

# PHYSICS

HL

PAPER 1

2017 — 2022



|            |                                               |          |
|------------|-----------------------------------------------|----------|
| Chapter 1  | <b>Measurements &amp; Uncertainties</b>       | Page 1   |
| Chapter 2  | <b>Mechanics</b>                              | Page 11  |
| Chapter 3  | <b>Thermal Physics</b>                        | Page 60  |
| Chapter 4  | <b>Oscillations &amp; Waves</b>               | Page 83  |
| Chapter 5  | <b>Electricity &amp; Magnetism</b>            | Page 128 |
| Chapter 6  | <b>Circular Motion &amp; Gravitation</b>      | Page 167 |
| Chapter 7  | <b>Atomic, Nuclear &amp; Particle Physics</b> | Page 181 |
| Chapter 8  | <b>Energy Production</b>                      | Page 209 |
| Chapter 9  | <b>Wave Phenomena</b>                         | Page 224 |
| Chapter 10 | <b>Fields</b>                                 | Page 246 |
| Chapter 11 | <b>Electromagnetic Induction</b>              | Page 269 |
| Chapter 12 | <b>Quantum &amp; Nuclear Physics</b>          | Page 308 |
|            | <b>ANSWERS</b>                                | Page 330 |



1 - (PHYSI/11\_HL\_Summer\_2017\_Q1) - *Measurements & Uncertainties*

What is the unit of electrical energy in fundamental SI units?

- A.  $\text{kg m}^2 \text{C}^{-1} \text{s}$
- B.  $\text{kg m s}^{-2}$
- C.  $\text{kg m}^2 \text{s}^{-2}$
- D.  $\text{kg m}^2 \text{s}^{-1} \text{A}$

2 - (PHYSI/12\_HL\_Summer\_2017\_Q1) - *Measurements & Uncertainties*

A stone falls from rest to the bottom of a water well of depth  $d$ . The time  $t$  taken to fall is  $2.0 \pm 0.2 \text{ s}$ .

The depth of the well is calculated to be 20 m using  $d = \frac{1}{2} a t^2$ . The uncertainty in  $a$  is negligible.

What is the absolute uncertainty in  $d$ ?

- A.  $\pm 0.2 \text{ m}$
- B.  $\pm 1 \text{ m}$
- C.  $\pm 2 \text{ m}$
- D.  $\pm 4 \text{ m}$

3 - (PHYSI/12\_HL\_Summer\_2017\_Q25) - *Measurements & Uncertainties*

Which of the following leads to a paradigm shift?

- A. Multi-loop circuits
- B. Standing waves
- C. Total internal reflection
- D. Atomic spectra

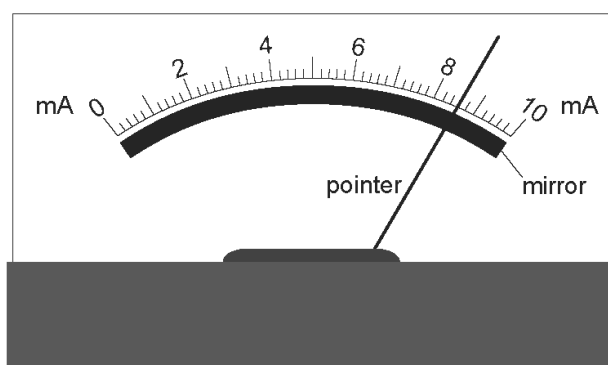
4 - (PHYSI/10\_HL\_Winter\_2017\_Q1) - *Measurements & Uncertainties*

What is a correct value for the charge on an electron?

- A.  $1.60 \times 10^{-12} \mu\text{C}$
- B.  $1.60 \times 10^{-15} \text{mC}$
- C.  $1.60 \times 10^{-22} \text{kC}$
- D.  $1.60 \times 10^{-24} \text{MC}$

5 - (PHYSI/10\_HL\_Winter\_2017\_Q2) - *Measurements & Uncertainties*

The diagram shows an analogue meter with a mirror behind the pointer.



What is the main purpose of the mirror?

- A. To provide extra light when reading the scale
- B. To reduce the risk of parallax error when reading the scale
- C. To enable the pointer to be seen from different angles
- D. To magnify the image of the pointer

6 - (PHYSI/11\_HL\_Summer\_2018\_Q1) - *Measurements & Uncertainties*A student measures the radius  $r$  of a sphere with an absolute uncertainty  $\Delta r$ . What is the fractional uncertainty in the volume of the sphere?

- A.  $\left(\frac{\Delta r}{r}\right)^3$
- B.  $3\frac{\Delta r}{r}$
- C.  $4\pi\frac{\Delta r}{r}$
- D.  $4\pi\left(\frac{\Delta r}{r}\right)^3$

7 - (PHYSI/12\_HL\_Summer\_2018\_Q1) - *Measurements & Uncertainties*

What is the best estimate for the diameter of a helium nucleus?

- A.  $10^{-21}$  m
- B.  $10^{-18}$  m
- C.  $10^{-15}$  m
- D.  $10^{-10}$  m

8 - (PHYSI/10\_HL\_Winter\_2018\_Q1) - *Measurements & Uncertainties*

The length of the side of a cube is  $2.0 \text{ cm} \pm 4\%$ . The mass of the cube is  $24.0 \text{ g} \pm 8\%$ . What is the percentage uncertainty of the density of the cube?

- A.  $\pm 2\%$
- B.  $\pm 8\%$
- C.  $\pm 12\%$
- D.  $\pm 20\%$

9 - (PHYSI/11\_HL\_Summer\_2019\_Q1) - *Measurements & Uncertainties*

A student is verifying the equation

$$x = \frac{2\lambda Y}{z}$$

The percentage uncertainties are:

| Quantity  | Uncertainty  |
|-----------|--------------|
| $\lambda$ | $\pm 10\%$   |
| $Y$       | $\pm 0.05\%$ |
| $z$       | $\pm 5\%$    |

What is the percentage uncertainty in  $x$ ?

- A. 5%
- B. 15%
- C. 25%
- D. 30%



10 - (PHYSI/11\_HL\_Summer\_2019\_Q2) - *Measurements & Uncertainties*

A student models the relationship between the pressure  $p$  of a gas and its temperature  $T$  as  $p = x + yT$ .

The units of  $p$  are pascal and the units of  $T$  are kelvin. What are the fundamental SI units of  $x$  and  $y$ ?

|    | $x$                              | $y$                                            |
|----|----------------------------------|------------------------------------------------|
| A. | $\text{kg m}^{-1} \text{s}^{-2}$ | $\text{kg m}^{-1} \text{s}^{-2} \text{K}^{-1}$ |
| B. | $\text{kg m}^{-1} \text{s}^{-2}$ | $\text{K}^{-1}$                                |
| C. | $\text{K}$                       | $\text{kg m}^{-1} \text{s}^{-2} \text{K}^{-1}$ |
| D. | $\text{K}$                       | $\text{K}^{-1}$                                |

11 - (PHYSI/12\_HL\_Summer\_2019\_Q1) - *Measurements & Uncertainties*

A student measures the radius  $R$  of a circular plate to determine its area. The absolute uncertainty in  $R$  is  $\Delta R$ .

What is the **fractional** uncertainty in the area of the plate?

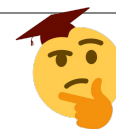
- A.  $\frac{2\Delta R}{R}$
- B.  $\left(\frac{\Delta R}{R}\right)^2$
- C.  $\frac{2\pi\Delta R}{R}$
- D.  $\pi\left(\frac{\Delta R}{R}\right)^2$

12 - (PHYSI/12\_HL\_Summer\_2019\_Q2) - *Measurements & Uncertainties*

A proton has momentum  $10^{-20} \text{ N s}$  and the uncertainty in the position of the proton is  $10^{-10} \text{ m}$ . What is the minimum **fractional** uncertainty in the momentum of this proton?

- A.  $5 \times 10^{-25}$
- B.  $5 \times 10^{-15}$
- C.  $5 \times 10^{-5}$
- D.  $2 \times 10^4$

13 - (PHYSI/10\_HL\_Winter\_2019\_Q1) - *Measurements & Uncertainties*



Which quantity has the fundamental SI units of  $\text{kg m}^{-1} \text{s}^{-2}$ ?

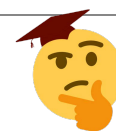
- A. Energy
- B. Force
- C. Momentum
- D. Pressure

14 - (PHYSI/10\_HL\_Winter\_2020\_Q1) - *Measurements & Uncertainties*

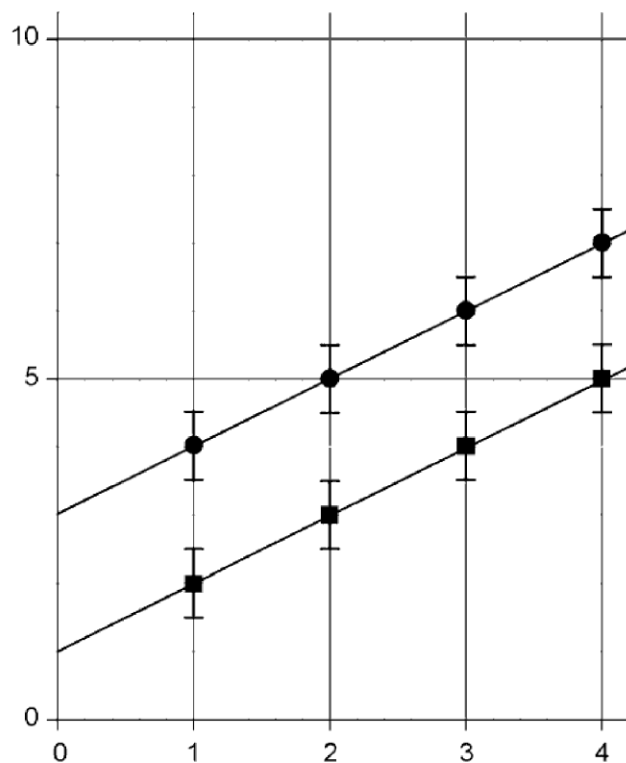
Which quantity has the same units as those for energy stored per unit volume?

- A. Density
- B. Force
- C. Momentum
- D. Pressure

## 15 - (PHYSI/11\_HL\_Summer\_2021\_Q1) - Measurements &amp; Uncertainties



Two sets of data, shown below with circles and squares, are obtained in two experiments. The size of the error bars is the same for all points.



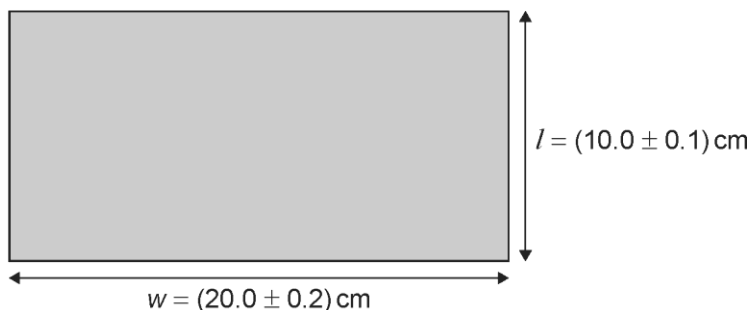
What is correct about the absolute uncertainty and the fractional uncertainty of the  $y$  intercept of the two lines of best fit?

|    | Absolute uncertainty | Fractional uncertainty |
|----|----------------------|------------------------|
| A. | larger for squares   | same                   |
| B. | larger for squares   | larger for squares     |
| C. | same                 | same                   |
| D. | same                 | larger for squares     |

16 - (PHYSI/12\_HL\_Summer\_2021\_Q1) - *Measurements & Uncertainties*

A student measures the length  $l$  and width  $w$  of a rectangular table top.

What is the absolute uncertainty of the perimeter of the table top?



- A. 0.3 cm
- B. 0.6 cm
- C. 1.2 cm
- D. 2.4 cm

17 - (PHYSI/10\_HL\_Winter\_2021\_Q1) - *Measurements & Uncertainties*

A ball of mass  $(50 \pm 1) \text{ g}$  is moving with a speed of  $(25 \pm 1) \text{ m s}^{-1}$ . What is the fractional uncertainty in the momentum of the ball?

- A. 0.02
- B. 0.04
- C. 0.06
- D. 0.08

18 - (PHYSI/11\_HL\_Summer\_2022\_Q1) - *Measurements & Uncertainties*

The intensity of a wave can be defined as the energy per unit area per unit time. What is the unit of intensity expressed in fundamental SI units?

- A.  $\text{kg m}^2 \text{ s}^{-1}$
- B.  $\text{kg m}^2 \text{ s}^{-3}$
- C.  $\text{kg s}^{-2}$
- D.  $\text{kg s}^{-3}$

**19** - (PHYSI/11\_HL\_Summer\_2022\_Q2) - *Measurements & Uncertainties*

The magnitude of the resultant of two forces acting on a body is 12 N. Which pair of forces acting on the body can combine to produce this resultant?

- A. 1 N and 2 N
- B. 1 N and 14 N
- C. 5 N and 6 N
- D. 6 N and 7 N

**20** - (PHYSI/11\_HL\_Summer\_2022\_Q3) - *Measurements & Uncertainties*

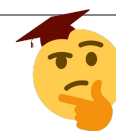
The uncertainty in reading a laboratory thermometer is  $0.5^{\circ}\text{C}$ . The temperature of a liquid falls from  $20^{\circ}\text{C}$  to  $10^{\circ}\text{C}$  as measured by the thermometer. What is the percentage uncertainty in the change in temperature?

- A. 2.5 %
- B. 5 %
- C. 7.5 %
- D. 10 %

**21** - (PHYSI/12\_HL\_Summer\_2022\_Q1) - *Measurements & Uncertainties*

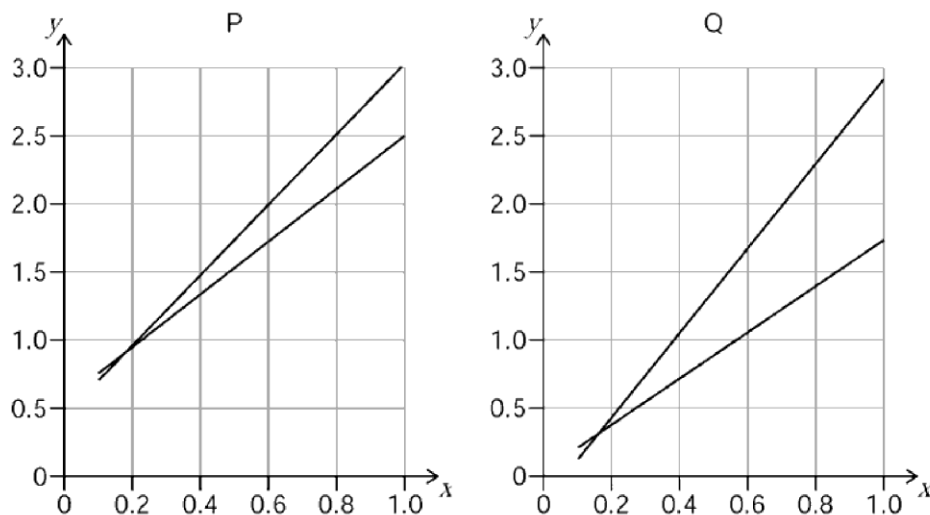
The radius of a circle is measured to be  $(10.0 \pm 0.5)\text{ cm}$ . What is the area of the circle?

- A.  $(314.2 \pm 0.3)\text{ cm}^2$
- B.  $(314 \pm 1)\text{ cm}^2$
- C.  $(314 \pm 15)\text{ cm}^2$
- D.  $(314 \pm 31)\text{ cm}^2$



## 22 – (PHYSI/12\_HL\_Summer\_2022\_Q2) – Measurements &amp; Uncertainties

Two different experiments, P and Q, generate two sets of data to confirm the proportionality of variables  $x$  and  $y$ . The graphs for the data from P and Q are shown. The maximum and minimum gradient lines are shown for both sets of data.



What is true about the systematic error and the uncertainty of the gradient when P is compared to Q?

|    | Systematic error | Uncertainty of the gradient |
|----|------------------|-----------------------------|
| A. | larger for set P | larger for set P            |
| B. | larger for set Q | larger for set P            |
| C. | larger for set P | larger for set Q            |
| D. | larger for set Q | larger for set Q            |

## 23 – (PHYSI/10\_HL\_Winter\_2022\_Q1) – Measurements &amp; Uncertainties

What is the definition of the SI unit for a force?

- A. The force required to accelerate, in the direction of the force, a mass of  $1\text{ kg}$  at  $1\text{ m s}^{-2}$
- B. The force required to accelerate, in the direction of the force, a mass at  $1\text{ m s}^{-2}$
- C. The weight of a mass of  $0.1\text{ kg}$
- D. The change in momentum per second

24 - (PHYSI/10\_HL\_Winter\_2022\_Q2) - *Measurements & Uncertainties*



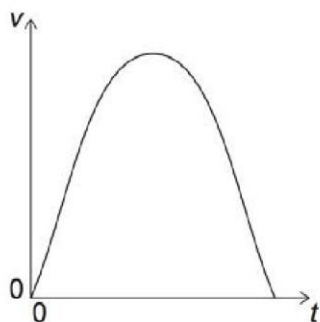
A rectangular sheet of paper has dimensions of  $(30.0 \pm 0.5)$  cm and  $(20.0 \pm 0.5)$  cm.

What is the percentage uncertainty of the perimeter of the paper?

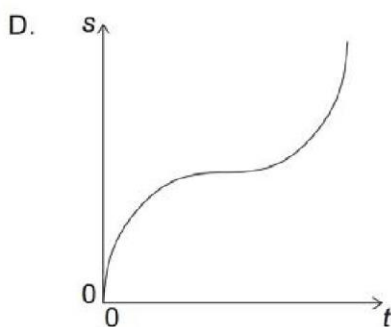
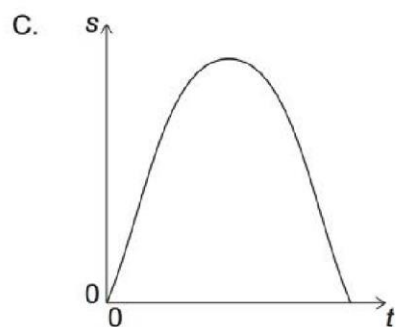
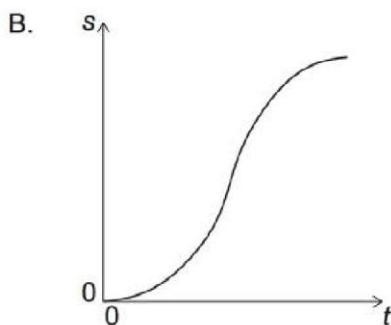
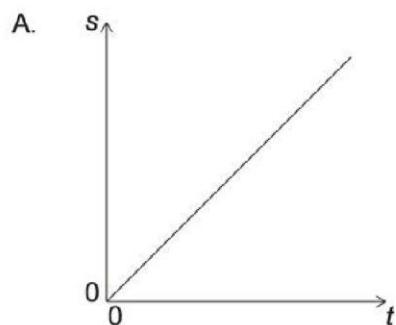
- A. 1 %
- B. 2 %
- C. 2.5 %
- D. 4 %

1 - (PHYSI/11\_HL\_Summer\_2017\_Q2) - *Mechanics*

The graph shows the variation of speed  $v$  of an object with time  $t$ .



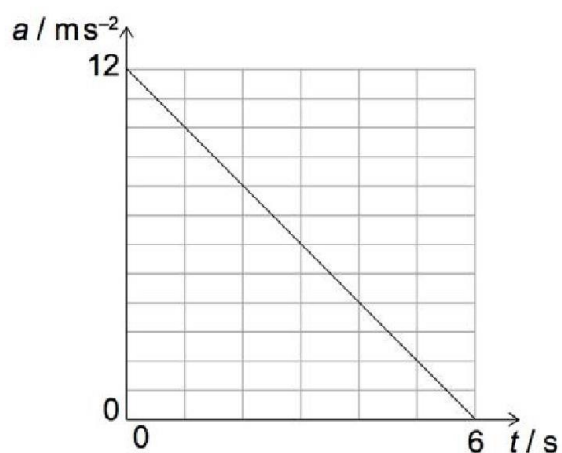
Which graph shows how the distance  $s$  travelled by the object varies with  $t$ ?





2 – (PHYSI/11\_HL\_Summer\_2017\_Q3) – *Mechanics*

The graph shows the variation of the acceleration  $a$  of an object with time  $t$ .



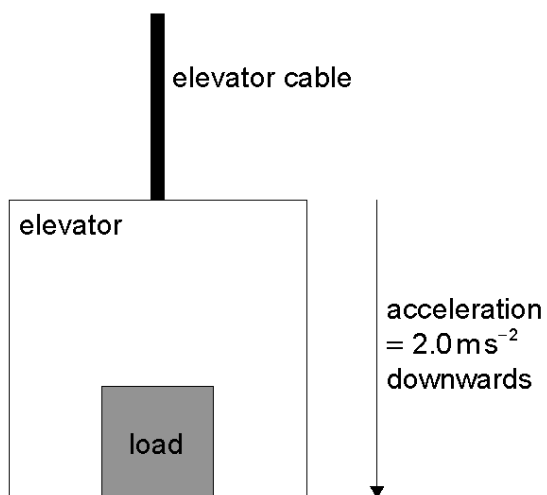
What is the change in speed of the object shown by the graph?

- A.  $0.5\text{ms}^{-1}$
- B.  $2.0\text{ms}^{-1}$
- C.  $36\text{ms}^{-1}$
- D.  $72\text{ms}^{-1}$

3 - (PHYSI/11\_HL\_Summer\_2017\_Q4) - *Mechanics*

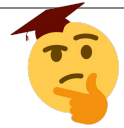


An elevator (lift) and its load have a total mass of 750 kg and accelerate vertically downwards at  $2.0 \text{ ms}^{-2}$ .

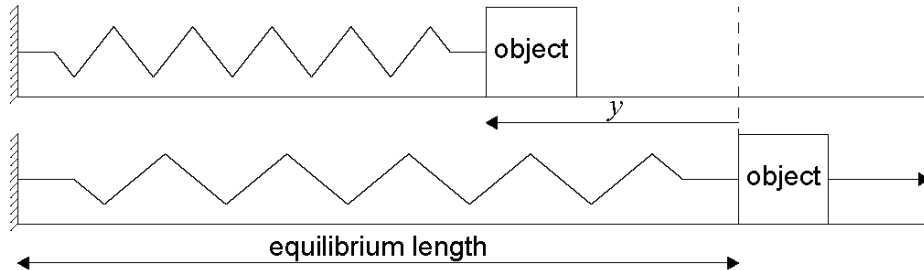


What is the tension in the elevator cable?

- A. 1.5 kN
- B. 6.0 kN
- C. 7.5 kN
- D. 9.0 kN

4 - (PHYSI/11\_HL\_Summer\_2017\_Q5) - *Mechanics*

A horizontal spring of spring constant  $k$  and negligible mass is compressed through a distance  $y$  from its equilibrium length. An object of mass  $m$  that moves on a frictionless surface is placed at the end of the spring. The spring is released and returns to its equilibrium length.



What is the speed of the object just after it leaves the spring?

- A.  $y\sqrt{\frac{k}{m}}$
- B.  $y\sqrt{\frac{m}{k}}$
- C.  $y\frac{k}{m}$
- D.  $y\frac{m}{k}$

5 - (PHYSI/11\_HL\_Summer\_2017\_Q6) - *Mechanics*

A car travelling at a constant velocity covers a distance of 100 m in 5.0 s. The thrust of the engine is 1.5 kN.

What is the power of the car?

- A. 0.75 kW
- B. 3.0 kW
- C. 7.5 kW
- D. 30 kW

6 - (PHYSI/11\_HL\_Summer\_2017\_Q7) - *Mechanics*

A cyclist accelerates in a straight line. At one instant, when the cyclist is exerting a forward force of 40 N, the air resistance acting on the cyclist is 10 N.

What is the rate of change of momentum of the cyclist at this instant?

- A.  $10\text{ kg ms}^{-2}$
- B.  $30\text{ kg ms}^{-2}$
- C.  $40\text{ kg ms}^{-2}$
- D.  $50\text{ kg ms}^{-2}$

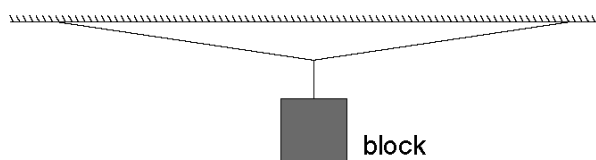
7 - (PHYSI/12\_HL\_Summer\_2017\_Q2) - *Mechanics*

A projectile is fired horizontally from the top of a cliff. The projectile hits the ground 4 s later at a distance of 2 km from the base of the cliff. What is the height of the cliff?

- A. 40 m
- B. 80 m
- C. 120 m
- D. 160 m

8 - (PHYSI/12\_HL\_Summer\_2017\_Q3) - *Mechanics*

A block of weight  $W$  is suspended by two strings of equal length. The strings are almost horizontal.

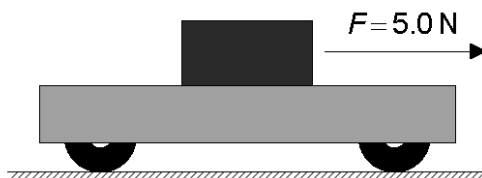


What is correct about the tension  $T$  in one string?

- A.  $T < \frac{W}{2}$
- B.  $T = \frac{W}{2}$
- C.  $\frac{W}{2} < T \leq W$
- D.  $T > W$

9 - (PHYSI/12\_HL\_Summer\_2017\_Q4) - *Mechanics*

A block of mass  $1.0\text{ kg}$  rests on a trolley of mass  $4.0\text{ kg}$ . The coefficient of dynamic friction between the block and the trolley is  $0.30$ .



A horizontal force  $F = 5.0\text{ N}$  acts on the block. The block slides over the trolley. What is the acceleration of the trolley?

- A.  $5.0\text{ ms}^{-2}$
- B.  $1.0\text{ ms}^{-2}$
- C.  $0.75\text{ ms}^{-2}$
- D.  $0.60\text{ ms}^{-2}$

10 - (PHYSI/12\_HL\_Summer\_2017\_Q5) - *Mechanics*

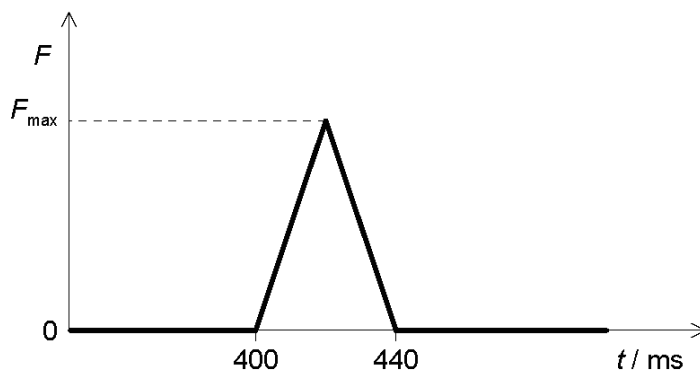
A tennis ball is released from rest at a height  $h$  above the ground. At each bounce  $50\%$  of its kinetic energy is lost to its surroundings. What is the height reached by the ball after its second bounce?

- A.  $\frac{h}{8}$
- B.  $\frac{h}{4}$
- C.  $\frac{h}{2}$
- D. zero

## 11 – (PHYSI/12\_HL\_Summer\_2017\_Q6) – Mechanics



A ball of mass  $0.2\text{ kg}$  strikes a force sensor and sticks to it. Just before impact the ball is travelling horizontally at a speed of  $4.0\text{ ms}^{-1}$ . The graph shows the variation with time  $t$  of the force  $F$  recorded by the sensor.



What is  $F_{\text{max}}$ ?

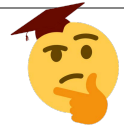
- A.  $2\text{ N}$
- B.  $4\text{ N}$
- C.  $20\text{ N}$
- D.  $40\text{ N}$

## 12 – (PHYSI/12\_HL\_Summer\_2017\_Q7) – Mechanics, Atomic, nuclear &amp; Particle Physics

A stationary nucleus of polonium-210 undergoes alpha decay to form lead-206. The initial speed of the alpha particle is  $v$ . What is the speed of the lead-206 nucleus?

- A.  $\frac{206}{4}v$
- B.  $v$
- C.  $\frac{206}{210}v$
- D.  $\frac{4}{206}v$

## 13 - (PHYSI/10\_HL\_Winter\_2017\_Q3) - Mechanics

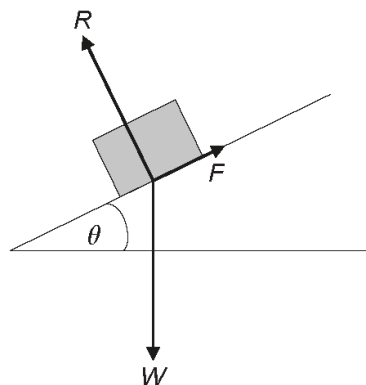


An object is released from a stationary hot air balloon at height  $h$  above the ground. An identical object is released at height  $h$  above the ground from another balloon that is rising at constant speed. Air resistance is negligible. What does **not** increase for the object released from the rising balloon?

- A. The distance through which it falls
- B. The time taken for it to reach the ground
- C. The speed with which it reaches the ground
- D. Its acceleration

## 14 - (PHYSI/10\_HL\_Winter\_2017\_Q4) - Mechanics

The diagram shows the forces acting on a block resting on an inclined plane. The angle  $\theta$  is adjusted until the block is just at the point of sliding.  $R$  is the normal reaction,  $W$  the weight of the block and  $F$  the maximum frictional force.



not to scale

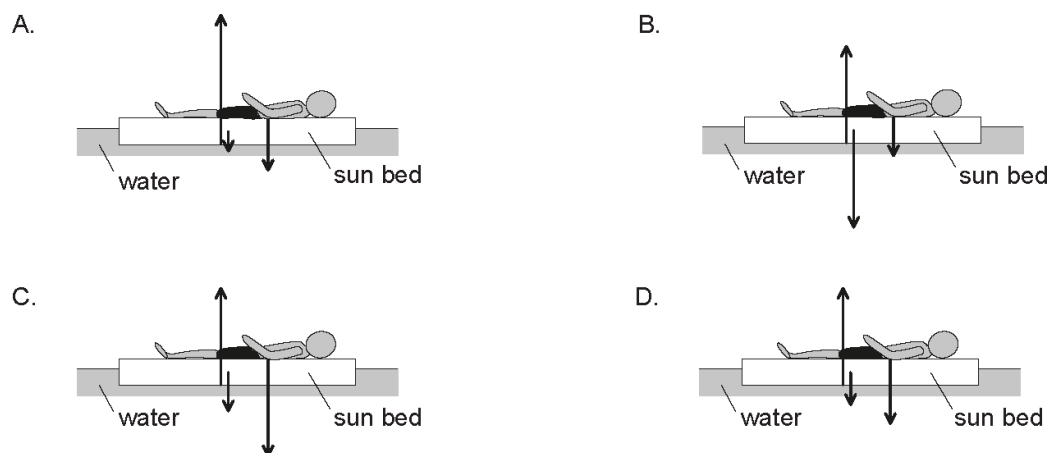
What is the maximum coefficient of static friction between the block and the plane?

- A.  $\sin \theta$
- B.  $\cos \theta$
- C.  $\tan \theta$
- D.  $\frac{1}{\tan \theta}$

## 15 - (PHYSI/10\_HL\_Winter\_2017\_Q5) - Mechanics

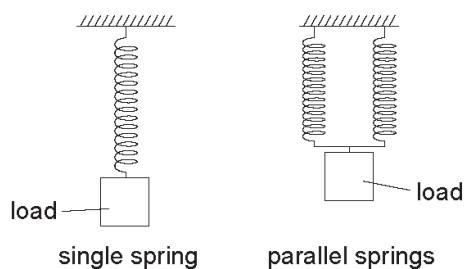


A sunbather is supported in water by a floating sun bed. Which diagram represents the magnitudes of the forces acting on the sun bed?



## 16 - (PHYSI/10\_HL\_Winter\_2017\_Q6) - Mechanics

A system that consists of a single spring stores a total elastic potential energy  $E_p$  when a load is added to the spring. Another identical spring connected in parallel is added to the system. The same load is now applied to the parallel springs.



What is the total elastic potential energy stored in the changed system?

- A.  $E_p$
- B.  $\frac{E_p}{2}$
- C.  $\frac{E_p}{4}$
- D.  $\frac{E_p}{8}$



17 - (PHYSI/10\_HL\_Winter\_2017\_Q7) - Mechanics



A toy car of mass  $0.15 \text{ kg}$  accelerates from a speed of  $10 \text{ cm s}^{-1}$  to a speed of  $15 \text{ cm s}^{-1}$ . What is the impulse acting on the car?

- A.  $7.5 \text{ mN s}$
- B.  $37.5 \text{ mN s}$
- C.  $0.75 \text{ N s}$
- D.  $3.75 \text{ N s}$

18 - (PHYSI/11\_HL\_Summer\_2018\_Q2) - Mechanics

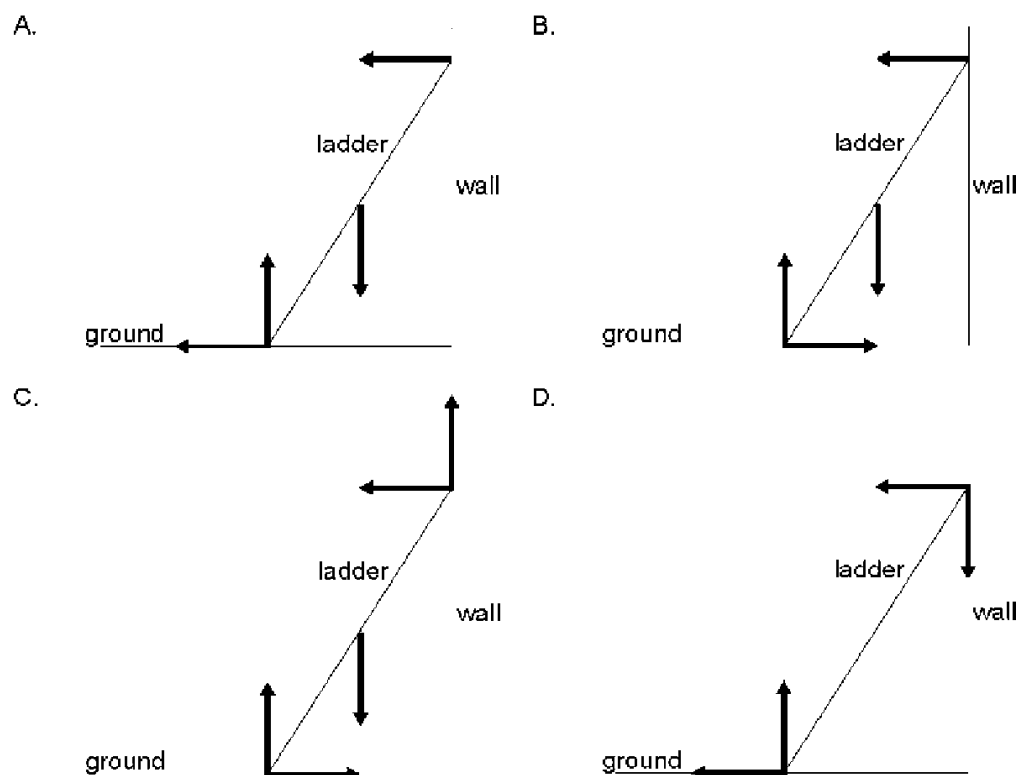
An object is projected vertically upwards at time  $t = 0$ . Air resistance is negligible. The object passes the same point above its starting position at times  $2 \text{ s}$  and  $8 \text{ s}$ .

If  $g = 10 \text{ ms}^{-2}$ , what is the initial speed of the object?

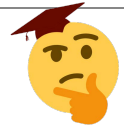
- A. 50
- B. 30
- C. 25
- D. 4

19 - (PHYSI/11\_HL\_Summer\_2018\_Q3) - Mechanics

A uniform ladder resting in equilibrium on rough ground leans against a smooth wall. Which diagram correctly shows the forces acting on the ladder?



20 – (PHYSI/11\_HL\_Summer\_2018\_Q4) – Mechanics



An object falls from rest from a height  $h$  close to the surface of the Moon. The Moon has no atmosphere.

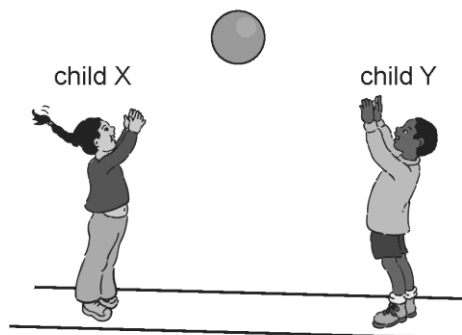
When the object has fallen to height  $\frac{h}{4}$  above the surface, what is

$\frac{\text{kinetic energy of the object at } \frac{h}{4}}{\text{gravitational potential energy of the object at } h}$  ?

- A.  $\frac{3}{4}$
- B.  $\frac{4}{3}$
- C.  $\frac{9}{16}$
- D.  $\frac{16}{9}$

21 – (PHYSI/11\_HL\_Summer\_2018\_Q5) – Mechanics

Child X throws a ball to child Y. The system consists of the ball, the children and the Earth. What is true for the system when the ball has been caught by Y?



[Source: <https://pixabay.com/en/playing-ball-kids-boy-girl-31339/>]

- A. The momentum of child Y is equal and opposite to the momentum of child X.
- B. The speed of rotation of the Earth will have changed.
- C. The ball has no net momentum while it is in the air.
- D. The total momentum of the system has not changed.

22 – (PHYSI/11\_HL\_Summer\_2018\_Q6) – *Mechanics*

A parachutist of total mass 70 kg is falling vertically through the air at a constant speed of  $8 \text{ m s}^{-1}$ . What is the total upward force acting on the parachutist?

- A. 0 N
- B. 70 N
- C. 560 N
- D. 700 N

23 – (PHYSI/11\_HL\_Summer\_2018\_Q7) – *Mechanics*

A stopper of mass 8 g leaves the opening of a container that contains pressurized gas.

The stopper accelerates from rest for a time of 16 ms and leaves the container at a speed of  $20 \text{ m s}^{-1}$ .

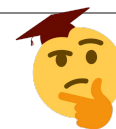
What is the order of magnitude of the force acting on the stopper?

- A.  $10^{-3} \text{ N}$
- B.  $10^0 \text{ N}$
- C.  $10^1 \text{ N}$
- D.  $10^3 \text{ N}$

24 – (PHYSI/11\_HL\_Summer\_2018\_Q26) – *Mechanics, Oscillations & Waves*

A mass at the end of a vertical spring and a simple pendulum perform oscillations on Earth that are simple harmonic with time period  $T$ . Both the pendulum and the mass-spring system are taken to the Moon. The acceleration of free fall on the Moon is smaller than that on Earth. What is correct about the time periods of the pendulum and the mass-spring system on the Moon?

|    | Simple pendulum  | Mass-spring system |
|----|------------------|--------------------|
| A. | $T$              | $T$                |
| B. | greater than $T$ | $T$                |
| C. | greater than $T$ | greater than $T$   |
| D. | $T$              | greater than $T$   |

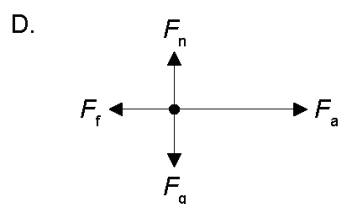
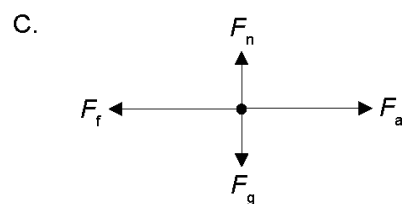
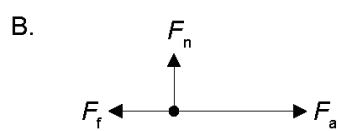
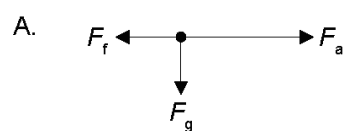
25 – (PHYSI/12\_HL\_Summer\_2018\_Q2) – *Mechanics*

A motor of input power 160 W raises a mass of 8.0 kg vertically at a constant speed of  $0.50 \text{ m s}^{-1}$ . What is the efficiency of the system?

- A. 0.63 %
- B. 25 %
- C. 50 %
- D. 100 %

26 – (PHYSI/12\_HL\_Summer\_2018\_Q3) – *Mechanics*

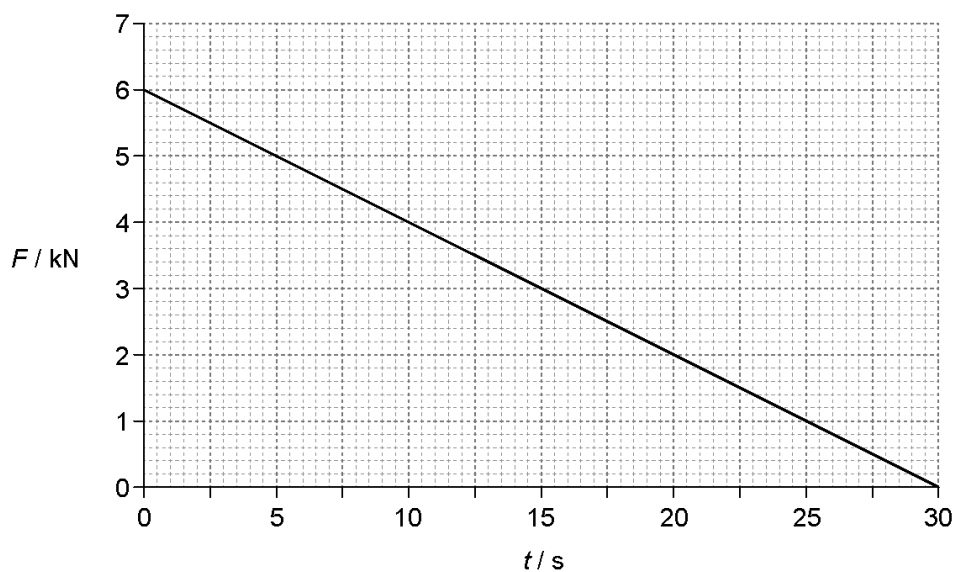
A box is accelerated to the right across rough ground by a horizontal force  $F_a$ . The force of friction is  $F_f$ . The weight of the box is  $F_g$  and the normal reaction is  $F_n$ . Which is the free-body diagram for this situation?



27 – (PHYSI/12\_HL\_Summer\_2018\_Q4) – Mechanics



The graph shows the variation with time  $t$  of the force  $F$  acting on an object of mass 15 000 kg. The object is at rest at  $t=0$ .

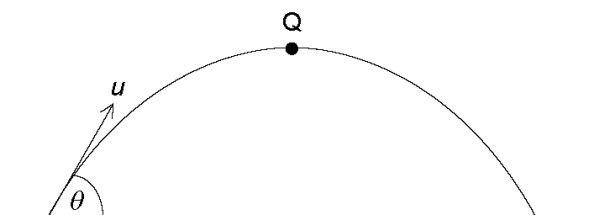


What is the speed of the object when  $t=30$  s?

- A.  $0.18 \text{ m s}^{-1}$
- B.  $6 \text{ m s}^{-1}$
- C.  $12 \text{ m s}^{-1}$
- D.  $180 \text{ m s}^{-1}$

28 – (PHYSI/12\_HL\_Summer\_2018\_Q5) – Mechanics

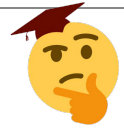
A ball of mass  $m$  is thrown with an initial speed of  $u$  at an angle  $\theta$  to the horizontal as shown. Q is the highest point of the motion. Air resistance is negligible.



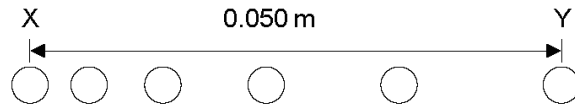
What is the momentum of the ball at Q?

- A. zero
- B.  $mu \cos \theta$
- C.  $mu$
- D.  $mu \sin \theta$

29 – (PHYSI/12\_HL\_Summer\_2018\_Q6) – Mechanics



A ball starts from rest and moves horizontally. Six positions of the ball are shown at time intervals of 1.0 ms. The horizontal distance between X, the initial position, and Y, the final position, is 0.050 m.

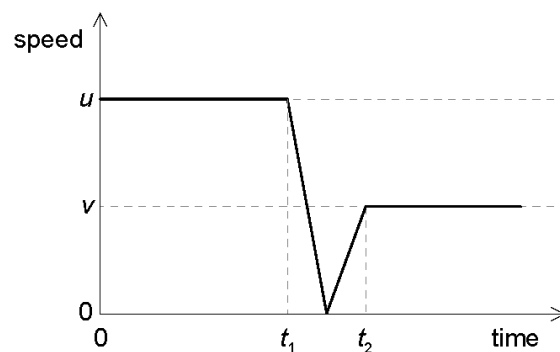


What is the average acceleration of the ball between X and Y?

- A.  $2000 \text{ m s}^{-2}$
- B.  $4000 \text{ m s}^{-2}$
- C.  $5000 \text{ m s}^{-2}$
- D.  $8000 \text{ m s}^{-2}$

30 – (PHYSI/12\_HL\_Summer\_2018\_Q7) – Mechanics

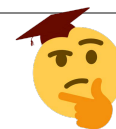
A ball of mass  $m$  collides with a vertical wall with an initial horizontal speed  $u$  and rebounds with a horizontal speed  $v$ . The graph shows the variation of the speed of the ball with time.



What is the magnitude of the mean net force on the ball during the collision?

- A.  $\frac{m(u-v)}{(t_2+t_1)}$
- B.  $\frac{m(u-v)}{(t_2-t_1)}$
- C.  $\frac{m(u+v)}{(t_2+t_1)}$
- D.  $\frac{m(u+v)}{(t_2-t_1)}$

31 - (PHYSI/10\_HL\_Winter\_2018\_Q2) - Mechanics

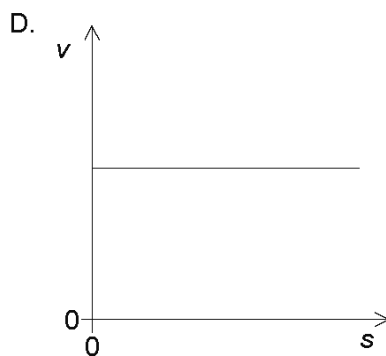
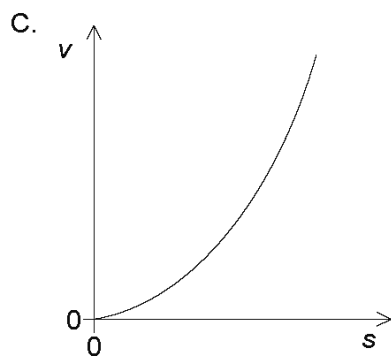
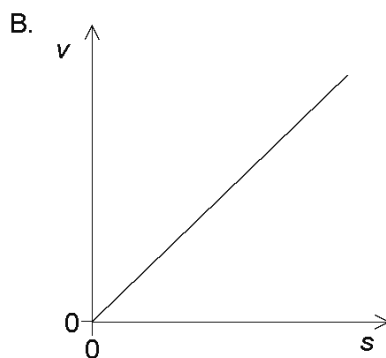
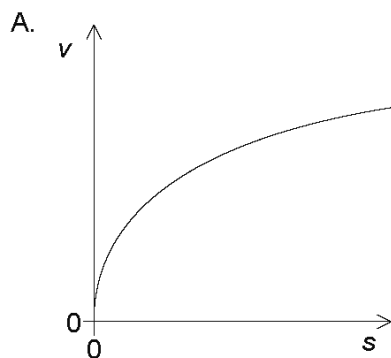


A truck has an initial speed of  $20 \text{ m s}^{-1}$ . It decelerates at  $4.0 \text{ m s}^{-2}$ . What is the distance taken by the truck to stop?

- A. 2.5 m
- B. 5.0 m
- C. 50 m
- D. 100 m

32 - (PHYSI/10\_HL\_Winter\_2018\_Q3) - Mechanics

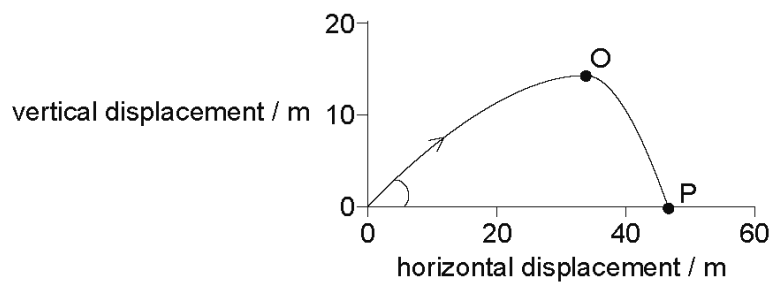
A runner starts from rest and accelerates at a constant rate throughout a race. Which graph shows the variation of speed  $v$  of the runner with distance travelled  $s$ ?



33 – (PHYSI/10\_HL\_Winter\_2018\_Q4) – Mechanics



A projectile is fired at an angle to the horizontal. The path of the projectile is shown.



Which gives the magnitude of the horizontal component and the magnitude of the vertical component of the velocity of the projectile between O and P?

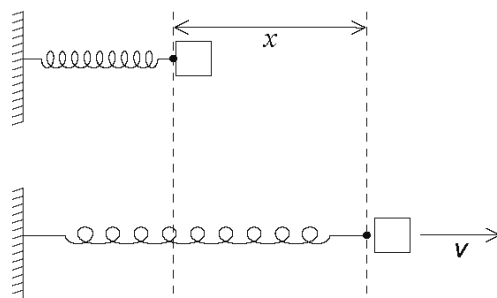
|    | Magnitude of horizontal component of velocity | Magnitude of vertical component of velocity |
|----|-----------------------------------------------|---------------------------------------------|
| A. | decreases                                     | increases                                   |
| B. | decreases                                     | constant                                    |
| C. | constant                                      | increases                                   |
| D. | constant                                      | constant                                    |



34 - (PHYSI/10\_HL\_Winter\_2018\_Q6) - Mechanics



A compressed spring is used to launch an object along a horizontal frictionless surface. When the spring is compressed through a distance  $x$  and released, the object leaves the spring at speed  $v$ . What is the distance through which the spring must be compressed for the object to leave the spring at  $\frac{v}{2}$ ?

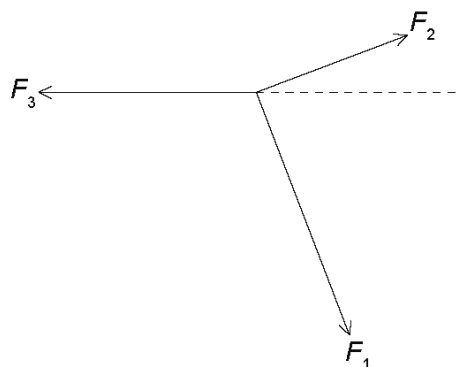


- A.  $\frac{x}{4}$
- B.  $\frac{x}{2}$
- C.  $\frac{x}{\sqrt{2}}$
- D.  $x\sqrt{2}$

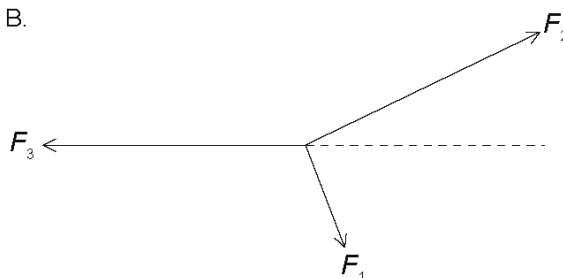
35 – (PHYSI/10\_HL\_Winter\_2018\_Q7) – *Mechanics*

Three forces act at a point. In which diagram is the point in equilibrium?

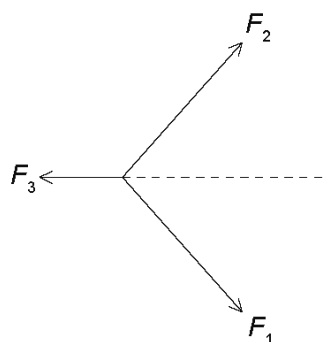
A.



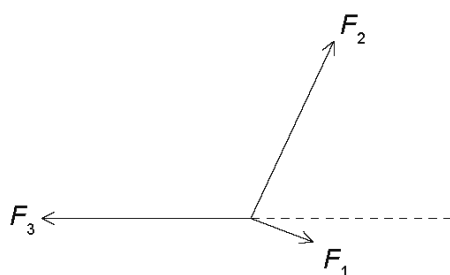
B.



C.



D.

36 – (PHYSI/11\_HL\_Summer\_2019\_Q3) – *Mechanics*

A sky diver is falling at terminal speed when she opens her parachute. What are the direction of her velocity vector and the direction of her acceleration vector before she reaches the new terminal speed?

|    | Direction of velocity vector | Direction of acceleration vector |
|----|------------------------------|----------------------------------|
| A. | upwards                      | upwards                          |
| B. | upwards                      | downwards                        |
| C. | downwards                    | upwards                          |
| D. | downwards                    | downwards                        |

37 – (PHYSI/11\_HL\_Summer\_2019\_Q4) – Mechanics



A sports car is accelerated from 0 to 100 km per hour in 3 s. What is the acceleration of the car?

- A.  $0.1g$
- B.  $0.3g$
- C.  $0.9g$
- D.  $3g$

38 – (PHYSI/11\_HL\_Summer\_2019\_Q5) – Mechanics

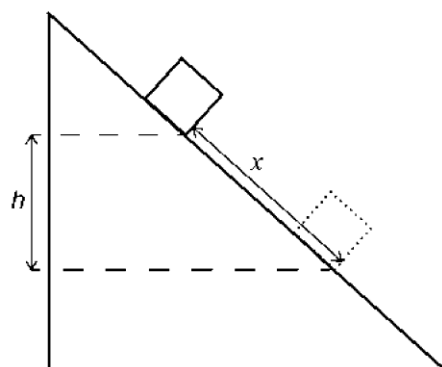
A girl throws an object horizontally at time  $t = 0$ . Air resistance can be ignored. At  $t = 0.50$  s the object travels horizontally a distance  $x$  in metres while it falls vertically through a distance  $y$  in metres.

What is the initial velocity of the object and the vertical distance fallen at  $t = 1.0$  s?

|    | Initial velocity / $\text{ms}^{-1}$ | Vertical distance fallen / m |
|----|-------------------------------------|------------------------------|
| A. | $x$                                 | $2y$                         |
| B. | $x$                                 | $4y$                         |
| C. | $2x$                                | $2y$                         |
| D. | $2x$                                | $4y$                         |

39 – (PHYSI/11\_HL\_Summer\_2019\_Q6) – Mechanics

An object of mass  $m$  is sliding down a ramp at constant speed. During the motion it travels a distance  $x$  along the ramp and falls through a vertical distance  $h$ . The coefficient of dynamic friction between the ramp and the object is  $\mu$ . What is the total energy transferred into thermal energy when the object travels distance  $x$ ?



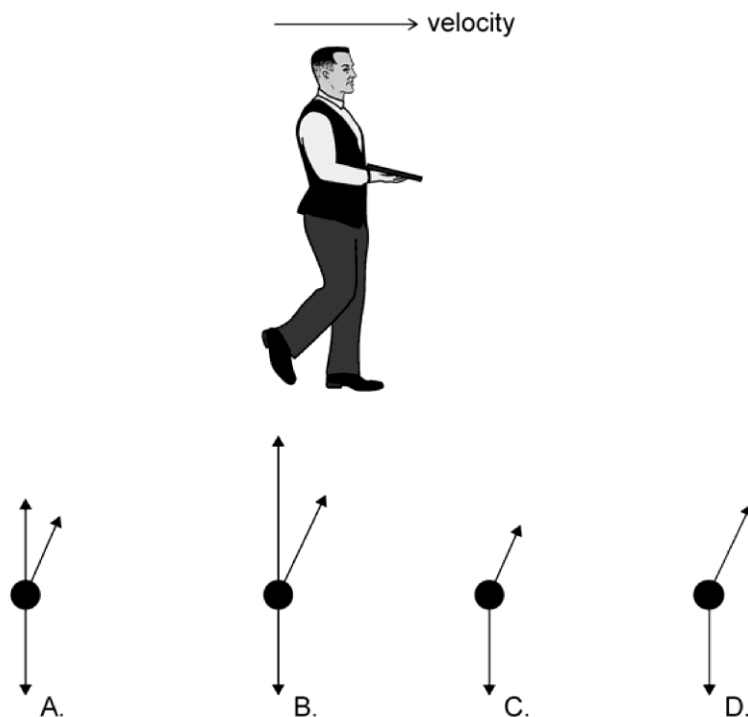
- A.  $mgh$
- B.  $mgx$
- C.  $\mu mgh$
- D.  $\mu mgx$

40 – (PHYSI/11\_HL\_Summer\_2019\_Q7) – Mechanics



A waiter carrying a tray is accelerating to the right as shown in the image.

What is the free-body diagram of the forces acting on the tray?



41 – (PHYSI/12\_HL\_Summer\_2019\_Q3) – Mechanics

A boy throws a ball horizontally at a speed of  $15 \text{ m s}^{-1}$  from the top of a cliff that is 80m above the surface of the sea. Air resistance is negligible.

What is the distance from the bottom of the cliff to the point where the ball lands in the sea?

- A. 45 m
- B. 60 m
- C. 80 m
- D. 240 m

42 – (PHYSI/12\_HL\_Summer\_2019\_Q4) – *Mechanics*

A book is at rest on a table. What is a pair of action–reaction forces for this situation according to Newton's third law of motion?

|    | Force 1                             | Force 2                            |
|----|-------------------------------------|------------------------------------|
| A. | the force of the book on the table  | the force of the book on the Earth |
| B. | the force of the table on the Earth | the force of the book on the table |
| C. | the force of the Earth on the book  | the force of the book on the Earth |
| D. | the force of the Earth on the book  | the force of the table on the book |

43 – (PHYSI/12\_HL\_Summer\_2019\_Q5) – *Mechanics*

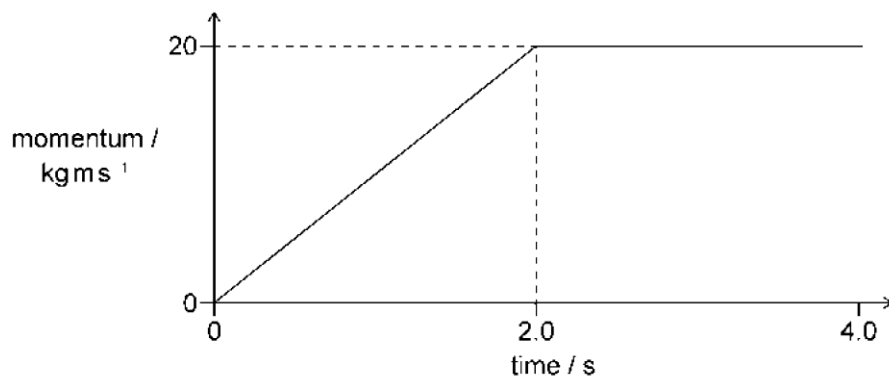
An object has a weight of  $6.10 \times 10^2 \text{ N}$ . What is the change in gravitational potential energy of the object when it moves through 8.0 m vertically?

- A. 5 kJ
- B. 4.9 kJ
- C. 4.88 kJ
- D. 4.880 kJ

## 44 – (PHYSI/12\_HL\_Summer\_2019\_Q6) – Mechanics



The graph shows the variation of momentum with time for an object.



What net force acts on the object for the first 2.0 s and for the second 2.0 s of the motion?

|    | Force for first 2.0 s / N | Force for second 2.0 s / N |
|----|---------------------------|----------------------------|
| A. | 10                        | 0                          |
| B. | 20                        | 40                         |
| C. | 10                        | 40                         |
| D. | 20                        | 0                          |

## 45 – (PHYSI/12\_HL\_Summer\_2019\_Q7) – Mechanics

A table-tennis ball of mass 3 g is fired with a speed of  $10 \text{ m s}^{-1}$  from a stationary toy gun of mass 0.600 kg. The gun and ball are an isolated system.

What are the recoil speed of the toy gun and the total momentum of the system immediately after the gun is fired?

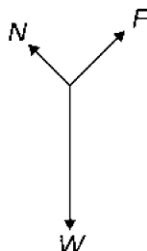
|    | Recoil speed of the toy gun / $\text{m s}^{-1}$ | Total momentum of the system / $\text{kg m s}^{-1}$ |
|----|-------------------------------------------------|-----------------------------------------------------|
| A. | 0.05                                            | 0                                                   |
| B. | 0.05                                            | 0.03                                                |
| C. | 0.5                                             | 0                                                   |
| D. | 0.5                                             | 0.03                                                |

46 – (PHYSI/12\_HL\_Summer\_2019\_Q8) – Mechanics

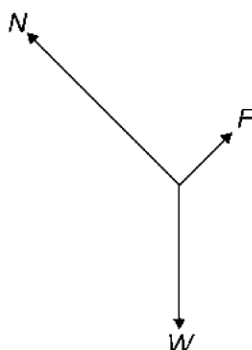


A block of weight  $W$  slides down a ramp at constant velocity. A friction force  $F$  acts between the bottom of the block and the surface of the ramp. A normal reaction  $N$  acts between the ramp and the block. What is the free-body diagram for the forces that act on the block?

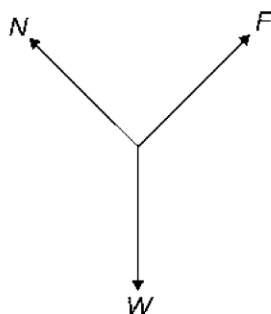
A.



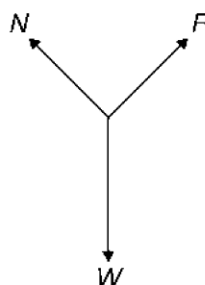
B.



C.



D.



47 – (PHYSI/12\_HL\_Summer\_2019\_Q10) – Mechanics, Circular Motion &amp; Gravitation

Satellite X is in orbit around the Earth. An identical satellite Y is in a higher orbit. What is correct for the total energy and the kinetic energy of the satellite Y compared with satellite X?

|    | Total energy of satellite X | Kinetic energy of satellite X |
|----|-----------------------------|-------------------------------|
| A. | larger                      | larger                        |
| B. | smaller                     | larger                        |
| C. | larger                      | smaller                       |
| D. | smaller                     | smaller                       |

48 – (PHYSI/10\_HL\_Winter\_2019\_Q2) – *Mechanics*

Two forces act along a straight line on an object that is initially at rest. One force is constant; the second force is in the opposite direction and proportional to the velocity of the object.



What is correct about the motion of the object?

- A. The acceleration increases from zero to a maximum.
- B. The acceleration increases from zero to a maximum and then decreases.
- C. The velocity increases from zero to a maximum.
- D. The velocity increases from zero to a maximum and then decreases.

49 – (PHYSI/10\_HL\_Winter\_2019\_Q3) – *Mechanics*

A ball falls from rest in the absence of air resistance. The position of the centre of the ball is determined at one-second intervals from the instant at which it is released. What are the distances, in metres, travelled by the centre of the ball during **each** second for the first 4.0 s of the motion?

- A. 5, 10, 15, 20
- B. 5, 15, 25, 35
- C. 5, 20, 45, 80
- D. 5, 25, 70, 150

50 – (PHYSI/10\_HL\_Winter\_2019\_Q4) – *Mechanics*

An object is thrown from a cliff at an angle to the horizontal. The ground below the cliff is horizontal.

Three quantities are known about this motion.

- I. The horizontal component of the initial velocity of the object
- II. The initial angle between the velocity of the object and the horizontal
- III. The height of the cliff

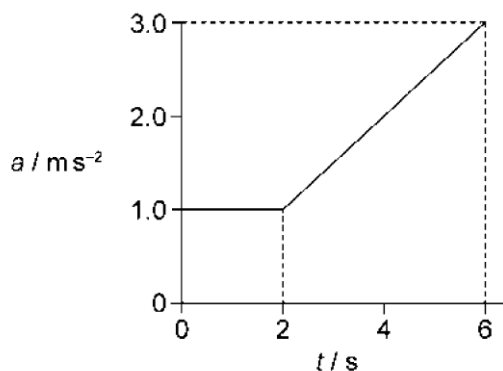
What are the quantities that must be known in order to determine the horizontal distance from the point of projection to the point at which the object hits the ground?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III



51 – (PHYSI/10\_HL\_Winter\_2019\_Q5) – *Mechanics*

The variation with time  $t$  of the acceleration  $a$  of an object is shown.



What is the change in velocity of the object from  $t = 0$  to  $t = 6 \text{ s}$ ?

- A.  $6 \text{ ms}^{-1}$
- B.  $8 \text{ ms}^{-1}$
- C.  $10 \text{ ms}^{-1}$
- D.  $14 \text{ ms}^{-1}$

52 – (PHYSI/10\_HL\_Winter\_2019\_Q6) – *Mechanics*

A nuclear particle has an energy of  $10^8 \text{ eV}$ . A grain of sand has a mass of  $32 \text{ mg}$ . What speed must the grain of sand have for its kinetic energy to equal the energy of the nuclear particle?

- A.  $1 \text{ mm s}^{-1}$
- B.  $3 \text{ mm s}^{-1}$
- C.  $10 \text{ mm s}^{-1}$
- D.  $16 \text{ mm s}^{-1}$

53 – (PHYSI/10\_HL\_Winter\_2019\_Q7) – *Mechanics*

The tension in a horizontal spring is directly proportional to the extension of the spring. The energy stored in the spring at extension  $x$  is  $E$ . What is the work done by the spring when its extension changes from  $x$  to  $\frac{x}{4}$ ?

- A.  $\frac{E}{16}$
- B.  $\frac{E}{4}$
- C.  $\frac{3E}{4}$
- D.  $\frac{15E}{16}$

54 – (PHYSI/10\_HL\_Winter\_2019\_Q22) – *Mechanics*

The equations of motion for uniform acceleration

- A. apply to all accelerations.
- B. cannot be proved mathematically.
- C. relate force to other quantities in mechanics.
- D. were developed through observing the natural world.

55 – (PHYSI/10\_HL\_Winter\_2020\_Q2) – *Mechanics*

An object of mass 8.0 kg is falling vertically through the air. The drag force acting on the object is 60 N. What is the best estimate of the acceleration of the object?

- A. Zero
- B.  $2.5 \text{ m s}^{-2}$
- C.  $7.5 \text{ m s}^{-2}$
- D.  $10 \text{ m s}^{-2}$

56 – (PHYSI/10\_HL\_Winter\_2020\_Q3) – *Mechanics*

A body is held in translational equilibrium by three coplanar forces of magnitude 3 N, 4 N and 5 N. Three statements about these forces are

- I. all forces are perpendicular to each other
- II. the forces cannot act in the same direction
- III. the vector sum of the forces is equal to zero.

Which statements are true?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

57 – (PHYSI/10\_HL\_Winter\_2020\_Q4) – *Mechanics*

An object of mass 1 kg is thrown downwards from a height of 20 m. The initial speed of the object is  $6 \text{ m s}^{-1}$ .

The object hits the ground at a speed of  $20 \text{ m s}^{-1}$ . Assume  $g = 10 \text{ m s}^{-2}$ . What is the best estimate of the energy transferred from the object to the air as it falls?

- A. 6 J
- B. 18 J
- C. 182 J
- D. 200 J

58 – (PHYSI/10\_HL\_Winter\_2020\_Q5) – *Mechanics*

A car is driven from rest along a straight horizontal road. The car engine exerts a constant driving force. Friction and air resistance are negligible. How does the power developed by the engine change with the distance travelled?

- A. Power does not change.
- B. Power decreases linearly.
- C. Power increases linearly.
- D. Power increases non-linearly.

59 – (PHYSI/10\_HL\_Winter\_2020\_Q6) – *Mechanics*

An object of mass  $2m$  moving at velocity  $3v$  collides with a stationary object of mass  $4m$ . The objects stick together after the collision. What is the final speed and the change in total kinetic energy immediately after the collision?

|    | Final speed | Change in total kinetic energy |
|----|-------------|--------------------------------|
| A. | $v$         | $3mv^2$                        |
| B. | $v$         | $6mv^2$                        |
| C. | $2v$        | $3mv^2$                        |
| D. | $2v$        | $6mv^2$                        |

60 – (PHYSI/11\_HL\_Summer\_2021\_Q2) – Mechanics

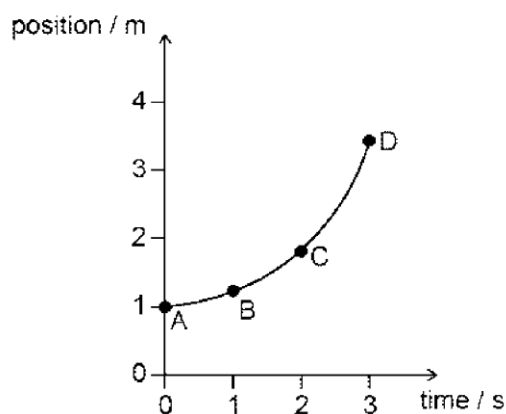


A large stone is dropped from a tall building. What is correct about the speed of the stone after 1 s?

- A. It is decreasing at increasing rate.
- B. It is decreasing at decreasing rate.
- C. It is increasing at increasing rate.
- D. It is increasing at decreasing rate.

61 – (PHYSI/11\_HL\_Summer\_2021\_Q3) – Mechanics

The graph shows how the position of an object varies with time in the interval from 0 to 3 s.



At which point does the instantaneous speed of the object equal its average speed over the interval from 0 to 3 s?

62 – (PHYSI/11\_HL\_Summer\_2021\_Q4) – Mechanics

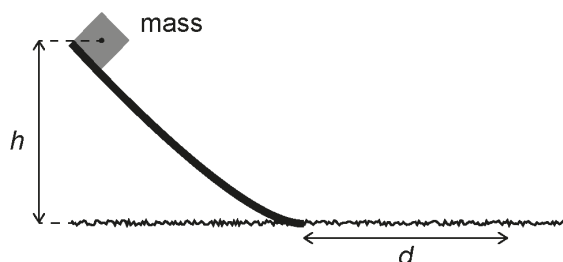
A car takes 20 minutes to climb a hill at constant speed. The mass of the car is 1200 kg and the car gains gravitational potential energy at a rate of 6.0 kW. Take the acceleration of gravity to be  $10 \text{ m s}^{-2}$ . What is the height of the hill?

- A. 0.6 m
- B. 10 m
- C. 600 m
- D. 6000 m

## 63 – (PHYSI/11\_HL\_Summer\_2021\_Q5) – Mechanics



A mass is released from the top of a smooth ramp of height  $h$ . After leaving the ramp, the mass slides on a rough horizontal surface.

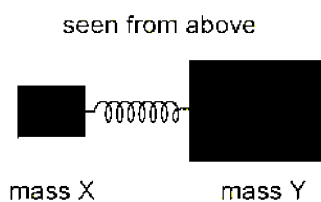


The mass comes to rest in a distance  $d$ . What is the coefficient of dynamic friction between the mass and the horizontal surface?

- A.  $\frac{gd}{h}$
- B.  $\sqrt{\frac{d}{2gh}}$
- C.  $\frac{d}{h}$
- D.  $\frac{h}{d}$

## 64 – (PHYSI/11\_HL\_Summer\_2021\_Q6) – Mechanics

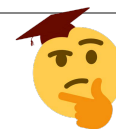
Masses X and Y rest on a smooth horizontal surface and are connected by a massless spring. The mass of X is 3.0 kg and the mass of Y is 6.0 kg. The masses are pushed toward each other until the elastic potential energy stored in the spring is 1.0 J.



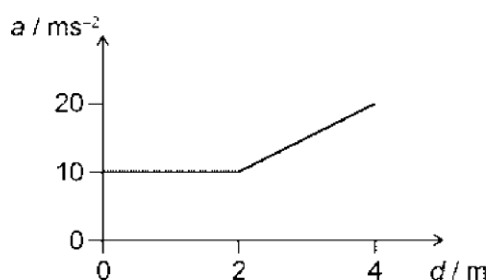
The masses are released. What is the maximum speed reached by mass Y?

- A.  $0.11 \text{ ms}^{-1}$
- B.  $0.33 \text{ ms}^{-1}$
- C.  $0.45 \text{ ms}^{-1}$
- D.  $0.66 \text{ ms}^{-1}$

65 – (PHYSI/11\_HL\_Summer\_2021\_Q7) – Mechanics



A force acts on an object of mass 40 kg. The graph shows how the acceleration  $a$  of the object varies with its displacement  $d$ .

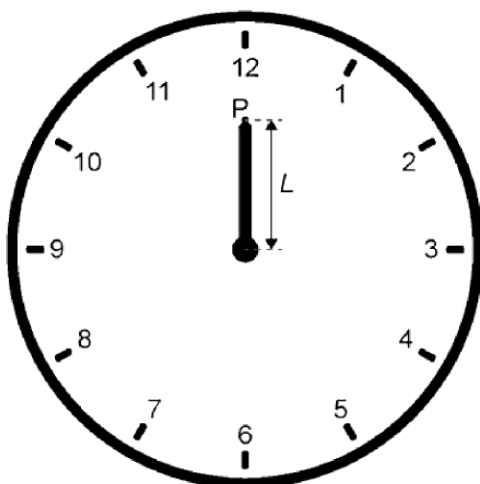


What is the work done by the force on the object?

- A. 50 J
- B. 2000 J
- C. 2400 J
- D. 3200 J

66 – (PHYSI/12\_HL\_Summer\_2021\_Q2) – Mechanics

The minute hand of a clock hanging on a vertical wall has length  $L = 30$  cm.



The minute hand is observed pointing at 12 and then again 30 minutes later when the minute hand is pointing at 6.

What is the average velocity and average speed of point P on the minute hand during this time interval?



|    | Average velocity                                | Average speed              |
|----|-------------------------------------------------|----------------------------|
| A. | $2 \text{ cm min}^{-1}$ vertically downwards    | $\pi \text{ cm min}^{-1}$  |
| B. | $2 \text{ cm min}^{-1}$ vertically upwards      | $\pi \text{ cm min}^{-1}$  |
| C. | $2\pi \text{ cm min}^{-1}$ vertically downwards | $2\pi \text{ cm min}^{-1}$ |
| D. | $2\pi \text{ cm min}^{-1}$ vertically upwards   | $2\pi \text{ cm min}^{-1}$ |

67 - (PHYSI/12\_HL\_Summer\_2021\_Q3) - Mechanics

A block rests on a rough horizontal plane. A force P is applied to the block and the block moves to the right.



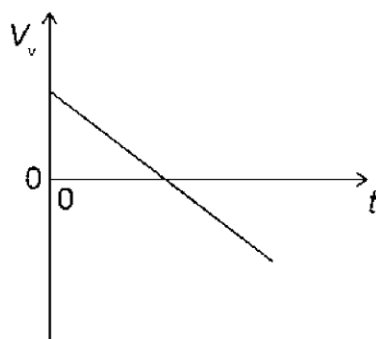
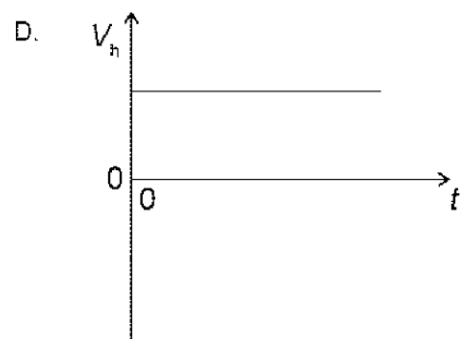
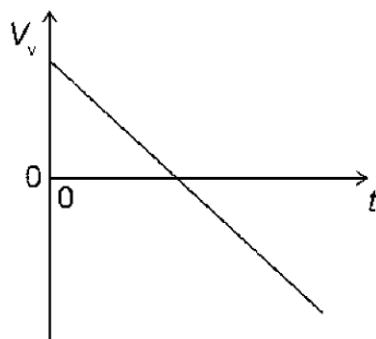
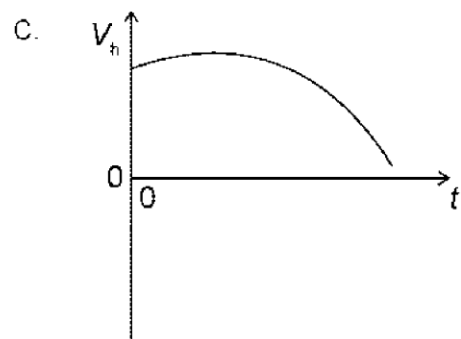
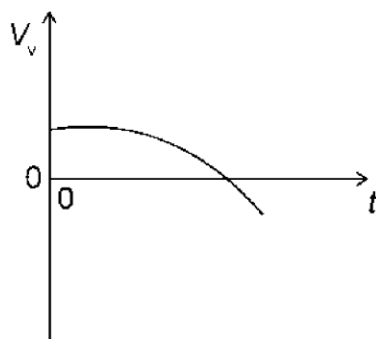
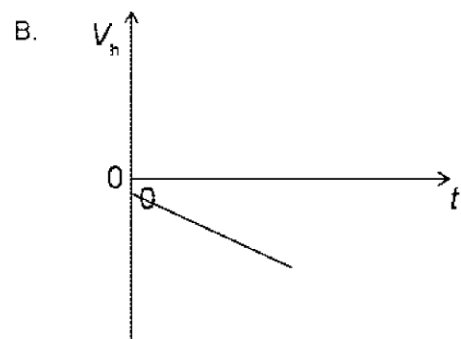
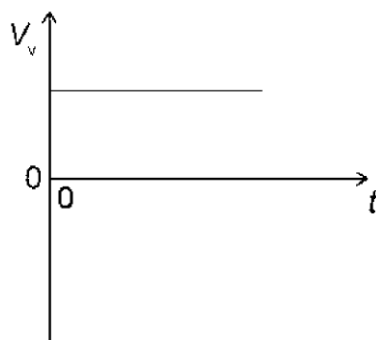
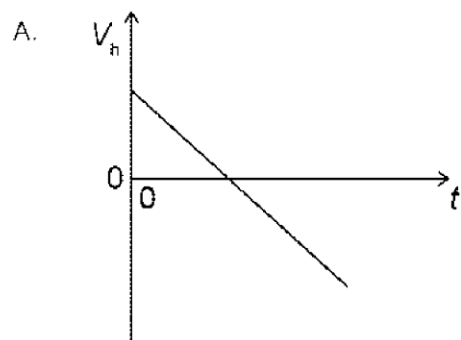
There is a coefficient of friction  $\mu_d$  giving rise to a frictional force F between the block and the plane. The force P is doubled. Will  $\mu_d$  and F be unchanged or greater?

|    | $\mu_d$   | F         |
|----|-----------|-----------|
| A. | unchanged | unchanged |
| B. | unchanged | greater   |
| C. | greater   | greater   |
| D. | greater   | unchanged |

68 – (PHYSI/12\_HL\_Summer\_2021\_Q4) – Mechanics



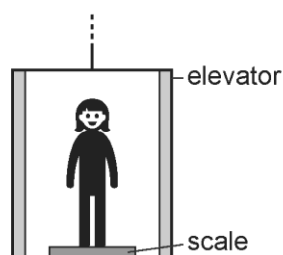
A projectile is launched at an angle above the horizontal with a horizontal component of velocity  $V_h$  and a vertical component of velocity  $V_v$ . Air resistance is negligible. Which graphs show the variation with time of  $V_h$  and of  $V_v$ ?





69 – (PHYSI/12\_HL\_Summer\_2021\_Q5) – *Mechanics*

A person with a weight of 600 N stands on a scale in an elevator.



What is the acceleration of the elevator when the scale reads 900 N?

- A.  $5.0 \text{ m s}^{-2}$  downwards
- B.  $1.5 \text{ m s}^{-2}$  downwards
- C.  $1.5 \text{ m s}^{-2}$  upwards
- D.  $5.0 \text{ m s}^{-2}$  upwards

70 – (PHYSI/12\_HL\_Summer\_2021\_Q6) – *Mechanics*

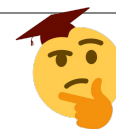
Two identical blocks, each of mass  $m$  and speed  $v$ , travel towards each other on a frictionless surface.



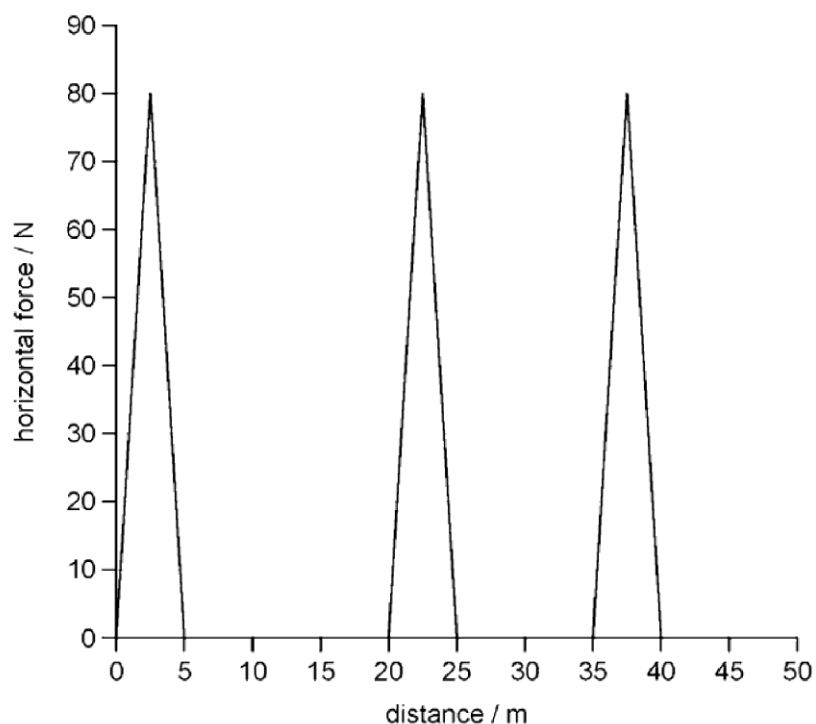
The blocks undergo a head-on collision. What is **definitely** true **immediately** after the collision?

- A. The momentum of each block is zero.
- B. The total momentum is zero.
- C. The momentum of each block is  $2mv$ .
- D. The total momentum is  $2mv$ .

71 – (PHYSI/12\_HL\_Summer\_2021\_Q7) – Mechanics



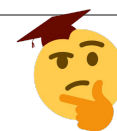
The graph shows the variation with distance of a horizontal force acting on an object. The object, initially at rest, moves horizontally through a distance of 50 m.



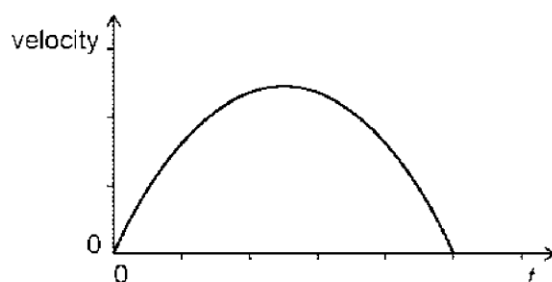
A constant frictional force of 2.0 N opposes the motion. What is the final kinetic energy of the object after it has moved 50 m?

