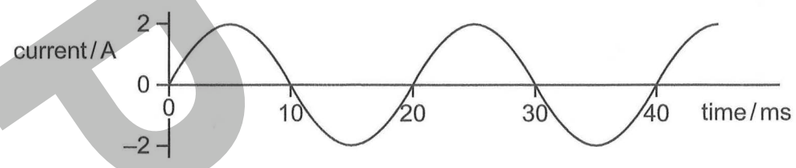
27 An a.c. generator is connected to a resistor of resistance 20 Ω. The graph shows the variation of the current in the resistor with time.



The rotational speed of the a.c. generator is halved.

What is now the mean power dissipated in the resistor?

A 5 W **B** 10 W **C** 20 W **D** 40 W

28 An electron has a kinetic energy E and a de Broglie wavelength λ.

The kinetic energy of the electron is increased to $9E$.

What is now the de Broglie wavelength of the electron?

A $\frac{\lambda}{3}$ **B** $\frac{\lambda}{9}$ **C** 3λ **D** 9λ

29 The nucleus of an isotope of bismuth is represented as $^{212}_{83}\text{Bi}$.

The nucleus has mass M, a proton has mass M_p and a neutron has mass M_n.

What is the mass defect for the bismuth nucleus?

A $M - 83M_p - 129M_n$

B $M - 212M_p - 83M_n$

C $83M_p + 129M_n - M$

D $212M_p + 83M_n - M$

30 A uranium-238 nucleus (mass 238.1249 u) decays into a thorium-234 nucleus (mass 234.1165 u) with the emission of an α-particle (mass 4.0026 u).

How much energy is released in this decay?

A 2.9×10^{-21} J **B** 4.8×10^{-16} J **C** 8.7×10^{-13} J **D** 6.0×10^{-10} J

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in collaboration with
CAMBRIDGE ASSESSMENT INTERNATIONAL EDUCATION
General Certificate of Education Advanced Level
Higher 2

PHYSICS

9749/01

Paper 1 Multiple Choice

October/November 2022

1 hour

Additional Materials: Multiple Choice Answer Sheet

0807181134

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and index number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE ON ANY BARCODES.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **16** printed pages.

Singapore Examinations and Assessment Board

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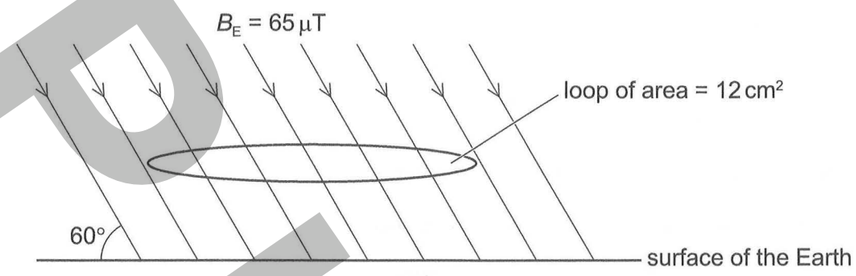
PiXL The Centre of Physics NOT

Data

speed of light in free space	$c = 3.00 \times 10^{8}\,\text{m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\,\text{H m}^{-1}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
	$(1/(36\pi)) \times 10^{-9}\,\text{F m}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19}\,\text{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\,\text{J s}$
unified atomic mass constant	$u = 1.66 \times 10^{-27}\,\text{kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31}\,\text{kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27}\,\text{kg}$
molar gas constant	$R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23}\,\text{mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23}\,\text{J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\text{N m}^2\,\text{kg}^{-2}$
acceleration of free fall	$g = 9.81\,\text{m s}^{-2}$

PLTC
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NOT

25 A flat, circular loop of wire, enclosing an area of $12\,\text{cm}^2$, is held horizontally above the Earth's surface. The Earth's magnetic flux density B_E is $65\,\mu\text{T}$ in a direction making an angle of 60° with the horizontal.



What is the magnetic flux through the loop of wire?

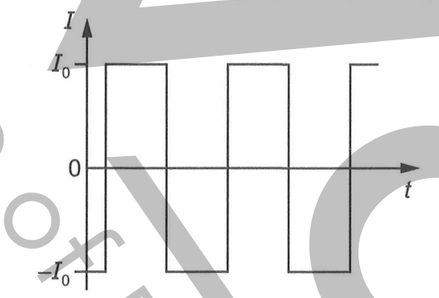
A $3.9 \times 10^{-8}\,\text{Wb}$

B $6.8 \times 10^{-8}\,\text{Wb}$

C $3.9 \times 10^{-4}\,\text{Wb}$

D $6.8 \times 10^{-4}\,\text{Wb}$

26 The variation with time t of an alternating current I is shown.

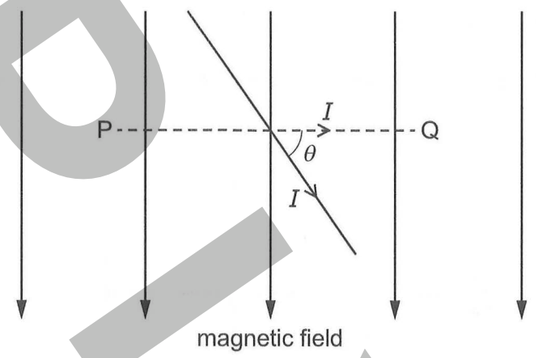


What are the peak and the root-mean-square (r.m.s.) values of the alternating current?

	peak current	r.m.s. current
A	I_0	I_0
B	I_0	$\frac{I_0}{\sqrt{2}}$
C	$2I_0$	I_0
D	$2I_0$	$\frac{I_0}{\sqrt{2}}$

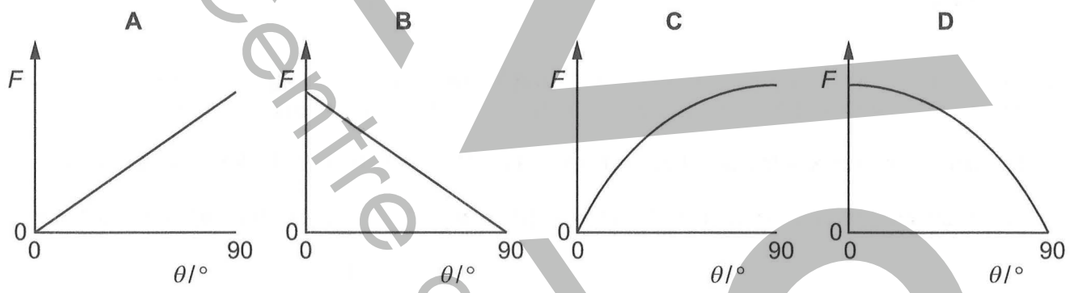
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24 A straight wire PQ, carrying a constant current I to the right, is placed at right angles to a uniform downward magnetic field, as shown by the dotted line in the diagram.



The wire is then rotated through an angle θ about an axis perpendicular to the plane of the diagram.

