H2 PHYSICS

Exam papers with worked solutions

(Selected from Top JC)

SET E

PAPER 1

Compiled by

THE PHYSICS CAFE

PHYSICS

Paper 1 Multiple Choice Questions

Additional Materials: Multiple Choice Answer Sheet

Candidates answer on the 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 index number on the space provided in the Multiple Choice Answer Sheet and shade the corresponding boxes.

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 Multiple Choice Answer Sheet.

Read the instructions on the Multiple Choice 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.

DATA AND FORMULAE

Data

speed of light in free space,	c	$= 3.00 \times 10^{8}$ m s^{-1}
permeability of free space,	μ_o	$= 4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_o	$= 8.85 \times 10^{-12}$ F m^{-1}
		$\approx (1/(36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge,	e	$= 1.60 \times 10^{-19}$ C
the Planck constant,	h	$= 6.63 \times 10^{-34}$ J s
unified atomic mass constant,	u	$= 1.66 \times 10^{-27}$ kg
rest mass of electron,	m_e	$= 9.11 \times 10^{-31}$ kg
rest mass of proton,	m_p	$= 1.67 \times 10^{-27}$ kg
molar gas constant,	R	$= 8.31$ J K^{-1} mol^{-1}
the Avogadro constant,	N_A	$= 6.02 \times 10^{23}$ mol^{-1}
the Boltzmann constant,	k	$= 1.38 \times 10^{-23}$ J K^{-1}
gravitational constant,	G	$= 6.67 \times 10^{-11}$ 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	$= p\Delta V$
Average kinetic energy of a molecule of an ideal gas	U	$= \frac{3}{2}kT$
hydrostatic pressure,	p	$= \rho gh$
gravitational potential,	Φ	$= -\frac{GM}{r}$
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 $k = \sqrt{\frac{8\pi^2 m(U-E)}{h^2}}$
radioactive decay,	x	$= x_o \exp(-\lambda t)$

decay constant, $\lambda = \frac{0.693}{t_{½}}$

Please enter your answers in the Multiple Choice Answer Sheet provided.

1 What is a reasonable estimate for the volume of a wooden metre rule found in a school laboratory?

A 1.5 cm^3 **B** 15 cm^3 **C** 150 cm^3 **D** 1500 cm^3

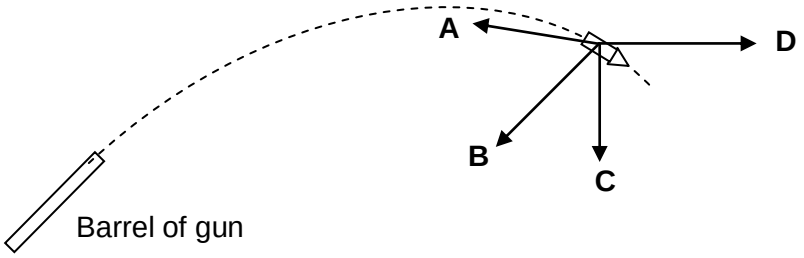
2 In an experiment, the external diameter d_1 and the internal diameter d_2 of a metal tube are found to be (64 $\pm$ 2) mm and (47 $\pm$ 1) mm respectively.

Which of the following indicates the maximum percentage error in the measurement taken for (d_1 - d_2) and the type of the error?

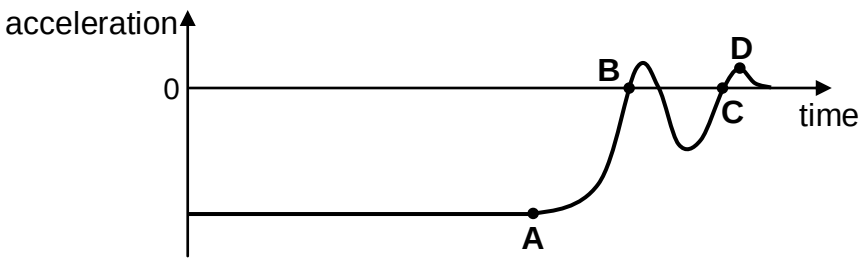
	Maximum percentage error in ($d_1 - d_2$)	*Type of the error*
A	6	Systematic
B	6	Random
C	18	Systematic
D	18	Random