- A. 100 J
- B. 500 J
- C. 600 J
- D. 1100 J

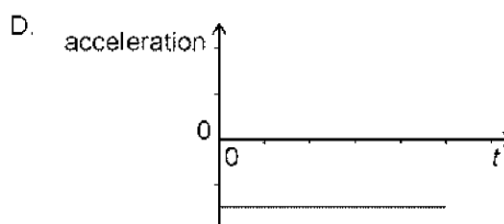
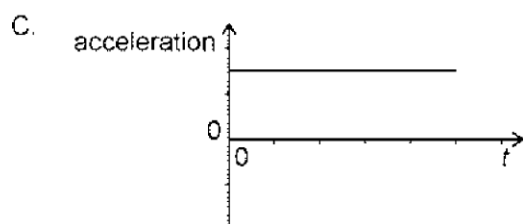
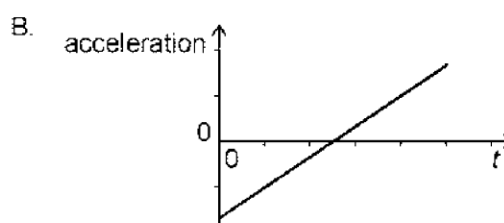
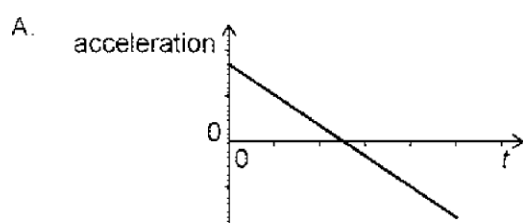
72 – (PHYSI/10\_HL\_Winter\_2021\_Q2) – Mechanics



The graph shows the variation with time  $t$  of the velocity of an object.

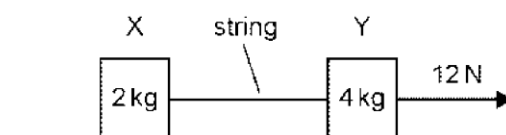


What is the variation with time  $t$  of the acceleration of the object?



73 – (PHYSI/10\_HL\_Winter\_2021\_Q3) – Mechanics

X and Y are two objects on a frictionless table connected by a string. The mass of X is 2 kg and the mass of Y is 4 kg. The mass of the string is negligible. A constant horizontal force of 12 N acts on Y.



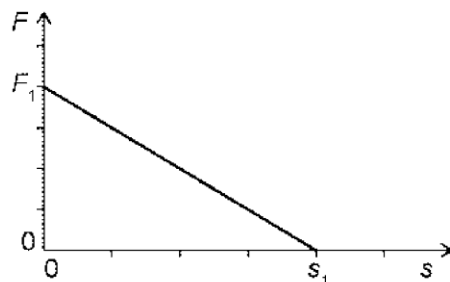
What are the acceleration of Y and the magnitude of the tension in the string?

|    | Acceleration of Y/ $\text{m s}^{-2}$ | Tension in the string/N |
|----|--------------------------------------|-------------------------|
| A. | 2                                    | 4                       |
| B. | 2                                    | 6                       |
| C. | 3                                    | 4                       |
| D. | 3                                    | 6                       |

74 – (PHYSI/10\_HL\_Winter\_2021\_Q4) – Mechanics



A net force  $F$  acts on an object of mass  $m$  that is initially at rest. The object moves in a straight line. The variation of  $F$  with the distance  $s$  is shown.



What is the speed of the object at the distance  $s_1$ ?

- A.  $\sqrt{\frac{F_1 s_1}{2m}}$
- B.  $\sqrt{\frac{F_1 s_1}{m}}$
- C.  $\sqrt{\frac{2F_1 s_1}{m}}$
- D.  $\sqrt{\frac{4F_1 s_1}{m}}$

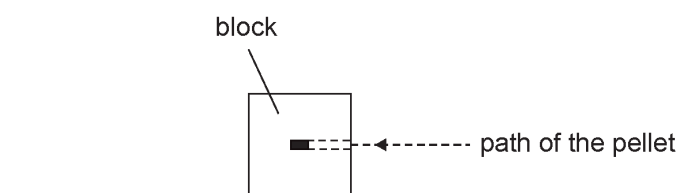
75 – (PHYSI/10\_HL\_Winter\_2021\_Q5) – Mechanics

A cyclist rides up a hill of vertical height 100 m in 500 s at a constant speed. The combined mass of the cyclist and the bicycle is 80 kg. The power developed by the cyclist is 200 W. What is the efficiency of the energy transfer in this system?

- A. 8 %
- B. 20 %
- C. 60 %
- D. 80 %

76 – (PHYSI/10\_HL\_Winter\_2021\_Q6) – *Mechanics*

A block rests on a frictionless horizontal surface. An air rifle pellet is fired horizontally into the block and remains embedded in the block.

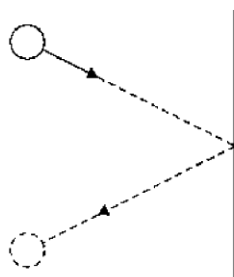


What happens to the total kinetic energy and to the total momentum of the block and pellet system as a result of the collision?

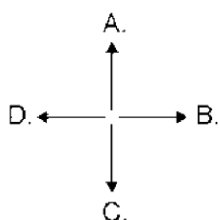
|    | Total kinetic energy | Total momentum |
|----|----------------------|----------------|
| A. | no change            | no change      |
| B. | no change            | decreases      |
| C. | decreases            | no change      |
| D. | decreases            | decreases      |

77 – (PHYSI/10\_HL\_Winter\_2021\_Q7) – *Mechanics*

A ball rolls on the floor towards a wall and rebounds with the same speed and at the same angle to the wall.



What is the direction of the impulse applied to the ball by the wall?



78 - (PHYSI/11\_HL\_Summer\_2022\_Q4) - Mechanics



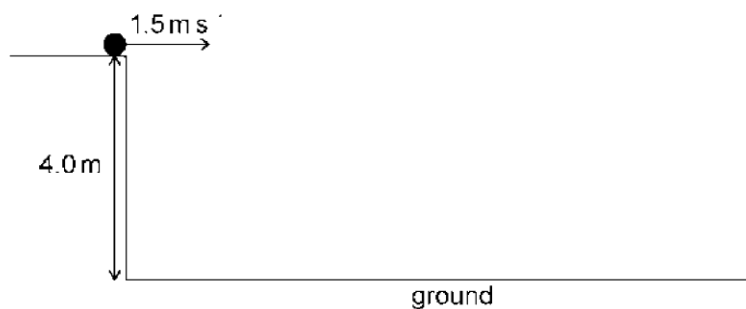
A block moving with initial speed  $v$  is brought to rest, after travelling a distance  $d$ , by a frictional force  $f$ . A second identical block moving with initial speed  $u$  is brought to rest in the same distance  $d$  by a frictional force  $\frac{f}{2}$ . What is  $u$ ?

- A.  $v$
- B.  $\frac{v}{\sqrt{2}}$
- C.  $\frac{v}{2}$
- D.  $\frac{v}{4}$

79 - (PHYSI/11\_HL\_Summer\_2022\_Q5) - Mechanics

A stone is kicked horizontally at a speed of  $1.5 \text{ m s}^{-1}$  from the edge of a cliff on one of Jupiter's moons. It hits the ground  $2.0 \text{ s}$  later. The height of the cliff is  $4.0 \text{ m}$ . Air resistance is negligible.

What is the magnitude of the displacement of the stone?

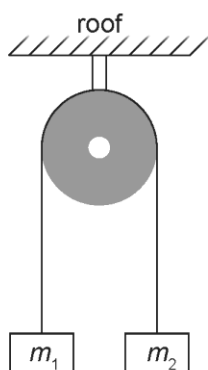


- A.  $7.0 \text{ m}$
- B.  $5.0 \text{ m}$
- C.  $4.0 \text{ m}$
- D.  $3.0 \text{ m}$

80 – (PHYSI/11\_HL\_Summer\_2022\_Q6) – Mechanics



Two masses  $m_1$  and  $m_2$  are connected by a string over a frictionless pulley of negligible mass. The masses are released from rest. Air resistance is negligible.



Mass  $m_2$  accelerates downwards at  $\frac{g}{2}$ . What is  $\frac{m_1}{m_2}$ ?

- A.  $\frac{1}{3}$
- B.  $\frac{1}{2}$
- C. 2
- D. 3

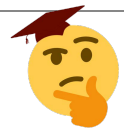
81 – (PHYSI/11\_HL\_Summer\_2022\_Q7) – Mechanics

A book is at rest on a table. One of the forces acting on the book is its weight.

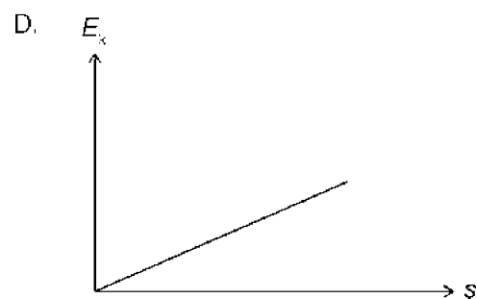
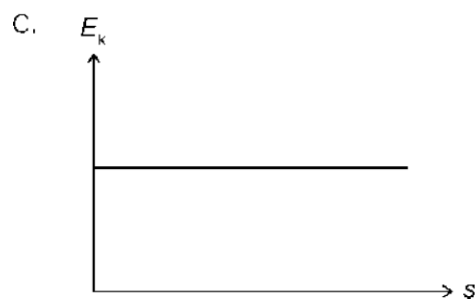
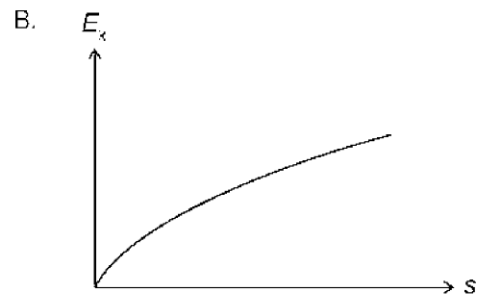
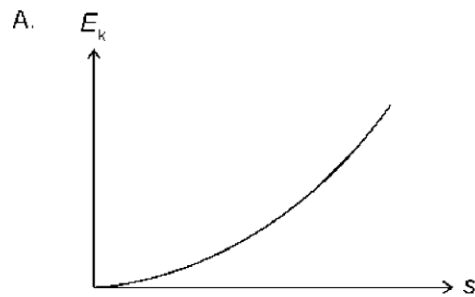
What is the other force that completes the force pair according to Newton's third law of motion?

- A. The pull of the book on Earth
- B. The pull of Earth on the book
- C. The push of the table on the book
- D. The push of the book on the table

82 – (PHYSI/11\_HL\_Summer\_2022\_Q8) – Mechanics



A cart travels from rest along a horizontal surface with a constant acceleration. What is the variation of the kinetic energy  $E_k$  of the cart with its distance  $s$  travelled? Air resistance is negligible.

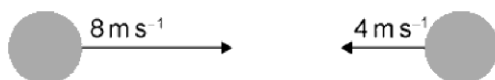




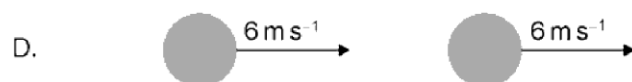
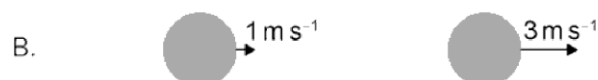
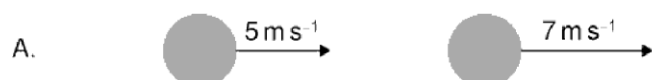
83 – (PHYSI/11\_HL\_Summer\_2022\_Q9) – Mechanics



Two bodies each of equal mass travelling in opposite directions collide head-on.



What is a possible outcome of the collision?



84 – (PHYSI/12\_HL\_Summer\_2022\_Q3) – Mechanics

An object is sliding from rest down a frictionless inclined plane. The object slides 1.0 m during the first second.



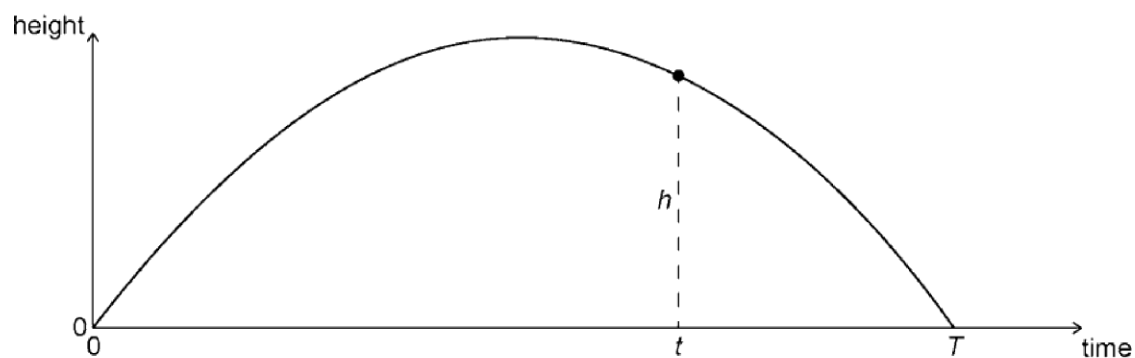
What distance will the object slide during the next second?

- A. 1.0 m
- B. 2.0 m
- C. 3.0 m
- D. 4.9 m

85 – (PHYSI/12\_HL\_Summer\_2022\_Q4) – Mechanics



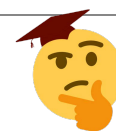
A ball is thrown upwards at time  $t = 0$ . The graph shows the variation with time of the height of the ball. The ball returns to the initial height at time  $T$ .



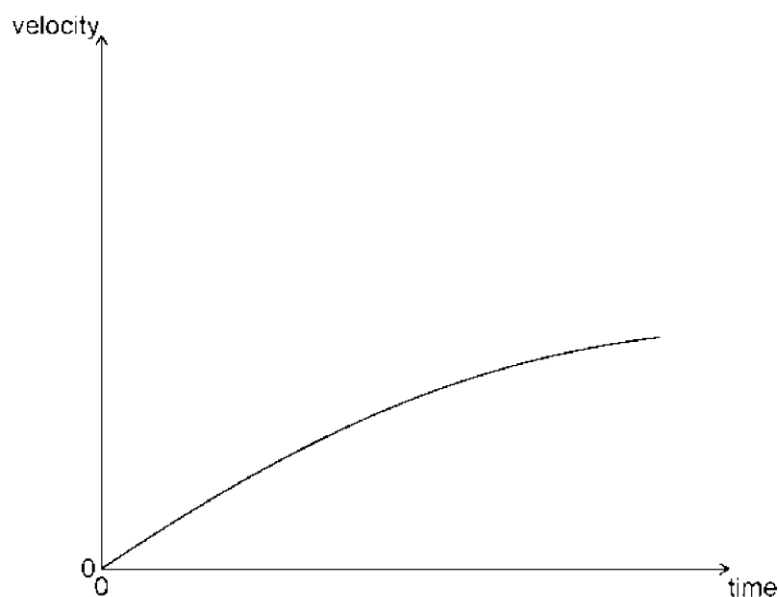
What is the height  $h$  at time  $t$ ?

- A.  $\frac{1}{2}gt^2$
- B.  $\frac{1}{2}gT^2$
- C.  $\frac{1}{2}gT(T-t)$
- D.  $\frac{1}{2}gt(T-t)$

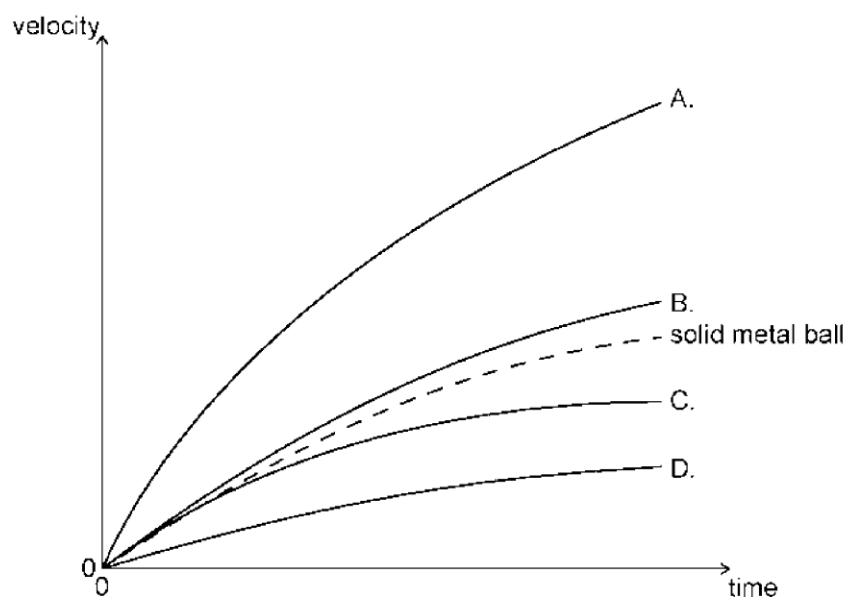
86 – (PHYSI/12\_HL\_Summer\_2022\_Q5) – Mechanics



A solid metal ball is dropped from a tower. The variation with time of the velocity of the ball is plotted.



A hollow metal ball with the same size and shape is dropped from the same tower. What graph will represent the variation with time of the velocity for the hollow metal ball?



87 – (PHYSI/12\_HL\_Summer\_2022\_Q6) – Mechanics



A rocket has just been launched vertically from Earth. The image shows the free-body diagram of the rocket.  $F_1$  represents a larger force than  $F_2$ .



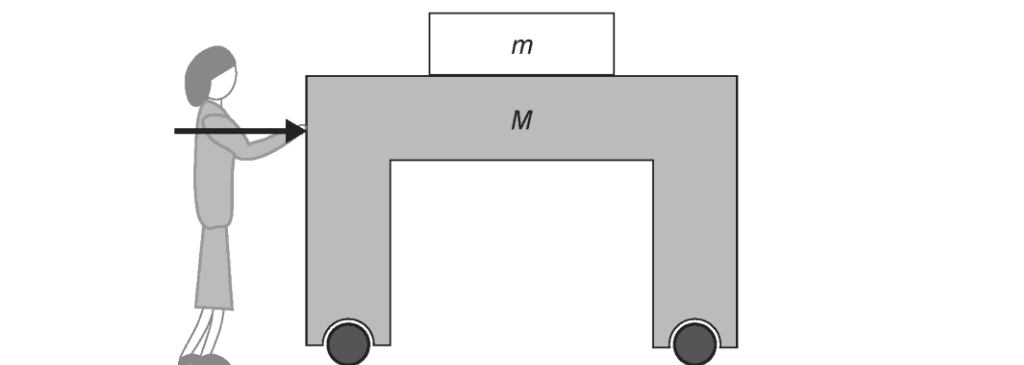
Which force pairs with  $F_1$  and which force pairs with  $F_2$ , according to Newton's third law?

|    | Force pair with $F_1$                  | Force pair with $F_2$                  |
|----|----------------------------------------|----------------------------------------|
| A. | force of rocket on exhaust gases       | force of exhaust gases on rocket       |
| B. | force of rocket on exhaust gases       | gravitational force of rocket on Earth |
| C. | gravitational force of Earth on rocket | force of exhaust gases on rocket       |
| D. | gravitational force of Earth on rocket | gravitational force of rocket on Earth |

88 – (PHYSI/12\_HL\_Summer\_2022\_Q7) – Mechanics

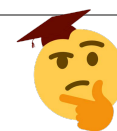
A book of mass  $m$  lies on top of a table of mass  $M$  that rolls freely along the ground. The coefficient of friction between the book and the table is  $\mu$ . A person is pushing the rolling table.

What is the maximum acceleration of the table so that the book does not slide backwards relative to the table?



- A.  $\frac{g}{\mu}$   
 B.  $\mu g$   
 C.  $\frac{mg}{M\mu}$   
 D.  $\frac{m}{M} \mu g$

89 – (PHYSI/12\_HL\_Summer\_2022\_Q8) – Mechanics



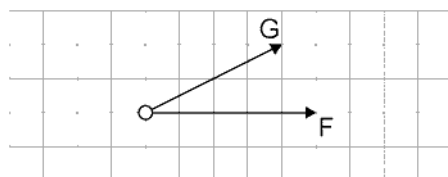
Two blocks of different masses are released from identical springs of elastic constant  $k = 100 \text{ N m}^{-1}$ , initially compressed a distance  $\Delta x = 0.1 \text{ m}$ . Block X has a mass of  $1 \text{ kg}$  and block Y has a mass of  $0.25 \text{ kg}$ .

What are the velocities of the blocks when they leave the springs?

|    | Velocity of block X    | Velocity of block Y    |
|----|------------------------|------------------------|
| A. | $1.0 \text{ m s}^{-1}$ | $1.0 \text{ m s}^{-1}$ |
| B. | $2.0 \text{ m s}^{-1}$ | $1.0 \text{ m s}^{-1}$ |
| C. | $1.0 \text{ m s}^{-1}$ | $2.0 \text{ m s}^{-1}$ |
| D. | $2.0 \text{ m s}^{-1}$ | $2.0 \text{ m s}^{-1}$ |

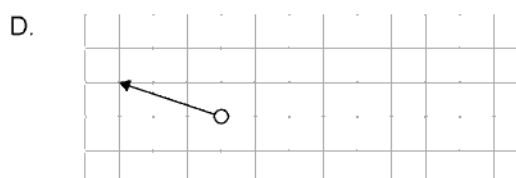
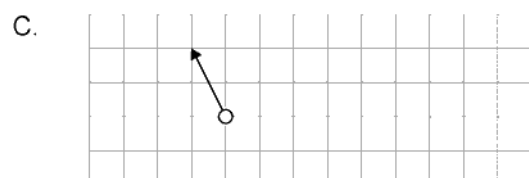
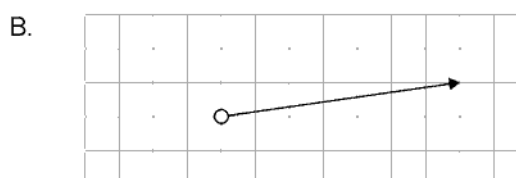
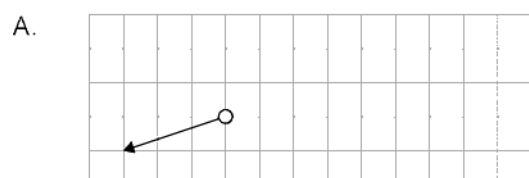
90 – (PHYSI/10\_HL\_Winter\_2022\_Q3) – Mechanics

Two forces, F and G, act on a system.



F is reversed in direction and G is halved.

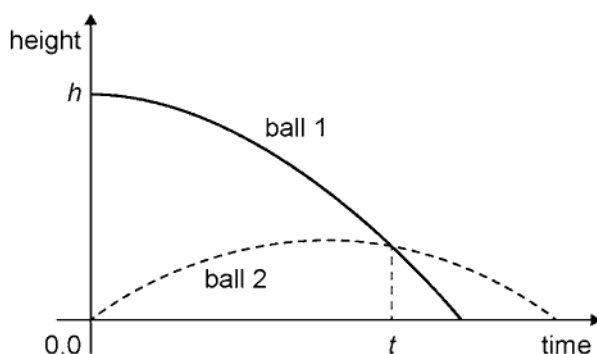
Which vector correctly represents the new resultant force?



## 91 – (PHYSI/10\_HL\_Winter\_2022\_Q4) – Mechanics



Ball 1 is dropped from rest from an initial height  $h$ . At the same instant, ball 2 is launched vertically upwards at an initial velocity  $u$ .

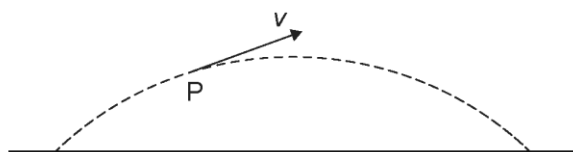


At what time are both balls at the same distance above the ground?

- A.  $\frac{h}{4u}$
- B.  $\frac{h}{2u}$
- C.  $\frac{h}{u}$
- D.  $\frac{2h}{u}$

## 92 – (PHYSI/10\_HL\_Winter\_2022\_Q5) – Mechanics

The diagram shows the trajectory of a projectile and the velocity  $v$  of the projectile at point P in its trajectory. P is located before the projectile reaches the peak altitude. Air resistance acts on the projectile. The acceleration of the projectile at P is  $a$ .



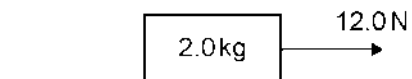
What are the magnitudes of the horizontal component and the vertical component of the acceleration of the projectile at P?

|    | Horizontal component of $a$ | Vertical component of $a$           |
|----|-----------------------------|-------------------------------------|
| A. | zero                        | greater than $9.8 \text{ m s}^{-2}$ |
| B. | non-zero                    | greater than $9.8 \text{ m s}^{-2}$ |
| C. | zero                        | $9.8 \text{ m s}^{-2}$              |
| D. | non-zero                    | $9.8 \text{ m s}^{-2}$              |

93 – (PHYSI/10\_HL\_Winter\_2022\_Q6) – *Mechanics*

An object of mass  $2.0\text{ kg}$  is on a horizontal surface. The object is pulled by a force of  $12.0\text{ N}$  and accelerates at  $2.0\text{ m s}^{-2}$ .

What is the coefficient of dynamic friction between the object and the surface?



- A. 0.3
- B. 0.4
- C. 0.6
- D. 0.8

94 – (PHYSI/10\_HL\_Winter\_2022\_Q7) – *Mechanics*

A person lifts a total mass of  $20\text{ kg}$  through a vertical distance of  $0.60\text{ m}$ . The person repeats the lift  $n$  times to transfer a total energy of  $6.0 \times 10^4\text{ J}$ .

What is  $n$ ?

- A. 5
- B. 50
- C. 500
- D. 5000

95 – (PHYSI/10\_HL\_Winter\_2022\_Q8) – *Mechanics*

An engine is exerting a horizontal force  $F$  on an object that is moving along a horizontal surface at a constant velocity  $v$ . The mass of the object is  $m$  and the coefficient of dynamic friction between the object and the surface is  $\mu$ .

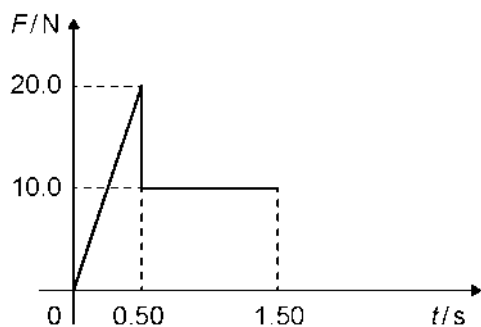
What is the power of the engine?

- A.  $\frac{Fv}{\mu}$
- B.  $\mu Fv$
- C.  $\frac{mgv}{\mu}$
- D.  $\mu mgv$

96 – (PHYSI/10\_HL\_Winter\_2022\_Q9) – Mechanics



A model rocket is launched from rest. The graph shows the variation with time  $t$  of the net force  $F$  applied on the rocket. The average mass of the rocket is 0.20 kg.



What is the maximum velocity reached by the rocket?

- A.  $3.0 \text{ ms}^{-1}$
- B.  $25 \text{ ms}^{-1}$
- C.  $75 \text{ ms}^{-1}$
- D.  $150 \text{ ms}^{-1}$

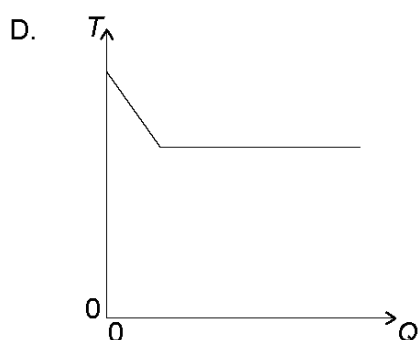
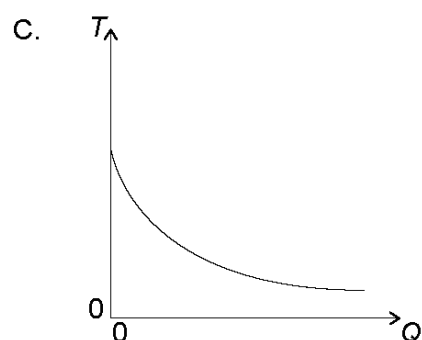
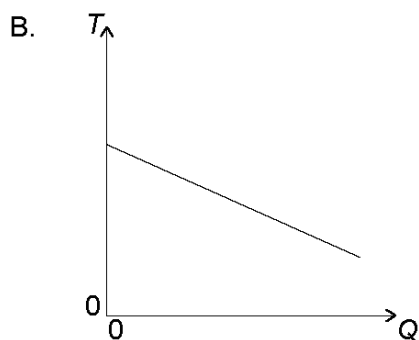
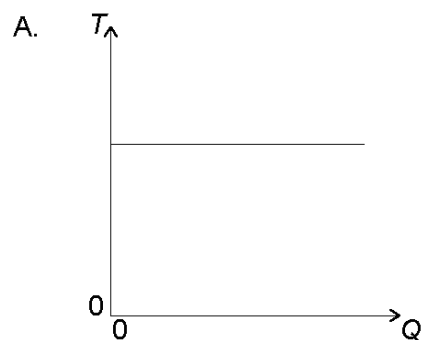


1 - (PHYSI/11\_HL\_Summer\_2017\_Q8) - Thermal Physics



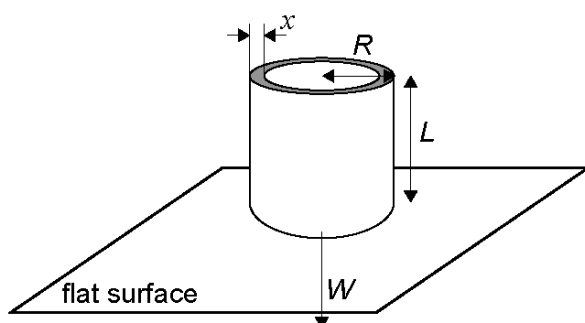
A liquid is initially at its freezing point. Energy is removed at a uniform rate from the liquid until it freezes completely.

Which graph shows how the temperature  $T$  of the liquid varies with the energy  $Q$  removed from the liquid?



2 - (PHYSI/11\_HL\_Summer\_2017\_Q9) - *Thermal Physics*

A thin-walled cylinder of weight  $W$ , open at both ends, rests on a flat surface. The cylinder has a height  $L$ , an average radius  $R$  and a thickness  $x$  where  $R$  is much greater than  $x$ .



What is the pressure exerted by the cylinder walls on the flat surface?

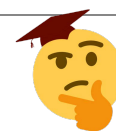
- A.  $\frac{W}{2\pi Rx}$
- B.  $\frac{W}{\pi R^2 x}$
- C.  $\frac{W}{\pi R^2}$
- D.  $\frac{W}{\pi R^2 L}$

3 - (PHYSI/11\_HL\_Summer\_2017\_Q10) - *Thermal Physics*

A fixed mass of an ideal gas in a closed container with a movable piston initially occupies a volume  $V$ . The position of the piston is changed, so that the mean kinetic energy of the particles in the gas is doubled and the pressure remains constant.

What is the new volume of the gas?

- A.  $\frac{V}{4}$
- B.  $\frac{V}{2}$
- C.  $2V$
- D.  $4V$

4 - (PHYSI/12\_HL\_Summer\_2017\_Q8) - *Thermal Physics*

A mass  $m$  of ice at a temperature of  $-5^{\circ}\text{C}$  is changed into water at a temperature of  $50^{\circ}\text{C}$ .

Specific heat capacity of ice  $= c_i$

Specific heat capacity of water  $= c_w$

Specific latent heat of fusion of ice  $= L$

Which expression gives the energy needed for this change to occur?

- A.  $55 m c_w + m L$
- B.  $55 m c_i + 5 m L$
- C.  $5 m c_i + 50 m c_w + m L$
- D.  $5 m c_i + 50 m c_w + 5 m L$

5 - (PHYSI/12\_HL\_Summer\_2017\_Q9) - *Thermal Physics*

A sealed container contains a mixture of oxygen and nitrogen gas.

The ratio  $\frac{\text{mass of an oxygen molecule}}{\text{mass of a nitrogen molecule}}$  is  $\frac{8}{7}$ .

The ratio  $\frac{\text{average kinetic energy of oxygen molecules}}{\text{average kinetic energy of nitrogen molecules}}$  is

- A. 1.
- B.  $\frac{7}{8}$ .
- C.  $\frac{8}{7}$ .
- D. dependent on the concentration of each gas.

6 - (PHYSI/12\_HL\_Summer\_2017\_Q10) - *Thermal Physics*



An ideal gas has a volume of 15 ml, a temperature of 20 °C and a pressure of 100 kPa. The volume of the gas is reduced to 5 ml and the temperature is raised to 40 °C. What is the new pressure of the gas?

- A. 600 kPa
- B. 320 kPa
- C. 200 kPa
- D. 35 kPa

7 - (PHYSI/10\_HL\_Winter\_2017\_Q8) - *Thermal Physics*

A 1.0 kW heater supplies energy to a liquid of mass 0.50 kg. The temperature of the liquid changes by 80 K in a time of 200 s. The specific heat capacity of the liquid is  $4.0 \text{ kJ kg}^{-1} \text{ K}^{-1}$ . What is the average power lost by the liquid?

- A. 0
- B. 200 W
- C. 800 W
- D. 1600 W

8 - (PHYSI/10\_HL\_Winter\_2017\_Q9) - *Thermal Physics*

The fraction of the internal energy that is due to molecular vibration varies in the different states of matter. What gives the order from highest fraction to lowest fraction of internal energy due to molecular vibration?

- A. liquid > gas > solid
- B. solid > liquid > gas
- C. solid > gas > liquid
- D. gas > liquid > solid

9 - (PHYSI/10\_HL\_Winter\_2017\_Q10) - *Thermal Physics*

What does the constant  $n$  represent in the equation of state for an ideal gas  $pV = nRT$ ?

- A. The number of atoms in the gas
- B. The number of moles of the gas
- C. The number of molecules of the gas
- D. The number of particles in the gas

10 - (PHYSI/11\_HL\_Summer\_2018\_Q8) - Thermal Physics

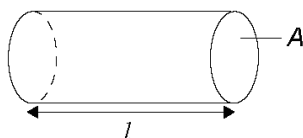


What are the units of the ratio  $\frac{\text{specific heat capacity of copper}}{\text{specific latent heat of vaporization of copper}}$ ?

- A. no units
- B. k
- C.  $\text{k}^{-1}$
- D.  $\text{k}^{-2}$

11 - (PHYSI/11\_HL\_Summer\_2018\_Q9) - Thermal Physics

A sealed cylinder of length  $l$  and cross-sectional area  $A$  contains  $N$  molecules of an ideal gas at kelvin temperature  $T$ .



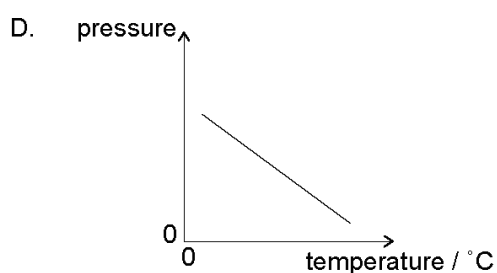
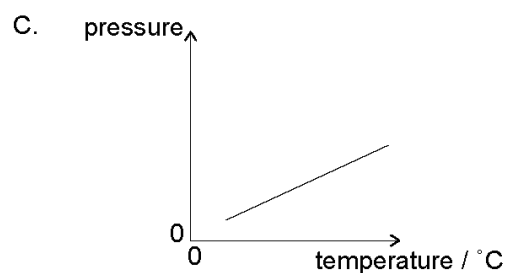
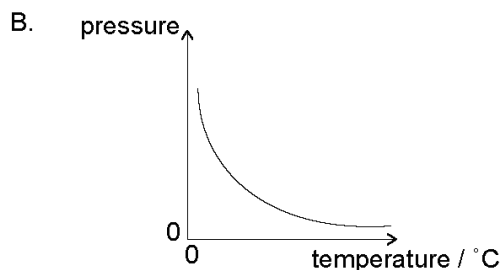
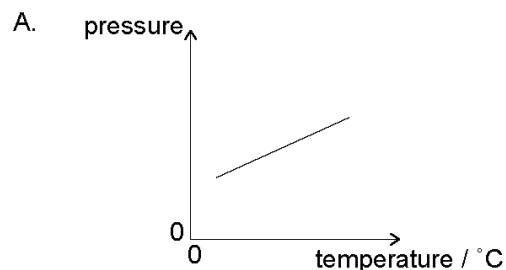
What is the force acting on the area of the cylinder marked  $A$  due to the gas?

- A.  $\frac{NRT}{l}$
- B.  $\frac{NRT}{lA}$
- C.  $\frac{Nk_B T}{lA}$
- D.  $\frac{Nk_B T}{l}$

## 12 - (PHYSI/11\_HL\_Summer\_2018\_Q10) - Thermal Physics

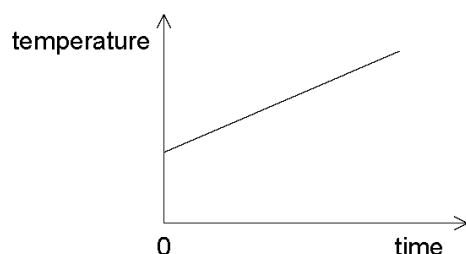


A fixed mass of an ideal gas is trapped in a cylinder of constant volume and its temperature is varied. Which graph shows the variation of the pressure of the gas with temperature in degrees Celsius?



## 13 - (PHYSI/12\_HL\_Summer\_2018\_Q8) - Thermal Physics

The graph shows how the temperature of a liquid varies with time when energy is supplied to the liquid at a constant rate  $P$ . The gradient of the graph is  $K$  and the liquid has a specific heat capacity  $c$ .



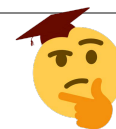
What is the mass of the liquid?

A.  $\frac{P}{cK}$

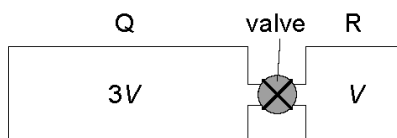
B.  $\frac{PK}{c}$

C.  $\frac{Pc}{K}$

D.  $\frac{cK}{P}$

14 - (PHYSI/12\_HL\_Summer\_2018\_Q9) - *Thermal Physics*

Q and R are two rigid containers of volume  $3V$  and  $V$  respectively containing molecules of the same ideal gas initially at the same temperature. The gas pressures in Q and R are  $p$  and  $3p$  respectively. The containers are connected through a valve of negligible volume that is initially closed.



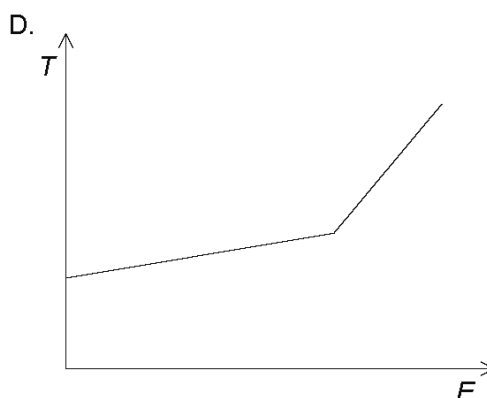
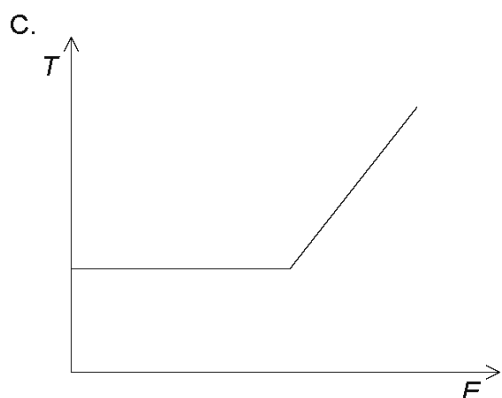
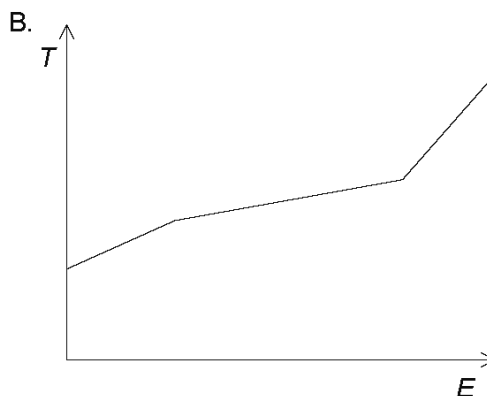
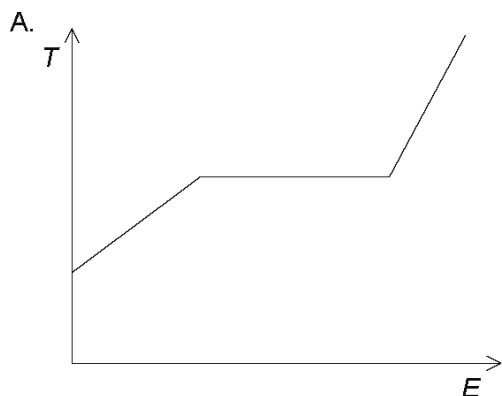
The valve is opened in such a way that the temperature of the gases does not change. What is the change of pressure in Q?

- A.  $+p$
- B.  $+\frac{p}{2}$
- C.  $-\frac{p}{2}$
- D.  $-p$

## 15 - (PHYSI/10\_HL\_Winter\_2018\_Q8) - Thermal Physics



A solid substance has just reached its melting point. Thermal energy is supplied to the substance at a constant rate. Which graph shows the variation of the temperature  $T$  of the substance with energy  $E$  supplied?



## 16 - (PHYSI/10\_HL\_Winter\_2018\_Q9) - Thermal Physics

A container is filled with a mixture of helium and oxygen at the same temperature. The molar mass of helium is  $4 \text{ g mol}^{-1}$  and that of oxygen is  $32 \text{ g mol}^{-1}$ .

What is the ratio  $\frac{\text{average speed of helium molecules}}{\text{average speed of oxygen molecules}}$ ?

A.  $\frac{1}{8}$

B.  $\frac{1}{\sqrt{8}}$

C.  $\sqrt{8}$

D. 8



17 - (PHYSI/10\_HL\_Winter\_2018\_Q10) - *Thermal Physics*

Container X contains 1.0 mol of an ideal gas. Container Y contains 2.0 mol of the ideal gas. Y has four times the volume of X. The pressure in X is twice that in Y.

What is  $\frac{\text{temperature of gas in X}}{\text{temperature of gas in Y}}$ ?

- A.  $\frac{1}{4}$
- B.  $\frac{1}{2}$
- C. 1
- D. 2

18 - (PHYSI/11\_HL\_Summer\_2019\_Q8) - *Thermal Physics*

Energy is transferred to water in a flask at a rate  $P$ . The water reaches boiling point and then  $P$  is increased. What are the changes to the temperature of the water and to the rate of vaporization of the water after the change?

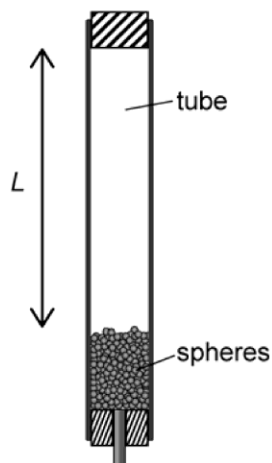
|    | Temperature    | Rate of vaporization |
|----|----------------|----------------------|
| A. | increases      | stays the same       |
| B. | increases      | increases            |
| C. | stays the same | stays the same       |
| D. | stays the same | increases            |

19 - (PHYSI/11\_HL\_Summer\_2019\_Q9) - Thermal Physics



An insulated tube is filled with a large number  $n$  of lead spheres, each of mass  $m$ . The tube is inverted  $s$  times so that the spheres completely fall through an average distance  $L$  each time. The temperature of the spheres is measured before and after the inversions and the resultant change in temperature is  $\Delta T$ .

What is the specific heat capacity of lead?



- A.  $\frac{sgL}{nm\Delta T}$
- B.  $\frac{sgL}{\Delta T}$
- C.  $\frac{sgL}{n\Delta T}$
- D.  $\frac{gL}{m\Delta T}$

20 - (PHYSI/11\_HL\_Summer\_2019\_Q10) - Thermal Physics

A gas storage tank of fixed volume  $V$  contains  $N$  molecules of an ideal gas at temperature  $T$ .

The pressure at kelvin temperature  $T$  is 20 MPa.  $\frac{N}{4}$  molecules are removed and the temperature changed to  $2T$ . What is the new pressure of the gas?

- A. 10 MPa
- B. 15 MPa
- C. 30 MPa
- D. 40 MPa

21 – (PHYSI/11\_HL\_Summer\_2019\_Q26) – *Thermal Physics*

A beaker containing 1 kg of water at room temperature is heated on a 400 W hot plate. The specific heat capacity of water is  $4200 \text{ J kg}^{-1} \text{ K}^{-1}$ .

The temperature of the water increases until it reaches a constant value. It is then removed from the hot plate.

What will be the initial rate of change of temperature?

- A.  $10 \text{ K s}^{-1}$
- B.  $1 \text{ K s}^{-1}$
- C.  $0.1 \text{ K s}^{-1}$
- D.  $0.01 \text{ K s}^{-1}$

22 – (PHYSI/12\_HL\_Summer\_2019\_Q9) – *Thermal Physics*

A substance changes from the solid phase to the gas phase without becoming a liquid and without a change in temperature.

What is true about the internal energy of the substance and the total intermolecular potential energy of the substance when this phase change occurs?

|    | Internal energy of the substance | Total intermolecular potential energy of the substance |
|----|----------------------------------|--------------------------------------------------------|
| A. | increases                        | no change                                              |
| B. | no change                        | no change                                              |
| C. | increases                        | increases                                              |
| D. | no change                        | increases                                              |

23 – (PHYSI/12\_HL\_Summer\_2019\_Q12) – *Thermal Physics*

A liquid of mass  $m$  and specific heat capacity  $c$  cools. The rate of change of the temperature of the liquid is  $k$ . What is the rate at which thermal energy is transferred from the liquid?

- A.  $\frac{mc}{k}$
- B.  $\frac{k}{mc}$
- C.  $\frac{1}{kmc}$
- D.  $kmc$

24 – (PHYSI/12\_HL\_Summer\_2019\_Q13) – *Thermal Physics*

The equation  $\frac{pV}{T} = \text{constant}$  is applied to a real gas where  $p$  is the pressure of the gas,  $V$  is its volume and  $T$  is its temperature.

What is correct about this equation?

- A. It is empirical.
- B. It is theoretical.
- C. It cannot be tested.
- D. It cannot be disproved.

25 – (PHYSI/12\_HL\_Summer\_2019\_Q14) – *Thermal Physics*

Cylinder X has a volume  $V$  and contains 3.0 mol of an ideal gas. Cylinder Y has a volume  $\frac{V}{2}$  and contains 2.0 mol of the same gas.

The gases in X and Y are at the same temperature  $T$ . The containers are joined by a valve which is opened so that the temperatures do not change.

What is the change in pressure in X?

- A.  $+\frac{1}{3}\left(\frac{RT}{V}\right)$
- B.  $-\frac{1}{3}\left(\frac{RT}{V}\right)$
- C.  $+\frac{2}{3}\left(\frac{RT}{V}\right)$
- D.  $-\frac{2}{3}\left(\frac{RT}{V}\right)$

26 – (PHYSI/10\_HL\_Winter\_2019\_Q8) – *Thermal Physics*

A mass  $m$  of water is at a temperature of 290 K. The specific heat capacity of water is  $c$ . Ice, at its melting point, is added to the water to reduce the water temperature to the freezing point. The specific latent heat of fusion for ice is  $L$ . What is the minimum mass of ice that is required?

- A.  $\frac{17mc}{L}$
- B.  $\frac{290mc}{L}$
- C.  $\frac{17mL}{c}$
- D.  $\frac{290mL}{c}$

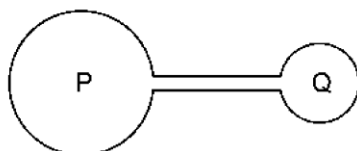
27 – (PHYSI/10\_HL\_Winter\_2019\_Q9) – *Thermal Physics*

Under which conditions of pressure and density will a real gas approximate to an ideal gas?

|    | Pressure | Density |
|----|----------|---------|
| A. | high     | high    |
| B. | high     | low     |
| C. | low      | high    |
| D. | low      | low     |

28 – (PHYSI/10\_HL\_Winter\_2019\_Q10) – *Thermal Physics*

Two flasks P and Q contain an ideal gas and are connected with a tube of negligible volume compared to that of the flasks. The volume of P is twice the volume of Q.



P is held at a temperature of 200 K and Q is held at a temperature of 400 K.

What is  $\frac{\text{mass of gas in P}}{\text{mass of gas in Q}}$ ?

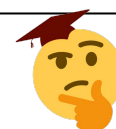
- A.  $\frac{1}{8}$
- B.  $\frac{1}{4}$
- C. 4
- D. 8

29 – (PHYSI/10\_HL\_Winter\_2020\_Q7) – *Thermal Physics*

What is **not** an assumption of the kinetic model of an ideal gas?

- A. Attractive forces between molecules are negligible.
- B. Collision duration is negligible compared with time between collisions.
- C. Molecules suffer negligible momentum change during wall collisions.
- D. Molecular volume is negligible compared with gas volume.

30 – (PHYSI/10\_HL\_Winter\_2020\_Q8) – *Thermal Physics*



A substance in the gas state has a density about 1000 times less than when it is in the liquid state. The diameter of a molecule is  $d$ . What is the best estimate of the average distance between molecules in the gas state?

- A.  $d$
- B.  $10d$
- C.  $100d$
- D.  $1000d$

31 – (PHYSI/10\_HL\_Winter\_2020\_Q9) – *Thermal Physics*

Two containers X and Y are maintained at the same temperature. X has volume  $4\text{ m}^3$  and Y has volume  $6\text{ m}^3$ . They both hold an ideal gas. The pressure in X is 100 Pa and the pressure in Y is 50 Pa. The containers are then joined by a tube of negligible volume. What is the final pressure in the containers?

- A. 70 Pa
- B. 75 Pa
- C. 80 Pa
- D. 150 Pa

32 – (PHYSI/11\_HL\_Summer\_2021\_Q8) – *Thermal Physics*

Which aspect of thermal physics is best explained by the molecular kinetic model?

- A. The equation of state of ideal gases
- B. The difference between Celsius and Kelvin temperature
- C. The value of the Avogadro constant
- D. The existence of gaseous isotopes

33 – (PHYSI/11\_HL\_Summer\_2021\_Q9) – Thermal Physics



When 40 kJ of energy is transferred to a quantity of a liquid substance, its temperature increases by 20 K. When 600 kJ of energy is transferred to the same quantity of the liquid at its boiling temperature, it vaporizes completely at constant temperature. What is

$$\frac{\text{specific latent heat of vaporization}}{\text{specific heat capacity of the liquid}}$$

for this substance?

- A.  $15 \text{ K}^{-1}$
- B. 15 K
- C.  $300 \text{ K}^{-1}$
- D. 300 K

34 – (PHYSI/11\_HL\_Summer\_2021\_Q10) – Thermal Physics

Two ideal gases X and Y are at the same temperature. The mass of a particle of gas X is larger than the mass of a particle of gas Y. Which is correct about the average kinetic energy and the average speed of the particles in gases X and Y?

|    | Average kinetic energy | Average speed |
|----|------------------------|---------------|
| A. | larger for Y           | larger for Y  |
| B. | same                   | larger for Y  |
| C. | same                   | same          |
| D. | larger for Y           | same          |

35 – (PHYSI/12\_HL\_Summer\_2021\_Q8) – Thermal Physics

A sample of oxygen gas with a volume of  $3.0 \text{ m}^3$  is at  $100^\circ\text{C}$ . The gas is heated so that it expands at a constant pressure to a final volume of  $6.0 \text{ m}^3$ . What is the final temperature of the gas?

- A.  $750^\circ\text{C}$
- B.  $470^\circ\text{C}$
- C.  $370^\circ\text{C}$
- D.  $200^\circ\text{C}$

36 – (PHYSI/12\_HL\_Summer\_2021\_Q9) – Thermal Physics



Two identical containers X and Y each contain an ideal gas. X has  $N$  molecules of gas at an absolute temperature of  $T$  and Y has  $3N$  molecules of gas at an absolute temperature of  $\frac{T}{2}$ . What is the ratio of the pressures  $\frac{P_Y}{P_X}$ ?



- A.  $\frac{1}{6}$
- B.  $\frac{2}{3}$
- C.  $\frac{3}{2}$
- D. 6

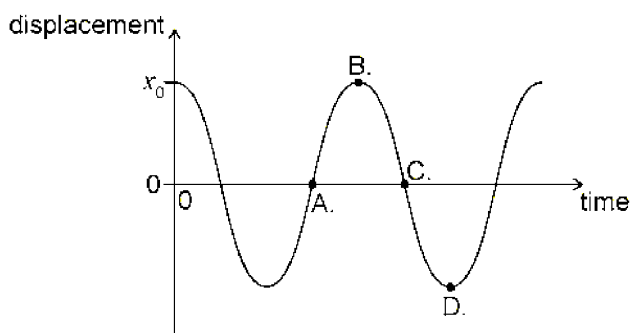
37 – (PHYSI/12\_HL\_Summer\_2021\_Q10) – Thermal Physics

A piece of metal at a temperature of  $100^\circ\text{C}$  is dropped into an equal mass of water at a temperature of  $15^\circ\text{C}$  in a container of negligible mass. The specific heat capacity of water is four times that of the metal. What is the final temperature of the mixture?

- A.  $83^\circ\text{C}$
- B.  $57^\circ\text{C}$
- C.  $45^\circ\text{C}$
- D.  $32^\circ\text{C}$

38 – (PHYSI/12\_HL\_Summer\_2021\_Q11) – Thermal Physics

The bob of a pendulum has an initial displacement  $x_0$  to the right. The bob is released and allowed to oscillate. The graph shows how the displacement varies with time. At which point is the velocity of the bob at its maximum magnitude directed towards the left?





39 – (PHYSI/10\_HL\_Winter\_2021\_Q8) – *Thermal Physics*



A liquid is vaporized to a gas at a constant temperature.

Three quantities of the substance are the

- I. total intermolecular potential energy
- II. root mean square speed of the molecules
- III. average distance between the molecules.

Which quantities are **greater** for the substance in the gas phase compared to the liquid phase?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

40 – (PHYSI/10\_HL\_Winter\_2021\_Q9) – *Thermal Physics*

An insulated container of negligible mass contains a mass  $2M$  of a liquid. A piece of a metal of mass  $M$  is dropped into the liquid. The temperature of the liquid increases by  $10^{\circ}\text{C}$  and the temperature of the metal decreases by  $80^{\circ}\text{C}$  in the same time.

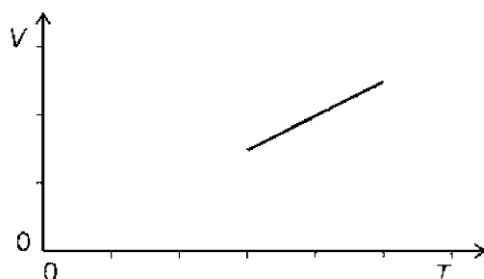
What is  $\frac{\text{specific heat capacity of the liquid}}{\text{specific heat capacity of the metal}}$ ?

- A. 2
- B. 4
- C. 8
- D. 16

41 – (PHYSI/10\_HL\_Winter\_2021\_Q10) – Thermal Physics



The molar mass of an ideal gas is  $M$ . A fixed mass  $m$  of the gas expands at a constant pressure  $p$ . The graph shows the variation with temperature  $T$  of the gas volume  $V$ .



What is the gradient of the graph?

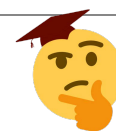
- A.  $\frac{Mp}{mR}$
- B.  $\frac{MR}{mp}$
- C.  $\frac{mp}{MR}$
- D.  $\frac{mR}{Mp}$

42 – (PHYSI/11\_HL\_Summer\_2022\_Q10) – Thermal Physics

A driver uses the brakes on a car to descend a hill at constant speed. What is correct about the internal energy of the brake discs?

- A. The internal energy increases.
- B. The internal energy decreases.
- C. There is no change in the internal energy.
- D. The internal energy is zero.

43 – (PHYSI/11\_HL\_Summer\_2022\_Q11) – Thermal Physics



Two blocks, X and Y, are placed in contact with each other. Data for the blocks are provided.

|                          | Block X | Block Y |
|--------------------------|---------|---------|
| Initial temperature / °C | 20      | 80      |
| Final temperature / °C   | 60      | 60      |
| Specific heat capacity   | $2c$    | $c$     |

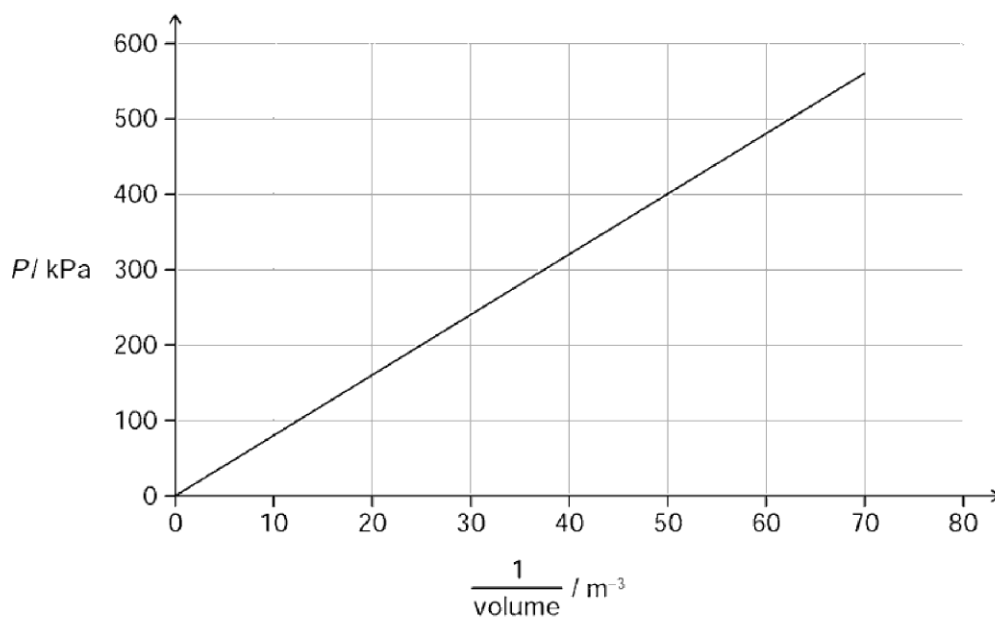
X has a mass  $m$ . What is the mass of Y?

- A.  $\frac{m}{4}$
- B.  $m$
- C.  $4m$
- D.  $6m$

## 44 - (PHYSI/11\_HL\_Summer\_2022\_Q12) - Thermal Physics



An ideal gas is maintained at a temperature of 100 K. The variation of the pressure  $P$  and  $\frac{1}{\text{volume}}$  of the gas is shown.



What is the quantity of the gas?

- A.  $\frac{2 \times 10^5}{R} \text{ mol}$
- B.  $\frac{200}{R} \text{ mol}$
- C.  $\frac{80}{R} \text{ mol}$
- D.  $\frac{4}{5R} \text{ mol}$

## 45 - (PHYSI/12\_HL\_Summer\_2022\_Q9) - Thermal Physics

What is true for an ideal gas?

- A.  $nRT = Nk_B T$
- B.  $nRT = k_B T$
- C.  $RT = Nk_B T$
- D.  $RT = k_B T$

46 - (PHYSI/12\_HL\_Summer\_2022\_Q10) - Thermal Physics



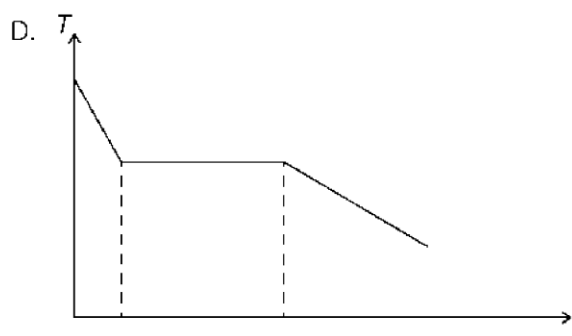
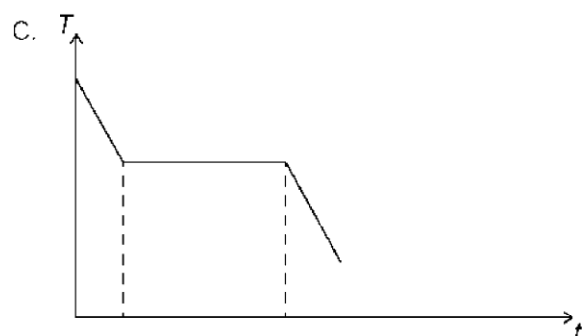
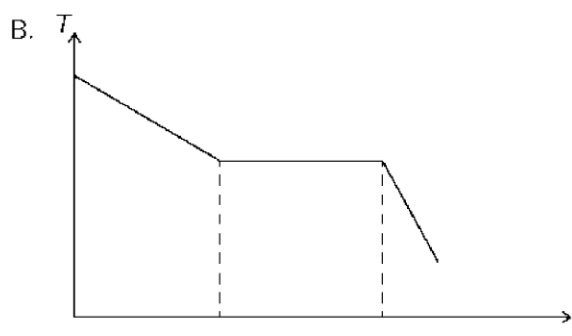
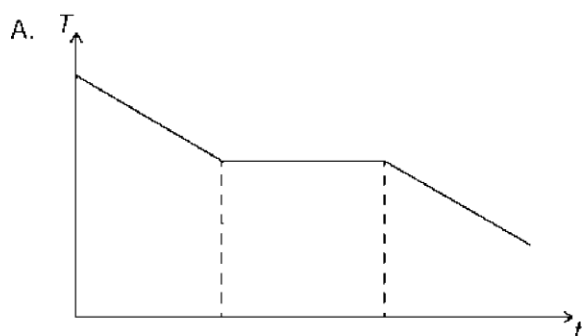
Which assumption is part of the molecular kinetic model of ideal gases?

- A. The work done on a system equals the change in kinetic energy of the system.
- B. The volume of a gas results from adding the volume of the individual molecules.
- C. A gas is made up of tiny identical particles in constant random motion.
- D. All particles in a gas have kinetic and potential energy.

47 - (PHYSI/12\_HL\_Summer\_2022\_Q11) - Thermal Physics

Water at room temperature is placed in a freezer. The specific heat capacity of water is twice the specific heat capacity of ice. Assume that thermal energy is transferred from the water at a constant rate.

Which graph shows the variation with time of the temperature of the water?



48 – (PHYSI/10\_HL\_Winter\_2022\_Q10) – *Thermal Physics*

Three samples of the same liquid are mixed in an insulated container. The masses and initial temperatures of the samples are:

|          | Mass | Initial temperature/°C |
|----------|------|------------------------|
| Sample 1 | $2M$ | 60                     |
| Sample 2 | $2M$ | 30                     |
| Sample 3 | $M$  | 0                      |

What is the equilibrium temperature of the mixture?

- A. 45 °C
- B. 36 °C
- C. 30 °C
- D. 24 °C

49 – (PHYSI/10\_HL\_Winter\_2022\_Q11) – *Thermal Physics*

Gases in the atmosphere are compounds of  $^{12}_6\text{C}$ ,  $^1_1\text{H}$ ,  $^{16}_8\text{O}$  and  $^{14}_7\text{N}$ .

Four of these gases are  $\text{CO}_2$ ,  $\text{N}_2\text{O}$ ,  $\text{CH}_4$  and  $\text{H}_2\text{O}$ . A pure sample of each gas is produced. Each sample has the same mass.

Which sample contains the greatest number of molecules?

- A.  $\text{N}_2\text{O}$
- B.  $\text{H}_2\text{O}$
- C.  $\text{CO}_2$
- D.  $\text{CH}_4$

50 – (PHYSI/10\_HL\_Winter\_2022\_Q12) – *Thermal Physics*

Three statements about Boltzmann's constant  $k_B$  are:

- I.  $k_B$  has a unit of  $\text{J K}^{-1}$
- II.  $k_B = \frac{\text{gas constant}}{\text{Avogadro's constant}}$
- III.  $k_B = \frac{\text{the average kinetic energy of particles}}{\text{temperature of the gas}}$

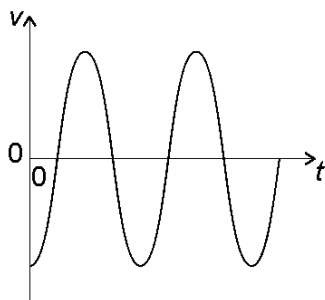
Which statements are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

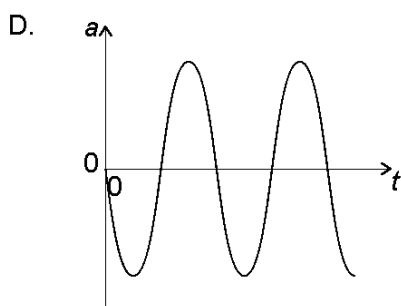
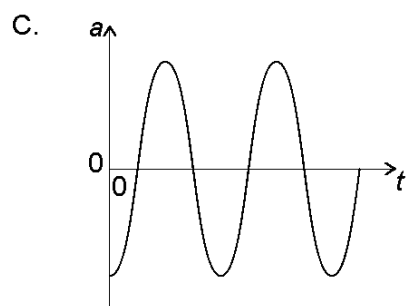
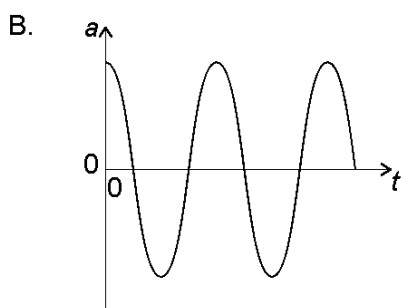
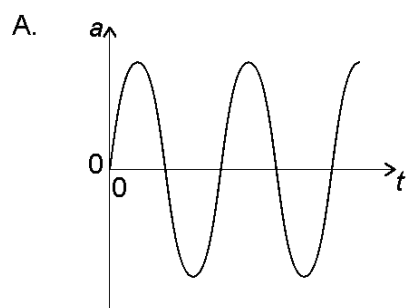
## 1 - (PHYSI/11\_HL\_Summer\_2017\_Q11) - Oscillations &amp; Waves



A particle undergoes simple harmonic motion (SHM). The graph shows the variation of velocity  $v$  of the particle with time  $t$ .



What is the variation with time of the acceleration  $a$  of the particle?



## 2 - (PHYSI/11\_HL\_Summer\_2017\_Q12) - Oscillations &amp; Waves

A travelling wave of period  $5.0\text{ms}$  travels along a stretched string at a speed of  $40\text{ms}^{-1}$ . Two points on the string are  $0.050\text{m}$  apart.

What is the phase difference between the two points?

- A. 0
- B.  $\frac{\pi}{2}$
- C.  $\pi$
- D.  $2\pi$



3 - (PHYSI/11\_HL\_Summer\_2017\_Q13) - Oscillations &amp; Waves



Properties of waves are

- I. polarization
- II. diffraction
- III. refraction

Which of these properties apply to sound waves?

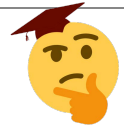
- A. I and II
- B. I and III
- C. II and III
- D. I, II and III

4 - (PHYSI/11\_HL\_Summer\_2017\_Q14) - Oscillations &amp; Waves

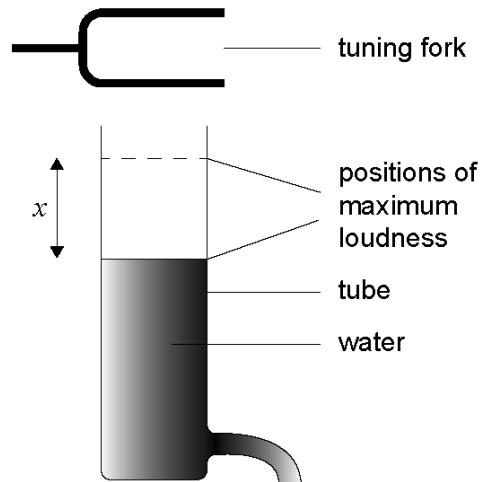
Unpolarized light of intensity  $I_0$  is incident on the first of two polarizing sheets. Initially the planes of polarization of the sheets are perpendicular.

Which sheet must be rotated and by what angle so that light of intensity  $\frac{I_0}{4}$  can emerge from the second sheet?

|    | Rotated sheet | Angle of rotation              |
|----|---------------|--------------------------------|
| A. | 1 only        | $\cos^{-1} \frac{\sqrt{2}}{2}$ |
| B. | 2 only        | $\cos^{-1} \frac{1}{2}$        |
| C. | 1 or 2        | $\cos^{-1} \frac{\sqrt{2}}{2}$ |
| D. | 1 or 2        | $\cos^{-1} \frac{1}{2}$        |

5 - (PHYSI/11\_HL\_Summer\_2017\_Q15) - *Oscillations & Waves*

Water is draining from a vertical tube that was initially full. A vibrating tuning fork is held near the top of the tube. For two positions of the water surface only, the sound is at its maximum loudness.



The distance between the two positions of maximum loudness is  $x$ .

What is the wavelength of the sound emitted by the tuning fork?

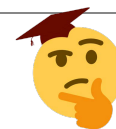
- A.  $\frac{x}{2}$
- B.  $x$
- C.  $\frac{3x}{2}$
- D.  $2x$

6 - (PHYSI/12\_HL\_Summer\_2017\_Q11) - *Oscillations & Waves*

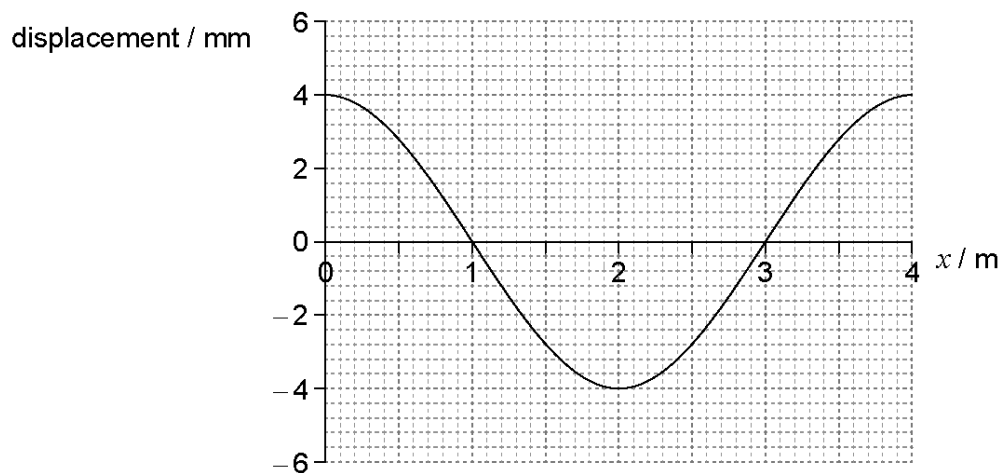
In simple harmonic oscillations which two quantities always have opposite directions?

- A. Kinetic energy and potential energy
- B. Velocity and acceleration
- C. Velocity and displacement
- D. Acceleration and displacement

7 - (PHYSI/12\_HL\_Summer\_2017\_Q12) - Oscillations &amp; Waves



The graph shows the variation with distance  $x$  of the displacement of the particles of a medium in which a longitudinal wave is travelling from left to right. Displacements to the right of equilibrium positions are positive.



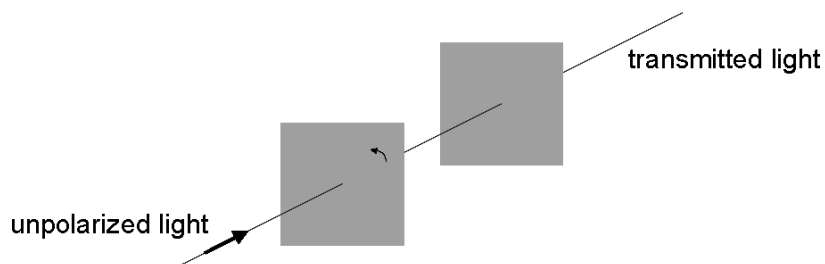
Which point is at the centre of a compression?

- A.  $x = 0$
- B.  $x = 1$  m
- C.  $x = 2$  m
- D.  $x = 3$  m

8 - (PHYSI/12\_HL\_Summer\_2017\_Q13) - Oscillations &amp; Waves



A beam of unpolarized light is incident on the first of two parallel polarizers. The transmission axes of the two polarizers are initially parallel.



The first polarizer is now rotated about the direction of the incident beam by an angle smaller than  $90^\circ$ . Which gives the changes, if any, in the intensity and polarization of the transmitted light?

|    | Intensity | Polarization |
|----|-----------|--------------|
| A. | different | same         |
| B. | different | different    |
| C. | same      | same         |
| D. | same      | different    |

9 - (PHYSI/12\_HL\_Summer\_2017\_Q14) - Oscillations &amp; Waves

The frequency of the first harmonic standing wave in a pipe that is open at both ends is 200 Hz. What is the frequency of the first harmonic in a pipe of the same length that is open at one end and closed at the other?

- A. 50 Hz
- B. 75 Hz
- C. 100 Hz
- D. 400 Hz

10 – (PHYSI/12\_HL\_Summer\_2017\_Q26) – Oscillations & Waves



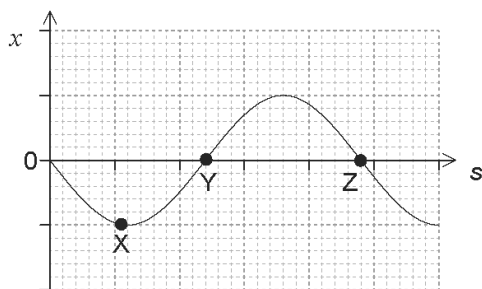
A mass oscillates with simple harmonic motion (SHM) of amplitude  $x_0$ . Its total energy is 16 J.

What is the kinetic energy of the mass when its displacement is  $\frac{x_0}{2}$ ?

- A. 4 J
- B. 8 J
- C. 12 J
- D. 16 J

11 – (PHYSI/10\_HL\_Winter\_2017\_Q11) – Oscillations & Waves

The graph shows the variation with position  $s$  of the displacement  $x$  of a wave undergoing simple harmonic motion (SHM).



What is the magnitude of the velocity at the displacements X, Y and Z?

|    | X       | Y       | Z       |
|----|---------|---------|---------|
| A. | maximum | zero    | maximum |
| B. | zero    | maximum | maximum |
| C. | maximum | maximum | zero    |
| D. | zero    | maximum | zero    |

## 12 - (PHYSI/10\_HL\_Winter\_2017\_Q12) - Oscillations &amp; Waves



Unpolarized light of intensity  $I_0$  is incident on a polarizing filter. Light from this filter is incident on a second filter, which has its axis of polarization at  $30^\circ$  to that of the first filter.

The value of  $\cos 30^\circ$  is  $\frac{\sqrt{3}}{2}$ . What is the intensity of the light emerging through the second filter?

A.  $\frac{\sqrt{3}}{2} I_0$

B.  $\frac{3}{2} I_0$

C.  $\frac{3}{4} I_0$

D.  $\frac{3}{8} I_0$

## 13 - (PHYSI/10\_HL\_Winter\_2017\_Q13) - Oscillations &amp; Waves

The refractive index for light travelling from medium X to medium Y is  $\frac{4}{3}$ . The refractive index for light travelling from medium Y to medium Z is  $\frac{3}{5}$ . What is the refractive index for light travelling from medium X to medium Z?

A.  $\frac{4}{5}$

B.  $\frac{15}{12}$

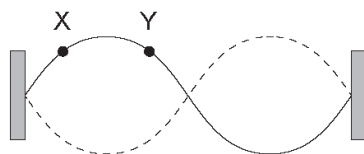
C.  $\frac{5}{4}$

D.  $\frac{29}{15}$

14 - (PHYSI/10\_HL\_Winter\_2017\_Q14) - Oscillations & Waves



The diagram shows a second harmonic standing wave on a string fixed at both ends.



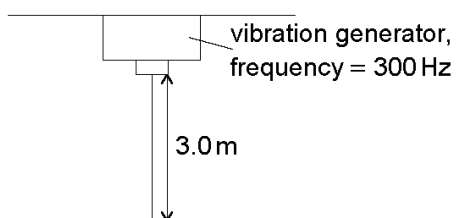
What is the phase difference, in rad, between the particle at X and the particle at Y?

- A. 0
- B.  $\frac{\pi}{4}$
- C.  $\frac{\pi}{2}$
- D.  $\frac{3\pi}{4}$

15 - (PHYSI/11\_HL\_Summer\_2018\_Q11) - Oscillations & Waves

A first-harmonic standing wave is formed on a vertical string of length 3.0 m using a vibration generator. The boundary conditions for this string are that it is fixed at one boundary and free at the other boundary.

diagram not to scale



The generator vibrates at a frequency of 300 Hz.

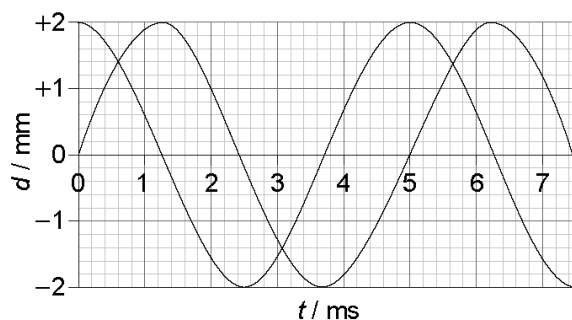
What is the speed of the wave on the string?

- A.  $0.90 \text{ km s}^{-1}$
- B.  $1.2 \text{ km s}^{-1}$
- C.  $1.8 \text{ km s}^{-1}$
- D.  $3.6 \text{ km s}^{-1}$

## 16 – (PHYSI/11\_HL\_Summer\_2018\_Q12) – Oscillations &amp; Waves



Two travelling waves are moving through a medium. The diagram shows, for a point in the medium, the variation with time  $t$  of the displacement  $d$  of each of the waves.



For the instant when  $t = 2.0$  ms, what is the phase difference between the waves and what is the resultant displacement of the waves?

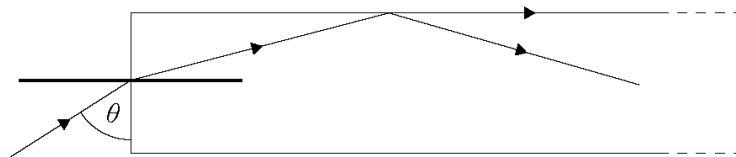
|    | Phase difference | Resultant displacement / mm |
|----|------------------|-----------------------------|
| A. | $45^\circ$       | -0.6                        |
| B. | $90^\circ$       | 2.6                         |
| C. | $45^\circ$       | 2.6                         |
| D. | $90^\circ$       | -0.6                        |



17 - (PHYSI/11\_HL\_Summer\_2018\_Q13) - Oscillations &amp; Waves



A ray of light passes from the air into a long glass plate of refractive index  $n$  at an angle  $\theta$  to the edge of the plate.



The ray is incident on the internal surface of the glass plate and the refracted ray travels along the external surface of the plate.

What change to  $n$  and what change to  $\theta$  will cause the ray to travel entirely within the plate after incidence?

|    | Change to $n$ | Change to $\theta$ |
|----|---------------|--------------------|
| A. | increase      | increase           |
| B. | increase      | decrease           |
| C. | decrease      | increase           |
| D. | decrease      | decrease           |

18 - (PHYSI/11\_HL\_Summer\_2018\_Q14) - Oscillations &amp; Waves

A system that is subject to a restoring force oscillates about an equilibrium position.

For the motion to be simple harmonic, the restoring force must be proportional to

- A. the amplitude of the oscillation.
- B. the displacement from the equilibrium position.
- C. the potential energy of the system.
- D. the period of the oscillation.

19 – (PHYSI/11\_HL\_Summer\_2018\_Q26) – *Mechanics, Oscillations & Waves*

A mass at the end of a vertical spring and a simple pendulum perform oscillations on Earth that are simple harmonic with time period  $T$ . Both the pendulum and the mass-spring system are taken to the Moon. The acceleration of free fall on the Moon is smaller than that on Earth. What is correct about the time periods of the pendulum and the mass-spring system on the Moon?

|    | Simple pendulum  | Mass-spring system |
|----|------------------|--------------------|
| A. | $T$              | $T$                |
| B. | greater than $T$ | $T$                |
| C. | greater than $T$ | greater than $T$   |
| D. | $T$              | greater than $T$   |

20 – (PHYSI/12\_HL\_Summer\_2018\_Q10) – *Oscillations & Waves*

Two sound waves from a point source on the ground travel through the ground to a detector. The speed of one wave is  $7.5 \text{ km s}^{-1}$ , the speed of the other wave is  $5.0 \text{ km s}^{-1}$ . The waves arrive at the detector 15 s apart. What is the distance from the point source to the detector?

- A. 38 km
- B. 45 km
- C. 113 km
- D. 225 km

21 – (PHYSI/12\_HL\_Summer\_2018\_Q11) – *Oscillations & Waves*

What is true about the acceleration of a particle that is oscillating with simple harmonic motion (SHM)?

- A. It is in the opposite direction to its velocity
- B. It is decreasing when the potential energy is increasing
- C. It is proportional to the frequency of the oscillation
- D. It is at a minimum when the velocity is at a maximum

22 – (PHYSI/12\_HL\_Summer\_2018\_Q12) – Oscillations &amp; Waves

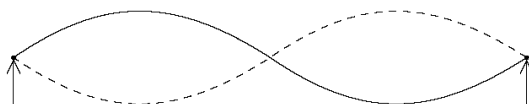


What are the changes in the speed and in the wavelength of monochromatic light when the light passes from water to air?

|    | Change in speed | Change in wavelength |
|----|-----------------|----------------------|
| A. | increases       | increases            |
| B. | increases       | decreases            |
| C. | decreases       | increases            |
| D. | decreases       | decreases            |

23 – (PHYSI/12\_HL\_Summer\_2018\_Q13) – Oscillations &amp; Waves

A string stretched between two fixed points sounds its second harmonic at frequency  $f$ .

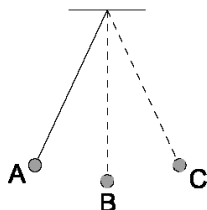


Which expression, where  $n$  is an integer, gives the frequencies of harmonics that have a node at the centre of the string?

- A.  $\frac{n+1}{2}f$
- B.  $nf$
- C.  $2nf$
- D.  $(2n+1)f$

24 – (PHYSI/12\_HL\_Summer\_2018\_Q24) – Oscillations &amp; Waves

A simple pendulum bob oscillates as shown.



At which position is the resultant force on the pendulum bob zero?

- A. At position A
- B. At position B
- C. At position C
- D. Resultant force is never zero during the oscillation

25 – (PHYSI/10\_HL\_Winter\_2018\_Q12) – *Oscillations & Waves*

A longitudinal wave moves through a medium. Relative to the direction of energy transfer through the medium, what are the displacement of the medium and the direction of propagation of the wave?

