NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

PHYSICS 9646/01

Paper 1 Multiple Choice

25 September 2014

1 hour 15 minutes

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and tutor's name on the Answer Sheet in the spaces provided unless this has been done for you.

There are **forty** 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.

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} Fm^{-1}
			$(1 / (36\ \pi)) \times 10^{-9}$ Fm^{-1}
elementary charge,	e	=	1.60×10^{-19} C
the Planck constant,	h	=	6.63×10^{-34} J s
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	=	$-Gm / r$
displacement of particle in s.h.m.	x	=	$x_o \sin \omega t$
velocity of particle in s.h.m.	v	=	$v_o \cos \omega t$
		=	$\pm \omega\sqrt{\left(x_o^{\,2} - x^2\right)}$
resistors in series,	R	=	$R_1 + R_2 + \ldots$
resistors in parallel,	$1/R$	=	$1/R_1 + 1/R_2 + \ldots$
electric potential,	V	=	$Q / 4\pi\varepsilon_o r$
alternating current/voltage,	x	=	$x_o \sin \omega t$
transmission coefficient,	T	=	exp(-2kd)
	where k	=	$\sqrt{\frac{8\pi^2 m\left(U - E\right)}{h^2}}$
radioactive decay,	x	=	$x_o \exp(-\lambda t)$
decay constant	λ	=	$\frac{0.693}{t_{1/2}}$

1 Intensity of a wave *I* at a distance *r* can be determined using the equation

$$I = \frac{P}{4\pi r^2}$$

where *P* is the power of the source.

The fractional error in the measurement of power is *a* and that in the measurement of distance is *b*. What is the fractional error in the calculated value of *I*?

A $a + 2b$ **B** $a - 8\pi b$ **C** $\frac{\Delta a}{a} - 2\frac{\Delta b}{b}$ **D** $\frac{\Delta a}{a} + 2\frac{\Delta b}{b}$

2 A steel rule can be read to the nearest millimetre. It is used to measure the length of a bar whose true length is 103 mm. Repeated measurements give the following readings:

Length / mm 102, 101, 101, 101, 102, 101

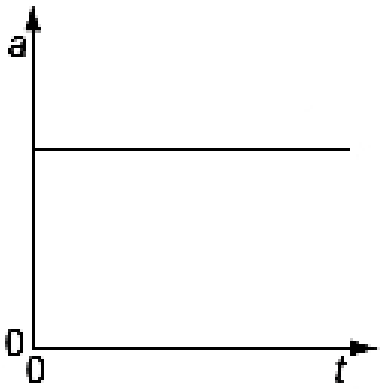
Are the readings accurate and precise to within 1 mm?

	results are **accurate** to within 1 mm	results are **precise** to within 1 mm
A	No	No
B	No	Yes
C	Yes	No
D	Yes	Yes

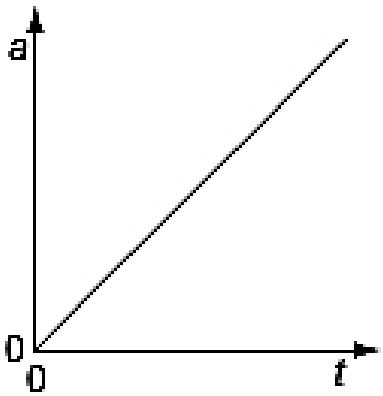
3 A tennis ball is released from rest at the top of a tall building.

Which graph best represents the variation with time *t* of the acceleration *a* of the ball as it falls, assuming that the effects of air resistance are appreciable?

A



B



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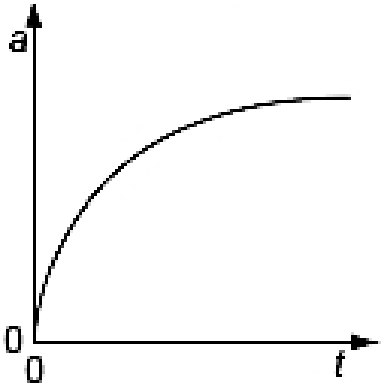
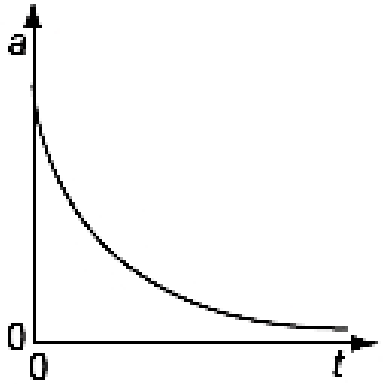


D



4 A hot air balloon carrying a passenger is descending at a constant velocity of 20.0 m s^{-1}. The passenger throws a stone horizontally at 15.0 m s^{-1} and 2.00 s later, the rock strikes the ground.

