TEMASEK JUNIOR COLLEGE

2025 JC2 PRELIMINARY EXAMINATION

Higher 2

PHYSICS 9749/01

Paper 1 Multiple Choice **18 September 2025**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and Civics group on the Answer Sheet in the spaces provided.

There are **thirty** questions in 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.

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.

Do NOT open the booklets until you are told to do so.

Data

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

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	=	ρgh
gravitational potential	ϕ	=	$-Gm/r$
temperature	T/K	=	T/°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	=	$x_o \sin\omega t$
velocity of particle in s.h.m.	v	=	$v_o \cos\omega t$
		=	$\pm\omega\sqrt{(x_o^2 - x^2)}$
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	=	$\frac{Q}{4\pi\varepsilon_o r}$
alternating current/voltage	x	=	$x_o \sin\omega t$
magnetic flux density due to a long straight wire	B	=	$\frac{\mu_o I}{2\pi d}$
magnetic flux density due to a flat circular coil	B	=	$\frac{\mu_o NI}{2r}$
magnetic flux density due to a long solenoid	B	=	$\mu_o nI$
radioactive decay	x	=	$x_0 \exp(-\lambda t)$
decay constant	λ	=	$\frac{ln2}{t_{1/2}}$

1 A capacitor is a device used to store electric charges. It consists of a pair of conducting plates. The capacitance *C* of a capacitor is defined as the ratio of the charge *Q* on either plate to the magnitude of the potential difference *V* between the plates, as depicted in the formula:

$$C = \frac{Q}{V}$$

Which of the following shows the SI base units for capacitance *C*?

A $A^2\ s^4\ m^{-2}\ kg^{-1}$ **B** $s^2\ m^{-2}\ kg^{-1}$ **C** $A^2\ m^{-2}\ kg^{-1}$ **D** $C^2\ kg^{-1}\ m^{-2}\ s^2$

2 Four students conduct their own experiments to determine the value of Planck's constant. The following table contains their experimental data.

Which student's measurement is accurate but imprecise, compared to the others?

student	Planck's constant, h / 10^{-34} J s				
A	6.64	6.61	6.61	6.64	6.65
B	6.62	6.63	6.63	6.64	6.63
C	6.63	6.68	6.61	6.68	6.65
D	6.62	6.61	6.63	6.62	6.62

3 The relation between the velocity v of waves in the sea with its wavelength λ, the surface tension γ and density ρ of sea water is given by:

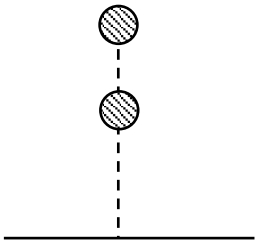
$$v = k\sqrt{\frac{\gamma}{\lambda\rho}}$$

where k = constant of proportionality.

If γ = (4.30 $\pm$ 0.05) N m^{-1}, ρ = (1450 $\pm$ 20) kg m^{-3} and the percentage uncertainty in λ is 5 %, what is the percentage uncertainty in the velocity of the waves?

A 2% **B** 3% **C** 4% **D** 8%

4 Two identical ball bearings are dropped simultaneously from rest from different heights as shown below. Air resistance is negligible.



As the stones fall, which of the following is true about the distance between them?

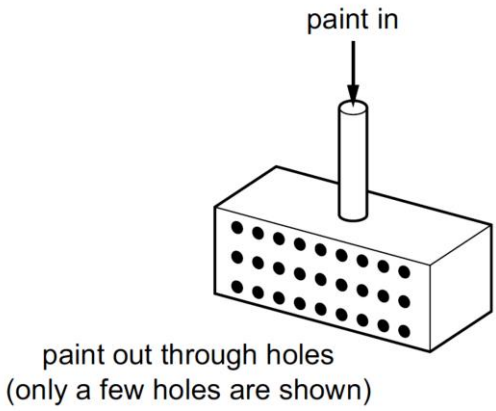
A The distance will remain the same.