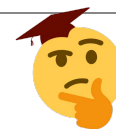
|    | Displacement of medium | Direction of propagation of wave |
|----|------------------------|----------------------------------|
| A. | parallel               | perpendicular                    |
| B. | parallel               | parallel                         |
| C. | perpendicular          | parallel                         |
| D. | perpendicular          | perpendicular                    |

26 – (PHYSI/10\_HL\_Winter\_2018\_Q13) – *Oscillations & Waves*

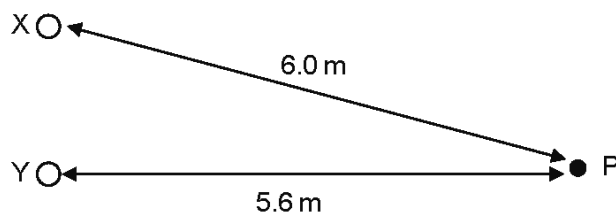
L is a point source of light. The intensity of the light at a distance  $2x$  from L is  $I$ . What is the intensity at a distance  $3x$  from L?

- A.  $\frac{4}{9}I$
- B.  $\frac{2}{3}I$
- C.  $\frac{3}{2}I$
- D.  $\frac{9}{4}I$

27 - (PHYSI/10\_HL\_Winter\_2018\_Q14) - Oscillations &amp; Waves



X and Y are two coherent sources of waves. The phase difference between X and Y is zero. The intensity at P due to X and Y separately is  $I$ . The wavelength of each wave is 0.20 m.



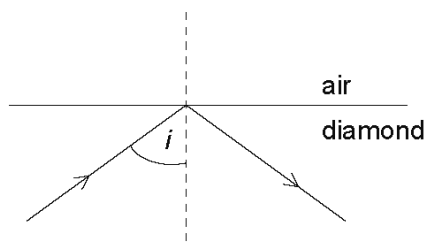
What is the resultant intensity at P?

- A. 0
- B.  $I$
- C.  $2I$
- D.  $4I$

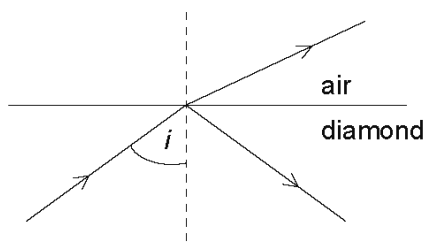
28 - (PHYSI/10\_HL\_Winter\_2018\_Q15) - Oscillations &amp; Waves

Light is incident at the boundary between air and diamond. The speed of light in diamond is less than the speed of light in air. The angle of incidence  $i$  of the light is greater than the critical angle. Which diagram is correct for this situation?

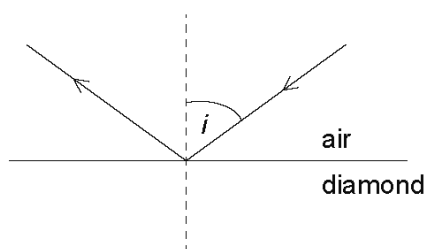
A.



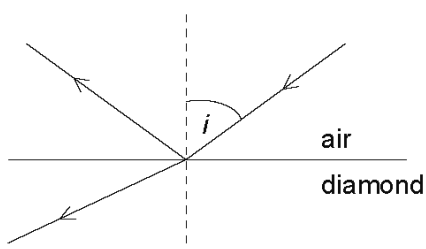
B.



C.



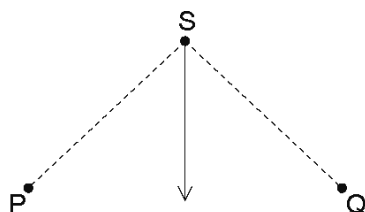
D.



29 – (PHYSI/10\_HL\_Winter\_2018\_Q18) – Oscillations &amp; Waves



Two parallel wires P and Q are perpendicular to the page and carry equal currents. Point S is the same distance from both wires. The arrow shows the magnetic field at S due to P and Q.



What are the correct directions for the current at P and the current at Q?

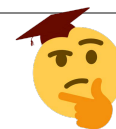
|    | Current direction at P | Current direction at Q |
|----|------------------------|------------------------|
| A. | into page              | out of page            |
| B. | out of page            | out of page            |
| C. | into page              | into page              |
| D. | out of page            | into page              |

30 – (PHYSI/10\_HL\_Winter\_2018\_Q26) – Oscillations &amp; Waves

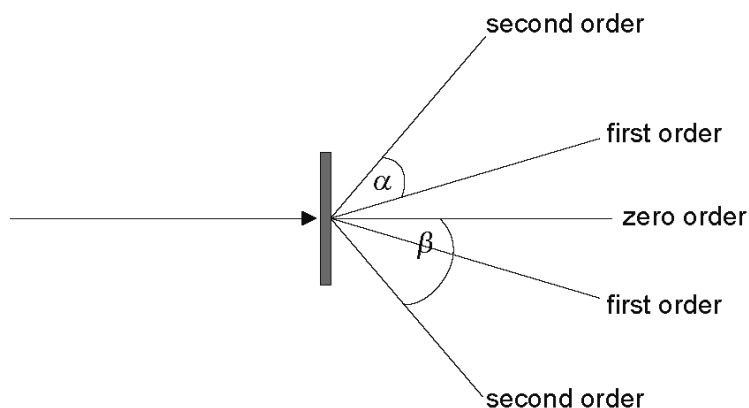
An object undergoing simple harmonic motion (SHM) has a period  $T$  and total energy  $E$ . The amplitude of oscillations is halved. What are the new period and total energy of the system?

|    | Period        | Total energy  |
|----|---------------|---------------|
| A. | $\frac{T}{2}$ | $\frac{E}{4}$ |
| B. | $\frac{T}{2}$ | $\frac{E}{2}$ |
| C. | $T$           | $\frac{E}{4}$ |
| D. | $T$           | $\frac{E}{2}$ |

31 – (PHYSI/10\_HL\_Winter\_2018\_Q28) – Oscillations & Waves, Wave Phenomena (ahl)



A beam of monochromatic light is incident normally on a diffraction grating. The grating spacing is  $d$ . The angles between the different orders are shown on the diagram.



What is the expression for the wavelength of light used?

- A.  $\frac{d \sin \alpha}{2}$
- B.  $\frac{d \sin \beta}{2}$
- C.  $d \sin \alpha$
- D.  $d \sin \beta$

32 – (PHYSI/10\_HL\_Winter\_2018\_Q29) – Oscillations & Waves

An ambulance siren emits a sound of frequency 1200 Hz. The speed of sound in air is  $330 \text{ m s}^{-1}$ . The ambulance moves towards a stationary observer at a constant speed of  $40 \text{ m s}^{-1}$ . What is the frequency heard by the observer?

- A.  $\frac{1200 \times 330}{370} \text{ Hz}$
- B.  $\frac{1200 \times 290}{330} \text{ Hz}$
- C.  $\frac{1200 \times 370}{330} \text{ Hz}$
- D.  $\frac{1200 \times 330}{290} \text{ Hz}$

33 - (PHYSI/11\_HL\_Summer\_2019\_Q11) - Oscillations &amp; Waves

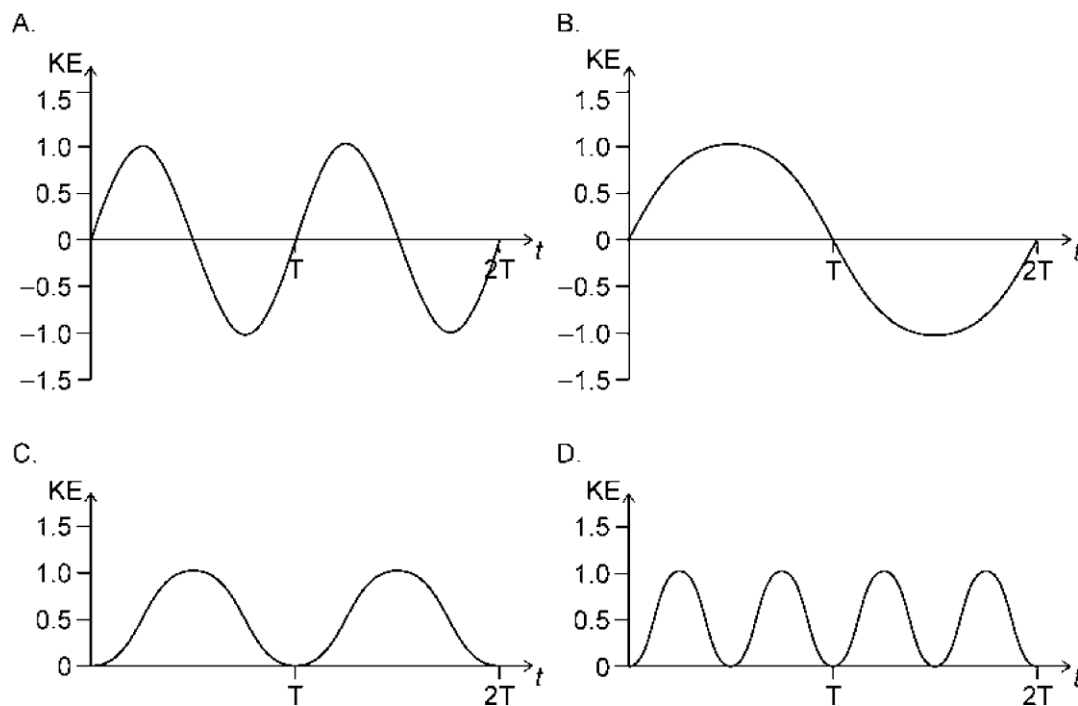


A particle performs simple harmonic motion (shm). What is the phase difference between the displacement and the acceleration of the particle?

- A. 0
- B.  $\frac{\pi}{2}$
- C.  $\pi$
- D.  $\frac{3\pi}{2}$

34 - (PHYSI/11\_HL\_Summer\_2019\_Q12) - Oscillations &amp; Waves

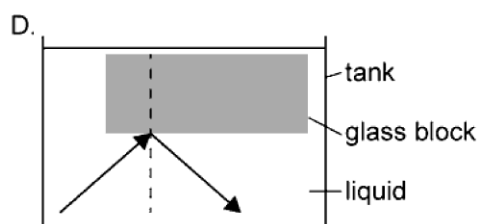
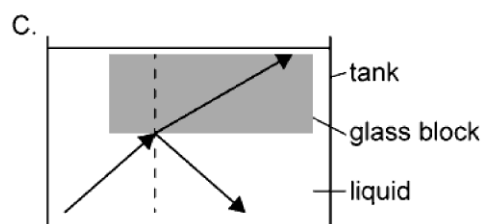
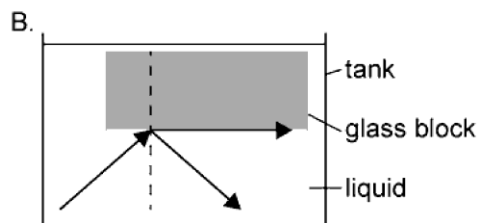
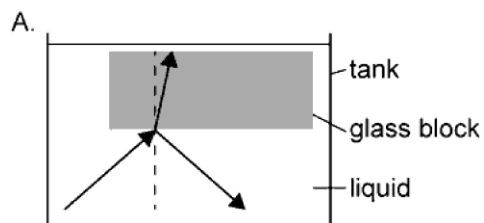
Which graph shows the variation with time  $t$  of the kinetic energy (KE) of an object undergoing simple harmonic motion (shm) of period  $T$ ?





35 – (PHYSI/11\_HL\_Summer\_2019\_Q13) – *Oscillations & Waves*

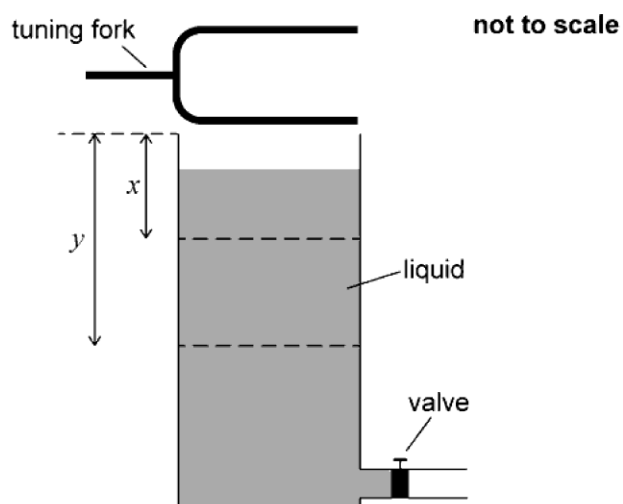
A glass block of refractive index 1.5 is immersed in a tank filled with a liquid of higher refractive index. Light is incident on the base of the glass block. Which is the correct diagram for rays incident on the glass block at an angle greater than the critical angle?



36 – (PHYSI/11\_HL\_Summer\_2019\_Q14) – *Oscillations & Waves*

In an experiment to determine the speed of sound in air, a tube that is open at the top is filled with water and a vibrating tuning fork is held over the tube as the water is released through a valve.

An increase in intensity in the sound is heard for the first time when the air column length is  $x$ . The next increase is heard when the air column length is  $y$ .



Which expressions are approximately correct for the wavelength of the sound?

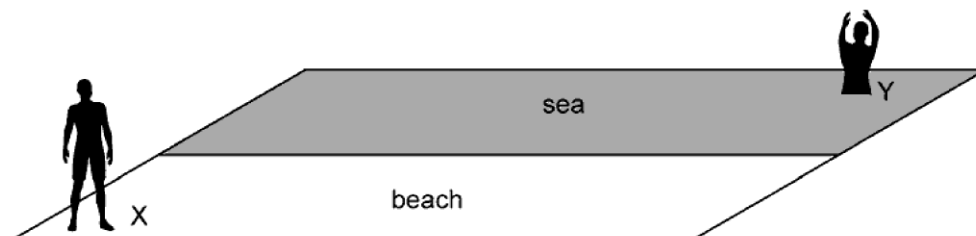
- I.  $4x$
  - II.  $4y$
  - III.  $\frac{4y}{3}$
- A. I and II
- B. I and III
- C. II and III
- D. I, II and III

37 – (PHYSI/11\_HL\_Summer\_2019\_Q27) – Oscillations & Waves, Wave Phenomena (ahl)



In science, models are extensively used to study real life situations.

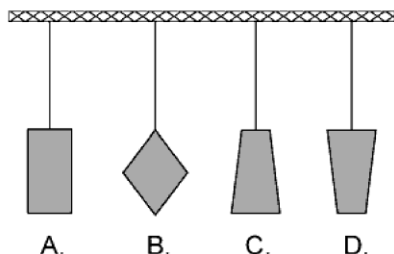
A person X on the beach wants to reach a person Y in the sea in the shortest possible time. The speed of person X on land is different from the speed of person X in the water. Which physical phenomenon will best model the path with the least time?



- A. Conservation of momentum
- B. Diffraction
- C. Flow of charge in a conductor
- D. Refraction

38 – (PHYSI/11\_HL\_Summer\_2019\_Q28) – Oscillations & Waves, Wave Phenomena (ahl)

The four pendulums shown have been cut from the same uniform sheet of board. They are attached to the ceiling with strings of equal length.



Which pendulum has the shortest period?

39 – (PHYSI/11\_HL\_Summer\_2019\_Q29) – Oscillations & Waves, Wave Phenomena (ahl)

In a Young's double-slit experiment, the distance between fringes is too small to be observed.

What change would increase the distance between fringes?

- A. Increasing the frequency of light
- B. Increasing the distance between slits
- C. Increasing the distance from the slits to the screen
- D. Increasing the distance between light source and slits

40 – (PHYSI/11\_HL\_Summer\_2019\_Q30) – Oscillations & Waves, Wave Phenomena (ahl)



The headlights of a car emit light of wavelength 400 nm and are separated by 1.2 m. The headlights are viewed by an observer whose eye has an aperture of 4.0 mm. The observer can just distinguish the headlights as separate images. What is the distance between the observer and the headlights?

- A. 8 km
- B. 10 km
- C. 15 km
- D. 20 km

41 – (PHYSI/11\_HL\_Summer\_2019\_Q31) – Oscillations & Waves, Wave Phenomena (ahl)

A transparent liquid film of refractive index 1.5 coats the outside of a glass lens of higher refractive index. The liquid film is used to eliminate reflection from the lens at wavelength  $\lambda$  in air.

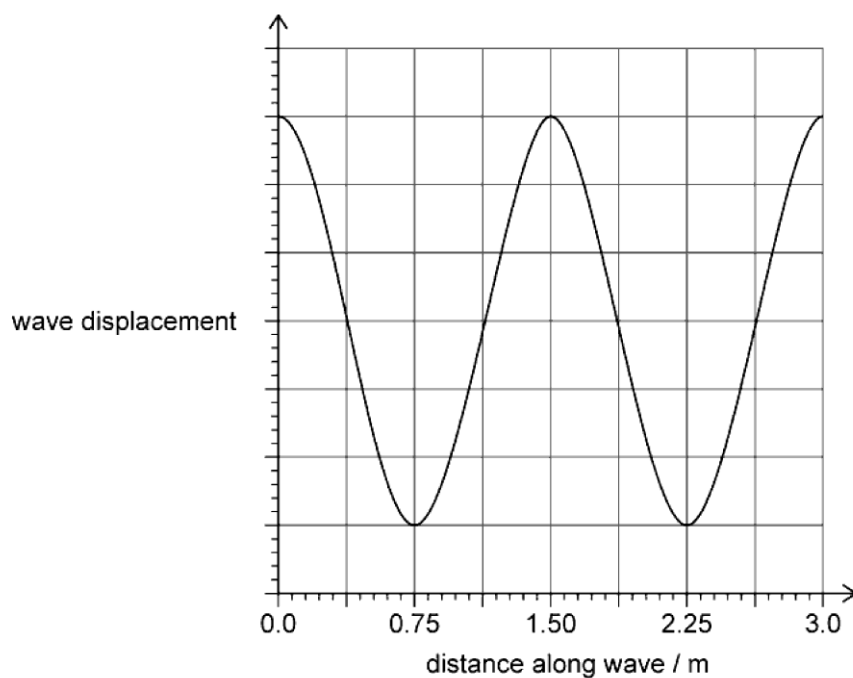
What is the minimum thickness of the liquid film coating and the phase change at the liquid–glass interface?

|    | Coating thickness   | Phase change |
|----|---------------------|--------------|
| A. | $\frac{\lambda}{3}$ | 0            |
| B. | $\frac{\lambda}{3}$ | $\pi$        |
| C. | $\frac{\lambda}{6}$ | 0            |
| D. | $\frac{\lambda}{6}$ | $\pi$        |

42 – (PHYSI/12\_HL\_Summer\_2019\_Q15) – Oscillations &amp; Waves



The graph shows the variation of the displacement of a wave with distance along the wave.  
The wave speed is  $0.50 \text{ m s}^{-1}$ .



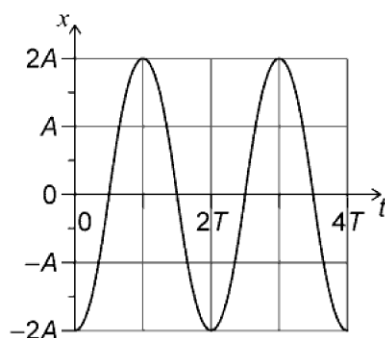
What is the period of the wave?

- A. 0.33 s
- B. 1.5 s
- C. 3.0 s
- D. 6.0 s

## 43 – (PHYSI/12\_HL\_Summer\_2019\_Q16) – Oscillations &amp; Waves



An object at the end of a spring oscillates vertically with simple harmonic motion (shm). The graph shows the variation with time  $t$  of the displacement  $x$  of the object.

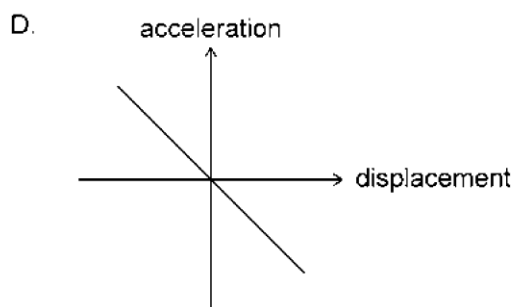
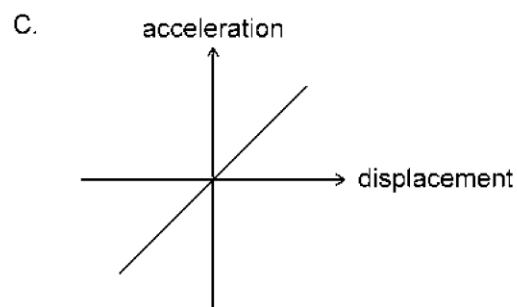
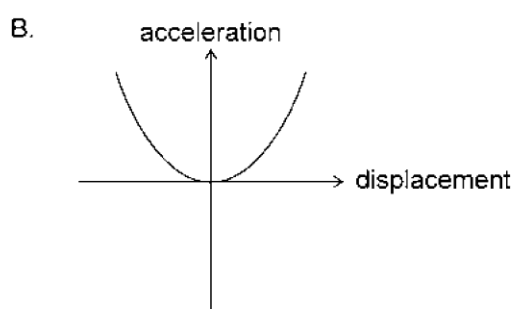
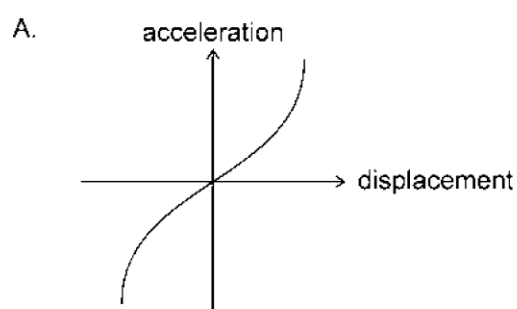


What is the velocity of the object?

- A.  $-\frac{2\pi A}{T} \sin\left(\frac{\pi t}{T}\right)$
- B.  $\frac{2\pi A}{T} \sin\left(\frac{\pi t}{T}\right)$
- C.  $-\frac{2\pi A}{T} \cos\left(\frac{\pi t}{T}\right)$
- D.  $\frac{2\pi A}{T} \cos\left(\frac{\pi t}{T}\right)$

## 44 – (PHYSI/12\_HL\_Summer\_2019\_Q17) – Oscillations &amp; Waves

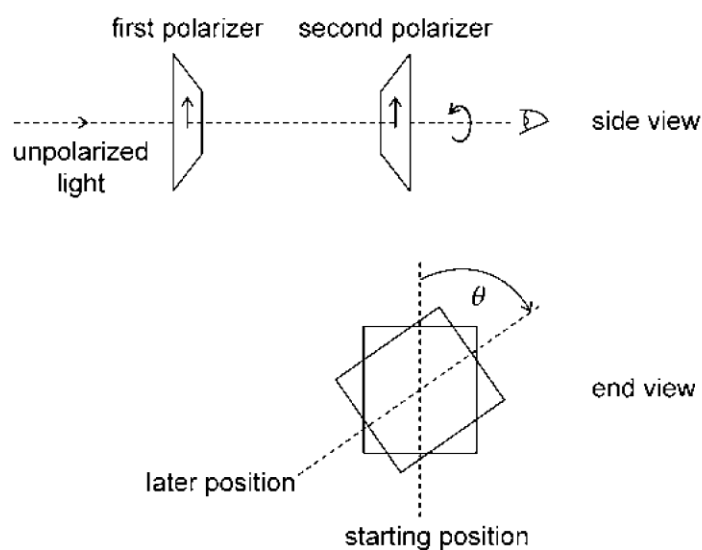
A mass on a spring is displaced from its equilibrium position. Which graph represents the variation of acceleration with displacement for the mass after it is released?



45 – (PHYSI/12\_HL\_Summer\_2019\_Q18) – Oscillations &amp; Waves

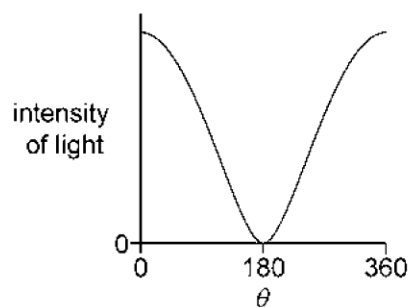


Unpolarized light is incident on two polarizers. The axes of polarization of both polarizers are initially parallel. The second polarizer is then rotated through  $360^\circ$  as shown.

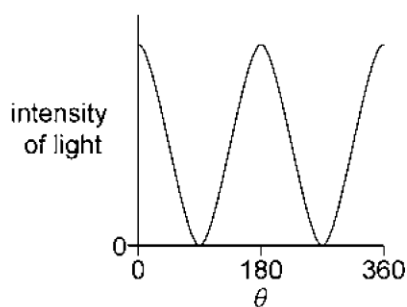


Which graph shows the variation of intensity with angle  $\theta$  for the light leaving the second polarizer?

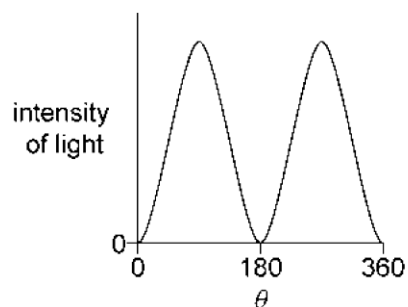
A.



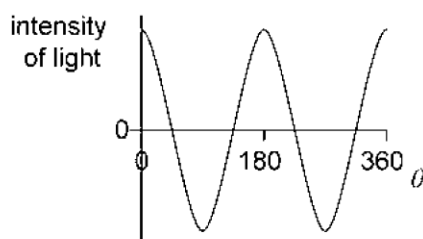
B.



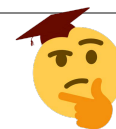
C.



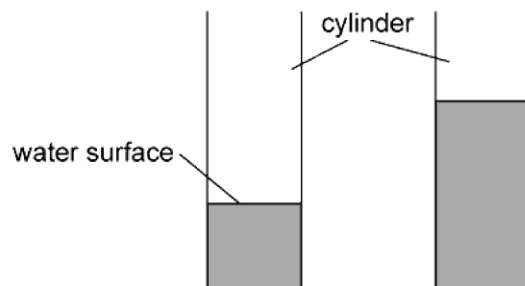
D.



46 – (PHYSI/12\_HL\_Summer\_2019\_Q19) – Oscillations &amp; Waves



A student blows across the top of a cylinder that contains water. A first-harmonic standing sound wave is produced in the air of the cylinder. More water is then added to the cylinder. The student blows so that a first-harmonic standing wave is produced with a different frequency.



What is the nature of the displacement in the air at the water surface and the change in frequency when the water is added?

|    | Nature of displacement | Change in frequency |
|----|------------------------|---------------------|
| A. | antinode               | decrease            |
| B. | antinode               | increase            |
| C. | node                   | decrease            |
| D. | node                   | increase            |

47 – (PHYSI/12\_HL\_Summer\_2019\_Q20) – Oscillations &amp; Waves

A third-harmonic standing wave of wavelength 0.80 m is set up on a string fixed at both ends. Two points on the wave are separated by a distance of 0.60 m. What is a possible phase difference between the two points on the wave?

- A.  $\frac{\pi}{4}$  rad
- B.  $\frac{\pi}{2}$  rad
- C.  $\pi$  rad
- D.  $\frac{3\pi}{2}$  rad



48 – (PHYSI/12\_HL\_Summer\_2019\_Q21) – Oscillations &amp; Waves



A train approaches a station and sounds a horn of constant frequency and constant intensity. An observer waiting at the station detects a frequency  $f_{\text{obs}}$  and an intensity  $I_{\text{obs}}$ . What are the changes, if any, in  $I_{\text{obs}}$  and  $f_{\text{obs}}$  as the train slows down?

|    | $I_{\text{obs}}$ | $f_{\text{obs}}$ |
|----|------------------|------------------|
| A. | no change        | decreases        |
| B. | increases        | increases        |
| C. | no change        | increases        |
| D. | increases        | decreases        |

49 – (PHYSI/12\_HL\_Summer\_2019\_Q22) – Oscillations &amp; Waves

Two stars are viewed with a telescope using a green filter. The images of the stars are just resolved. What is the change, if any, to the angular separation of the images of the stars and to the resolution of the images when the green filter is replaced by a violet filter?

|    | Angular separation of the stars | Resolution of the images |
|----|---------------------------------|--------------------------|
| A. | no change                       | remains resolved         |
| B. | decreases                       | no longer resolved       |
| C. | decreases                       | remains resolved         |
| D. | no change                       | no longer resolved       |

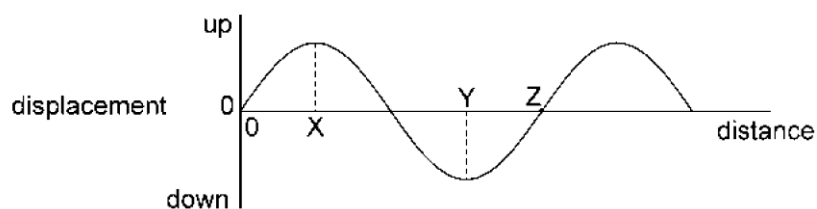
50 – (PHYSI/12\_HL\_Summer\_2019\_Q37) – Oscillations &amp; Waves, Circular Motion &amp; Gravitation

The orbital radius of the Earth around the Sun is 1.5 times that of Venus. What is the intensity of solar radiation at the orbital radius of Venus?

- A.  $0.6 \text{ kWm}^{-2}$
- B.  $0.9 \text{ kWm}^{-2}$
- C.  $2 \text{ kWm}^{-2}$
- D.  $3 \text{ kWm}^{-2}$

51 – (PHYSI/10\_HL\_Winter\_2019\_Q11) – *Oscillations & Waves*

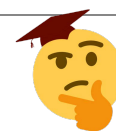
A transverse travelling wave is moving through a medium. The graph shows, for one instant, the variation with distance of the displacement of particles in the medium.



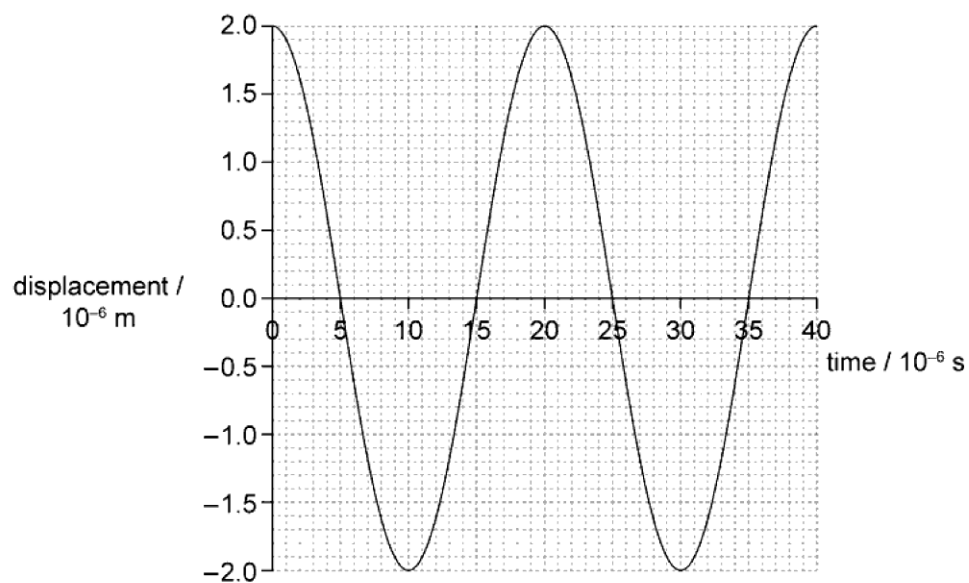
The frequency of the wave is  $25\text{ Hz}$  and the speed of the wave is  $100\text{ m s}^{-1}$ . What is correct for this wave?

- A. The particles at X and Y are in phase.
- B. The velocity of the particle at X is a maximum.
- C. The horizontal distance between X and Z is  $3.0\text{ m}$ .
- D. The velocity of the particle at Y is  $100\text{ m s}^{-1}$ .

52 – (PHYSI/10\_HL\_Winter\_2019\_Q12) – Oscillations &amp; Waves



The graph shows the variation with time for the displacement of a particle in a travelling wave.

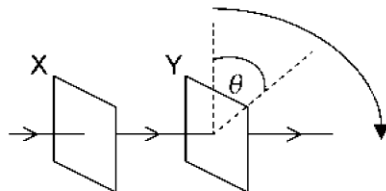


What are the frequency and amplitude for the oscillation of the particle?

|    | Frequency / kHz | Amplitude / $\mu\text{m}$ |
|----|-----------------|---------------------------|
| A. | 20              | 2                         |
| B. | 20              | 4                         |
| C. | 50              | 2                         |
| D. | 50              | 4                         |

53 – (PHYSI/10\_HL\_Winter\_2019\_Q13) – *Oscillations & Waves*

Unpolarized light is incident on two polarizing filters X and Y. They are arranged so that light emerging from Y has a maximum intensity. X is fixed and Y is rotated through  $\theta$  about the direction of the incident beam in its own plane.



What are the first three successive values of  $\theta$  for which the final transmitted intensity is a maximum?

- A.  $90^\circ, 180^\circ, 270^\circ$
- B.  $90^\circ, 270^\circ, 450^\circ$
- C.  $180^\circ, 360^\circ, 540^\circ$
- D.  $180^\circ, 540^\circ, 720^\circ$

54 – (PHYSI/10\_HL\_Winter\_2019\_Q14) – *Oscillations & Waves*

A pipe of length 0.6 m is filled with a gas and closed at one end. The speed of sound in the gas is  $300 \text{ m s}^{-1}$ . What are the frequencies of the first two harmonics in the tube?

- A. 125 Hz and 250 Hz
- B. 125 Hz and 375 Hz
- C. 250 Hz and 500 Hz
- D. 250 Hz and 750 Hz

55 – (PHYSI/10\_HL\_Winter\_2019\_Q26) – *Oscillations & Waves*

An object undergoes simple harmonic motion (shm) of amplitude  $x_0$ . When the displacement of the object is  $\frac{x_0}{3}$ , the speed of the object is  $v$ . What is the speed when the displacement is  $x_0$ ?

- A. 0
- B.  $\frac{v}{3}$
- C.  $\frac{\sqrt{2}}{3}v$
- D.  $3v$

56 - (PHYSI/10\_HL\_Winter\_2019\_Q27) - *Oscillations & Waves, Wave Phenomena (ahl)*

Light of frequency 500 THz is incident on a single slit and forms a diffraction pattern. The first diffraction minimum forms at an angle of  $2.4 \times 10^{-3}$  rad to the central maximum. The frequency of the light is now changed to 750 THz. What is the angle between the first diffraction minimum and the central maximum?

- A.  $1.6 \times 10^{-3}$  rad
- B.  $1.8 \times 10^{-3}$  rad
- C.  $2.4 \times 10^{-3}$  rad
- D.  $3.6 \times 10^{-3}$  rad

57 - (PHYSI/10\_HL\_Winter\_2019\_Q28) - *Oscillations & Waves, Wave Phenomena (ahl)*

Light of wavelength  $\lambda$  is normally incident on a diffraction grating of spacing  $3\lambda$ . What is the angle between the two second-order maxima?

- A.  $\sin^{-1} \frac{2}{3}$
- B.  $\sin^{-1} \frac{4}{3}$
- C.  $2 \sin^{-1} \frac{2}{3}$
- D.  $>90^\circ$  so no second orders appear

58 - (PHYSI/10\_HL\_Winter\_2020\_Q10) - *Oscillations & Waves*

An object moves with simple harmonic motion. The acceleration of the object is

- A. constant.
- B. always directed away from the centre of the oscillation.
- C. a maximum at the centre of the oscillation.
- D. a maximum at the extremes of the oscillation.

59 - (PHYSI/10\_HL\_Winter\_2020\_Q11) - *Oscillations & Waves*

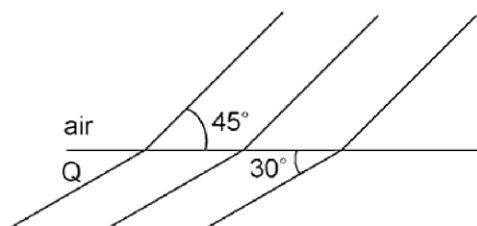
A travelling wave has a frequency of 500 Hz. The closest distance between two points on the wave that have a phase difference of  $60^\circ \left( \frac{\pi}{3} \text{ rad} \right)$  is 0.050 m. What is the speed of the wave?

- A.  $25 \text{ m s}^{-1}$
- B.  $75 \text{ m s}^{-1}$
- C.  $150 \text{ m s}^{-1}$
- D.  $300 \text{ m s}^{-1}$

60 – (PHYSI/10\_HL\_Winter\_2020\_Q12) – Oscillations &amp; Waves



Wavefronts travel from air to medium Q as shown.



What is the refractive index of Q?

- A.  $\frac{\sin 30^\circ}{\sin 45^\circ}$
- B.  $\frac{\sin 45^\circ}{\sin 30^\circ}$
- C.  $\frac{\sin 45^\circ}{\sin 60^\circ}$
- D.  $\frac{\sin 60^\circ}{\sin 45^\circ}$

61 – (PHYSI/10\_HL\_Winter\_2020\_Q13) – Oscillations &amp; Waves

The air in a pipe, open at both ends, vibrates in the second harmonic mode.



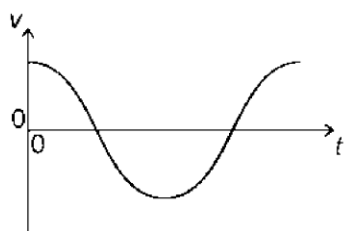
What is the phase difference between the motion of a particle at P and the motion of a particle at Q?

- A. 0
- B.  $\frac{\pi}{2}$
- C.  $\pi$
- D.  $2\pi$

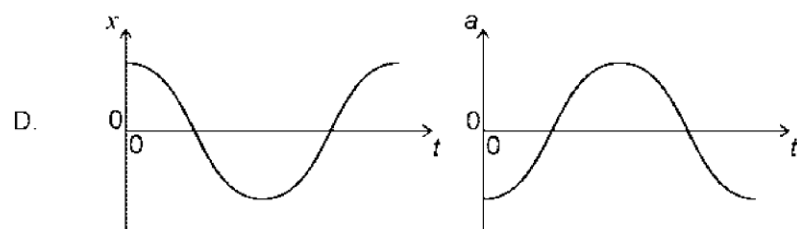
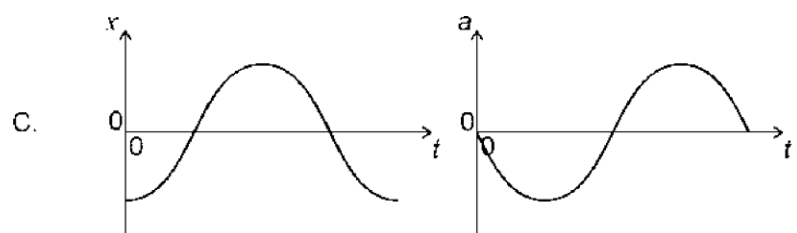
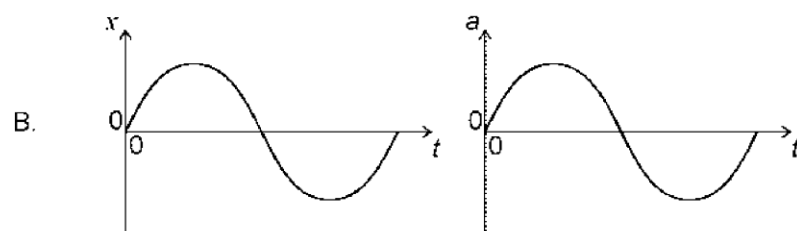
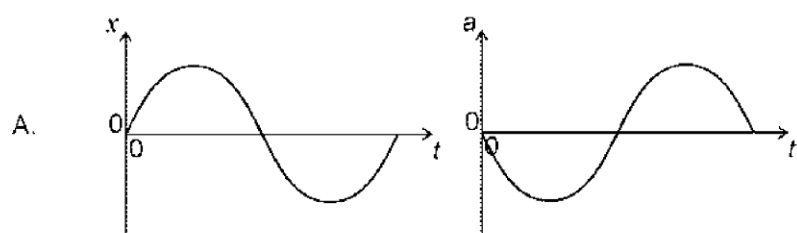
62 – (PHYSI/11\_HL\_Summer\_2021\_Q11) – Oscillations &amp; Waves



An object performs simple harmonic motion (shm). The graph shows how the velocity  $v$  of the object varies with time  $t$ .



The displacement of the object is  $x$  and its acceleration is  $a$ . What is the variation of  $x$  with  $t$  and the variation of  $a$  with  $t$ ?



63 – (PHYSI/11\_HL\_Summer\_2021\_Q12) – Oscillations &amp; Waves



A sound wave has a frequency of 1.0 kHz and a wavelength of 0.33 m. What is the distance travelled by the wave in 2.0 ms and the nature of the wave?

|    | Distance travelled in 2.0 ms | Nature of the wave |
|----|------------------------------|--------------------|
| A. | 0.17 m                       | longitudinal       |
| B. | 0.17 m                       | transverse         |
| C. | 0.66 m                       | longitudinal       |
| D. | 0.66 m                       | transverse         |

64 – (PHYSI/11\_HL\_Summer\_2021\_Q13) – Oscillations &amp; Waves

Monochromatic light of wavelength  $\lambda$  is incident on a double slit. The resulting interference pattern is observed on a screen a distance  $y$  from the slits. The distance between consecutive fringes in the pattern is 55 mm when the slit separation is  $a$ .

$\lambda$ ,  $y$  and  $a$  are all doubled. What is the new distance between consecutive fringes?

- A. 55 mm
- B. 110 mm
- C. 220 mm
- D. 440 mm

65 – (PHYSI/11\_HL\_Summer\_2021\_Q14) – Oscillations &amp; Waves

A metal rod of length 45 cm is clamped at its mid point. The speed of sound in the metal rod is  $1500 \text{ m s}^{-1}$  and the speed of sound in air is  $300 \text{ m s}^{-1}$ . The metal rod vibrates at its first harmonic. What is the wavelength in air of the sound wave produced by the metal rod?

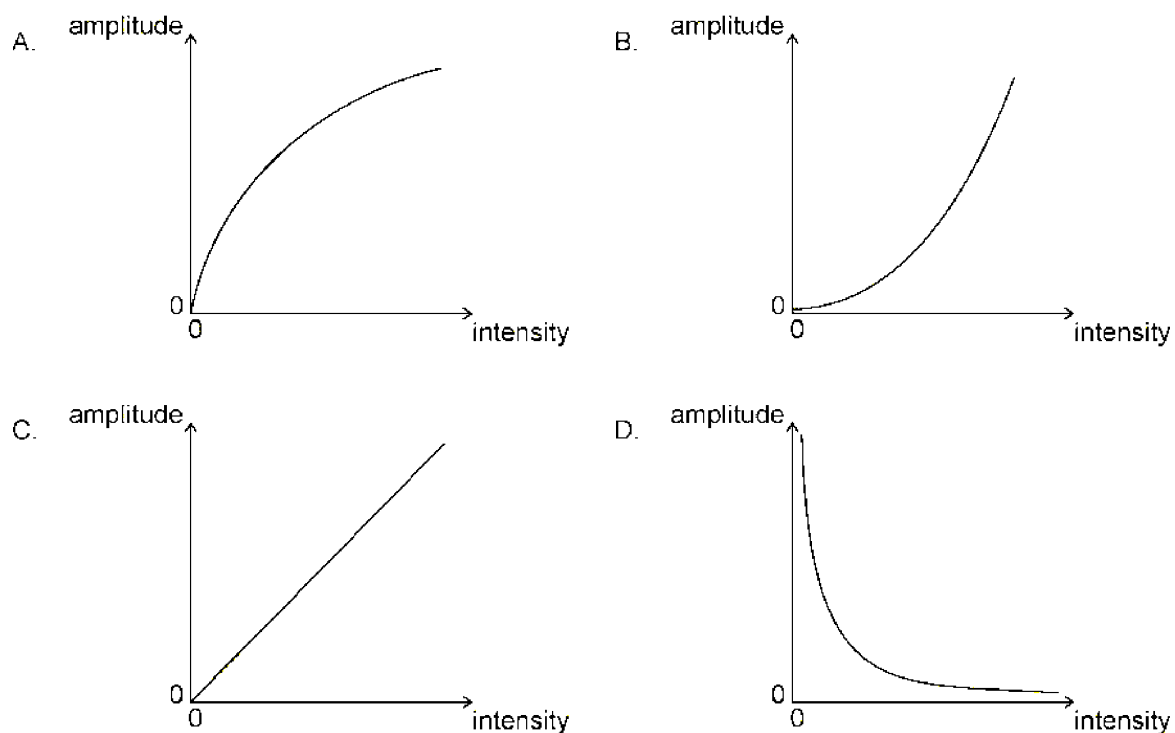
- A. 4.5 cm
- B. 9.0 cm
- C. 18 cm
- D. 90 cm



66 – (PHYSI/12\_HL\_Summer\_2021\_Q12) – Oscillations &amp; Waves

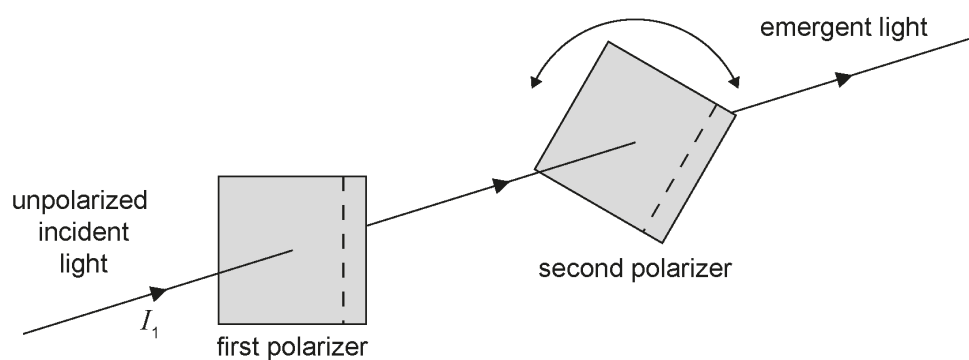


Which graph shows the variation of amplitude with intensity for a wave?



67 – (PHYSI/12\_HL\_Summer\_2021\_Q13) – Oscillations &amp; Waves

Unpolarized light of intensity  $I_1$  is incident on a polarizer. The light that passes through this polarizer then passes through a second polarizer.



The second polarizer can be rotated to vary the intensity of the emergent light. What is the maximum value of the intensity emerging from the second polarizer?

- A.  $\frac{I_1}{4}$
- B.  $\frac{I_1}{2}$
- C.  $\frac{2I_1}{3}$
- D.  $I_1$

68 – (PHYSI/12\_HL\_Summer\_2021\_Q14) – *Oscillations & Waves*

The frequency of the first harmonic in a pipe is measured. An adjustment is then made which causes the speed of sound in the pipe to increase. What is true for the frequency and the wavelength of the first harmonic when the speed of sound has increased?

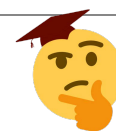
|    | Frequency | Wavelength |
|----|-----------|------------|
| A. | increase  | unchanged  |
| B. | unchanged | increase   |
| C. | increase  | increase   |
| D. | unchanged | unchanged  |

69 – (PHYSI/10\_HL\_Winter\_2021\_Q11) – *Oscillations & Waves*

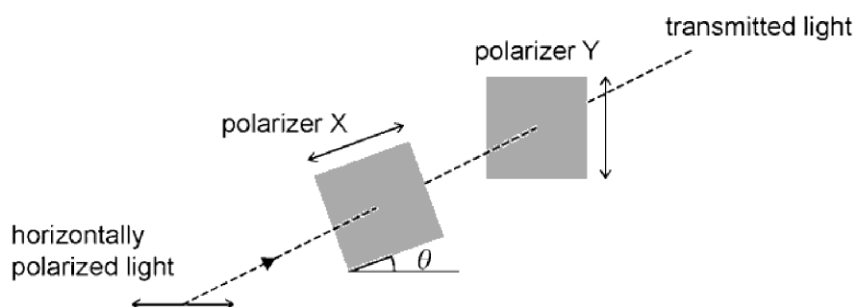
A travelling wave on the surface of a lake has wavelength  $\lambda$ . Two points along the wave oscillate with the phase difference of  $\pi$ . What is the smallest possible distance between these two points?

- A.  $\frac{\lambda}{4}$
- B.  $\frac{\lambda}{2}$
- C.  $\lambda$
- D.  $2\lambda$

70 - (PHYSI/10\_HL\_Winter\_2021\_Q12) - Oscillations &amp; Waves



Horizontally polarized light is incident on a pair of polarizers X and Y. The axis of polarization of X makes an angle  $\theta$  with the horizontal. The axis of polarization of Y is vertical.

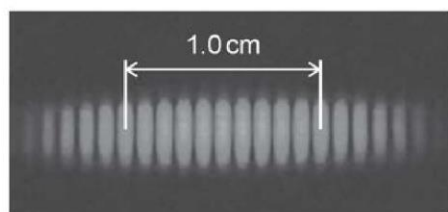


What is  $\theta$  so that the intensity of the light transmitted through Y is a maximum?

- A.  $0^\circ$
- B.  $45^\circ$
- C.  $90^\circ$
- D.  $180^\circ$

71 - (PHYSI/10\_HL\_Winter\_2021\_Q13) - Oscillations &amp; Waves

The diagram shows an interference pattern observed on a screen in a double-slit experiment with monochromatic light of wavelength 600 nm. The screen is 1.0 m from the slits.



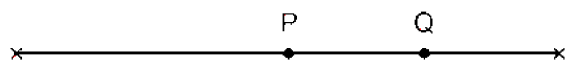
What is the separation of the slits?

- A.  $6.0 \times 10^{-7} \text{ m}$
- B.  $6.0 \times 10^{-6} \text{ m}$
- C.  $6.0 \times 10^{-5} \text{ m}$
- D.  $6.0 \times 10^{-4} \text{ m}$

72 - (PHYSI/10\_HL\_Winter\_2021\_Q14) - Oscillations &amp; Waves



A string is fixed at both ends. P and Q are two particles on the string.

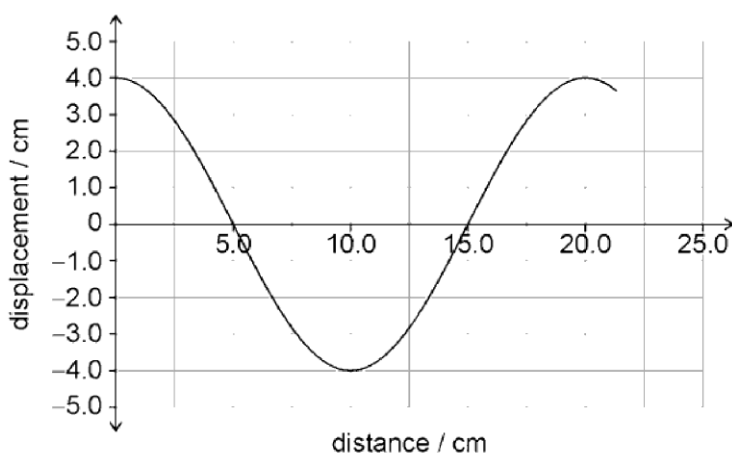


The first harmonic standing wave is formed in the string. What is correct about the motion of P and Q?

- A. P is a node and Q is an antinode.
- B. P is an antinode and Q is a node.
- C. P and Q oscillate with the same amplitude.
- D. P and Q oscillate with the same frequency.

73 - (PHYSI/11\_HL\_Summer\_2022\_Q13) - Oscillations &amp; Waves

A wave of period 10 ms travels through a medium. The graph shows the variation of particle displacement with distance for the wave.



What is the average speed of a particle in the medium during one cycle?

- A.  $4.0 \text{ ms}^{-1}$
- B.  $8.0 \text{ ms}^{-1}$
- C.  $16 \text{ ms}^{-1}$
- D.  $20 \text{ ms}^{-1}$

74 - (PHYSI/11\_HL\_Summer\_2022\_Q14) - Oscillations &amp; Waves

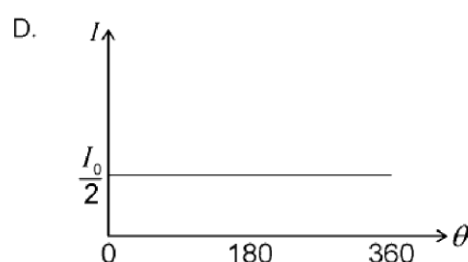
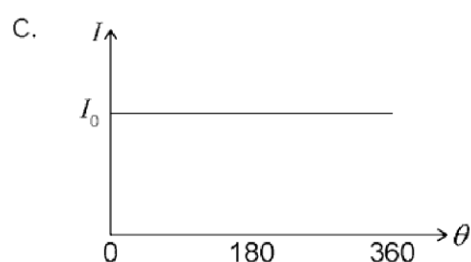
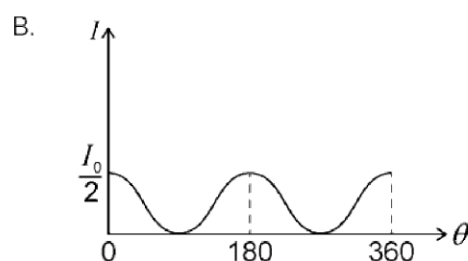
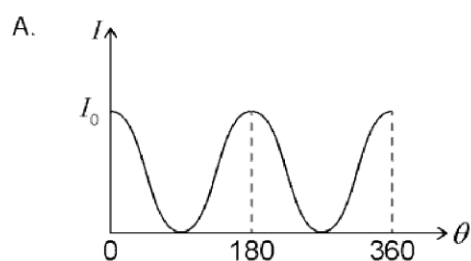


An interference pattern with minima of zero intensity is observed between light waves. What must be true about the frequency and amplitude of the light waves?

|    | frequency | amplitude |
|----|-----------|-----------|
| A. | different | different |
| B. | different | same      |
| C. | same      | same      |
| D. | same      | different |

75 - (PHYSI/11\_HL\_Summer\_2022\_Q15) - Oscillations &amp; Waves

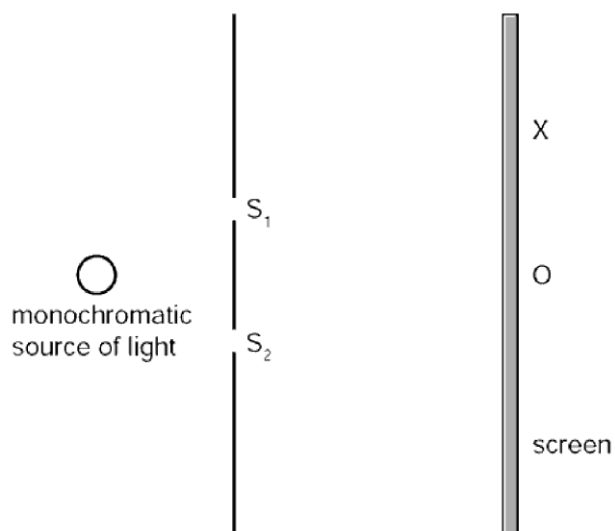
A beam of unpolarized light of intensity  $I_0$  is incident on a polarizing filter. The polarizing filter is rotated through an angle  $\theta$ . What is the variation in the intensity  $I$  of the beam with angle  $\theta$  after passing through the polarizing filter?



76 – (PHYSI/11\_HL\_Summer\_2022\_Q16) – Oscillations &amp; Waves



Monochromatic light of wavelength  $\lambda$  is incident on two slits  $S_1$  and  $S_2$ . An interference pattern is observed on the screen.



O is equidistant from  $S_1$  and  $S_2$ . A bright fringe is observed at O and a dark fringe at X.

There are two dark fringes between O and X. What is the path difference between the light arriving at X from the two slits?

- A.  $\frac{\lambda}{2}$
- B.  $\frac{3\lambda}{2}$
- C.  $\frac{5\lambda}{2}$
- D.  $\frac{7\lambda}{2}$

77 – (PHYSI/11\_HL\_Summer\_2022\_Q17) – *Oscillations & Waves*



A standing wave is formed on a string. P and Q are adjacent antinodes on the wave. Three statements are made by a student:

- I. The distance between P and Q is half a wavelength.
- II. P and Q have a phase difference of  $\pi$  rad.
- III. Energy is transferred between P and Q.

Which statements are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

78 – (PHYSI/12\_HL\_Summer\_2022\_Q12) – *Oscillations & Waves*

A particle undergoes simple harmonic motion. Which quantities of the motion can be simultaneously zero?

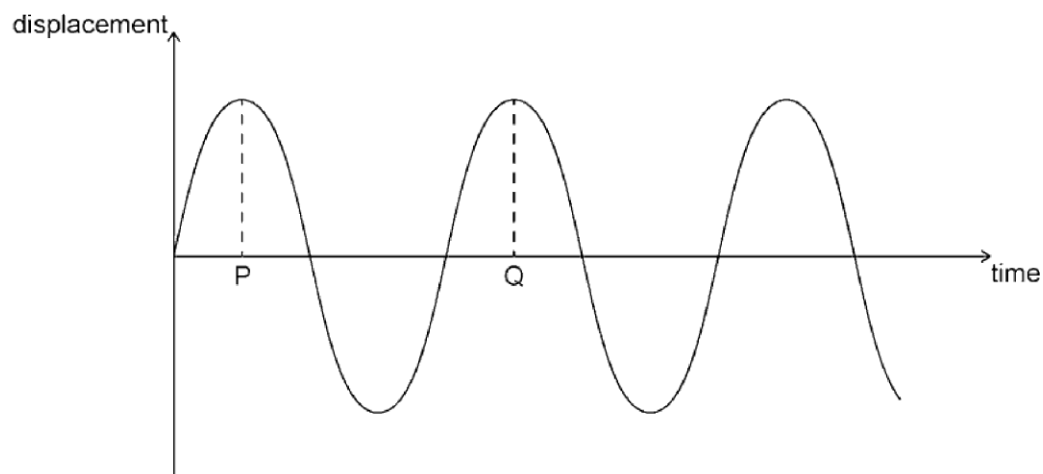
- A. Displacement and velocity
- B. Displacement and acceleration
- C. Velocity and acceleration
- D. Displacement, velocity and acceleration

79 – (PHYSI/12\_HL\_Summer\_2022\_Q13) – Oscillations &amp; Waves

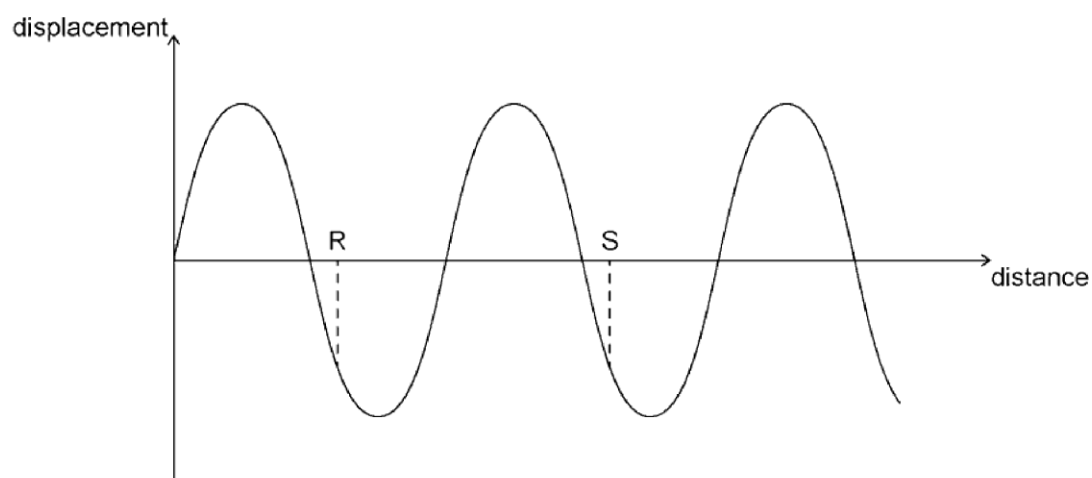


A wave travels along a string. Graph M shows the variation with time of the displacement of a point X on the string. Graph N shows the variation with distance of the displacement of the string. PQ and RS are marked on the graphs.

Graph M



Graph N

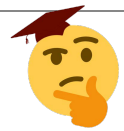


What is the speed of the wave?

- A.  $\frac{PQ}{RS}$
- B.  $PQ \times RS$
- C.  $\frac{RS}{PQ}$
- D.  $\frac{1}{PQ \times RS}$



80 – (PHYSI/12\_HL\_Summer\_2022\_Q14) – Oscillations & Waves



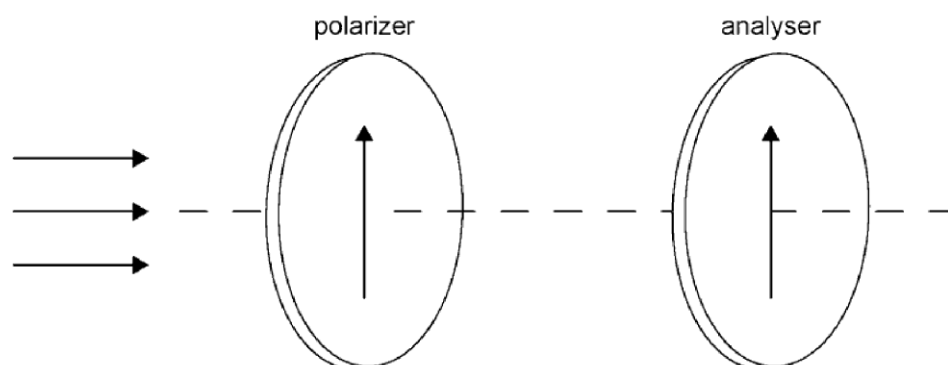
The refractive index of glass is  $\frac{3}{2}$  and the refractive index of water is  $\frac{4}{3}$ . What is the critical angle for light travelling from glass to water?

- A.  $\sin^{-1}\left(\frac{1}{2}\right)$
- B.  $\sin^{-1}\left(\frac{2}{3}\right)$
- C.  $\sin^{-1}\left(\frac{3}{4}\right)$
- D.  $\sin^{-1}\left(\frac{8}{9}\right)$

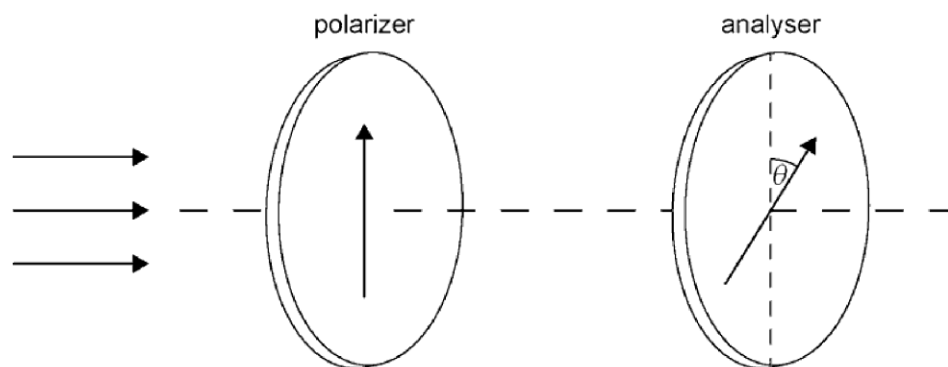
81 – (PHYSI/12\_HL\_Summer\_2022\_Q15) – Oscillations &amp; Waves



Unpolarized light with an intensity of  $320 \text{ W m}^{-2}$  goes through a polarizer and an analyser, originally aligned parallel.



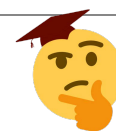
The analyser is rotated through an angle  $\theta = 30^\circ$ .  $\cos 30^\circ = \frac{\sqrt{3}}{2}$ .



What is the intensity of the light emerging from the analyser?

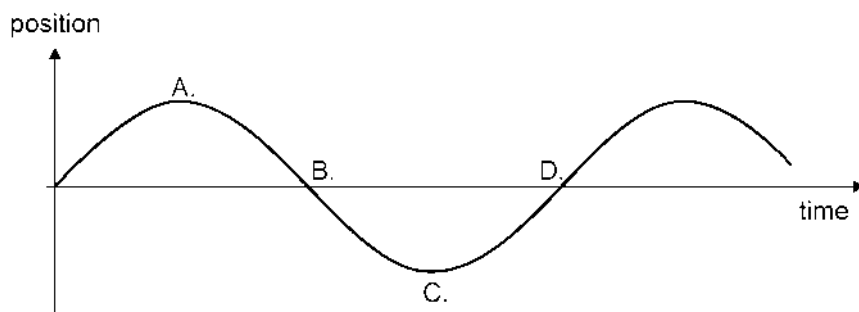
- A.  $120 \text{ W m}^{-2}$
- B.  $80\sqrt{3} \text{ W m}^{-2}$
- C.  $240 \text{ W m}^{-2}$
- D.  $160\sqrt{3} \text{ W m}^{-2}$

82 – (PHYSI/10\_HL\_Winter\_2022\_Q13) – Oscillations &amp; Waves



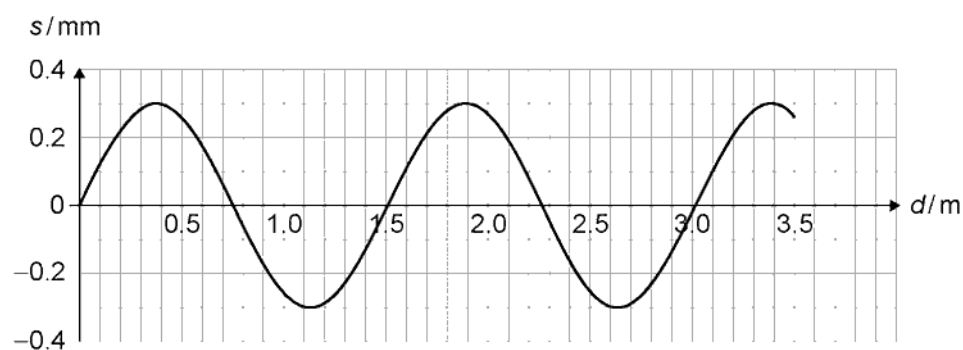
An object oscillates at the free end of a vertical spring. The graph shows the variation of the object's position with time.

At which position does the object have zero velocity and a negative acceleration?



83 – (PHYSI/10\_HL\_Winter\_2022\_Q14) – Oscillations &amp; Waves

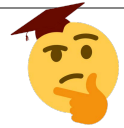
A sound wave travels through a gas at a speed of  $270 \text{ m s}^{-1}$ . The graph shows the variation of the displacement  $s$  of the gas particles with distance  $d$  from the source.



What is the frequency of the wave?

- A. 180 Hz
- B. 360 Hz
- C. 450 Hz
- D. 900 Hz

84 - (PHYSI/10\_HL\_Winter\_2022\_Q15) - *Oscillations & Waves*



A point source emits a sound wave of amplitude  $Z$ . A person stands a distance  $L$  from the source. The amplitude is changed to  $2Z$ .

What distance must the person move through in order to hear the original intensity again?

- A.  $L$
- B.  $2L$
- C.  $3L$
- D.  $7L$

1 - (PHYSI/11\_HL\_Summer\_2017\_Q16) - *Electricity & Magnetism*

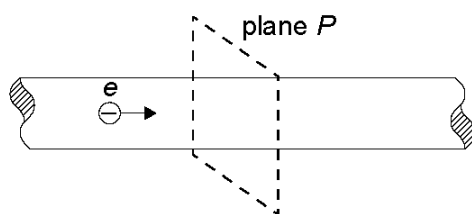


An electron is accelerated through a potential difference of 2.5 MV. What is the change in kinetic energy of the electron?

- A.  $0.4 \mu\text{J}$
- B.  $0.4 \text{ nJ}$
- C.  $0.4 \text{ pJ}$
- D.  $0.4 \text{ fJ}$

2 - (PHYSI/11\_HL\_Summer\_2017\_Q17) - *Electricity & Magnetism*

Electrons, each with a charge  $e$ , move with speed  $v$  along a metal wire. The electric current in the wire is  $I$ .



Plane  $P$  is perpendicular to the wire. How many electrons pass through plane  $P$  in each second?

- A.  $\frac{e}{I}$
- B.  $\frac{ve}{I}$
- C.  $\frac{I}{ve}$
- D.  $\frac{I}{e}$

3 - (PHYSI/11\_HL\_Summer\_2017\_Q18) - Electricity &amp; Magnetism



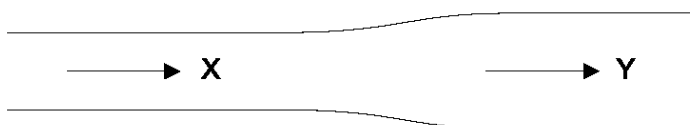
An electron travelling at speed  $v$  perpendicular to a magnetic field of strength  $B$  experiences a force  $F$ .

What is the force acting on an alpha particle travelling at  $2v$  parallel to a magnetic field of strength  $2B$ ?

- A. 0
- B.  $2F$
- C.  $4F$
- D.  $8F$

4 - (PHYSI/12\_HL\_Summer\_2017\_Q16) - Electricity &amp; Magnetism

A wire has variable cross-sectional area. The cross-sectional area at Y is double that at X.

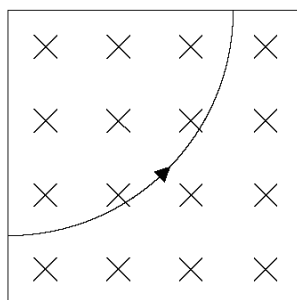


At X, the current in the wire is  $I$  and the electron drift speed is  $v$ . What is the current and the electron drift speed at Y?

|    | Current | Drift speed   |
|----|---------|---------------|
| A. | $I$     | $v$           |
| B. | $I$     | $\frac{v}{2}$ |
| C. | $2I$    | $v$           |
| D. | $2I$    | $\frac{v}{2}$ |

5 - (PHYSI/12\_HL\_Summer\_2017\_Q17) - *Electricity & Magnetism*

The diagram shows the path of a particle in a region of uniform magnetic field. The field is directed into the plane of the page.



This particle could be

- A. an alpha particle.
- B. a beta particle.
- C. a photon.
- D. a neutron.

6 - (PHYSI/10\_HL\_Winter\_2017\_Q15) - *Electricity & Magnetism*

Two wires, X and Y, are made from the same metal. The wires are connected in series. The radius of X is twice that of Y. The carrier drift speed in X is  $v_x$  and in Y it is  $v_y$ .

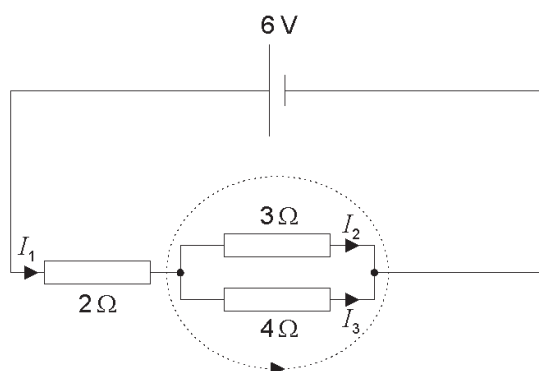
What is the value of the ratio  $\frac{v_x}{v_y}$ ?

- A. 0.25
- B. 0.50
- C. 2.00
- D. 4.00

## 7 - (PHYSI/10\_HL\_Winter\_2017\_Q16) - Electricity &amp; Magnetism



Kirchhoff's laws are applied to the circuit shown.

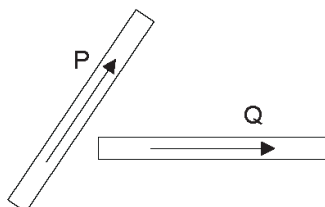


What is the equation for the dotted loop?

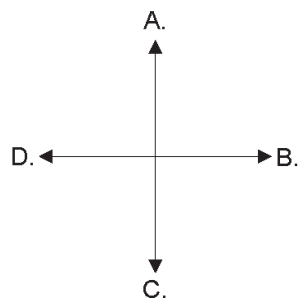
- A.  $0 = 3I_2 + 4I_3$
- B.  $0 = 4I_3 - 3I_2$
- C.  $6 = 2I_1 + 3I_2 + 4I_3$
- D.  $6 = 3I_2 + 4I_3$

## 8 - (PHYSI/10\_HL\_Winter\_2017\_Q17) - Electricity &amp; Magnetism

The diagram shows two current-carrying wires, P and Q, that both lie in the plane of the paper. The arrows show the conventional current direction in the wires.



The electromagnetic force on Q is in the same plane as that of the wires. What is the direction of the electromagnetic force acting on Q?

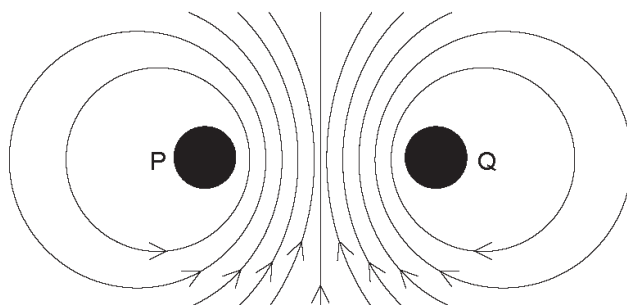




## 9 - (PHYSI/10\_HL\_Winter\_2017\_Q18) - Electricity &amp; Magnetism



The diagram shows the magnetic field surrounding two current-carrying metal wires P and Q. The wires are parallel to each other and at right angles to the plane of the page.

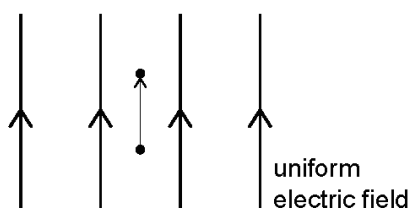


What is the direction of the electron flow in P and the direction of the electron flow in Q?

|    | Direction of electron flow in P | Direction of electron flow in Q |
|----|---------------------------------|---------------------------------|
| A. | into page                       | into page                       |
| B. | into page                       | out of page                     |
| C. | out of page                     | into page                       |
| D. | out of page                     | out of page                     |

## 10 - (PHYSI/11\_HL\_Summer\_2018\_Q15) - Electricity &amp; Magnetism

An ion of charge  $+Q$  moves vertically upwards through a small distance  $s$  in a uniform vertical electric field. The electric field has a strength  $E$  and its direction is shown in the diagram.



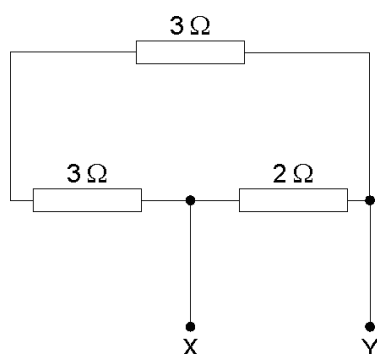
What is the electric potential difference between the initial and final position of the ion?

- A.  $\frac{EQ}{s}$
- B.  $EQs$
- C.  $Es$
- D.  $\frac{E}{s}$

11 - (PHYSI/11\_HL\_Summer\_2018\_Q16) - Electricity & Magnetism



Three resistors are connected as shown. What is the value of the total resistance between X and Y?



- A.  $1.5\ \Omega$
- B.  $1.9\ \Omega$
- C.  $6.0\ \Omega$
- D.  $8.0\ \Omega$

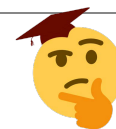
12 - (PHYSI/11\_HL\_Summer\_2018\_Q17) - Electricity & Magnetism

When an electric cell of negligible internal resistance is connected to a resistor of resistance  $4R$ , the power dissipated in the resistor is  $P$ .

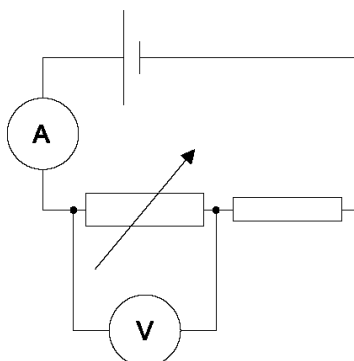
What is the power dissipated in a resistor of resistance value  $R$  when it is connected to the same cell?

- A.  $\frac{P}{4}$
- B.  $P$
- C.  $4P$
- D.  $16P$

## 13 – (PHYSI/12\_HL\_Summer\_2018\_Q14) – Electricity &amp; Magnetism



A cell with negligible internal resistance is connected as shown. The ammeter and the voltmeter are both ideal.



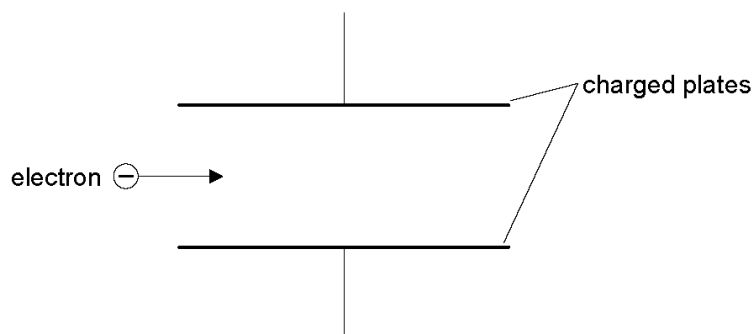
What changes occur in the ammeter reading and in the voltmeter reading when the resistance of the variable resistor is increased?

|    | Change in ammeter reading | Change in voltmeter reading |
|----|---------------------------|-----------------------------|
| A. | increases                 | increases                   |
| B. | increases                 | decreases                   |
| C. | decreases                 | increases                   |
| D. | decreases                 | decreases                   |

## 14 - (PHYSI/12\_HL\_Summer\_2018\_Q15) - Electricity &amp; Magnetism



An electron enters the region between two charged parallel plates initially moving parallel to the plates.

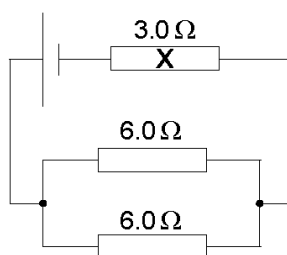


The electromagnetic force acting on the electron

- A. causes the electron to decrease its horizontal speed.
- B. causes the electron to increase its horizontal speed.
- C. is parallel to the field lines and in the opposite direction to them.
- D. is perpendicular to the field direction.

## 15 - (PHYSI/12\_HL\_Summer\_2018\_Q16) - Electricity &amp; Magnetism

A cell of emf 6.0 V and negligible internal resistance is connected to three resistors as shown. The resistors have resistance of  $3.0\ \Omega$  and  $6.0\ \Omega$  as shown.



What is the current in resistor X?

- A. 0.40 A
- B. 0.50 A
- C. 1.0 A
- D. 2.0 A

16 - (PHYSI/10\_HL\_Winter\_2018\_Q16) - *Electricity & Magnetism*

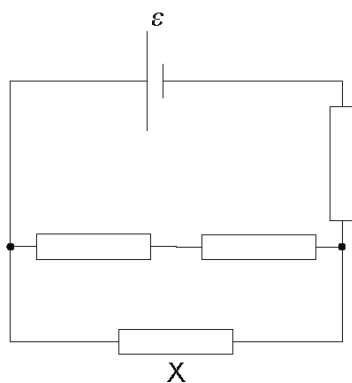


A wire of length  $L$  is used in an electric heater. When the potential difference across the wire is 200 V, the power dissipated in the wire is 1000 W. The same potential difference is applied across a second similar wire of length  $2L$ . What is the power dissipated in the second wire?

- A. 250 W
- B. 500 W
- C. 2000 W
- D. 4000 W

17 - (PHYSI/10\_HL\_Winter\_2018\_Q17) - *Electricity & Magnetism*

A combination of four identical resistors each of resistance  $R$  are connected to a source of emf  $\mathcal{E}$  of negligible internal resistance. What is the current in the resistor X?

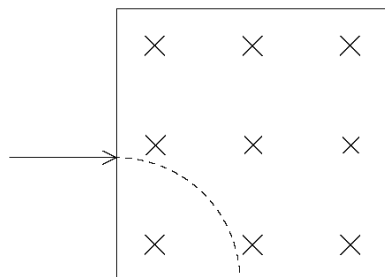


- A.  $\frac{\mathcal{E}}{5R}$
- B.  $\frac{3\mathcal{E}}{10R}$
- C.  $\frac{2\mathcal{E}}{5R}$
- D.  $\frac{3\mathcal{E}}{5R}$

18 - (PHYSI/10\_HL\_Winter\_2018\_Q19) - Electricity &amp; Magnetism



A particle of mass  $m$  and charge of magnitude  $q$  enters a region of uniform magnetic field  $B$  that is directed into the page. The particle follows a circular path of radius  $R$ . What are the sign of the charge of the particle and the speed of the particle?



|    | Charge of the particle | Speed of the particle  |
|----|------------------------|------------------------|
| A. | positive               | $\frac{qBR}{m}$        |
| B. | negative               | $\frac{qBR}{m}$        |
| C. | negative               | $\sqrt{\frac{qBR}{m}}$ |
| D. | positive               | $\sqrt{\frac{qBR}{m}}$ |

19 - (PHYSI/10\_HL\_Winter\_2018\_Q24) - Electricity &amp; Magnetism, Energy Production

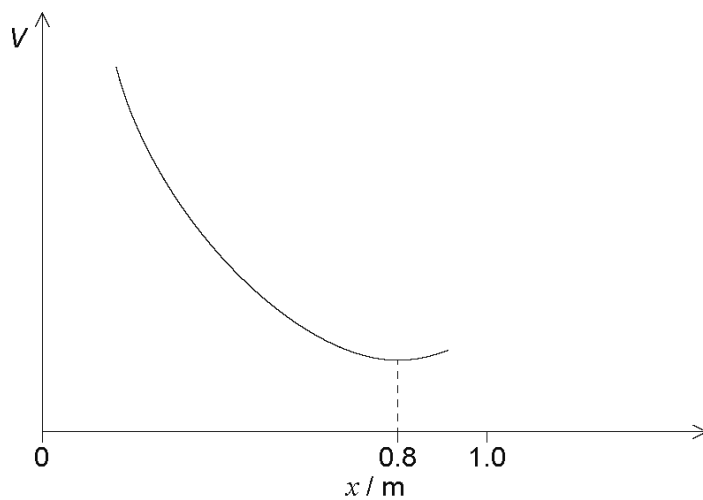
A photovoltaic panel of area  $S$  has an efficiency of 20%. A second photovoltaic panel has an efficiency of 15%. What is the area of the second panel so that both panels produce the same power under the same conditions?

- A.  $\frac{S}{3}$
- B.  $\frac{3S}{4}$
- C.  $\frac{5S}{4}$
- D.  $\frac{4S}{3}$

20 – (PHYSI/10\_HL\_Winter\_2018\_Q30) – Electricity &amp; Magnetism



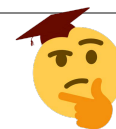
Two point charges  $Q_1$  and  $Q_2$  are one metre apart. The graph shows the variation of electric potential  $V$  with distance  $x$  from  $Q_1$ .



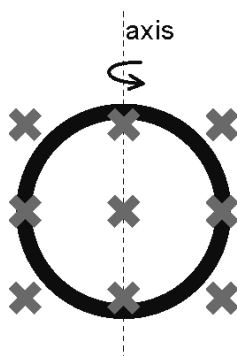
What is  $\frac{Q_1}{Q_2}$ ?

- A.  $\frac{1}{16}$
- B.  $\frac{1}{4}$
- C. 4
- D. 16

21 – (PHYSI/10\_HL\_Winter\_2018\_Q33) – Electricity & Magnetism, Electromagnetic Induction (ahl)



A ring of area  $S$  is in a uniform magnetic field  $X$ . Initially the magnetic field is perpendicular to the plane of the ring. The ring is rotated by  $180^\circ$  about the axis in time  $T$ .



What is the average induced emf in the ring?