Which graph shows how the magnitude of the magnetic force F on the wire varies with θ in the range 0° to 90°?

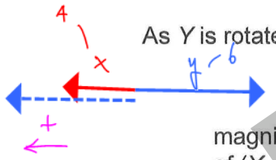


Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on / by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
gravitational potential	$\phi = -\frac{Gm}{r}$
temperature	$T/\text{K} = T/^\circ\text{C} + 273.15$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2\rangle$
mean translational kinetic energy of an ideal gas molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $= \pm \omega \sqrt{(x_0^2 - x^2)}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
alternating current / voltage	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_0 NI}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 nI$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

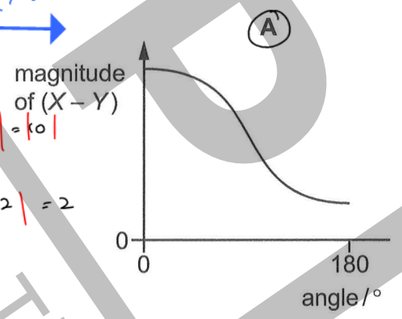
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1 X and Y are vectors. The magnitude of X is less than the magnitude of Y. The vectors are initially in opposite directions.

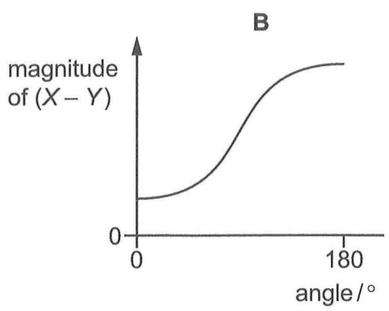


As Y is rotated through 180°, how does the magnitude of the vector $(X - Y)$ vary?

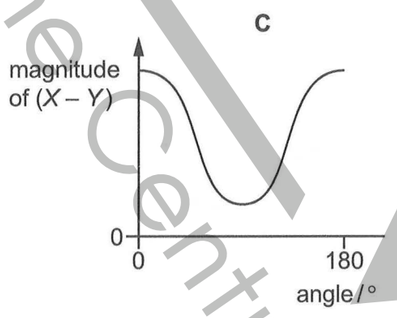
A



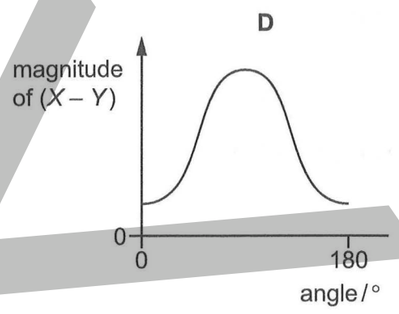
B



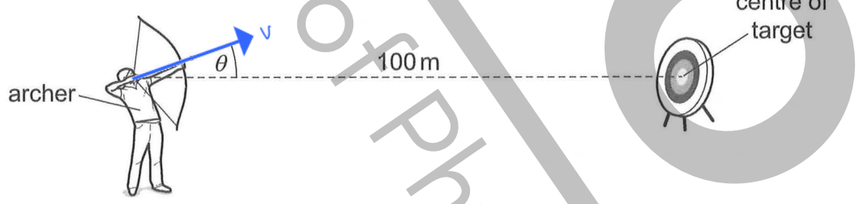
C



D



2 An archer is standing level with the centre of a target, as shown.



The archer is a distance of 100 m from the target. The length of the arrow is negligible.

The archer fires an arrow at an angle θ above the horizontal. The arrow hits the centre of the target 2.0 s later. Air resistance is negligible.

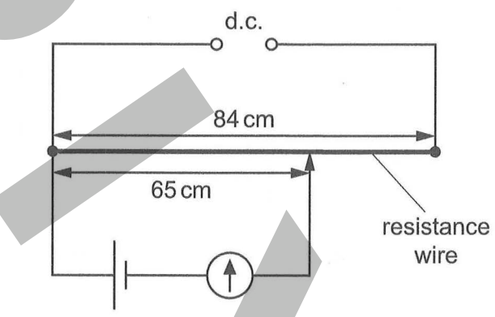
What is θ?

A 2.8° **B** 5.5° **C** 11° **D** 79°

22 A resistance wire is taped to a length of wood to form a potentiometer. The length between the contacts is 84 cm.

The potential gradient along this wire is 14.3 V m^{-1}.

A cell is connected in parallel with 65 cm of the resistance wire. The centre-zero galvanometer shows no deflection.



What is the electromotive force (e.m.f.) of the cell?

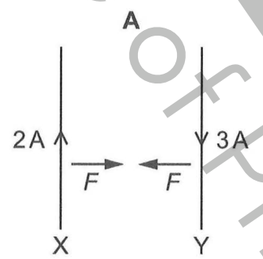
A 2.7 V **B** 9.3 V **C** 11 V **D** 12 V

23 Two long, straight, current-carrying wires, X and Y, are parallel. The current in wire X is 2 A and the current in wire Y is 3 A. The two wires attract each other due to these currents.

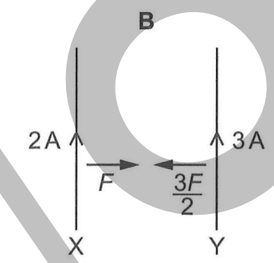
The current in wire X is towards the top of the page. The magnitude of the force on wire X is F.

Which diagram shows the magnitude of the force on wire Y and the direction of the current in Y?

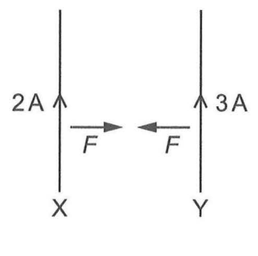
A



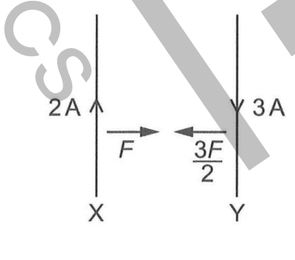
B



C



D



20 A length of metal wire with a circular cross-section is connected into an electric circuit. The wire carries a constant electric current.



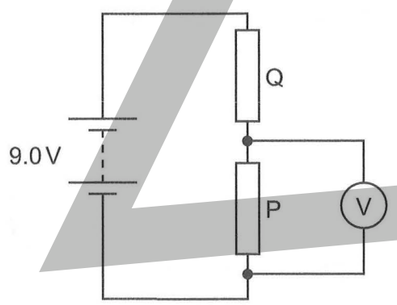
Part of the wire has a diameter that increases uniformly with distance along the wire.

The drift velocity v of the charge carriers is related by a constant K to the diameter d of the wire.

Which equation for v is correct?

A $v = \frac{K}{d^2}$ **B** $v = \frac{K}{d}$ **C** $v = Kd$ **D** $v = Kd^2$

21 Two resistors, P and Q, are connected in series to a 9.0 V battery with negligible internal resistance.



The resistance of the voltmeter is equal to the resistance of P.