B The distance will decrease until they come in contact.

C The distance will increase continuously.

D The distance will increase initially then remain the same.

5 A device for spraying paint consists of a box with its axes horizontal and vertical. One of its vertical faces contains small holes. Paint is fed into the box under pressure via a vertical tube and exits through the holes as fine horizontal streams.

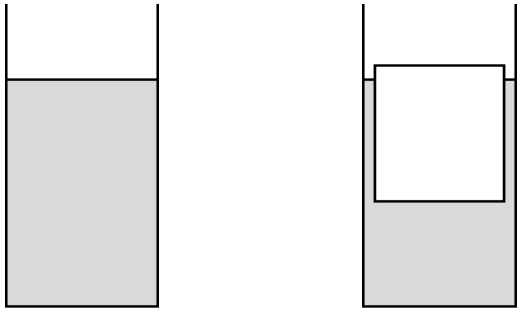


The paint is ejected at a speed of 3.0 m s^{-1} through 27 holes, each of area 0.4 mm^2. The density of the paint is 900 kg m^{-3}.

What is the horizontal force required to hold the device stationary as it ejects the paint?

A 21 mN **B** 29 mN **C** 44 mN **D** 87 mN

6 A cup contains 100 g of water. The pressure at the bottom of the cup is *P*.

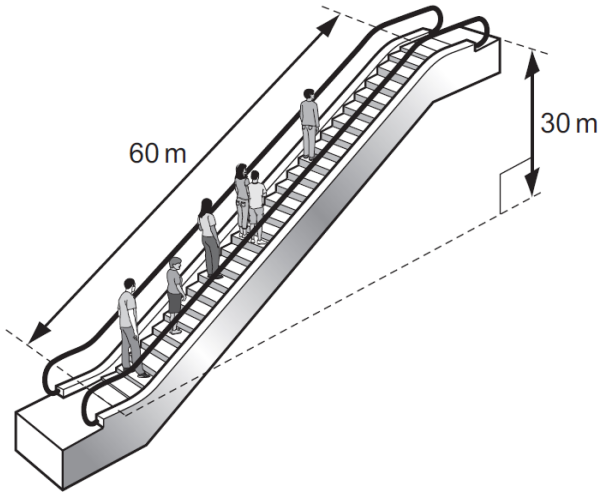


50 g of water is removed from the cup, frozen into ice, and added back to the cup, as shown above. 10% of the volume of the ice is above the surface of the water.

What is the new pressure at the bottom of the cup?

A 0.95*P* **B** *P* **C** 1.05*P* **D** 1.10*P*

7 An escalator is 60 m long and lifts passengers through a vertical height of 30 m.



To drive the escalator against the forces of friction when there are no passengers requires a power of 2.5 kW.

The escalator is used by passengers of average mass 62 kg and the power to overcome friction remains constant.

How much power is required to drive the escalator when it is carrying 20 passengers and is travelling at 0.75 m s^{-1}?

A 4.6 kW **B** 7.1 kW **C** 9.1 kW **D** 11.6 kW

8 The engine of a boat supplies a constant power of 110 kW to propel the boat forward. The boat attains a maximum speed of 21.0 m s^{-1}.

If the magnitude of the resistive force acting on the boat is proportional to the square of the boat's speed, what is the resultant force acting on the boat when it is moving at the instant when its speed is 15.0 m s^{-1}?

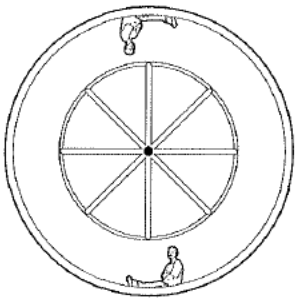
A 2.7 kN **B** 3.6 kN **C** 4.7 kN **D** 7.3 kN

9 An astronomical gas cloud has mass M and radius R. The gravitational potential on its surface S is $-\frac{GM}{R}$ and at its centre 0 it is $-\frac{3GM}{2R}$

A unit mass is moved slowly by means of an external force from the surface S to the centre O. What is the work done on the mass by the external force?