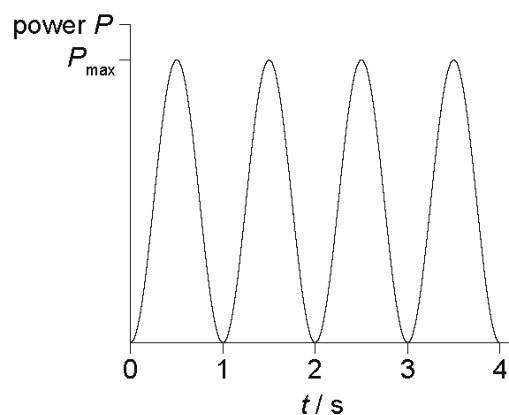
- A. 0
- B.  $\frac{XS}{2T}$
- C.  $\frac{XS}{T}$
- D.  $\frac{2XS}{T}$



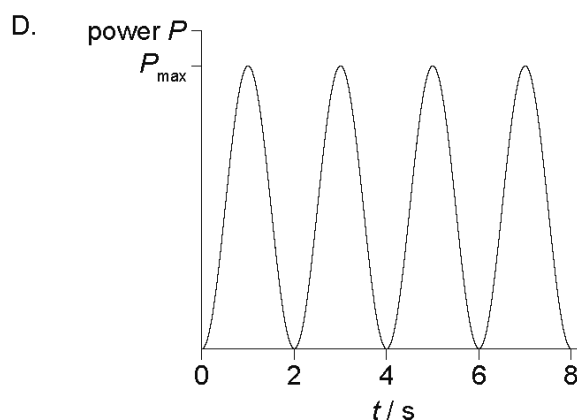
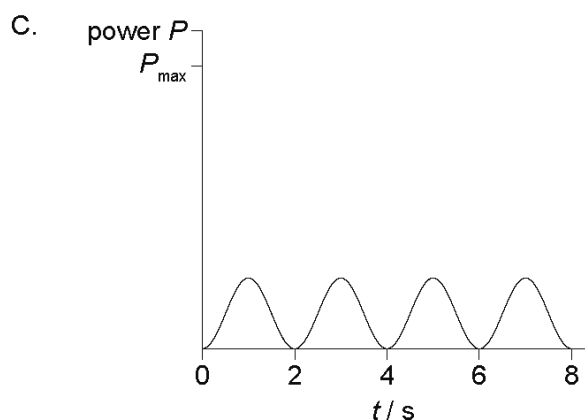
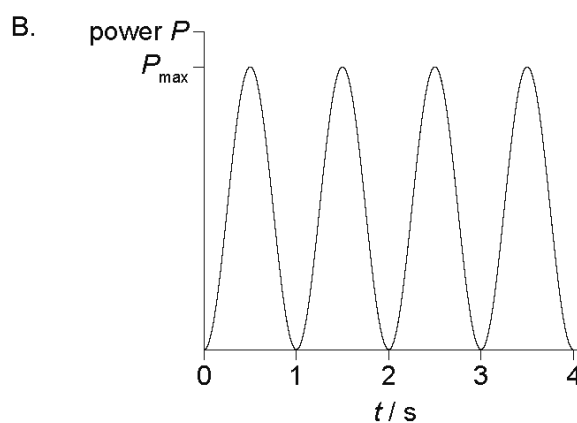
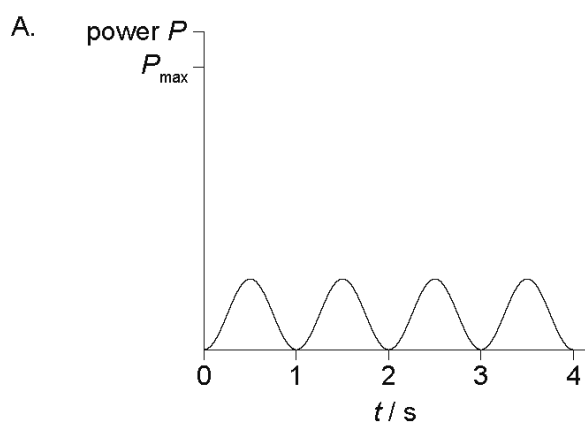
22 – (PHYSI/10\_HL\_Winter\_2018\_Q34) – Electricity &amp; Magnetism



The graph shows the variation of the peak output power  $P$  with time of an alternating current (ac) generator.



Which graph shows the variation of the peak output power with time when the frequency of rotation is decreased?



23 – (PHYSI/10\_HL\_Winter\_2018\_Q35) – Electricity &amp; Magnetism



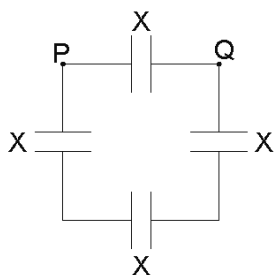
A current of  $1.0 \times 10^{-3} \text{ A}$  flows in the primary coil of a step-up transformer. The number of turns in the primary coil is  $N_p$  and the number of turns in the secondary coil is  $N_s$ . One coil has 1000 times more turns than the other coil.

What is  $\frac{N_p}{N_s}$  and what is the current in the secondary coil for this transformer?

|    | $\frac{N_p}{N_s}$ | Current in secondary coil / A |
|----|-------------------|-------------------------------|
| A. | $\frac{1}{1000}$  | $1.0 \times 10^{-6}$          |
| B. | 1000              | 1.0                           |
| C. | $\frac{1}{1000}$  | 1.0                           |
| D. | 1000              | $1.0 \times 10^{-6}$          |

24 – (PHYSI/10\_HL\_Winter\_2018\_Q36) – Electricity &amp; Magnetism

Four identical capacitors of capacitance  $X$  are connected as shown in the diagram.



What is the effective capacitance between P and Q?

- A.  $\frac{X}{3}$
- B.  $X$
- C.  $\frac{4X}{3}$
- D.  $4X$

25 - (PHYSI/11\_HL\_Summer\_2019\_Q15) - Electricity &amp; Magnetism



Charge flows through a liquid. The charge flow is made up of positive and negative ions. In one second 0.10 C of negative ions flow in one direction and 0.10 C of positive ions flow in the opposite direction.

What is the magnitude of the electric current flowing through the liquid?

- A. 0 A
- B. 0.05 A
- C. 0.10 A
- D. 0.20 A

26 - (PHYSI/11\_HL\_Summer\_2019\_Q16) - Electricity &amp; Magnetism

Two parallel plates are a distance  $a$  apart with a potential difference between them. A point charge moves from the negatively charged plate to the positively charged plate. The charge gains kinetic energy  $W$ . The distance between the plates is doubled and the potential difference between them is halved. What is the kinetic energy gained by an identical charge moving between these plates?

- A.  $\frac{W}{2}$
- B.  $W$
- C.  $2W$
- D.  $4W$

27 - (PHYSI/11\_HL\_Summer\_2019\_Q17) - Electricity &amp; Magnetism

A resistor of resistance  $R$  is connected to a fully charged cell of negligible internal resistance. A constant power  $P$  is dissipated in the resistor and the cell discharges in time  $t$ . An identical cell is connected in series with two identical resistors each of resistance  $R$ .

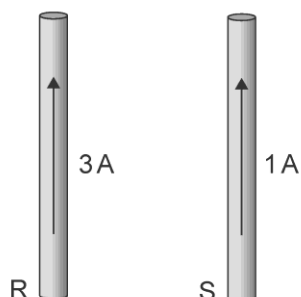
What is the power dissipated in each resistor and the time taken to discharge the cell?

|    | Power dissipated in each resistor | Time taken to discharge the cell |
|----|-----------------------------------|----------------------------------|
| A. | $\frac{P}{4}$                     | $\frac{t}{2}$                    |
| B. | $\frac{P}{4}$                     | $2t$                             |
| C. | $\frac{P}{2}$                     | $\frac{t}{2}$                    |
| D. | $\frac{P}{2}$                     | $2t$                             |

28 - (PHYSI/11\_HL\_Summer\_2019\_Q18) - Electricity & Magnetism



Two currents of 3 A and 1 A are established in the same direction through two parallel straight wires R and S.



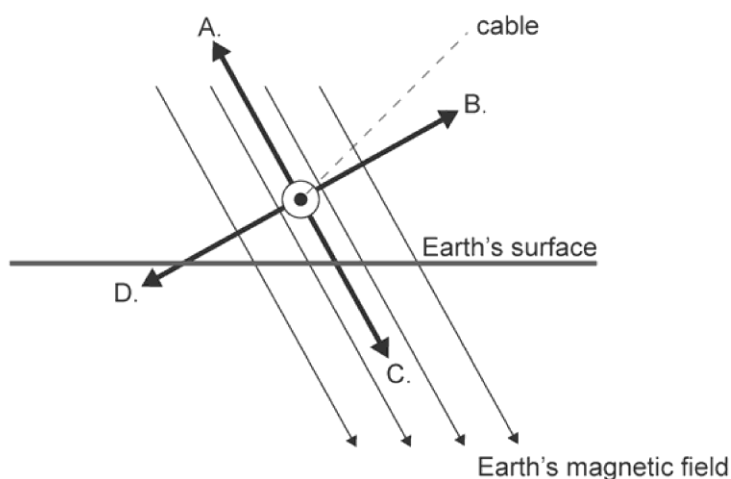
What is correct about the magnetic forces acting on each wire?

- A. Both wires exert equal magnitude attractive forces on each other.
- B. Both wires exert equal magnitude repulsive forces on each other.
- C. Wire R exerts a larger magnitude attractive force on wire S.
- D. Wire R exerts a larger magnitude repulsive force on wire S.

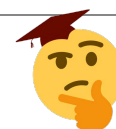
29 - (PHYSI/11\_HL\_Summer\_2019\_Q19) - Electricity & Magnetism

A horizontal electrical cable carries a steady current out of the page. The Earth's magnetic field exerts a force on the cable.

Which arrow shows the direction of the force on the cable due to the Earth's magnetic field?



30 – (PHYSI/11\_HL\_Summer\_2019\_Q36) – *Electromagnetic Induction (ahl), Electricity & Magnetism*



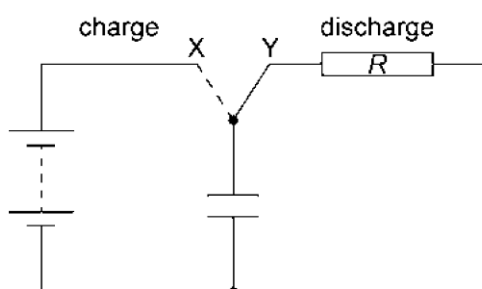
Two capacitors of  $3\mu\text{F}$  and  $6\mu\text{F}$  are connected in series and charged using a  $9\text{V}$  battery.

What charge is stored on each capacitor?

|    | Charge stored on $3\mu\text{F}$ capacitor | Charge stored on $6\mu\text{F}$ capacitor |
|----|-------------------------------------------|-------------------------------------------|
| A. | $18\mu\text{C}$                           | $18\mu\text{C}$                           |
| B. | $81\mu\text{C}$                           | $81\mu\text{C}$                           |
| C. | $18\mu\text{C}$                           | $81\mu\text{C}$                           |
| D. | $81\mu\text{C}$                           | $18\mu\text{C}$                           |

31 – (PHYSI/11\_HL\_Summer\_2019\_Q37) – *Electromagnetic Induction (ahl), Electricity & Magnetism*

The circuit diagram shows a capacitor that is charged by the battery after the switch is connected to terminal X. The cell has emf  $V$  and internal resistance  $r$ . After the switch is connected to terminal Y the capacitor discharges through the resistor of resistance  $R$ .



What is the nature of the current and magnitude of the initial current in the resistor after the switch is connected to terminal Y?

|    | Nature of current | Magnitude of initial current |
|----|-------------------|------------------------------|
| A. | increasing        | $\frac{V}{R}$                |
| B. | increasing        | $\frac{V}{R+r}$              |
| C. | decreasing        | $\frac{V}{R}$                |
| D. | decreasing        | $\frac{V}{R+r}$              |

32 – (PHYSI/12\_HL\_Summer\_2019\_Q23) – Electricity &amp; Magnetism



A particle with a charge  $ne$  is accelerated through a potential difference  $V$ .

What is the magnitude of the work done on the particle?

- A.  $eV$
- B.  $neV$
- C.  $\frac{nV}{e}$
- D.  $\frac{eV}{n}$

33 – (PHYSI/12\_HL\_Summer\_2019\_Q24) – Electricity &amp; Magnetism

In an experiment to determine the resistivity of a material, a student measures the resistance of several wires made from the pure material. The wires have the same length but different diameters.

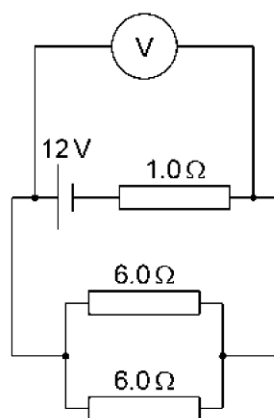
Which quantities should the student plot on the  $x$ -axis and the  $y$ -axis of a graph to obtain a straight line?

|    | $x$ -axis             | $y$ -axis                     |
|----|-----------------------|-------------------------------|
| A. | diameter <sup>2</sup> | resistance                    |
| B. | diameter              | resistance                    |
| C. | diameter <sup>2</sup> | $\frac{1}{\text{resistance}}$ |
| D. | diameter              | $\frac{1}{\text{resistance}}$ |

34 – (PHYSI/12\_HL\_Summer\_2019\_Q25) – Electricity & Magnetism



Three resistors of resistance  $1.0\,\Omega$ ,  $6.0\,\Omega$  and  $6.0\,\Omega$  are connected as shown. The voltmeter is ideal and the cell has an emf of  $12\,\text{V}$  with negligible internal resistance.



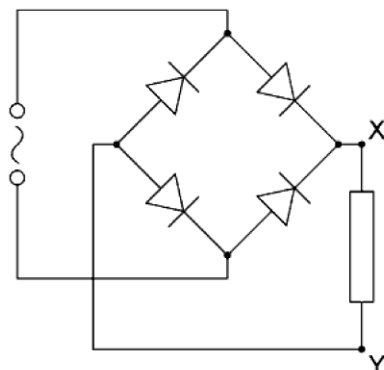
What is the reading on the voltmeter?

- A.  $3.0\,\text{V}$
- B.  $4.0\,\text{V}$
- C.  $8.0\,\text{V}$
- D.  $9.0\,\text{V}$

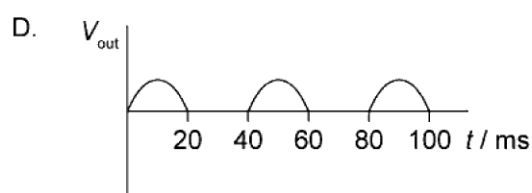
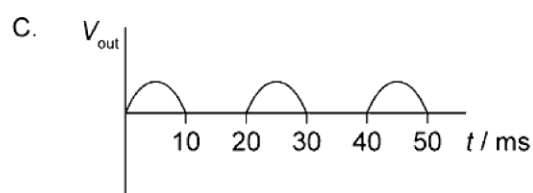
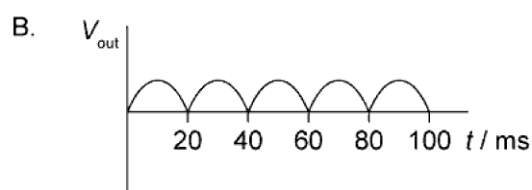
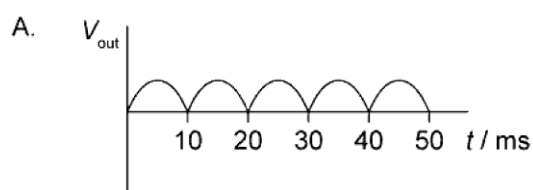
35 – (PHYSI/12\_HL\_Summer\_2019\_Q26) – Electricity &amp; Magnetism



The input to a diode bridge rectification circuit is sinusoidal with a time period of 20 ms.



Which graph shows the variation with time  $t$  of the output voltage  $V_{\text{out}}$  between X and Y?



36 – (PHYSI/12\_HL\_Summer\_2019\_Q27) – Electromagnetic Induction (ahl), Electricity &amp; Magnetism

Three identical capacitors are connected in series. The total capacitance of the arrangement is  $\frac{1}{9}$  mF. The three capacitors are then connected in parallel. What is the capacitance of the parallel arrangement?

- A.  $\frac{1}{3}$  mF
- B. 1 mF
- C. 3 mF
- D. 81 mF



37 – (PHYSI/12\_HL\_Summer\_2019\_Q28) – Electricity & Magnetism, Electromagnetic Induction (ahl)



A transformer with 600 turns in the primary coil is used to change an alternating root mean square (rms) potential difference of  $240\text{ V}_{\text{rms}}$  to  $12\text{ V}_{\text{rms}}$ .

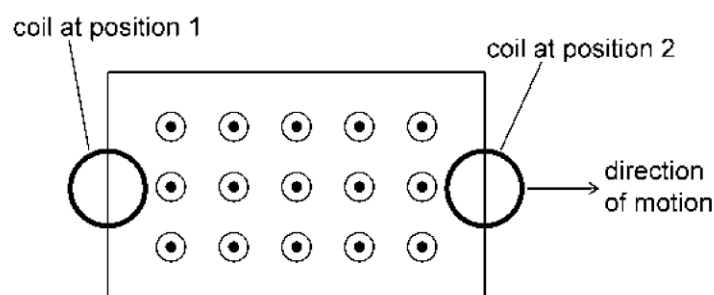
When connected to the secondary coil, a lamp labelled “120 W, 12 V” lights normally. The current in the primary coil is 0.60 A when the lamp is lit.

What are the number of secondary turns and the efficiency of the transformer?

|    | Number of secondary turns | Efficiency |
|----|---------------------------|------------|
| A. | 12000                     | 99 %       |
| B. | 30                        | 99 %       |
| C. | 12000                     | 83 %       |
| D. | 30                        | 83 %       |

38 – (PHYSI/12\_HL\_Summer\_2019\_Q29) – Electricity & Magnetism, Electromagnetic Induction (ahl)

A circular coil of wire moves through a region of uniform magnetic field directed out of the page.



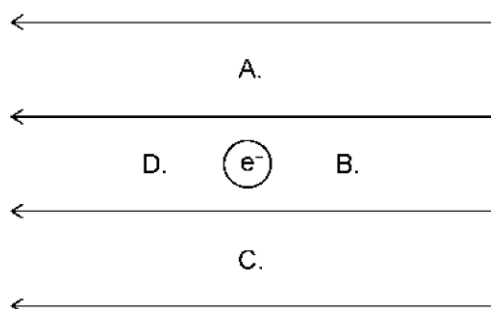
What is the direction of the induced conventional current in the coil for the marked positions?

|    | Position 1       | Position 2       |
|----|------------------|------------------|
| A. | clockwise        | clockwise        |
| B. | counterclockwise | clockwise        |
| C. | clockwise        | counterclockwise |
| D. | counterclockwise | counterclockwise |

39 – (PHYSI/12\_HL\_Summer\_2019\_Q30) – Electricity & Magnetism, Fields (ahl)

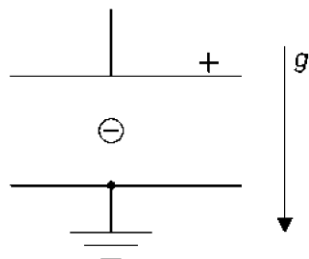


An electron is fixed in position in a uniform electric field. What is the position for which the electrical potential energy of the electron is greatest?



40 – (PHYSI/10\_HL\_Winter\_2019\_Q15) – Electricity & Magnetism

A negatively charged particle in a uniform gravitational field is positioned mid-way between two charged conducting plates.



The potential difference between the plates is adjusted until the particle is held at rest relative to the plates.

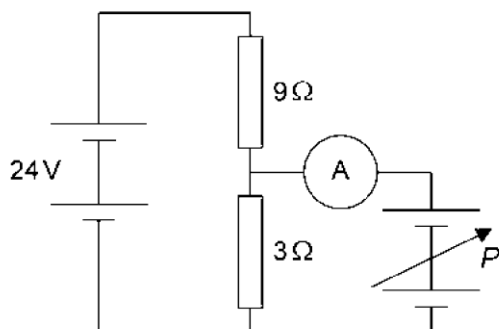
What change will cause the particle to accelerate downwards relative to the plates?

- A. Decreasing the charge on the particle
- B. Decreasing the separation of the plates
- C. Increasing the length of the plates
- D. Increasing the potential difference between the plates

41 – (PHYSI/10\_HL\_Winter\_2019\_Q16) – Electricity & Magnetism



Two power supplies, one of constant emf  $24\text{ V}$  and the other of variable emf  $P$ , are connected to two resistors as shown. Both power supplies have negligible internal resistances.



What is the magnitude of  $P$  for the reading on the ammeter to be zero?

- A. Zero
- B.  $6\text{ V}$
- C.  $8\text{ V}$
- D.  $18\text{ V}$

42 – (PHYSI/10\_HL\_Winter\_2019\_Q17) – Electricity & Magnetism

When a wire with an electric current  $I$  is placed in a magnetic field of strength  $B$  it experiences a magnetic force  $F$ . What is the direction of  $F$ ?

- A. In a direction determined by  $I$  only
- B. In a direction determined by  $B$  only
- C. In the plane containing  $I$  and  $B$
- D. At  $90^\circ$  to the plane containing  $I$  and  $B$

43 – (PHYSI/10\_HL\_Winter\_2019\_Q31) – Electricity & Magnetism, Fields (ahl)

The force acting between two point charges is  $F$  when the separation of the charges is  $x$ . What is the force between the charges when the separation is increased to  $3x$ ?

- A.  $\frac{F}{3}$
- B.  $\frac{F}{3x^2}$
- C.  $\frac{F}{9}$
- D.  $\frac{F}{9x^2}$

44 – (PHYSI/10\_HL\_Winter\_2019\_Q32) – *Electricity & Magnetism*



An electron enters a uniform electric field of strength  $E$  with a velocity  $v$ . The direction of  $v$  is not parallel to  $E$ . What is the path of the electron after entering the field?

- A. Circular
- B. Parabolic
- C. Parallel to  $E$
- D. Parallel to  $v$

45 – (PHYSI/10\_HL\_Winter\_2020\_Q14) – *Electricity & Magnetism*

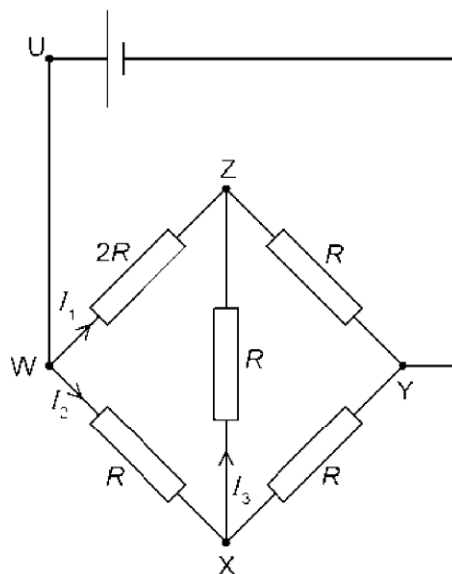
A metal wire has  $n$  free charge carriers per unit volume. The charge on the carrier is  $q$ . What additional quantity is needed to determine the current per unit area in the wire?

- A. Cross-sectional area of the wire
- B. Drift speed of charge carriers
- C. Potential difference across the wire
- D. Resistivity of the metal

46 - (PHYSI/10\_HL\_Winter\_2020\_Q15) - Electricity &amp; Magnetism



A cell of electromotive force (emf)  $E$  and zero internal resistance is in the circuit shown.



What is correct for loop WXYUW?

- A.  $E = 3I_1R - I_3R$
- B.  $E = I_3R - I_2R$
- C.  $E = I_3R$
- D.  $E = 2I_2R - I_3R$

47 - (PHYSI/10\_HL\_Winter\_2020\_Q16) - Electricity &amp; Magnetism

What is the relationship between the resistivity  $\rho$  of a uniform wire, the radius  $r$  of the wire and the length  $l$  of the wire when its resistance is constant?

- A.  $\rho \propto r^2l$
- B.  $\rho \propto rl^2$
- C.  $\rho \propto \frac{l}{r^2}$
- D.  $\rho \propto \frac{r^2}{l}$

48 – (PHYSI/10\_HL\_Winter\_2020\_Q17) – Electricity &amp; Magnetism



A power station generates 250 kW of power at a potential difference of 25 kV. The energy is transmitted through cables of total resistance  $4.0\ \Omega$ .

What is the power loss in the cables?

- A. 0.04 kW
- B. 0.4 kW
- C. 4 kW
- D. 40 kW

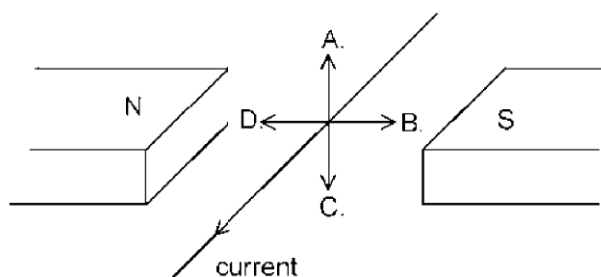
49 – (PHYSI/10\_HL\_Winter\_2020\_Q18) – Electricity &amp; Magnetism

An electrical power supply has an internal resistance. It supplies a direct current  $I$  to an external circuit for a time  $t$ . What is the electromotive force (emf) of the power supply?

- A.  $\frac{\text{total energy transferred to the whole circuit}}{I \times t}$
- B.  $\frac{\text{total power transferred to the whole circuit}}{I \times t}$
- C.  $\frac{\text{total energy transferred to the external circuit}}{I \times t}$
- D.  $\frac{\text{total power transferred to the external circuit}}{I \times t}$

50 – (PHYSI/10\_HL\_Winter\_2020\_Q19) – Electricity &amp; Magnetism

A current in a wire lies between the poles of a magnet. What is the direction of the electromagnetic force on the wire?



51 – (PHYSI/11\_HL\_Summer\_2021\_Q15) – *Electricity & Magnetism*

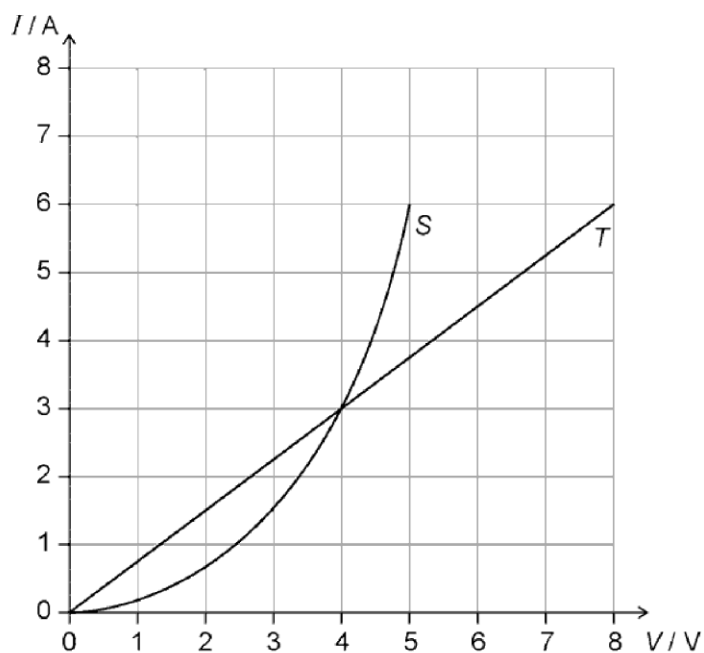
Two charges  $Q_1$  and  $Q_2$ , each equal to  $2 \text{ nC}$ , are separated by a distance  $3 \text{ m}$  in a vacuum. What is the electric force on  $Q_2$  and the electric field due to  $Q_1$  at the position of  $Q_2$ ?

|    | Electric force on $Q_2$      | Electric field due to $Q_1$ at the position of $Q_2$ |
|----|------------------------------|------------------------------------------------------|
| A. | $4 \times 10^{-9} \text{ N}$ | $2 \text{ N C}^{-1}$                                 |
| B. | $4 \text{ N}$                | $2 \text{ N C}^{-1}$                                 |
| C. | $4 \times 10^{-9} \text{ N}$ | $2 \times 10^{-9} \text{ N C}^{-1}$                  |
| D. | $4 \text{ N}$                | $2 \times 10^{-9} \text{ N C}^{-1}$                  |

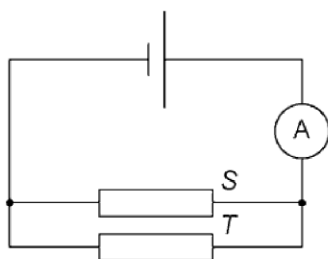
52 - (PHYSI/11\_HL\_Summer\_2021\_Q16) - Electricity &amp; Magnetism



Two conductors  $S$  and  $T$  have the  $V/I$  characteristic graphs shown below.



When the conductors are placed in the circuit below, the reading of the ammeter is 6.0 A.



What is the emf of the cell?

- A. 4.0 V
- B. 5.0 V
- C. 8.0 V
- D. 13 V



53 - (PHYSI/11\_HL\_Summer\_2021\_Q17) - *Electricity & Magnetism*

For a real cell in a circuit, the terminal potential difference is at its closest to the emf when

- A. the internal resistance is much smaller than the load resistance.
- B. a large current flows in the circuit.
- C. the cell is not completely discharged.
- D. the cell is being recharged.

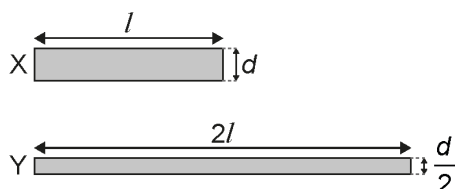
54 - (PHYSI/11\_HL\_Summer\_2021\_Q18) - *Electricity & Magnetism*

An electron enters the space inside a current-carrying solenoid. The velocity of the electron is parallel to the solenoid's axis. The electron is

- A. slowed down.
- B. speeded up.
- C. undeflected.
- D. deflected outwards.

55 - (PHYSI/12\_HL\_Summer\_2021\_Q15) - *Electricity & Magnetism*

The diagram shows two cylindrical wires, X and Y. Wire X has a length  $l$ , a diameter  $d$ , and a resistivity  $\rho$ . Wire Y has a length  $2l$ , a diameter of  $\frac{d}{2}$  and a resistivity of  $\frac{\rho}{2}$ .



What is  $\frac{\text{resistance of X}}{\text{resistance of Y}}$ ?

- A. 4
- B. 2
- C. 0.5
- D. 0.25

56 - (PHYSI/12\_HL\_Summer\_2021\_Q16) - Electricity &amp; Magnetism

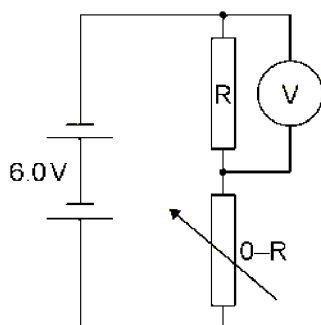


An ion moves in a circle in a uniform magnetic field. Which single change would increase the radius of the circular path?

- A. Decreasing the speed of the ion
- B. Increasing the charge of the ion
- C. Increasing the mass of the ion
- D. Increasing the strength of the magnetic field

57 - (PHYSI/12\_HL\_Summer\_2021\_Q17) - Electricity &amp; Magnetism

A circuit contains a variable resistor of maximum resistance  $R$  and a fixed resistor, also of resistance  $R$ , connected in series. The emf of the battery is  $6.0\text{V}$  and its internal resistance is negligible.



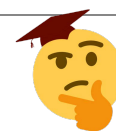
What are the initial and final voltmeter readings when the variable resistor is increased from an initial resistance of zero to a final resistance of  $R$ ?

|    | Initial voltmeter reading / V | Final voltmeter reading / V |
|----|-------------------------------|-----------------------------|
| A. | 0                             | 6.0                         |
| B. | 6.0                           | 0                           |
| C. | 6.0                           | 3.0                         |
| D. | 3.0                           | 6.0                         |

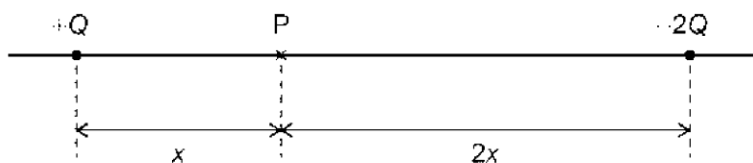
58 - (PHYSI/12\_HL\_Summer\_2021\_Q18) - Electricity &amp; Magnetism

Magnetic field lines are an example of

- A. a discovery that helps us understand magnetism.
- B. a model to aid in visualization.
- C. a pattern in data from experiments.
- D. a theory to explain concepts in magnetism.

59 - (PHYSI/10\_HL\_Winter\_2021\_Q15) - *Electricity & Magnetism*

A charge  $+Q$  and a charge  $-2Q$  are a distance  $3x$  apart. Point P is on the line joining the charges, at a distance  $x$  from  $+Q$ .



The magnitude of the electric field produced at P by the charge  $+Q$  alone is  $E$ .

What is the total electric field at P?

- A.  $\frac{E}{2}$  to the right
- B.  $\frac{E}{2}$  to the left
- C.  $\frac{3E}{2}$  to the right
- D.  $\frac{3E}{2}$  to the left

60 - (PHYSI/10\_HL\_Winter\_2021\_Q16) - *Electricity & Magnetism*

Two wires, X and Y, are made of the same material and have equal length. The diameter of X is twice that of Y.

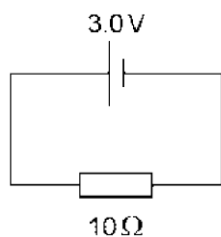
What is  $\frac{\text{resistance of X}}{\text{resistance of Y}}$ ?

- A.  $\frac{1}{4}$
- B.  $\frac{1}{2}$
- C. 2
- D. 4

## 61 – (PHYSI/10\_HL\_Winter\_2021\_Q17) – Electricity &amp; Magnetism



A cell has an emf of  $3.0\text{ V}$  and an internal resistance of  $2.0\Omega$ . The cell is connected in series with a resistance of  $10\Omega$ .

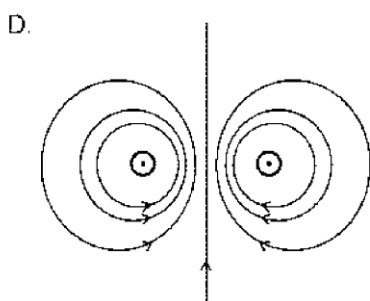
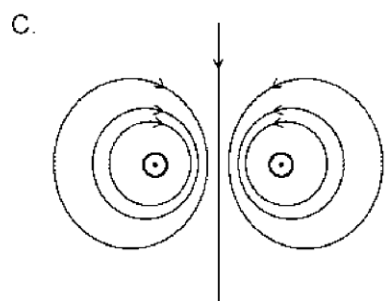
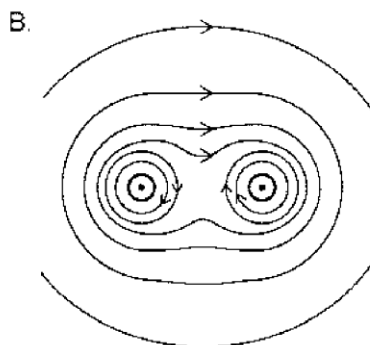
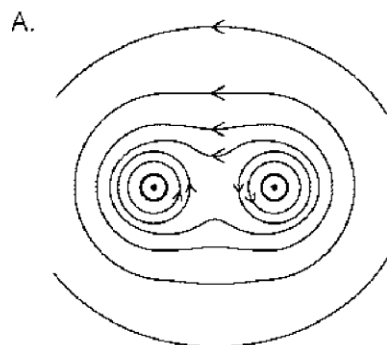


What is the terminal potential difference of the cell?

- A.  $0.5\text{ V}$
- B.  $1.5\text{ V}$
- C.  $2.5\text{ V}$
- D.  $3.0\text{ V}$

## 62 – (PHYSI/10\_HL\_Winter\_2021\_Q18) – Electricity &amp; Magnetism

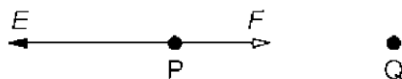
Two parallel wires carry equal currents in the same direction out of the paper. Which diagram shows the magnetic field surrounding the wires?



## 63 – (PHYSI/11\_HL\_Summer\_2022\_Q18) – Electricity &amp; Magnetism



P and Q are two opposite point charges. The force  $F$  acting on P due to Q and the electric field strength  $E$  at P are shown.

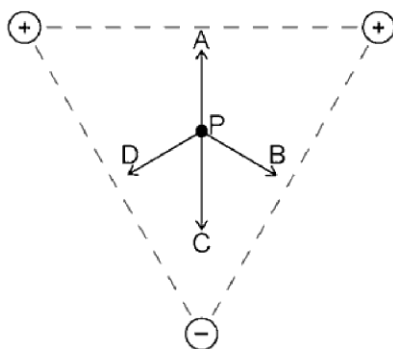


Which diagram shows the force on Q due to P and the electric field strength at Q?

- A.
- B.
- C.
- D.

## 64 – (PHYSI/11\_HL\_Summer\_2022\_Q19) – Electricity &amp; Magnetism

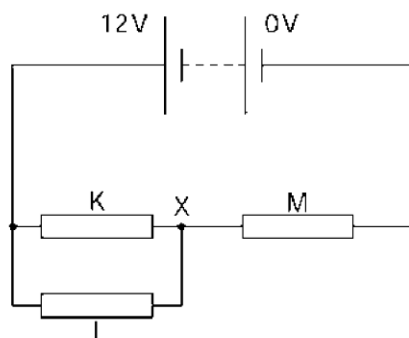
Three point charges of equal magnitude are placed at the vertices of an equilateral triangle. The signs of the charges are shown. Point P is equidistant from the vertices of the triangle. What is the direction of the resultant electric field at P?



65 – (PHYSI/11\_HL\_Summer\_2022\_Q20) – Electricity &amp; Magnetism



In the circuit shown, the battery has an emf of 12 V and negligible internal resistance. Three identical resistors are connected as shown. The resistors each have a resistance of  $10\Omega$ .



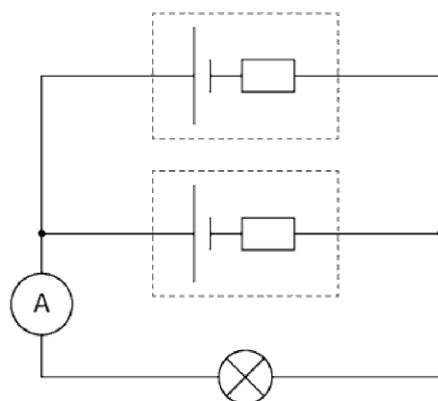
The resistor L is removed. What is the change in potential at X?

- A. Increases by 2 V
- B. Decreases by 2 V
- C. Increases by 4 V
- D. Decreases by 4 V

66 – (PHYSI/11\_HL\_Summer\_2022\_Q21) – Electricity &amp; Magnetism

Two cells are connected in parallel as shown below. Each cell has an emf of 5.0 V and an internal resistance of  $2.0\Omega$ . The lamp has a resistance of  $4.0\Omega$ . The ammeter is ideal.

What is the reading on the ammeter?

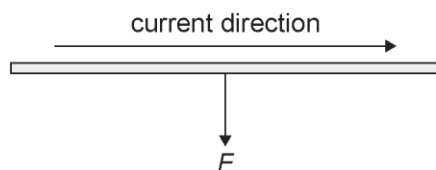


- A. 1.0 A
- B. 1.3 A
- C. 2.0 A
- D. 2.5 A

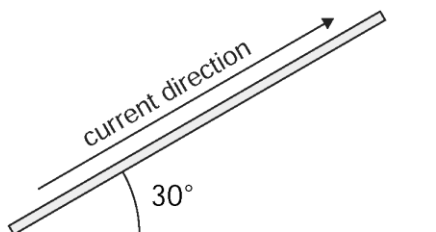
67 – (PHYSI/11\_HL\_Summer\_2022\_Q22) – Electricity &amp; Magnetism



A conductor is placed in a uniform magnetic field perpendicular to the plane of the paper. A force  $F$  acts on the conductor when there is a current in the conductor as shown.



The conductor is rotated  $30^\circ$  about the axis of the magnetic field.

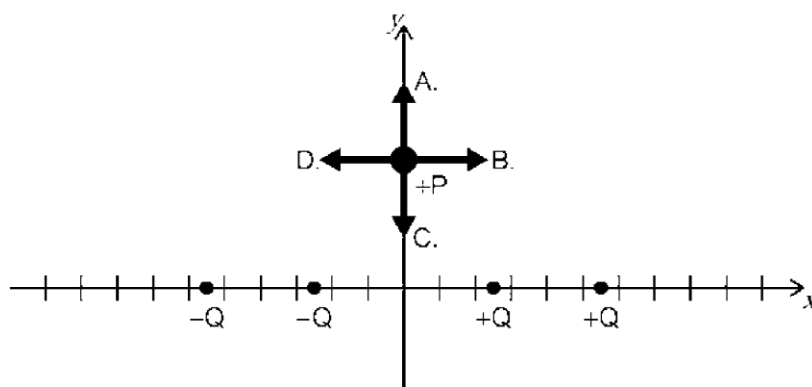


What is the direction of the magnetic field and what is the magnitude of the force on the conductor after the rotation?

|    | Direction of magnetic field   | Magnitude of force |
|----|-------------------------------|--------------------|
| A. | into the plane of the paper   | $F$                |
| B. | into the plane of the paper   | $\frac{F}{2}$      |
| C. | out of the plane of the paper | $F$                |
| D. | out of the plane of the paper | $\frac{F}{2}$      |

68 – (PHYSI/12\_HL\_Summer\_2022\_Q16) – Electricity &amp; Magnetism

Four particles, two of charge  $+Q$  and two of charge  $-Q$ , are positioned on the  $x$ -axis as shown. A particle P with a positive charge is placed on the  $y$ -axis. What is the direction of the net electrostatic force on this particle?



69 - (PHYSI/12\_HL\_Summer\_2022\_Q17) - Electricity &amp; Magnetism



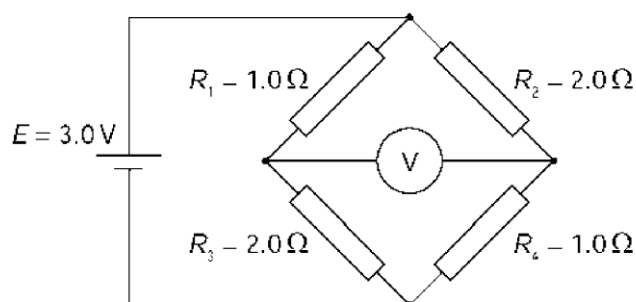
A battery of negligible internal resistance is connected to a lamp. A second identical lamp is added in series. What is the change in potential difference across the first lamp and what is the change in the output power of the battery?

|    | Change in potential difference | Output power of battery |
|----|--------------------------------|-------------------------|
| A. | decreases                      | decreases               |
| B. | decreases                      | increases               |
| C. | no change                      | decreases               |
| D. | no change                      | increases               |

70 - (PHYSI/12\_HL\_Summer\_2022\_Q18) - Electricity &amp; Magnetism

A circuit consists of a cell of emf  $E = 3.0\text{V}$  and four resistors connected as shown. Resistors  $R_1$  and  $R_4$  are  $1.0\,\Omega$  and resistors  $R_2$  and  $R_3$  are  $2.0\,\Omega$ .

What is the voltmeter reading?



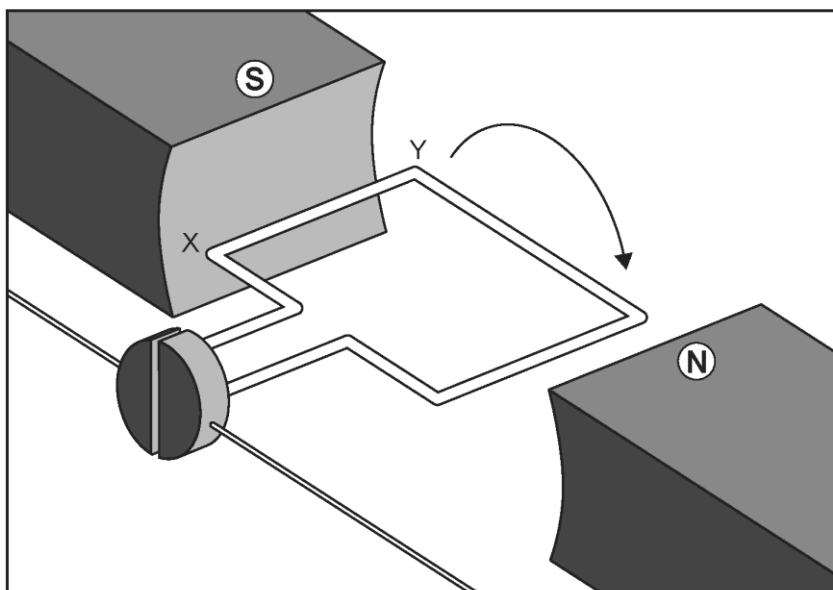
- A. 0.50V
- B. 1.0V
- C. 1.5V
- D. 2.0V



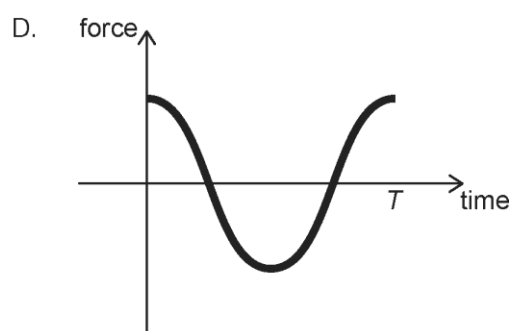
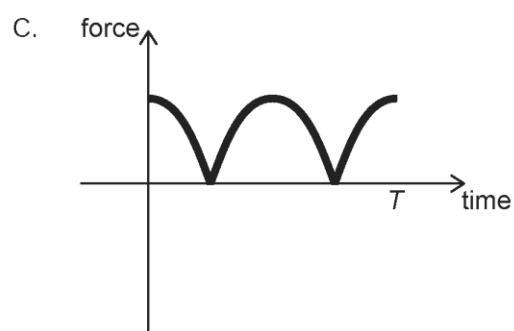
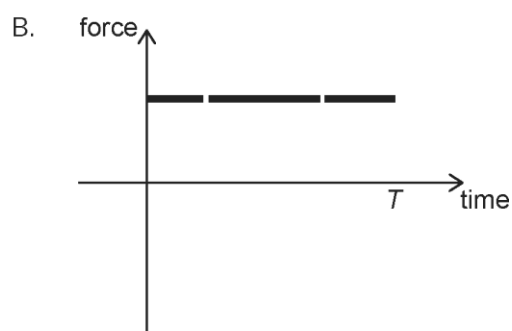
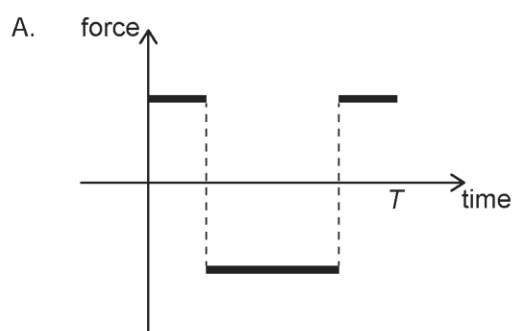
71 - (PHYSI/12\_HL\_Summer\_2022\_Q19) - Electricity &amp; Magnetism



The coil of a direct current electric motor is turning with a period  $T$ . At  $t = 0$  the coil is in the position shown in the diagram. Assume the magnetic field is uniform across the coil.



Which graph shows the variation with time of the force exerted on section XY of the coil during one complete turn?



72 – (PHYSI/10\_HL\_Winter\_2022\_Q16) – *Electricity & Magnetism*

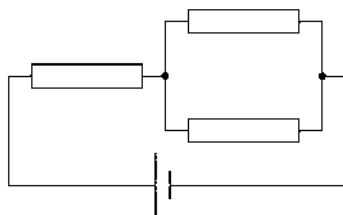
Two copper wires of equal lengths but different diameters are used to connect a cell to a load. Wire 1 has a diameter  $M$ , wire 2 has a diameter  $2M$ . The electron drift velocities in wires 1 and 2 are  $v_1$  and  $v_2$ .

What is  $\frac{v_2}{v_1}$ ?

- A. 4
- B. 2
- C.  $\frac{1}{2}$
- D.  $\frac{1}{4}$

73 – (PHYSI/10\_HL\_Winter\_2022\_Q17) – *Electricity & Magnetism*

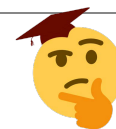
A cell of negligible internal resistance is connected to three identical resistors. The current in the cell is 3.0 A.



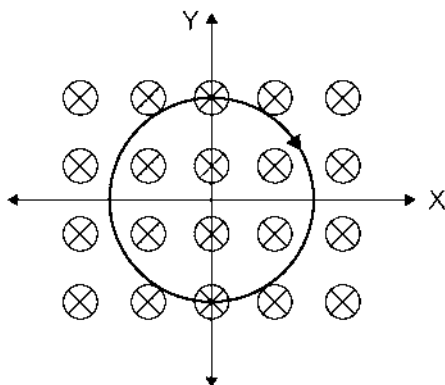
The resistors are now arranged in series.

What is the new current in the cell?

- A. 1.0 A
- B. 1.5 A
- C. 3.0 A
- D. 9.0 A

74 – (PHYSI/10\_HL\_Winter\_2022\_Q18) – *Electricity & Magnetism*

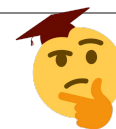
A loop of wire lies in a magnetic field directed into the plane of the page. The loop carries a current in a clockwise direction.



The magnetic force acting on the wire tends to

- A. rotate the loop about the X axis.
- B. rotate the loop about the Y axis.
- C. reduce the radius of the loop.
- D. increase the radius of the loop.

## 1 - (PHYSI/11\_HL\_Summer\_2017\_Q19) - Circular Motion &amp; Gravitation

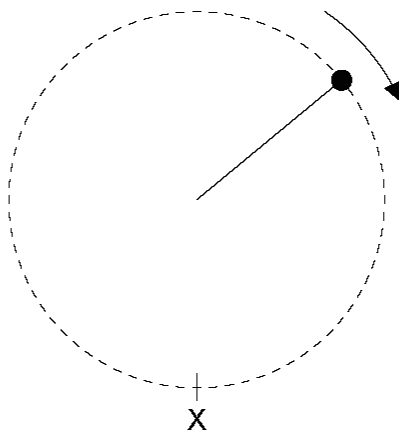


An object of constant mass is tied to the end of a rope of length  $l$  and made to move in a horizontal circle. The speed of the object is increased until the rope breaks at speed  $v$ . The length of the rope is then changed. At what other combination of rope length and speed will the rope break?

|    | Rope length | Speed         |
|----|-------------|---------------|
| A. | $4l$        | $2v$          |
| B. | $2l$        | $v$           |
| C. | $2l$        | $\frac{v}{2}$ |
| D. | $4l$        | $\frac{v}{2}$ |

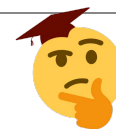
## 2 - (PHYSI/12\_HL\_Summer\_2017\_Q18) - Circular Motion &amp; Gravitation

A small ball of weight  $W$  is attached to a string and moves in a vertical circle of radius  $R$ .

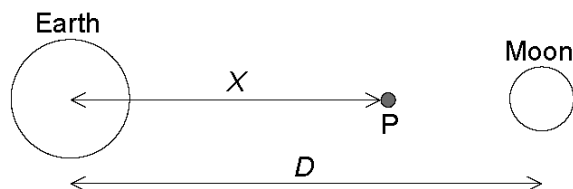


What is the smallest kinetic energy of the ball at position X for the ball to maintain the circular motion with radius  $R$ ?

- A.  $\frac{WR}{2}$
- B.  $WR$
- C.  $2WR$
- D.  $\frac{5WR}{2}$

3 - (PHYSI/12\_HL\_Summer\_2017\_Q19) - *Circular Motion & Gravitation*

The centre of the Earth is separated from the centre of the Moon by a distance  $D$ . Point P lies on a line joining the centre of the Earth and the centre of the Moon, a distance  $X$  from the centre of the Earth. The gravitational field strength at P is zero.



What is the ratio  $\frac{\text{mass of the Moon}}{\text{mass of the Earth}}$ ?

A.  $\frac{(D-X)^2}{X^2}$

B.  $\frac{(D-X)}{X}$

C.  $\frac{X^2}{(D-X)^2}$

D.  $\frac{X}{D-X}$

4 - (PHYSI/10\_HL\_Winter\_2017\_Q19) - *Circular Motion & Gravitation*

A satellite X of mass  $m$  orbits the Earth with a period  $T$ . What will be the orbital period of satellite Y of mass  $2m$  occupying the same orbit as X?

A.  $\frac{T}{2}$

B.  $T$

C.  $\sqrt{2}T$

D.  $2T$



5 - (PHYSI/11\_HL\_Summer\_2018\_Q18) - Circular Motion &amp; Gravitation

An object of mass  $m$  at the end of a string of length  $r$  moves in a vertical circle at a constant angular speed  $\omega$ .

What is the tension in the string when the object is at the bottom of the circle?

- A.  $m(\omega^2 r + g)$
- B.  $m(\omega^2 r - g)$
- C.  $mg(\omega^2 r + 1)$
- D.  $mg(\omega^2 r - 1)$

6 - (PHYSI/11\_HL\_Summer\_2018\_Q32) - Circular Motion &amp; Gravitation

An electron of mass  $m_e$  orbits an alpha particle of mass  $m_\alpha$  in a circular orbit of radius  $r$ . Which expression gives the speed of the electron?

- A.  $\sqrt{\frac{2ke^2}{m_e r}}$
- B.  $\sqrt{\frac{2ke^2}{m_\alpha r}}$
- C.  $\sqrt{\frac{4ke^2}{m_e r}}$
- D.  $\sqrt{\frac{4ke^2}{m_\alpha r}}$

7 - (PHYSI/12\_HL\_Summer\_2018\_Q17) - Circular Motion &amp; Gravitation

An object of mass  $m$  moves in a horizontal circle of radius  $r$  with a constant speed  $v$ . What is the rate at which work is done by the centripetal force?

- A.  $\frac{mv^3}{r}$
- B.  $\frac{mv^3}{2\pi r}$
- C.  $\frac{mv^3}{4\pi r}$
- D. zero

8 - (PHYSI/10\_HL\_Winter\_2018\_Q5) - Circular Motion &amp; Gravitation



A mass  $m$  attached to a string of length  $R$  moves in a vertical circle with a constant speed. The tension in the string at the top of the circle is  $T$ . What is the kinetic energy of the mass at the top of the circle?

- A.  $\frac{R(T + mg)}{2}$
- B.  $\frac{R(T - mg)}{2}$
- C.  $\frac{Rmg}{2}$
- D.  $\frac{R(2T + mg)}{2}$

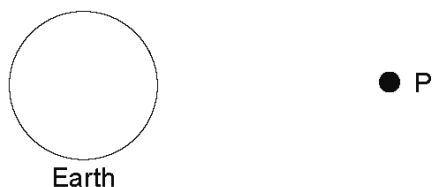
9 - (PHYSI/10\_HL\_Winter\_2018\_Q11) - Circular Motion &amp; Gravitation

A particle moving in a circle completes 5 revolutions in 3 s. What is the frequency?

- A.  $\frac{3}{5}$  Hz
- B.  $\frac{5}{3}$  Hz
- C.  $\frac{3\pi}{5}$  Hz
- D.  $\frac{5\pi}{3}$  Hz

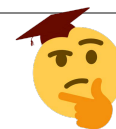
10 - (PHYSI/10\_HL\_Winter\_2018\_Q31) - Circular Motion &amp; Gravitation

The gravitational potential at point P due to Earth is  $V$ .



What is the definition of the gravitational potential at P?

- A. Work done per unit mass to move a point mass from infinity to P
- B. Work done per unit mass to move a point mass from P to infinity
- C. Work done to move a point mass from infinity to P
- D. Work done to move a point mass from P to infinity

11 - (PHYSI/10\_HL\_Winter\_2018\_Q32) - *Circular Motion & Gravitation*

The escape speed for the Earth is  $v_{\text{esc}}$ . Planet X has half the density of the Earth and twice the radius. What is the escape speed for planet X?

- A.  $\frac{v_{\text{esc}}}{2}$
- B.  $\frac{v_{\text{esc}}}{\sqrt{2}}$
- C.  $v_{\text{esc}}$
- D.  $\sqrt{2} v_{\text{esc}}$

12 - (PHYSI/11\_HL\_Summer\_2019\_Q20) - *Circular Motion & Gravitation*

Satellite X orbits a planet with orbital radius  $R$ . Satellite Y orbits the same planet with orbital radius  $2R$ . Satellites X and Y have the same mass.

What is the ratio  $\frac{\text{centripetal acceleration of X}}{\text{centripetal acceleration of Y}}$ ?

- A.  $\frac{1}{4}$
- B.  $\frac{1}{2}$
- C. 2
- D. 4

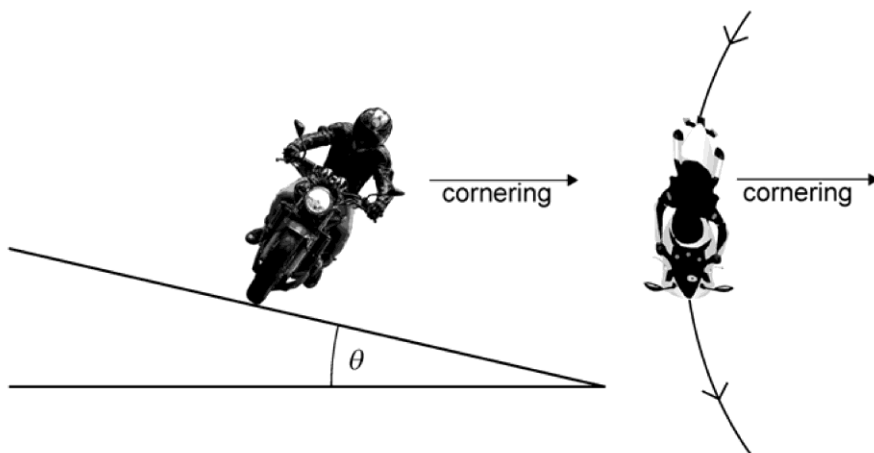


13 - (PHYSI/11\_HL\_Summer\_2019\_Q21) - Circular Motion &amp; Gravitation



A motorcyclist is cornering on a curved race track.

Which combination of changes of banking angle  $\theta$  and coefficient of friction  $\mu$  between the tyres and road allows the motorcyclist to travel around the corner at greater speed?



|    | Banking angle $\theta$ | Coefficient of friction $\mu$ |
|----|------------------------|-------------------------------|
| A. | increase               | increase                      |
| B. | increase               | decrease                      |
| C. | decrease               | increase                      |
| D. | decrease               | decrease                      |

14 - (PHYSI/12\_HL\_Summer\_2019\_Q10) - Mechanics, Circular Motion &amp; Gravitation

Satellite X is in orbit around the Earth. An identical satellite Y is in a higher orbit. What is correct for the total energy and the kinetic energy of the satellite Y compared with satellite X?

|    | Total energy of satellite X | Kinetic energy of satellite X |
|----|-----------------------------|-------------------------------|
| A. | larger                      | larger                        |
| B. | smaller                     | larger                        |
| C. | larger                      | smaller                       |
| D. | smaller                     | smaller                       |



## 15 - (PHYSI/12\_HL\_Summer\_2019\_Q11) - Circular Motion &amp; Gravitation

The escape speed from a planet of radius  $R$  is  $v_{\text{esc}}$ . A satellite orbits the planet at a distance  $R$  from the surface of the planet. What is the orbital speed of the satellite?

- A.  $\frac{1}{2}v_{\text{esc}}$
- B.  $\frac{\sqrt{2}}{2}v_{\text{esc}}$
- C.  $\sqrt{2}v_{\text{esc}}$
- D.  $2v_{\text{esc}}$

## 16 - (PHYSI/12\_HL\_Summer\_2019\_Q32) - Circular Motion &amp; Gravitation

A particle of mass  $0.02 \text{ kg}$  moves in a horizontal circle of diameter  $1 \text{ m}$  with an angular velocity of  $3\pi \text{ rad s}^{-1}$ .

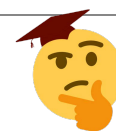
What is the magnitude and direction of the force responsible for this motion?

|    | Magnitude of force / N | Direction of force         |
|----|------------------------|----------------------------|
| A. | $0.03\pi$              | away from centre of circle |
| B. | $0.03\pi$              | towards centre of circle   |
| C. | $0.09\pi^2$            | away from centre of circle |
| D. | $0.09\pi^2$            | towards centre of circle   |

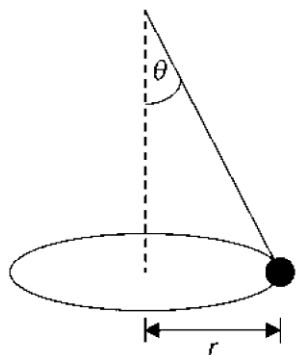
## 17 - (PHYSI/12\_HL\_Summer\_2019\_Q37) - Oscillations &amp; Waves, Circular Motion &amp; Gravitation

The orbital radius of the Earth around the Sun is 1.5 times that of Venus. What is the intensity of solar radiation at the orbital radius of Venus?

- A.  $0.6 \text{ kWm}^{-2}$
- B.  $0.9 \text{ kWm}^{-2}$
- C.  $2 \text{ kWm}^{-2}$
- D.  $3 \text{ kWm}^{-2}$

18 – (PHYSI/10\_HL\_Winter\_2019\_Q18) – *Circular Motion & Gravitation*

An object hangs from a light string and moves in a horizontal circle of radius  $r$ .



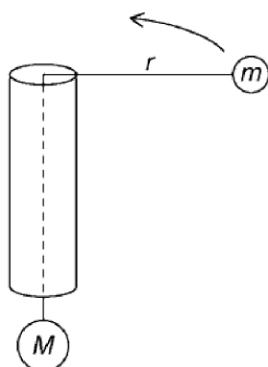
The string makes an angle  $\theta$  with the vertical. The angular speed of the object is  $\omega$ . What is  $\tan \theta$ ?

- A.  $\frac{\omega^2 r}{g}$
- B.  $\frac{g}{\omega^2 r}$
- C.  $\frac{\omega r^2}{g}$
- D.  $\frac{g}{\omega r^2}$

19 - (PHYSI/10\_HL\_Winter\_2020\_Q20) - Circular Motion &amp; Gravitation



Mass  $M$  is attached to one end of a string. The string is passed through a hollow tube and mass  $m$  is attached to the other end. Friction between the tube and string is negligible.



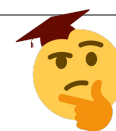
Mass  $m$  travels at constant speed  $v$  in a horizontal circle of radius  $r$ . What is mass  $M$ ?

- A.  $\frac{mv^2}{r}$
- B.  $mv^2rg$
- C.  $\frac{mgv^2}{r}$
- D.  $\frac{mv^2}{gr}$

20 - (PHYSI/11\_HL\_Summer\_2021\_Q19) - Circular Motion &amp; Gravitation

A child stands on a horizontal rotating platform that is moving at constant angular speed. The centripetal force on the child is provided by

- A. the gravitational force on the child.
- B. the friction on the child's feet.
- C. the tension in the child's muscles.
- D. the normal reaction of the platform on the child.



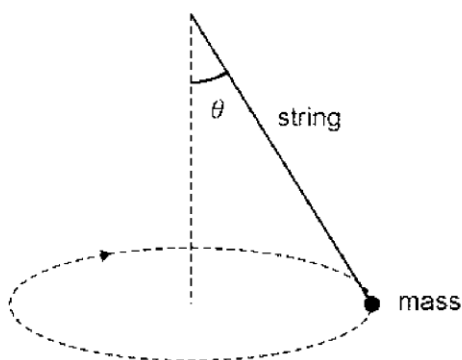
## 21 - (PHYSI/12\_HL\_Summer\_2021\_Q19) - Circular Motion &amp; Gravitation

An object moves in a circle of constant radius. Values of the centripetal force  $F$  are measured for different values of angular velocity  $\omega$ . A graph is plotted with  $\omega$  on the  $x$ -axis. Which quantity plotted on the  $y$ -axis will produce a straight-line graph?

- A.  $\sqrt{F}$
- B.  $F$
- C.  $F^2$
- D.  $\frac{1}{F}$

## 22 - (PHYSI/10\_HL\_Winter\_2021\_Q19) - Circular Motion &amp; Gravitation

A mass at the end of a string is moving in a horizontal circle at constant speed. The string makes an angle  $\theta$  to the vertical.

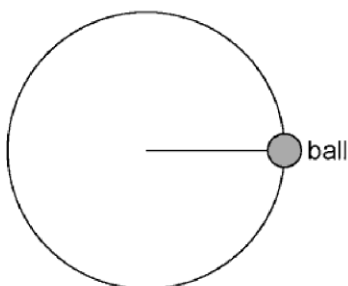


What is the magnitude of the acceleration of the mass?

- A.  $g$
- B.  $g \sin \theta$
- C.  $g \cos \theta$
- D.  $g \tan \theta$

23 – (PHYSI/11\_HL\_Summer\_2022\_Q23) – *Circular Motion & Gravitation*

A ball of mass  $0.3\text{ kg}$  is attached to a light, inextensible string. It is rotated in a vertical circle. The length of the string is  $0.6\text{ m}$  and the speed of rotation of the ball is  $4\text{ m s}^{-1}$ .



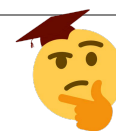
What is the tension when the string is horizontal?

- A.  $5\text{ N}$
- B.  $8\text{ N}$
- C.  $11\text{ N}$
- D.  $13\text{ N}$

24 – (PHYSI/11\_HL\_Summer\_2022\_Q24) – *Circular Motion & Gravitation*

P and Q are two moons of equal densities orbiting a planet. The orbital radius of P is twice the orbital radius of Q. The volume of P is half that of Q. The force exerted by the planet on P is  $F$ . What is the force exerted by the planet on Q?

- A.  $F$
- B.  $2F$
- C.  $4F$
- D.  $8F$



25 – (PHYSI/12\_HL\_Summer\_2022\_Q20) – *Circular Motion & Gravitation*

A satellite is orbiting Earth in a circular path at constant speed. Three statements about the resultant force on the satellite are:

- I. It is equal to the gravitational force of attraction on the satellite.
- II. It is equal to the mass of the satellite multiplied by its acceleration.
- III. It is equal to the centripetal force on the satellite.

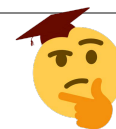
Which combination of statements is correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

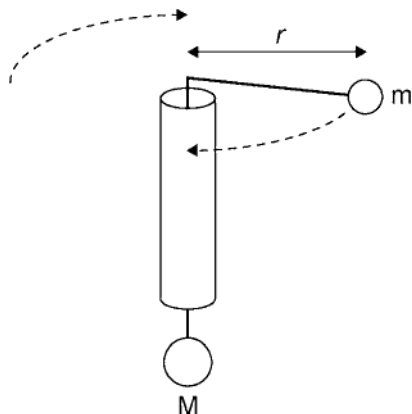
26 – (PHYSI/12\_HL\_Summer\_2022\_Q21) – *Circular Motion & Gravitation*

An astronaut is orbiting Earth in a spaceship. Why does the astronaut experience weightlessness?

- A. The astronaut is outside the gravitational field of Earth.
- B. The acceleration of the astronaut is the same as the acceleration of the spaceship.
- C. The spaceship is travelling at a high speed tangentially to the orbit.
- D. The gravitational field is zero at that point.

27 – (PHYSI/10\_HL\_Winter\_2022\_Q19) – *Circular Motion & Gravitation*

Two masses  $M$  and  $m$  are connected by a string that runs without friction through a stationary tube. Mass  $m$  rotates at constant speed in a horizontal circle of radius  $0.25\text{ m}$ . The weight of  $M$  provides the centripetal force for the motion of  $m$ . The time period for the rotation of  $m$  is  $0.50\text{ s}$ .

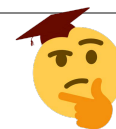


What is  $\frac{\text{mass of } M}{\text{mass of } m}$ ?

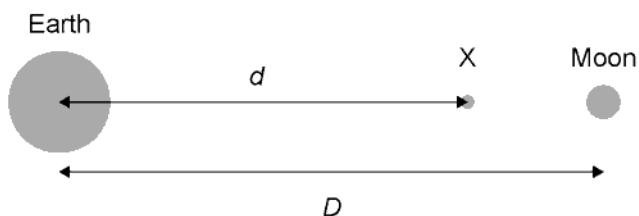
- A. 1
- B. 2
- C. 4
- D. 8



28 – (PHYSI/10\_HL\_Winter\_2022\_Q20) – Circular Motion &amp; Gravitation



The centre of the Earth and the Moon are a distance  $D$  apart. There is a point X between them where their gravitational fields cancel out. The distance from the centre of the Earth to X is  $d$ . The mass of the Earth is  $M_E$  and the mass of the Moon is  $M_M$ .



What is correct at X?

- A.  $\frac{M_E}{d} = \frac{M_M}{D-d}$
- B.  $\frac{M_E}{D-d} = \frac{M_M}{d}$
- C.  $\frac{M_E}{d^2} = \frac{M_M}{(D-d)^2}$
- D.  $\frac{M_E}{d^2} = \frac{M_M}{D^2-d^2}$

1 - (PHYSI/11\_HL\_Summer\_2017\_Q20) - Atomic,nuclear & Particle Physics



A pure sample of nuclide A and a pure sample of nuclide B have the same activity at time  $t = 0$ . Nuclide A has a half-life of  $T$ , nuclide B has a half-life of  $2T$ .

What is  $\frac{\text{activity of A}}{\text{activity of B}}$  when  $t = 4T$ ?

- A. 4
- B. 2
- C.  $\frac{1}{2}$
- D.  $\frac{1}{4}$

2 - (PHYSI/11\_HL\_Summer\_2017\_Q21) - Atomic,nuclear & Particle Physics

What is the definition of the unified atomic mass unit?

- A.  $\frac{1}{12}$  the mass of a neutral atom of carbon-12
- B. The mass of a neutral atom of hydrogen-1
- C.  $\frac{1}{12}$  the mass of a nucleus of carbon-12
- D. The mass of a nucleus of hydrogen-1

3 - (PHYSI/11\_HL\_Summer\_2017\_Q22) - Atomic,nuclear &amp; Particle Physics



In nuclear fission, a nucleus of element X absorbs a neutron (n) to give a nucleus of element Y and a nucleus of element Z.



What is  $\frac{\text{magnitude of the binding energy per nucleon of Y}}{\text{magnitude of the binding energy per nucleon of X}}$  and  $\frac{\text{total binding energy of Y and Z}}{\text{total binding energy of X}}$ ?

|    | Magnitude of the binding energy per nucleon of Y<br>Magnitude of the binding energy per nucleon of X | Total binding energy of Y and Z<br>Total binding energy of X |
|----|------------------------------------------------------------------------------------------------------|--------------------------------------------------------------|
| A. | greater than 1                                                                                       | greater than 1                                               |
| B. | less than 1                                                                                          | greater than 1                                               |
| C. | greater than 1                                                                                       | less than 1                                                  |
| D. | less than 1                                                                                          | less than 1                                                  |

4 - (PHYSI/12\_HL\_Summer\_2017\_Q7) - Mechanics, Atomic,nuclear &amp; Particle Physics

A stationary nucleus of polonium-210 undergoes alpha decay to form lead-206. The initial speed of the alpha particle is  $v$ . What is the speed of the lead-206 nucleus?

- A.  $\frac{206}{4}v$
- B.  $v$
- C.  $\frac{206}{210}v$
- D.  $\frac{4}{206}v$

5 - (PHYSI/12\_HL\_Summer\_2017\_Q20) - Atomic,nuclear &amp; Particle Physics

The binding energy per nucleon of  ${}^{11}_4\text{Be}$  is 6 MeV. What is the energy required to separate the nucleons of this nucleus?

- A. 24 MeV
- B. 42 MeV
- C. 66 MeV
- D. 90 MeV

6 - (PHYSI/12\_HL\_Summer\_2017\_Q21) - Atomic, nuclear &amp; Particle Physics



In the nuclear reaction  $X + Y \rightarrow Z + W$ , involving nuclides X, Y, Z and W, energy is released. Which is correct about the masses ( $M$ ) and the binding energies ( $BE$ ) of the nuclides?

|    | Masses                  | Binding energies            |
|----|-------------------------|-----------------------------|
| A. | $M_X + M_Y < M_Z + M_W$ | $BE_X + BE_Y < BE_Z + BE_W$ |
| B. | $M_X + M_Y < M_Z + M_W$ | $BE_X + BE_Y > BE_Z + BE_W$ |
| C. | $M_X + M_Y > M_Z + M_W$ | $BE_X + BE_Y < BE_Z + BE_W$ |
| D. | $M_X + M_Y > M_Z + M_W$ | $BE_X + BE_Y > BE_Z + BE_W$ |

7 - (PHYSI/12\_HL\_Summer\_2017\_Q22) - Atomic, nuclear &amp; Particle Physics

The reaction  $p^+ + n^0 \rightarrow p^+ + \pi^0$  does not occur because it violates the conservation law of

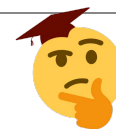
- A. electric charge.
- B. baryon number.
- C. lepton number.
- D. strangeness.

8 - (PHYSI/10\_HL\_Winter\_2017\_Q20) - Atomic, nuclear &amp; Particle Physics

Which statement about atomic spectra is **not** true?

- A. They provide evidence for discrete energy levels in atoms.
- B. Emission and absorption lines of equal frequency correspond to transitions between the same two energy levels.
- C. Absorption lines arise when electrons gain energy.
- D. Emission lines always correspond to the visible part of the electromagnetic spectrum.

## 9 - (PHYSI/10\_HL\_Winter\_2017\_Q21) - Atomic, nuclear &amp; Particle Physics

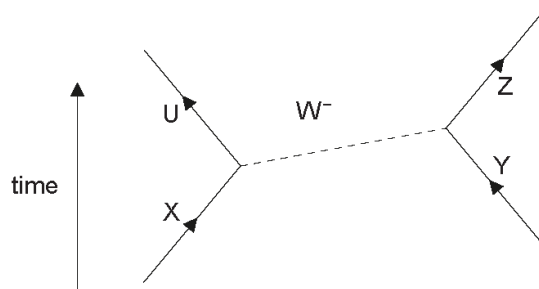


What gives the total change in nuclear mass and the change in nuclear binding energy as a result of a nuclear fusion reaction?

|    | Nuclear mass | Nuclear binding energy |
|----|--------------|------------------------|
| A. | decreases    | decreases              |
| B. | decreases    | increases              |
| C. | increases    | decreases              |
| D. | increases    | increases              |

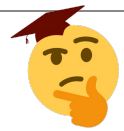
## 10 - (PHYSI/10\_HL\_Winter\_2017\_Q22) - Atomic, nuclear &amp; Particle Physics

The Feynman diagram shows a particle interaction involving a  $W^-$  boson.

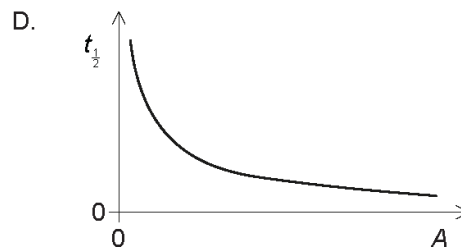
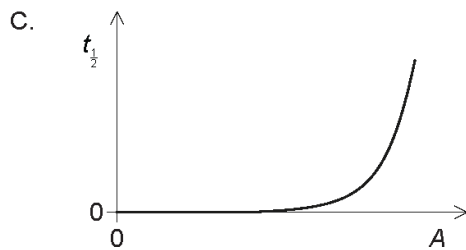
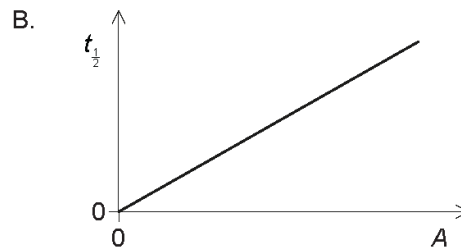
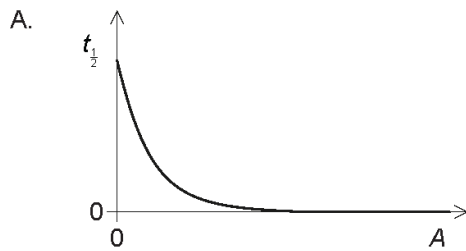


Which particles are interacting?

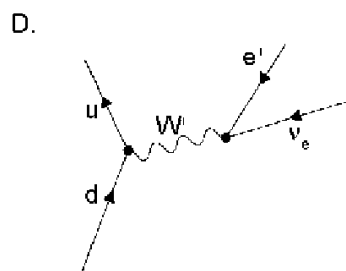
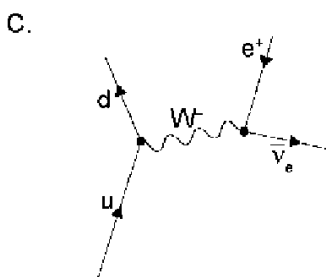
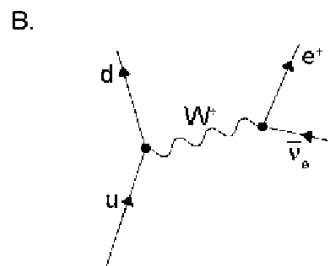
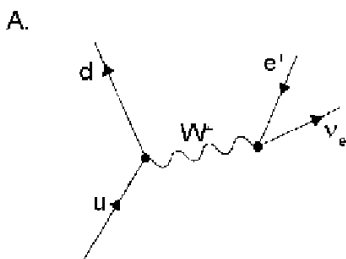
- A. U and Y
- B.  $W^-$  boson and Y
- C. X and Y
- D. U and X


**11** - (PHYSI/10\_HL\_Winter\_2017\_Q23) - Atomic,nuclear & Particle Physics

Samples of different radioactive nuclides have equal numbers of nuclei. Which graph shows the relationship between the half-life  $t_{1/2}$  and the activity  $A$  for the samples?


**12** - (PHYSI/11\_HL\_Summer\_2018\_Q19) - Atomic,nuclear & Particle Physics

Which Feynman diagram shows beta-plus ( $\beta^+$ ) decay?



13 - (PHYSI/11\_HL\_Summer\_2018\_Q20) - Atomic, nuclear &amp; Particle Physics



The average binding energy per nucleon of the  $^{15}_8\text{O}$  nucleus is 7.5 MeV. What is the total energy required to separate the nucleons of one nucleus of  $^{15}_8\text{O}$ ?

- A. 53 MeV
- B. 60 MeV
- C. 113 MeV
- D. 173 MeV

14 - (PHYSI/11\_HL\_Summer\_2018\_Q21) - Atomic, nuclear &amp; Particle Physics

What is correct about the Higgs Boson?

- A. It was predicted before it was observed.
- B. It was difficult to detect because it is charged.
- C. It is not part of the Standard Model.
- D. It was difficult to detect because it has no mass.

15 - (PHYSI/12\_HL\_Summer\_2018\_Q18) - Atomic, nuclear &amp; Particle Physics

A detector, placed close to a radioactive source, detects an activity of 260 Bq. The average background activity at this location is 20 Bq. The radioactive nuclide has a half-life of 9 hours. What activity is detected after 36 hours?

- A. 15 Bq
- B. 16 Bq
- C. 20 Bq
- D. 35 Bq

16 - (PHYSI/12\_HL\_Summer\_2018\_Q19) - Atomic, nuclear &amp; Particle Physics

Element X decays through a series of alpha ( $\alpha$ ) and beta minus ( $\beta^-$ ) emissions. Which series of emissions results in an isotope of X?

- A.  $1\alpha$  and  $2\beta^-$
- B.  $1\alpha$  and  $4\beta^-$
- C.  $2\alpha$  and  $2\beta^-$
- D.  $2\alpha$  and  $3\beta^-$

17 - (PHYSI/12\_HL\_Summer\_2018\_Q20) - Atomic, nuclear & Particle Physics



Identify the conservation law violated in the proposed reaction.

$$p^+ + p^+ \rightarrow p^+ + n^0 + \mu^+$$

- A. Strangeness
- B. Lepton number
- C. Charge
- D. Baryon number

18 - (PHYSI/10\_HL\_Winter\_2018\_Q20) - Atomic, nuclear & Particle Physics

In the Rutherford-Geiger-Marsden scattering experiment it was observed that a small percentage of alpha particles are deflected through large angles.

Three features of the atom are

- I. the nucleus is positively charged
- II. the nucleus contains neutrons
- III. the nucleus is much smaller than the atom.

Which features can be inferred from the observation?

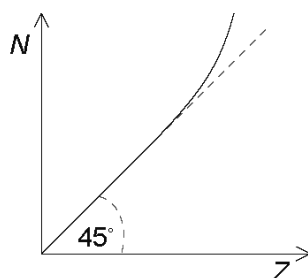
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III



19 - (PHYSI/10\_HL\_Winter\_2018\_Q21) - Atomic,nuclear &amp; Particle Physics



The graph shows the variation of the number of neutrons  $N$  with the atomic number  $Z$  for stable nuclei. The same scale is used in the  $N$  and  $Z$  axes.



Which information can be inferred from the graph?

- I. For stable nuclei with high  $Z$ ,  $N$  is larger than  $Z$ .
- II. For stable nuclei with small  $Z$ ,  $N = Z$ .
- III. All stable nuclei have more neutrons than protons.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

20 - (PHYSI/10\_HL\_Winter\_2018\_Q22) - Atomic,nuclear &amp; Particle Physics

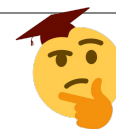
The following decay is observed.

$$\mu^- \rightarrow e^- + \nu_\mu + X$$

What is particle  $X$ ?

- A.  $\gamma$
- B.  $\bar{\nu}_e$
- C.  $Z^0$
- D.  $\nu_e$

21 - (PHYSI/10\_HL\_Winter\_2018\_Q23) - Atomic,nuclear &amp; Particle Physics

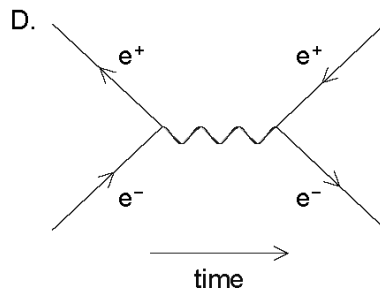
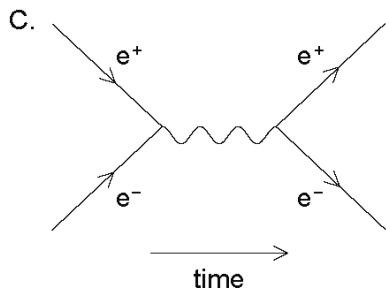
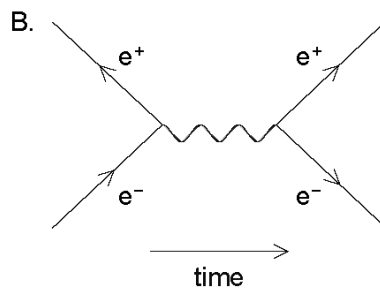
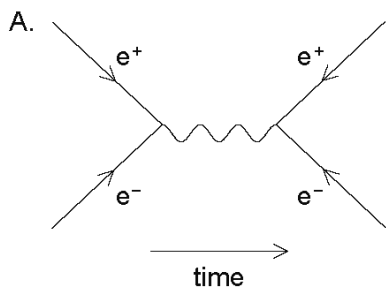


What is the function of control rods in a nuclear power plant?