The reading on the voltmeter is 6.0 V.

What is the value of the ratio $\frac{\text{resistance of the voltmeter}}{\text{resistance of Q}}$?

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

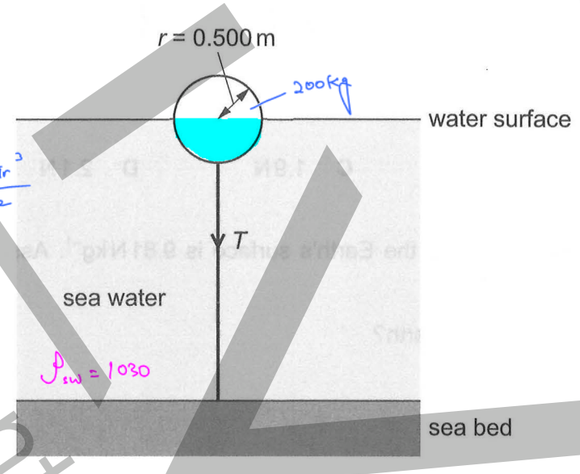
3 Object P travels at 2.0 m s^{-1} and collides elastically with object Q, which is initially at rest.

After the collision, object P rebounds with a speed of 0.50 m s^{-1}.

What is the ratio $\frac{\text{mass of P}}{\text{mass of Q}}$?

A $\frac{1}{3}$ **B** $\frac{3}{5}$ **C** $\frac{5}{3}$ **D** $\frac{3}{1}$

4 A spherical buoy is attached to the sea bed by a rope, as shown. The buoy is in equilibrium.



The buoy has a radius r of 0.500 m and a mass of 200 kg.

The density of the sea water in which the buoy floats is 1030 kg m^{-3}.

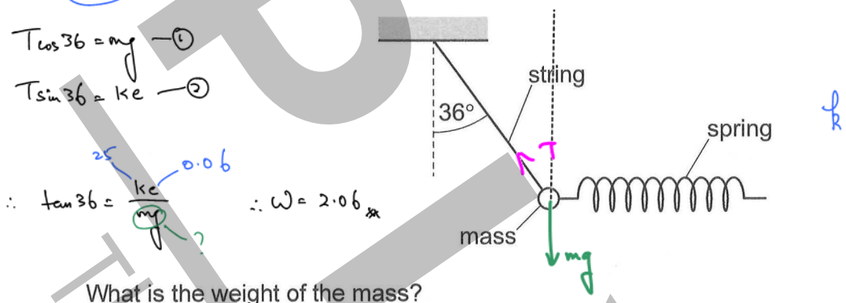
Exactly half of the volume of the buoy is below the surface of the water.

What is the tension T in the rope?

A 606 N **B** 683 N **C** 3330 N **D** 4610 N

5 A mass is tied to the end of a string. The mass is pulled horizontally to one side by a spring of spring constant 25 N m^{-1}.

The mass is in equilibrium and the extension of the spring is 0.060 m. The string is at an angle of 36° to the vertical, as shown.



What is the weight of the mass?

A 1.1 N **B** 1.5 N **C** 1.9 N **D** 2.1 N

6 The gravitational field strength at the Earth's surface is 9.81 N kg^{-1}. Assume that the Earth is a sphere of radius 6.37 × 10^{6} m.

What is the mean density of the Earth?

A 1840 kg m^{-3}

B 2890 kg m^{-3}

C 5510 kg m^{-3}

D 4.68 × 10^{10} kg m^{-3}

7 A pendulum of mass 0.40 kg swings from a frictionless pivot.

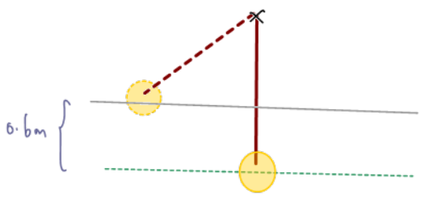
The pendulum is released from rest at a height of 0.60 m above its lowest point.

After n complete oscillations, the maximum height h of the pendulum, in metres, is given by

$$h = 0.60\,e^{-0.10n}.$$

What is the work done against air resistance by the pendulum in the first two oscillations?

A 0.11 J **B** 0.43 J **C** 0.49 J **D** 2.4 J



18 When light waves pass through a double slit, interference patterns are observed. Similar interference patterns can be observed using a double source of other types of wave.

Interference maxima produced by a double source of different types of wave are observed at a distance of 15 m from the source.

In which case are the maxima furthest apart?

A red light of wavelength 700 nm from sources 4.0 mm apart

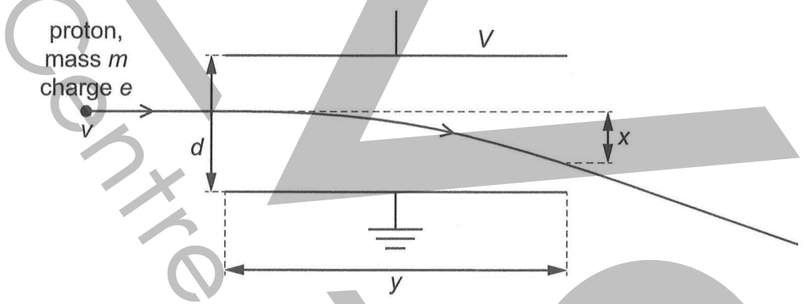
B sound waves of wavelength 20 mm from sources 50 mm apart

C blue light of wavelength 450 nm from sources 2.0 mm apart

D surface water waves of wavelength 10 mm from sources 200 mm apart

19 A proton, of mass m, charge e and velocity v, enters a uniform electric field between two parallel plates at right angles to the field. The region between the plates is a vacuum.

The length of the plates is y, the separation of the plates is d and the potential difference across the plates is V.

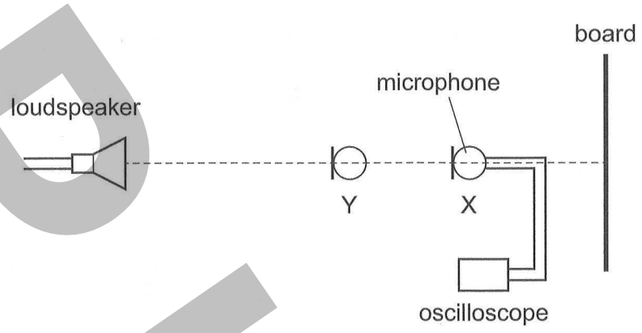


The vertical deflection of the proton is x at the point where it leaves the region between the plates.

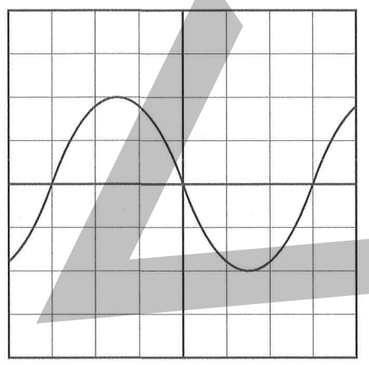
Which equation for x is correct?