What is the speed at which the rock strikes the ground?

A 15.0 m s^{-1} **B** 30.0 m s^{-1} **C** 42.4 m s^{-1} **D** 59.6 m s^{-1}

5 A box of weight W is being pushed, by a force, F up a frictionless surface inclined at an angle α. F is directed at an angle of β below the horizontal. What is the magnitude of the acceleration of the box?

A $\dfrac{\left[F\cos(\alpha+\beta)-W\sin\alpha\right]g}{W}$

B $\dfrac{\left[F\cos(\alpha-\beta)-W\sin\alpha\right]g}{W}$

C $\dfrac{\left[F\cos\alpha\cos\beta-W\sin\alpha\right]g}{W}$

D $\dfrac{\left[F\sin\alpha\sin\beta-W\sin\alpha\right]g}{W}$

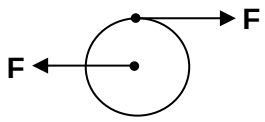
6 A 80.0 kg mass falls from a 3.00 m tall ledge down onto the ground. It hits a hard surface and comes to rest in 0.0250 s. What is the average force exerted by the surface on it?

A 19.6 N **B** 785 N **C** 24 600 N **D** 25 300 N

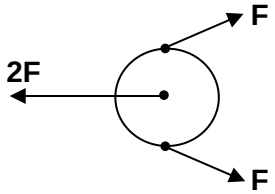
7 A metal disc is acted upon by a number of forces. The forces are all in the plane of the disc and the weight of the disc is negligible.

In which of the following situations is the disc in static equilibrium?

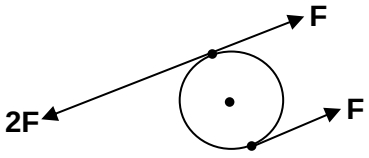
A



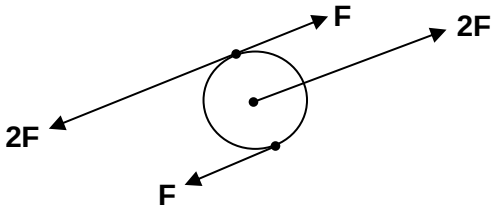
B



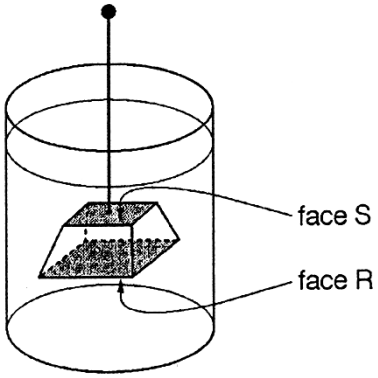
C



D



8 The diagram shows a block of copper suspended in water. The block experiences an upthrust from the water.



Which statement is the basis of an explanation for this upthrust?

A Copper is denser than water.

B The pressure of water increases with depth.

C The density of water increases with depth.

D The area of face R is greater than the area of face S.

9 A particle is dropped from rest at a height h above the surface of a viscous liquid column of height 0.80 m. It attains a speed of 7.5 m s^{-1} after it has penetrated 0.60 m of the viscous liquid column. If the mass of the particle is 0.80 kg and the viscous liquid offers a constant retarding force of 120 N, what is the height, h, from which the particle is released?

A 2.3 m **B** 3.5 m **C** 11.4 m **D** 15.7 m

10 An object of mass 400 kg is lifted through a vertical height of 1200 m in 2.0 minutes by an electric motor. What is the amount of electrical power needed if the overall efficiency of the system is 80%?

A 3.1 kW **B** 4.9 kW **C** 49 kW **D** 2900 kW

11 A particle of mass m moves in a circle of radius r at a uniform speed with frequency f. What is the kinetic energy of the particle?

A $\frac{m f^2 r^2}{4\pi^2}$ **B** $\frac{m f^2 r}{2}$ **C** $2\pi^2 m f^2 r^2$ **D** $4\pi^2 m f^2 r^2$

12 A car of mass m moving at a constant speed v passes over a humpback bridge of radius of curvature r. (A humpback bridge is curves in a semicircle above a river).

Given that the car remains in contact with the road, what is the net force R exerted by the car on the road when it is at the top of the bridge?