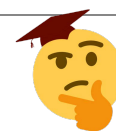
- A. To slow neutrons down
- B. To regulate fuel supply
- C. To exchange thermal energy
- D. To regulate the reaction rate

22 - (PHYSI/10\_HL\_Winter\_2018\_Q38) - Atomic,nuclear &amp; Particle Physics

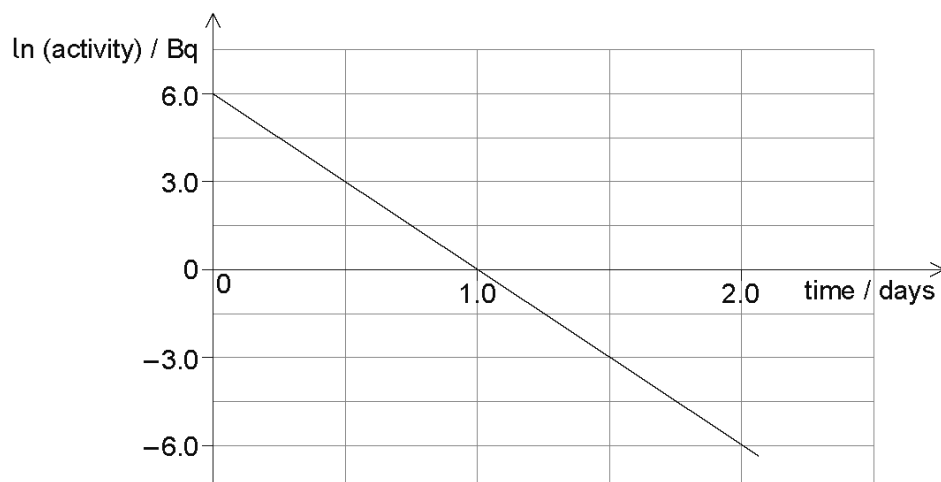
Which is the correct Feynman diagram for pair annihilation and pair production?



23 – (PHYSI/10\_HL\_Winter\_2018\_Q39) – Atomic,nuclear &amp; Particle Physics



The graph shows the variation of the natural log of activity,  $\ln(\text{activity})$ , against time for a radioactive nuclide.



What is the decay constant, in  $\text{days}^{-1}$ , of the radioactive nuclide?

- A.  $\frac{1}{6}$
- B.  $\frac{1}{3}$
- C. 3
- D. 6

24 – (PHYSI/10\_HL\_Winter\_2018\_Q40) – Atomic,nuclear &amp; Particle Physics

A radioactive nuclide is known to have a very long half-life.

Three quantities known for a pure sample of the nuclide are

- I. the activity of the nuclide
- II. the number of nuclide atoms
- III. the mass number of the nuclide.

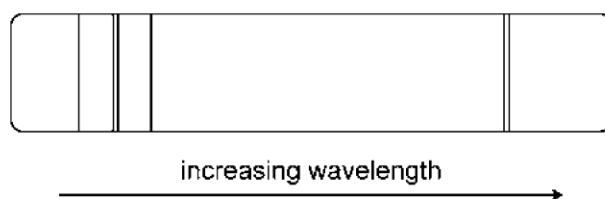
What quantities are required to determine the half-life of the nuclide?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

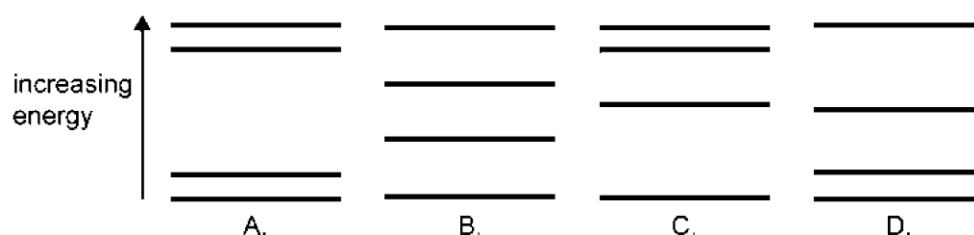
25 - (PHYSI/11\_HL\_Summer\_2019\_Q22) - Atomic, nuclear &amp; Particle Physics



The diagram shows the emission spectrum of an atom.

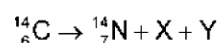


Which of the following atomic energy level models can produce this spectrum?



26 - (PHYSI/11\_HL\_Summer\_2019\_Q23) - Atomic, nuclear &amp; Particle Physics

The carbon isotope  $^{14}_6\text{C}$  is radioactive. It decays according to the equation



What are X and Y?

|    | X              | Y             |
|----|----------------|---------------|
| A. | $^0_{-1}\beta$ | $\nu_e$       |
| B. | $^0_{-1}\beta$ | $\bar{\nu}_e$ |
| C. | $^0_1\beta$    | $\nu_e$       |
| D. | $^0_1\beta$    | $\bar{\nu}_e$ |

27 - (PHYSI/11\_HL\_Summer\_2019\_Q24) - Atomic, nuclear &amp; Particle Physics

The rest mass of the helium isotope  $^3_2\text{He}$  is  $m$ .

Which expression gives the binding energy per nucleon for  $^3_2\text{He}$ ?

- A.  $\frac{(2m_p + m_n + m)c^2}{3}$
- B.  $\frac{(2m_p + m_n - m)c^2}{3}$
- C.  $(2m_p + m_n + m)c^2$
- D.  $(2m_p + m_n - m)c^2$

28 - (PHYSI/12\_HL\_Summer\_2019\_Q31) - Atomic,nuclear &amp; Particle Physics



A proton of velocity  $v$  enters a region of electric and magnetic fields. The proton is not deflected. An electron and an alpha particle enter the same region with velocity  $v$ . Which is correct about the paths of the electron and the alpha particle?

|    | Path of electron | Path of alpha particle |
|----|------------------|------------------------|
| A. | deflected        | deflected              |
| B. | deflected        | not deflected          |
| C. | not deflected    | deflected              |
| D. | not deflected    | not deflected          |

29 - (PHYSI/12\_HL\_Summer\_2019\_Q33) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)

A radioactive nuclide with atomic number  $Z$  undergoes a process of beta-plus ( $\beta^+$ ) decay. What is the atomic number for the nuclide produced and what is another particle emitted during the decay?

|    | Atomic number | Particle      |
|----|---------------|---------------|
| A. | $Z - 1$       | neutrino      |
| B. | $Z + 1$       | neutrino      |
| C. | $Z - 1$       | anti-neutrino |
| D. | $Z + 1$       | anti-neutrino |

30 - (PHYSI/12\_HL\_Summer\_2019\_Q34) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)

The  $\pi^+$  meson contains an up ( $u$ ) quark. What is the quark structure of the  $\pi^-$  meson?

- A.  $ud$
- B.  $u\bar{d}$
- C.  $\bar{u}d$
- D.  $\bar{u}\bar{d}$

31 - (PHYSI/12\_HL\_Summer\_2019\_Q35) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)



Three conservation laws in nuclear reactions are

- I. conservation of charge
- II. conservation of baryon number
- III. conservation of lepton number.

The reaction

$$n \rightarrow \pi^- + e^+ + \bar{\nu}_e$$

is proposed.

Which conservation laws are violated in the proposed reaction?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

32 - (PHYSI/12\_HL\_Summer\_2019\_Q36) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)

A neutron collides head-on with a stationary atom in the moderator of a nuclear power station. The kinetic energy of the neutron changes as a result. There is also a change in the probability that this neutron can cause nuclear fission.

What are these changes?

|    | Change in kinetic energy<br>of the neutron | Change in probability of<br>causing nuclear fission |
|----|--------------------------------------------|-----------------------------------------------------|
| A. | increase                                   | increase                                            |
| B. | decrease                                   | increase                                            |
| C. | increase                                   | decrease                                            |
| D. | decrease                                   | decrease                                            |

33 - (PHYSI/12\_HL\_Summer\_2019\_Q40) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)

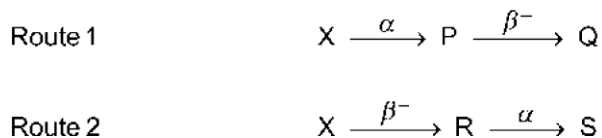
Photons of discrete energy are emitted during gamma decay. This is evidence for

- A. atomic energy levels.
- B. nuclear energy levels.
- C. pair annihilation.
- D. quantum tunneling.

34 - (PHYSI/10\_HL\_Winter\_2019\_Q19) - Atomic,nuclear &amp; Particle Physics



Nuclide X can decay by two routes. In Route 1 alpha ( $\alpha$ ) decay is followed by beta-minus ( $\beta^-$ ) decay. In Route 2  $\beta^-$  decay is followed by  $\alpha$  decay. P and R are the intermediate products and Q and S are the final products.



Which statement is correct?

- A. Q and S are different isotopes of the same element.
- B. The mass numbers of X and R are the same.
- C. The atomic numbers of P and R are the same.
- D. X and R are different isotopes of the same element.

35 - (PHYSI/10\_HL\_Winter\_2019\_Q20) - Atomic,nuclear &amp; Particle Physics

A proton, an electron and an alpha particle are at rest. Which particle has the smallest magnitude of ratio of charge to mass and which particle has the largest magnitude of ratio of charge to mass?

|    | Smallest charge to mass ratio | Largest charge to mass ratio |
|----|-------------------------------|------------------------------|
| A. | alpha                         | electron                     |
| B. | electron                      | alpha                        |
| C. | electron                      | proton                       |
| D. | proton                        | electron                     |

36 - (PHYSI/10\_HL\_Winter\_2019\_Q21) - Atomic,nuclear &amp; Particle Physics

Gamma ( $\gamma$ ) radiation

- A. is deflected by a magnetic field.
- B. affects a photographic plate.
- C. originates in the electron cloud outside a nucleus.
- D. is deflected by an electric field.

37 - (PHYSI/10\_HL\_Winter\_2019\_Q40) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)



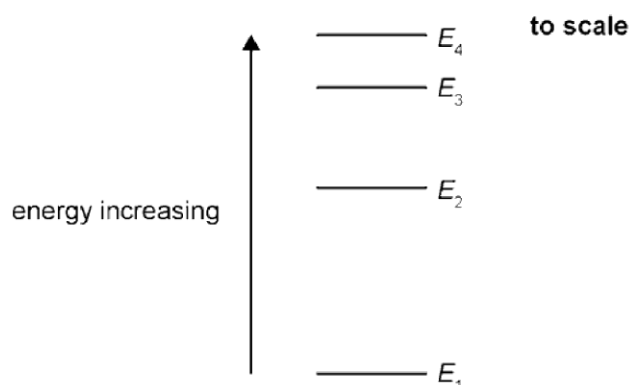
A pure sample of a radioactive nuclide contains  $N_0$  atoms at time  $t = 0$ . At time  $t$ , there are  $N$  atoms of the nuclide remaining in the sample. The half-life of the nuclide is  $t_{\frac{1}{2}}$ .

What is the decay rate of this sample proportional to?

- A.  $N$
- B.  $N_0 - N$
- C.  $t$
- D.  $t_{\frac{1}{2}}$

38 - (PHYSI/10\_HL\_Winter\_2020\_Q21) - Atomic,nuclear &amp; Particle Physics

Four of the energy states for an atom are shown. Transition between any two states is possible.



What is the shortest wavelength of radiation that can be emitted from these four states?

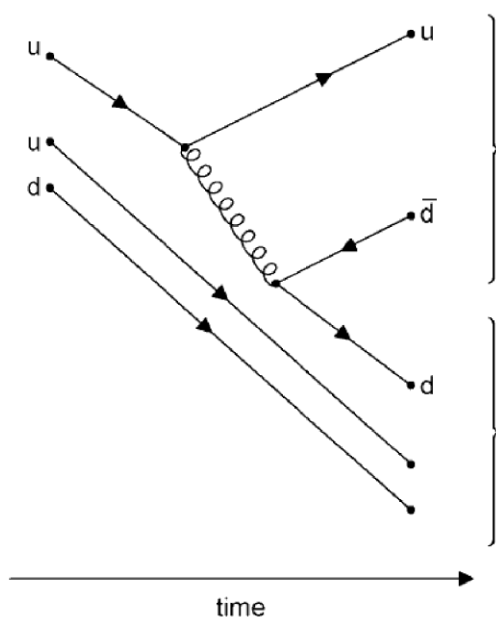
- A.  $\frac{hc}{E_4 - E_1}$
- B.  $\frac{hc}{E_4} - \frac{hc}{E_1}$
- C.  $\frac{hc}{E_4 - E_3}$
- D.  $\frac{hc}{E_4} - \frac{hc}{E_3}$



39 – (PHYSI/10\_HL\_Winter\_2020\_Q22) – Atomic,nuclear &amp; Particle Physics



The Feynman diagram shows some of the changes in a proton–proton collision.



What is the equation for this collision?

- A.  $p + p \rightarrow p + n + \pi^+$
- B.  $p + p \rightarrow p + n + \pi^-$
- C.  $p + p \rightarrow p + \bar{n} + \pi^+$
- D.  $p + p \rightarrow p + \bar{n} + \pi^-$

40 – (PHYSI/10\_HL\_Winter\_2020\_Q23) – Atomic,nuclear &amp; Particle Physics

Three historical developments in physics were

- I. wave–particle duality
- II. the kinetic model
- III. the equivalence of mass and energy.

Which of these represented a paradigm shift in scientific thinking?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

41 – (PHYSI/10\_HL\_Winter\_2020\_Q24) – Atomic, nuclear &amp; Particle Physics, Energy Production



The mass of nuclear fuel in a nuclear reactor decreases at the rate of 8 mg every hour. The overall reaction process has an efficiency of 50 %. What is the maximum power output of the reactor?

- A. 100 MW
- B. 200 MW
- C. 100 GW
- D. 200 GW

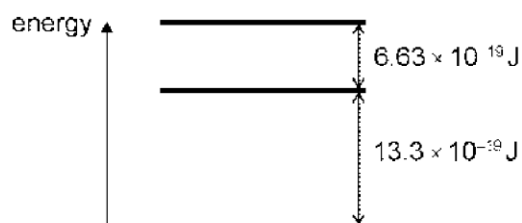
42 – (PHYSI/10\_HL\_Winter\_2020\_Q40) – Atomic, nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)

The Rutherford-Geiger-Marsden experiment shows that

- A. alpha particles do not obey Coulomb's law.
- B. there is a fixed nuclear radius for each nucleus.
- C. a large proportion of alpha particles are undeflected.
- D. the Bohr model of the hydrogen atom is confirmed.

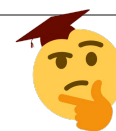
43 – (PHYSI/11\_HL\_Summer\_2021\_Q20) – Atomic, nuclear &amp; Particle Physics

A simple model of an atom has three energy levels. The differences between adjacent energy levels are shown below.



What are the two smallest frequencies in the emission spectrum of this atom?

- A.  $0.5 \times 10^{15}$  Hz and  $1.0 \times 10^{15}$  Hz
- B.  $0.5 \times 10^{15}$  Hz and  $1.5 \times 10^{15}$  Hz
- C.  $1.0 \times 10^{15}$  Hz and  $2.0 \times 10^{15}$  Hz
- D.  $1.0 \times 10^{15}$  Hz and  $3.0 \times 10^{15}$  Hz



44 - (PHYSI/11\_HL\_Summer\_2021\_Q21) - Atomic, nuclear & Particle Physics

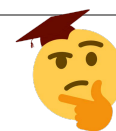
What is the relation between the value of the unified atomic mass unit in grams and the value of Avogadro's constant in  $\text{mol}^{-1}$ ?

- A. Their ratio is 1.
- B. Their product is 1.
- C. Their sum is 1.
- D. Their difference is 0.

45 - (PHYSI/11\_HL\_Summer\_2021\_Q22) - Atomic, nuclear & Particle Physics

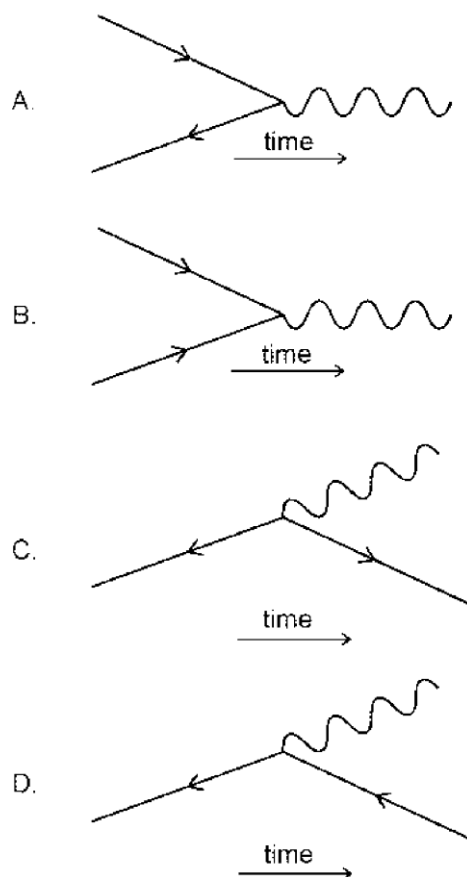
In a hydrogen atom, the sum of the masses of a proton and of an electron is larger than the mass of the atom. Which interaction is mainly responsible for this difference?

- A. Electromagnetic
- B. Strong nuclear
- C. Weak nuclear
- D. Gravitational



46 – (PHYSI/11\_HL\_Summer\_2021\_Q23) – Atomic,nuclear &amp; Particle Physics

Which Feynman diagram describes the annihilation of an electron and its antiparticle?



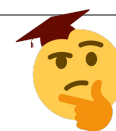
47 – (PHYSI/12\_HL\_Summer\_2021\_Q20) – Atomic,nuclear &amp; Particle Physics

A sample of a pure radioactive nuclide initially contains  $N_0$  atoms. The initial activity of the sample is  $A_0$ .

A second sample of the same nuclide initially contains  $2N_0$  atoms.

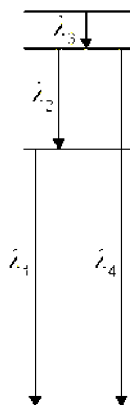
What is the activity of the second sample after three half lives?

- A.  $\frac{A_0}{2}$
- B.  $\frac{A_0}{4}$
- C.  $\frac{A_0}{6}$
- D.  $\frac{A_0}{8}$



48 – (PHYSI/12\_HL\_Summer\_2021\_Q21) – Atomic,nuclear &amp; Particle Physics

The diagram below shows four energy levels for the atoms of a gas. The diagram is drawn to scale. The wavelengths of the photons emitted by the energy transitions between levels are shown.



What are the wavelengths of spectral lines, emitted by the gas, in order of decreasing frequency?

- A.  $\lambda_3, \lambda_2, \lambda_1, \lambda_4$
- B.  $\lambda_4, \lambda_1, \lambda_2, \lambda_3$
- C.  $\lambda_4, \lambda_3, \lambda_2, \lambda_1$
- D.  $\lambda_4, \lambda_2, \lambda_1, \lambda_3$

49 – (PHYSI/12\_HL\_Summer\_2021\_Q22) – Atomic,nuclear &amp; Particle Physics

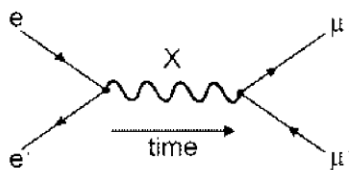
During the nuclear fission of nucleus X into nucleus Y and nucleus Z, energy is released. The binding energies per nucleon of X, Y and Z are  $B_X$ ,  $B_Y$  and  $B_Z$  respectively. What is true about the binding energy per nucleon of X, Y and Z?

- A.  $B_Y > B_X$  and  $B_Z > B_X$
- B.  $B_X = B_Y$  and  $B_X = B_Z$
- C.  $B_X > B_Y$  and  $B_X > B_Z$
- D.  $B_X = B_Y + B_Z$

50 – (PHYSI/12\_HL\_Summer\_2021\_Q23) – Atomic,nuclear &amp; Particle Physics



Consider the Feynman diagram below.



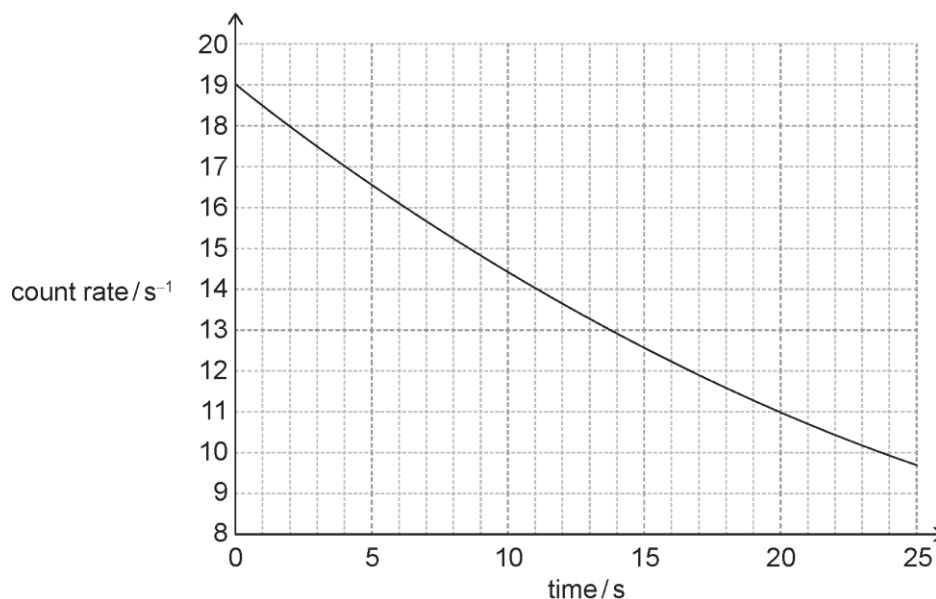
What is the exchange particle X?

- A. Lepton
- B. Gluon
- C. Meson
- D. Photon

51 – (PHYSI/10\_HL\_Winter\_2021\_Q20) – Atomic,nuclear &amp; Particle Physics

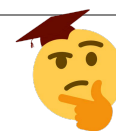
A detector measures the count rate from a sample of a radioactive nuclide. The graph shows the variation with time of the count rate.

The nuclide has a half-life of 20 s. The average background count rate is constant.



What is the average background count rate?

- A. 1 s<sup>-1</sup>
- B. 2 s<sup>-1</sup>
- C. 3 s<sup>-1</sup>
- D. 4 s<sup>-1</sup>



52 - (PHYSI/10\_HL\_Winter\_2021\_Q21) - Atomic, nuclear &amp; Particle Physics

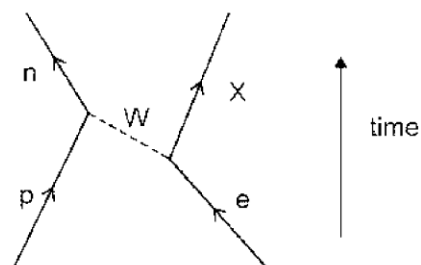
The mass of a nucleus of iron-56 ( ${}^{56}_{26}\text{Fe}$ ) is  $M$ .

What is the mass defect of the nucleus of iron-56?

- A.  $M - 26m_p - 56m_n$
- B.  $26m_p + 30m_n - M$
- C.  $M - 26m_p - 56m_n - 26m_e$
- D.  $26m_p + 30m_n + 26m_e - M$

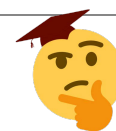
53 - (PHYSI/10\_HL\_Winter\_2021\_Q22) - Atomic, nuclear &amp; Particle Physics

The Feynman diagram shows an interaction between a proton and an electron.



What is the charge of the exchange particle and what is the lepton number of particle X?

|    | Charge of the exchange particle | Lepton number of particle X |
|----|---------------------------------|-----------------------------|
| A. | $-e$                            | $-1$                        |
| B. | $e$                             | $+1$                        |
| C. | $+e$                            | $-1$                        |
| D. | $+e$                            | $+1$                        |

54 – (PHYSI/10\_HL\_Winter\_2021\_Q23) – *Atomic, nuclear & Particle Physics*

The Higgs boson was discovered in the Large Hadron Collider at CERN. Which statements are correct about the discovery of the Higgs boson?

- I. It was independent of previous theoretical work.
- II. It involved analysing large amounts of experimental data.
- III. It was consistent with the standard model of particle physics.

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

55 – (PHYSI/11\_HL\_Summer\_2022\_Q25) – *Atomic, nuclear & Particle Physics*

A pure sample of iodine-131 decays into xenon with a half-life of 8 days.

What is  $\frac{\text{number of iodine atoms remaining}}{\text{number of xenon atoms formed}}$  after 24 days?

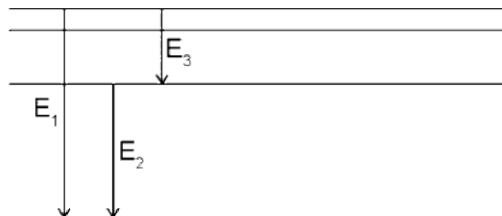
- A.  $\frac{1}{8}$
- B.  $\frac{1}{7}$
- C.  $\frac{7}{8}$
- D.  $\frac{8}{7}$



56 - (PHYSI/11\_HL\_Summer\_2022\_Q26) - Atomic, nuclear &amp; Particle Physics



The diagram shows atomic transitions  $E_1$ ,  $E_2$  and  $E_3$  when a particular atom changes its energy state. The wavelengths of the photons that correspond to these transitions are  $\lambda_1$ ,  $\lambda_2$  and  $\lambda_3$ .

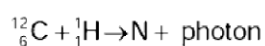


What is correct for these wavelengths?

- A.  $\lambda_1 > \lambda_2 > \lambda_3$
- B.  $\lambda_1 = \lambda_2 + \lambda_3$
- C.  $\frac{1}{\lambda_1} = \frac{1}{\lambda_2 + \lambda_3}$
- D.  $\frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$

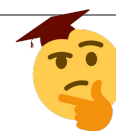
57 - (PHYSI/11\_HL\_Summer\_2022\_Q27) - Atomic, nuclear &amp; Particle Physics

Carbon (C-12) and hydrogen (H-1) undergo nuclear fusion to form nitrogen.



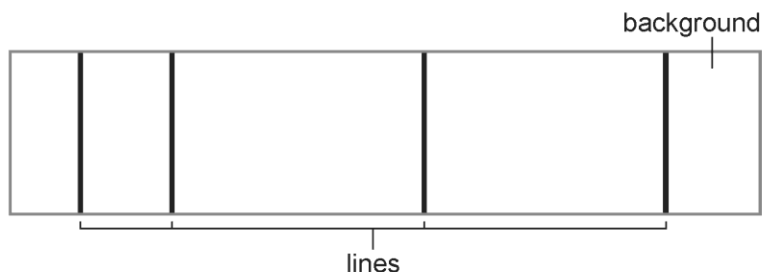
What is the number of neutrons and number of nucleons in the nitrogen nuclide?

|    | Number of neutrons | Number of nucleons |
|----|--------------------|--------------------|
| A. | 7                  | 13                 |
| B. | 6                  | 13                 |
| C. | 6                  | 7                  |
| D. | 7                  | 6                  |



58 – (PHYSI/12\_HL\_Summer\_2022\_Q22) – Atomic,nuclear &amp; Particle Physics

White light is emitted from a hot filament. The light passes through hydrogen gas at low pressure and then through a diffraction grating onto a screen. A pattern of lines against a background appears on the screen.



What is the appearance of the lines and background on the screen?

|    | Lines | Background |
|----|-------|------------|
| A. | dark  | black      |
| B. | white | coloured   |
| C. | white | black      |
| D. | dark  | coloured   |

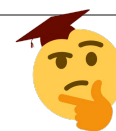
59 – (PHYSI/12\_HL\_Summer\_2022\_Q23) – Atomic,nuclear &amp; Particle Physics

Three statements about electrons are:

- I. Electrons interact through virtual photons.
- II. Electrons interact through gluons.
- III. Electrons interact through particles W and Z.

Which statements identify the particles mediating the forces experienced by electrons?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III



60 – (PHYSI/12\_HL\_Summer\_2022\_Q24) – Atomic, nuclear & Particle Physics

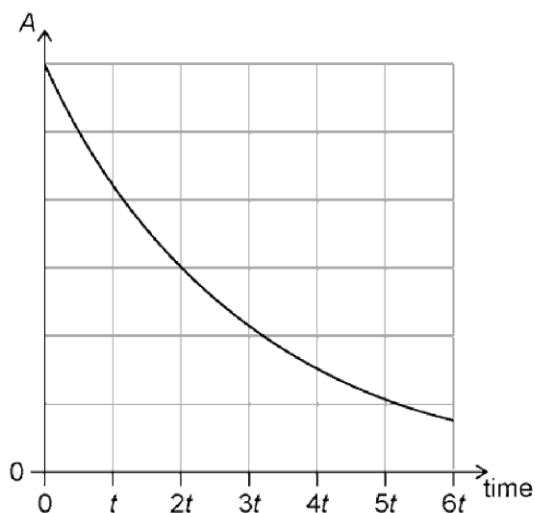
A neutron is absorbed by a nucleus of uranium-235 ( $^{235}_{92}\text{U}$ ). One possible outcome is the production of two nuclides, barium-144 ( $^{144}_{56}\text{Ba}$ ) and krypton-89 ( $^{89}_{36}\text{Kr}$ ).

How many neutrons are released in this reaction?

- A. 0
- B. 1
- C. 2
- D. 3

61 – (PHYSI/12\_HL\_Summer\_2022\_Q25) – Atomic, nuclear & Particle Physics

A radioactive nuclide X decays into a nuclide Y. The graph shows the variation with time of the activity  $A$  of X. X and Y have the same nucleon number.



What is true about nuclide X?

- A. alpha ( $\alpha$ ) emitter with a half-life of  $t$
- B. alpha ( $\alpha$ ) emitter with a half-life of  $2t$
- C. beta-minus ( $\beta^-$ ) emitter with a half-life of  $t$
- D. beta-minus ( $\beta^-$ ) emitter with a half-life of  $2t$

62 - (PHYSI/10\_HL\_Winter\_2022\_Q21) - Atomic, nuclear &amp; Particle Physics



The unified atomic mass unit,  $u$ , is a non-SI unit usually used by scientists to state atomic masses.

What is  $u$ ?

- A. It is the mean of the masses of a proton and a neutron.
- B. It is the mean of the masses of protons and neutrons in all chemical elements.
- C. It is  $\frac{1}{16}$  the mass of an  $^{16}_8\text{O}$  atom.
- D. It is  $\frac{1}{12}$  the mass of a  $^{12}_6\text{C}$  atom.

63 - (PHYSI/10\_HL\_Winter\_2022\_Q22) - Atomic, nuclear &amp; Particle Physics

The nuclide uranium-237 follows a sequence of three decays to produce the nuclide uranium-233.

What is a possible sequence for these decays?

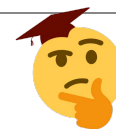
- A. Beta plus, alpha, beta plus
- B. Beta minus, alpha, beta minus
- C. Alpha, beta plus, beta minus
- D. Alpha, beta minus, beta plus

64 - (PHYSI/10\_HL\_Winter\_2022\_Q23) - Atomic, nuclear &amp; Particle Physics

Which development in physics constituted a paradigm shift?

- A. The classification of variables into scalars and vectors
- B. The determination of the velocity of light in different media
- C. The equivalence of  $F = ma$  to  $F = \frac{\Delta p}{\Delta t}$  when the mass of the system is constant
- D. The equivalence of mass and energy

65 – (PHYSI/10\_HL\_Winter\_2022\_Q24) – Atomic, nuclear &amp; Particle Physics

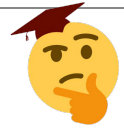


A fusion reaction of one nucleus of hydrogen-2 and one nucleus of hydrogen-3 converts 0.019 u to energy. A fission reaction of one nucleus of uranium-235 converts a mass of 0.190 u to energy.

What is the ratio  $\frac{\text{specific energy of this fusion of hydrogen}}{\text{specific energy of this fission of uranium}}$  ?

- A. 0.1
- B. 0.2
- C. 5
- D. 10

1 - (PHYSI/11\_HL\_Summer\_2017\_Q23) - *Energy Production*



An object can lose energy through

- I. conduction
- II. convection
- III. radiation

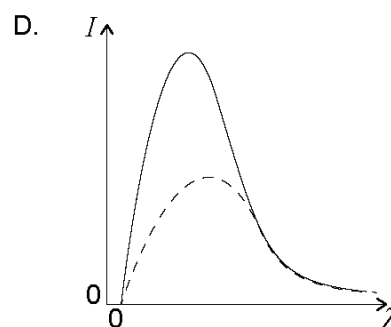
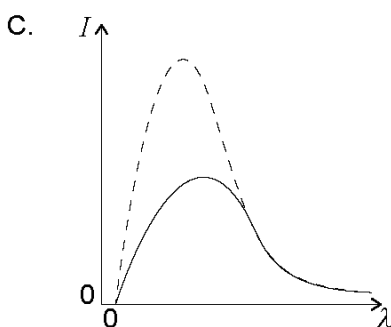
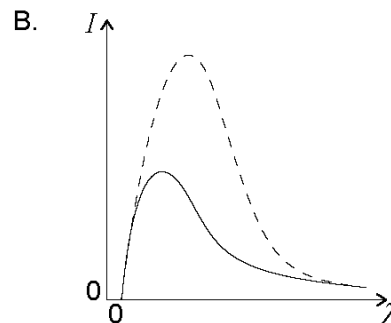
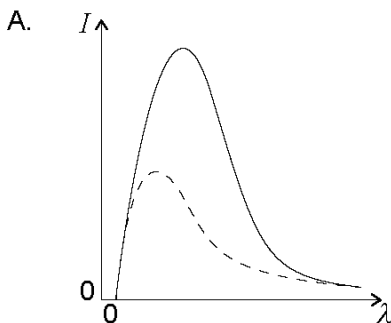
What are the principal means for losing energy for a hot rock resting on the surface of the Moon?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

2 - (PHYSI/11\_HL\_Summer\_2017\_Q24) - *Energy Production*

Planet X and planet Y both emit radiation as black bodies. Planet X has a surface temperature that is less than the surface temperature of planet Y.

What is the graph of the variation of intensity  $I$  with wavelength  $\lambda$  for the radiation emitted by planet Y? The graph for planet X is shown dotted.



3 - (PHYSI/11\_HL\_Summer\_2017\_Q25) - *Energy Production*



The average albedo of glacier ice is 0.25.

What is  $\frac{\text{power absorbed by glacier ice}}{\text{power reflected by glacier ice}}$ ?

- A. 0.25
- B. 0.33
- C. 2.5
- D. 3.0

4 - (PHYSI/12\_HL\_Summer\_2017\_Q23) - *Energy Production*

The main role of a moderator in a nuclear fission reactor is to

- A. slow down neutrons.
- B. absorb neutrons.
- C. reflect neutrons back to the reactor.
- D. accelerate neutrons.

5 - (PHYSI/12\_HL\_Summer\_2017\_Q24) - *Energy Production*

A room is at a constant temperature of 300 K. A hotplate in the room is at a temperature of 400 K and loses energy by radiation at a rate of  $P$ . What is the rate of loss of energy from the hotplate when its temperature is 500 K?

- A.  $\frac{4^4}{5^4}P$
- B.  $\frac{5^4 + 3^4}{4^4 + 3^4}P$
- C.  $\frac{5^4}{4^4}P$
- D.  $\frac{5^4 - 3^4}{4^4 - 3^4}P$

## 6 - (PHYSI/10\_HL\_Winter\_2017\_Q24) - Energy Production



Which of the energy sources are classified as renewable and non-renewable?

|    | Renewable   | Non-renewable |
|----|-------------|---------------|
| A. | Sun         | wind          |
| B. | natural gas | geothermal    |
| C. | biomass     | crude oil     |
| D. | uranium-235 | coal          |

## 7 - (PHYSI/10\_HL\_Winter\_2017\_Q25) - Energy Production

A black body emits radiation with its greatest intensity at a wavelength of  $\lambda_{\max}$ . The surface temperature of the black body doubles without any other change occurring. What is the wavelength at which the greatest intensity of radiation is emitted?

- A.  $\lambda_{\max}$
- B.  $\frac{\lambda_{\max}}{2}$
- C.  $\frac{\lambda_{\max}}{4}$
- D.  $\frac{\lambda_{\max}}{16}$

## 8 - (PHYSI/10\_HL\_Winter\_2017\_Q26) - Energy Production

The three statements give possible reasons why an average value should be used for the solar constant.

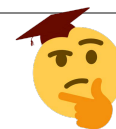
- I. The Sun's output varies during its 11 year cycle.
- II. The Earth is in elliptical orbit around the Sun.
- III. The plane of the Earth's spin on its axis is tilted to the plane of its orbit about the Sun.

Which are the correct reasons for using an average value for the solar constant?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III



9 - (PHYSI/11\_HL\_Summer\_2018\_Q22) - *Energy Production*



What is equivalent to  $\frac{\text{specific energy of a fuel}}{\text{energy density of a fuel}}$ ?

- A. density of the fuel
- B.  $\frac{1}{\text{density of the fuel}}$
- C.  $\frac{\text{energy stored in the fuel}}{\text{density of the fuel}}$
- D.  $\frac{\text{density of the fuel}}{\text{energy stored in the fuel}}$

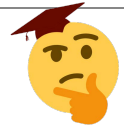
10 - (PHYSI/11\_HL\_Summer\_2018\_Q23) - *Energy Production*

A nuclear reactor contains atoms that are used for moderation and atoms that are used for control.

What are the ideal properties of the moderator atoms and the control atoms in terms of neutron absorption?

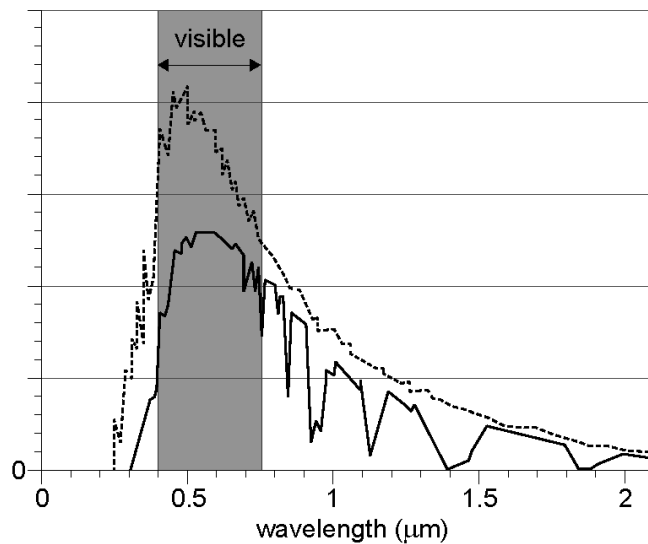
|    | Ideal moderator atom      | Ideal control atom        |
|----|---------------------------|---------------------------|
| A. | poor absorber of neutrons | poor absorber of neutrons |
| B. | poor absorber of neutrons | good absorber of neutrons |
| C. | good absorber of neutrons | poor absorber of neutrons |
| D. | good absorber of neutrons | good absorber of neutrons |

## 11 - (PHYSI/11\_HL\_Summer\_2018\_Q24) - Energy Production



The dashed line on the graph shows the variation with wavelength of the intensity of solar radiation before passing through the Earth's atmosphere.

The solid line on the graph shows the variation with wavelength of the intensity of solar radiation after it has passed through the Earth's atmosphere.

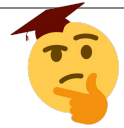


[Source: Reproduced by permission of Martin Green, UNSW Sydney]

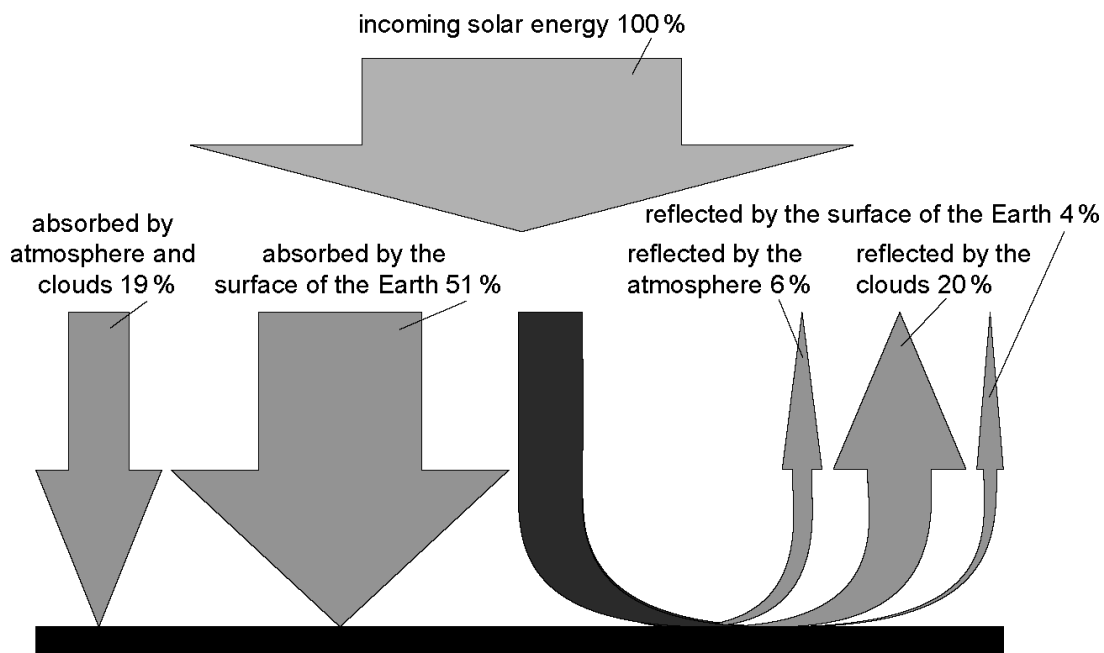
Which feature of the graph helps explain the greenhouse effect?

- A. Infrared radiation is absorbed at specific wavelengths.
- B. There is little absorption at infrared wavelengths.
- C. There is substantial absorption at visible wavelengths.
- D. There is little absorption at UV wavelengths.

## 12 - (PHYSI/11\_HL\_Summer\_2018\_Q25) - Energy Production



The diagram shows a simple climate model for the Earth.



What does this model predict for the average albedo of the Earth?

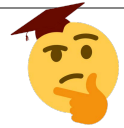
- A. 0.30
- B. 0.51
- C. 0.70
- D. 0.81

## 13 - (PHYSI/12\_HL\_Summer\_2018\_Q21) - Energy Production

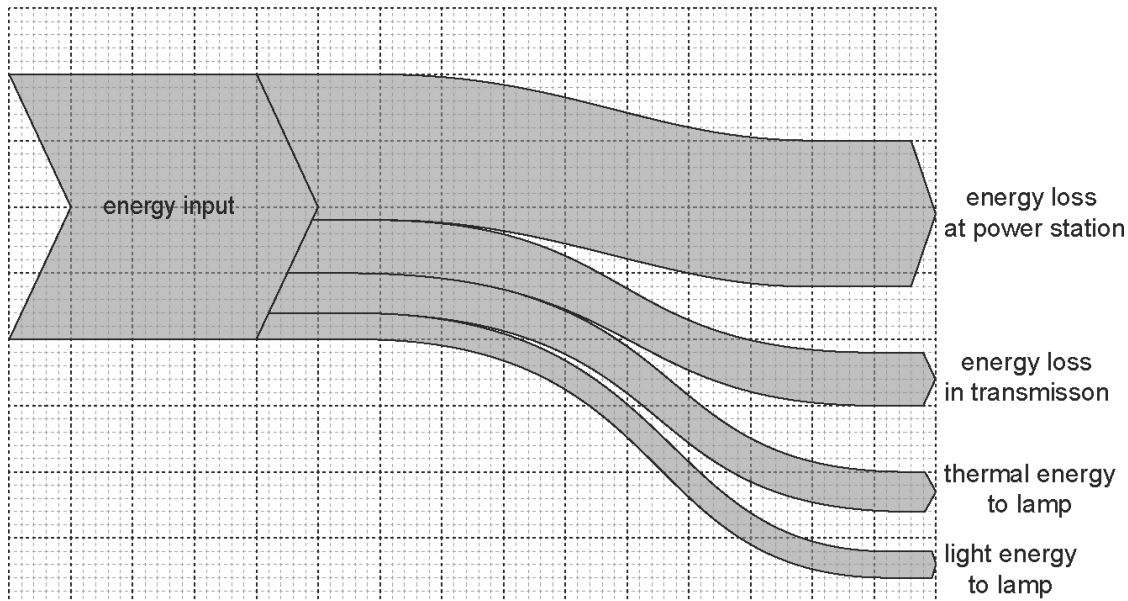
A wind turbine has a power output  $p$  when the wind speed is  $v$ . The efficiency of the wind turbine does not change. What is the wind speed at which the power output is  $\frac{p}{2}$ ?

- A.  $\frac{v}{4}$
- B.  $\frac{v}{\sqrt{8}}$
- C.  $\frac{v}{2}$
- D.  $\frac{v}{\sqrt[3]{2}}$

## 14 - (PHYSI/12\_HL\_Summer\_2018\_Q22) - Energy Production



The Sankey diagram shows the energy input from fuel that is eventually converted to useful domestic energy in the form of light in a filament lamp.



What is true for this Sankey diagram?

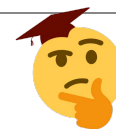
- A. The overall efficiency of the process is 10 %.
- B. Generation and transmission losses account for 55 % of the energy input.
- C. Useful energy accounts for half of the transmission losses.
- D. The energy loss in the power station equals the energy that leaves it.

## 15 - (PHYSI/12\_HL\_Summer\_2018\_Q23) - Energy Production

What part of a nuclear power station is principally responsible for increasing the chance that a neutron will cause fission?

- A. Moderator
- B. Control rod
- C. Pressure vessel
- D. Heat exchanger

16 - (PHYSI/10\_HL\_Winter\_2018\_Q24) - Electricity & Magnetism, Energy Production

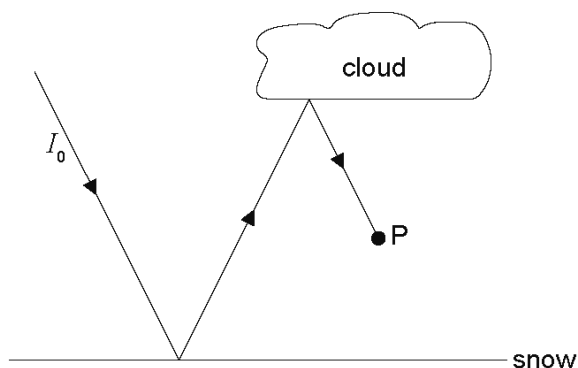


A photovoltaic panel of area  $S$  has an efficiency of 20%. A second photovoltaic panel has an efficiency of 15%. What is the area of the second panel so that both panels produce the same power under the same conditions?

- A.  $\frac{S}{3}$
- B.  $\frac{3S}{4}$
- C.  $\frac{5S}{4}$
- D.  $\frac{4S}{3}$

17 - (PHYSI/10\_HL\_Winter\_2018\_Q25) - Energy Production

Light of intensity  $I_0$  is incident on a snow-covered area of Earth. In a model of this situation, the albedo of the cloud is 0.30 and the albedo for the snow surface is 0.80. What is the intensity of the light at P due to the incident ray  $I_0$ ?



- A.  $0.14 I_0$
- B.  $0.24 I_0$
- C.  $0.50 I_0$
- D.  $0.55 I_0$

18 - (PHYSI/11\_HL\_Summer\_2019\_Q25) - *Energy Production*

Most power stations rely on a turbine and a generator to produce electrical energy. Which power station works on a different principle?

- A. Nuclear
- B. Solar
- C. Fossil fuel
- D. Wind

19 - (PHYSI/10\_HL\_Winter\_2019\_Q23) - *Energy Production*

What are the units of specific energy and energy density?

|    | Specific energy    | Energy density    |
|----|--------------------|-------------------|
| A. | $\text{J m}^{-1}$  | $\text{J m}^{-2}$ |
| B. | $\text{J kg}^{-1}$ | $\text{J m}^{-3}$ |
| C. | $\text{J kg}^{-1}$ | $\text{J m}^{-2}$ |
| D. | $\text{J m}^{-1}$  | $\text{J m}^{-3}$ |

20 - (PHYSI/10\_HL\_Winter\_2019\_Q24) - *Energy Production*

What is the function of the moderator in a thermal nuclear fission reactor?

- A. To decrease the kinetic energy of neutrons emitted from fission reactions
- B. To increase the kinetic energy of neutrons emitted from fission reactions
- C. To decrease the overall number of neutrons available for fission
- D. To increase the overall number of neutrons available for fission

21 - (PHYSI/10\_HL\_Winter\_2019\_Q25) - *Energy Production*

What is meant by the statement that the average albedo of the Moon is 0.1?

- A. 10% of the radiation incident on the Moon is absorbed by its surface
- B. 10% of the radiation emitted by the Moon is absorbed by its atmosphere
- C. 10% of the radiation incident on the Moon is reflected by its surface
- D. 10% of the radiation emitted by the Moon is at infrared wavelengths

22 – (PHYSI/10\_HL\_Winter\_2020\_Q24) – *Atomic, nuclear & Particle Physics, Energy Production*



The mass of nuclear fuel in a nuclear reactor decreases at the rate of 8 mg every hour. The overall reaction process has an efficiency of 50 %. What is the maximum power output of the reactor?

- A. 100 MW
- B. 200 MW
- C. 100 GW
- D. 200 GW

23 – (PHYSI/10\_HL\_Winter\_2020\_Q25) – *Energy Production*

A nuclear power station contains an alternating current generator. What energy transfer is performed by the generator?

- A. Electrical to kinetic
- B. Kinetic to electrical
- C. Nuclear to kinetic
- D. Nuclear to electrical

24 – (PHYSI/10\_HL\_Winter\_2020\_Q26) – *Energy Production*

The average temperature of the surface of a planet is five times greater than the average temperature of the surface of its moon. The emissivities of the planet and the moon are the same. The average intensity radiated by the planet is  $I$ . What is the average intensity radiated by its moon?

- A.  $\frac{I}{25}$
- B.  $\frac{I}{125}$
- C.  $\frac{I}{625}$
- D.  $\frac{I}{3125}$

25 – (PHYSI/11\_HL\_Summer\_2021\_Q24) – *Energy Production*



Burning one litre of gasoline produces more energy than burning one kilogram of coal, and the density of gasoline is smaller than  $1 \text{ g cm}^{-3}$ . What can be deduced from this information?

- A. Energy density is greater for gasoline.
- B. Specific energy is greater for gasoline.
- C. Energy density is greater for coal.
- D. Specific energy is greater for coal.

26 – (PHYSI/11\_HL\_Summer\_2021\_Q25) – *Energy Production*

Which change produces the largest percentage increase in the maximum theoretical power output of a wind turbine?

- A. Doubling the area of the blades
- B. Doubling the density of the fluid
- C. Doubling the radius of the blades
- D. Doubling the speed of the fluid

27 – (PHYSI/12\_HL\_Summer\_2021\_Q24) – *Energy Production*

What is the main role of carbon dioxide in the greenhouse effect?

- A. It absorbs incoming radiation from the Sun.
- B. It absorbs outgoing radiation from the Earth.
- C. It reflects incoming radiation from the Sun.
- D. It reflects outgoing radiation from the Earth.

28 – (PHYSI/12\_HL\_Summer\_2021\_Q25) – *Energy Production*

A model of an ideal wind turbine with blade length  $l_0$  is designed to produce a power  $P$  when the average wind speed is  $v$ . A second ideal wind turbine is designed to produce a power  $\frac{P}{2}$  when the average wind speed is  $\frac{v}{2}$ . What is the blade length for the second wind turbine?

- A.  $\frac{l_0}{2}$
- B.  $l_0$
- C.  $2 l_0$
- D.  $4 l_0$



29 - (PHYSI/10\_HL\_Winter\_2021\_Q24) - Energy Production

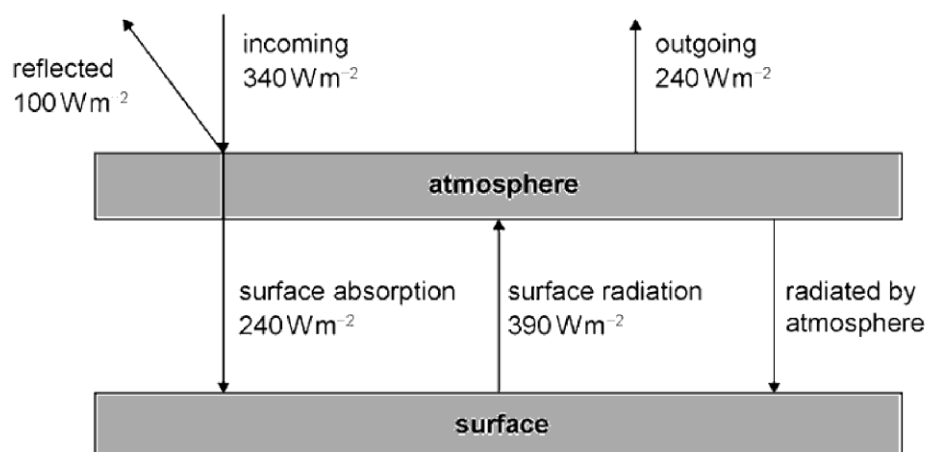


A fuel has mass density  $\rho$  and energy density  $u$ . What mass of the fuel has to be burned to release thermal energy  $E$ ?

- A.  $\frac{\rho E}{u}$
- B.  $\frac{uE}{\rho}$
- C.  $\frac{\rho u}{E}$
- D.  $\rho u E$

30 - (PHYSI/10\_HL\_Winter\_2021\_Q25) - Energy Production

The diagram shows a simple model of the energy balance in the Earth surface-atmosphere system. The intensities of the radiations are given.



What is the average intensity radiated by the atmosphere towards the surface?

- A.  $100 \text{ Wm}^{-2}$
- B.  $150 \text{ Wm}^{-2}$
- C.  $240 \text{ Wm}^{-2}$
- D.  $390 \text{ Wm}^{-2}$

31 – (PHYSI/11\_HL\_Summer\_2022\_Q28) – Energy Production

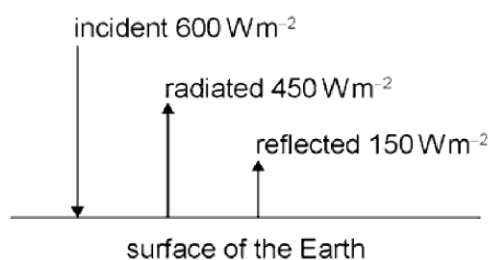


Wind of speed  $v$  flows through a wind generator. The wind speed drops to  $\frac{v}{3}$  after passing through the blades. What is the maximum possible efficiency of the generator?

- A.  $\frac{1}{27}$
- B.  $\frac{8}{27}$
- C.  $\frac{19}{27}$
- D.  $\frac{26}{27}$

32 – (PHYSI/11\_HL\_Summer\_2022\_Q29) – Energy Production

The diagram shows, for a region on the Earth's surface, the incident, radiated and reflected intensities of the solar radiation.



What is the albedo of the region?

- A.  $\frac{1}{4}$
- B.  $\frac{1}{3}$
- C.  $\frac{3}{4}$
- D. 1

33 – (PHYSI/12\_HL\_Summer\_2022\_Q26) – Energy Production



Photovoltaic cells and solar heating panels are used to transfer the electromagnetic energy of the Sun's rays into other forms of energy. What is the form of energy into which solar energy is transferred in photovoltaic cells and solar heating panels?

|    | Photovoltaic cells | Solar heating panels |
|----|--------------------|----------------------|
| A. | electrical energy  | thermal energy       |
| B. | thermal energy     | thermal energy       |
| C. | electrical energy  | electrical energy    |
| D. | thermal energy     | electrical energy    |

34 – (PHYSI/12\_HL\_Summer\_2022\_Q27) – Energy Production

Three statements about fossil fuels are:

- I. There is a finite amount of fossil fuels on Earth.
- II. The transfer of energy from fossil fuels increases the concentration of  $\text{CO}_2$  in the atmosphere.
- III. The geographic distribution of fossil fuels is uneven and has led to economic inequalities.

Which statements justify the development of alternative energy sources?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

35 – (PHYSI/12\_HL\_Summer\_2022\_Q28) – Energy Production

The age of the Earth is about  $4.5 \times 10^9$  years.

What area of physics provides experimental evidence for this conclusion?

- A. Newtonian mechanics
- B. Optics
- C. Radioactivity
- D. Electromagnetism

36 - (PHYSI/10\_HL\_Winter\_2022\_Q25) - Energy Production



Water is to be pumped through a vertical height difference of 12.5 m. The pump is driven by a wind turbine that has an efficiency of 50 % and an area swept by the blades of  $100 \text{ m}^2$ . The average wind speed is  $5.0 \text{ m s}^{-1}$  and the air density is  $1.2 \text{ kg m}^{-3}$ .

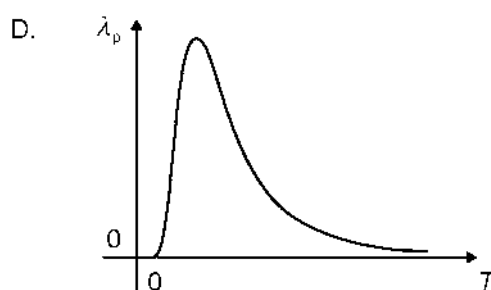
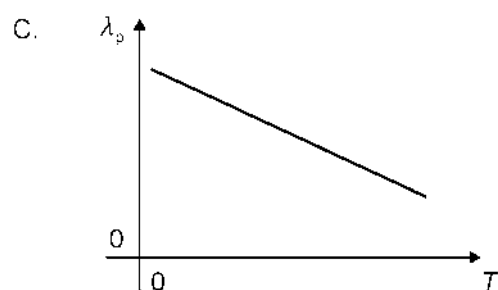
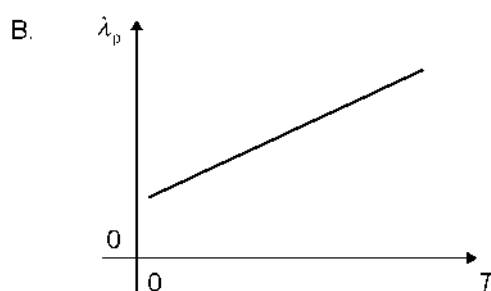
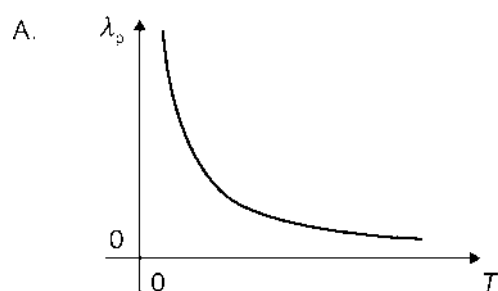
What is the maximum mass of water that can be pumped every second?

- A. 3 kg
- B. 30 kg
- C. 60 kg
- D. 120 kg

37 - (PHYSI/10\_HL\_Winter\_2022\_Q26) - Energy Production

The electromagnetic spectrum radiated by a black body at temperature  $T$  shows a peak at wavelength  $\lambda_p$ .

What is the variation of  $\lambda_p$  with  $T$ ?



## 1 - (PHYSI/11\_HL\_Summer\_2017\_Q27) - Wave Phenomena (ahl)



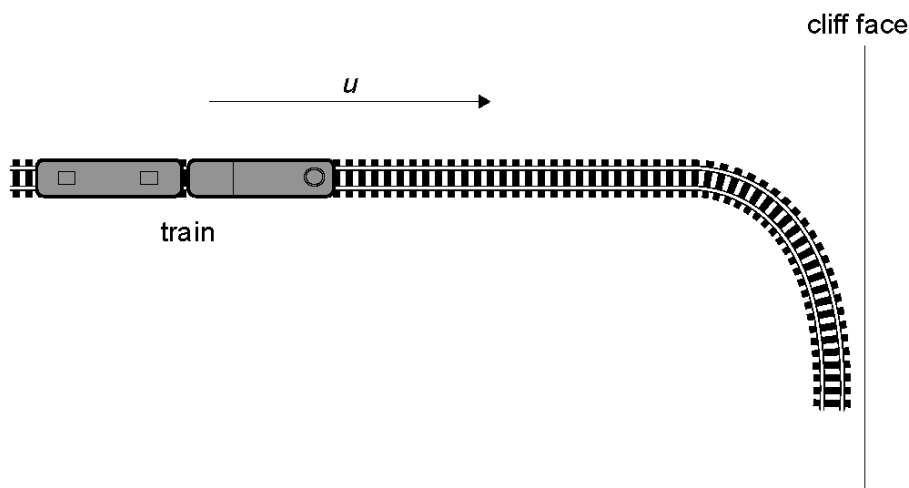
For fringes to be observed in a double-slit interference experiment, the slits must emit waves that are coherent.

What conditions are required for the frequency of the waves and for the phase difference between the waves so that the waves are coherent?

|    | Frequency of waves  | Phase difference between waves |
|----|---------------------|--------------------------------|
| A. | same                | variable                       |
| B. | same                | constant                       |
| C. | constant difference | variable                       |
| D. | constant difference | constant                       |

## 2 - (PHYSI/11\_HL\_Summer\_2017\_Q28) - Wave Phenomena (ahl)

A train moving at speed  $u$  relative to the ground, sounds a whistle of constant frequency  $f$  as it moves towards a vertical cliff face.

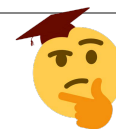


The sound from the whistle reaches the cliff face and is reflected back to the train. The speed of sound in stationary air is  $c$ .

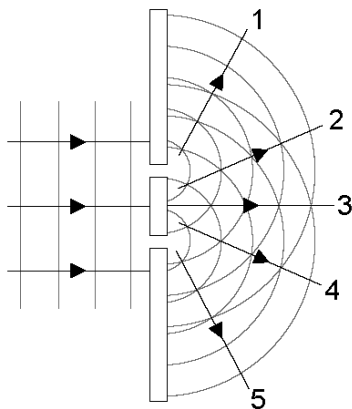
What whistle frequency is observed on the train after the reflection?

- A.  $\frac{(c+u)}{(c-u)} f$
- B.  $(c+u) f$
- C.  $(c-u) f$
- D.  $\frac{(c-u)}{(c+u)} f$

3 - (PHYSI/12\_HL\_Summer\_2017\_Q27) - Wave Phenomena (ahl)



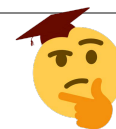
Blue light is incident on two narrow slits. Constructive interference takes place along the lines labelled 1 to 5.



The blue light is now replaced by red light. What additional change is needed so that the lines of constructive interference remain in the same angular positions?

- A. Make the slits wider
- B. Make the slits narrower
- C. Move the slits closer together
- D. Move the slits further apart

4 - (PHYSI/12\_HL\_Summer\_2017\_Q28) - Wave Phenomena (ahl)



Two points illuminated by monochromatic light are separated by a small distance. The light from the two sources passes through a small circular aperture and is detected on a screen far away.



The images of the two light sources are just resolved. What changes to the wavelength and the size of the aperture will definitely allow the two images to be well-resolved?

|    | Wavelength | Size of aperture |
|----|------------|------------------|
| A. | increase   | increase         |
| B. | increase   | decrease         |
| C. | decrease   | increase         |
| D. | decrease   | decrease         |

5 - (PHYSI/12\_HL\_Summer\_2017\_Q29) - Wave Phenomena (ahl)

A train travelling in a straight line emits a sound of constant frequency  $f$ . An observer at rest very close to the path of the train detects a sound of continuously decreasing frequency. The train is

- A. approaching the observer at constant speed.
- B. approaching the observer at increasing speed.
- C. moving away from the observer at constant speed.
- D. moving away from the observer at increasing speed.

6 - (PHYSI/10\_HL\_Winter\_2017\_Q27) - Wave Phenomena (ahl)



A spring loaded with mass  $m$  oscillates with simple harmonic motion. The amplitude of the motion is  $A$  and the spring has total energy  $E$ . What is the total energy of the spring when the mass is increased to  $3m$  and the amplitude is increased to  $2A$ ?

- A.  $2E$
- B.  $4E$
- C.  $12E$
- D.  $18E$

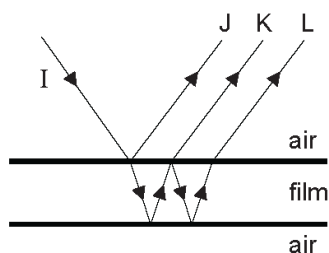
7 - (PHYSI/10\_HL\_Winter\_2017\_Q28) - Wave Phenomena (ahl)

Monochromatic light is incident on two identical slits to produce an interference pattern on a screen. One slit is then covered so that no light emerges from it. What is the change to the pattern observed on the screen?

- A. Fewer maxima will be observed.
- B. The intensity of the central maximum will increase.
- C. The outer maxima will become narrower.
- D. The width of the central maximum will decrease.

8 - (PHYSI/10\_HL\_Winter\_2017\_Q29) - Wave Phenomena (ahl)

A transparent liquid forms a parallel-sided thin film in air. The diagram shows a ray I incident on the upper air–film boundary at normal incidence (the rays are shown at an angle to the normal for clarity).



Reflections from the top and bottom surfaces of the film result in three rays J, K and L. Which of the rays has undergone a phase change of  $\pi$  rad?

- A. J only
- B. J and L only
- C. J and K only
- D. J, K and L



## 9 - (PHYSI/10\_HL\_Winter\_2017\_Q30) - Wave Phenomena (ahl)



A stationary sound source emits waves of wavelength  $\lambda$  and speed  $v$ . The source now moves away from a stationary observer. What are the wavelength and speed of the sound as measured by the observer?

|    | Wavelength             | Speed         |
|----|------------------------|---------------|
| A. | longer than $\lambda$  | equal to $v$  |
| B. | longer than $\lambda$  | less than $v$ |
| C. | shorter than $\lambda$ | equal to $v$  |
| D. | shorter than $\lambda$ | less than $v$ |

## 10 - (PHYSI/11\_HL\_Summer\_2018\_Q27) - Wave Phenomena (ahl)

Monochromatic light of wavelength  $\lambda$  in air is incident normally on a thin film of refractive index  $n$ . The film is surrounded by air. The intensity of the reflected light is a minimum. What is a possible thickness of the film?

- A.  $\frac{\lambda}{4n}$
- B.  $\frac{3\lambda}{4n}$
- C.  $\frac{\lambda}{n}$
- D.  $\frac{5\lambda}{4n}$

## 11 - (PHYSI/11\_HL\_Summer\_2018\_Q28) - Wave Phenomena (ahl)

Monochromatic light is incident on 4 rectangular, parallel slits. The first principal maximum is observed at an angle  $\theta$  to the direction of the incident light. The number of slits is increased to 8 each having the same width and spacing as the first 4.

Three statements about the first principal maximum with 8 slits are

- I. the angle at which it is observed is greater than  $\theta$
- II. its intensity increases
- III. its width decreases.

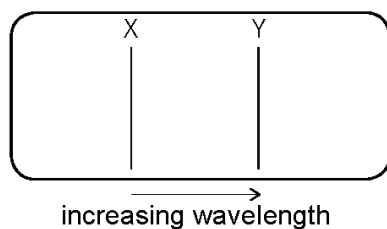
Which statements are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

## 12 - (PHYSI/11\_HL\_Summer\_2018\_Q29) - Wave Phenomena (ahl)



Two lines X and Y in the emission spectrum of hydrogen gas are measured by an observer stationary with respect to the gas sample.



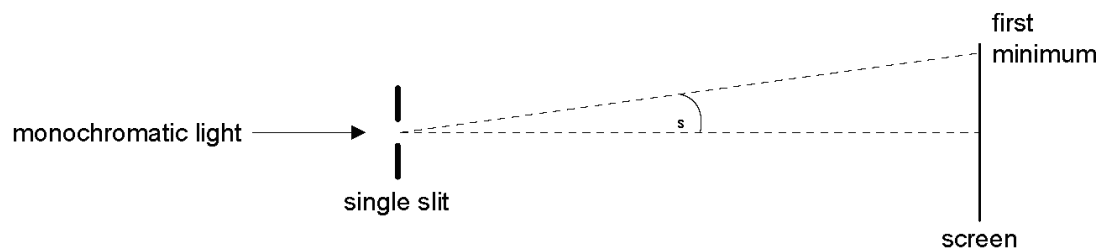
The emission spectrum is then measured by an observer moving away from the gas sample.

What are the correct shifts  $X^*$  and  $Y^*$  for spectral lines X and Y?

- A.
- B.
- C.
- D.

## 13 - (PHYSI/12\_HL\_Summer\_2018\_Q25) - Wave Phenomena (ahl)

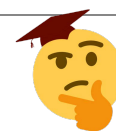
A beam of monochromatic light is incident on a single slit and a diffraction pattern forms on the screen.



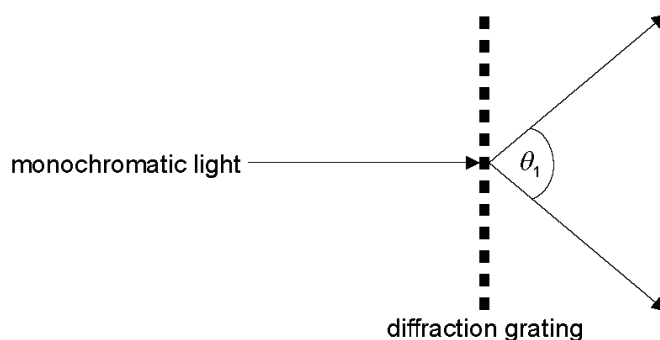
What change will increase  $\theta_s$ ?

- A. Increase the width of the slit
- B. Decrease the width of the slit
- C. Increase the distance between the slit and the screen
- D. Decrease the distance between the slit and the screen

14 - (PHYSI/12\_HL\_Summer\_2018\_Q26) - Wave Phenomena (ahl)



A beam of monochromatic light is incident on a diffraction grating of  $N$  lines per unit length. The angle between the first orders is  $\theta_1$ .



What is the wavelength of the light?

- A.  $\frac{\sin \theta_1}{N}$
- B.  $N \sin \theta_1$
- C.  $N \sin \left( \frac{\theta_1}{2} \right)$
- D.  $\frac{\sin \left( \frac{\theta_1}{2} \right)}{N}$

15 - (PHYSI/12\_HL\_Summer\_2018\_Q27) - Wave Phenomena (ahl)

A train is approaching an observer with constant speed

$$\frac{c}{34}$$

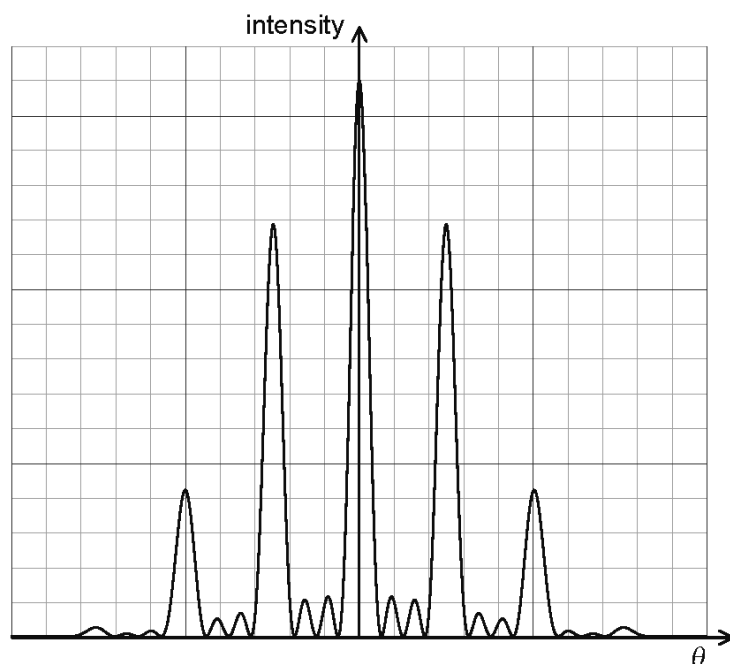
where  $c$  is the speed of sound in still air. The train emits sound of wavelength  $\lambda$ . What is the observed speed of the sound and observed wavelength as the train approaches?

|    | Speed of sound   | Wavelength             |
|----|------------------|------------------------|
| A. | $c$              | $\frac{33\lambda}{34}$ |
| B. | $\frac{35c}{34}$ | $\frac{33\lambda}{34}$ |
| C. | $c$              | $\lambda$              |
| D. | $\frac{35c}{34}$ | $\lambda$              |

16 – (PHYSI/10\_HL\_Winter\_2018\_Q27) – Wave Phenomena (ahl)



The graph shows the variation with diffraction angle of the intensity of light when monochromatic light is incident on four slits.



The number of slits is increased keeping the width and the separation of the slits unchanged.

Three possible changes to the pattern are

- I. the separation of the primary maxima increases
- II. the intensity of the primary maxima increases
- III. the width of the primary maxima decreases.

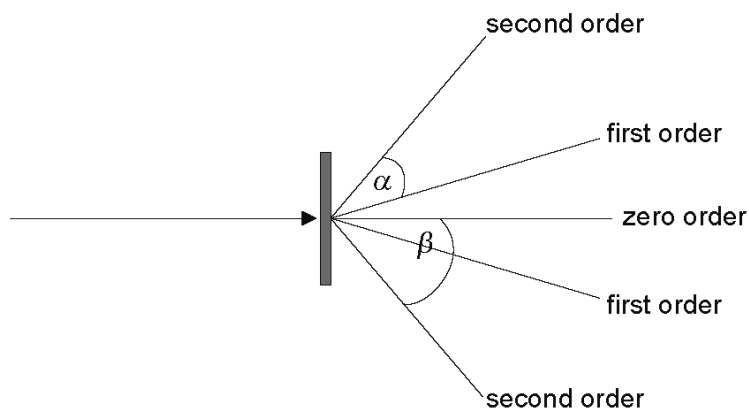
Which of the possible changes are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

17 - (PHYSI/10\_HL\_Winter\_2018\_Q28) - Oscillations & Waves, Wave Phenomena (ahl)



A beam of monochromatic light is incident normally on a diffraction grating. The grating spacing is  $d$ . The angles between the different orders are shown on the diagram.



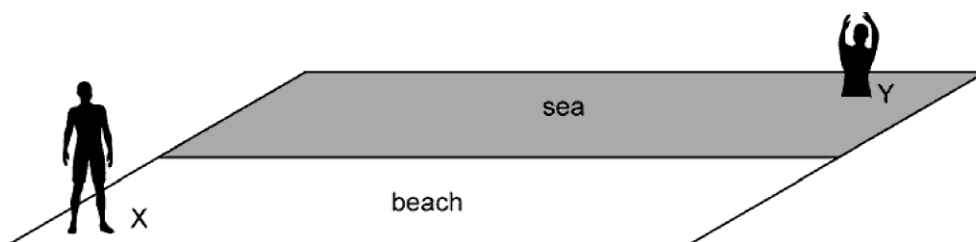
What is the expression for the wavelength of light used?

- A.  $\frac{d \sin \alpha}{2}$
- B.  $\frac{d \sin \beta}{2}$
- C.  $d \sin \alpha$
- D.  $d \sin \beta$

18 - (PHYSI/11\_HL\_Summer\_2019\_Q27) - Oscillations & Waves, Wave Phenomena (ahl)

In science, models are extensively used to study real life situations.

A person X on the beach wants to reach a person Y in the sea in the shortest possible time. The speed of person X on land is different from the speed of person X in the water. Which physical phenomenon will best model the path with the least time?

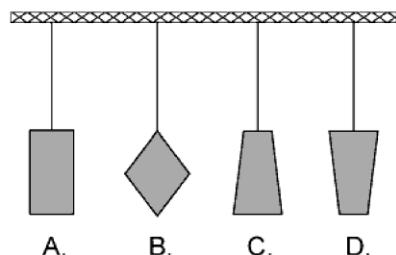


- A. Conservation of momentum
- B. Diffraction
- C. Flow of charge in a conductor
- D. Refraction

19 - (PHYSI/11\_HL\_Summer\_2019\_Q28) - Oscillations & Waves, Wave Phenomena (ahl)



The four pendulums shown have been cut from the same uniform sheet of board. They are attached to the ceiling with strings of equal length.



Which pendulum has the shortest period?

20 - (PHYSI/11\_HL\_Summer\_2019\_Q29) - Oscillations & Waves, Wave Phenomena (ahl)

In a Young's double-slit experiment, the distance between fringes is too small to be observed.

What change would increase the distance between fringes?

- A. Increasing the frequency of light
- B. Increasing the distance between slits
- C. Increasing the distance from the slits to the screen
- D. Increasing the distance between light source and slits

21 - (PHYSI/11\_HL\_Summer\_2019\_Q30) - Oscillations & Waves, Wave Phenomena (ahl)

The headlights of a car emit light of wavelength 400 nm and are separated by 1.2 m. The headlights are viewed by an observer whose eye has an aperture of 4.0 mm. The observer can just distinguish the headlights as separate images. What is the distance between the observer and the headlights?

- A. 8 km
- B. 10 km
- C. 15 km
- D. 20 km

22 – (PHYSI/11\_HL\_Summer\_2019\_Q31) – *Oscillations & Waves, Wave Phenomena (ahl)*



A transparent liquid film of refractive index 1.5 coats the outside of a glass lens of higher refractive index. The liquid film is used to eliminate reflection from the lens at wavelength  $\lambda$  in air.

What is the minimum thickness of the liquid film coating and the phase change at the liquid–glass interface?

|    | Coating thickness   | Phase change |
|----|---------------------|--------------|
| A. | $\frac{\lambda}{3}$ | 0            |
| B. | $\frac{\lambda}{3}$ | $\pi$        |
| C. | $\frac{\lambda}{6}$ | 0            |
| D. | $\frac{\lambda}{6}$ | $\pi$        |

23 – (PHYSI/10\_HL\_Winter\_2019\_Q27) – *Oscillations & Waves, Wave Phenomena (ahl)*

Light of frequency 500 THz is incident on a single slit and forms a diffraction pattern. The first diffraction minimum forms at an angle of  $2.4 \times 10^{-3}$  rad to the central maximum. The frequency of the light is now changed to 750 THz. What is the angle between the first diffraction minimum and the central maximum?

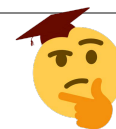
- A.  $1.6 \times 10^{-3}$  rad
- B.  $1.8 \times 10^{-3}$  rad
- C.  $2.4 \times 10^{-3}$  rad
- D.  $3.6 \times 10^{-3}$  rad

24 – (PHYSI/10\_HL\_Winter\_2019\_Q28) – *Oscillations & Waves, Wave Phenomena (ahl)*

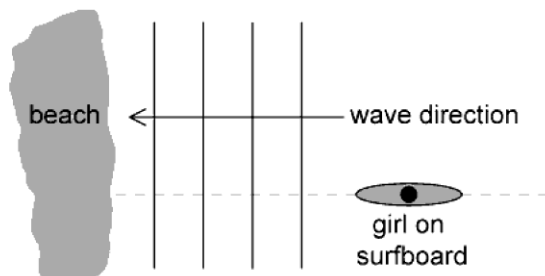
Light of wavelength  $\lambda$  is normally incident on a diffraction grating of spacing  $3\lambda$ . What is the angle between the two second-order maxima?

- A.  $\sin^{-1} \frac{2}{3}$
- B.  $\sin^{-1} \frac{4}{3}$
- C.  $2 \sin^{-1} \frac{2}{3}$
- D.  $>90^\circ$  so no second orders appear

25 – (PHYSI/10\_HL\_Winter\_2019\_Q29) – Wave Phenomena (ahl)



Sea waves move towards a beach at a constant speed of  $2.0 \text{ ms}^{-1}$ . They arrive at the beach with a frequency of  $0.10 \text{ Hz}$ . A girl on a surfboard is moving in the sea at right angles to the wave fronts. She observes that the surfboard crosses the wave fronts with a frequency of  $0.40 \text{ Hz}$ .



What is the speed of the surfboard and what is the direction of motion of the surfboard relative to the beach?

|    | Speed of surfboard<br>relative to the beach / $\text{ms}^{-1}$ | Direction of motion of<br>surfboard relative to the beach |
|----|----------------------------------------------------------------|-----------------------------------------------------------|
| A. | 6.0                                                            | towards beach                                             |
| B. | 6.0                                                            | away from beach                                           |
| C. | 1.5                                                            | towards beach                                             |
| D. | 1.5                                                            | away from beach                                           |

26 – (PHYSI/10\_HL\_Winter\_2020\_Q27) – Wave Phenomena (ahl)

A simple pendulum and a mass–spring system oscillate with the same time period. The mass of the pendulum bob and the mass on the spring are initially identical. The masses are halved.

What is  $\frac{\text{time period of pendulum}}{\text{time period of mass–spring system}}$  when the masses have been changed?

- A.  $\frac{\sqrt{2}}{2}$
- B. 1
- C.  $\sqrt{2}$
- D. 2



27 – (PHYSI/10\_HL\_Winter\_2020\_Q28) – Wave Phenomena (ahl)



Light is incident on a diffraction grating. The wavelengths of two spectral lines of the light differ by 0.59 nm and have a mean wavelength of 590 nm. The spectral lines are just resolved in the fourth order of the grating. What is the minimum number of grating lines that were illuminated?

- A. 25
- B. 250
- C. 1000
- D. 4000

28 – (PHYSI/10\_HL\_Winter\_2020\_Q29) – Wave Phenomena (ahl)

White light is incident normally on separate diffraction gratings X and Y. Y has a greater number of lines per metre than X. Three statements about differences between X and Y are

- I. adjacent slits in the gratings are further apart for X than for Y
- II. the angle between red and blue light in a spectral order is greater in X than in Y
- III. the total number of visible orders is greater for X than for Y.

Which statements are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

29 – (PHYSI/11\_HL\_Summer\_2021\_Q26) – Wave Phenomena (ahl)

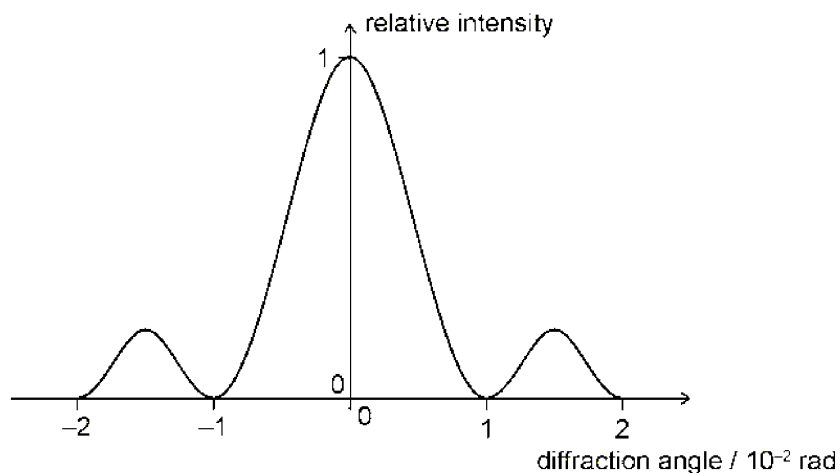
Which is correct for the tangential acceleration of a simple pendulum at small amplitudes?