A $x = \dfrac{eVy^2}{2mdv^2}$ **B** $x = \dfrac{2mdv^2}{eVy^2}$ **C** $x = \dfrac{eVv^2}{2mdy^2}$ **D** $x = \dfrac{mdy^2}{2eVv^2}$

17 Stationary sound waves are investigated using the apparatus shown.



X and Y are adjacent positions of the microphone that give maximum amplitude on the oscilloscope, as shown.



oscilloscope screen when microphone is at X

The distance XY is 5.0 cm and the time base of the oscilloscope is 0.050 ms div^{-1}.

What are the frequency and the wavelength of the sound wave?

	frequency / kHz	wavelength / cm
A	3.3	5.0
B	3.3	10
C	5.0	5.0
D	5.0	10

8 A solid, flat disc rotates about its centre in the horizontal plane.

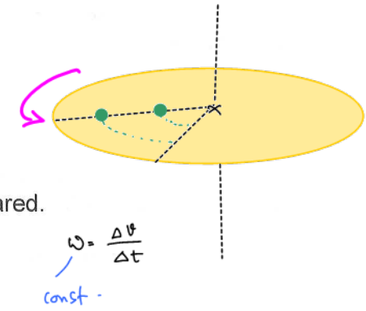
What is the relationship between the angular velocity of a point on the disc and the distance of the point from the centre of the disc?

A Angular velocity is directly proportional to the distance.

B Angular velocity is inversely proportional to the distance.

C Angular velocity is independent of distance.

D Angular velocity is directly proportional to the distance squared.



9 Geostationary satellites are used for communications.

Which statement about geostationary satellites is correct?

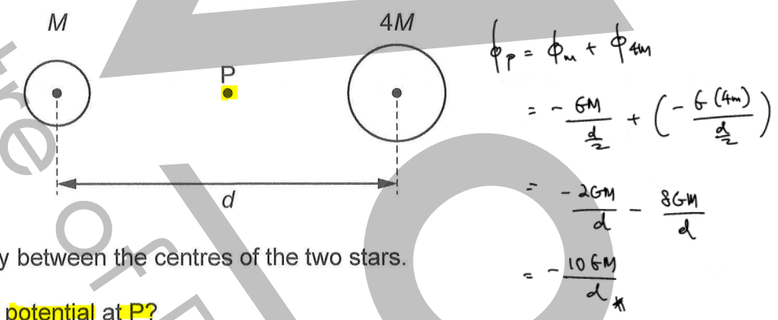
A Heavier geostationary satellites are in higher orbits.

B Lighter geostationary satellites have shorter orbital periods.

C Their orbits are in the plane of the equator of the Earth.

D Their speed is the same as the point on the Earth directly below them.

10 Two isolated stars, of mass M and $4M$, are separated in space by a distance d between the centres of the stars.



Point P is a point midway between the centres of the two stars.

What is the gravitational potential at P?

A $\frac{-4GM^2}{d}$ **B** $\frac{-6GM}{d}$ **C** $\frac{-8GM^2}{d}$ **D** $\frac{-10GM}{d}$

11 A container filled with an ideal gas is at a temperature of 80 °C. The root-mean-square (r.m.s.) speed of the gas molecules is 350 m s^{-1}.

The temperature of the gas is increased to 160 °C.

What is now the r.m.s. speed of the gas molecules?

A 390 m s^{-1} **B** 430 m s^{-1} **C** 490 m s^{-1} **D** 700 m s^{-1}

$c_{rms} \propto \sqrt{T}$

$\frac{c_{rms-1}}{c_{rms-2}} = \frac{\sqrt{T_1}}{\sqrt{T_2}}$ (350 / ? ; $\sqrt{80+273.15}$ / $\sqrt{160+273.15}$)

$\therefore c_{rms-2} = 387.6$

PLOT The Centre of Physics

12 A fixed mass of an ideal gas is at a pressure of 1.0×10^5 Pa. It has a temperature of 300 K and a volume of 0.010 m^3.

What is the total kinetic energy of the gas molecules after the volume is changed to 0.0050 m^3 at constant temperature?

A 500 J **B** 1000 J **C** 1500 J **D** 2000 J

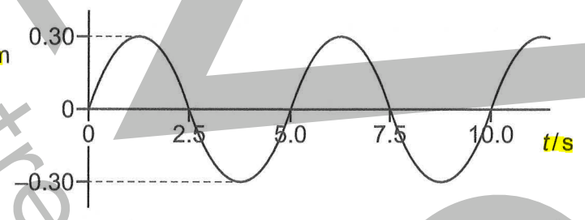
13 An airgun pellet, of mass m and specific heat capacity c, hits a steel plate at speed v. During the impact, 50% of the pellet's kinetic energy is converted to thermal energy in the pellet.

What is the rise in temperature of the pellet?

A $\frac{v^2}{2c}$ **B** $\frac{v^2}{4c}$ **C** $\frac{mv^2}{2c}$ **D** $\frac{mv^2}{4c}$

14 A pendulum oscillates with simple harmonic motion.

Its motion is represented by the graph of its displacement x against time t.



Which equation relates the velocity v of the pendulum, in m s^{-1}, to the time t in s?

A $v = 0.30 \cos 1.3t$

B $v = 0.30 \cos 31t$

C $v = 0.38 \cos 1.3t$

D $v = 9.4 \cos 31t$

15 What is **not** an example of resonance?

A A loudspeaker oscillates with large amplitude when the volume control of the radio is raised.

B The air column inside an organ pipe produces a loud sound when excited by a vibrating metal strip.

C The external mirror of a lorry vibrates with large amplitude when the engine turns at a particular rate.

D A child on a swing goes higher by swinging her legs at regular intervals.

16 A transverse wave is travelling along a long rope.

Diagram 1 shows the variation with distance of the displacement of the rope at an instant.

Diagram 2 shows the variation with time of the displacement of a point on the rope.

diagram 1

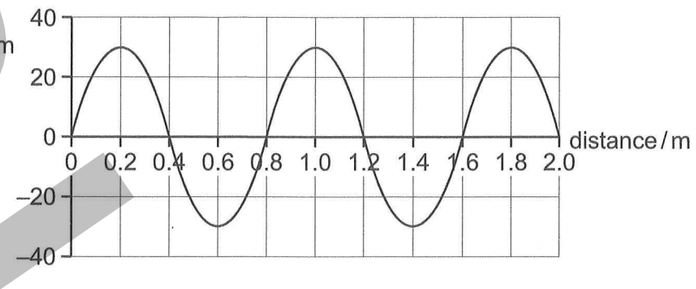
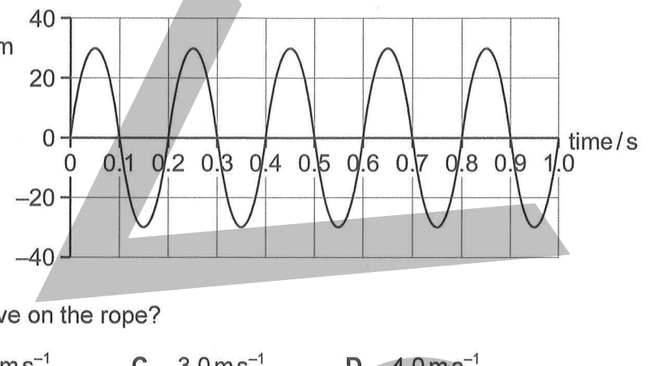


diagram 2



What is the speed of the wave on the rope?