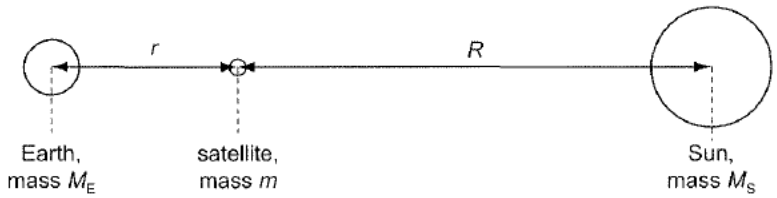
A $-\frac{5GM}{2R}$ **B** $-\frac{GM}{2R}$ **C** $\frac{GM}{2R}$ **D** $\frac{5GM}{2R}$

10 On a fairground ride, passengers are rotated in a vertical wheel of radius 4.00 m. Passengers complete one revolution in 3.70s.
A passenger of mass 77.0 kg is shown in the diagram when at the top of the wheel and when at the bottom of the wheel. What is the force acting by the wheel on the passenger?



	force at top	**force at bottom**
A	1640 N down	133 N up
B	1640 N up	133 N down
C	133 N down	1640 N up
D	133 N up	1640 N down

11 The diagram shows a solar satellite, mass m, positioned directly between the Earth, mass M_E, and the Sun, mass M_S. The satellite is a distance r from the Earth and a distance R from the Sun.



The satellite rotates in a circle around the Sun once a year and therefore moves around the Sun with the Earth, both having the same angular velocity ω
Which force = mass x acceleration equation applies for the satellite?

A $\frac{GM_S m}{R^2} = m \times (R\omega^2)$

B $\frac{GM_E m}{r^2} = m \times (R\omega^2)$

C $\frac{GM_E m}{r^2} - \frac{GM_S m}{R^2} = m \times (R\omega^2)$

D $\frac{GM_S m}{R^2} - \frac{GM_E m}{r^2} = m \times (R\omega^2)$

12 A satellite orbiting the Earth moves to an orbit further away from the Earth, such that its gravitational potential energy increases **by** E. By how much does its kinetic energy changes?

A It increases by E.

B It decreases by E.

C It increases by $\frac{E}{2}$.

D It decreases by $\frac{E}{2}$.

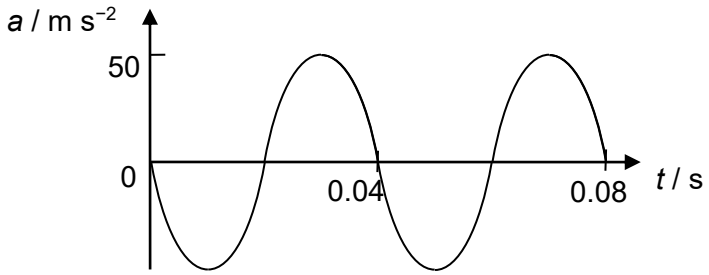
13 Two vessels A and B of volume V and $8V$ respectively are connected by a tube of negligible volume and contain an ideal gas at an initial temperature of 10 °C.

Vessel A initially contains n moles of the ideal gas. Its temperature is then raised to 80 °C while the temperature of B is maintained at 10 °C.

How many moles of gas will be transferred between the vessels when steady state is reached?

A 0.18 n **B** 0.21 n **C** 0.82 n **D** 0.86 n

14 A body performs simple harmonic motion with period T. The graph shows the variation with time t of its acceleration a.



What is the ratio of the body's displacement to its amplitude at time $t = \frac{5T}{8}$?