3 The diagram shows a shell fired from a toy gun and is being acted on by air resistance.

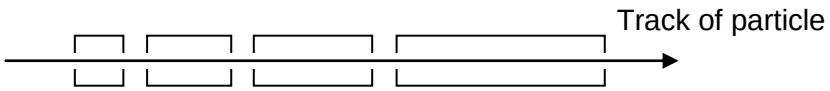
Which labeled arrow shows the direction of the resultant force on the shell when it is at the position shown?



4 A particle starts from rest and moves in a straight line. Its motion is represented by the acceleration–time graph shown below. At which point is its velocity maximum?



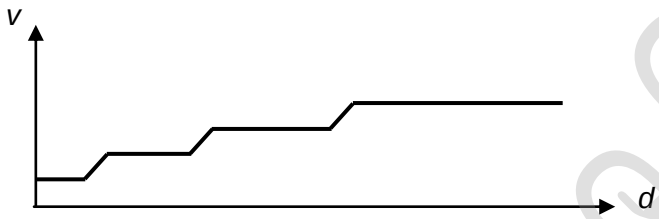
5 A linear accelerator sends a charged particle along the axis of a set of coaxial hollow cylinders as shown in the diagram.



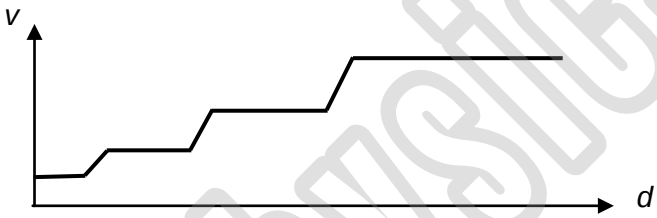
Metal cylinders

The particle travels at constant speed inside each cylinder. The particle crosses the gaps between the cylinders at equal time intervals, and at each gap its kinetic energy increases by a fixed amount. Which of the graphs best represents the way in which *v*, the velocity of the particles varies with *d*, the distance along its track?