A $mg + \frac{mv^2}{r}$ **B** $\frac{mv^2}{r}$ **C** mg **D** $\frac{mv^2}{r} - mg$

13 The average density of Planet P is twice that of Planet Q, and the radius of Planet P is half that of Planet Q.

The gravitational field strength at the surface of P is 13.4 N kg^{-1}. What is the gravitational field strength at the surface of Q?

A 3.4 N kg^{-1} **B** 13.4 N kg^{-1} **C** 53.6 N kg^{-1} **D** 80.4 N kg^{-1}

14 Which of the following correctly shows the relationships between potential energy U, kinetic energy,K and the total energy, E, of a satellite?

A $U = -2K = 2E$

B $U = -K = E$

C $U = -\frac{1}{2} K = \frac{1}{2} E$

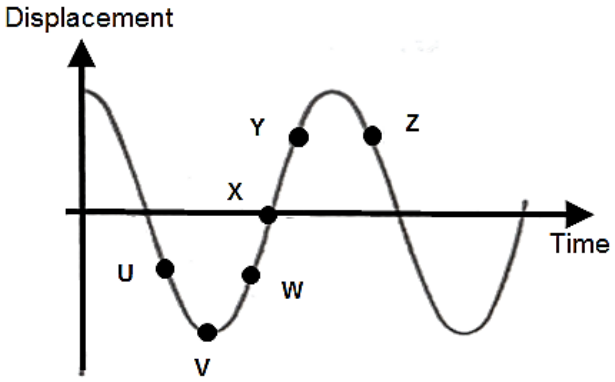
D $U = K = \frac{1}{2} E$

15 A sphere attached to a horizontal spring is oscillating on a smooth horizontal surface at a frequency of 2.0 Hz. The amplitude of oscillation is 2.0 cm.

What is the speed of the sphere when it is at a distance 1.0 cm from equilibrium position?

A 6.3 cm s^{-1} **B** 22 cm s^{-1} **C** 25 cm s^{-1} **D** 31 cm s^{-1}

16 The diagram below shows a displacement-time graph of a body performing simple harmonic motion.



At which one of the points, U, V, W, X, Y or Z, is the body travelling *and* accelerating in the opposite direction?

A U, Y **B** V, X **C** W, Z **D** X, Z

17 The pressure of an ideal gas increases at constant volume. Which of the following shows the correct changes to the quantities?

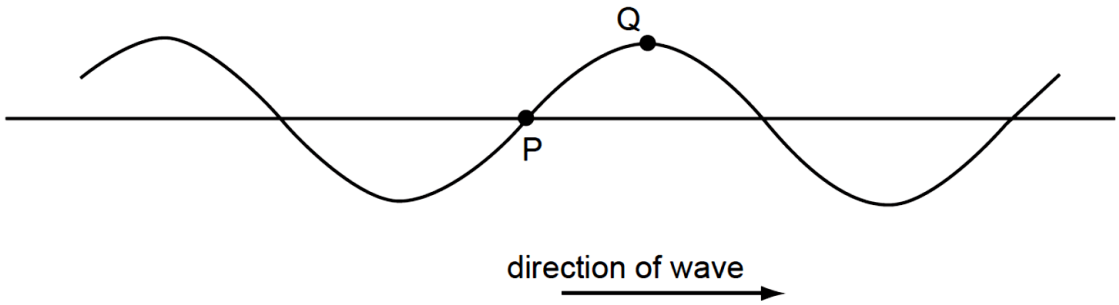
	heat absorbed	work done by the system	change in internal energy
A	+	+	+
B	+	–	0
C	+	0	+
D	–	0	–

18 A pressure of 1.0×10^{-7} mm of Hg is achieved in a vacuum system. How many gas molecules are present in 1000 cm^3 of gas if the temperature is 20 °C? (760 mm of Hg = 1.01×10^5 Pa).

A 4.8×10^{16} **B** 3.3×10^{15} **C** 4.8×10^{13} **D** 3.3×10^{12}

19 The diagram shows a transverse wave on a rope. The wave is travelling from left to right.

At the instant shown, the points P and Q on the rope have zero displacement and maximum displacement respectively.



Which of the following describes the direction of motion, if any, of the points P and Q at this instant?

	point P	point Q
A	downwards	downwards
B	downwards	stationary
C	upwards	downwards
D	to the right	to the right

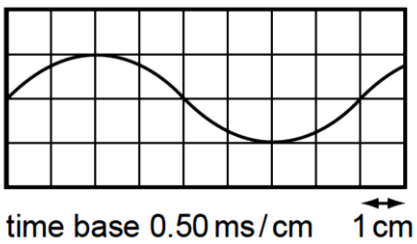
20 A stationary sound wave is set up between a loudspeaker and a wall.