A -0.71 **B** 0.71 **C** -0.87 **D** 0.87

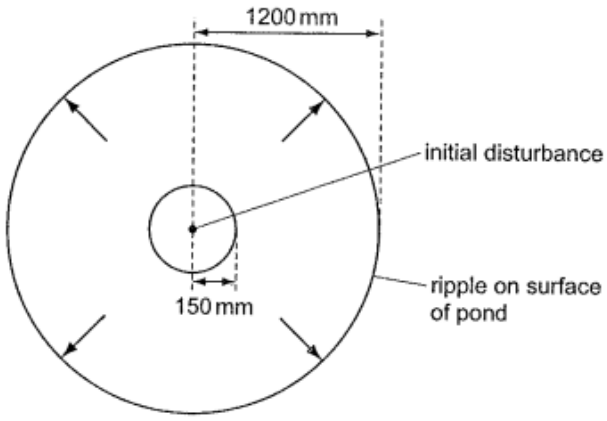
15 In a horizontal spring-mass system, a mass m oscillates with a frequency f and an amplitude x. The total energy of the oscillating system is E.

What is the total energy of a spring-mass system with a mass 0.50 m, frequency 3.0 f and amplitude 0.40 x?

A 0.24E **B** 0.60E **C** 0.72E **D** 1.8E

16 Ripples on the surface of a pond spread out in circles from the point of an initial disturbance. Assume that the energy of the wave is spread over the entire circumference of the ripple.

For one such ripple, the amplitude of the ripple at a distance of 150 mm from the disturbance is 2.0 mm.



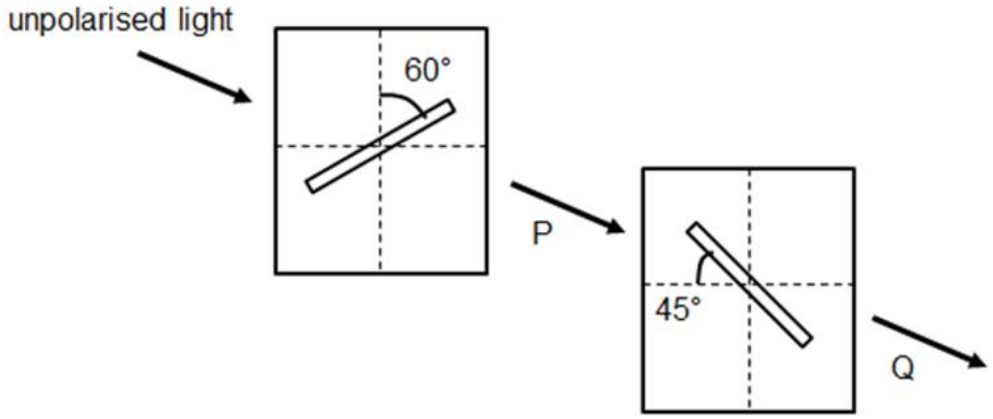
What will be the amplitude of the ripple at a distance of 1200 mm from the disturbance?

(Assume no energy is lost in the propagation of the ripple.)

A 0.031 mm **B** 0.13 mm **C** 0.25 mm **D** 0.71 mm

17 A beam of unpolarised light with amplitude A and intensity I is passed through two optical polarisers.

The first polariser's transmission axis is oriented at 60° to the vertical, while the second polariser's transmission axis is oriented at 45° to the horizontal.