A 1.5 m s^{-1} **B** 2.0 m s^{-1} **C** 3.0 m s^{-1} **D** 4.0 m s^{-1}

12 A fixed mass of an ideal gas is at a pressure of 1.0×10^5 Pa. It has a temperature of 300 K and a volume of 0.010 m^3.

What is the total kinetic energy of the gas molecules after the volume is changed to 0.0050 m^3 at constant temperature?

A 500 J **B** 1000 J **C** 1500 J **D** 2000 J

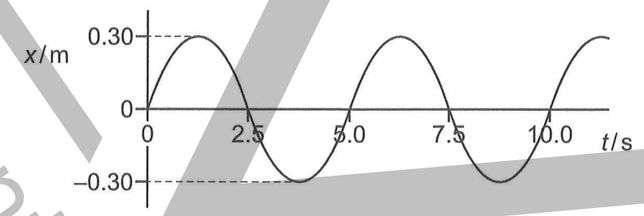
13 An airgun pellet, of mass m and specific heat capacity c, hits a steel plate at speed v. During the impact, 50% of the pellet's kinetic energy is converted to thermal energy in the pellet.

What is the rise in temperature of the pellet?

A $\frac{v^2}{2c}$ **B** $\frac{v^2}{4c}$ **C** $\frac{mv^2}{2c}$ **D** $\frac{mv^2}{4c}$

14 A pendulum oscillates with simple harmonic motion.

Its motion is represented by the graph of its displacement x against time t.



Which equation relates the velocity v of the pendulum, in m s^{-1}, to the time t in s?

A $v = 0.30 \cos 1.3t$

B $v = 0.30 \cos 31t$

C $v = 0.38 \cos 1.3t$

D $v = 9.4 \cos 31t$

15 What is **not** an example of resonance?

A A loudspeaker oscillates with large amplitude when the volume control of the radio is raised.

B The air column inside an organ pipe produces a loud sound when excited by a vibrating metal strip.

C The external mirror of a lorry vibrates with large amplitude when the engine turns at a particular rate.

D A child on a swing goes higher by swinging her legs at regular intervals.

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16 A transverse wave is travelling along a long rope.

Diagram 1 shows the variation with distance of the displacement of the rope at an instant.

Diagram 2 shows the variation with time of the displacement of a point on the rope.

diagram 1

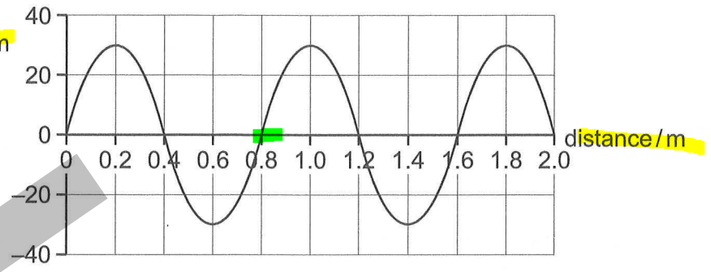
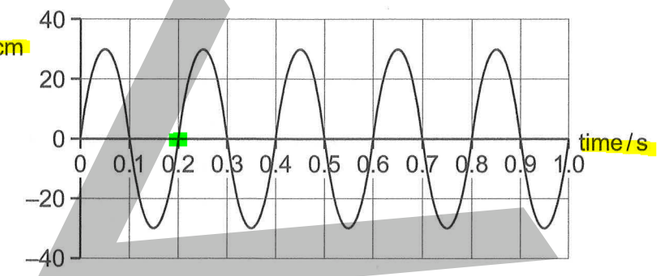


diagram 2



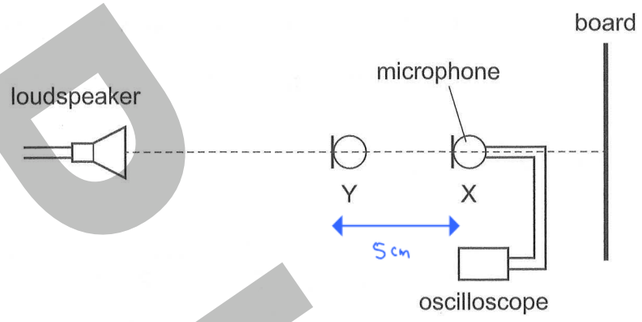
What is the speed of the wave on the rope?

A 1.5 m s^{-1} **B** 2.0 m s^{-1} **C** 3.0 m s^{-1} **D** 4.0 m s^{-1}

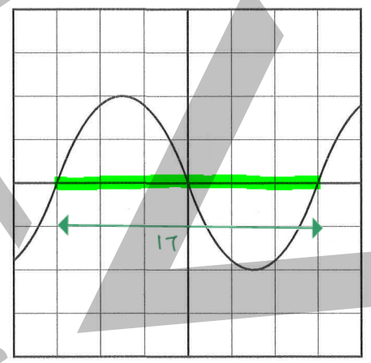
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[Turn over

17 Stationary sound waves are investigated using the apparatus shown.



X and Y are adjacent positions of the microphone that give maximum amplitude on the oscilloscope, as shown.



oscilloscope screen when microphone is at X

The distance XY is 5.0 cm and the time base of the oscilloscope is 0.050 ms div^{-1}.

What are the frequency and the wavelength of the sound wave?

	frequency / kHz	wavelength / cm
A	3.3	5.0
B	3.3	10
C	5.0	5.0
D	5.0	10

8 A solid, flat disc rotates about its centre in the horizontal plane.

What is the relationship between the angular velocity of a point on the disc and the distance of the point from the centre of the disc?

A Angular velocity is directly proportional to the distance.

B Angular velocity is inversely proportional to the distance.

C Angular velocity is independent of distance.

D Angular velocity is directly proportional to the distance squared.

9 Geostationary satellites are used for communications.

Which statement about geostationary satellites is correct?

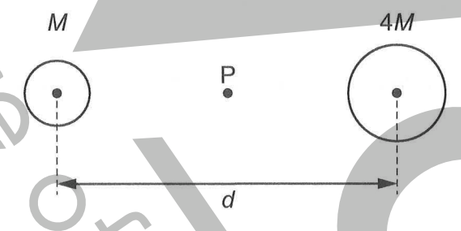
A Heavier geostationary satellites are in higher orbits.