A microphone is connected to a cathode-ray oscilloscope (c.r.o.) and is moved along a line directly between the loudspeaker and the wall. The amplitude of the trace on the c.r.o. rises to a maximum at a position X, falls to a minimum and then rises once again to a maximum at a position Y.

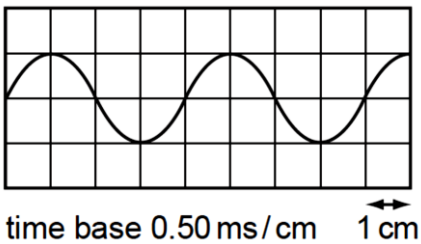
The distance between X and Y is 33 cm. The speed of sound in air is 330 m s^{-1}.

Which diagram represents the c.r.o. trace of the sound received at X?

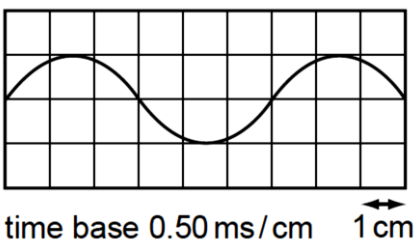
A



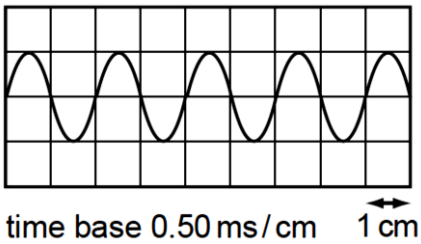
B



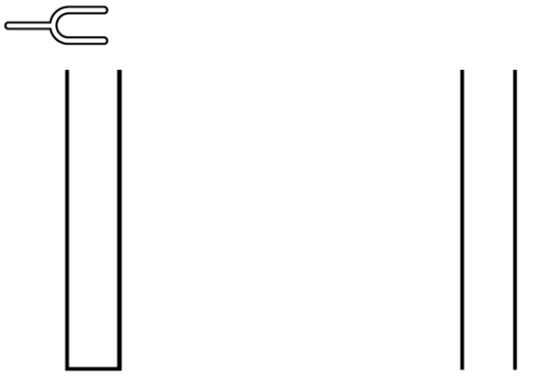
C



D



21 The diagram shows two tubes.



The tubes are identical except tube X is closed at its lower end while tube Y is open at its lower end. Both tubes have open upper ends.

A tuning fork placed above tube X causes resonance of the air at frequency *f*. No resonance is found at any lower frequency than *f* with tube X.

Which tuning fork will produce resonance when placed just above tube Y?

A a fork of frequency $\frac{f}{2}$

B a fork of frequency $\frac{2f}{3}$

C a fork of frequency $\frac{3f}{2}$

D a fork of frequency $2f$

22 When the light from two lamps falls on a screen, no interference pattern can be obtained.

This is because the

A lamps are not point sources.

B lamps emit light of different amplitudes.

C light from the lamps is not coherent.

D light from the lamps is white.

23 In which of the following cases does an electric field do positive work on a charged particle?

A A positive charge is moved to a point of higher electric potential.

B A negative charge moves opposite to the direction of the electric field.

C A positive charge completes one circular path around a stationary positive charge.

D A negative charge is moved perpendicular to the electric field between two parallel and oppositely charged plates.

24 Which one of the following statements about the electric potential at a point is correct?

A An alternative unit for electrical potential is the joule.

B The potential is given by the rate of change of electric field strength with distance.

C The potential at a point due to a system of point charges is given by the sum of the potentials due to the individual charges at that point.

D The potential at a point is defined as the work done in moving one proton from infinity to the point.

25 A wire has resistance R. A second wire has twice the length, twice the diameter, and twice the resistivity of the first wire. What is the resistance of the second wire?

A $8R$ **B** R **C** $\frac{R}{2}$ **D** $\frac{R}{4}$

26 If a certain resistor obeys Ohm's law, its resistance will

A change as the voltage across the resistor changes.

B change as the current through the resistor changes.

C change as the energy given off by the electrons in their collisions changes.

D not change.

27 Three resistors, each of different value, are connected in a circuit with an e.m.f. of 12 V with negligible internal resistance. For which of the following resistor combinations is the total power dissipated the greatest?