- A. It is inversely proportional to displacement.
- B. It is proportional to displacement.
- C. It is opposite to displacement.
- D. It is proportional and opposite to displacement.

30 - (PHYSI/11\_HL\_Summer\_2021\_Q27) - Wave Phenomena (ahl)



The diagram shows the diffraction pattern for light passing through a single slit.



What is

$$\frac{\text{wavelength of light}}{\text{width of slit}}$$

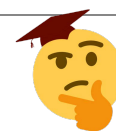
- A. 0.01
- B. 0.02
- C. 1
- D. 2

31 - (PHYSI/11\_HL\_Summer\_2021\_Q28) - Wave Phenomena (ahl)

Light is incident on a diffraction grating. The wavelength lines 600.0 nm and 601.5 nm are just resolved in the second order spectrum. How many slits of the diffraction grating are illuminated?

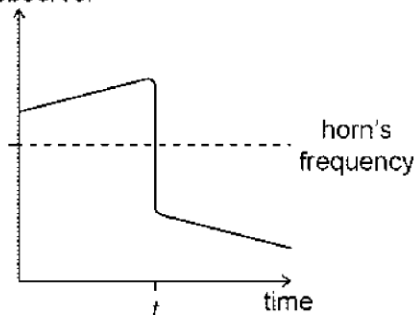
- A. 20
- B. 40
- C. 200
- D. 400

32 – (PHYSI/11\_HL\_Summer\_2021\_Q29) – Wave Phenomena (ahl)

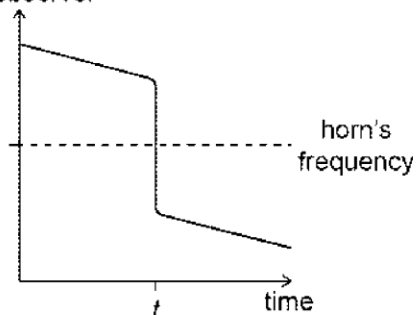


On approaching a stationary observer, a train sounds its horn and decelerates at a constant rate. At time  $t$  the train passes by the observer and continues to decelerate at the same rate. Which diagram shows the variation with time of the frequency of the sound measured by the observer?

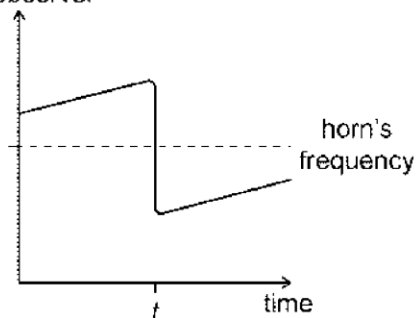
A. frequency measured by observer



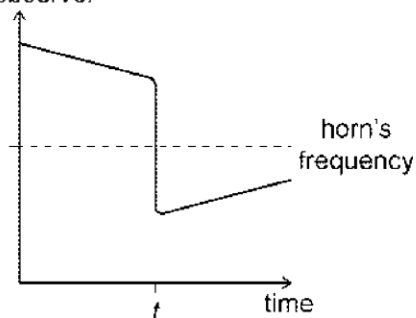
B. frequency measured by observer



C. frequency measured by observer



D. frequency measured by observer



33 – (PHYSI/12\_HL\_Summer\_2021\_Q26) – Wave Phenomena (ahl)

A mass–spring system oscillates vertically with a period of  $T$  at the surface of the Earth. The gravitational field strength at the surface of Mars is  $0.3g$ . What is the period of the same mass–spring system on the surface of Mars?

- A.  $0.09T$
- B.  $0.3T$
- C.  $T$
- D.  $3T$

34 - (PHYSI/12\_HL\_Summer\_2021\_Q27) - Wave Phenomena (ahl)



Light passes through a diffraction grating. Which quantity must be decreased to improve the resolution of the diffraction grating?

- A. The grating spacing
- B. The number of grating lines illuminated by the light source
- C. The number of grating lines per millimetre
- D. The spectral order being observed

35 - (PHYSI/12\_HL\_Summer\_2021\_Q28) - Wave Phenomena (ahl)

A train is moving in a straight line away from a stationary observer when the train horn emits a sound of frequency  $f_0$ . The speed of the train is  $0.10v$  where  $v$  is the speed of sound. What is the frequency of the horn as heard by the observer?

- A.  $\frac{0.9}{1} f_0$
- B.  $\frac{1}{1.1} f_0$
- C.  $\frac{1.1}{1} f_0$
- D.  $\frac{1}{0.9} f_0$

36 - (PHYSI/12\_HL\_Summer\_2021\_Q29) - Wave Phenomena (ahl)

Monochromatic light of wavelength  $\lambda$  passes through a single-slit of width  $b$  and produces a diffraction pattern on a screen. Which combination of changes to  $b$  and  $\lambda$  will cause the greatest decrease in the width of the central maximum?

|    | Slit width     | Wavelength of light  |
|----|----------------|----------------------|
| A. | $\frac{1}{2}b$ | $\frac{1}{2}\lambda$ |
| B. | $\frac{1}{2}b$ | $2\lambda$           |
| C. | $2b$           | $\frac{1}{2}\lambda$ |
| D. | $2b$           | $2\lambda$           |

37 – (PHYSI/10\_HL\_Winter\_2021\_Q26) – Wave Phenomena (ahl)



A simple pendulum undergoes simple harmonic motion. The gravitational potential energy of the pendulum is zero at the equilibrium position. How many times during **one** oscillation is the kinetic energy of the pendulum equal to its gravitational potential energy?

- A. 1
- B. 2
- C. 3
- D. 4

38 – (PHYSI/10\_HL\_Winter\_2021\_Q27) – Wave Phenomena (ahl)

When monochromatic light is incident on a single slit a diffraction pattern forms on a screen. The width of the slit is decreased.

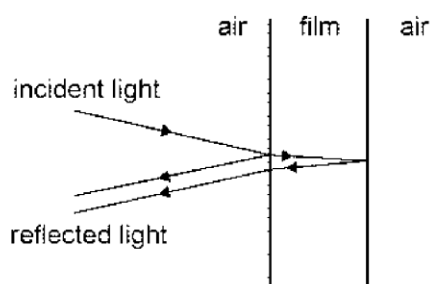
What are the changes in the width and in the intensity of the central maximum of the diffraction pattern?

|    | Width of the central maximum | Intensity of the central maximum |
|----|------------------------------|----------------------------------|
| A. | increases                    | increases                        |
| B. | increases                    | decreases                        |
| C. | decreases                    | increases                        |
| D. | decreases                    | decreases                        |

39 – (PHYSI/10\_HL\_Winter\_2021\_Q28) – Wave Phenomena (ahl)



Monochromatic light of wavelength  $\lambda$  in air is incident normally on a thin liquid film of refractive index  $n$  that is suspended in air. The rays are shown at an angle to the normal for clarity.



What is the minimum thickness of the film so that the reflected light undergoes constructive interference?

- A.  $\frac{\lambda}{4n}$
- B.  $\frac{\lambda}{3n}$
- C.  $\frac{\lambda}{2n}$
- D.  $\frac{\lambda}{n}$

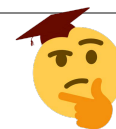
40 – (PHYSI/10\_HL\_Winter\_2021\_Q29) – Wave Phenomena (ahl)

A beam of light containing two different wavelengths is incident on a diffraction grating. The wavelengths are just resolved in the third order of diffraction.

What change increases the resolution of the image?

- A. Increasing the width of the incident beam
- B. Increasing the intensity of light
- C. Decreasing the number of lines per unit length in the diffraction grating
- D. Decreasing the order of diffraction

41 - (PHYSI/11\_HL\_Summer\_2022\_Q30) - Wave Phenomena (ahl)



Light of wavelength  $\lambda$  is diffracted after passing through a very narrow single slit of width  $x$ . The intensity of the central maximum of the diffracted light is  $I_0$ . The slit width is doubled.

What is the intensity of central maximum and the angular position of the first minimum?

|    | Intensity | Angular position of first minimum |
|----|-----------|-----------------------------------|
| A. | $2I_0$    | $\frac{\lambda}{x}$               |
| B. | $2I_0$    | $\frac{\lambda}{2x}$              |
| C. | $4I_0$    | $\frac{\lambda}{x}$               |
| D. | $4I_0$    | $\frac{\lambda}{2x}$              |

42 - (PHYSI/11\_HL\_Summer\_2022\_Q31) - Wave Phenomena (ahl)

An observer with an eye of pupil diameter  $d$  views the headlights of a car that emit light of wavelength  $\lambda$ . The distance between the headlights is  $L$ .

What is the greatest distance between the observer and the car at which the images of the headlights will be resolved by the observer's eye?

- A.  $\frac{1.22\lambda}{Ld}$
- B.  $\frac{1.22\lambda L}{d}$
- C.  $\frac{Ld}{1.22\lambda}$
- D.  $\frac{d}{1.22\lambda L}$

43 - (PHYSI/12\_HL\_Summer\_2022\_Q29) - Wave Phenomena (ahl)



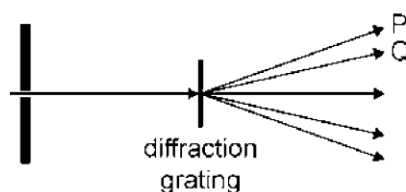
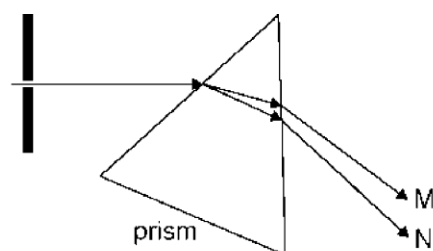
A simple pendulum has a time period  $T$  on the Earth. The pendulum is taken to the Moon where the gravitational field strength is  $\frac{1}{6}$  that of the Earth.

What is the time period of the pendulum on the Moon?

- A.  $T\sqrt{6}$
- B.  $T$
- C.  $\frac{\sqrt{6}}{6}T$
- D.  $\frac{T}{6}$

44 - (PHYSI/12\_HL\_Summer\_2022\_Q30) - Wave Phenomena (ahl)

In two different experiments, white light is passed through a single slit and then is either refracted through a prism or diffracted with a diffraction grating. The prism produces a band of colours from M to N. The diffraction grating produces a first order spectrum P to Q.



What are the colours observed at M and P?

|    | M      | P      |
|----|--------|--------|
| A. | red    | red    |
| B. | red    | violet |
| C. | violet | red    |
| D. | violet | violet |



45 – (PHYSI/12\_HL\_Summer\_2022\_Q31) – Wave Phenomena (ahl)



A train is sounding its whistle when approaching a train station. Three statements about the sound received by a stationary observer at the station are:

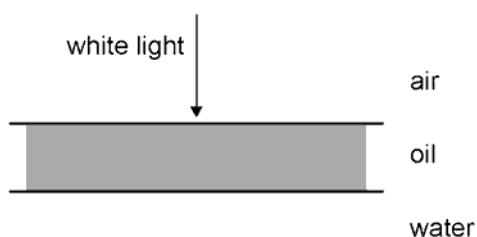
- I. The frequency received is higher than the frequency emitted by the train.
- II. The wavelength received is longer than the wavelength emitted by the train.
- III. The speed of the sound received is not affected by the motion of the train.

Which combination of statements is correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

46 – (PHYSI/10\_HL\_Winter\_2022\_Q27) – Wave Phenomena (ahl)

A ray of white light is normally incident on a thin layer of oil on water. The refractive index of oil is  $\frac{3}{2}$  and the refractive index of water is  $\frac{4}{3}$ .



The wavelength of violet light in air is  $\lambda_v$ .

What is the minimum thickness of the thin layer of oil so that the colour of the reflected light is violet?

- A.  $\frac{\lambda_v}{6}$
- B.  $\frac{3\lambda_v}{4}$
- C.  $\frac{\lambda_v}{2}$
- D.  $\frac{\lambda_v}{3}$

47 – (PHYSI/10\_HL\_Winter\_2022\_Q28) – Wave Phenomena (ahl)



A telescope can just resolve images that are separated by an angle of  $2 \times 10^{-7}$  rad. Two stars are a distance of  $4 \times 10^{16}$  m from each other.

What is the maximum distance between the stars and the telescope for their images to be resolved by the telescope?

- A.  $2 \times 10^9$  m
- B.  $2 \times 10^{11}$  m
- C.  $2 \times 10^{23}$  m
- D.  $4 \times 10^{23}$  m

48 – (PHYSI/10\_HL\_Winter\_2022\_Q29) – Wave Phenomena (ahl)

An ambulance emitting a sound of frequency  $f$  is moving towards a point X at a velocity of  $+40 \text{ m s}^{-1}$ . A car is moving away from X at a velocity of  $+20 \text{ m s}^{-1}$ .

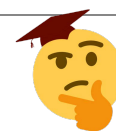


The speed of sound is  $v$ .

What is the frequency detected in the car?

- A.  $f \frac{(v - 20)}{(v - 40)}$
- B.  $f \frac{v}{(v - 20)}$
- C.  $f \frac{(v + 20)}{(v + 40)}$
- D.  $f \frac{(v + 20)}{(v - 40)}$

1 - (PHYSI/11\_HL\_Summer\_2017\_Q26) - Fields (ahl)

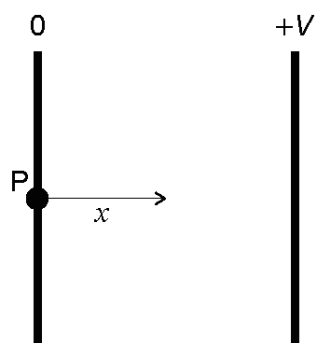


A pendulum oscillating near the surface of the Earth swings with a time period  $T$ . What is the time period of the same pendulum near the surface of the planet Mercury where the gravitational field strength is  $0.4g$ ?

- A.  $0.4T$
- B.  $0.6T$
- C.  $1.6T$
- D.  $2.5T$

2 - (PHYSI/11\_HL\_Summer\_2017\_Q29) - Fields (ahl)

An electric field acts in the space between two charged parallel plates. One plate is at zero potential and the other is at potential  $+V$ .



The distance  $x$  is measured from point P in the direction perpendicular to the plate.

What is the dependence of the electric field strength  $E$  on  $x$  and what is the dependence of the electric potential  $V$  on  $x$ ?

|    | $E$                             | $V$                 |
|----|---------------------------------|---------------------|
| A. | proportional to $\frac{1}{x^2}$ | constant            |
| B. | constant                        | proportional to $x$ |
| C. | proportional to $x$             | proportional to $x$ |
| D. | proportional to $x^2$           | constant            |

3 - (PHYSI/11\_HL\_Summer\_2017\_Q30) - Fields (ahl)



A satellite at the surface of the Earth has a weight  $W$  and gravitational potential energy  $E_p$ . The satellite is then placed in a circular orbit with a radius twice that of the Earth.

What is the weight of the satellite and the gravitational potential energy of the satellite when placed in orbit?

|    | Weight   | Gravitational potential energy |
|----|----------|--------------------------------|
| A. | $0.25 W$ | $0.25 E_p$                     |
| B. | $0.5 W$  | $0.25 E_p$                     |
| C. | $0.25 W$ | $0.5 E_p$                      |
| D. | $0.5 W$  | $0.5 E_p$                      |

4 - (PHYSI/11\_HL\_Summer\_2017\_Q31) - Fields (ahl)

Two point charges are at rest as shown.

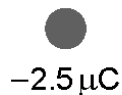
At which position is the electric field strength greatest?

C.

A.



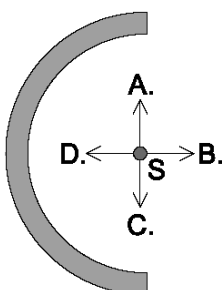
B.



D.

5 - (PHYSI/12\_HL\_Summer\_2017\_Q15) - Fields (ahl)

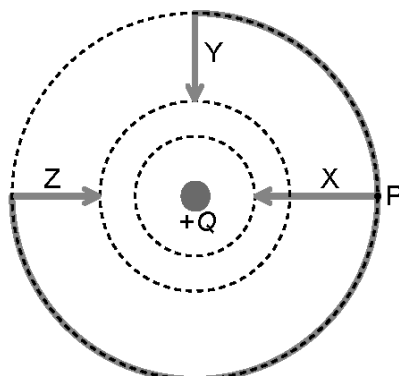
Positive charge is uniformly distributed on a semi-circular plastic rod. What is the direction of the electric field strength at point S?



6 - (PHYSI/12\_HL\_Summer\_2017\_Q30) - Fields (ahl)



A positive charge  $Q$  is deposited on the surface of a small sphere. The dotted lines represent equipotentials.



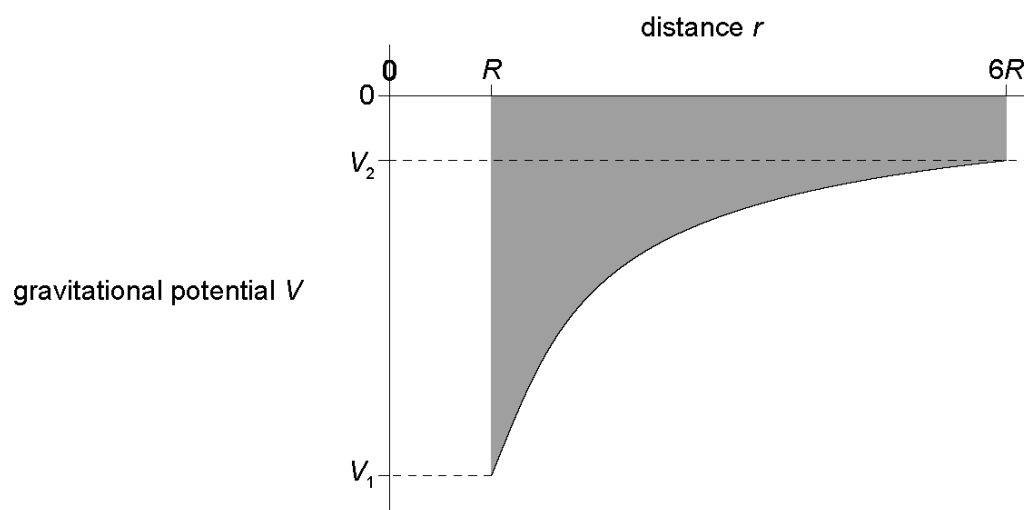
A small positive point charge is moved from point P closer to the sphere along three different paths X, Y and Z. The work done along each path is  $W_X$ ,  $W_Y$  and  $W_Z$ . What is a correct comparison of  $W_X$ ,  $W_Y$  and  $W_Z$ ?

- A.  $W_Z > W_Y > W_X$
- B.  $W_X > W_Y = W_Z$
- C.  $W_X = W_Y = W_Z$
- D.  $W_Z = W_Y > W_X$

7 - (PHYSI/12\_HL\_Summer\_2017\_Q31) - Fields (ahl)



The graph shows the variation of the gravitational potential  $V$  with distance  $r$  from the centre of a uniform spherical planet. The radius of the planet is  $R$ . The shaded area is  $S$ .



What is the work done by the gravitational force as a point mass  $m$  is moved from the surface of the planet to a distance  $6R$  from the centre?

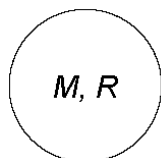
- A.  $m(V_2 - V_1)$
- B.  $m(V_1 - V_2)$
- C.  $mS$
- D.  $S$

8 - (PHYSI/12\_HL\_Summer\_2017\_Q32) - Fields (ahl)

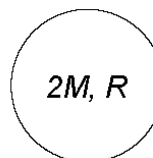


Four uniform planets have masses and radii as shown. Which planet has the smallest escape speed?

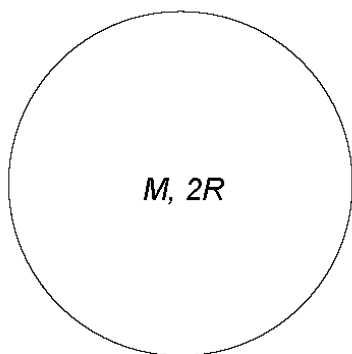
A.



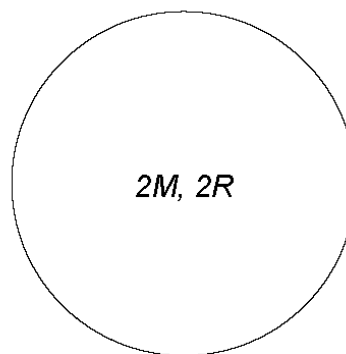
B.



C.



D.



9 - (PHYSI/10\_HL\_Winter\_2017\_Q32) - Fields (ahl)

A spacecraft moves towards the Earth under the influence of the gravitational field of the Earth. The three quantities that depend on the distance  $r$  of the spacecraft from the centre of the Earth are the

- I. gravitational potential energy of the spacecraft
- II gravitational field strength acting on the spacecraft
- III. gravitational force acting on the spacecraft.

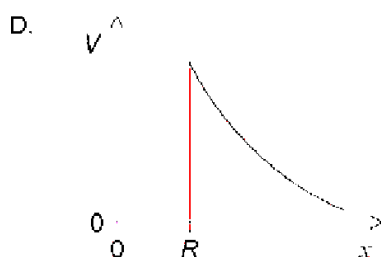
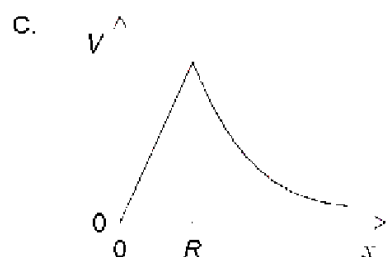
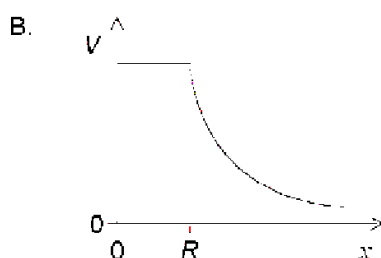
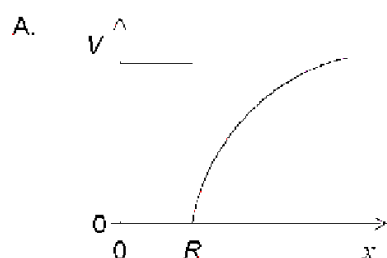
Which of the quantities are proportional to  $\frac{1}{r^2}$ ?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

10 – (PHYSI/10\_HL\_Winter\_2017\_Q33) – Fields (ahl)

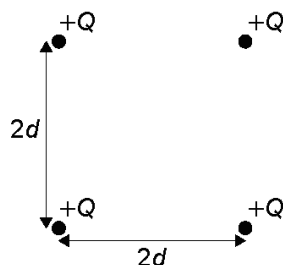


An isolated hollow metal sphere of radius  $R$  carries a positive charge. Which graph shows the variation of potential  $V$  with distance  $x$  from the centre of the sphere?



11 – (PHYSI/11\_HL\_Summer\_2018\_Q30) – Fields (ahl)

Four identical, positive, point charges of magnitude  $Q$  are placed at the vertices of a square of side  $2d$ . What is the electric potential produced at the centre of the square by the four charges?



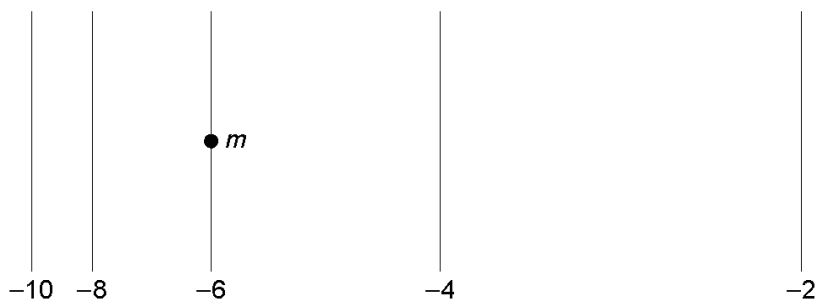
- A. 0
- B.  $\frac{4kQ}{d}$
- C.  $\frac{\sqrt{2}kQ}{d}$
- D.  $\frac{2\sqrt{2}kQ}{d}$



## 12 - (PHYSI/11\_HL\_Summer\_2018\_Q31) - Fields (ahl)



The diagram shows 5 gravitational equipotential lines. The gravitational potential on each line is indicated. A point mass  $m$  is placed on the middle line and is then released. Values given in  $\text{MJ kg}^{-1}$ .

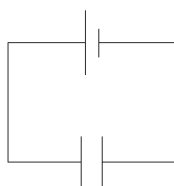


Which is correct about the direction of motion and the acceleration of the point mass?

|    | Direction    | Acceleration |
|----|--------------|--------------|
| A. | to the right | decreasing   |
| B. | to the right | increasing   |
| C. | to the left  | decreasing   |
| D. | to the left  | increasing   |

## 13 - (PHYSI/11\_HL\_Summer\_2018\_Q36) - Fields (ahl)

A parallel plate capacitor is connected to a cell of negligible internal resistance.



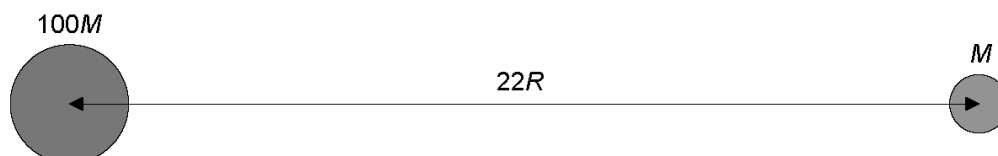
The energy stored in the capacitor is 4 J and the electric field in between the plates is  $100 \text{ NC}^{-1}$ . The distance between the plates of the capacitor is doubled. What are the energy stored and the electric field strength?

|    | Energy / J | Electric field strength / $\text{NC}^{-1}$ |
|----|------------|--------------------------------------------|
| A. | 2          | 50                                         |
| B. | 8          | 50                                         |
| C. | 2          | 200                                        |
| D. | 8          | 200                                        |

14 - (PHYSI/12\_HL\_Summer\_2018\_Q28) - Fields (ahl)



A moon of mass  $M$  orbits a planet of mass  $100M$ . The radius of the planet is  $R$  and the distance between the centres of the planet and moon is  $22R$ .

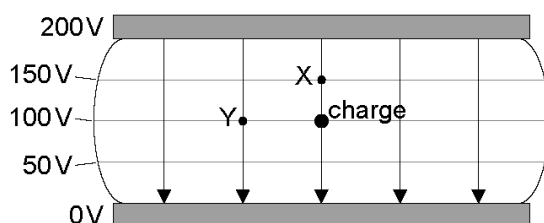


What is the distance from the centre of the planet at which the total gravitational potential has a maximum value?

- A.  $2R$
- B.  $11R$
- C.  $20R$
- D.  $2R$  and  $20R$

15 - (PHYSI/12\_HL\_Summer\_2018\_Q29) - Fields (ahl)

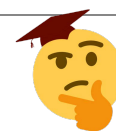
The diagram shows the electric field and the electric equipotential surfaces between two charged parallel plates. The potential difference between the plates is 200 V.



What is the work done, in nJ, by the electric field in moving a negative charge of magnitude 1 nC from the position shown to X and to Y?

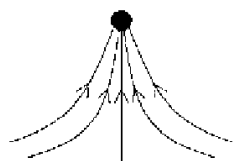
|    | To X | To Y |
|----|------|------|
| A. | 50   | 0    |
| B. | -50  | 0    |
| C. | 50   | 100  |
| D. | -50  | -100 |

16 – (PHYSI/12\_HL\_Summer\_2018\_Q30) – Fields (ahl)

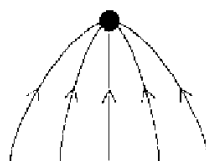


A positive point charge is placed above a metal plate at zero electric potential. Which diagram shows the pattern of electric field lines between the charge and the plate?

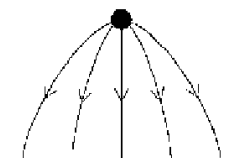
A.



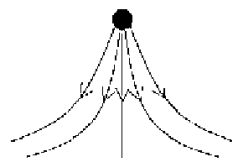
B.



C.

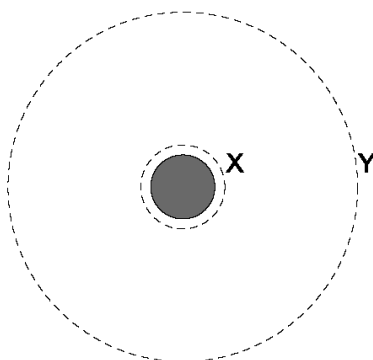


D.



17 – (PHYSI/12\_HL\_Summer\_2018\_Q31) – Fields (ahl)

A satellite orbiting a planet moves from orbit X to orbit Y.



What is the change in the kinetic energy and the change in the gravitational potential energy as a result?

|    | Kinetic energy | Gravitational potential energy |
|----|----------------|--------------------------------|
| A. | increases      | increases                      |
| B. | increases      | decreases                      |
| C. | decreases      | increases                      |
| D. | decreases      | decreases                      |

18 - (PHYSI/12\_HL\_Summer\_2018\_Q32) - Fields (ahl)



The mass of the Earth is  $M_E$  and the mass of the Moon is  $M_M$ . Their respective radii are  $R_E$  and  $R_M$ .

Which is the ratio  $\frac{\text{escape speed from the Earth}}{\text{escape speed from the Moon}}$ ?

A.  $\sqrt{\frac{M_M R_M}{M_E R_E}}$

B.  $\sqrt{\frac{M_E R_E}{M_M R_M}}$

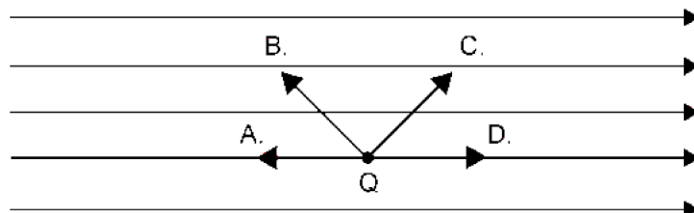
C.  $\sqrt{\frac{M_E R_M}{M_M R_E}}$

D.  $\sqrt{\frac{M_M R_E}{M_E R_M}}$

19 - (PHYSI/11\_HL\_Summer\_2019\_Q32) - Fields (ahl)

A negative charge  $Q$  is to be moved within an electric field  $E$ , to equidistant points from its position, as shown.

Which path requires the most work done?



20 - (PHYSI/11\_HL\_Summer\_2019\_Q33) - Fields (ahl)

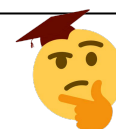
The escape velocity for an object at the surface of the Earth is  $v_{\text{esc}}$ . The diameter of the Moon is 4 times smaller than that of the Earth and the mass of the Moon is 81 times smaller than that of the Earth. What is the escape velocity of the object on the Moon?

A.  $\frac{2}{81}v_{\text{esc}}$

B.  $\frac{4}{81}v_{\text{esc}}$

C.  $\frac{2}{9}v_{\text{esc}}$

D.  $\frac{4}{9}v_{\text{esc}}$

21 – (PHYSI/11\_HL\_Summer\_2019\_Q34) – *Fields (ahl)*

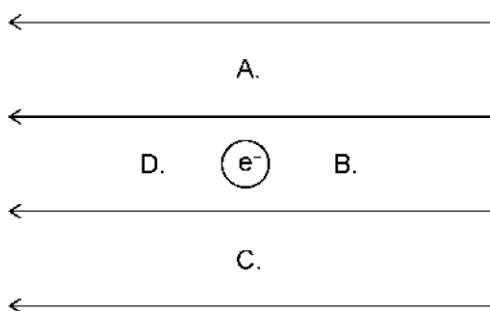
A satellite in a circular orbit around the Earth needs to reduce its orbital radius.

What is the work done by the satellite rocket engine and the change in kinetic energy resulting from this shift in orbital height?

|    | Work done by the satellite rocket engine | Kinetic energy |
|----|------------------------------------------|----------------|
| A. | positive                                 | increase       |
| B. | positive                                 | decrease       |
| C. | negative                                 | increase       |
| D. | negative                                 | decrease       |

22 – (PHYSI/12\_HL\_Summer\_2019\_Q30) – *Electricity & Magnetism, Fields (ahl)*

An electron is fixed in position in a uniform electric field. What is the position for which the electrical potential energy of the electron is greatest?

23 – (PHYSI/10\_HL\_Winter\_2019\_Q30) – *Fields (ahl)*

The gravitational potential is  $V$  at a distance  $R$  above the surface of a spherical planet of radius  $R$  and uniform density. What is the gravitational potential a distance  $2R$  above the surface of the planet?

- A.  $\frac{V}{4}$
- B.  $\frac{4V}{9}$
- C.  $\frac{V}{2}$
- D.  $\frac{2V}{3}$

24 – (PHYSI/10\_HL\_Winter\_2019\_Q31) – *Electricity & Magnetism, Fields (ahl)*



The force acting between two point charges is  $F$  when the separation of the charges is  $x$ . What is the force between the charges when the separation is increased to  $3x$ ?

- A.  $\frac{F}{3}$
- B.  $\frac{F}{3x^2}$
- C.  $\frac{F}{9}$
- D.  $\frac{F}{9x^2}$

25 – (PHYSI/10\_HL\_Winter\_2020\_Q30) – *Fields (ahl)*

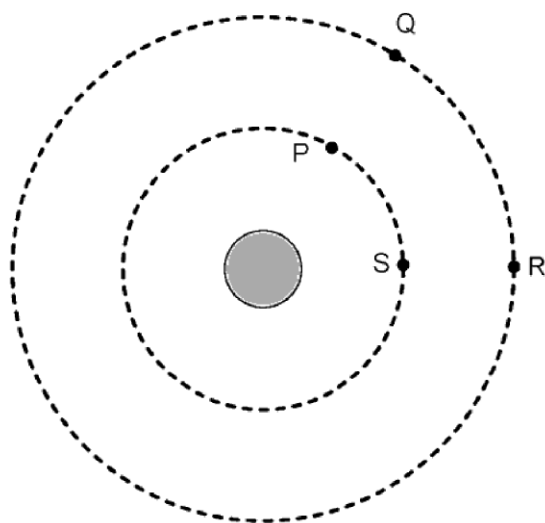
Two satellites W and X have the same mass. They have circular orbits around the same planet. W is closer to the surface than X. What quantity is smaller for W than for X?

- A. Gravitational force from the planet
- B. Angular velocity
- C. Orbital speed
- D. Orbital period

26 – (PHYSI/10\_HL\_Winter\_2020\_Q31) – Fields (ahl)



P and S are two points on a gravitational equipotential surface around a planet. Q and R are two points on a different gravitational equipotential surface at a greater distance from the planet.



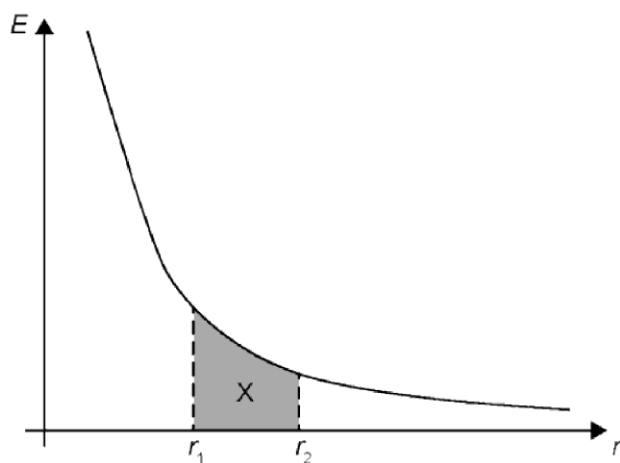
The greatest work done by the gravitational force is when moving a mass from

- A. P to S.
- B. Q to R.
- C. R to P.
- D. S to R.

27 – (PHYSI/10\_HL\_Winter\_2020\_Q32) – Fields (ahl)



The graph shows the variation of electric field strength  $E$  with distance  $r$  from a point charge.



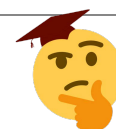
The shaded area  $X$  is the area under the graph between two separations  $r_1$  and  $r_2$  from the charge.

What is  $X$ ?

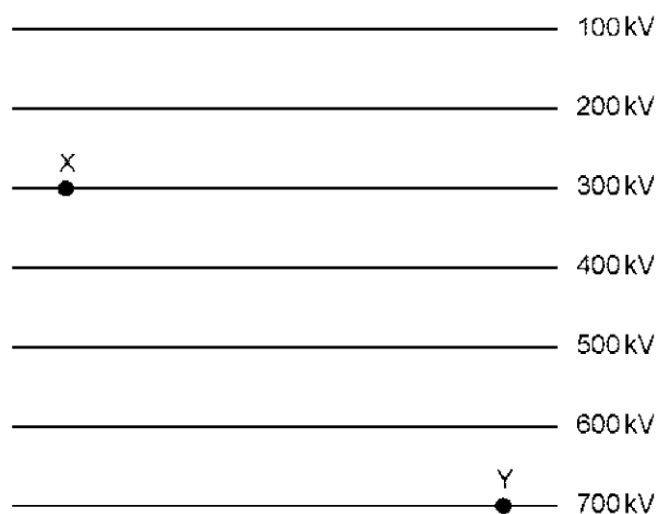
- A. The electric field average between  $r_1$  and  $r_2$
- B. The electric potential difference between  $r_1$  and  $r_2$
- C. The work done in moving a charge from  $r_1$  to  $r_2$
- D. The work done in moving a charge from  $r_2$  to  $r_1$



28 – (PHYSI/11\_HL\_Summer\_2021\_Q30) – Fields (ahl)



A particle with charge  $-2.5 \times 10^{-6} \text{ C}$  moves from point X to point Y due to a uniform electrostatic field. The diagram shows some equipotential lines of the field.



What is correct about the motion of the particle from X to Y and the magnitude of the work done by the field on the particle?

|    | Motion of the particle from X to Y | Magnitude of the work done by the field on the particle |
|----|------------------------------------|---------------------------------------------------------|
| A. | uniform linear                     | 0 J                                                     |
| B. | uniform linear                     | 1 J                                                     |
| C. | uniformly accelerated              | 0 J                                                     |
| D. | uniformly accelerated              | 1 J                                                     |

29 – (PHYSI/11\_HL\_Summer\_2021\_Q31) – Fields (ahl)

Which is a correct unit for gravitational potential?

- A.  $\text{m}^2 \text{s}^{-2}$
- B.  $\text{J kg}$
- C.  $\text{m s}^{-2}$
- D.  $\text{Nm}^{-1} \text{kg}^{-1}$

30 - (PHYSI/11\_HL\_Summer\_2021\_Q32) - Fields (ahl)



A planet has radius  $R$ . The escape speed from the surface of the planet is  $v$ . At what distance from the surface of the planet is the orbital speed  $0.5v$ ?

- A.  $0.5R$
- B.  $R$
- C.  $2R$
- D.  $4R$

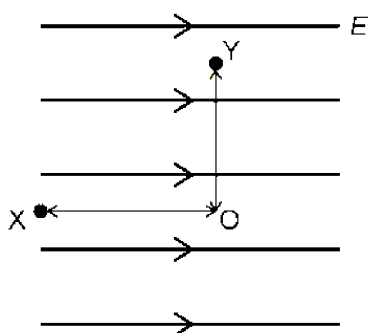
31 - (PHYSI/12\_HL\_Summer\_2021\_Q30) - Fields (ahl)

An object of mass  $m$  released from rest near the surface of a planet has an initial acceleration  $z$ . What is the gravitational field strength near the surface of the planet?

- A.  $z$
- B.  $\frac{z}{m}$
- C.  $mz$
- D.  $\frac{m}{z}$

32 - (PHYSI/12\_HL\_Summer\_2021\_Q31) - Fields (ahl)

The points X and Y are in a uniform electric field of strength  $E$ . The distance OX is  $x$  and the distance OY is  $y$ .



What is the magnitude of the change in electric potential between X and Y?

- A.  $Ex$
- B.  $Ey$
- C.  $E(x + y)$
- D.  $E\sqrt{x^2 + y^2}$

33 – (PHYSI/12\_HL\_Summer\_2021\_Q32) – Fields (ahl)

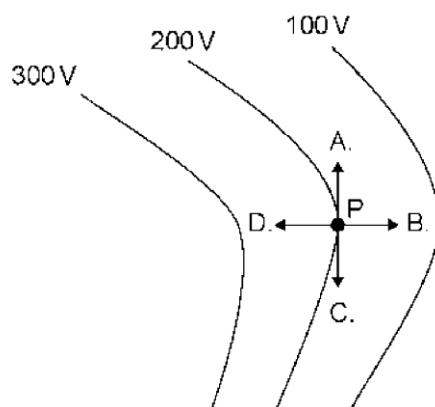


A satellite orbits planet X with a speed  $v_x$  at a distance  $r$  from the centre of planet X. Another satellite orbits planet Y at a speed of  $v_y$  at a distance  $r$  from the centre of planet Y. The mass of planet X is  $M$  and the mass of planet Y is  $4M$ . What is the ratio of  $\frac{v_x}{v_y}$ ?

- A. 0.25
- B. 0.5
- C. 2.0
- D. 4.0

34 – (PHYSI/10\_HL\_Winter\_2021\_Q30) – Fields (ahl)

The diagram shows equipotential lines for an electric field. Which arrow represents the acceleration of an electron at point P?



35 – (PHYSI/10\_HL\_Winter\_2021\_Q31) – Fields (ahl)

Two charged parallel plates have electric potentials of 10V and 20V.

20V

10V

A particle with charge  $+2.0\mu\text{C}$  is moved from the 10V plate to the 20V plate. What is the change in the electric potential energy of the particle?

- A.  $-20\mu\text{J}$
- B.  $-10\mu\text{J}$
- C.  $10\mu\text{J}$
- D.  $20\mu\text{J}$

36 – (PHYSI/10\_HL\_Winter\_2021\_Q32) – Fields (ahl)

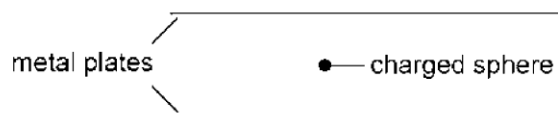


A satellite of mass  $m$  orbits a planet of mass  $M$  in a circular orbit of radius  $r$ . What is the work that must be done on the satellite to increase its orbital radius to  $2r$ ?

- A.  $\frac{GMm}{r}$
- B.  $\frac{GMm}{2r}$
- C.  $\frac{GMm}{4r}$
- D.  $\frac{GMm}{8r}$

37 – (PHYSI/11\_HL\_Summer\_2022\_Q32) – Fields (ahl)

A charged sphere in a gravitational field is initially stationary between two parallel metal plates. There is a potential difference  $V$  between the plates.



Three changes can be made:

- I. Increase the separation of the metal plates
- II. Increase  $V$
- III. Apply a magnetic field into the plane of the paper

What changes made separately will cause the charged sphere to accelerate?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

38 - (PHYSI/11\_HL\_Summer\_2022\_Q33) - Fields (ahl)

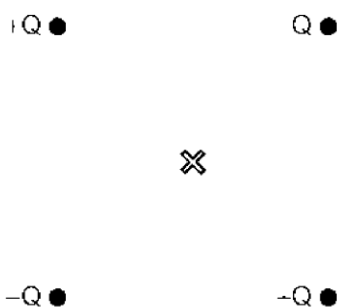


An object of mass  $m$  is launched from the surface of the Earth. The Earth has a mass  $M$  and radius  $r$ . The acceleration due to gravity at the surface of the Earth is  $g$ . What is the escape speed of the object from the surface of the Earth?

- A.  $\sqrt{gr}$
- B.  $\sqrt{2gr}$
- C.  $\sqrt{2Mgr}$
- D.  $\sqrt{2mgr}$

39 - (PHYSI/12\_HL\_Summer\_2022\_Q32) - Fields (ahl)

Two positive and two negative charges are located at the corners of a square as shown. Point X is the centre of the square. What is the value of the electric field  $E$  and the electric potential  $V$  at X due to the four charges?

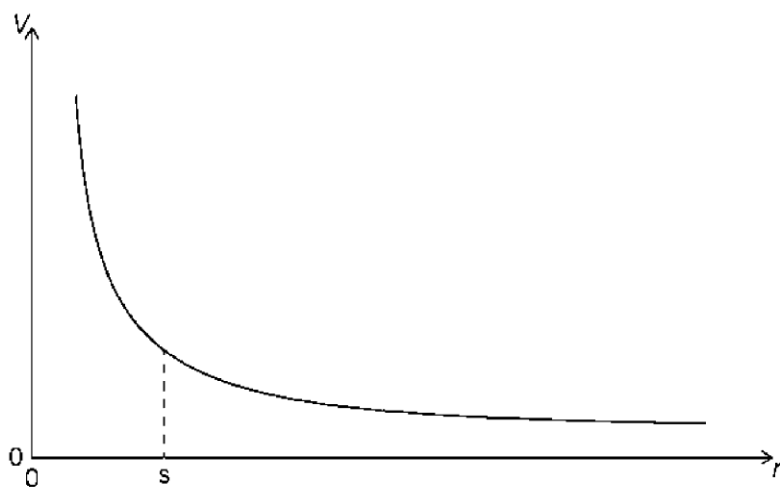


|    | Electric field $E$ at X | Electric potential $V$ at X |
|----|-------------------------|-----------------------------|
| A. | $E = 0$                 | $V = 0$                     |
| B. | $E \neq 0$              | $V = 0$                     |
| C. | $E = 0$                 | $V \neq 0$                  |
| D. | $E \neq 0$              | $V \neq 0$                  |

40 – (PHYSI/12\_HL\_Summer\_2022\_Q33) – Fields (ahl)



The graph shows the variation with distance  $r$  of the electric potential  $V$  from a charge  $Q$ .



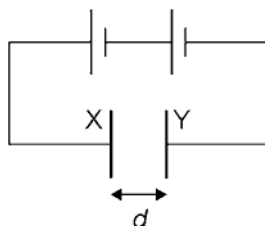
What is the electric field strength at distance  $s$ ?

- A. The area under the graph between  $s$  and infinity
- B. The area under the graph between 0 and  $s$
- C. The gradient of the tangent at  $s$
- D. The negative of the gradient of the tangent at  $s$

41 – (PHYSI/10\_HL\_Winter\_2022\_Q30) – Fields (ahl)



A parallel-plate capacitor is fully charged using a battery.



The capacitor has a capacitance  $C$  and a charge  $Q$ . The plates X and Y of the capacitor are a distance  $d$  apart. Edge effects are negligible.

Three statements about the fully charged capacitor are:

- I. The electric field strength between the plates is  $\frac{Q}{Cd}$ .
- II. The electric field lines are at right angles to the plates.
- III. The equipotential surfaces are parallel to the plates.

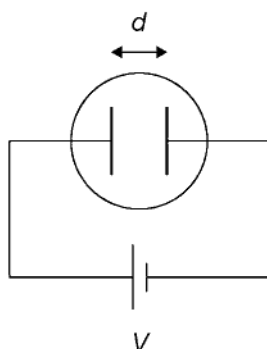
Which statements are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

42 – (PHYSI/10\_HL\_Winter\_2022\_Q31) – Fields (ahl)



An electric field is established between two electrodes separated by distance  $d$ , held at a potential difference of  $V$ . A charged particle in this field experiences a force  $F$ .



What is the charge on the particle?

- A.  $\frac{d}{FV}$
- B.  $\frac{FV}{d}$
- C.  $\frac{V}{Fd}$
- D.  $\frac{Fd}{V}$

43 – (PHYSI/10\_HL\_Winter\_2022\_Q32) – Fields (ahl)

Two satellites are in circular orbits around the Earth. Both satellites have the same mass and satellite X is closer to Earth than satellite Y.

What is correct for the orbital periods of X and Y and the total energies of X and Y?

|    | Orbital periods  | Total energies   |
|----|------------------|------------------|
| A. | X greater than Y | X greater than Y |
| B. | X greater than Y | Y greater than X |
| C. | Y greater than X | X greater than Y |
| D. | Y greater than X | Y greater than X |

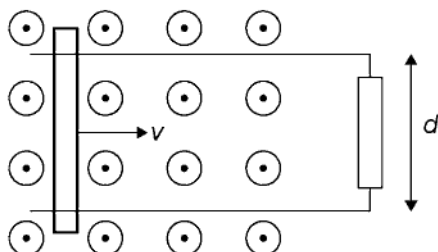


44 – (PHYSI/10\_HL\_Winter\_2022\_Q33) – Fields (ahl)

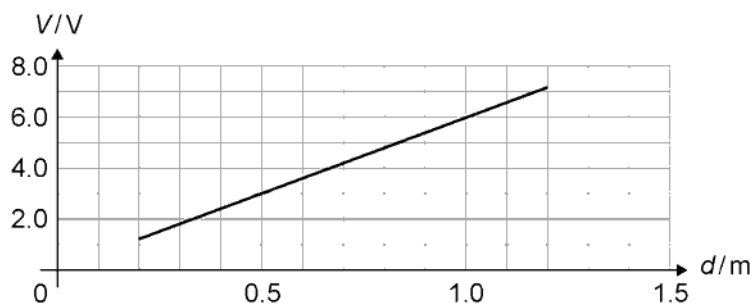


A resistor connects two parallel conducting rails a distance  $d$  apart. A conducting bar rolls along the rails at a constant velocity  $v$  through a uniform magnetic field of  $2.0\text{ T}$  perpendicular to the rails as shown.

The voltage  $V$  across the resistor is measured.



The graph shows the variation of  $V$  with  $d$ .



What is  $v$ ?

- A.  $0.33\text{ ms}^{-1}$
- B.  $3.0\text{ ms}^{-1}$
- C.  $6.0\text{ ms}^{-1}$
- D.  $12.0\text{ ms}^{-1}$

1 - (PHYSI/11\_HL\_Summer\_2017\_Q32) - *Electromagnetic Induction (ahl)*

A direct current (dc) of 5A dissipates a power  $P$  in a resistor. Which peak value of the alternating current (ac) will dissipate an average power  $P$  in the same resistor?

- A. 5A
- B.  $\frac{5}{2}$  A
- C.  $\frac{5}{\sqrt{2}}$  A
- D.  $5\sqrt{2}$  A

2 - (PHYSI/11\_HL\_Summer\_2017\_Q33) - *Electromagnetic Induction (ahl)*

What are the units of magnetic flux and magnetic field strength?

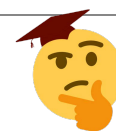
|    | Magnetic flux      | Magnetic field strength |
|----|--------------------|-------------------------|
| A. | $\text{Wb m}^{-2}$ | Wb                      |
| B. | Wb                 | T                       |
| C. | Wb                 | $\text{T m}^{-2}$       |
| D. | $\text{T m}^{-2}$  | $\text{Wb m}^{-2}$      |

3 - (PHYSI/11\_HL\_Summer\_2017\_Q34) - *Electromagnetic Induction (ahl)*

A battery is used to charge a capacitor fully through a resistor of resistance  $R$ . The energy supplied by the battery is  $E_b$ . The energy stored by the capacitor is  $E_c$ .

What is the relationship between  $E_b$  and  $E_c$ ?

- A.  $E_b < E_c$
- B.  $E_b = E_c$
- C.  $E_b > E_c$
- D. The relationship depends on  $R$ .

4 - (PHYSI/11\_HL\_Summer\_2017\_Q35) - *Electromagnetic Induction (ahl)*

A capacitor is charged by a constant current of  $2.5\mu\text{A}$  for 100s. As a result the potential difference across the capacitor increases by 5.0V.

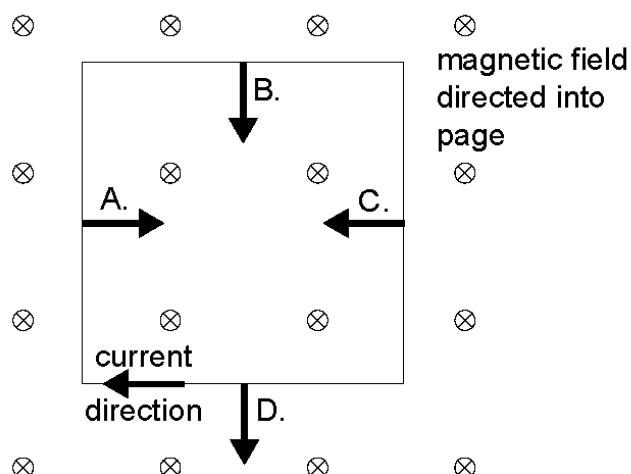
What is the capacitance of the capacitor?

- A.  $20\mu\text{F}$
- B.  $50\mu\text{F}$
- C.  $20\text{mF}$
- D.  $50\text{mF}$

5 - (PHYSI/11\_HL\_Summer\_2017\_Q36) - *Electromagnetic Induction (ahl)*

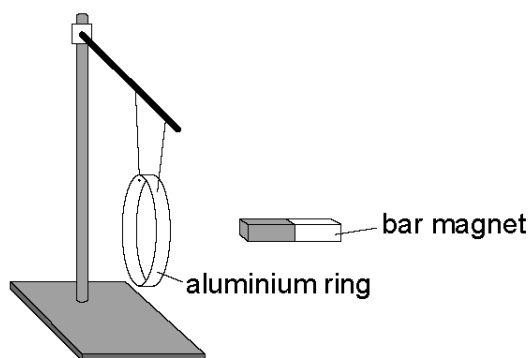
A conducting square coil is placed in a region where there is a uniform magnetic field. The magnetic field is directed into the page. There is a clockwise current in the coil.

What is a correct force that acts on a side of the coil?



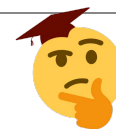
6 - (PHYSI/12\_HL\_Summer\_2017\_Q33) - *Electromagnetic Induction (ahl)*

The diagram shows a bar magnet near an aluminium ring.

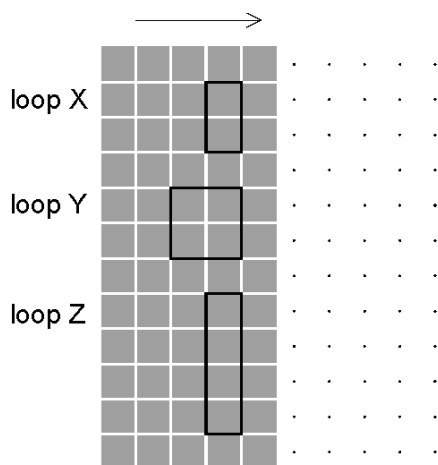


The ring is supported so that it is free to move. The ring is initially at rest. In experiment 1 the magnet is moved towards the ring. In experiment 2 the magnet is moved away from the ring. For each experiment what is the initial direction of motion of the ring?

|    | Experiment 1 | Experiment 2 |
|----|--------------|--------------|
| A. | to the left  | to the left  |
| B. | to the left  | to the right |
| C. | to the right | to the left  |
| D. | to the right | to the right |

7 - (PHYSI/12\_HL\_Summer\_2017\_Q34) - *Electromagnetic Induction (ahl)*

Three conducting loops, X, Y and Z, are moving with the same speed from a region of zero magnetic field to a region of uniform non-zero magnetic field.

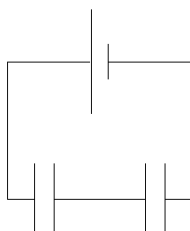


Which loop(s) has/have the largest induced electromotive force (emf) at the instant when the loops enter the magnetic field?

- A. Z only
- B. Y only
- C. Y and Z only
- D. X and Y only

8 - (PHYSI/12\_HL\_Summer\_2017\_Q35) - *Electromagnetic Induction (ahl)*

Two capacitors of different capacitance are connected in series to a source of emf of negligible internal resistance.

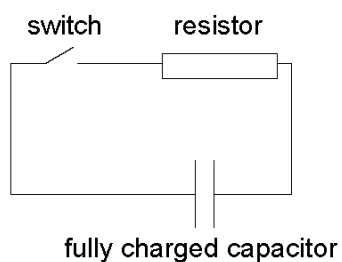


What is correct about the potential difference across each capacitor and the charge on each capacitor?

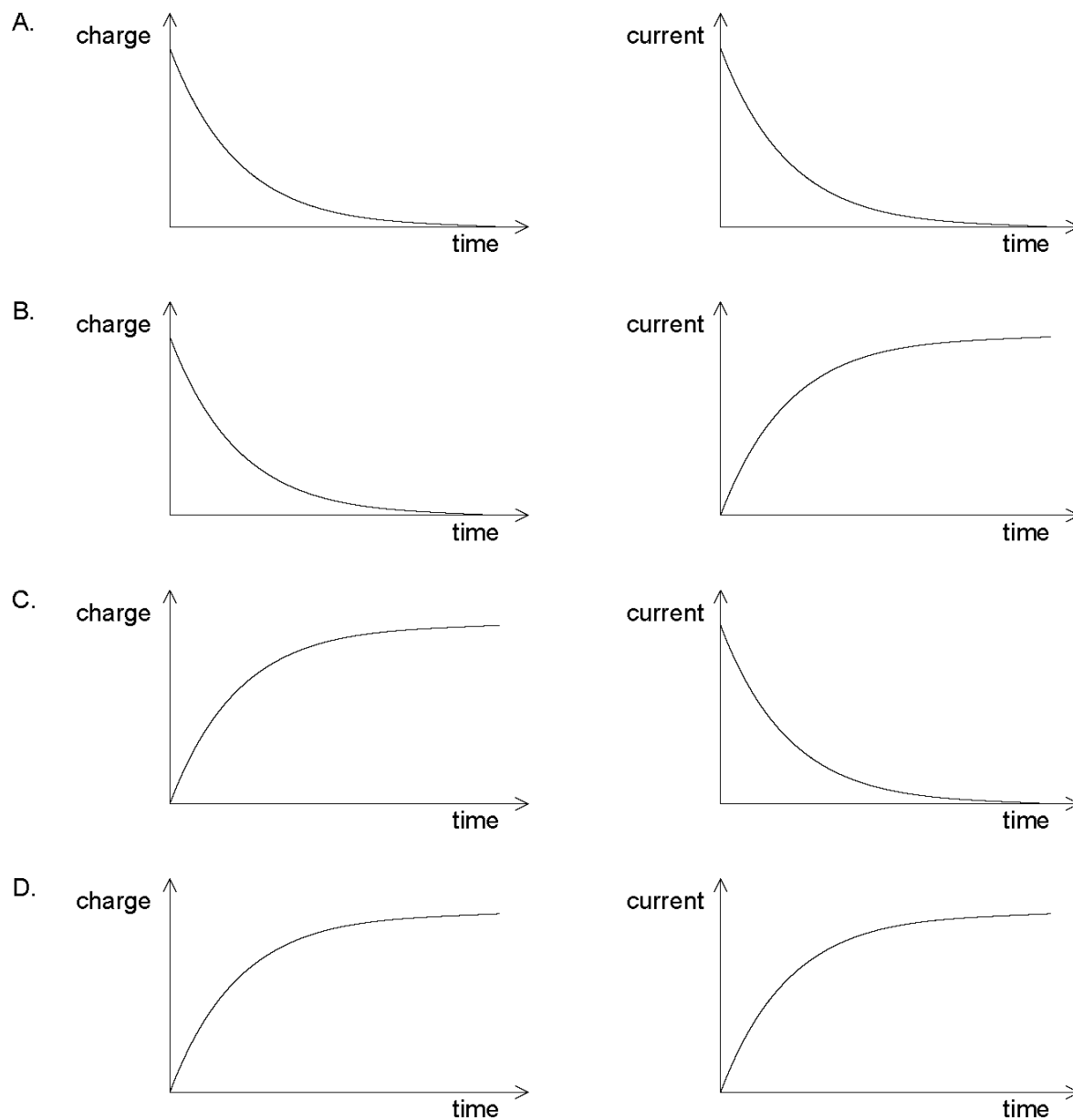
|    | Potential difference | Charge    |
|----|----------------------|-----------|
| A. | same                 | same      |
| B. | same                 | different |
| C. | different            | same      |
| D. | different            | different |

9 - (PHYSI/12\_HL\_Summer\_2017\_Q36) - *Electromagnetic Induction (ahl)*

A fully charged capacitor is connected to a resistor. When the switch is closed the capacitor will discharge through the resistor.



Which graphs correctly show how the charge on the capacitor and the current in the circuit vary with time during the discharging of the capacitor?



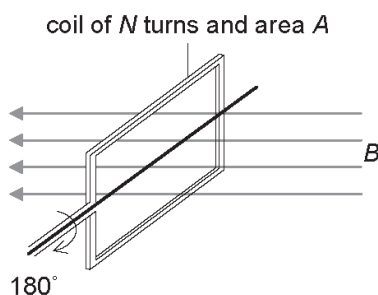
**10** - (PHYSI/10\_HL\_Winter\_2017\_Q31) - *Electromagnetic Induction (ahl)*

A charge of  $-3\text{ C}$  is moved from A to B and then back to A. The electric potential at A is  $+10\text{ V}$  and the electric potential at B is  $-20\text{ V}$ . What is the work done in moving the charge from A to B and the total work done?

|    | Work done in moving<br>from A to B / J | Total work done<br>/ J |
|----|----------------------------------------|------------------------|
| A. | 30                                     | 0                      |
| B. | 30                                     | 60                     |
| C. | 90                                     | 0                      |
| D. | 90                                     | 180                    |

**11** - (PHYSI/10\_HL\_Winter\_2017\_Q34) - *Electromagnetic Induction (ahl)*

The plane of a coil is positioned at right angles to a magnetic field of flux density  $B$ . The coil has  $N$  turns, each of area  $A$ . The coil is rotated through  $180^\circ$  in time  $t$ .



What is the magnitude of the induced emf?

- A.  $\frac{BA}{t}$
- B.  $\frac{2BA}{t}$
- C.  $\frac{BAN}{t}$
- D.  $\frac{2BAN}{t}$



12 - (PHYSI/10\_HL\_Winter\_2017\_Q35) - *Electromagnetic Induction (ahl)*

The ratio  $\frac{\text{number of primary turns}}{\text{number of secondary turns}}$  for a transformer is 2.5.

The primary coil of the transformer draws a current of 0.25 A from a 200 V alternating current (ac) supply. The current in the secondary coil is 0.5 A. What is the efficiency of the transformer?

- A. 20 %
- B. 50 %
- C. 80 %
- D. 100 %

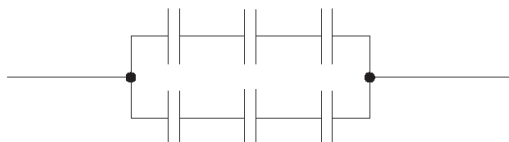
13 - (PHYSI/10\_HL\_Winter\_2017\_Q36) - *Electromagnetic Induction (ahl)*

An alternating current (ac) generator produces a peak emf  $E_0$  and periodic time  $T$ . What are the peak emf and periodic time when the frequency of rotation is doubled?

|    | Peak emf | Periodic time |
|----|----------|---------------|
| A. | $2E_0$   | $2T$          |
| B. | $2E_0$   | $\frac{T}{2}$ |
| C. | $E_0$    | $2T$          |
| D. | $E_0$    | $\frac{T}{2}$ |

14 - (PHYSI/10\_HL\_Winter\_2017\_Q37) - *Electromagnetic Induction (ahl)*

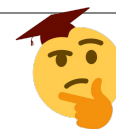
Six identical capacitors, each of value  $C$ , are connected as shown.



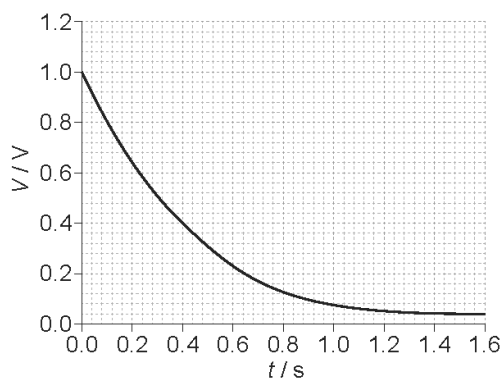
What is the total capacitance?

- A.  $\frac{C}{6}$
- B.  $\frac{2C}{3}$
- C.  $\frac{3C}{2}$
- D.  $6C$

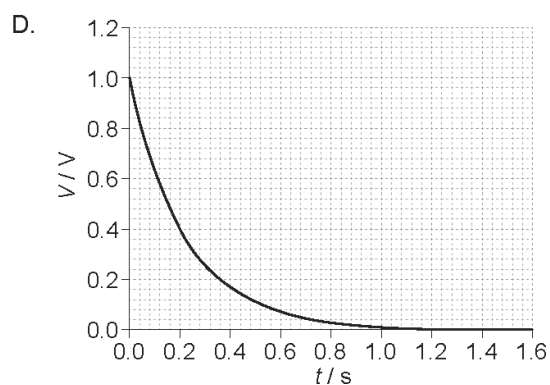
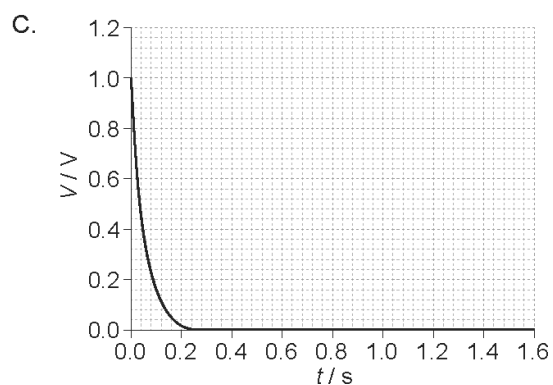
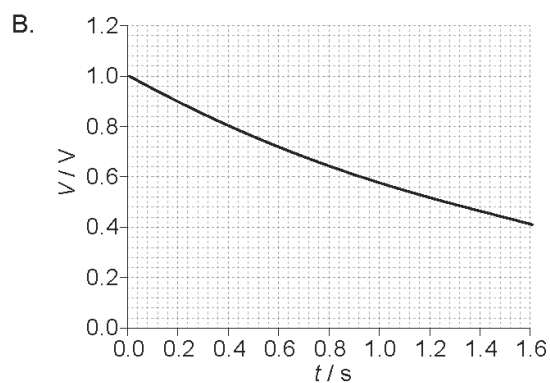
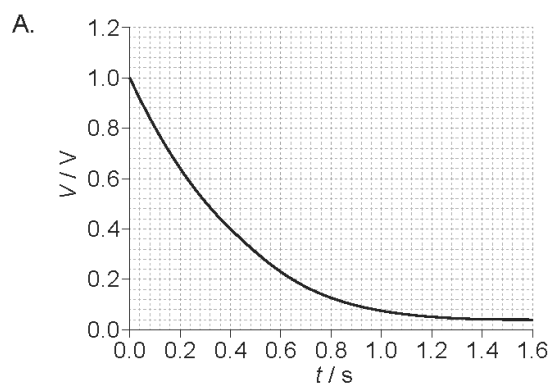
## 15 - (PHYSI/10\_HL\_Winter\_2017\_Q38) - Electromagnetic Induction (ahl)

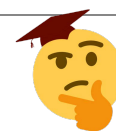


A capacitor of capacitance  $C$  discharges through a resistor of resistance  $R$ . The graph shows the variation with time  $t$  of the voltage  $V$  across the capacitor.

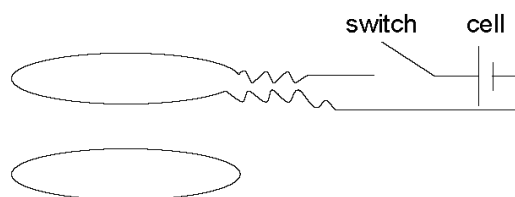


The capacitor is changed to one of value  $2C$  and the resistor is changed to one of value  $2R$ . Which graph shows the variation with  $t$  of  $V$  when the new combination is discharged?



16 - (PHYSI/11\_HL\_Summer\_2018\_Q33) - *Electromagnetic Induction (ahl)*

Two identical circular coils are placed one below the other so that their planes are both horizontal. The top coil is connected to a cell and a switch.

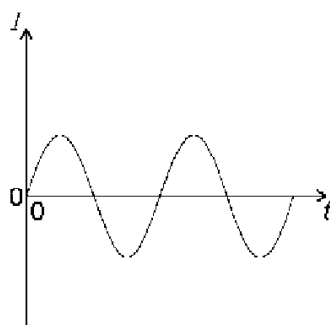


The switch is closed and then opened. What is the force between the coils when the switch is closing and when the switch is opening?

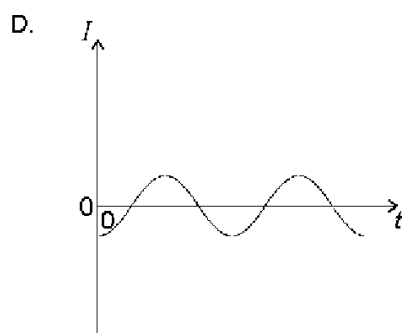
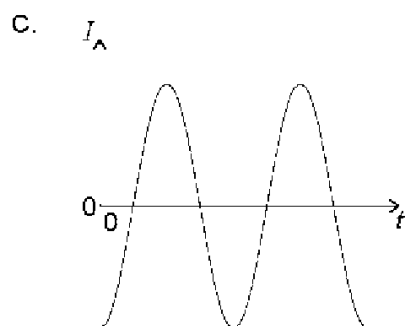
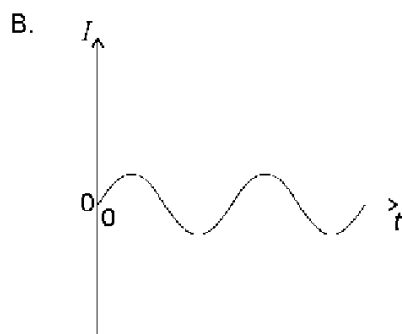
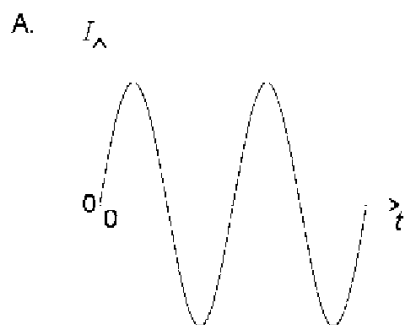
|    | Switch is closing | Switch is opening |
|----|-------------------|-------------------|
| A. | attractive        | attractive        |
| B. | attractive        | repulsive         |
| C. | repulsive         | attractive        |
| D. | repulsive         | repulsive         |

17 - (PHYSI/11\_HL\_Summer\_2018\_Q34) - *Electromagnetic Induction (ahl)*

The graph shows the variation with time  $t$  of the current  $I$  in the primary coil of an ideal transformer.

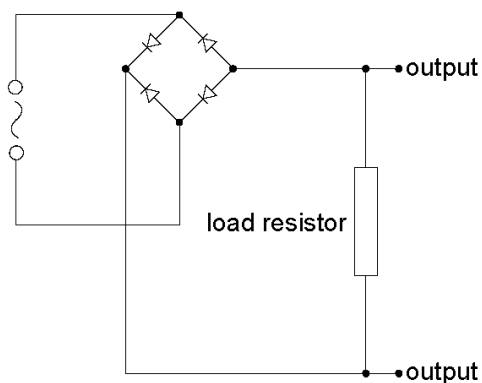


The number of turns in the primary coil is 100 and the number of turns in the secondary coil is 200. Which graph shows the variation with time of the current in the secondary coil?

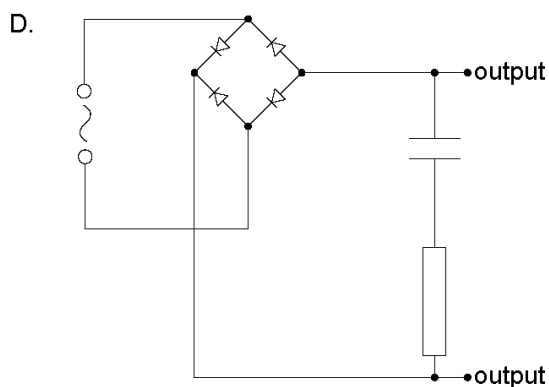
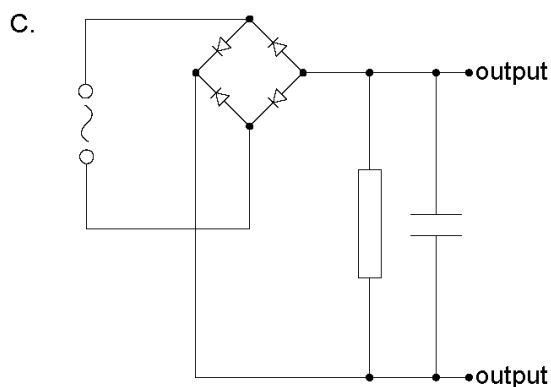
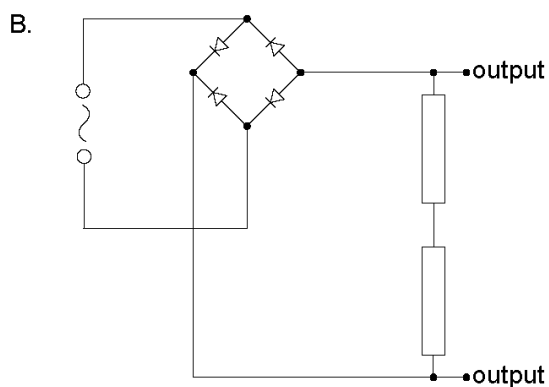
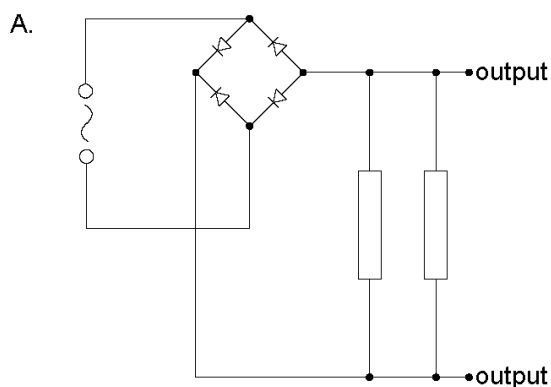


18 - (PHYSI/11\_HL\_Summer\_2018\_Q35) - *Electromagnetic Induction (ahl)*

The diagram shows a diode bridge rectification circuit and a load resistor.

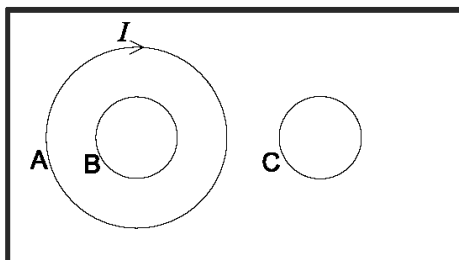


The input is a sinusoidal signal. Which of the following circuits will produce the most smoothed output signal?



19 - (PHYSI/12\_HL\_Summer\_2018\_Q33) - *Electromagnetic Induction (ahl)*

The current  $I$  flowing in loop A in a clockwise direction is increasing so as to induce a current both in loops B and C. All three loops are on the same plane.

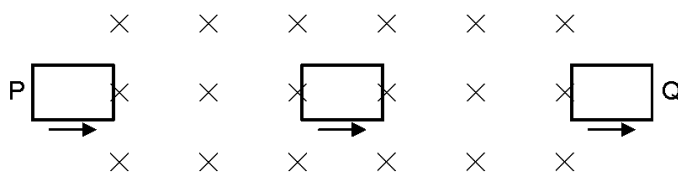


What is the direction of the induced currents in loop B and loop C?

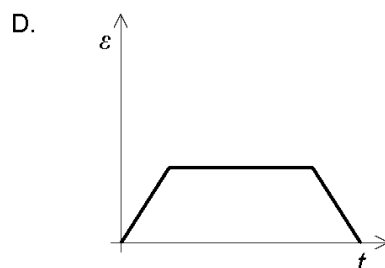
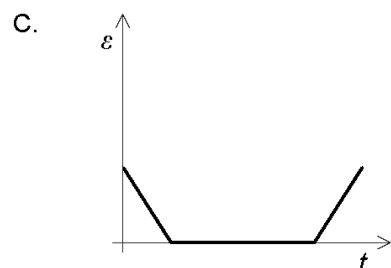
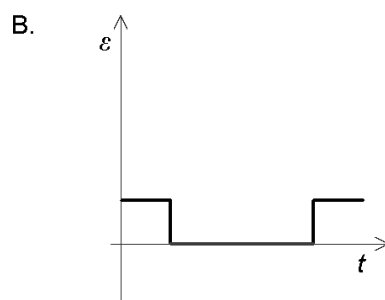
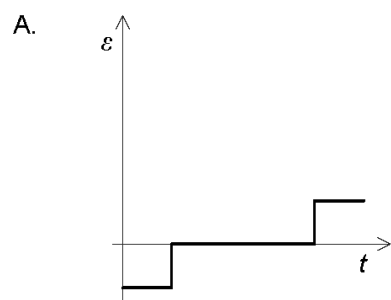
|    | Loop B         | Loop C         |
|----|----------------|----------------|
| A. | clockwise      | clockwise      |
| B. | clockwise      | anti-clockwise |
| C. | anti-clockwise | clockwise      |
| D. | anti-clockwise | anti-clockwise |

20 - (PHYSI/12\_HL\_Summer\_2018\_Q34) - *Electromagnetic Induction (ahl)*

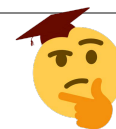
A rectangular flat coil moves at constant speed through a uniform magnetic field. The direction of the field is into the plane of the paper.



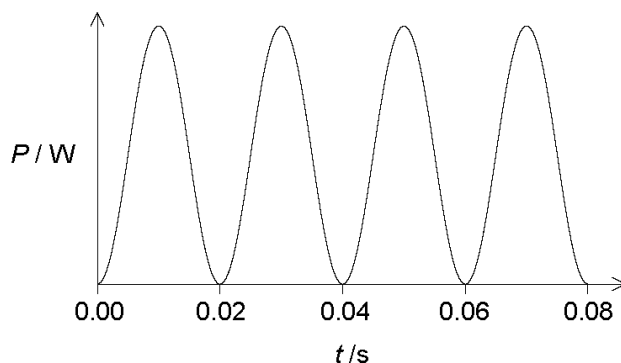
Which graph shows the variation with time  $t$ , of the induced emf  $\mathcal{E}$  in the coil as it moves from P to Q?



## 21 - (PHYSI/12\_HL\_Summer\_2018\_Q35) - Electromagnetic Induction (ahl)



The graph shows the power dissipated in a resistor of  $100\ \Omega$  when connected to an alternating current (ac) power supply of root mean square voltage ( $V_{\text{rms}}$ )  $60\ \text{V}$ .

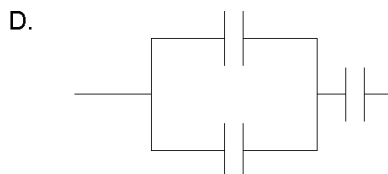
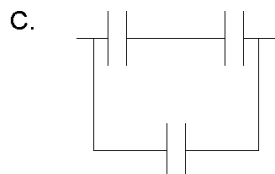
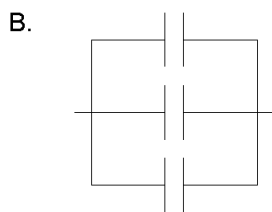


What are the frequency of the ac power supply and the average power dissipated in the resistor?

|    | Frequency of the<br>ac power supply / Hz | Average power dissipated<br>in the resistor / W |
|----|------------------------------------------|-------------------------------------------------|
| A. | 25                                       | 36                                              |
| B. | 50                                       | 36                                              |
| C. | 25                                       | 18                                              |
| D. | 50                                       | 18                                              |

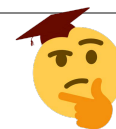
## 22 - (PHYSI/12\_HL\_Summer\_2018\_Q36) - Electromagnetic Induction (ahl)

Three capacitors, each one with a capacitance  $C$ , are connected such that their combined capacitance is  $1.5C$ . How are they connected?

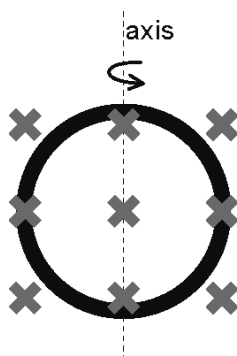




23 – (PHYSI/10\_HL\_Winter\_2018\_Q33) – Electricity &amp; Magnetism, Electromagnetic Induction (ahl)



A ring of area  $S$  is in a uniform magnetic field  $X$ . Initially the magnetic field is perpendicular to the plane of the ring. The ring is rotated by  $180^\circ$  about the axis in time  $T$ .

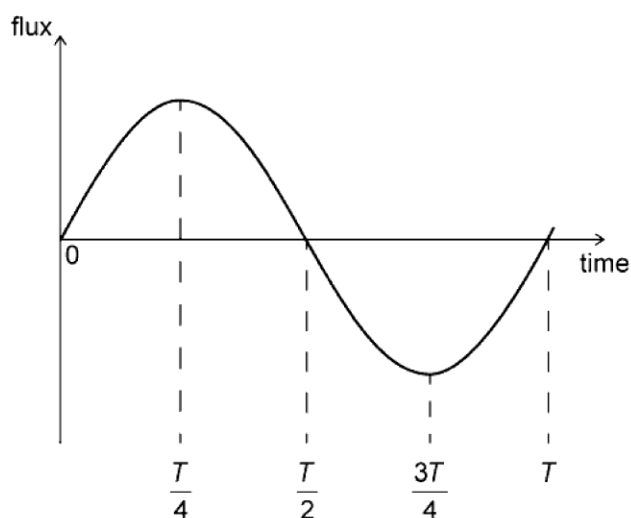


What is the average induced emf in the ring?

- A. 0
- B.  $\frac{XS}{2T}$
- C.  $\frac{XS}{T}$
- D.  $\frac{2XS}{T}$

24 - (PHYSI/11\_HL\_Summer\_2019\_Q35) - *Electromagnetic Induction (ahl)*

The graph below shows the variation with time of the magnetic flux through a coil.



Which of the following gives three times for which the magnitude of the induced emf is a maximum?

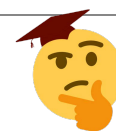
- A.  $0, \frac{T}{4}, \frac{T}{2}$
- B.  $0, \frac{T}{2}, T$
- C.  $0, \frac{T}{4}, T$
- D.  $\frac{T}{4}, \frac{T}{2}, \frac{3T}{4}$

25 - (PHYSI/11\_HL\_Summer\_2019\_Q36) - *Electromagnetic Induction (ahl), Electricity & Magnetism*

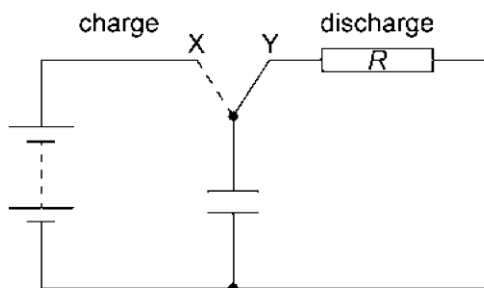
Two capacitors of  $3\mu\text{F}$  and  $6\mu\text{F}$  are connected in series and charged using a 9V battery.

What charge is stored on each capacitor?

|    | Charge stored on $3\mu\text{F}$ capacitor | Charge stored on $6\mu\text{F}$ capacitor |
|----|-------------------------------------------|-------------------------------------------|
| A. | $18\mu\text{C}$                           | $18\mu\text{C}$                           |
| B. | $81\mu\text{C}$                           | $81\mu\text{C}$                           |
| C. | $18\mu\text{C}$                           | $81\mu\text{C}$                           |
| D. | $81\mu\text{C}$                           | $18\mu\text{C}$                           |

26 - (PHYSI/11\_HL\_Summer\_2019\_Q37) - *Electromagnetic Induction (ahl), Electricity & Magnetism*

The circuit diagram shows a capacitor that is charged by the battery after the switch is connected to terminal X. The cell has emf  $V$  and internal resistance  $r$ . After the switch is connected to terminal Y the capacitor discharges through the resistor of resistance  $R$ .