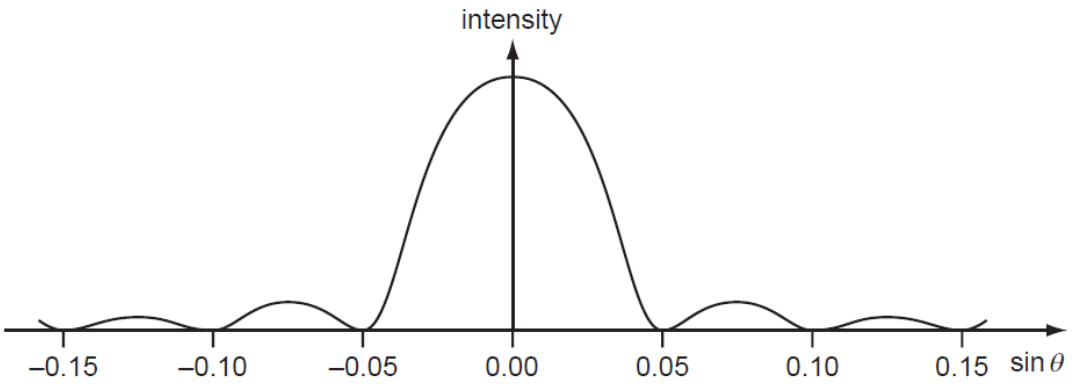


What is the intensity of the light at P and amplitude of the light at Q?

	Intensity of light at P	**Amplitude of light at Q**
A	$\frac{1}{\sqrt{2}}I$	$A\sin 15^\circ$
B	$\frac{1}{\sqrt{2}}I$	$\frac{1}{2}A\sin 15^\circ$
C	$\frac{1}{2}I$	$A\sin 15^\circ$
D	$\frac{1}{2}I$	$\frac{1}{\sqrt{2}}A\sin 15^\circ$

18 A parallel, monochromatic beam of electromagnetic radiation is incident at right angles onto a single slit of width 0.010 mm.

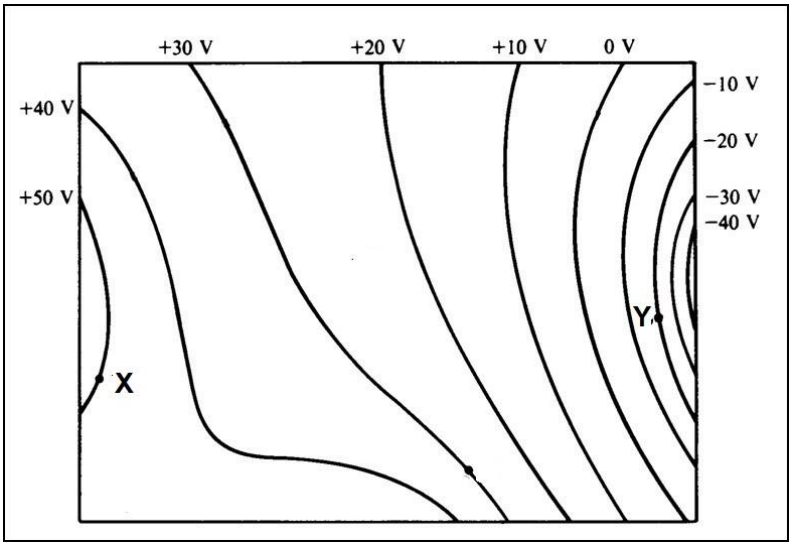
The graph shows how the intensity of the radiation varies with the sine of the angle θ through which the light is diffracted.



What is the wavelength of the radiation?

A 500 nm **B** 750 nm **C** 500 μm **D** 750 μm

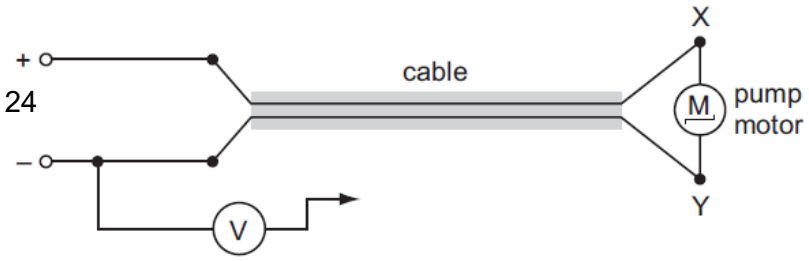
19 The diagram shows the electric equipotential lines in a non-uniform electric field.