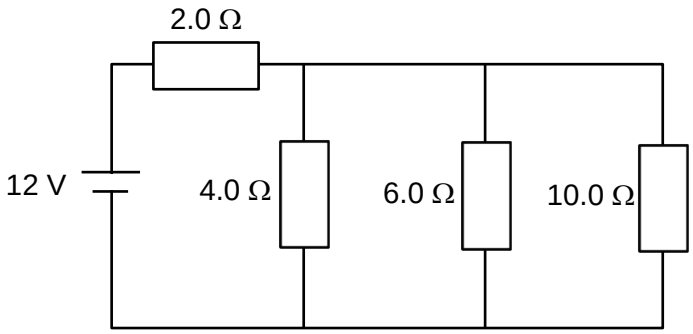
A All three resistors in series.

B All three resistors in parallel.

C Two of the resistors in parallel with the third resistor in series with the parallel pair.

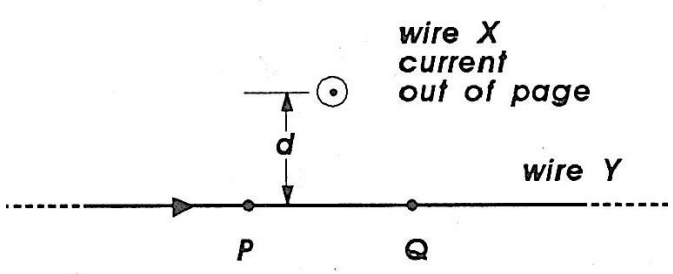
D Insufficient information to determine.

28 Three resistors connected in parallel have individual values of 4.0 Ω, 6.0 Ω and 10.0 Ω, respectively. If this combination is connected in series with a 12 V battery and a 2.0 Ω resistor, what is the current in the 10 Ω resistor?



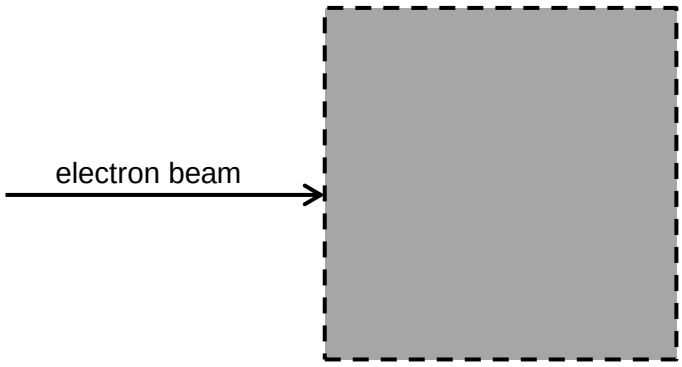
A 0.59 A **B** 1.0 A **C** 11 A **D** 16 A

29 Two long straight wires X and Y are placed perpendicular to each other at a distance *d* apart. A current flows out of the page in wire X while a current flows from left to right in wire Y. What are the directions of the forces acting on wire Y at points P and Q due to the magnetic field produced by wire X?



	force at P	force at Q
A	out of page	into page
B	into page	out of page
C	towards X	away from X
D	towards X	towards X

30 In the diagram, the shaded area represents a uniform magnetic field directed at right-angles into the plane of the paper.



A horizontal beam of electrons enters the field, travelling from left to right.

In which direction is this beam deflected by the field?