What is the nature of the current and magnitude of the initial current in the resistor after the switch is connected to terminal Y?

|    | Nature of current | Magnitude of initial current |
|----|-------------------|------------------------------|
| A. | increasing        | $\frac{V}{R}$                |
| B. | increasing        | $\frac{V}{R+r}$              |
| C. | decreasing        | $\frac{V}{R}$                |
| D. | decreasing        | $\frac{V}{R+r}$              |

27 - (PHYSI/12\_HL\_Summer\_2019\_Q27) - *Electromagnetic Induction (ahl), Electricity & Magnetism*

Three identical capacitors are connected in series. The total capacitance of the arrangement is  $\frac{1}{9}$  mF. The three capacitors are then connected in parallel. What is the capacitance of the parallel arrangement?

- A.  $\frac{1}{3}$  mF  
 B. 1 mF  
 C. 3 mF  
 D. 81 mF

28 – (PHYSI/12\_HL\_Summer\_2019\_Q28) – Electricity & Magnetism, Electromagnetic Induction (ahl)



A transformer with 600 turns in the primary coil is used to change an alternating root mean square (rms) potential difference of  $240\text{ V}_{\text{rms}}$  to  $12\text{ V}_{\text{rms}}$ .

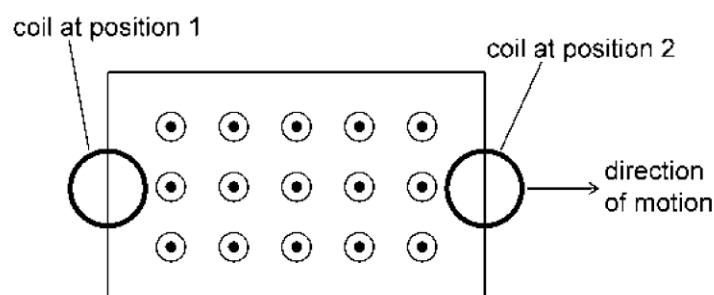
When connected to the secondary coil, a lamp labelled “120 W, 12 V” lights normally. The current in the primary coil is 0.60 A when the lamp is lit.

What are the number of secondary turns and the efficiency of the transformer?

|    | Number of secondary turns | Efficiency |
|----|---------------------------|------------|
| A. | 12000                     | 99 %       |
| B. | 30                        | 99 %       |
| C. | 12000                     | 83 %       |
| D. | 30                        | 83 %       |

29 – (PHYSI/12\_HL\_Summer\_2019\_Q29) – Electricity & Magnetism, Electromagnetic Induction (ahl)

A circular coil of wire moves through a region of uniform magnetic field directed out of the page.

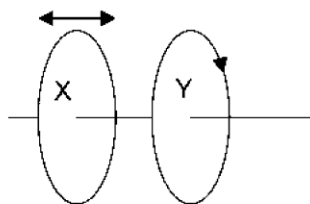


What is the direction of the induced conventional current in the coil for the marked positions?

|    | Position 1       | Position 2       |
|----|------------------|------------------|
| A. | clockwise        | clockwise        |
| B. | counterclockwise | clockwise        |
| C. | clockwise        | counterclockwise |
| D. | counterclockwise | counterclockwise |

30 – (PHYSI/10\_HL\_Winter\_2019\_Q33) – *Electromagnetic Induction (ahl)*

X and Y are two plane coils parallel to each other that have a common axis. There is a constant direct current in Y.

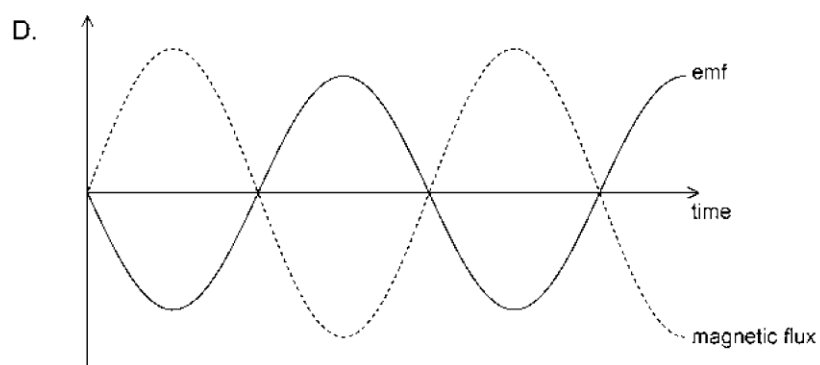
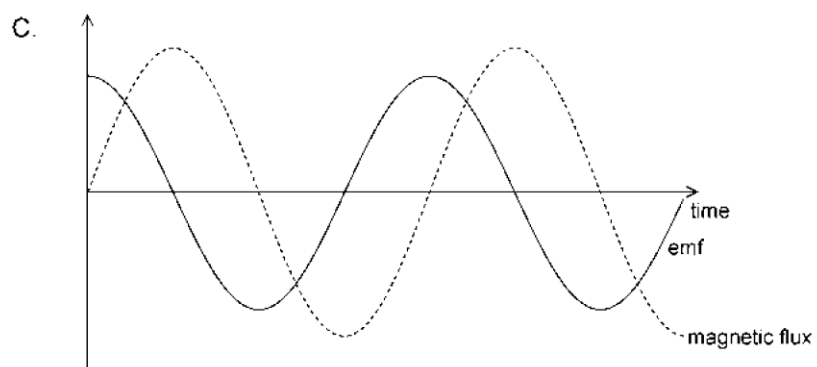
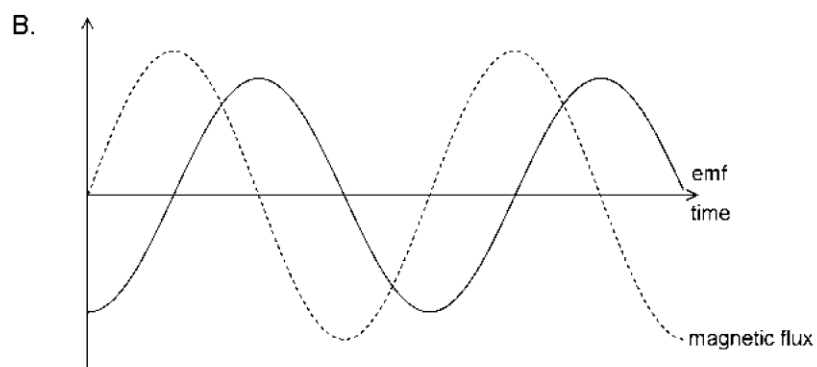
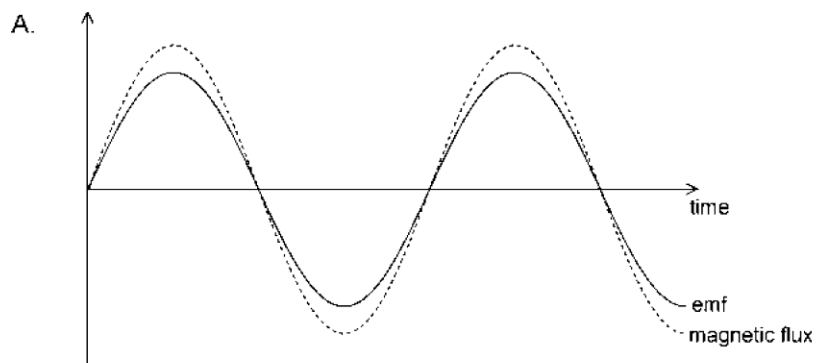


X is first moved towards Y and later is moved away from Y. What, as X moves, is the direction of the current in X relative to that in Y?

|    | Current direction in X<br>as X moves towards Y | Current direction in X<br>as X moves away from Y |
|----|------------------------------------------------|--------------------------------------------------|
| A. | same direction as in Y                         | same direction as in Y                           |
| B. | same direction as in Y                         | opposite direction to Y                          |
| C. | opposite direction to Y                        | same direction as in Y                           |
| D. | opposite direction to Y                        | opposite direction to Y                          |

31 - (PHYSI/10\_HL\_Winter\_2019\_Q34) - *Electromagnetic Induction (ahl)*

A coil is rotated in a uniform magnetic field. An alternating emf is induced in the coil. What is a possible phase relationship between the magnetic flux through the coil and the induced emf in the coil when the variations of both quantities are plotted with time?



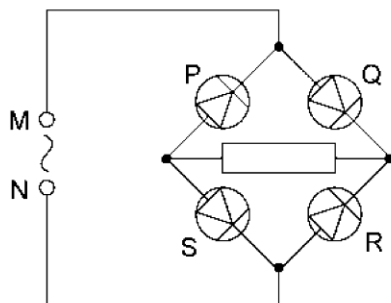
32 - (PHYSI/10\_HL\_Winter\_2019\_Q35) - *Electromagnetic Induction (ahl)*

A capacitor of capacitance  $1.0\mu\text{F}$  stores a charge of  $15\mu\text{C}$ . The capacitor is discharged through a  $25\Omega$  resistor. What is the maximum current in the resistor?

- A. 0.60 mA
- B. 1.7 mA
- C. 0.60 A
- D. 1.7 A

33 - (PHYSI/10\_HL\_Winter\_2019\_Q36) - *Electromagnetic Induction (ahl)*

A diode bridge rectification circuit is constructed as shown. An alternating potential difference is applied between M and N.



Three statements about circuits are

- I. when diode P conducts, Q does not conduct
- II. when diode S conducts, neither P nor R conducts
- III. the direction of conventional current in the resistor is from left to right.

Which statements are correct for this circuit?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

34 - (PHYSI/10\_HL\_Winter\_2020\_Q33) - *Electromagnetic Induction (ahl)*

Why are high voltages and low currents used when electricity is transmitted over long distances?

- A. Cables can be closer to the ground.
- B. Electrons have a greater drift speed.
- C. Energy losses are reduced.
- D. Resistance of the power lines is reduced.

35 - (PHYSI/10\_HL\_Winter\_2020\_Q34) - *Electromagnetic Induction (ahl)*

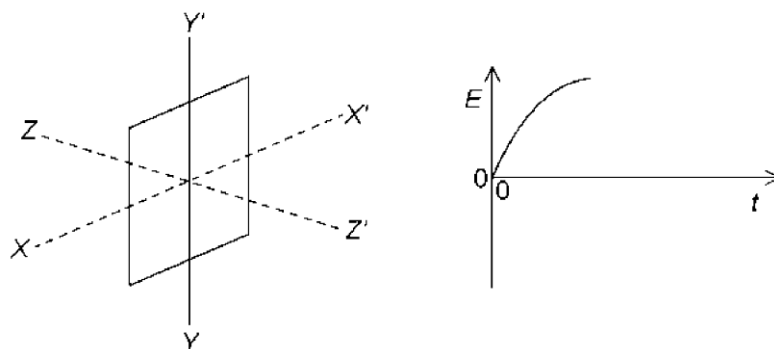
Power  $P$  is dissipated in a resistor of resistance  $R$  when there is a direct current  $I$  in the resistor.

What is the average power dissipation in a resistance  $\frac{R}{2}$  when the alternating root-mean-square (rms) current in the resistor is  $2I$ ?

- A.  $P$
- B.  $2P$
- C.  $4P$
- D.  $8P$

36 - (PHYSI/10\_HL\_Winter\_2020\_Q35) - *Electromagnetic Induction (ahl)*

A rectangular coil rotates at a constant angular velocity. At the instant shown, the plane of the coil is at right angles to the line  $ZZ'$ . A uniform magnetic field acts in the direction  $ZZ'$ .



What rotation of the coil about a specified axis will produce the graph of electromotive force (emf)  $E$  against time  $t$ ?

- A. Through  $\frac{\pi}{2}$  about  $ZZ'$
- B. Through  $\pi$  about  $YY'$
- C. Through  $\frac{\pi}{2}$  about  $XX'$
- D. Through  $\pi$  about  $XX'$



37 - (PHYSI/10\_HL\_Winter\_2020\_Q36) - *Electromagnetic Induction (ahl)*

A capacitor of capacitance  $C$  has initial charge  $Q$ . The capacitor is discharged through a resistor of resistance  $R$ . The potential difference  $V$  across the capacitor varies with time.

What is true for this capacitor?

- A. After time  $\frac{RC}{2}$  the potential difference across the capacitor is halved.
- B. The capacitor discharges more quickly when the resistance is changed to  $2R$ .
- C. The rate of change of charge on the capacitor is proportional to  $V$ .
- D. The time for the capacitor to lose half its charge is  $\frac{\ln 2}{RC}$ .

38 - (PHYSI/11\_HL\_Summer\_2021\_Q33) - *Electromagnetic Induction (ahl)*

A conducting ring encloses an area of  $2.0 \text{ cm}^2$  and is perpendicular to a magnetic field of strength  $5.0 \text{ mT}$ . The direction of the magnetic field is reversed in a time  $4.0 \text{ s}$ . What is the average emf induced in the ring?

- A. 0
- B.  $0.25 \mu\text{V}$
- C.  $0.40 \mu\text{V}$
- D.  $0.50 \mu\text{V}$

39 - (PHYSI/11\_HL\_Summer\_2021\_Q34) - *Electromagnetic Induction (ahl)*

The conservation of which quantity explains Lenz's law?

- A. Charge
- B. Energy
- C. Magnetic field
- D. Mass

40 - (PHYSI/11\_HL\_Summer\_2021\_Q35) - *Electromagnetic Induction (ahl)*

A resistor designed for use in a direct current (dc) circuit is labelled “50 W,  $2\ \Omega$ ”. The resistor is connected in series with an alternating current (ac) power supply of peak potential difference 10 V. What is the average power dissipated by the resistor in the ac circuit?

- A. 25 W
- B. 35 W
- C. 50 W
- D. 100 W

41 - (PHYSI/11\_HL\_Summer\_2021\_Q36) - *Electromagnetic Induction (ahl)*

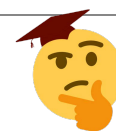
A capacitor of capacitance  $X$  is connected to a power supply of voltage  $V$ . At time  $t = 0$ , the capacitor is disconnected from the supply and discharged through a resistor of resistance  $R$ . What is the variation with time of the charge on the capacitor?

- A.  $\frac{X}{V} e^{-Rt/X}$
- B.  $\frac{X}{V} e^{-t/RX}$
- C.  $XVe^{-Rt/X}$
- D.  $XVe^{-t/RX}$

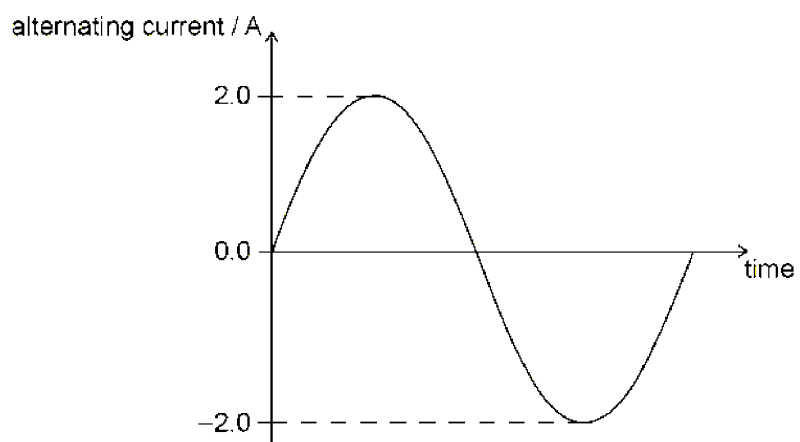
42 - (PHYSI/12\_HL\_Summer\_2021\_Q33) - *Electromagnetic Induction (ahl)*

A parallel-plate capacitor is connected to a cell of constant emf. The capacitor plates are then moved closer together without disconnecting the cell. What are the changes in the capacitance of the capacitor and the energy stored in the capacitor?

|    | Capacitance | Energy    |
|----|-------------|-----------|
| A. | increases   | increases |
| B. | increases   | decreases |
| C. | decreases   | decreases |
| D. | decreases   | increases |

43 - (PHYSI/12\_HL\_Summer\_2021\_Q34) - *Electromagnetic Induction (ahl)*

The graph shows the variation of an alternating current with time in a  $4.0\,\Omega$  resistor.

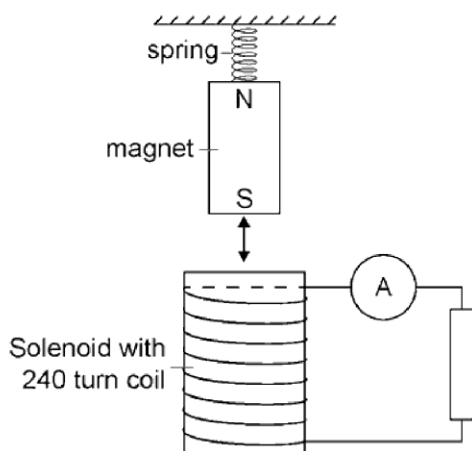


What is the average power dissipated in the resistor?

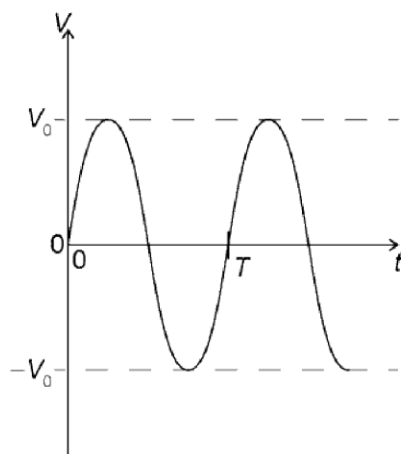
- A. 4 W
- B. 8 W
- C. 16 W
- D. 32 W

44 - (PHYSI/12\_HL\_Summer\_2021\_Q35) - *Electromagnetic Induction (ahl)*

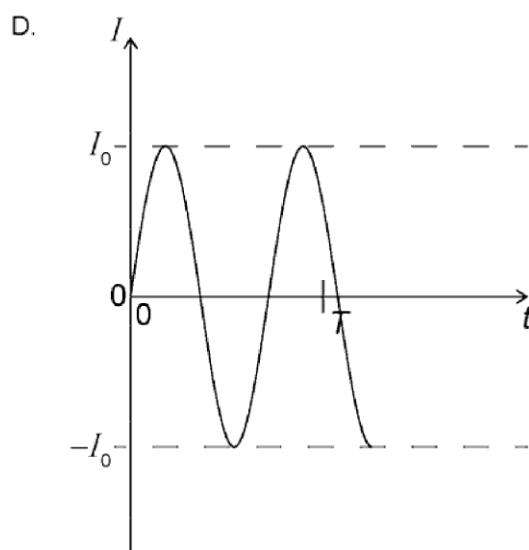
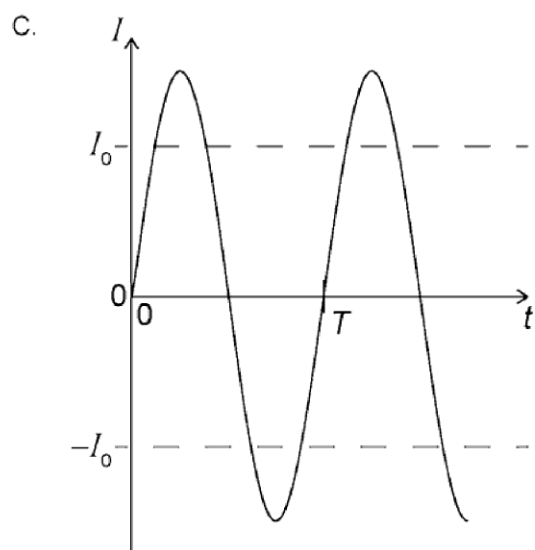
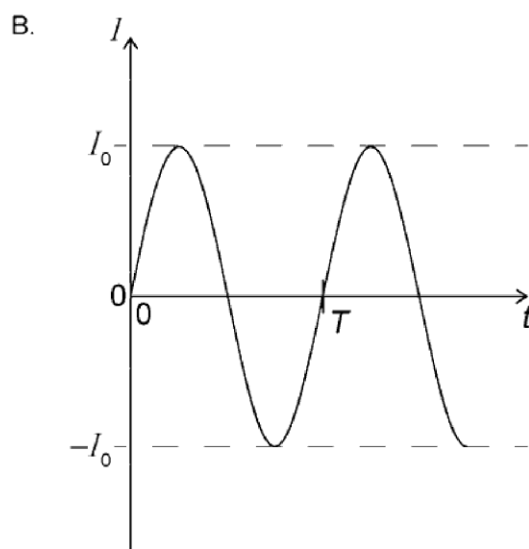
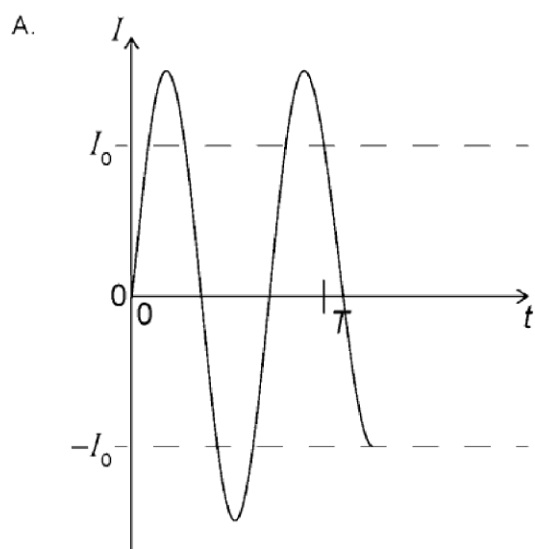
A magnet connected to a spring oscillates above a solenoid with a 240 turn coil as shown.



The graph below shows the variation with time  $t$  of the emf across the solenoid with the period,  $T$ , of the system shown.

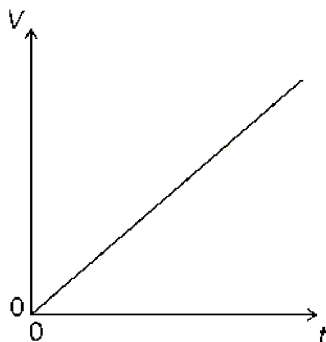


The spring is replaced with one that allows the magnet to oscillate with a higher frequency. Which graph shows the new variation with time  $t$  of the current  $I$  in the resistor for this new set-up?



45 – (PHYSI/12\_HL\_Summer\_2021\_Q36) – *Electromagnetic Induction (ahl)*

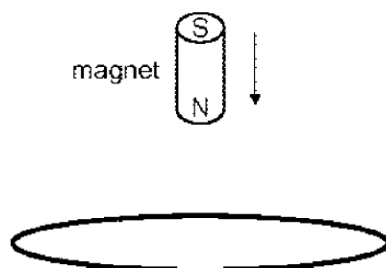
A capacitor is charged with a constant current  $I$ . The graph shows the variation of potential difference  $V$  across the capacitor with time  $t$ . The gradient of the graph is  $G$ . What is the capacitance of the capacitor?



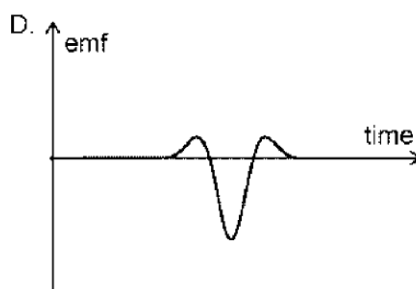
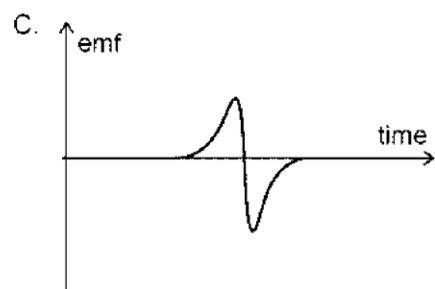
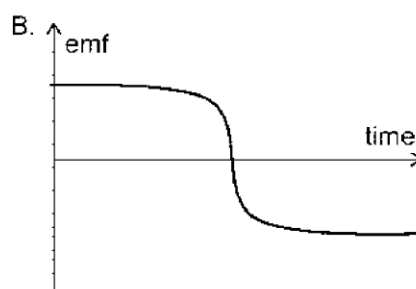
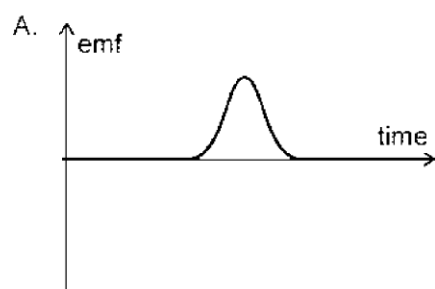
- A.  $\frac{I}{G}$
- B.  $\frac{G}{I}$
- C.  $G \times I$
- D.  $\frac{1}{G \times I}$

46 – (PHYSI/10\_HL\_Winter\_2021\_Q33) – *Electromagnetic Induction (ahl)*

A small magnet is released from rest to drop through a stationary horizontal conducting ring.

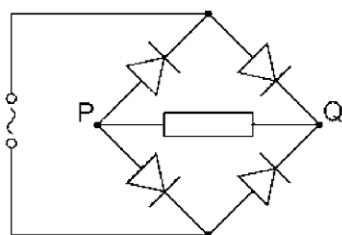


What is the variation with time of the emf induced in the ring?



47 - (PHYSI/10\_HL\_Winter\_2021\_Q34) - *Electromagnetic Induction (ahl)*

An alternating supply is connected to a diode bridge rectification circuit.



The conventional current in the load resistor

- A. is a maximum twice during one oscillation of the input voltage.
- B. is never zero.
- C. has a zero average value during one oscillation of the input voltage.
- D. can only flow from P to Q.

48 - (PHYSI/10\_HL\_Winter\_2021\_Q35) - *Electromagnetic Induction (ahl)*

The root mean square (rms) current in the primary coil of an ideal transformer is 2.0 A. The rms voltage in the secondary coil is 50 V. The average power transferred from the secondary coil is 20 W.

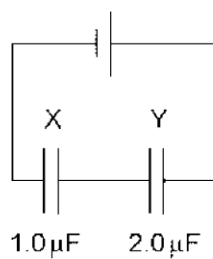
What is  $\frac{N_p}{N_s}$  and what is the average power transferred from the primary coil?

|    | $\frac{N_p}{N_s}$ | Average power transferred from the primary coil / W |
|----|-------------------|-----------------------------------------------------|
| A. | $\frac{1}{5}$     | 4.0                                                 |
| B. | 5                 | 20                                                  |
| C. | $\frac{1}{5}$     | 20                                                  |
| D. | 5                 | 100                                                 |



49 – (PHYSI/10\_HL\_Winter\_2021\_Q36) – *Electromagnetic Induction (ahl)*

Two initially uncharged capacitors X and Y are connected in series to a cell as shown.

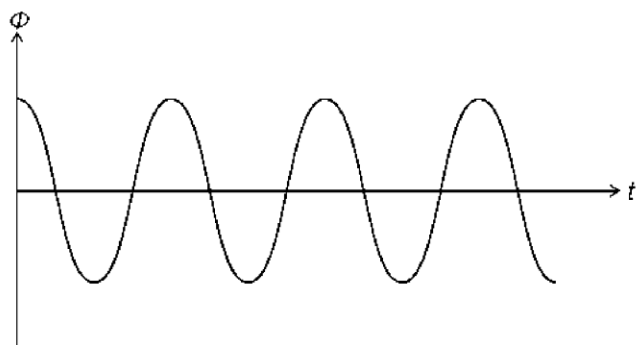


What is  $\frac{\text{voltage across X}}{\text{voltage across Y}}$ ?

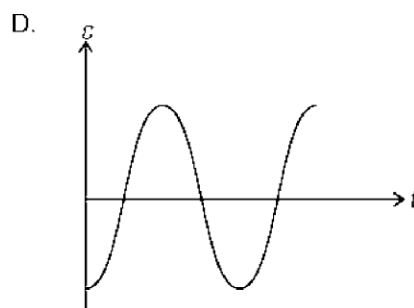
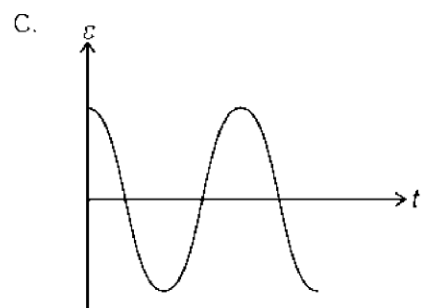
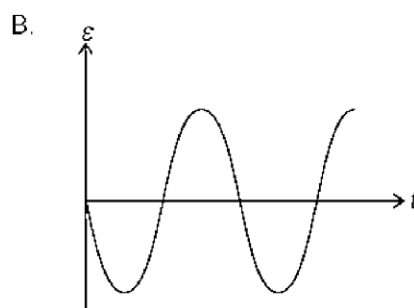
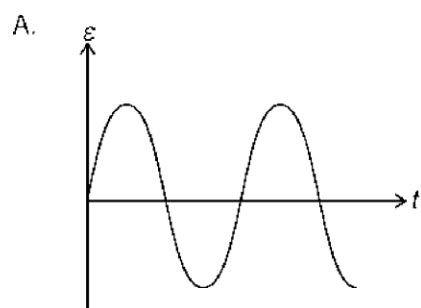
- A.  $\frac{1}{2}$
- B. 1
- C. 2
- D. 4

50 - (PHYSI/11\_HL\_Summer\_2022\_Q34) - *Electromagnetic Induction (ahl)*

The graph shows the variation of magnetic flux  $\Phi$  in a coil with time  $t$ .

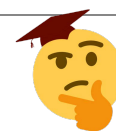


What represents the variation with time of the induced emf  $\varepsilon$  across the coil?

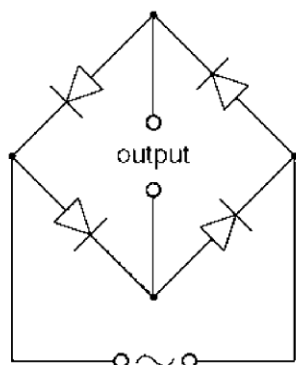
51 - (PHYSI/11\_HL\_Summer\_2022\_Q35) - *Electromagnetic Induction (ahl)*

A direct current  $I$  in a lamp dissipates power  $P$ . What root mean square (rms) value of an alternating current dissipates average power  $P$  through the same lamp?

- A.  $\frac{I}{2}$
- B.  $\frac{I}{\sqrt{2}}$
- C.  $I$
- D.  $I\sqrt{2}$

52 - (PHYSI/11\_HL\_Summer\_2022\_Q36) - *Electromagnetic Induction (ahl)*

The arrangement shows four diodes connected to an alternating current (ac) supply. The output is connected to an external circuit.

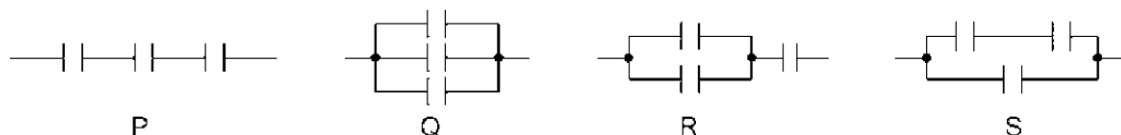


What is the output to the external circuit?

- A. Full-wave rectified current
- B. Half-wave rectified current
- C. Constant non-zero current
- D. Zero current

53 - (PHYSI/11\_HL\_Summer\_2022\_Q37) - *Electromagnetic Induction (ahl)*

Three identical capacitors are connected together as shown.

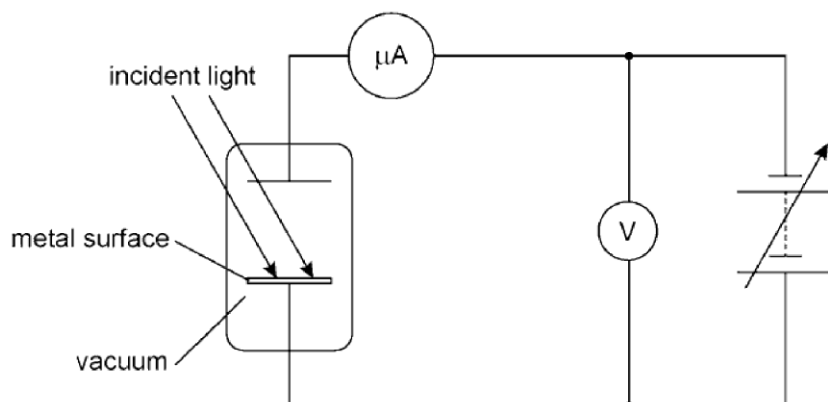


What is the order of increasing total capacitance for these arrangements?

- A. P, S, R, Q
- B. Q, R, S, P
- C. P, R, S, Q
- D. Q, S, R, P

54 - (PHYSI/11\_HL\_Summer\_2022\_Q38) - *Electromagnetic Induction (ahl)*

Light with photons of energy  $8.0 \times 10^{-20} \text{ J}$  are incident on a metal surface in a photoelectric experiment.



The work function of the metal surface is  $4.8 \times 10^{-20} \text{ J}$ . What minimum voltage is required for the ammeter reading to fall to zero?

- A. 0.2 V
- B. 0.3 V
- C. 0.5 V
- D. 0.8 V

55 - (PHYSI/12\_HL\_Summer\_2022\_Q34) - *Electromagnetic Induction (ahl)*

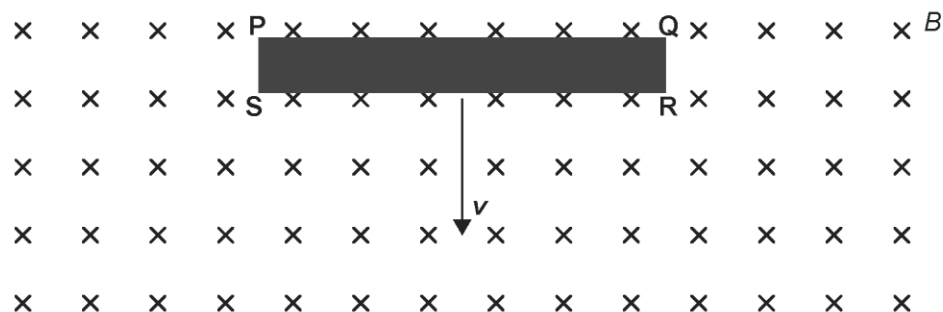
Which two features are necessary for the operation of a transformer?

|    | Feature one                                               | Feature two                  |
|----|-----------------------------------------------------------|------------------------------|
| A. | electrical connection between primary and secondary coils | input of alternating current |
| B. | magnetic interaction between primary and secondary coils  | input of alternating current |
| C. | electrical connection between primary and secondary coils | input of direct current      |
| D. | magnetic interaction between primary and secondary coils  | input of direct current      |

56 - (PHYSI/12\_HL\_Summer\_2022\_Q35) - Electromagnetic Induction (ahl)



A conducting bar with vertices PQRS is moving vertically downwards with constant velocity  $v$  through a horizontal magnetic field  $B$  that is directed into the plane of the page.

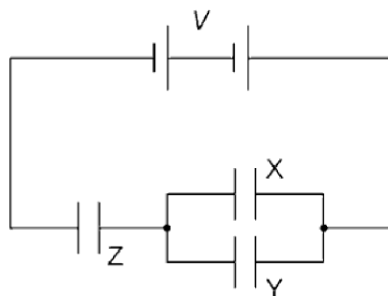


Which side of the bar will have the greatest density of electrons?

- A. PQ
- B. QR
- C. RS
- D. SP

57 - (PHYSI/12\_HL\_Summer\_2022\_Q36) - Electromagnetic Induction (ahl)

A circuit consists of three identical capacitors of capacitance  $C$  and a battery of voltage  $V$ . Two capacitors are connected in parallel with a third in series. The capacitors are fully charged.



What is the charge stored in capacitors X and Z?

|    | Charge stored in capacitor Z | Charge stored in capacitor X |
|----|------------------------------|------------------------------|
| A. | $\frac{CV}{3}$               | $\frac{CV}{3}$               |
| B. | $\frac{CV}{3}$               | $\frac{2CV}{3}$              |
| C. | $\frac{2CV}{3}$              | $\frac{CV}{3}$               |
| D. | $\frac{2CV}{3}$              | $\frac{2CV}{3}$              |

58 - (PHYSI/12\_HL\_Summer\_2022\_Q37) - *Electromagnetic Induction (ahl)*

Three correct statements about the behaviour of electrons are:

- I. An electron beam is used to investigate the structure of crystals.
- II. An electron beam produces a pattern of fringes when sent through two narrow parallel slits.
- III. Electromagnetic radiation ejects electrons from the surface of a metal.

Which statements are explained using the wave-like properties of electrons?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

59 - (PHYSI/12\_HL\_Summer\_2022\_Q38) - *Electromagnetic Induction (ahl)*

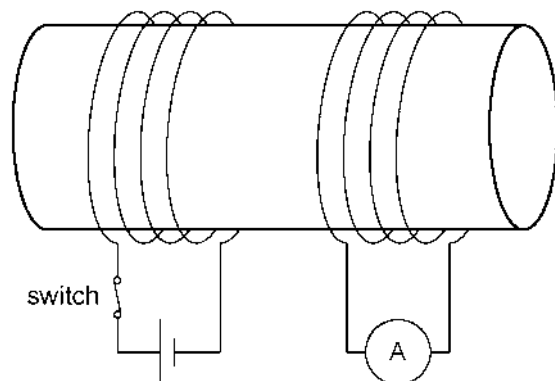
Samples of two radioactive nuclides X and Y are held in a container. The number of particles of X is half the number of particles of Y. The half-life of X is twice the half-life of Y.

What is the initial value of  $\frac{\text{activity of radioisotope X}}{\text{activity of radioisotope Y}}$ ?

- A.  $\frac{1}{4}$
- B.  $\frac{1}{2}$
- C. 1
- D. 4

60 – (PHYSI/10\_HL\_Winter\_2022\_Q34) – *Electromagnetic Induction (ahl)*

Two coils of wire are wound around an iron cylinder. One coil is connected in a circuit with a cell and a switch that is initially closed. The other coil is connected to an ammeter. The switch is opened at time  $t_0$ .



What is the ammeter reading before  $t_0$  and what is the ammeter reading after  $t_0$ ?

|    | Ammeter reading before $t_0$ | Ammeter reading after $t_0$       |
|----|------------------------------|-----------------------------------|
| A. | zero                         | a peak of current falling to zero |
| B. | zero                         | zero                              |
| C. | non zero                     | a peak of current falling to zero |
| D. | non-zero                     | zero                              |

61 – (PHYSI/10\_HL\_Winter\_2022\_Q35) – *Electromagnetic Induction (ahl)*

What is the purpose of using a step-up transformer at a power station?

- A. To step up the current to decrease the energy losses
- B. To step up the current to decrease the power transmitted
- C. To step up the voltage to decrease the energy losses
- D. To step up the voltage to decrease the power transmitted

62 – (PHYSI/10\_HL\_Winter\_2022\_Q36) – *Electromagnetic Induction (ahl)*

A student states three facts about the time constant of a resistor-capacitor series circuit.

- I. It is the time required for the capacitor to be charged through the resistor to a voltage of  $0.632 V$  from an initial value of zero, where  $V$  is the voltage of the source.
- II. It is the time required for the capacitor to be discharged through the resistor to a voltage of  $0.632 V$ , where  $V$  is the initial voltage of the capacitor.
- III. It is the product of the resistance of the resistor and the capacitance of the capacitor.

Which statements are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III



1 - (PHYSI/11\_HL\_Summer\_2017\_Q37) - Quantum &amp; Nuclear Physics (ahl)



The diameter of a silver-108 ( $^{108}_{47}\text{Ag}$ ) nucleus is approximately three times that of the diameter of a nucleus of

- A.  $^4_2\text{He}$ .
- B.  $^7_3\text{Li}$ .
- C.  $^{11}_5\text{B}$ .
- D.  $^{20}_{10}\text{Ne}$ .

2 - (PHYSI/11\_HL\_Summer\_2017\_Q38) - Quantum &amp; Nuclear Physics (ahl)

What can be used to calculate the probability of finding an electron in a particular region of space?

- A.  $\frac{\text{Planck's constant}}{4\pi \times \text{uncertainty in energy}}$
- B.  $\frac{\text{Planck's constant}}{4\pi \times \text{uncertainty in speed}}$
- C. The magnitude of the wave function
- D. The magnitude of the (wave function)<sup>2</sup>

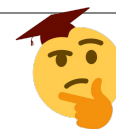
3 - (PHYSI/11\_HL\_Summer\_2017\_Q39) - Quantum &amp; Nuclear Physics (ahl)

A photon of energy  $E$  and wavelength  $\lambda$  is scattered from an electron initially at rest.

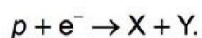
What is the energy of the photon and the wavelength of the photon when the electron moves away?

|    | Energy of photon | Wavelength of photon   |
|----|------------------|------------------------|
| A. | greater than $E$ | less than $\lambda$    |
| B. | less than $E$    | less than $\lambda$    |
| C. | greater than $E$ | greater than $\lambda$ |
| D. | less than $E$    | greater than $\lambda$ |

4 - (PHYSI/11\_HL\_Summer\_2017\_Q40) - Quantum &amp; Nuclear Physics (ahl)



Electron capture can be represented by the equation



What are X and Y?

|    | X        | Y                     |
|----|----------|-----------------------|
| A. | proton   | positron              |
| B. | electron | positron              |
| C. | neutron  | electron antineutrino |
| D. | neutron  | electron neutrino     |

5 - (PHYSI/12\_HL\_Summer\_2017\_Q37) - Quantum &amp; Nuclear Physics (ahl)

When monochromatic light is incident on a metallic surface, electrons are emitted from the surface. The following changes are considered.

- I. Increase the intensity of the incident light
- II. Increase the frequency of light
- III. Decrease the work function of the surface

Which changes will result in electrons of greater energy being emitted from the surface?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

6 - (PHYSI/12\_HL\_Summer\_2017\_Q38) - Quantum &amp; Nuclear Physics (ahl)



In the Bohr model for hydrogen an electron in the ground state has orbit radius  $r$  and speed  $v$ . In the first excited state the electron has orbit radius  $4r$ . What is the speed of the electron in the first excited state?

A.  $\frac{v}{2}$

B.  $\frac{v}{4}$

C.  $\frac{v}{8}$

D.  $\frac{v}{16}$

7 - (PHYSI/12\_HL\_Summer\_2017\_Q39) - Quantum &amp; Nuclear Physics (ahl)

A neutron of mass  $m$  is confined within a nucleus of diameter  $d$ . Ignoring numerical constants, what is an approximate expression for the kinetic energy of the neutron?

A.  $\frac{h^2}{md^2}$

B.  $\frac{h}{md}$

C.  $\frac{mh^2}{d^2}$

D.  $\frac{h}{m^2d}$

8 - (PHYSI/12\_HL\_Summer\_2017\_Q40) - Quantum &amp; Nuclear Physics (ahl)

A radioactive element has decay constant  $\lambda$  (expressed in  $\text{s}^{-1}$ ). The number of nuclei of this element at  $t=0$  is  $N$ . What is the expected number of nuclei that will have decayed after 1 s?

A.  $N(1 - e^{-\lambda})$

B.  $\frac{N}{\lambda}$

C.  $Ne^{-\lambda}$

D.  $\lambda N$



9 - (PHYSI/10\_HL\_Winter\_2017\_Q39) - *Quantum & Nuclear Physics (ahl)*

Monochromatic electromagnetic radiation is incident on a metal surface. The kinetic energy of the electrons released from the metal

- A. is constant because the photons have a constant energy.
- B. is constant because the metal has a constant work function.
- C. varies because the electrons are not equally bound to the metal lattice.
- D. varies because the work function of the metal is different for different electrons.

10 - (PHYSI/10\_HL\_Winter\_2017\_Q40) - *Quantum & Nuclear Physics (ahl)*

A photon interacts with a nearby nucleus to produce an electron. What is the name of this process?

- A. Pair annihilation
- B. Pair production
- C. Electron diffraction
- D. Quantum tunnelling

11 - (PHYSI/11\_HL\_Summer\_2018\_Q37) - *Quantum & Nuclear Physics (ahl)*

Two radioactive nuclides, X and Y, have half-lives of 50s and 100s respectively. At time  $t = 0$  samples of X and Y contain the same number of nuclei.

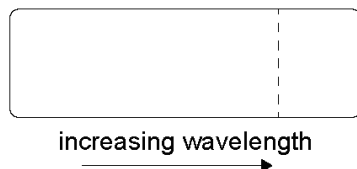
What is  $\frac{\text{number of nuclei of X undecayed}}{\text{number of nuclei of Y undecayed}}$  when  $t = 200\text{s}$ ?

- A. 4
- B. 2
- C.  $\frac{1}{2}$
- D.  $\frac{1}{4}$

12 - (PHYSI/11\_HL\_Summer\_2018\_Q38) - Quantum &amp; Nuclear Physics (ahl)



According to the Bohr model for hydrogen, visible light is emitted when electrons make transitions from excited states down to the state with  $n = 2$ . The dotted line in the following diagram represents the transition from  $n = 3$  to  $n = 2$  in the spectrum of hydrogen.



Which of the following diagrams could represent the visible light emission spectrum of hydrogen?

A.

B.

C.

D.

13 - (PHYSI/11\_HL\_Summer\_2018\_Q39) - Quantum &amp; Nuclear Physics (ahl)

A particle of fixed energy is close to a potential barrier.

Which changes to the width of the barrier and to the height of the barrier will always make the tunnelling probability greater?

|    | Width of the barrier | Height of the barrier |
|----|----------------------|-----------------------|
| A. | increase             | increase              |
| B. | increase             | decrease              |
| C. | decrease             | increase              |
| D. | decrease             | decrease              |

14 - (PHYSI/11\_HL\_Summer\_2018\_Q40) - Quantum &amp; Nuclear Physics (ahl)



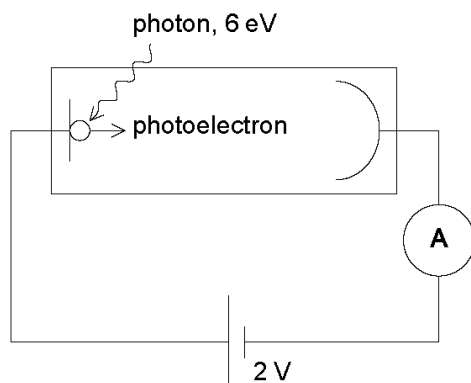
Alpha particles with energy  $E$  are directed at nuclei with atomic number  $Z$ . Small deviations from the predictions of the Rutherford scattering model are observed.

Which change in  $E$  and which change in  $Z$  is most likely to result in greater deviations from the Rutherford scattering model?

|    | <b>E</b> | <b>Z</b> |
|----|----------|----------|
| A. | increase | increase |
| B. | increase | decrease |
| C. | decrease | increase |
| D. | decrease | decrease |

15 - (PHYSI/12\_HL\_Summer\_2018\_Q37) - Quantum &amp; Nuclear Physics (ahl)

A photoelectric cell is connected in series with a battery of emf 2 V. Photons of energy 6 eV are incident on the cathode of the photoelectric cell. The work function of the surface of the cathode is 3 eV.



What is the maximum kinetic energy of the photoelectrons that reach the anode?

- A. 1 eV
- B. 3 eV
- C. 5 eV
- D. 8 eV



16 - (PHYSI/12\_HL\_Summer\_2018\_Q38) - *Quantum & Nuclear Physics (ahl)*

Which of the following is evidence for the wave nature of the electron?

- A. Continuous energy spectrum in  $\beta^-$  decay
- B. Electron diffraction from crystals
- C. Existence of atomic energy levels
- D. Existence of nuclear energy levels

17 - (PHYSI/12\_HL\_Summer\_2018\_Q39) - *Quantum & Nuclear Physics (ahl)*

An electron of initial energy  $E$  tunnels through a potential barrier. What is the energy of the electron after tunnelling?

- A. greater than  $E$
- B.  $E$
- C. less than  $E$
- D. zero

18 - (PHYSI/12\_HL\_Summer\_2018\_Q40) - *Quantum & Nuclear Physics (ahl)*

Two samples X and Y of different radioactive isotopes have the same initial activity. Sample X has twice the number of atoms as sample Y. The half-life of X is  $T$ . What is the half-life of Y?

- A.  $2T$
- B.  $T$
- C.  $\frac{T}{2}$
- D.  $\frac{T}{4}$

19 - (PHYSI/10\_HL\_Winter\_2018\_Q37) - *Quantum & Nuclear Physics (ahl)*

When green light is incident on a clean zinc plate no photoelectrons are emitted. What change may cause the emission of photoelectrons?

- A. Using a metal plate with larger work function
- B. Changing the angle of incidence of the green light on the zinc plate
- C. Using shorter wavelength radiation
- D. Increasing the intensity of the green light

20 - (PHYSI/11\_HL\_Summer\_2019\_Q38) - Quantum &amp; Nuclear Physics (ahl)



A metallic surface is first irradiated with infrared radiation and photoelectrons are emitted from the surface. The infrared radiation is replaced by ultraviolet radiation of the same intensity.

What will be the change in the kinetic energy of the photoelectrons and the rate at which they are ejected?

|    | Kinetic energy of photoelectrons | Rate of ejected photoelectrons |
|----|----------------------------------|--------------------------------|
| A. | increase                         | decrease                       |
| B. | decrease                         | decrease                       |
| C. | increase                         | constant                       |
| D. | decrease                         | constant                       |

21 - (PHYSI/11\_HL\_Summer\_2019\_Q39) - Quantum &amp; Nuclear Physics (ahl)

The half-life of a radioactive nuclide is 8.0 s. The initial activity of a pure sample of the nuclide is 10000 Bq. What is the approximate activity of the sample after 4.0 s?

- A. 2500 Bq
- B. 5000 Bq
- C. 7100 Bq
- D. 7500 Bq

22 - (PHYSI/11\_HL\_Summer\_2019\_Q40) - Quantum &amp; Nuclear Physics (ahl)

A particle is confined within a nucleus. What is the order of magnitude of the uncertainty in the momentum of the particle?

- A.  $10^{-10}$  N s
- B.  $10^{-15}$  N s
- C.  $10^{-20}$  N s
- D.  $10^{-25}$  N s



23 - (PHYSI/12\_HL\_Summer\_2019\_Q33) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)



A radioactive nuclide with atomic number  $Z$  undergoes a process of beta-plus ( $\beta^+$ ) decay. What is the atomic number for the nuclide produced and what is another particle emitted during the decay?

|    | Atomic number | Particle      |
|----|---------------|---------------|
| A. | $Z - 1$       | neutrino      |
| B. | $Z + 1$       | neutrino      |
| C. | $Z - 1$       | anti-neutrino |
| D. | $Z + 1$       | anti-neutrino |

24 - (PHYSI/12\_HL\_Summer\_2019\_Q34) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)

The  $\pi^+$  meson contains an up ( $u$ ) quark. What is the quark structure of the  $\pi^-$  meson?

- A.  $ud$
- B.  $u\bar{d}$
- C.  $\bar{u}d$
- D.  $\bar{u}\bar{d}$

25 - (PHYSI/12\_HL\_Summer\_2019\_Q35) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)

Three conservation laws in nuclear reactions are

- I. conservation of charge
- II. conservation of baryon number
- III. conservation of lepton number.

The reaction

$$n \rightarrow \pi^- + e^+ + \bar{\nu}_e$$

is proposed.

Which conservation laws are violated in the proposed reaction?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

26 - (PHYSI/12\_HL\_Summer\_2019\_Q36) - Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)



A neutron collides head-on with a stationary atom in the moderator of a nuclear power station. The kinetic energy of the neutron changes as a result. There is also a change in the probability that this neutron can cause nuclear fission.

What are these changes?

|    | Change in kinetic energy of the neutron | Change in probability of causing nuclear fission |
|----|-----------------------------------------|--------------------------------------------------|
| A. | increase                                | increase                                         |
| B. | decrease                                | increase                                         |
| C. | increase                                | decrease                                         |
| D. | decrease                                | decrease                                         |

27 - (PHYSI/12\_HL\_Summer\_2019\_Q38) - Quantum &amp; Nuclear Physics (ahl)

Photons of a certain frequency incident on a metal surface cause the emission of electrons from the surface. The intensity of the light is constant and the frequency of photons is increased. What is the effect, if any, on the number of emitted electrons and the energy of emitted electrons?

|    | Number of emitted electrons | Energy of emitted electrons |
|----|-----------------------------|-----------------------------|
| A. | no change                   | no change                   |
| B. | decrease                    | increase                    |
| C. | decrease                    | no change                   |
| D. | no change                   | increase                    |

28 - (PHYSI/12\_HL\_Summer\_2019\_Q39) - Quantum &amp; Nuclear Physics (ahl)

Three possible features of an atomic model are

- I. orbital radius
- II. quantized energy
- III. quantized angular momentum.

Which of these are features of the Bohr model for hydrogen?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II, and III



29 - (PHYSI/12\_HL\_Summer\_2019\_Q40) - *Atomic, nuclear & Particle Physics, Quantum & Nuclear Physics (ahl)*

Photons of discrete energy are emitted during gamma decay. This is evidence for

- A. atomic energy levels.
- B. nuclear energy levels.
- C. pair annihilation.
- D. quantum tunneling.

30 - (PHYSI/10\_HL\_Winter\_2019\_Q37) - *Quantum & Nuclear Physics (ahl)*

An electron of low energy is enclosed within a high potential barrier. What is the process by which the electron can escape?

- A. Quantum tunneling
- B. Energy–mass conversion
- C. Diffraction
- D. Barrier climbing

31 - (PHYSI/10\_HL\_Winter\_2019\_Q38) - *Quantum & Nuclear Physics (ahl)*

A beam of monochromatic radiation is made up of photons each of momentum  $p$ . The intensity of the beam is doubled without changing frequency. What is the momentum of each photon after the change?

- A.  $\frac{p}{2}$
- B.  $p$
- C.  $2p$
- D.  $4p$

32 - (PHYSI/10\_HL\_Winter\_2019\_Q39) - *Quantum & Nuclear Physics (ahl)*

Three observations of the behaviour of electrons are

- I. electron emission as a result of the photoelectric effect
- II. electron diffraction as an electron interacts with an atom
- III. emission of radio waves as a result of electrons oscillating in a conductor.

Which observations are evidence that the electron behaves as a particle?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

33 - (PHYSI/10\_HL\_Winter\_2019\_Q40) - Atomic, nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)



A pure sample of a radioactive nuclide contains  $N_0$  atoms at time  $t = 0$ . At time  $t$ , there are  $N$  atoms of the nuclide remaining in the sample. The half-life of the nuclide is  $t_{\frac{1}{2}}$ .

What is the decay rate of this sample proportional to?

- A.  $N$
- B.  $N_0 - N$
- C.  $t$
- D.  $t_{\frac{1}{2}}$

34 - (PHYSI/10\_HL\_Winter\_2020\_Q37) - Quantum &amp; Nuclear Physics (ahl)

Monochromatic light is incident on a metal surface and electrons are released. The intensity of the incident light is increased. What changes, if any, occur to the rate of emission of electrons and to the kinetic energy of the emitted electrons?

|    | Rate of emission of electrons | Kinetic energy of the emitted electrons |
|----|-------------------------------|-----------------------------------------|
| A. | increase                      | increase                                |
| B. | decrease                      | no change                               |
| C. | decrease                      | increase                                |
| D. | increase                      | no change                               |

35 - (PHYSI/10\_HL\_Winter\_2020\_Q38) - Quantum &amp; Nuclear Physics (ahl)

The diameter of a nucleus of a particular nuclide X is 12 fm. What is the nucleon number of X?

- A. 5
- B. 10
- C. 125
- D. 155

36 - (PHYSI/10\_HL\_Winter\_2020\_Q39) - Quantum &amp; Nuclear Physics (ahl)



A photon has a wavelength  $\lambda$ . What are the energy and momentum of the photon?

|    | Energy of photon     | Momentum of photon  |
|----|----------------------|---------------------|
| A. | $\frac{hc}{\lambda}$ | $\frac{h}{\lambda}$ |
| B. | $\frac{hc}{\lambda}$ | $\frac{\lambda}{h}$ |
| C. | $\frac{h\lambda}{c}$ | $\frac{h}{\lambda}$ |
| D. | $\frac{h\lambda}{c}$ | $\frac{\lambda}{h}$ |

37 - (PHYSI/10\_HL\_Winter\_2020\_Q40) - Atomic, nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)

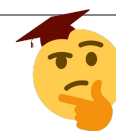
The Rutherford-Geiger-Marsden experiment shows that

- A. alpha particles do not obey Coulomb's law.
- B. there is a fixed nuclear radius for each nucleus.
- C. a large proportion of alpha particles are undeflected.
- D. the Bohr model of the hydrogen atom is confirmed.

38 - (PHYSI/11\_HL\_Summer\_2021\_Q37) - Quantum &amp; Nuclear Physics (ahl)

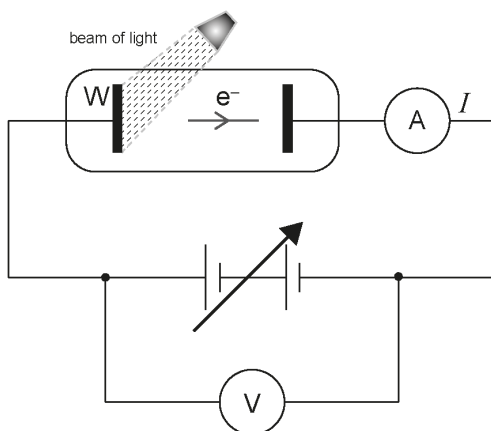
What is a consequence of the uncertainty principle?

- A. The absorption spectrum of hydrogen atoms is discrete.
- B. Electrons in low energy states have short lifetimes.
- C. Electrons cannot exist within nuclei.
- D. Photons do not have momentum.

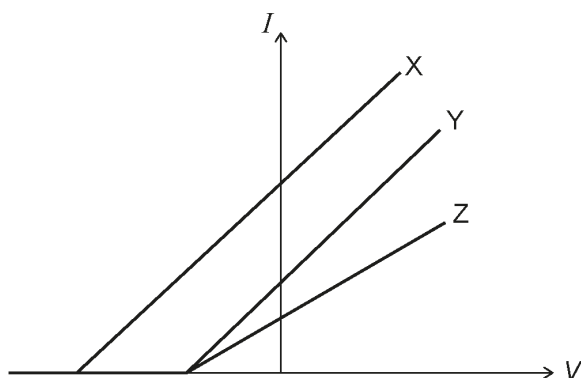


39 – (PHYSI/11\_HL\_Summer\_2021\_Q38) – Quantum & Nuclear Physics (ahl)

In a photoelectric effect experiment, a beam of light is incident on a metallic surface W in a vacuum.



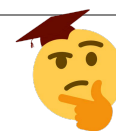
The graph shows how the current  $I$  varies with the potential difference  $V$  when three different beams X, Y, and Z are incident on W at different times.



- I. X and Y have the same frequency.
- II. Y and Z have different intensity.
- III. Y and Z have the same frequency.

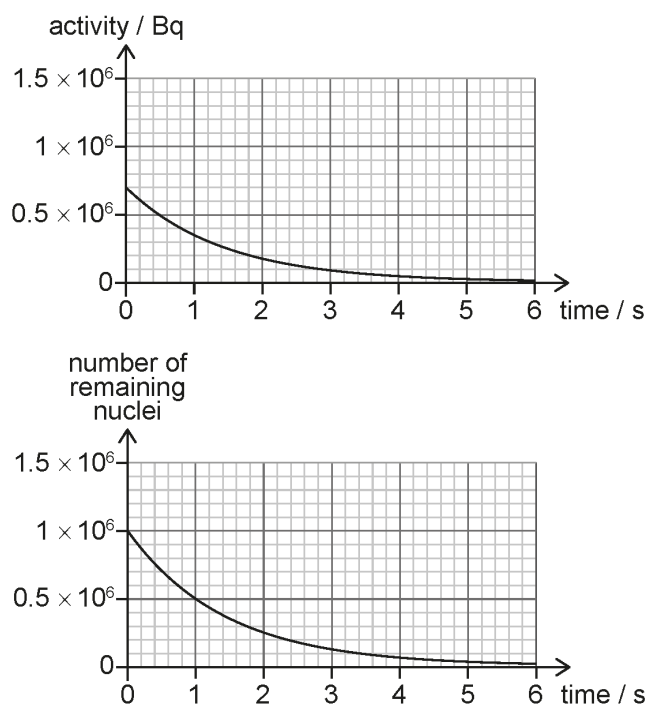
Which statements are correct?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III



40 - (PHYSI/11\_HL\_Summer\_2021\_Q39) - Quantum &amp; Nuclear Physics (ahl)

The graphs show the variation with time of the activity and the number of remaining nuclei for a sample of a radioactive nuclide.



What is the decay constant of the nuclide?

- A.  $0.7 \text{ s}^{-1}$
- B.  $1 \text{ s}^{-1}$
- C.  $\frac{1}{0.7} \text{ s}^{-1}$
- D.  $1.5 \text{ s}^{-1}$

41 - (PHYSI/11\_HL\_Summer\_2021\_Q40) - Quantum &amp; Nuclear Physics (ahl)

What was a reason to postulate the existence of neutrinos?

- A. Nuclear energy levels had a continuous spectrum.
- B. The photon emission spectrum only contained specific wavelengths.
- C. Some particles were indistinguishable from their antiparticle.
- D. The energy of emitted beta particles had a continuous spectrum.



42 - (PHYSI/12\_HL\_Summer\_2021\_Q37) - Quantum &amp; Nuclear Physics (ahl)

A particle of energy  $E$  is incident upon a barrier and has a certain probability of quantum tunnelling through the barrier. Assuming  $E$  remains constant, which combination of changes in particle mass and barrier length will increase the probability of the particle tunnelling through the barrier?

|    | Particle mass | Barrier length |
|----|---------------|----------------|
| A. | decrease      | decrease       |
| B. | increase      | decrease       |
| C. | decrease      | increase       |
| D. | increase      | increase       |

43 - (PHYSI/12\_HL\_Summer\_2021\_Q38) - Quantum &amp; Nuclear Physics (ahl)

Element X has a nucleon number  $A_x$  and a nuclear density  $\rho_x$ . Element Y has a nucleon number of  $2A_x$ . What is an estimate of the nuclear density of element Y?

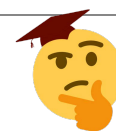
- A.  $\frac{1}{2}\rho_x$
- B.  $\rho_x$
- C.  $2\rho_x$
- D.  $8\rho_x$

44 - (PHYSI/12\_HL\_Summer\_2021\_Q39) - Quantum &amp; Nuclear Physics (ahl)

What is true for the Bohr model for the hydrogen atom?

- A. Angular momentum of electrons is quantized.
- B. Electrons are described by wave functions.
- C. Electrons never exist in fixed orbitals.
- D. Electrons will continuously emit radiation.





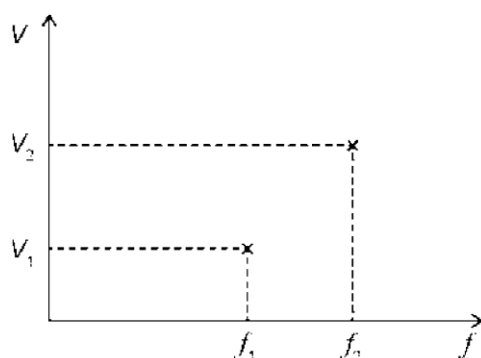
45 - (PHYSI/12\_HL\_Summer\_2021\_Q40) - Quantum &amp; Nuclear Physics (ahl)

An electron of non-relativistic speed  $v$  interacts with an atom. All the energy of the electron is transferred to an emitted photon of frequency  $f$ . An electron of speed  $2v$  now interacts with the same atom and all its energy is transmitted to a second photon. What is the frequency of the second photon?

- A.  $\frac{f}{4}$
- B.  $\frac{f}{2}$
- C.  $2f$
- D.  $4f$

46 - (PHYSI/10\_HL\_Winter\_2021\_Q37) - Quantum &amp; Nuclear Physics (ahl)

In a photoelectric experiment a stopping voltage  $V$  required to prevent photoelectrons from flowing across the photoelectric cell is measured for light of two frequencies  $f_1$  and  $f_2$ . The results obtained are shown.



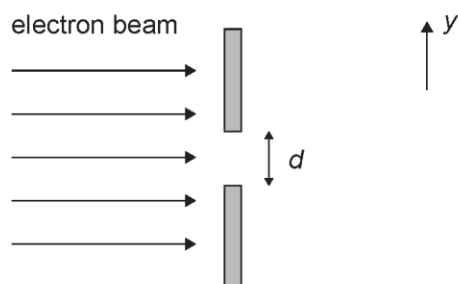
The ratio  $\frac{V_2 - V_1}{f_2 - f_1}$  is an estimate of

- A.  $e$
- B.  $h$
- C.  $\frac{e}{h}$
- D.  $\frac{h}{e}$

47 - (PHYSI/10\_HL\_Winter\_2021\_Q38) - Quantum &amp; Nuclear Physics (ahl)



A beam of electrons moving in the direction shown is incident on a rectangular slit of width  $d$ .

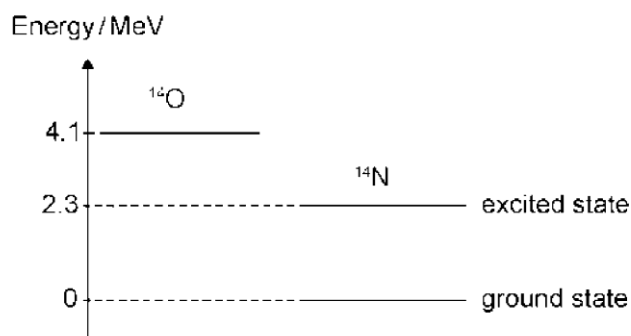


The component of momentum of the electrons in direction  $y$  after passing through the slit is  $p$ . The uncertainty in  $p$  is

- A. proportional to  $d$
- B. proportional to  $\frac{1}{d}$
- C. proportional to  $\frac{1}{d^2}$
- D. zero

48 - (PHYSI/10\_HL\_Winter\_2021\_Q39) - Quantum &amp; Nuclear Physics (ahl)

Some of the nuclear energy levels of oxygen-14 ( $^{14}\text{O}$ ) and nitrogen-14 ( $^{14}\text{N}$ ) are shown.



A nucleus of  $^{14}\text{O}$  decays into a nucleus of  $^{14}\text{N}$  with the emission of a positron and a gamma ray. What is the maximum energy of the positron and the energy of the gamma ray?

|    | Maximum energy<br>of the positron / MeV | Energy of the<br>gamma ray / MeV |
|----|-----------------------------------------|----------------------------------|
| A. | 1.8                                     | 2.3                              |
| B. | 1.8                                     | 4.1                              |
| C. | 2.3                                     | 1.8                              |
| D. | 4.1                                     | 2.3                              |

49 - (PHYSI/10\_HL\_Winter\_2021\_Q40) - *Quantum & Nuclear Physics (ahl)*



The size of a nucleus can be estimated from electron diffraction experiments. What is the order of magnitude of the de Broglie wavelength of the electrons in these experiments?

- A.  $10^{-15}$  m
- B.  $10^{-13}$  m
- C.  $10^{-11}$  m
- D.  $10^{-9}$  m

50 - (PHYSI/11\_HL\_Summer\_2022\_Q39) - *Quantum & Nuclear Physics (ahl)*

What is evidence for wave–particle duality?

- A. Line spectra of elements
- B. Electron-diffraction experiments
- C. Rutherford alpha-scattering experiments
- D. Gamma-ray spectra

51 - (PHYSI/11\_HL\_Summer\_2022\_Q40) - *Quantum & Nuclear Physics (ahl)*

The decay constant,  $\lambda$ , of a radioactive sample can be defined as

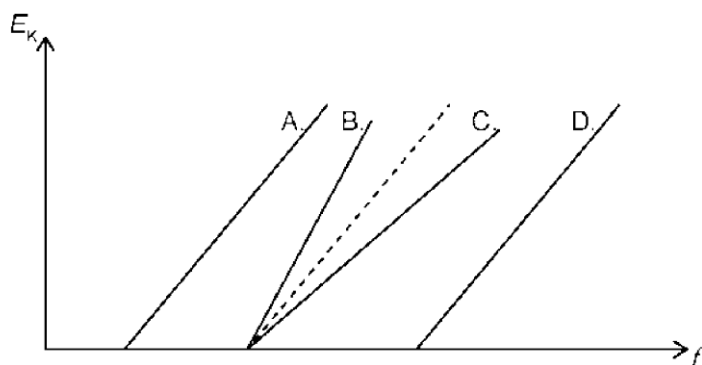
- A. the number of disintegrations in the radioactive sample.
- B. the number of disintegrations per unit time in the radioactive sample.
- C. the probability that a nucleus decays in the radioactive sample.
- D. the probability that a nucleus decays per unit time in the radioactive sample.

52 - (PHYSI/12\_HL\_Summer\_2022\_Q39) - Quantum &amp; Nuclear Physics (ahl)



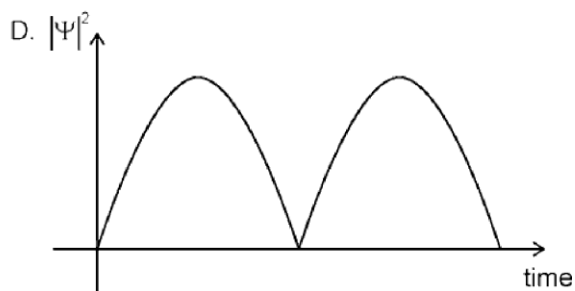
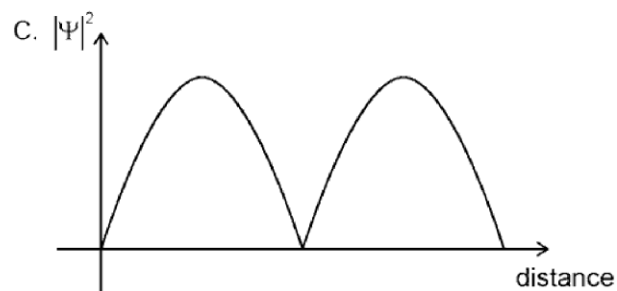
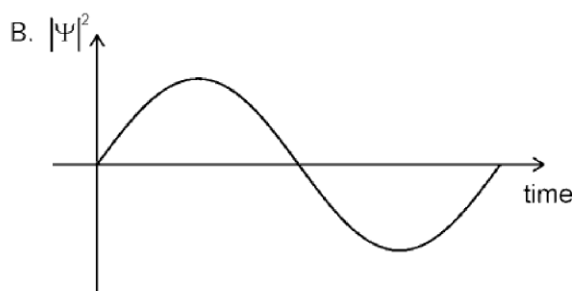
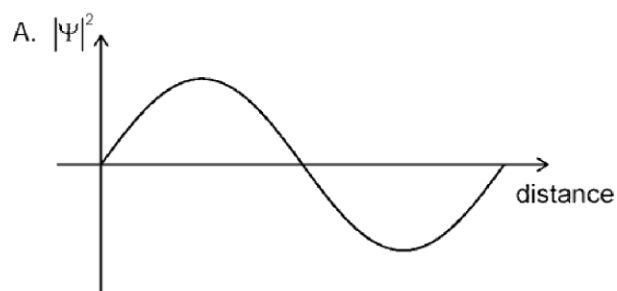
The dashed line represents the variation with incident electromagnetic frequency  $f$  of the kinetic energy  $E_k$  of the photoelectrons ejected from a metal surface. The metal surface is then replaced with one that requires less energy to remove an electron from the surface.

Which graph of the variation of  $E_k$  with  $f$  will be observed?



53 - (PHYSI/12\_HL\_Summer\_2022\_Q40) - Quantum &amp; Nuclear Physics (ahl)

Which graph shows a possible probability density function  $|\Psi|^2 = \frac{P(r)}{\Delta V}$  for a given wave function  $\Psi$  of an electron?





54 - (PHYSI/10\_HL\_Winter\_2022\_Q37) - Quantum & Nuclear Physics (ahl)

Monochromatic electromagnetic radiation ejects photoelectrons from a metal surface. The minimum frequency for which this is possible is  $f$ .

When radiation of frequency  $2f$  is incident on the surface, the kinetic energy of the photoelectrons is  $K$ .

What is the kinetic energy of the photoelectrons when the frequency of the radiation is  $4f$ ?

- A.  $K$
- B.  $2K$
- C.  $3K$
- D.  $4K$

55 - (PHYSI/10\_HL\_Winter\_2022\_Q38) - Quantum & Nuclear Physics (ahl)

A student quotes three equations related to atomic and nuclear physics:

I.  $E = \frac{-13.6}{n^2} \text{ eV}$

II.  $N = N_0 e^{-\lambda t}$

III.  $mvr = \frac{nh}{2\pi}$

Which equations refer to the Bohr model for hydrogen?

- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

56 - (PHYSI/10\_HL\_Winter\_2022\_Q39) - Quantum & Nuclear Physics (ahl)

Which emission shows a continuous energy spectrum?

- A. Photons during energy transitions between atomic energy states
- B. Gamma photons from the nuclei of radioactive isotopes
- C. Beta particles from the nuclei of radioactive isotopes
- D. Alpha particles from the nuclei of radioactive isotopes

57 – (PHYSI/10\_HL\_Winter\_2022\_Q40) – Quantum &amp; Nuclear Physics (ahl)



The nucleus of the isotope hydrogen-2 has a radius  $R$  and a density  $\rho$ .