An electron moves from point X to Y. Which of the following is correct with regard to the comparison of the electric potential energy U as well as the magnitude of the electric force F of the electron at point **X** and **Y**?

	Electric Potential energy	Magnitude of electric force
A	$U_Y < U_x$	$F_Y < F_X$
B	$U_Y < U_x$	$F_Y > F_X$
C	$U_Y > U_x$	$F_Y < F_X$
D	$U_Y > U_x$	$F_Y > F_X$

20 The diagram shows the electric motor for a garden pump connected to a 24 V power supply by an insulated two-core cable.

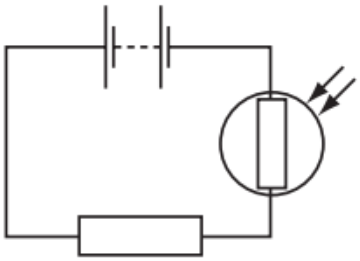


The motor does not work, so to find the fault, the negative terminal of a voltmeter is connected to the negative terminal of the power supply and its other end is connected in turn to terminals X and Y at the motor.

Which row represents the correct conclusion from two voltmeter readings?

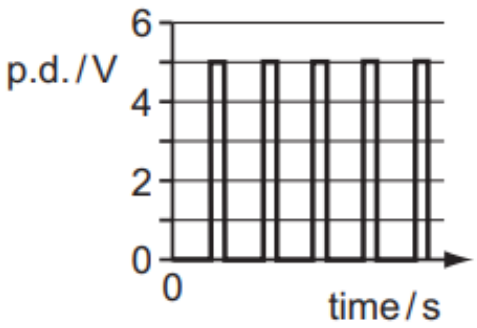
	voltmeter reading connected to X / V	*voltmeter reading connected to Y / V*	*conclusion*
A	24	0	break in positive wire of cable
B	24	12	break in negative wire of cable
C	24	24	break in connection within the motor
D	24	24	break in negative wire of cable

21 The resistance of a light-dependent resistor (LDR) is 5 MΩ in the dark and 1 kΩ when light shines on it. The LDR is connected in series with a 6 V battery with negligible internal resistance and a 5 kΩ resistor. The circuit is placed in a dark room and the LDR is then illuminated by a flashing lamp

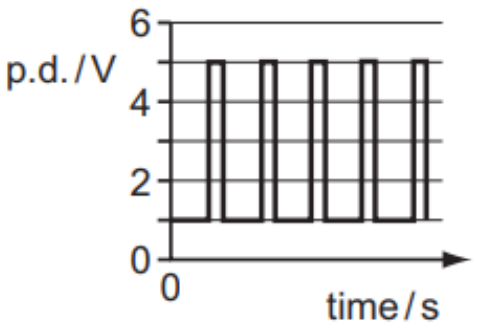


Which diagram shows how the p.d. across the 5kΩ resistor varies with time?