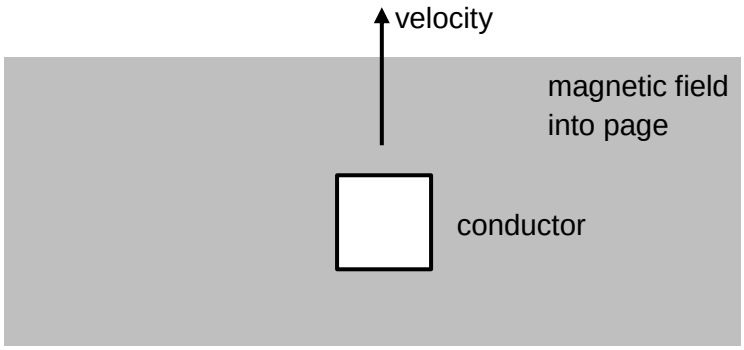
A upwards

B downwards

C into the plane of the paper

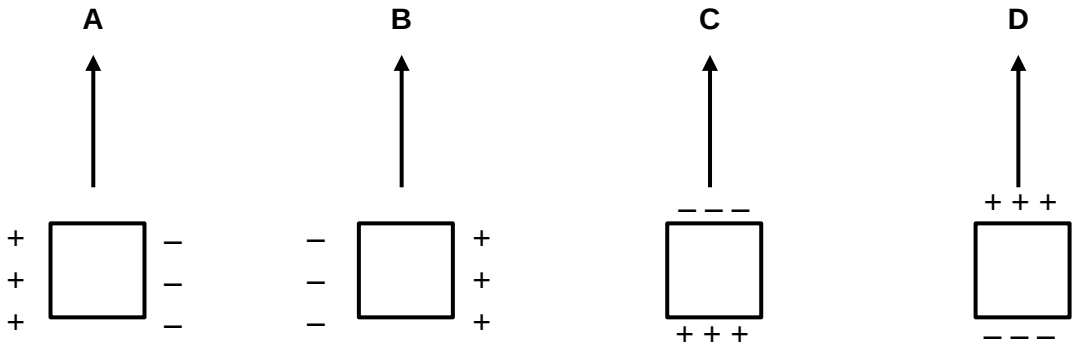
D out of the plane of the paper

31 A conductor in the shape of a solid square is moving with constant velocity in a region of magnetic field as shown.

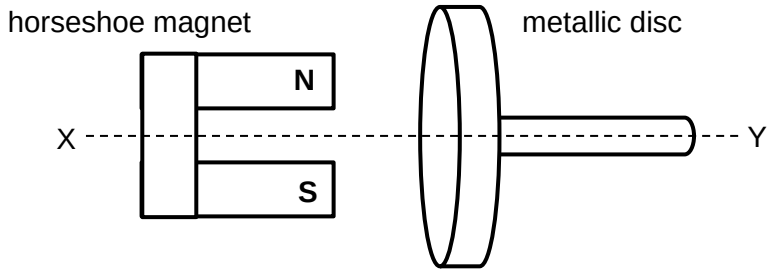


The direction of the field is into the plane of the page.

Which of the following diagrams correctly represents the separation of the induced charges?



32 A horseshoe magnet is brought near to a metallic disc which is free to rotate about the axis XY as shown.



When the magnet is rotated along the axis XY, the disc will

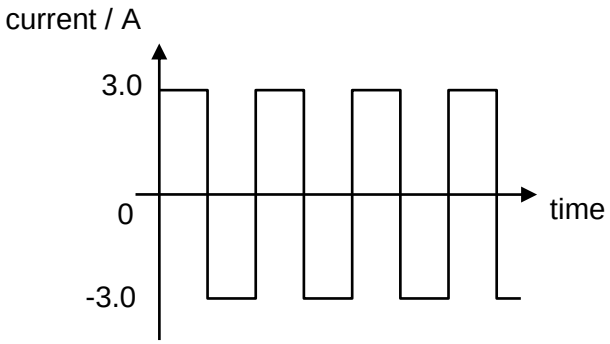
A remain stationary.

B rotate in the same direction as the magnet.

C rotate in the opposite direction as the magnet.

D oscillate along the axis XY.

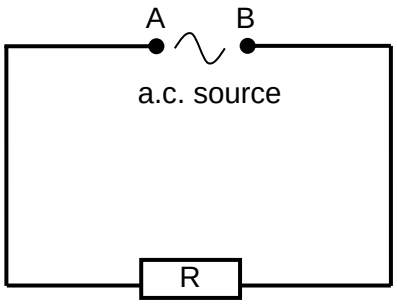
33 The diagram below shows a rectangular waveform with a peak current of 3.0 A.



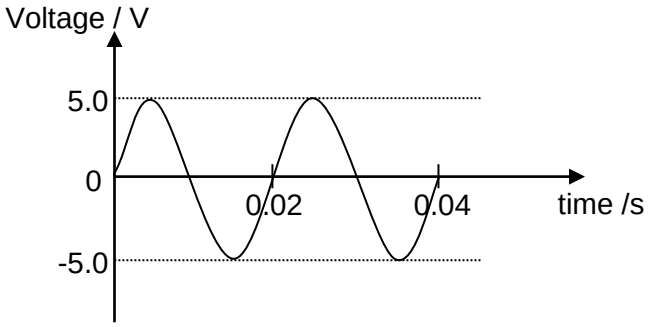
In order to obtain the same r.m.s. current as the waveform shown, a sinusoidal current of the same frequency should have a peak value of

A 2.1 A **B** 3.0 A **C** 4.2 A **D** 6.0 A

34 An a.c. supply is connected across a resistor R.



The voltage across AB varies sinusoidally with a peak voltage of 5.0 V as shown.



Which is the following statements about the setup is **not** correct?