B Lighter geostationary satellites have shorter orbital periods.

C Their orbits are in the plane of the equator of the Earth.

D Their speed is the same as the point on the Earth directly below them.

10 Two isolated stars, of mass M and $4M$, are separated in space by a distance d between the centres of the stars.



Point P is a point midway between the centres of the two stars.

What is the gravitational potential at P?

A $\frac{-4GM^2}{d}$ B $\frac{-6GM}{d}$ C $\frac{-8GM^2}{d}$ D $\frac{-10GM}{d}$

11 A container filled with an ideal gas is at a temperature of 80 °C. The root-mean-square (r.m.s.) speed of the gas molecules is 350 m s^{-1}.

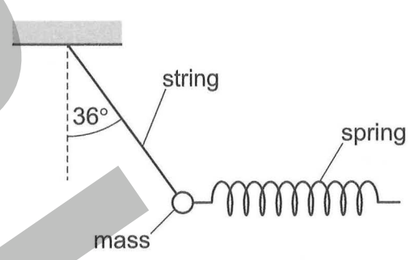
The temperature of the gas is increased to 160 °C.

What is now the r.m.s. speed of the gas molecules?

A 390 m s^{-1} B 430 m s^{-1} C 490 m s^{-1} D 700 m s^{-1}

5 A mass is tied to the end of a string. The mass is pulled horizontally to one side by a spring of spring constant 25 N m^{-1}.

The mass is in equilibrium and the extension of the spring is 0.060 m. The string is at an angle of 36° to the vertical, as shown.



What is the weight of the mass?

A 1.1 N B 1.5 N C 1.9 N D 2.1 N

6 The gravitational field strength at the Earth's surface is 9.81 N kg^{-1}. Assume that the Earth is a sphere of radius 6.37×10^6 m.

What is the mean density of the Earth?

A 1840 kg m^{-3}

B 2890 kg m^{-3}

C 5510 kg m^{-3}

D 4.68×10^{10} kg m^{-3}

7 A pendulum of mass 0.40 kg swings from a frictionless pivot.

The pendulum is released from rest at a height of 0.60 m above its lowest point.

After n complete oscillations, the maximum height h of the pendulum, in metres, is given by

$$h = 0.60\,e^{-0.10n}.$$

What is the work done against air resistance by the pendulum in the first two oscillations?

A 0.11 J B 0.43 J C 0.49 J D 2.4 J

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18 When light waves pass through a double slit, interference patterns are observed. Similar interference patterns can be observed using a double source of other types of wave.

Interference maxima produced by a double source of different types of wave are observed at a distance of 15 m from the source.

In which case are the maxima furthest apart?

A red light of wavelength 700 nm from sources 4.0 mm apart

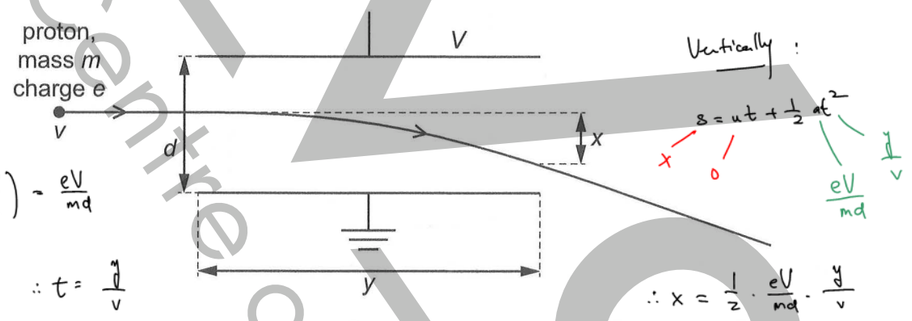
B sound waves of wavelength 20 mm from sources 50 mm apart

C blue light of wavelength 450 nm from sources 2.0 mm apart

D surface water waves of wavelength 10 mm from sources 200 mm apart

19 A proton, of mass m, charge e and velocity v, enters a uniform electric field between two parallel plates at right angles to the field. The region between the plates is a vacuum.

The length of the plates is y, the separation of the plates is d and the potential difference across the plates is V.



The vertical deflection of the proton is x at the point where it leaves the region between the plates.

Which equation for x is correct?

A $x = \dfrac{eVy^2}{2mdv^2}$ B $x = \dfrac{2mdv^2}{eVy^2}$ C $x = \dfrac{eVv^2}{2mdy^2}$ D $x = \dfrac{mdy^2}{2eVv^2}$

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20 A length of metal wire with a circular cross-section is connected into an electric circuit. The wire carries a constant electric current.



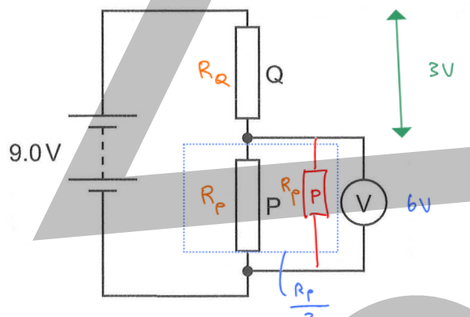
Part of the wire has a diameter that increases uniformly with distance along the wire.

The drift velocity v of the charge carriers is related by a constant K to the diameter d of the wire.

Which equation for v is correct?

A $v = \frac{K}{d^2}$ **B** $v = \frac{K}{d}$ **C** $v = Kd$ **D** $v = Kd^2$

21 Two resistors, P and Q, are connected in series to a 9.0 V battery with negligible internal resistance.



The resistance of the voltmeter is equal to the resistance of P.

The reading on the voltmeter is 6.0 V.

What is the value of the ratio $\frac{\text{resistance of the voltmeter}}{\text{resistance of Q}}$?

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

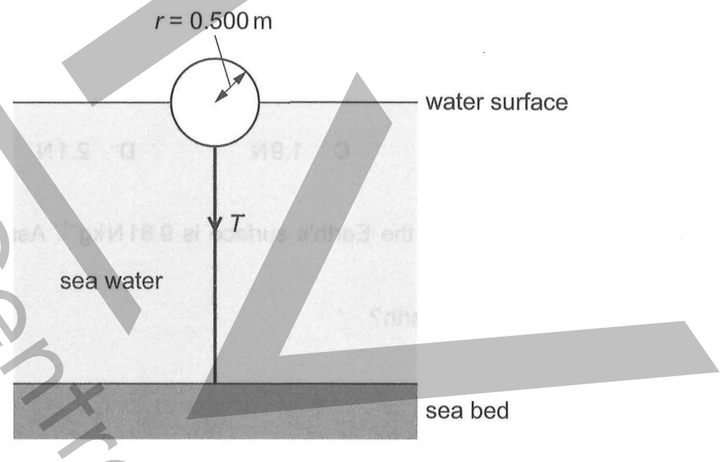
3 Object P travels at 2.0 m s^{-1} and collides elastically with object Q, which is initially at rest.