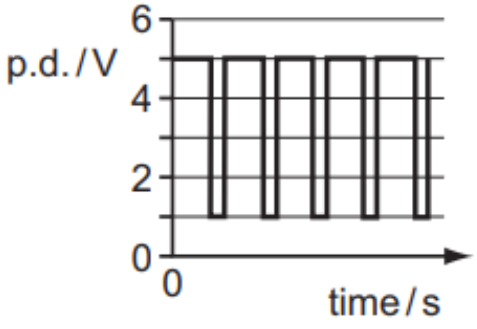
A



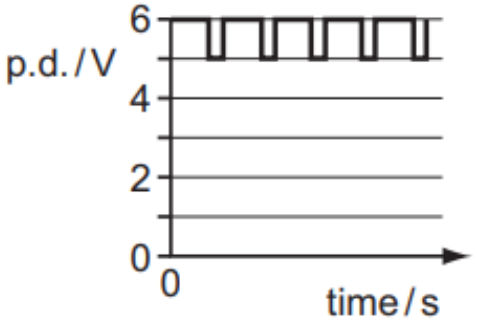
B



C



D



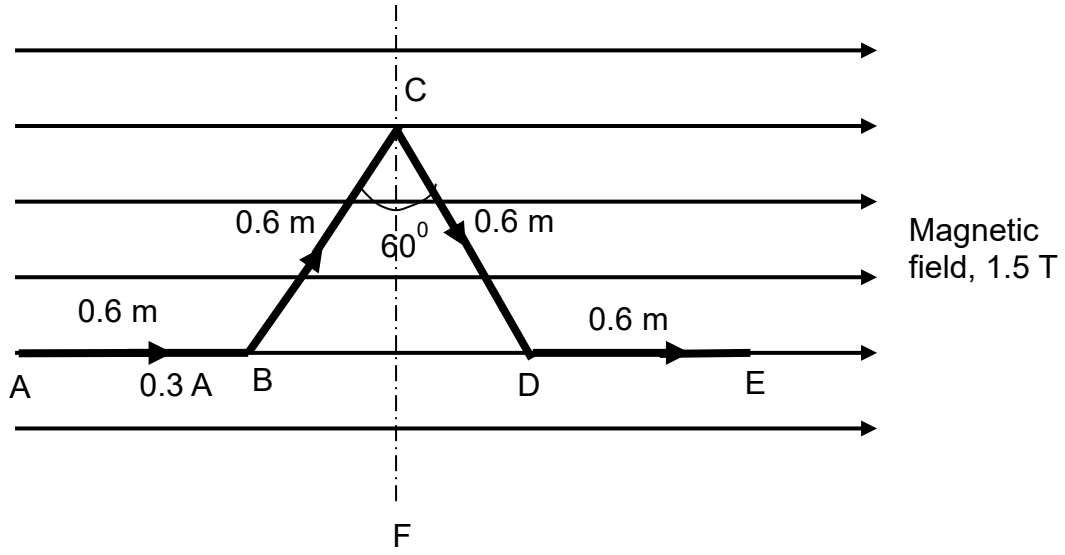
22 A steady current *I* dissipates a certain power in a variable resistor. When a sinusoidal alternating current is used, the variable resistor has to be reduced to one quarter of its initial value to obtain the same power. What is the peak value of the alternating current?

A $\sqrt{2}I$ **B** $2I$ **C** $2\sqrt{2}I$ **D** $4\sqrt{2}I$

23 Two very long, straight, parallel wires carry equal steady current I in opposite directions. The distance between the wires is d. At a certain instant of time, a point charge q is at a point equidistant from the two wires, in the plane of the wires. Its instantaneous velocity v is perpendicular to this plane. The magnitude of the force due to the magnetic field acting on the charge at this instant is

A 0 N **B** $\frac{\mu_0 Iqv}{2\pi d}$ **C** $\frac{\mu_0 Iqv}{\pi d}$ **D** $\frac{2\mu_0 Iqv}{\pi d}$

24 A current of 0.3 A flows in a conductor ABCDE that lies on the plane of the paper as shown in the figure below.

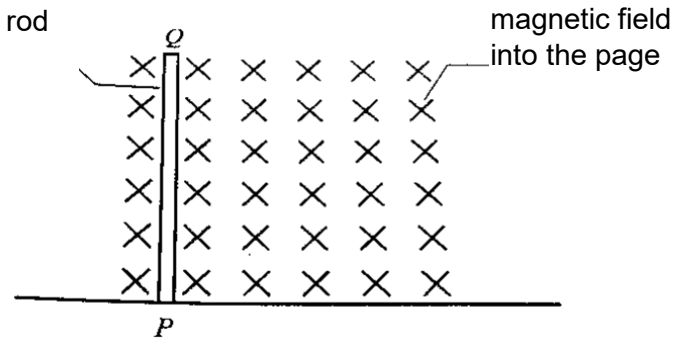


The conductor is inside a region of a uniform magnetic field having a magnetic field strength of 1.5 T. AB and DE are parallel to the magnetic field. Angle BCD is 60°. The lengths of segments AB, BC, CD and DE are 0.6 m each.