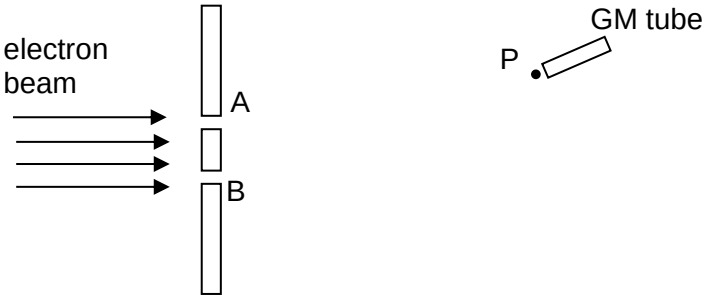
A The frequency of the supply is 50 Hz.

B A steady d.c. supply of $\frac{5}{\sqrt{2}}$V will transfer the same power as the a.c. supply.

C An electron reverses its direction of travel every 0.02 s.

D A p-n semiconductor diode connected to the circuit will be able to rectify the a.c. source to obtain a d.c. output at R.

35 An electron beam is directed towards a double-slit arrangement as shown. On the other side of the slits, a Geiger-Muller (GM) tube is placed to detect all the electrons that arrive at P.



When slit B is covered the amplitude of the wave function of the electron beam at P is 10 units and the GM tube detects 200 electrons arriving per unit time. When slit A is covered, the amplitude of the wave function at P is 6 units. When both slits are open and it happens that there is a destructive interference at P, the number of electrons per unit time detected at P is

A 32 **B** 72 **C** 128 **D** 180

36 Two close parallel plates of separation d are connected to a potential difference V_o / V. An electron escapes from the positive plate with a kinetic energy E / J (< eV_o where e is the charge of the electron) by absorbing an energetic photon. Considering the quantum behavior of electrons, the probability for the electron to reach the negative plate

A is zero.

B depends on d only.

C depends on the ratio $\frac{E}{V_o}$ only.

D depends on the ratio $\frac{E}{V_o}$ and d.

37 When light of frequency less than threshold is shone onto a metal, no electron is emitted regardless how long is the light radiated on the metal. However, it was found that when laser light of frequency lower than the threshold is used, electrons could be emitted. Which of the following is the correct explanation?

A The photon theory does not apply to laser light.

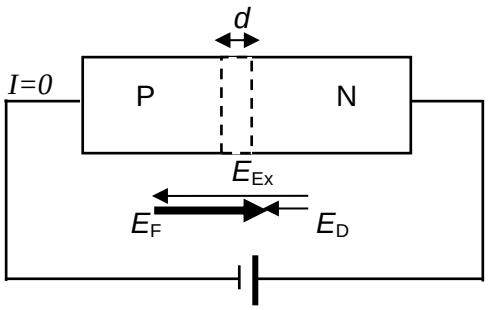
B Each laser photon has a higher momentum that can knock out the electrons.

C Laser light has very high intensity and is highly coherent so the electrons have a chance to absorb more than a photon at the same time.

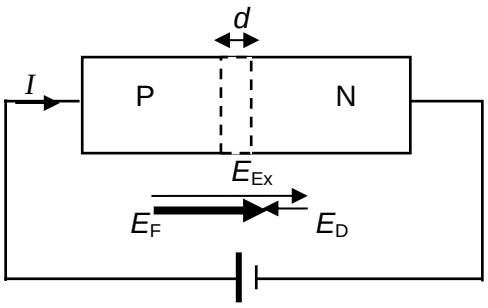
D Laser light exhibits wave behaviour rather than particulate behaviour so that the electron can absorb the wave energy continuously for a longer time interval.

38 A P-N junction is connected to an external d.c. source. Which of the following correctly shows the direction of the conventional current I, relative width of the depletion layer d, directions as well as relative strengths of the external electric field E_{Ex}, internal electric field E_D due to the depletion layer and the resultant electric field E_F acting on the P-N junction?

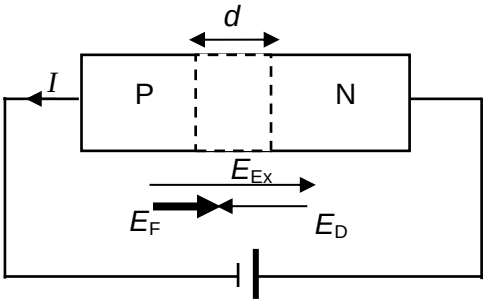
A



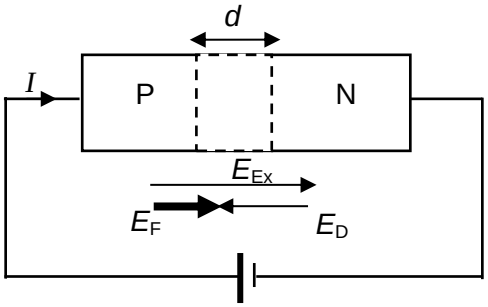
B



C



D



39 A sample of material initially contains atoms of only one radioactive isotope. Which one of the following quantities is reduced to one half of its initial value during a time equal to the half-life of the radioactive isotope?