After the collision, object P rebounds with a speed of 0.50 m s^{-1}.

What is the ratio $\frac{\text{mass of P}}{\text{mass of Q}}$?

A $\frac{1}{3}$ **B** $\frac{3}{5}$ **C** $\frac{5}{3}$ **D** $\frac{3}{1}$

4 A spherical buoy is attached to the sea bed by a rope, as shown. The buoy is in equilibrium.



The buoy has a radius r of 0.500 m and a mass of 200 kg.

The density of the sea water in which the buoy floats is 1030 kg m^{-3}.

Exactly half of the volume of the buoy is below the surface of the water.

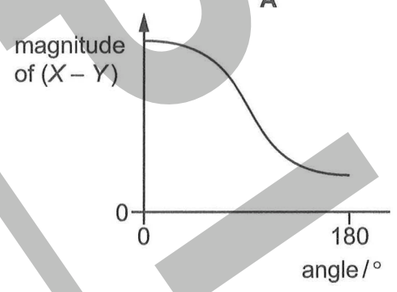
What is the tension T in the rope?

A 606 N **B** 683 N **C** 3330 N **D** 4610 N

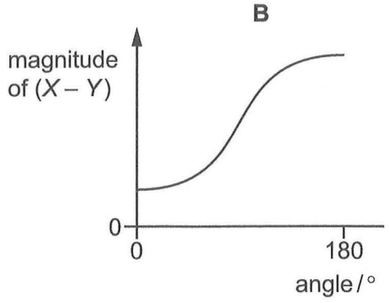
1 X and Y are vectors. The magnitude of X is less than the magnitude of Y. The vectors are initially in opposite directions.

As Y is rotated through 180°, how does the magnitude of the vector $(X - Y)$ vary?

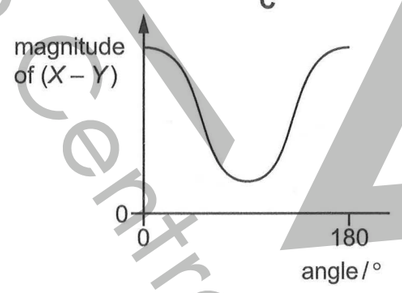
A



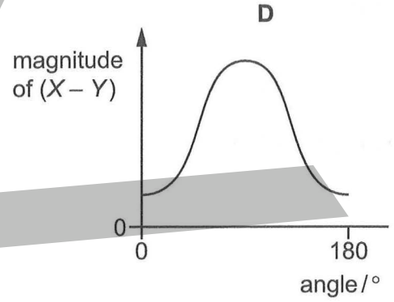
B



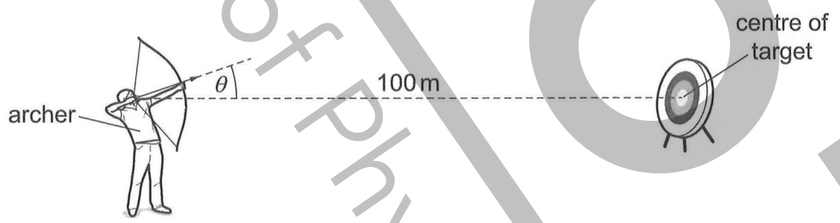
C



D



2 An archer is standing level with the centre of a target, as shown.



The archer is a distance of 100 m from the target. The length of the arrow is negligible.

The archer fires an arrow at an angle θ above the horizontal. The arrow hits the centre of the target 2.0 s later. Air resistance is negligible.

What is θ?

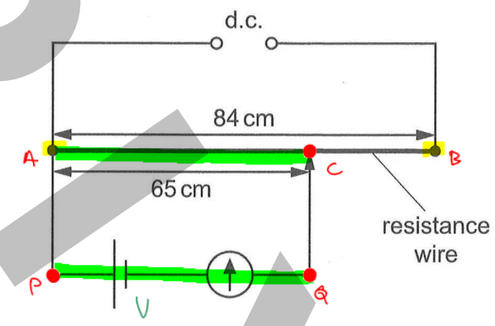
A 2.8° **B** 5.5° **C** 11° **D** 79°

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22 A resistance wire is taped to a length of wood to form a potentiometer. The length between the contacts is 84 cm.

The potential gradient along this wire is 14.3 V m^{-1}.

A cell is connected in parallel with 65 cm of the resistance wire. The centre-zero galvanometer shows no deflection.



What is the electromotive force (e.m.f.) of the cell?

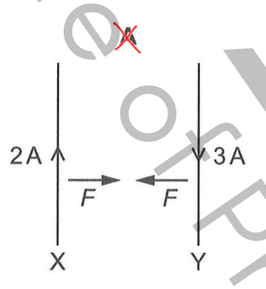
A 2.7 V **B** 9.3 V **C** 11 V **D** 12 V

23 Two long, straight, current-carrying wires, X and Y, are parallel. The current in wire X is 2 A and the current in wire Y is 3 A. The two wires attract each other due to these currents.

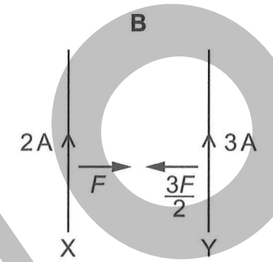
The current in wire X is towards the top of the page. The magnitude of the force on wire X is F.

Which diagram shows the magnitude of the force on wire Y and the direction of the current in Y?

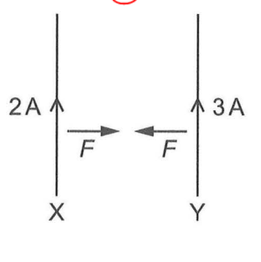
A



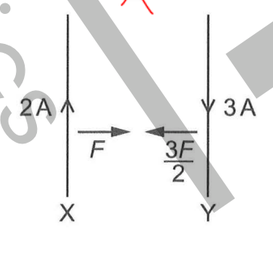
B



C

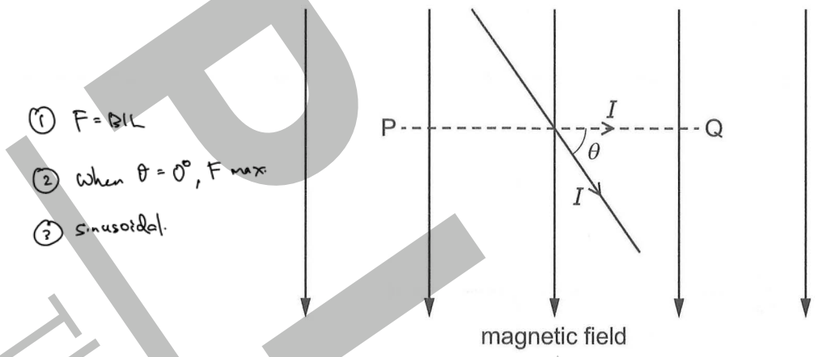


D



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24 A straight wire PQ, carrying a constant current I to the right, is placed at right angles to a uniform downward magnetic field, as shown by the dotted line in the diagram.