Which of the following describe the resultant force and resultant torque on the conductor?

	magnitude of resultant force	torque (view from the top)
A	0 N	Clockwise about CF
B	0 N	No resultant torque
C	0.47 N	Anti-clockwise about CF
D	0.47 N	No resultant torque

25 A vertical rod PQ is hinged to a flat surface at the end P and placed in a uniform magnetic field that acts into the page, as shown in the diagram. When the rod is lightly pushed to the right at the end Q, it swings downwards while still hinged at P.



Just before the end Q hits the flat surface, which of the following statements is correct?

A Q is at a higher electrical potential than P.

B An upward magnetic force acts on the rod.

C An induced current flows to Q from P

D The rod rotates clockwise with a constant angular speed.

26 The magnetic flux linking a conducting loop changes sinusoidally with time.

Which of the following describes the phase difference between the magnetic flux linkage and the e.m.f. induced?

A They are in phase with each other.

B They are out of phase by $\pi/4$ rad.

C They are out of phase by $\pi/2$ rad.

D They are out of phase by π rad.

27 A metal surface is illuminated with a beam of monochromatic electromagnetic radiation. Based on the photoelectric effect, photoelectrons may be emitted from the metal surface.

Which statement about the photoelectrons is correct?

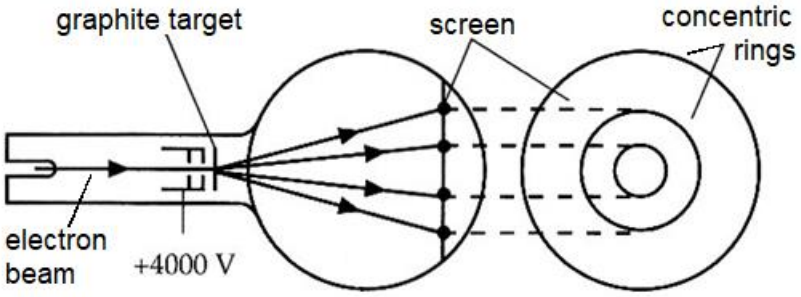
A No emission of photoelectrons occurs if the radiation is below a threshold intensity.

B Photoelectrons are emitted only if the wavelength of the radiation is greater than a minimum value.

C The maximum speed of the photoelectrons emitted increases when the intensity of the radiation increases provided frequency of radiation remains constant.

D The rate of emission of photoelectrons decreases when the frequency of the radiation increases at constant intensity.

28 In an experimental setup, a beam of accelerated electrons strikes an extremely thin layer of polycrystalline graphite target and concentric rings are seen on the tube face as shown.



If the setup is modified such that instead of electron beam, a beam of protons strike the graphite target with the same speed, what can be observed on the screen?

A The radii of the concentric rings decrease.

B The radii of the concentric rings increase.

C The radii of the concentric rings remain the same.

D No rings appear can be seen

29 A radioactive source consists of a mixture of two isotopes P and Q.

P has a half-life of 60 minutes and Q has a half-life of 30 minutes. The initial count rate recorded by a suitable counter is 800 min^{-1}. After 120 minutes the counter registers a count rate of 80 min^{-1}.

What was the initial count rate of P?

A 160 min^{-1}

B 240 min^{-1}

C 480 min^{-1}

D 640 min^{-1}

30 Uranium-238 decays by a series of alpha, beta and gamma decays into a final stable nuclide.

Which of the following is the final stable nuclide of the series?

A ^{205}Tl

B ^{206}Pb

C ^{207}Pb

D ^{208}Pb

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