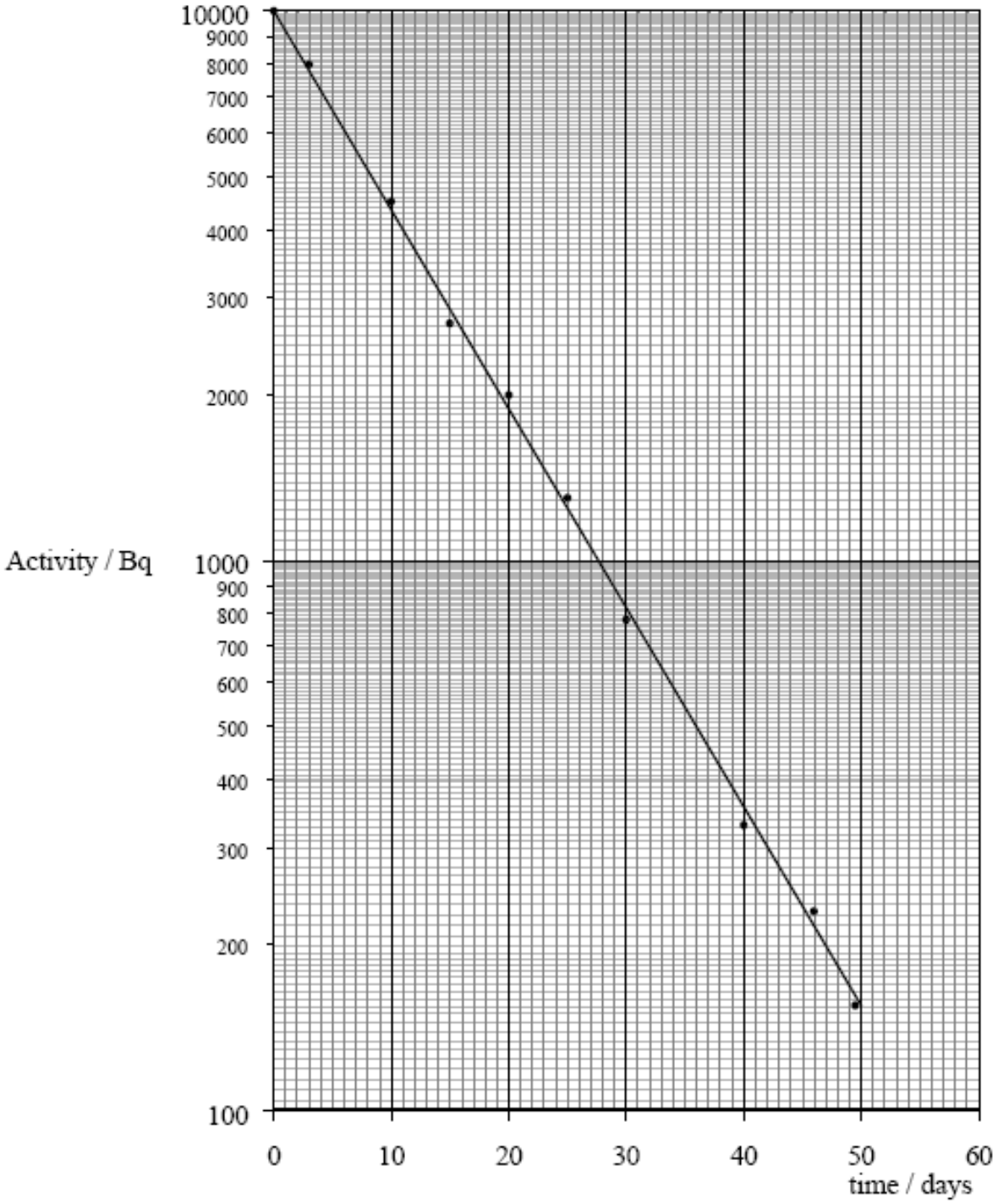
A total mass of the sample

B total number of atoms in the sample

C total number of nuclei in the sample

D activity of the radioactive isotope in the sample

40 The activity of a sample of Iodine-131 is plotted as a function of time as shown below. The activity scale is logarithmic.



The half-life of Iodine-131 is close to

A 180 days **B** 55 days **C** 28 days **D** 8 days