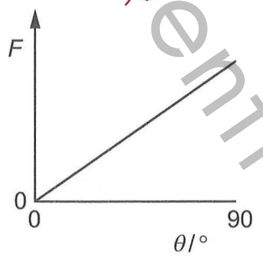


① F = BIL
② when θ = 0°, F max
③ sinusoidal.

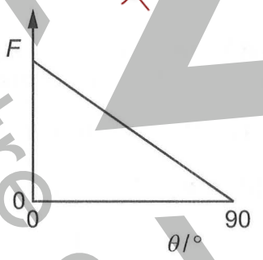
The wire is then rotated through an angle θ about an axis perpendicular to the plane of the diagram.

Which graph shows how the magnitude of the magnetic force F on the wire varies with θ in the range 0° to 90°?

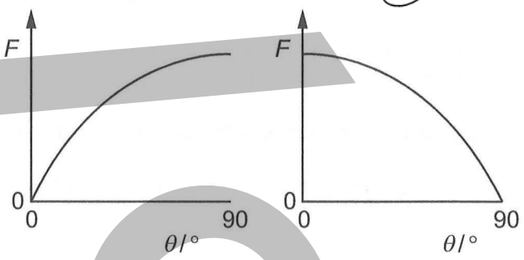
A



B



C



D

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Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on / by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
gravitational potential	$\phi = -\frac{Gm}{r}$
temperature	$T/\text{K} = T/^\circ\text{C} + 273.15$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $= \pm \omega \sqrt{(x_0^2 - x^2)}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
alternating current / voltage	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_0 NI}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 nI$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

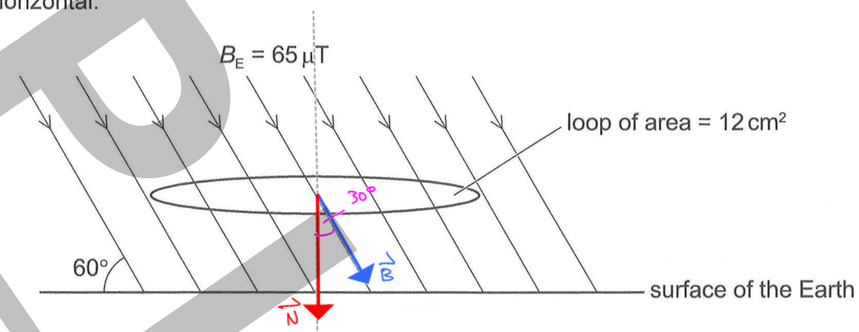
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Data

speed of light in free space	$c = 3.00 \times 10^8\ \text{m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\ \text{H m}^{-1}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\ \text{F m}^{-1}$
	$(1/(36\pi)) \times 10^{-9}\ \text{F m}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19}\ \text{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\ \text{J s}$
unified atomic mass constant	$u = 1.66 \times 10^{-27}\ \text{kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31}\ \text{kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27}\ \text{kg}$
molar gas constant	$R = 8.31\ \text{J K}^{-1}\ \text{mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23}\ \text{mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23}\ \text{J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$
acceleration of free fall	$g = 9.81\ \text{m s}^{-2}$

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25 A flat, circular loop of wire, enclosing an area of 12 cm^2, is held horizontally above the Earth's surface. The Earth's magnetic flux density B_E is 65 μT in a direction making an angle of 60° with the horizontal.



What is the magnetic flux through the loop of wire?

A 3.9×10^{-8} Wb

B 6.8×10^{-8} Wb

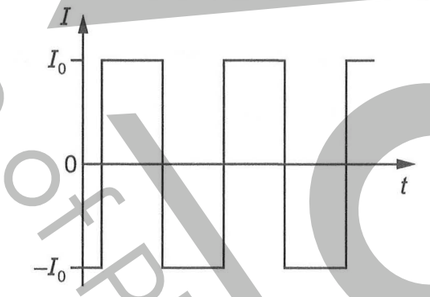
C 3.9×10^{-4} Wb

D 6.8×10^{-4} Wb

$\Phi = BA\cos\theta = 6.75 \times 10^{-8}$

65 μ, 12×10⁻⁴, 30

26 The variation with time t of an alternating current I is shown.



What are the peak and the root-mean-square (r.m.s.) values of the alternating current?

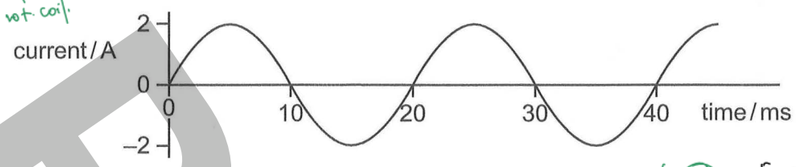
	peak current	r.m.s. current
A	I_0	I_0
B	I_0	$\frac{I_0}{\sqrt{2}}$
C	$2I_0$	I_0
D	$2I_0$	$\frac{I_0}{\sqrt{2}}$

① $I_{peak} = I_0$

② $I_{rms} = I_0$ ∵ eg. wave.

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27 An a.c. generator is connected to a resistor of resistance 20 Ω. The graph shows the variation of the current in the resistor with time.



The rotational speed of the a.c. generator is halved.

What is now the mean power dissipated in the resistor?

A 5 W **B** 10 W **C** 20 W **D** 40 W

28 An electron has a kinetic energy E and a de Broglie wavelength λ.

The kinetic energy of the electron is increased to $9E$.

What is now the de Broglie wavelength of the electron?

A $\frac{\lambda}{3}$ **B** $\frac{\lambda}{9}$ **C** 3λ **D** 9λ

29 The nucleus of an isotope of bismuth is represented as $^{212}_{83}Bi$.

The nucleus has mass M, a proton has mass M_p and a neutron has mass M_n.

What is the mass defect for the bismuth nucleus?

A $M - 83M_p - 129M_n$

B $M - 212M_p - 83M_n$

C $83M_p + 129M_n - M$

D $212M_p + 83M_n - M$

30 A uranium-238 nucleus (mass 238.1249 u) decays into a thorium-234 nucleus (mass 234.1165 u) with the emission of an α-particle (mass 4.0026 u).

How much energy is released in this decay?

A 2.9×10^{-21} J **B** 4.8×10^{-16} J **C** 8.7×10^{-13} J **D** 6.0×10^{-10} J

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MINISTRY OF EDUCATION, SINGAPORE
in collaboration with
CAMBRIDGE ASSESSMENT INTERNATIONAL EDUCATION
General Certificate of Education Advanced Level
Higher 2

PHYSICS

9749/01

Paper 1 Multiple Choice

October/November 2022

1 hour

Additional Materials: Multiple Choice Answer Sheet

0807181134

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and index number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE ON ANY BARCODES.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **16** printed pages.

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