What are the approximate radius and density of a nucleus of oxygen-16?

|    | Oxygen-16<br>radius | Oxygen-16<br>density |
|----|---------------------|----------------------|
| A. | $2R$                | $\rho$               |
| B. | $2R$                | $2\rho$              |
| C. | $8R$                | $\rho$               |
| D. | $8R$                | $2\rho$              |



# ANSWERS

| IB DIPLOMA                                                                                  | PHYSICS –HL –P1 | CH1 - MEASUREMENTS & UNCERTAINTIES                                                  |
|---------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <b>1</b> - (PHYSI/11_HL_Summer_2017_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>C  |                 |  |
| <b>2</b> - (PHYSI/12_HL_Summer_2017_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>D  |                 |                                                                                     |
| <b>3</b> - (PHYSI/12_HL_Summer_2017_Q25) - <i>Measurements &amp; Uncertainties</i><br><br>D |                 |                                                                                     |
| <b>4</b> - (PHYSI/10_HL_Winter_2017_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>C  |                 |                                                                                     |
| <b>5</b> - (PHYSI/10_HL_Winter_2017_Q2) - <i>Measurements &amp; Uncertainties</i><br><br>B  |                 |                                                                                     |
| <b>6</b> - (PHYSI/11_HL_Summer_2018_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>B  |                 |                                                                                     |
| <b>7</b> - (PHYSI/12_HL_Summer_2018_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>C  |                 |                                                                                     |
| <b>8</b> - (PHYSI/10_HL_Winter_2018_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>D  |                 |                                                                                     |
| <b>9</b> - (PHYSI/11_HL_Summer_2019_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>B  |                 |                                                                                     |
| <b>10</b> - (PHYSI/11_HL_Summer_2019_Q2) - <i>Measurements &amp; Uncertainties</i><br><br>A |                 |                                                                                     |



| IB DIPLOMA                                                                                  | PHYSICS –HL –P1 | CH1 - MEASUREMENTS & UNCERTAINTIES                                                  |
|---------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <b>11</b> - (PHYSI/12_HL_Summer_2019_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>A |                 |  |
| <b>12</b> - (PHYSI/12_HL_Summer_2019_Q2) - <i>Measurements &amp; Uncertainties</i><br><br>C |                 |                                                                                     |
| <b>13</b> - (PHYSI/10_HL_Winter_2019_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>D |                 |                                                                                     |
| <b>14</b> - (PHYSI/10_HL_Winter_2020_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>D |                 |                                                                                     |
| <b>15</b> - (PHYSI/11_HL_Summer_2021_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>D |                 |                                                                                     |
| <b>16</b> - (PHYSI/12_HL_Summer_2021_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>B |                 |                                                                                     |
| <b>17</b> - (PHYSI/10_HL_Winter_2021_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>C |                 |                                                                                     |
| <b>18</b> - (PHYSI/11_HL_Summer_2022_Q1) - <i>Measurements &amp; Uncertainties</i><br><br>D |                 |                                                                                     |
| <b>19</b> - (PHYSI/11_HL_Summer_2022_Q2) - <i>Measurements &amp; Uncertainties</i><br><br>D |                 |                                                                                     |

**20** - (PHYSI/11\_HL\_Summer\_2022\_Q3) - *Measurements & Uncertainties*

D

**21** - (PHYSI/12\_HL\_Summer\_2022\_Q1) - *Measurements & Uncertainties*

D

**22** - (PHYSI/12\_HL\_Summer\_2022\_Q2) - *Measurements & Uncertainties*

C

**23** - (PHYSI/10\_HL\_Winter\_2022\_Q1) - *Measurements & Uncertainties*

A

**24** - (PHYSI/10\_HL\_Winter\_2022\_Q2) - *Measurements & Uncertainties*

B

| IB DIPLOMA                                                                  | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|-----------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>1</b> - (PHYSI/11_HL_Summer_2017_Q2) - <i>Mechanics</i><br><br><b>B</b>  |                   |  |
| <b>2</b> - (PHYSI/11_HL_Summer_2017_Q3) - <i>Mechanics</i><br><br><b>C</b>  |                   |                                                                                     |
| <b>3</b> - (PHYSI/11_HL_Summer_2017_Q4) - <i>Mechanics</i><br><br><b>B</b>  |                   |                                                                                     |
| <b>4</b> - (PHYSI/11_HL_Summer_2017_Q5) - <i>Mechanics</i><br><br><b>A</b>  |                   |                                                                                     |
| <b>5</b> - (PHYSI/11_HL_Summer_2017_Q6) - <i>Mechanics</i><br><br><b>D</b>  |                   |                                                                                     |
| <b>6</b> - (PHYSI/11_HL_Summer_2017_Q7) - <i>Mechanics</i><br><br><b>B</b>  |                   |                                                                                     |
| <b>7</b> - (PHYSI/12_HL_Summer_2017_Q2) - <i>Mechanics</i><br><br><b>B</b>  |                   |                                                                                     |
| <b>8</b> - (PHYSI/12_HL_Summer_2017_Q3) - <i>Mechanics</i><br><br><b>D</b>  |                   |                                                                                     |
| <b>9</b> - (PHYSI/12_HL_Summer_2017_Q4) - <i>Mechanics</i><br><br><b>C</b>  |                   |                                                                                     |
| <b>10</b> - (PHYSI/12_HL_Summer_2017_Q5) - <i>Mechanics</i><br><br><b>B</b> |                   |                                                                                     |

| IB DIPLOMA                                                                                                  | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|-------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>11</b> - (PHYSI/12_HL_Summer_2017_Q6) - <i>Mechanics</i><br><br>D                                        |                   |  |
| <b>12</b> - (PHYSI/12_HL_Summer_2017_Q7) - <i>Mechanics, Atomic,nuclear &amp; Particle Physics</i><br><br>D |                   |                                                                                     |
| <b>13</b> - (PHYSI/10_HL_Winter_2017_Q3) - <i>Mechanics</i><br><br>D                                        |                   |                                                                                     |
| <b>14</b> - (PHYSI/10_HL_Winter_2017_Q4) - <i>Mechanics</i><br><br>C                                        |                   |                                                                                     |
| <b>15</b> - (PHYSI/10_HL_Winter_2017_Q5) - <i>Mechanics</i><br><br>D                                        |                   |                                                                                     |
| <b>16</b> - (PHYSI/10_HL_Winter_2017_Q6) - <i>Mechanics</i><br><br>B                                        |                   |                                                                                     |
| <b>17</b> - (PHYSI/10_HL_Winter_2017_Q7) - <i>Mechanics</i><br><br>A                                        |                   |                                                                                     |
| <b>18</b> - (PHYSI/11_HL_Summer_2018_Q2) - <i>Mechanics</i><br><br>A                                        |                   |                                                                                     |
| <b>19</b> - (PHYSI/11_HL_Summer_2018_Q3) - <i>Mechanics</i><br><br>B                                        |                   |                                                                                     |

| IB DIPLOMA                                                                                             | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|--------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>20</b> - (PHYSI/11_HL_Summer_2018_Q4) - <i>Mechanics</i></p> <p>A</p>                            |                   |  |
| <p><b>21</b> - (PHYSI/11_HL_Summer_2018_Q5) - <i>Mechanics</i></p> <p>D</p>                            |                   |                                                                                     |
| <p><b>22</b> - (PHYSI/11_HL_Summer_2018_Q6) - <i>Mechanics</i></p> <p>D</p>                            |                   |                                                                                     |
| <p><b>23</b> - (PHYSI/11_HL_Summer_2018_Q7) - <i>Mechanics</i></p> <p>C</p>                            |                   |                                                                                     |
| <p><b>24</b> - (PHYSI/11_HL_Summer_2018_Q26) - <i>Mechanics, Oscillations &amp; Waves</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>25</b> - (PHYSI/12_HL_Summer_2018_Q2) - <i>Mechanics</i></p> <p>B</p>                            |                   |                                                                                     |
| <p><b>26</b> - (PHYSI/12_HL_Summer_2018_Q3) - <i>Mechanics</i></p> <p>D</p>                            |                   |                                                                                     |
| <p><b>27</b> - (PHYSI/12_HL_Summer_2018_Q4) - <i>Mechanics</i></p> <p>B</p>                            |                   |                                                                                     |
| <p><b>28</b> - (PHYSI/12_HL_Summer_2018_Q5) - <i>Mechanics</i></p> <p>B</p>                            |                   |                                                                                     |

| IB DIPLOMA                                                                  | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|-----------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>29</b> - (PHYSI/12_HL_Summer_2018_Q6) - <i>Mechanics</i></p> <p>B</p> |                   |  |
| <p><b>30</b> - (PHYSI/12_HL_Summer_2018_Q7) - <i>Mechanics</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>31</b> - (PHYSI/10_HL_Winter_2018_Q2) - <i>Mechanics</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>32</b> - (PHYSI/10_HL_Winter_2018_Q3) - <i>Mechanics</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>33</b> - (PHYSI/10_HL_Winter_2018_Q4) - <i>Mechanics</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>34</b> - (PHYSI/10_HL_Winter_2018_Q6) - <i>Mechanics</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>35</b> - (PHYSI/10_HL_Winter_2018_Q7) - <i>Mechanics</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>36</b> - (PHYSI/11_HL_Summer_2019_Q3) - <i>Mechanics</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>37</b> - (PHYSI/11_HL_Summer_2019_Q4) - <i>Mechanics</i></p> <p>C</p> |                   |                                                                                     |

| IB DIPLOMA                                                                  | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|-----------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>38</b> - (PHYSI/11_HL_Summer_2019_Q5) - <i>Mechanics</i><br><br><b>D</b> |                   |  |
| <b>39</b> - (PHYSI/11_HL_Summer_2019_Q6) - <i>Mechanics</i><br><br><b>A</b> |                   |                                                                                     |
| <b>40</b> - (PHYSI/11_HL_Summer_2019_Q7) - <i>Mechanics</i><br><br><b>D</b> |                   |                                                                                     |
| <b>41</b> - (PHYSI/12_HL_Summer_2019_Q3) - <i>Mechanics</i><br><br><b>B</b> |                   |                                                                                     |
| <b>42</b> - (PHYSI/12_HL_Summer_2019_Q4) - <i>Mechanics</i><br><br><b>C</b> |                   |                                                                                     |
| <b>43</b> - (PHYSI/12_HL_Summer_2019_Q5) - <i>Mechanics</i><br><br><b>B</b> |                   |                                                                                     |
| <b>44</b> - (PHYSI/12_HL_Summer_2019_Q6) - <i>Mechanics</i><br><br><b>A</b> |                   |                                                                                     |
| <b>45</b> - (PHYSI/12_HL_Summer_2019_Q7) - <i>Mechanics</i><br><br><b>A</b> |                   |                                                                                     |
| <b>46</b> - (PHYSI/12_HL_Summer_2019_Q8) - <i>Mechanics</i><br><br><b>D</b> |                   |                                                                                     |

| IB DIPLOMA                                                                                                      | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|-----------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>47</b> - (PHYSI/12_HL_Summer_2019_Q10) - <i>Mechanics, Circular Motion &amp; Gravitation</i></p> <p>B</p> |                   |  |
| <p><b>48</b> - (PHYSI/10_HL_Winter_2019_Q2) - <i>Mechanics</i></p> <p>C</p>                                     |                   |                                                                                     |
| <p><b>49</b> - (PHYSI/10_HL_Winter_2019_Q3) - <i>Mechanics</i></p> <p>B</p>                                     |                   |                                                                                     |
| <p><b>50</b> - (PHYSI/10_HL_Winter_2019_Q4) - <i>Mechanics</i></p> <p>D</p>                                     |                   |                                                                                     |
| <p><b>51</b> - (PHYSI/10_HL_Winter_2019_Q5) - <i>Mechanics</i></p> <p>C</p>                                     |                   |                                                                                     |
| <p><b>52</b> - (PHYSI/10_HL_Winter_2019_Q6) - <i>Mechanics</i></p> <p>A</p>                                     |                   |                                                                                     |
| <p><b>53</b> - (PHYSI/10_HL_Winter_2019_Q7) - <i>Mechanics</i></p> <p>D</p>                                     |                   |                                                                                     |
| <p><b>54</b> - (PHYSI/10_HL_Winter_2019_Q22) - <i>Mechanics</i></p> <p>D</p>                                    |                   |                                                                                     |
| <p><b>55</b> - (PHYSI/10_HL_Winter_2020_Q2) - <i>Mechanics</i></p> <p>B</p>                                     |                   |                                                                                     |



| IB DIPLOMA                                                           | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|----------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>56</b> - (PHYSI/10_HL_Winter_2020_Q3) - <i>Mechanics</i><br><br>C |                   |  |
| <b>57</b> - (PHYSI/10_HL_Winter_2020_Q4) - <i>Mechanics</i><br><br>B |                   |                                                                                     |
| <b>58</b> - (PHYSI/10_HL_Winter_2020_Q5) - <i>Mechanics</i><br><br>D |                   |                                                                                     |
| <b>59</b> - (PHYSI/10_HL_Winter_2020_Q6) - <i>Mechanics</i><br><br>B |                   |                                                                                     |
| <b>60</b> - (PHYSI/11_HL_Summer_2021_Q2) - <i>Mechanics</i><br><br>D |                   |                                                                                     |
| <b>61</b> - (PHYSI/11_HL_Summer_2021_Q3) - <i>Mechanics</i><br><br>C |                   |                                                                                     |
| <b>62</b> - (PHYSI/11_HL_Summer_2021_Q4) - <i>Mechanics</i><br><br>C |                   |                                                                                     |
| <b>63</b> - (PHYSI/11_HL_Summer_2021_Q5) - <i>Mechanics</i><br><br>D |                   |                                                                                     |
| <b>64</b> - (PHYSI/11_HL_Summer_2021_Q6) - <i>Mechanics</i><br><br>B |                   |                                                                                     |

| IB DIPLOMA                                                                  | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|-----------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>65</b> - (PHYSI/11_HL_Summer_2021_Q7) - <i>Mechanics</i></p> <p>B</p> |                   |  |
| <p><b>66</b> - (PHYSI/12_HL_Summer_2021_Q2) - <i>Mechanics</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>67</b> - (PHYSI/12_HL_Summer_2021_Q3) - <i>Mechanics</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>68</b> - (PHYSI/12_HL_Summer_2021_Q4) - <i>Mechanics</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>69</b> - (PHYSI/12_HL_Summer_2021_Q5) - <i>Mechanics</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>70</b> - (PHYSI/12_HL_Summer_2021_Q6) - <i>Mechanics</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>71</b> - (PHYSI/12_HL_Summer_2021_Q7) - <i>Mechanics</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>72</b> - (PHYSI/10_HL_Winter_2021_Q2) - <i>Mechanics</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>73</b> - (PHYSI/10_HL_Winter_2021_Q3) - <i>Mechanics</i></p> <p>A</p> |                   |                                                                                     |

| IB DIPLOMA                                                                  | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|-----------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>74</b> - (PHYSI/10_HL_Winter_2021_Q4) - <i>Mechanics</i><br><br><b>B</b> |                   |  |
| <b>75</b> - (PHYSI/10_HL_Winter_2021_Q5) - <i>Mechanics</i><br><br><b>D</b> |                   |                                                                                     |
| <b>76</b> - (PHYSI/10_HL_Winter_2021_Q6) - <i>Mechanics</i><br><br><b>C</b> |                   |                                                                                     |
| <b>77</b> - (PHYSI/10_HL_Winter_2021_Q7) - <i>Mechanics</i><br><br><b>D</b> |                   |                                                                                     |
| <b>78</b> - (PHYSI/11_HL_Summer_2022_Q4) - <i>Mechanics</i><br><br><b>B</b> |                   |                                                                                     |
| <b>79</b> - (PHYSI/11_HL_Summer_2022_Q5) - <i>Mechanics</i><br><br><b>B</b> |                   |                                                                                     |
| <b>80</b> - (PHYSI/11_HL_Summer_2022_Q6) - <i>Mechanics</i><br><br><b>A</b> |                   |                                                                                     |
| <b>81</b> - (PHYSI/11_HL_Summer_2022_Q7) - <i>Mechanics</i><br><br><b>A</b> |                   |                                                                                     |
| <b>82</b> - (PHYSI/11_HL_Summer_2022_Q8) - <i>Mechanics</i><br><br><b>D</b> |                   |                                                                                     |

| IB DIPLOMA                                                                  | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|-----------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>83</b> - (PHYSI/11_HL_Summer_2022_Q9) - <i>Mechanics</i><br><br><b>B</b> |                   |  |
| <b>84</b> - (PHYSI/12_HL_Summer_2022_Q3) - <i>Mechanics</i><br><br><b>C</b> |                   |                                                                                     |
| <b>85</b> - (PHYSI/12_HL_Summer_2022_Q4) - <i>Mechanics</i><br><br><b>D</b> |                   |                                                                                     |
| <b>86</b> - (PHYSI/12_HL_Summer_2022_Q5) - <i>Mechanics</i><br><br><b>C</b> |                   |                                                                                     |
| <b>87</b> - (PHYSI/12_HL_Summer_2022_Q6) - <i>Mechanics</i><br><br><b>B</b> |                   |                                                                                     |
| <b>88</b> - (PHYSI/12_HL_Summer_2022_Q7) - <i>Mechanics</i><br><br><b>B</b> |                   |                                                                                     |
| <b>89</b> - (PHYSI/12_HL_Summer_2022_Q8) - <i>Mechanics</i><br><br><b>C</b> |                   |                                                                                     |
| <b>90</b> - (PHYSI/10_HL_Winter_2022_Q3) - <i>Mechanics</i><br><br><b>D</b> |                   |                                                                                     |
| <b>91</b> - (PHYSI/10_HL_Winter_2022_Q4) - <i>Mechanics</i><br><br><b>C</b> |                   |                                                                                     |

| IB DIPLOMA                                                                  | PHYSICS – HL – P1 | CH2 - MECHANICS                                                                     |
|-----------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>92</b> - (PHYSI/10_HL_Winter_2022_Q5) - <i>Mechanics</i></p> <p>B</p> |                   |  |
| <p><b>93</b> - (PHYSI/10_HL_Winter_2022_Q6) - <i>Mechanics</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>94</b> - (PHYSI/10_HL_Winter_2022_Q7) - <i>Mechanics</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>95</b> - (PHYSI/10_HL_Winter_2022_Q8) - <i>Mechanics</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>96</b> - (PHYSI/10_HL_Winter_2022_Q9) - <i>Mechanics</i></p> <p>C</p> |                   |                                                                                     |

1 - (PHYSI/11\_HL\_Summer\_2017\_Q8) - *Thermal Physics*

A



2 - (PHYSI/11\_HL\_Summer\_2017\_Q9) - *Thermal Physics*

A

3 - (PHYSI/11\_HL\_Summer\_2017\_Q10) - *Thermal Physics*

C

4 - (PHYSI/12\_HL\_Summer\_2017\_Q8) - *Thermal Physics*

C

5 - (PHYSI/12\_HL\_Summer\_2017\_Q9) - *Thermal Physics*

A

6 - (PHYSI/12\_HL\_Summer\_2017\_Q10) - *Thermal Physics*

B

7 - (PHYSI/10\_HL\_Winter\_2017\_Q8) - *Thermal Physics*

B

8 - (PHYSI/10\_HL\_Winter\_2017\_Q9) - *Thermal Physics*

B

9 - (PHYSI/10\_HL\_Winter\_2017\_Q10) - *Thermal Physics*

B

10 - (PHYSI/11\_HL\_Summer\_2018\_Q8) - *Thermal Physics*

C

| IB DIPLOMA                                                                         | PHYSICS – HL – P1 | CH3 - THERMAL PHYSICS                                                               |
|------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>11</b> - (PHYSI/11_HL_Summer_2018_Q9) - <i>Thermal Physics</i><br><br><b>D</b>  |                   |  |
| <b>12</b> - (PHYSI/11_HL_Summer_2018_Q10) - <i>Thermal Physics</i><br><br><b>A</b> |                   |                                                                                     |
| <b>13</b> - (PHYSI/12_HL_Summer_2018_Q8) - <i>Thermal Physics</i><br><br><b>A</b>  |                   |                                                                                     |
| <b>14</b> - (PHYSI/12_HL_Summer_2018_Q9) - <i>Thermal Physics</i><br><br><b>B</b>  |                   |                                                                                     |
| <b>15</b> - (PHYSI/10_HL_Winter_2018_Q8) - <i>Thermal Physics</i><br><br><b>C</b>  |                   |                                                                                     |
| <b>16</b> - (PHYSI/10_HL_Winter_2018_Q9) - <i>Thermal Physics</i><br><br><b>C</b>  |                   |                                                                                     |
| <b>17</b> - (PHYSI/10_HL_Winter_2018_Q10) - <i>Thermal Physics</i><br><br><b>C</b> |                   |                                                                                     |
| <b>18</b> - (PHYSI/11_HL_Summer_2019_Q8) - <i>Thermal Physics</i><br><br><b>D</b>  |                   |                                                                                     |
| <b>19</b> - (PHYSI/11_HL_Summer_2019_Q9) - <i>Thermal Physics</i><br><br><b>B</b>  |                   |                                                                                     |

| IB DIPLOMA                                                                         | PHYSICS – HL – P1 | CH3 - THERMAL PHYSICS                                                               |
|------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>20</b> - (PHYSI/11_HL_Summer_2019_Q10) - <i>Thermal Physics</i></p> <p>C</p> |                   |  |
| <p><b>21</b> - (PHYSI/11_HL_Summer_2019_Q26) - <i>Thermal Physics</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>22</b> - (PHYSI/12_HL_Summer_2019_Q9) - <i>Thermal Physics</i></p> <p>C</p>  |                   |                                                                                     |
| <p><b>23</b> - (PHYSI/12_HL_Summer_2019_Q12) - <i>Thermal Physics</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>24</b> - (PHYSI/12_HL_Summer_2019_Q13) - <i>Thermal Physics</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>25</b> - (PHYSI/12_HL_Summer_2019_Q14) - <i>Thermal Physics</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>26</b> - (PHYSI/10_HL_Winter_2019_Q8) - <i>Thermal Physics</i></p> <p>A</p>  |                   |                                                                                     |
| <p><b>27</b> - (PHYSI/10_HL_Winter_2019_Q9) - <i>Thermal Physics</i></p> <p>D</p>  |                   |                                                                                     |
| <p><b>28</b> - (PHYSI/10_HL_Winter_2019_Q10) - <i>Thermal Physics</i></p> <p>C</p> |                   |                                                                                     |



**29** - (PHYSI/10\_HL\_Winter\_2020\_Q7) - *Thermal Physics*

C



**30** - (PHYSI/10\_HL\_Winter\_2020\_Q8) - *Thermal Physics*

B

**31** - (PHYSI/10\_HL\_Winter\_2020\_Q9) - *Thermal Physics*

A

**32** - (PHYSI/11\_HL\_Summer\_2021\_Q8) - *Thermal Physics*

A

**33** - (PHYSI/11\_HL\_Summer\_2021\_Q9) - *Thermal Physics*

D

**34** - (PHYSI/11\_HL\_Summer\_2021\_Q10) - *Thermal Physics*

B

**35** - (PHYSI/12\_HL\_Summer\_2021\_Q8) - *Thermal Physics*

B

**36** - (PHYSI/12\_HL\_Summer\_2021\_Q9) - *Thermal Physics*

C

**37** - (PHYSI/12\_HL\_Summer\_2021\_Q10) - *Thermal Physics*

D

**38** - (PHYSI/12\_HL\_Summer\_2021\_Q11) - *Thermal Physics*

C



**39** - (PHYSI/10\_HL\_Winter\_2021\_Q8) - *Thermal Physics*

B

**40** - (PHYSI/10\_HL\_Winter\_2021\_Q9) - *Thermal Physics*

B

**41** - (PHYSI/10\_HL\_Winter\_2021\_Q10) - *Thermal Physics*

D

**42** - (PHYSI/11\_HL\_Summer\_2022\_Q10) - *Thermal Physics*

A

**43** - (PHYSI/11\_HL\_Summer\_2022\_Q11) - *Thermal Physics*

C

**44** - (PHYSI/11\_HL\_Summer\_2022\_Q12) - *Thermal Physics*

C

**45** - (PHYSI/12\_HL\_Summer\_2022\_Q9) - *Thermal Physics*

A

**46** - (PHYSI/12\_HL\_Summer\_2022\_Q10) - *Thermal Physics*

C

**47** - (PHYSI/12\_HL\_Summer\_2022\_Q11) - *Thermal Physics*

B



**48** - (PHYSI/10\_HL\_Winter\_2022\_Q10) - *Thermal Physics*

B

**49** - (PHYSI/10\_HL\_Winter\_2022\_Q11) - *Thermal Physics*

D

**50** - (PHYSI/10\_HL\_Winter\_2022\_Q12) - *Thermal Physics*

A

1 - (PHYSI/11\_HL\_Summer\_2017\_Q11) - *Oscillations & Waves*

A



2 - (PHYSI/11\_HL\_Summer\_2017\_Q12) - *Oscillations & Waves*

B

3 - (PHYSI/11\_HL\_Summer\_2017\_Q13) - *Oscillations & Waves*

C

4 - (PHYSI/11\_HL\_Summer\_2017\_Q14) - *Oscillations & Waves*

C

5 - (PHYSI/11\_HL\_Summer\_2017\_Q15) - *Oscillations & Waves*

D

6 - (PHYSI/12\_HL\_Summer\_2017\_Q11) - *Oscillations & Waves*

D

7 - (PHYSI/12\_HL\_Summer\_2017\_Q12) - *Oscillations & Waves*

B

8 - (PHYSI/12\_HL\_Summer\_2017\_Q13) - *Oscillations & Waves*

A

9 - (PHYSI/12\_HL\_Summer\_2017\_Q14) - *Oscillations & Waves*

C

10 - (PHYSI/12\_HL\_Summer\_2017\_Q26) - *Oscillations & Waves*

C

**11** - (PHYSI/10\_HL\_Winter\_2017\_Q11) - *Oscillations & Waves*

B



**12** - (PHYSI/10\_HL\_Winter\_2017\_Q12) - *Oscillations & Waves*

D

**13** - (PHYSI/10\_HL\_Winter\_2017\_Q13) - *Oscillations & Waves*

A

**14** - (PHYSI/10\_HL\_Winter\_2017\_Q14) - *Oscillations & Waves*

A

**15** - (PHYSI/11\_HL\_Summer\_2018\_Q11) - *Oscillations & Waves*

D

**16** - (PHYSI/11\_HL\_Summer\_2018\_Q12) - *Oscillations & Waves*

D

**17** - (PHYSI/11\_HL\_Summer\_2018\_Q13) - *Oscillations & Waves*

A

**18** - (PHYSI/11\_HL\_Summer\_2018\_Q14) - *Oscillations & Waves*

B

**19** - (PHYSI/11\_HL\_Summer\_2018\_Q26) - *Mechanics, Oscillations & Waves*

B

| IB DIPLOMA                                                                                  | PHYSICS – HL – P1 | CH4 - OSCILLATIONS & WAVES                                                          |
|---------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>20</b> - (PHYSI/12_HL_Summer_2018_Q10) - <i>Oscillations &amp; Waves</i></p> <p>D</p> |                   |  |
| <p><b>21</b> - (PHYSI/12_HL_Summer_2018_Q11) - <i>Oscillations &amp; Waves</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>22</b> - (PHYSI/12_HL_Summer_2018_Q12) - <i>Oscillations &amp; Waves</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>23</b> - (PHYSI/12_HL_Summer_2018_Q13) - <i>Oscillations &amp; Waves</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>24</b> - (PHYSI/12_HL_Summer_2018_Q24) - <i>Oscillations &amp; Waves</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>25</b> - (PHYSI/10_HL_Winter_2018_Q12) - <i>Oscillations &amp; Waves</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>26</b> - (PHYSI/10_HL_Winter_2018_Q13) - <i>Oscillations &amp; Waves</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>27</b> - (PHYSI/10_HL_Winter_2018_Q14) - <i>Oscillations &amp; Waves</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>28</b> - (PHYSI/10_HL_Winter_2018_Q15) - <i>Oscillations &amp; Waves</i></p> <p>A</p> |                   |                                                                                     |

**29** - (PHYSI/10\_HL\_Winter\_2018\_Q18) - *Oscillations & Waves*

A



**30** - (PHYSI/10\_HL\_Winter\_2018\_Q26) - *Oscillations & Waves*

C

**31** - (PHYSI/10\_HL\_Winter\_2018\_Q28) - *Oscillations & Waves, Wave Phenomena (ahl)*

B

**32** - (PHYSI/10\_HL\_Winter\_2018\_Q29) - *Oscillations & Waves*

D

**33** - (PHYSI/11\_HL\_Summer\_2019\_Q11) - *Oscillations & Waves*

C

**34** - (PHYSI/11\_HL\_Summer\_2019\_Q12) - *Oscillations & Waves*

D

**35** - (PHYSI/11\_HL\_Summer\_2019\_Q13) - *Oscillations & Waves*

D

**36** - (PHYSI/11\_HL\_Summer\_2019\_Q14) - *Oscillations & Waves*

B

**37** - (PHYSI/11\_HL\_Summer\_2019\_Q27) - *Oscillations & Waves, Wave Phenomena (ahl)*

D

**38** - (PHYSI/11\_HL\_Summer\_2019\_Q28) - *Oscillations & Waves, Wave Phenomena (ahl)*

D



**39** - (PHYSI/11\_HL\_Summer\_2019\_Q29) - *Oscillations & Waves, Wave Phenomena (ahl)*

C

**40** - (PHYSI/11\_HL\_Summer\_2019\_Q30) - *Oscillations & Waves, Wave Phenomena (ahl)*

B

**41** - (PHYSI/11\_HL\_Summer\_2019\_Q31) - *Oscillations & Waves, Wave Phenomena (ahl)*

D

**42** - (PHYSI/12\_HL\_Summer\_2019\_Q15) - *Oscillations & Waves*

C

**43** - (PHYSI/12\_HL\_Summer\_2019\_Q16) - *Oscillations & Waves*

A

**44** - (PHYSI/12\_HL\_Summer\_2019\_Q17) - *Oscillations & Waves*

D

**45** - (PHYSI/12\_HL\_Summer\_2019\_Q18) - *Oscillations & Waves*

B

**46** - (PHYSI/12\_HL\_Summer\_2019\_Q19) - *Oscillations & Waves*

D



47 - (PHYSI/12\_HL\_Summer\_2019\_Q20) - *Oscillations & Waves*

C



48 - (PHYSI/12\_HL\_Summer\_2019\_Q21) - *Oscillations & Waves*

D

49 - (PHYSI/12\_HL\_Summer\_2019\_Q22) - *Oscillations & Waves*

A

50 - (PHYSI/12\_HL\_Summer\_2019\_Q37) - *Oscillations & Waves, Circular Motion & Gravitation*

D

51 - (PHYSI/10\_HL\_Winter\_2019\_Q11) - *Oscillations & Waves*

C

52 - (PHYSI/10\_HL\_Winter\_2019\_Q12) - *Oscillations & Waves*

C

53 - (PHYSI/10\_HL\_Winter\_2019\_Q13) - *Oscillations & Waves*

C

54 - (PHYSI/10\_HL\_Winter\_2019\_Q14) - *Oscillations & Waves*

B

55 - (PHYSI/10\_HL\_Winter\_2019\_Q26) - *Oscillations & Waves*

A

**56** - (PHYSI/10\_HL\_Winter\_2019\_Q27) - *Oscillations & Waves, Wave Phenomena (ahl)*

A



**57** - (PHYSI/10\_HL\_Winter\_2019\_Q28) - *Oscillations & Waves, Wave Phenomena (ahl)*

C

**58** - (PHYSI/10\_HL\_Winter\_2020\_Q10) - *Oscillations & Waves*

D

**59** - (PHYSI/10\_HL\_Winter\_2020\_Q11) - *Oscillations & Waves*

C

**60** - (PHYSI/10\_HL\_Winter\_2020\_Q12) - *Oscillations & Waves*

B

**61** - (PHYSI/10\_HL\_Winter\_2020\_Q13) - *Oscillations & Waves*

C

**62** - (PHYSI/11\_HL\_Summer\_2021\_Q11) - *Oscillations & Waves*

A

**63** - (PHYSI/11\_HL\_Summer\_2021\_Q12) - *Oscillations & Waves*

C

**64** - (PHYSI/11\_HL\_Summer\_2021\_Q13) - *Oscillations & Waves*

B

**65** - (PHYSI/11\_HL\_Summer\_2021\_Q14) - *Oscillations & Waves*

C



**66** - (PHYSI/12\_HL\_Summer\_2021\_Q12) - *Oscillations & Waves*

B

**67** - (PHYSI/12\_HL\_Summer\_2021\_Q13) - *Oscillations & Waves*

B

**68** - (PHYSI/12\_HL\_Summer\_2021\_Q14) - *Oscillations & Waves*

A

**69** - (PHYSI/10\_HL\_Winter\_2021\_Q11) - *Oscillations & Waves*

B

**70** - (PHYSI/10\_HL\_Winter\_2021\_Q12) - *Oscillations & Waves*

B

**71** - (PHYSI/10\_HL\_Winter\_2021\_Q13) - *Oscillations & Waves*

D

**72** - (PHYSI/10\_HL\_Winter\_2021\_Q14) - *Oscillations & Waves*

D

**73** - (PHYSI/11\_HL\_Summer\_2022\_Q13) - *Oscillations & Waves*

C

**74** - (PHYSI/11\_HL\_Summer\_2022\_Q14) - *Oscillations & Waves*

C



**75** - (PHYSI/11\_HL\_Summer\_2022\_Q15) - *Oscillations & Waves*

D

**76** - (PHYSI/11\_HL\_Summer\_2022\_Q16) - *Oscillations & Waves*

C

**77** - (PHYSI/11\_HL\_Summer\_2022\_Q17) - *Oscillations & Waves*

A

**78** - (PHYSI/12\_HL\_Summer\_2022\_Q12) - *Oscillations & Waves*

B

**79** - (PHYSI/12\_HL\_Summer\_2022\_Q13) - *Oscillations & Waves*

C

**80** - (PHYSI/12\_HL\_Summer\_2022\_Q14) - *Oscillations & Waves*

D

**81** - (PHYSI/12\_HL\_Summer\_2022\_Q15) - *Oscillations & Waves*

A

**82** - (PHYSI/10\_HL\_Winter\_2022\_Q13) - *Oscillations & Waves*

A

**83-** (PHYSI/10\_HL\_Winter\_2022\_Q14) – *Oscillations & Waves*



A

**84-** (PHYSI/10\_HL\_Winter\_2022\_Q15) – *Oscillations & Waves*

A

| IB DIPLOMA                                                                              | PHYSICS – HL – P1 | CH5 - ELECTRICITY & MAGNETISM                                                       |
|-----------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>1</b> - (PHYSI/11_HL_Summer_2017_Q16) - <i>Electricity &amp; Magnetism</i><br><br>C  |                   |  |
| <b>2</b> - (PHYSI/11_HL_Summer_2017_Q17) - <i>Electricity &amp; Magnetism</i><br><br>D  |                   |                                                                                     |
| <b>3</b> - (PHYSI/11_HL_Summer_2017_Q18) - <i>Electricity &amp; Magnetism</i><br><br>A  |                   |                                                                                     |
| <b>4</b> - (PHYSI/12_HL_Summer_2017_Q16) - <i>Electricity &amp; Magnetism</i><br><br>B  |                   |                                                                                     |
| <b>5</b> - (PHYSI/12_HL_Summer_2017_Q17) - <i>Electricity &amp; Magnetism</i><br><br>A  |                   |                                                                                     |
| <b>6</b> - (PHYSI/10_HL_Winter_2017_Q15) - <i>Electricity &amp; Magnetism</i><br><br>A  |                   |                                                                                     |
| <b>7</b> - (PHYSI/10_HL_Winter_2017_Q16) - <i>Electricity &amp; Magnetism</i><br><br>B  |                   |                                                                                     |
| <b>8</b> - (PHYSI/10_HL_Winter_2017_Q17) - <i>Electricity &amp; Magnetism</i><br><br>A  |                   |                                                                                     |
| <b>9</b> - (PHYSI/10_HL_Winter_2017_Q18) - <i>Electricity &amp; Magnetism</i><br><br>B  |                   |                                                                                     |
| <b>10</b> - (PHYSI/11_HL_Summer_2018_Q15) - <i>Electricity &amp; Magnetism</i><br><br>C |                   |                                                                                     |

**11** - (PHYSI/11\_HL\_Summer\_2018\_Q16) - *Electricity & Magnetism*

A



**12** - (PHYSI/11\_HL\_Summer\_2018\_Q17) - *Electricity & Magnetism*

C

**13** - (PHYSI/12\_HL\_Summer\_2018\_Q14) - *Electricity & Magnetism*

C

**14** - (PHYSI/12\_HL\_Summer\_2018\_Q15) - *Electricity & Magnetism*

C

**15** - (PHYSI/12\_HL\_Summer\_2018\_Q16) - *Electricity & Magnetism*

C

**16** - (PHYSI/10\_HL\_Winter\_2018\_Q16) - *Electricity & Magnetism*

B

**17** - (PHYSI/10\_HL\_Winter\_2018\_Q17) - *Electricity & Magnetism*

C

**18** - (PHYSI/10\_HL\_Winter\_2018\_Q19) - *Electricity & Magnetism*

B

**19** - (PHYSI/10\_HL\_Winter\_2018\_Q24) - *Electricity & Magnetism, Energy Production*

D

| IB DIPLOMA                                                                                                                      | PHYSICS – HL – P1 | CH5 - ELECTRICITY & MAGNETISM                                                       |
|---------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>20</b> - (PHYSI/10_HL_Winter_2018_Q30) - <i>Electricity &amp; Magnetism</i></p> <p>D</p>                                  |                   |  |
| <p><b>21</b> - (PHYSI/10_HL_Winter_2018_Q33) - <i>Electricity &amp; Magnetism, Electromagnetic Induction (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>22</b> - (PHYSI/10_HL_Winter_2018_Q34) - <i>Electricity &amp; Magnetism</i></p> <p>C</p>                                  |                   |                                                                                     |
| <p><b>23</b> - (PHYSI/10_HL_Winter_2018_Q35) - <i>Electricity &amp; Magnetism</i></p> <p>A</p>                                  |                   |                                                                                     |
| <p><b>24</b> - (PHYSI/10_HL_Winter_2018_Q36) - <i>Electricity &amp; Magnetism</i></p> <p>C</p>                                  |                   |                                                                                     |
| <p><b>25</b> - (PHYSI/11_HL_Summer_2019_Q15) - <i>Electricity &amp; Magnetism</i></p> <p>D</p>                                  |                   |                                                                                     |
| <p><b>26</b> - (PHYSI/11_HL_Summer_2019_Q16) - <i>Electricity &amp; Magnetism</i></p> <p>A</p>                                  |                   |                                                                                     |
| <p><b>27</b> - (PHYSI/11_HL_Summer_2019_Q17) - <i>Electricity &amp; Magnetism</i></p> <p>B</p>                                  |                   |                                                                                     |
| <p><b>28</b> - (PHYSI/11_HL_Summer_2019_Q18) - <i>Electricity &amp; Magnetism</i></p> <p>A</p>                                  |                   |                                                                                     |



| IB DIPLOMA                                                                                                                      | PHYSICS – HL – P1 | CH5 - ELECTRICITY & MAGNETISM                                                       |
|---------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>29</b> - (PHYSI/11_HL_Summer_2019_Q19) - <i>Electricity &amp; Magnetism</i></p> <p>B</p>                                  |                   |  |
| <p><b>30</b> - (PHYSI/11_HL_Summer_2019_Q36) - <i>Electromagnetic Induction (ahl), Electricity &amp; Magnetism</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>31</b> - (PHYSI/11_HL_Summer_2019_Q37) - <i>Electromagnetic Induction (ahl), Electricity &amp; Magnetism</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>32</b> - (PHYSI/12_HL_Summer_2019_Q23) - <i>Electricity &amp; Magnetism</i></p> <p>B</p>                                  |                   |                                                                                     |
| <p><b>33</b> - (PHYSI/12_HL_Summer_2019_Q24) - <i>Electricity &amp; Magnetism</i></p> <p>C</p>                                  |                   |                                                                                     |
| <p><b>34</b> - (PHYSI/12_HL_Summer_2019_Q25) - <i>Electricity &amp; Magnetism</i></p> <p>D</p>                                  |                   |                                                                                     |
| <p><b>35</b> - (PHYSI/12_HL_Summer_2019_Q26) - <i>Electricity &amp; Magnetism</i></p> <p>A</p>                                  |                   |                                                                                     |
| <p><b>36</b> - (PHYSI/12_HL_Summer_2019_Q27) - <i>Electromagnetic Induction (ahl), Electricity &amp; Magnetism</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>37</b> - (PHYSI/12_HL_Summer_2019_Q28) - <i>Electricity &amp; Magnetism, Electromagnetic Induction (ahl)</i></p> <p>D</p> |                   |                                                                                     |

**38** - (PHYSI/12\_HL\_Summer\_2019\_Q29) - *Electricity & Magnetism, Electromagnetic Induction (ahl)*

C



**39** - (PHYSI/12\_HL\_Summer\_2019\_Q30) - *Electricity & Magnetism, Fields (ahl)*

D

**40** - (PHYSI/10\_HL\_Winter\_2019\_Q15) - *Electricity & Magnetism*

A

**41** - (PHYSI/10\_HL\_Winter\_2019\_Q16) - *Electricity & Magnetism*

B

**42** - (PHYSI/10\_HL\_Winter\_2019\_Q17) - *Electricity & Magnetism*

D

**43** - (PHYSI/10\_HL\_Winter\_2019\_Q31) - *Electricity & Magnetism, Fields (ahl)*

C

**44** - (PHYSI/10\_HL\_Winter\_2019\_Q32) - *Electricity & Magnetism*

B

**45** - (PHYSI/10\_HL\_Winter\_2020\_Q14) - *Electricity & Magnetism*

B

**46** - (PHYSI/10\_HL\_Winter\_2020\_Q15) - *Electricity & Magnetism*

D

| IB DIPLOMA                                                                                     | PHYSICS – HL – P1 | CH5 - ELECTRICITY & MAGNETISM                                                       |
|------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>47</b> - (PHYSI/10_HL_Winter_2020_Q16) - <i>Electricity &amp; Magnetism</i></p> <p>D</p> |                   |  |
| <p><b>48</b> - (PHYSI/10_HL_Winter_2020_Q17) - <i>Electricity &amp; Magnetism</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>49</b> - (PHYSI/10_HL_Winter_2020_Q18) - <i>Electricity &amp; Magnetism</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>50</b> - (PHYSI/10_HL_Winter_2020_Q19) - <i>Electricity &amp; Magnetism</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>51</b> - (PHYSI/11_HL_Summer_2021_Q15) - <i>Electricity &amp; Magnetism</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>52</b> - (PHYSI/11_HL_Summer_2021_Q16) - <i>Electricity &amp; Magnetism</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>53</b> - (PHYSI/11_HL_Summer_2021_Q17) - <i>Electricity &amp; Magnetism</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>54</b> - (PHYSI/11_HL_Summer_2021_Q18) - <i>Electricity &amp; Magnetism</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>55</b> - (PHYSI/12_HL_Summer_2021_Q15) - <i>Electricity &amp; Magnetism</i></p> <p>D</p> |                   |                                                                                     |

**56** - (PHYSI/12\_HL\_Summer\_2021\_Q16) - *Electricity & Magnetism*

C



**57** - (PHYSI/12\_HL\_Summer\_2021\_Q17) - *Electricity & Magnetism*

C

**58** - (PHYSI/12\_HL\_Summer\_2021\_Q18) - *Electricity & Magnetism*

B

**59** - (PHYSI/10\_HL\_Winter\_2021\_Q15) - *Electricity & Magnetism*

C

**60** - (PHYSI/10\_HL\_Winter\_2021\_Q16) - *Electricity & Magnetism*

A

**61** - (PHYSI/10\_HL\_Winter\_2021\_Q17) - *Electricity & Magnetism*

C

**62** - (PHYSI/10\_HL\_Winter\_2021\_Q18) - *Electricity & Magnetism*

A

**63** - (PHYSI/11\_HL\_Summer\_2022\_Q18) - *Electricity & Magnetism*

B

**64** - (PHYSI/11\_HL\_Summer\_2022\_Q19) - *Electricity & Magnetism*

C

65 - (PHYSI/11\_HL\_Summer\_2022\_Q20) - *Electricity & Magnetism*

B



66 - (PHYSI/11\_HL\_Summer\_2022\_Q21) - *Electricity & Magnetism*

A

67 - (PHYSI/11\_HL\_Summer\_2022\_Q22) - *Electricity & Magnetism*

C

68 - (PHYSI/12\_HL\_Summer\_2022\_Q16) - *Electricity & Magnetism*

D

69 - (PHYSI/12\_HL\_Summer\_2022\_Q17) - *Electricity & Magnetism*

A

70 - (PHYSI/12\_HL\_Summer\_2022\_Q18) - *Electricity & Magnetism*

B

71 - (PHYSI/12\_HL\_Summer\_2022\_Q19) - *Electricity & Magnetism*

A

72 - (PHYSI/10\_HL\_Winter\_2022\_Q16) - *Electricity & Magnetism*

D

73 - (PHYSI/10\_HL\_Winter\_2022\_Q17) - *Electricity & Magnetism*

B

74 - (PHYSI/10\_HL\_Winter\_2022\_Q18) - *Electricity & Magnetism*



D

1 - (PHYSI/11\_HL\_Summer\_2017\_Q19) - *Circular Motion & Gravitation*

A



2 - (PHYSI/12\_HL\_Summer\_2017\_Q18) - *Circular Motion & Gravitation*

D

3 - (PHYSI/12\_HL\_Summer\_2017\_Q19) - *Circular Motion & Gravitation*

A

4 - (PHYSI/10\_HL\_Winter\_2017\_Q19) - *Circular Motion & Gravitation*

B

5 - (PHYSI/11\_HL\_Summer\_2018\_Q18) - *Circular Motion & Gravitation*

A

6 - (PHYSI/11\_HL\_Summer\_2018\_Q32) - *Circular Motion & Gravitation*

A

7 - (PHYSI/12\_HL\_Summer\_2018\_Q17) - *Circular Motion & Gravitation*

D

8 - (PHYSI/10\_HL\_Winter\_2018\_Q5) - *Circular Motion & Gravitation*

A

9 - (PHYSI/10\_HL\_Winter\_2018\_Q11) - *Circular Motion & Gravitation*

B

10 - (PHYSI/10\_HL\_Winter\_2018\_Q31) - *Circular Motion & Gravitation*

A

| IB DIPLOMA                                                                                                                     | PHYSICS –HL –P1 | CH6 - CIRCULAR MOTION & GRAVITATION                                                 |
|--------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <b>11</b> - (PHYSI/10_HL_Winter_2018_Q32) - <i>Circular Motion &amp; Gravitation</i><br><br><b>D</b>                           |                 |  |
| <b>12</b> - (PHYSI/11_HL_Summer_2019_Q20) - <i>Circular Motion &amp; Gravitation</i><br><br><b>D</b>                           |                 |                                                                                     |
| <b>13</b> - (PHYSI/11_HL_Summer_2019_Q21) - <i>Circular Motion &amp; Gravitation</i><br><br><b>A</b>                           |                 |                                                                                     |
| <b>14</b> - (PHYSI/12_HL_Summer_2019_Q10) - <i>Mechanics, Circular Motion &amp; Gravitation</i><br><br><b>B</b>                |                 |                                                                                     |
| <b>15</b> - (PHYSI/12_HL_Summer_2019_Q11) - <i>Circular Motion &amp; Gravitation</i><br><br><b>A</b>                           |                 |                                                                                     |
| <b>16</b> - (PHYSI/12_HL_Summer_2019_Q32) - <i>Circular Motion &amp; Gravitation</i><br><br><b>D</b>                           |                 |                                                                                     |
| <b>17</b> - (PHYSI/12_HL_Summer_2019_Q37) - <i>Oscillations &amp; Waves, Circular Motion &amp; Gravitation</i><br><br><b>D</b> |                 |                                                                                     |
| <b>18</b> - (PHYSI/10_HL_Winter_2019_Q18) - <i>Circular Motion &amp; Gravitation</i><br><br><b>A</b>                           |                 |                                                                                     |
| <b>19</b> - (PHYSI/10_HL_Winter_2020_Q20) - <i>Circular Motion &amp; Gravitation</i><br><br><b>D</b>                           |                 |                                                                                     |



**20** - (PHYSI/11\_HL\_Summer\_2021\_Q19) - *Circular Motion & Gravitation*

B



**21** - (PHYSI/12\_HL\_Summer\_2021\_Q19) - *Circular Motion & Gravitation*

A

**22** - (PHYSI/10\_HL\_Winter\_2021\_Q19) - *Circular Motion & Gravitation*

D

**23** - (PHYSI/11\_HL\_Summer\_2022\_Q23) - *Circular Motion & Gravitation*

B

**24** - (PHYSI/11\_HL\_Summer\_2022\_Q24) - *Circular Motion & Gravitation*

D

**25** - (PHYSI/12\_HL\_Summer\_2022\_Q20) - *Circular Motion & Gravitation*

D

**26** - (PHYSI/12\_HL\_Summer\_2022\_Q21) - *Circular Motion & Gravitation*

B

**27** - (PHYSI/10\_HL\_Winter\_2022\_Q19) - *Circular Motion & Gravitation*

C

**28** - (PHYSI/10\_HL\_Winter\_2022\_Q20) - *Circular Motion & Gravitation*

C

| IB DIPLOMA                                                                                                        | PHYSICS – HL – P1 | CH7 - ATOMIC,NUCLEAR & PARTICLE PHYSICS                                             |
|-------------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>1</b> - (PHYSI/11_HL_Summer_2017_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>D</b>           |                   |  |
| <b>2</b> - (PHYSI/11_HL_Summer_2017_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>A</b>           |                   |                                                                                     |
| <b>3</b> - (PHYSI/11_HL_Summer_2017_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>A</b>           |                   |                                                                                     |
| <b>4</b> - (PHYSI/12_HL_Summer_2017_Q7) - <i>Mechanics, Atomic,nuclear &amp; Particle Physics</i><br><br><b>D</b> |                   |                                                                                     |
| <b>5</b> - (PHYSI/12_HL_Summer_2017_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>C</b>           |                   |                                                                                     |
| <b>6</b> - (PHYSI/12_HL_Summer_2017_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>C</b>           |                   |                                                                                     |
| <b>7</b> - (PHYSI/12_HL_Summer_2017_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>B</b>           |                   |                                                                                     |
| <b>8</b> - (PHYSI/10_HL_Winter_2017_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>D</b>           |                   |                                                                                     |
| <b>9</b> - (PHYSI/10_HL_Winter_2017_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>B</b>           |                   |                                                                                     |
| <b>10</b> - (PHYSI/10_HL_Winter_2017_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>C</b>          |                   |                                                                                     |

| IB DIPLOMA                                                                                               | PHYSICS –HL –P1 | CH7 - ATOMIC,NUCLEAR & PARTICLE PHYSICS                                             |
|----------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <b>11</b> - (PHYSI/10_HL_Winter_2017_Q23) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>D</b> |                 |  |
| <b>12</b> - (PHYSI/11_HL_Summer_2018_Q19) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>A</b> |                 |                                                                                     |
| <b>13</b> - (PHYSI/11_HL_Summer_2018_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>C</b> |                 |                                                                                     |
| <b>14</b> - (PHYSI/11_HL_Summer_2018_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>A</b> |                 |                                                                                     |
| <b>15</b> - (PHYSI/12_HL_Summer_2018_Q18) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>D</b> |                 |                                                                                     |
| <b>16</b> - (PHYSI/12_HL_Summer_2018_Q19) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>A</b> |                 |                                                                                     |
| <b>17</b> - (PHYSI/12_HL_Summer_2018_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>B</b> |                 |                                                                                     |
| <b>18</b> - (PHYSI/10_HL_Winter_2018_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>B</b> |                 |                                                                                     |
| <b>19</b> - (PHYSI/10_HL_Winter_2018_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br><b>A</b> |                 |                                                                                     |

| IB DIPLOMA                                                                                               | PHYSICS – HL – P1 | CH7 - ATOMIC,NUCLEAR & PARTICLE PHYSICS                                             |
|----------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>20</b> - (PHYSI/10_HL_Winter_2018_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                   |  |
| <p><b>21</b> - (PHYSI/10_HL_Winter_2018_Q23) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>22</b> - (PHYSI/10_HL_Winter_2018_Q38) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>23</b> - (PHYSI/10_HL_Winter_2018_Q39) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>24</b> - (PHYSI/10_HL_Winter_2018_Q40) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>25</b> - (PHYSI/11_HL_Summer_2019_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>26</b> - (PHYSI/11_HL_Summer_2019_Q23) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>27</b> - (PHYSI/11_HL_Summer_2019_Q24) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>28</b> - (PHYSI/12_HL_Summer_2019_Q31) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                   |                                                                                     |

| IB DIPLOMA                                                                                                                                    | PHYSICS – HL – P1 | CH7 - ATOMIC,NUCLEAR & PARTICLE PHYSICS                                             |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>29</b> - (PHYSI/12_HL_Summer_2019_Q33) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>A</p> |                   |  |
| <p><b>30</b> - (PHYSI/12_HL_Summer_2019_Q34) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>31</b> - (PHYSI/12_HL_Summer_2019_Q35) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>32</b> - (PHYSI/12_HL_Summer_2019_Q36) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>33</b> - (PHYSI/12_HL_Summer_2019_Q40) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>34</b> - (PHYSI/10_HL_Winter_2019_Q19) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p>                                      |                   |                                                                                     |
| <p><b>35</b> - (PHYSI/10_HL_Winter_2019_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>A</p>                                      |                   |                                                                                     |
| <p><b>36</b> - (PHYSI/10_HL_Winter_2019_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p>                                      |                   |                                                                                     |
| <p><b>37</b> - (PHYSI/10_HL_Winter_2019_Q40) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>A</p> |                   |                                                                                     |

| IB DIPLOMA                                                                                                                             | PHYSICS –HL –P1 | CH7 - ATOMIC,NUCLEAR & PARTICLE PHYSICS                                             |
|----------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <b>38</b> - (PHYSI/10_HL_Winter_2020_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br>A                                      |                 |  |
| <b>39</b> - (PHYSI/10_HL_Winter_2020_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br>A                                      |                 |                                                                                     |
| <b>40</b> - (PHYSI/10_HL_Winter_2020_Q23) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br>B                                      |                 |                                                                                     |
| <b>41</b> - (PHYSI/10_HL_Winter_2020_Q24) - <i>Atomic,nuclear &amp; Particle Physics, Energy Production</i><br><br>A                   |                 |                                                                                     |
| <b>42</b> - (PHYSI/10_HL_Winter_2020_Q40) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i><br><br>C |                 |                                                                                     |
| <b>43</b> - (PHYSI/11_HL_Summer_2021_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br>C                                      |                 |                                                                                     |
| <b>44</b> - (PHYSI/11_HL_Summer_2021_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br>B                                      |                 |                                                                                     |
| <b>45</b> - (PHYSI/11_HL_Summer_2021_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br>A                                      |                 |                                                                                     |
| <b>46</b> - (PHYSI/11_HL_Summer_2021_Q23) - <i>Atomic,nuclear &amp; Particle Physics</i><br><br>A                                      |                 |                                                                                     |

| IB DIPLOMA                                                                                        | PHYSICS –HL –P1 | CH7 - ATOMIC,NUCLEAR & PARTICLE PHYSICS                                             |
|---------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <p>47 - (PHYSI/12_HL_Summer_2021_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                 |  |
| <p>48 - (PHYSI/12_HL_Summer_2021_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                 |                                                                                     |
| <p>49 - (PHYSI/12_HL_Summer_2021_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>A</p> |                 |                                                                                     |
| <p>50 - (PHYSI/12_HL_Summer_2021_Q23) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                 |                                                                                     |
| <p>51 - (PHYSI/10_HL_Winter_2021_Q20) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>C</p> |                 |                                                                                     |
| <p>52 - (PHYSI/10_HL_Winter_2021_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                 |                                                                                     |
| <p>53 - (PHYSI/10_HL_Winter_2021_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                 |                                                                                     |
| <p>54 - (PHYSI/10_HL_Winter_2021_Q23) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>C</p> |                 |                                                                                     |
| <p>55 - (PHYSI/11_HL_Summer_2022_Q25) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                 |                                                                                     |

| IB DIPLOMA                                                                                        | PHYSICS –HL –P1 | CH7 - ATOMIC,NUCLEAR & PARTICLE PHYSICS                                             |
|---------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <p>56 - (PHYSI/11_HL_Summer_2022_Q26) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                 |  |
| <p>57 - (PHYSI/11_HL_Summer_2022_Q27) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                 |                                                                                     |
| <p>58 - (PHYSI/12_HL_Summer_2022_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                 |                                                                                     |
| <p>59 - (PHYSI/12_HL_Summer_2022_Q23) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                 |                                                                                     |
| <p>60 - (PHYSI/12_HL_Summer_2022_Q24) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                 |                                                                                     |
| <p>61 - (PHYSI/12_HL_Summer_2022_Q25) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                 |                                                                                     |
| <p>62 - (PHYSI/10_HL_Winter_2022_Q21) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                 |                                                                                     |
| <p>63 - (PHYSI/10_HL_Winter_2022_Q22) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>B</p> |                 |                                                                                     |
| <p>64 - (PHYSI/10_HL_Winter_2022_Q23) - <i>Atomic,nuclear &amp; Particle Physics</i></p> <p>D</p> |                 |                                                                                     |



65 – (PHYSI/10\_HL\_Winter\_2022\_Q24) – *Atomic, nuclear & Particle Physics*



C

| IB DIPLOMA                                                                           | PHYSICS – HL – P1 | CH8 - ENERGY PRODUCTION                                                             |
|--------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>1</b> - (PHYSI/11_HL_Summer_2017_Q23) - <i>Energy Production</i><br><br><b>B</b>  |                   |  |
| <b>2</b> - (PHYSI/11_HL_Summer_2017_Q24) - <i>Energy Production</i><br><br><b>D</b>  |                   |                                                                                     |
| <b>3</b> - (PHYSI/11_HL_Summer_2017_Q25) - <i>Energy Production</i><br><br><b>D</b>  |                   |                                                                                     |
| <b>4</b> - (PHYSI/12_HL_Summer_2017_Q23) - <i>Energy Production</i><br><br><b>A</b>  |                   |                                                                                     |
| <b>5</b> - (PHYSI/12_HL_Summer_2017_Q24) - <i>Energy Production</i><br><br><b>D</b>  |                   |                                                                                     |
| <b>6</b> - (PHYSI/10_HL_Winter_2017_Q24) - <i>Energy Production</i><br><br><b>C</b>  |                   |                                                                                     |
| <b>7</b> - (PHYSI/10_HL_Winter_2017_Q25) - <i>Energy Production</i><br><br><b>B</b>  |                   |                                                                                     |
| <b>8</b> - (PHYSI/10_HL_Winter_2017_Q26) - <i>Energy Production</i><br><br><b>A</b>  |                   |                                                                                     |
| <b>9</b> - (PHYSI/11_HL_Summer_2018_Q22) - <i>Energy Production</i><br><br><b>B</b>  |                   |                                                                                     |
| <b>10</b> - (PHYSI/11_HL_Summer_2018_Q23) - <i>Energy Production</i><br><br><b>B</b> |                   |                                                                                     |

| IB DIPLOMA                                                                                                 | PHYSICS – HL – P1 | CH8 - ENERGY PRODUCTION                                                             |
|------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>11</b> - (PHYSI/11_HL_Summer_2018_Q24) - <i>Energy Production</i><br><br>A                              |                   |  |
| <b>12</b> - (PHYSI/11_HL_Summer_2018_Q25) - <i>Energy Production</i><br><br>A                              |                   |                                                                                     |
| <b>13</b> - (PHYSI/12_HL_Summer_2018_Q21) - <i>Energy Production</i><br><br>D                              |                   |                                                                                     |
| <b>14</b> - (PHYSI/12_HL_Summer_2018_Q22) - <i>Energy Production</i><br><br>A                              |                   |                                                                                     |
| <b>15</b> - (PHYSI/12_HL_Summer_2018_Q23) - <i>Energy Production</i><br><br>A                              |                   |                                                                                     |
| <b>16</b> - (PHYSI/10_HL_Winter_2018_Q24) - <i>Electricity &amp; Magnetism, Energy Production</i><br><br>D |                   |                                                                                     |
| <b>17</b> - (PHYSI/10_HL_Winter_2018_Q25) - <i>Energy Production</i><br><br>B                              |                   |                                                                                     |
| <b>18</b> - (PHYSI/11_HL_Summer_2019_Q25) - <i>Energy Production</i><br><br>B                              |                   |                                                                                     |
| <b>19</b> - (PHYSI/10_HL_Winter_2019_Q23) - <i>Energy Production</i><br><br>B                              |                   |                                                                                     |

**20** - (PHYSI/10\_HL\_Winter\_2019\_Q24) - *Energy Production*

A



**21** - (PHYSI/10\_HL\_Winter\_2019\_Q25) - *Energy Production*

C

**22** - (PHYSI/10\_HL\_Winter\_2020\_Q24) - *Atomic,nuclear & Particle Physics, Energy Production*

A

**23** - (PHYSI/10\_HL\_Winter\_2020\_Q25) - *Energy Production*

B

**24** - (PHYSI/10\_HL\_Winter\_2020\_Q26) - *Energy Production*

C

**25** - (PHYSI/11\_HL\_Summer\_2021\_Q24) - *Energy Production*

B

**26** - (PHYSI/11\_HL\_Summer\_2021\_Q25) - *Energy Production*

D

**27** - (PHYSI/12\_HL\_Summer\_2021\_Q24) - *Energy Production*

B

**28** - (PHYSI/12\_HL\_Summer\_2021\_Q25) - *Energy Production*

C

**29** - (PHYSI/10\_HL\_Winter\_2021\_Q24) - *Energy Production*

A



**30** - (PHYSI/10\_HL\_Winter\_2021\_Q25) - *Energy Production*

B

**31** - (PHYSI/11\_HL\_Summer\_2022\_Q28) - *Energy Production*

D

**32** - (PHYSI/11\_HL\_Summer\_2022\_Q29) - *Energy Production*

A

**33** - (PHYSI/12\_HL\_Summer\_2022\_Q26) - *Energy Production*

A

**34** - (PHYSI/12\_HL\_Summer\_2022\_Q27) - *Energy Production*

D

**35** - (PHYSI/12\_HL\_Summer\_2022\_Q28) - *Energy Production*

C

**36** - (PHYSI/10\_HL\_Winter\_2022\_Q25) - *Energy Production*

B

**37** - (PHYSI/10\_HL\_Winter\_2022\_Q26) - *Energy Production*

A

1 - (PHYSI/11\_HL\_Summer\_2017\_Q27) - *Wave Phenomena (ahl)*

B



2 - (PHYSI/11\_HL\_Summer\_2017\_Q28) - *Wave Phenomena (ahl)*

A

3 - (PHYSI/12\_HL\_Summer\_2017\_Q27) - *Wave Phenomena (ahl)*

D

4 - (PHYSI/12\_HL\_Summer\_2017\_Q28) - *Wave Phenomena (ahl)*

C

5 - (PHYSI/12\_HL\_Summer\_2017\_Q29) - *Wave Phenomena (ahl)*

D

6 - (PHYSI/10\_HL\_Winter\_2017\_Q27) - *Wave Phenomena (ahl)*

B

7 - (PHYSI/10\_HL\_Winter\_2017\_Q28) - *Wave Phenomena (ahl)*

A

8 - (PHYSI/10\_HL\_Winter\_2017\_Q29) - *Wave Phenomena (ahl)*

A

9 - (PHYSI/10\_HL\_Winter\_2017\_Q30) - *Wave Phenomena (ahl)*

A

10 - (PHYSI/11\_HL\_Summer\_2018\_Q27) - *Wave Phenomena (ahl)*

C

**11** - (PHYSI/11\_HL\_Summer\_2018\_Q28) - *Wave Phenomena (ahl)*

C



**12** - (PHYSI/11\_HL\_Summer\_2018\_Q29) - *Wave Phenomena (ahl)*

C

**13** - (PHYSI/12\_HL\_Summer\_2018\_Q25) - *Wave Phenomena (ahl)*

B

**14** - (PHYSI/12\_HL\_Summer\_2018\_Q26) - *Wave Phenomena (ahl)*

D

**15** - (PHYSI/12\_HL\_Summer\_2018\_Q27) - *Wave Phenomena (ahl)*

A

**16** - (PHYSI/10\_HL\_Winter\_2018\_Q27) - *Wave Phenomena (ahl)*

C

**17** - (PHYSI/10\_HL\_Winter\_2018\_Q28) - *Oscillations & Waves, Wave Phenomena (ahl)*

B

**18** - (PHYSI/11\_HL\_Summer\_2019\_Q27) - *Oscillations & Waves, Wave Phenomena (ahl)*

D

**19** - (PHYSI/11\_HL\_Summer\_2019\_Q28) - *Oscillations & Waves, Wave Phenomena (ahl)*

D

**20** - (PHYSI/11\_HL\_Summer\_2019\_Q29) - *Oscillations & Waves, Wave Phenomena (ahl)*

C



**21** - (PHYSI/11\_HL\_Summer\_2019\_Q30) - *Oscillations & Waves, Wave Phenomena (ahl)*

B

**22** - (PHYSI/11\_HL\_Summer\_2019\_Q31) - *Oscillations & Waves, Wave Phenomena (ahl)*

D

**23** - (PHYSI/10\_HL\_Winter\_2019\_Q27) - *Oscillations & Waves, Wave Phenomena (ahl)*

A

**24** - (PHYSI/10\_HL\_Winter\_2019\_Q28) - *Oscillations & Waves, Wave Phenomena (ahl)*

C

**25** - (PHYSI/10\_HL\_Winter\_2019\_Q29) - *Wave Phenomena (ahl)*

B

**26** - (PHYSI/10\_HL\_Winter\_2020\_Q27) - *Wave Phenomena (ahl)*

C

**27** - (PHYSI/10\_HL\_Winter\_2020\_Q28) - *Wave Phenomena (ahl)*

B

**28** - (PHYSI/10\_HL\_Winter\_2020\_Q29) - *Wave Phenomena (ahl)*

B



**29** - (PHYSI/11\_HL\_Summer\_2021\_Q26) - *Wave Phenomena (ahl)*

D



**30** - (PHYSI/11\_HL\_Summer\_2021\_Q27) - *Wave Phenomena (ahl)*

A

**31** - (PHYSI/11\_HL\_Summer\_2021\_Q28) - *Wave Phenomena (ahl)*

C

**32** - (PHYSI/11\_HL\_Summer\_2021\_Q29) - *Wave Phenomena (ahl)*

D

**33** - (PHYSI/12\_HL\_Summer\_2021\_Q26) - *Wave Phenomena (ahl)*

C

**34** - (PHYSI/12\_HL\_Summer\_2021\_Q27) - *Wave Phenomena (ahl)*

A

**35** - (PHYSI/12\_HL\_Summer\_2021\_Q28) - *Wave Phenomena (ahl)*

B

**36** - (PHYSI/12\_HL\_Summer\_2021\_Q29) - *Wave Phenomena (ahl)*

C

**37** - (PHYSI/10\_HL\_Winter\_2021\_Q26) - *Wave Phenomena (ahl)*

D

**38** - (PHYSI/10\_HL\_Winter\_2021\_Q27) - *Wave Phenomena (ahl)*

B



**39** - (PHYSI/10\_HL\_Winter\_2021\_Q28) - *Wave Phenomena (ahl)*

A

**40** - (PHYSI/10\_HL\_Winter\_2021\_Q29) - *Wave Phenomena (ahl)*

A

**41** - (PHYSI/11\_HL\_Summer\_2022\_Q30) - *Wave Phenomena (ahl)*

B

**42** - (PHYSI/11\_HL\_Summer\_2022\_Q31) - *Wave Phenomena (ahl)*

C

**43** - (PHYSI/12\_HL\_Summer\_2022\_Q29) - *Wave Phenomena (ahl)*

A

**44** - (PHYSI/12\_HL\_Summer\_2022\_Q30) - *Wave Phenomena (ahl)*

A

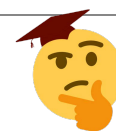
**45** - (PHYSI/12\_HL\_Summer\_2022\_Q31) - *Wave Phenomena (ahl)*

B

**46** - (PHYSI/10\_HL\_Winter\_2022\_Q27) - *Wave Phenomena (ahl)*

A

**47** - (PHYSI/10\_HL\_Winter\_2022\_Q28) - *Wave Phenomena (ahl)*



C

**48** - (PHYSI/10\_HL\_Winter\_2022\_Q29) - *Wave Phenomena (ahl)*

A

| IB DIPLOMA                                                               | PHYSICS – HL – P1 | CH10 - FIELDS (AHL)                                                                 |
|--------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>1</b> - (PHYSI/11_HL_Summer_2017_Q26) - <i>Fields (ahl)</i><br><br>C  |                   |  |
| <b>2</b> - (PHYSI/11_HL_Summer_2017_Q29) - <i>Fields (ahl)</i><br><br>B  |                   |                                                                                     |
| <b>3</b> - (PHYSI/11_HL_Summer_2017_Q30) - <i>Fields (ahl)</i><br><br>C  |                   |                                                                                     |
| <b>4</b> - (PHYSI/11_HL_Summer_2017_Q31) - <i>Fields (ahl)</i><br><br>B  |                   |                                                                                     |
| <b>5</b> - (PHYSI/12_HL_Summer_2017_Q15) - <i>Fields (ahl)</i><br><br>B  |                   |                                                                                     |
| <b>6</b> - (PHYSI/12_HL_Summer_2017_Q30) - <i>Fields (ahl)</i><br><br>B  |                   |                                                                                     |
| <b>7</b> - (PHYSI/12_HL_Summer_2017_Q31) - <i>Fields (ahl)</i><br><br>B  |                   |                                                                                     |
| <b>8</b> - (PHYSI/12_HL_Summer_2017_Q32) - <i>Fields (ahl)</i><br><br>C  |                   |                                                                                     |
| <b>9</b> - (PHYSI/10_HL_Winter_2017_Q32) - <i>Fields (ahl)</i><br><br>C  |                   |                                                                                     |
| <b>10</b> - (PHYSI/10_HL_Winter_2017_Q33) - <i>Fields (ahl)</i><br><br>B |                   |                                                                                     |

| IB DIPLOMA                                                                      | PHYSICS – HL – P1 | CH10 - FIELDS (AHL)                                                                 |
|---------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>11</b> - (PHYSI/11_HL_Summer_2018_Q30) - <i>Fields (ahl)</i></p> <p>D</p> |                   |  |
| <p><b>12</b> - (PHYSI/11_HL_Summer_2018_Q31) - <i>Fields (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>13</b> - (PHYSI/11_HL_Summer_2018_Q36) - <i>Fields (ahl)</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>14</b> - (PHYSI/12_HL_Summer_2018_Q28) - <i>Fields (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>15</b> - (PHYSI/12_HL_Summer_2018_Q29) - <i>Fields (ahl)</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>16</b> - (PHYSI/12_HL_Summer_2018_Q30) - <i>Fields (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>17</b> - (PHYSI/12_HL_Summer_2018_Q31) - <i>Fields (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>18</b> - (PHYSI/12_HL_Summer_2018_Q32) - <i>Fields (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>19</b> - (PHYSI/11_HL_Summer_2019_Q32) - <i>Fields (ahl)</i></p> <p>D</p> |                   |                                                                                     |

| IB DIPLOMA                                                                                                   | PHYSICS – HL – P1 | CH10 - FIELDS (AHL)                                                                 |
|--------------------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>20</b> - (PHYSI/11_HL_Summer_2019_Q33) - <i>Fields (ahl)</i></p> <p>C</p>                              |                   |  |
| <p><b>21</b> - (PHYSI/11_HL_Summer_2019_Q34) - <i>Fields (ahl)</i></p> <p>C</p>                              |                   |                                                                                     |
| <p><b>22</b> - (PHYSI/12_HL_Summer_2019_Q30) - <i>Electricity &amp; Magnetism, Fields (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>23</b> - (PHYSI/10_HL_Winter_2019_Q30) - <i>Fields (ahl)</i></p> <p>D</p>                              |                   |                                                                                     |
| <p><b>24</b> - (PHYSI/10_HL_Winter_2019_Q31) - <i>Electricity &amp; Magnetism, Fields (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>25</b> - (PHYSI/10_HL_Winter_2020_Q30) - <i>Fields (ahl)</i></p> <p>D</p>                              |                   |                                                                                     |
| <p><b>26</b> - (PHYSI/10_HL_Winter_2020_Q31) - <i>Fields (ahl)</i></p> <p>C</p>                              |                   |                                                                                     |
| <p><b>27</b> - (PHYSI/10_HL_Winter_2020_Q32) - <i>Fields (ahl)</i></p> <p>B</p>                              |                   |                                                                                     |
| <p><b>28</b> - (PHYSI/11_HL_Summer_2021_Q30) - <i>Fields (ahl)</i></p> <p>D</p>                              |                   |                                                                                     |

| IB DIPLOMA                                                                      | PHYSICS – HL – P1 | CH10 - FIELDS (AHL)                                                                 |
|---------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>29</b> - (PHYSI/11_HL_Summer_2021_Q31) - <i>Fields (ahl)</i></p> <p>A</p> |                   |  |
| <p><b>30</b> - (PHYSI/11_HL_Summer_2021_Q32) - <i>Fields (ahl)</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>31</b> - (PHYSI/12_HL_Summer_2021_Q30) - <i>Fields (ahl)</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>32</b> - (PHYSI/12_HL_Summer_2021_Q31) - <i>Fields (ahl)</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>33</b> - (PHYSI/12_HL_Summer_2021_Q32) - <i>Fields (ahl)</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>34</b> - (PHYSI/10_HL_Winter_2021_Q30) - <i>Fields (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>35</b> - (PHYSI/10_HL_Winter_2021_Q31) - <i>Fields (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>36</b> - (PHYSI/10_HL_Winter_2021_Q32) - <i>Fields (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>37</b> - (PHYSI/11_HL_Summer_2022_Q32) - <i>Fields (ahl)</i></p> <p>A</p> |                   |                                                                                     |

| IB DIPLOMA                                                                      | PHYSICS – HL – P1 | CH10 - FIELDS (AHL)                                                                 |
|---------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>38</b> - (PHYSI/11_HL_Summer_2022_Q33) - <i>Fields (ahl)</i></p> <p>B</p> |                   |  |
| <p><b>39</b> - (PHYSI/12_HL_Summer_2022_Q32) - <i>Fields (ahl)</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>40</b> - (PHYSI/12_HL_Summer_2022_Q33) - <i>Fields (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>41</b> - (PHYSI/10_HL_Winter_2022_Q30) - <i>Fields (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>42</b> - (PHYSI/10_HL_Winter_2022_Q31) - <i>Fields (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>43</b> - (PHYSI/10_HL_Winter_2022_Q32) - <i>Fields (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>44</b> - (PHYSI/10_HL_Winter_2022_Q33) - <i>Fields (ahl)</i></p> <p>B</p> |                   |                                                                                     |



| IB DIPLOMA                                                                                  | PHYSICS – HL – P1 | CH11 - ELECTROMAGNETIC<br>INDUCTION (AHL)                                           |
|---------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <b>1</b> - (PHYSI/11_HL_Summer_2017_Q32) - <i>Electromagnetic Induction (ahl)</i><br><br>D  |                   |  |
| <b>2</b> - (PHYSI/11_HL_Summer_2017_Q33) - <i>Electromagnetic Induction (ahl)</i><br><br>B  |                   |                                                                                     |
| <b>3</b> - (PHYSI/11_HL_Summer_2017_Q34) - <i>Electromagnetic Induction (ahl)</i><br><br>C  |                   |                                                                                     |
| <b>4</b> - (PHYSI/11_HL_Summer_2017_Q35) - <i>Electromagnetic Induction (ahl)</i><br><br>B  |                   |                                                                                     |
| <b>5</b> - (PHYSI/11_HL_Summer_2017_Q36) - <i>Electromagnetic Induction (ahl)</i><br><br>D  |                   |                                                                                     |
| <b>6</b> - (PHYSI/12_HL_Summer_2017_Q33) - <i>Electromagnetic Induction (ahl)</i><br><br>B  |                   |                                                                                     |
| <b>7</b> - (PHYSI/12_HL_Summer_2017_Q34) - <i>Electromagnetic Induction (ahl)</i><br><br>A  |                   |                                                                                     |
| <b>8</b> - (PHYSI/12_HL_Summer_2017_Q35) - <i>Electromagnetic Induction (ahl)</i><br><br>C  |                   |                                                                                     |
| <b>9</b> - (PHYSI/12_HL_Summer_2017_Q36) - <i>Electromagnetic Induction (ahl)</i><br><br>A  |                   |                                                                                     |
| <b>10</b> - (PHYSI/10_HL_Winter_2017_Q31) - <i>Electromagnetic Induction (ahl)</i><br><br>C |                   |                                                                                     |

| IB DIPLOMA                                                                                         | PHYSICS – HL – P1 | CH11 - ELECTROMAGNETIC INDUCTION (AHL)                                              |
|----------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>11</b> - (PHYSI/10_HL_Winter_2017_Q34) - <i>Electromagnetic Induction (ahl)</i></p> <p>D</p> |                   |  |
| <p><b>12</b> - (PHYSI/10_HL_Winter_2017_Q35) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>13</b> - (PHYSI/10_HL_Winter_2017_Q36) - <i>Electromagnetic Induction (ahl)</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>14</b> - (PHYSI/10_HL_Winter_2017_Q37) - <i>Electromagnetic Induction (ahl)</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>15</b> - (PHYSI/10_HL_Winter_2017_Q38) - <i>Electromagnetic Induction (ahl)</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>16</b> - (PHYSI/11_HL_Summer_2018_Q33) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>17</b> - (PHYSI/11_HL_Summer_2018_Q34) - <i>Electromagnetic Induction (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>18</b> - (PHYSI/11_HL_Summer_2018_Q35) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p> |                   |                                                                                     |
| <p><b>19</b> - (PHYSI/12_HL_Summer_2018_Q33) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p> |                   |                                                                                     |

| IB DIPLOMA                                                                                                                      | PHYSICS –HL –P1 | CH11 - ELECTROMAGNETIC<br>INDUCTION (AHL)                                           |
|---------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <p><b>20</b> - (PHYSI/12_HL_Summer_2018_Q34) - <i>Electromagnetic Induction (ahl)</i></p> <p>A</p>                              |                 |  |
| <p><b>21</b> - (PHYSI/12_HL_Summer_2018_Q35) - <i>Electromagnetic Induction (ahl)</i></p> <p>A</p>                              |                 |                                                                                     |
| <p><b>22</b> - (PHYSI/12_HL_Summer_2018_Q36) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p>                              |                 |                                                                                     |
| <p><b>23</b> - (PHYSI/10_HL_Winter_2018_Q33) - <i>Electricity &amp; Magnetism, Electromagnetic Induction (ahl)</i></p> <p>D</p> |                 |                                                                                     |
| <p><b>24</b> - (PHYSI/11_HL_Summer_2019_Q35) - <i>Electromagnetic Induction (ahl)</i></p> <p>B</p>                              |                 |                                                                                     |
| <p><b>25</b> - (PHYSI/11_HL_Summer_2019_Q36) - <i>Electromagnetic Induction (ahl), Electricity &amp; Magnetism</i></p> <p>A</p> |                 |                                                                                     |
| <p><b>26</b> - (PHYSI/11_HL_Summer_2019_Q37) - <i>Electromagnetic Induction (ahl), Electricity &amp; Magnetism</i></p> <p>C</p> |                 |                                                                                     |
| <p><b>27</b> - (PHYSI/12_HL_Summer_2019_Q27) - <i>Electromagnetic Induction (ahl), Electricity &amp; Magnetism</i></p> <p>B</p> |                 |                                                                                     |
| <p><b>28</b> - (PHYSI/12_HL_Summer_2019_Q28) - <i>Electricity &amp; Magnetism, Electromagnetic Induction (ahl)</i></p> <p>D</p> |                 |                                                                                     |

| IB DIPLOMA                                                                                                                      | PHYSICS –HL –P1 | CH11 -ELECTROMAGNETIC<br>INDUCTION (AHL)                                            |
|---------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <p><b>29</b> - (PHYSI/12_HL_Summer_2019_Q29) - <i>Electricity &amp; Magnetism, Electromagnetic Induction (ahl)</i></p> <p>C</p> |                 |  |
| <p><b>30</b> - (PHYSI/10_HL_Winter_2019_Q33) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p>                              |                 |                                                                                     |
| <p><b>31</b> - (PHYSI/10_HL_Winter_2019_Q34) - <i>Electromagnetic Induction (ahl)</i></p> <p>B</p>                              |                 |                                                                                     |
| <p><b>32</b> - (PHYSI/10_HL_Winter_2019_Q35) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p>                              |                 |                                                                                     |
| <p><b>33</b> - (PHYSI/10_HL_Winter_2019_Q36) - <i>Electromagnetic Induction (ahl)</i></p> <p>A</p>                              |                 |                                                                                     |
| <p><b>34</b> - (PHYSI/10_HL_Winter_2020_Q33) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p>                              |                 |                                                                                     |
| <p><b>35</b> - (PHYSI/10_HL_Winter_2020_Q34) - <i>Electromagnetic Induction (ahl)</i></p> <p>B</p>                              |                 |                                                                                     |
| <p><b>36</b> - (PHYSI/10_HL_Winter_2020_Q35) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p>                              |                 |                                                                                     |
| <p><b>37</b> - (PHYSI/10_HL_Winter_2020_Q36) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p>                              |                 |                                                                                     |

| IB DIPLOMA                                                                                         | PHYSICS – HL – P1 | CH11 - ELECTROMAGNETIC<br>INDUCTION (AHL)                                           |
|----------------------------------------------------------------------------------------------------|-------------------|-------------------------------------------------------------------------------------|
| <p><b>38</b> - (PHYSI/11_HL_Summer_2021_Q33) - <i>Electromagnetic Induction (ahl)</i></p> <p>D</p> |                   |  |
| <p><b>39</b> - (PHYSI/11_HL_Summer_2021_Q34) - <i>Electromagnetic Induction (ahl)</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>40</b> - (PHYSI/11_HL_Summer_2021_Q35) - <i>Electromagnetic Induction (ahl)</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>41</b> - (PHYSI/11_HL_Summer_2021_Q36) - <i>Electromagnetic Induction (ahl)</i></p> <p>D</p> |                   |                                                                                     |
| <p><b>42</b> - (PHYSI/12_HL_Summer_2021_Q33) - <i>Electromagnetic Induction (ahl)</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>43</b> - (PHYSI/12_HL_Summer_2021_Q34) - <i>Electromagnetic Induction (ahl)</i></p> <p>B</p> |                   |                                                                                     |
| <p><b>44</b> - (PHYSI/12_HL_Summer_2021_Q35) - <i>Electromagnetic Induction (ahl)</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>45</b> - (PHYSI/12_HL_Summer_2021_Q36) - <i>Electromagnetic Induction (ahl)</i></p> <p>A</p> |                   |                                                                                     |
| <p><b>46</b> - (PHYSI/10_HL_Winter_2021_Q33) - <i>Electromagnetic Induction (ahl)</i></p> <p>C</p> |                   |                                                                                     |

47 - (PHYSI/10\_HL\_Winter\_2021\_Q34) - *Electromagnetic Induction (ahl)*

A

48 - (PHYSI/10\_HL\_Winter\_2021\_Q35) - *Electromagnetic Induction (ahl)*

C

49 - (PHYSI/10\_HL\_Winter\_2021\_Q36) - *Electromagnetic Induction (ahl)*

C

50 - (PHYSI/11\_HL\_Summer\_2022\_Q34) - *Electromagnetic Induction (ahl)*

A

51 - (PHYSI/11\_HL\_Summer\_2022\_Q35) - *Electromagnetic Induction (ahl)*

C

52 - (PHYSI/11\_HL\_Summer\_2022\_Q36) - *Electromagnetic Induction (ahl)*

D

53 - (PHYSI/11\_HL\_Summer\_2022\_Q37) - *Electromagnetic Induction (ahl)*

C

54 - (PHYSI/11\_HL\_Summer\_2022\_Q38) - *Electromagnetic Induction (ahl)*

A

55 - (PHYSI/12\_HL\_Summer\_2022\_Q34) - *Electromagnetic Induction (ahl)*

B

56 - (PHYSI/12\_HL\_Summer\_2022\_Q35) - *Electromagnetic Induction (ahl)*

D

57 - (PHYSI/12\_HL\_Summer\_2022\_Q36) - *Electromagnetic Induction (ahl)*

C

58 - (PHYSI/12\_HL\_Summer\_2022\_Q37) - *Electromagnetic Induction (ahl)*

A

59 - (PHYSI/12\_HL\_Summer\_2022\_Q38) - *Electromagnetic Induction (ahl)*

A

60 - (PHYSI/10\_HL\_Winter\_2022\_Q34) - *Electromagnetic Induction (ahl)*

A

61 - (PHYSI/10\_HL\_Winter\_2022\_Q35) - *Electromagnetic Induction (ahl)*

C

62 - (PHYSI/10\_HL\_Winter\_2022\_Q36) - *Electromagnetic Induction (ahl)*

B

| IB DIPLOMA                                                                                      | PHYSICS –HL –P1 | CH12 - QUANTUM & NUCLEAR<br>PHYSICS (AHL)                                           |
|-------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <b>1</b> - (PHYSI/11_HL_Summer_2017_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>A  |                 |  |
| <b>2</b> - (PHYSI/11_HL_Summer_2017_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>D  |                 |                                                                                     |
| <b>3</b> - (PHYSI/11_HL_Summer_2017_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>D  |                 |                                                                                     |
| <b>4</b> - (PHYSI/11_HL_Summer_2017_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>D  |                 |                                                                                     |
| <b>5</b> - (PHYSI/12_HL_Summer_2017_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>C  |                 |                                                                                     |
| <b>6</b> - (PHYSI/12_HL_Summer_2017_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>A  |                 |                                                                                     |
| <b>7</b> - (PHYSI/12_HL_Summer_2017_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>A  |                 |                                                                                     |
| <b>8</b> - (PHYSI/12_HL_Summer_2017_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>A  |                 |                                                                                     |
| <b>9</b> - (PHYSI/10_HL_Winter_2017_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>C  |                 |                                                                                     |
| <b>10</b> - (PHYSI/10_HL_Winter_2017_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>B |                 |                                                                                     |



| IB DIPLOMA                                                                                             | PHYSICS –HL –P1 | CH12 - QUANTUM & NUCLEAR<br>PHYSICS (AHL)                                           |
|--------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <b>11</b> - (PHYSI/11_HL_Summer_2018_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br><b>D</b> |                 |  |
| <b>12</b> - (PHYSI/11_HL_Summer_2018_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br><b>B</b> |                 |                                                                                     |
| <b>13</b> - (PHYSI/11_HL_Summer_2018_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br><b>D</b> |                 |                                                                                     |
| <b>14</b> - (PHYSI/11_HL_Summer_2018_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br><b>B</b> |                 |                                                                                     |
| <b>15</b> - (PHYSI/12_HL_Summer_2018_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br><b>A</b> |                 |                                                                                     |
| <b>16</b> - (PHYSI/12_HL_Summer_2018_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br><b>B</b> |                 |                                                                                     |
| <b>17</b> - (PHYSI/12_HL_Summer_2018_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br><b>B</b> |                 |                                                                                     |
| <b>18</b> - (PHYSI/12_HL_Summer_2018_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br><b>C</b> |                 |                                                                                     |
| <b>19</b> - (PHYSI/10_HL_Winter_2018_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br><b>C</b> |                 |                                                                                     |

| IB DIPLOMA                                                                                                                                    | PHYSICS –HL –P1 | CH12 - QUANTUM & NUCLEAR<br>PHYSICS (AHL)                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <p><b>20</b> - (PHYSI/11_HL_Summer_2019_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>A</p>                                        |                 |  |
| <p><b>21</b> - (PHYSI/11_HL_Summer_2019_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>C</p>                                        |                 |                                                                                     |
| <p><b>22</b> - (PHYSI/11_HL_Summer_2019_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>C</p>                                        |                 |                                                                                     |
| <p><b>23</b> - (PHYSI/12_HL_Summer_2019_Q33) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>A</p> |                 |                                                                                     |
| <p><b>24</b> - (PHYSI/12_HL_Summer_2019_Q34) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>C</p> |                 |                                                                                     |
| <p><b>25</b> - (PHYSI/12_HL_Summer_2019_Q35) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>C</p> |                 |                                                                                     |
| <p><b>26</b> - (PHYSI/12_HL_Summer_2019_Q36) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>B</p> |                 |                                                                                     |
| <p><b>27</b> - (PHYSI/12_HL_Summer_2019_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>B</p>                                        |                 |                                                                                     |
| <p><b>28</b> - (PHYSI/12_HL_Summer_2019_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>D</p>                                        |                 |                                                                                     |

| IB DIPLOMA                                                                                                                                    | PHYSICS –HL –P1 | CH12 - QUANTUM & NUCLEAR<br>PHYSICS (AHL)                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <p><b>29</b> - (PHYSI/12_HL_Summer_2019_Q40) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>B</p> |                 |  |
| <p><b>30</b> - (PHYSI/10_HL_Winter_2019_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>A</p>                                        |                 |                                                                                     |
| <p><b>31</b> - (PHYSI/10_HL_Winter_2019_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>B</p>                                        |                 |                                                                                     |
| <p><b>32</b> - (PHYSI/10_HL_Winter_2019_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>B</p>                                        |                 |                                                                                     |
| <p><b>33</b> - (PHYSI/10_HL_Winter_2019_Q40) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>A</p> |                 |                                                                                     |
| <p><b>34</b> - (PHYSI/10_HL_Winter_2020_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>D</p>                                        |                 |                                                                                     |
| <p><b>35</b> - (PHYSI/10_HL_Winter_2020_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>C</p>                                        |                 |                                                                                     |
| <p><b>36</b> - (PHYSI/10_HL_Winter_2020_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p>A</p>                                        |                 |                                                                                     |
| <p><b>37</b> - (PHYSI/10_HL_Winter_2020_Q40) - <i>Atomic,nuclear &amp; Particle Physics, Quantum &amp; Nuclear Physics (ahl)</i></p> <p>C</p> |                 |                                                                                     |

| IB DIPLOMA                                                                                      | PHYSICS –HL –P1 | CH12 - QUANTUM & NUCLEAR<br>PHYSICS (AHL)                                           |
|-------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <b>38</b> - (PHYSI/11_HL_Summer_2021_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>C |                 |  |
| <b>39</b> - (PHYSI/11_HL_Summer_2021_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>C |                 |                                                                                     |
| <b>40</b> - (PHYSI/11_HL_Summer_2021_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>A |                 |                                                                                     |
| <b>41</b> - (PHYSI/11_HL_Summer_2021_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>D |                 |                                                                                     |
| <b>42</b> - (PHYSI/12_HL_Summer_2021_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>A |                 |                                                                                     |
| <b>43</b> - (PHYSI/12_HL_Summer_2021_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>B |                 |                                                                                     |
| <b>44</b> - (PHYSI/12_HL_Summer_2021_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>A |                 |                                                                                     |
| <b>45</b> - (PHYSI/12_HL_Summer_2021_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>D |                 |                                                                                     |
| <b>46</b> - (PHYSI/10_HL_Winter_2021_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i><br><br>D |                 |                                                                                     |

| IB DIPLOMA                                                                                                    | PHYSICS –HL –P1 | CH12 - QUANTUM & NUCLEAR<br>PHYSICS (AHL)                                           |
|---------------------------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------------------|
| <p><b>47</b> - (PHYSI/10_HL_Winter_2021_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p><b>B</b></p> |                 |  |
| <p><b>48</b> - (PHYSI/10_HL_Winter_2021_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p><b>A</b></p> |                 |                                                                                     |
| <p><b>49</b> - (PHYSI/10_HL_Winter_2021_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p><b>A</b></p> |                 |                                                                                     |
| <p><b>50</b> - (PHYSI/11_HL_Summer_2022_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p><b>B</b></p> |                 |                                                                                     |
| <p><b>51</b> - (PHYSI/11_HL_Summer_2022_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p><b>D</b></p> |                 |                                                                                     |
| <p><b>52</b> - (PHYSI/12_HL_Summer_2022_Q39) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p><b>A</b></p> |                 |                                                                                     |
| <p><b>53</b> - (PHYSI/12_HL_Summer_2022_Q40) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p><b>C</b></p> |                 |                                                                                     |
| <p><b>54</b> - (PHYSI/10_HL_Winter_2022_Q37) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p><b>C</b></p> |                 |                                                                                     |
| <p><b>55</b> - (PHYSI/10_HL_Winter_2022_Q38) - <i>Quantum &amp; Nuclear Physics (ahl)</i></p> <p><b>B</b></p> |                 |                                                                                     |

56 - (PHYSI/10\_HL\_Winter\_2022\_Q39) - *Quantum & Nuclear Physics (ahl)*



C

57 - (PHYSI/10\_HL\_Winter\_2022\_Q40) - *Quantum & Nuclear Physics (ahl)*

A