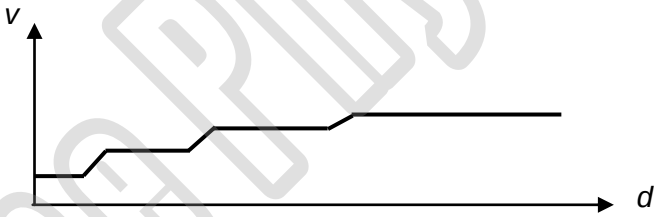
A



B

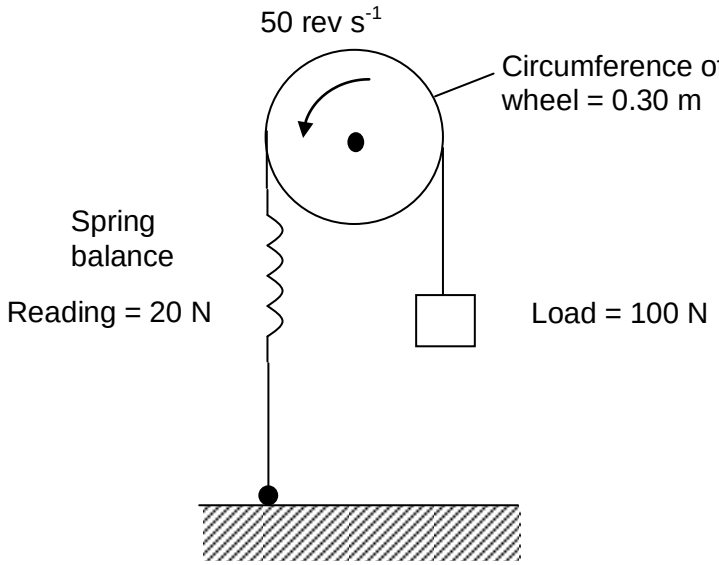


C



D

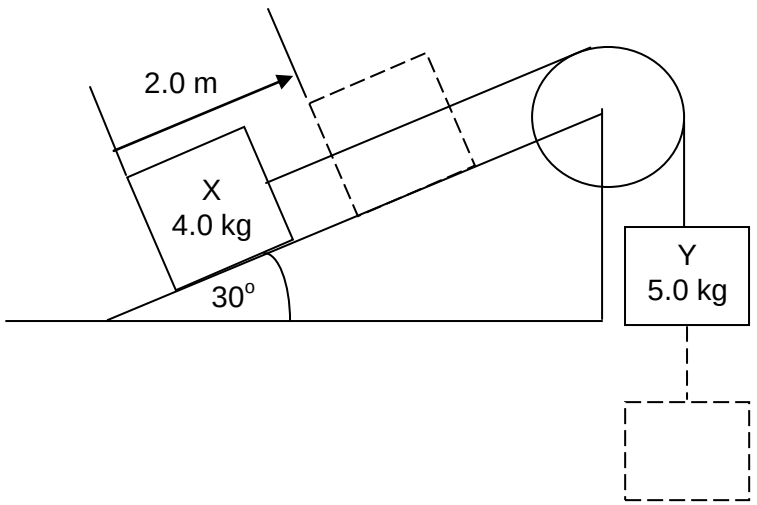
6 The figure shows a wheel which is driven by an electric motor. A rope is fastened at one end to a spring balance. The rope passes over the wheel and supports a freely hanging load. When the wheel is turning at a steady speed, the balance reading is constant.



What is the output power of the motor?

A 0.3 kW **B** 1.2 kW **C** 1.5 kW **D** 1.8 kW

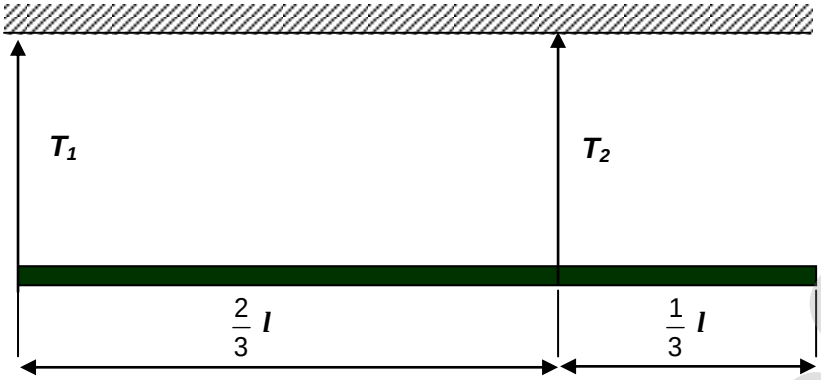
7 The figure shows two bodies X and Y connected by light cord passing over a light, free-running pulley. X starts from rest and moves on a smooth plane inclined at 30° to the horizontal.



What will be the total kinetic energy of the system when X has traveled 2.0 m along the plane? Take g as 9.81 m s^{-2}.

A 20 J **B** 59 J **C** 64 J **D** 132 J

8 A heavy uniform beam of length l is supported by two vertical cords as shown.



What is the ratio $\frac{T_1}{T_2}$ of the tensions in these cords?

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

9 A particle which moves from rest is acted upon by two forces: a constant forward force and a retarding force which is directly proportional to its velocity. Which of the following statements about the subsequent motion of the particle is true?

A Its velocity increases from zero to a maximum.

B Its acceleration increases from zero to a maximum.

C Its velocity increases from zero to a maximum and then decreases.

D Its acceleration increases from zero to a maximum and then decreases.

10 A raindrop of mass m is falling vertically through the air with a steady speed v. The raindrop experiences a retarding force kv due to the air, where k is a constant. The acceleration of free fall is g.

Which expression gives the kinetic energy of the raindrop?

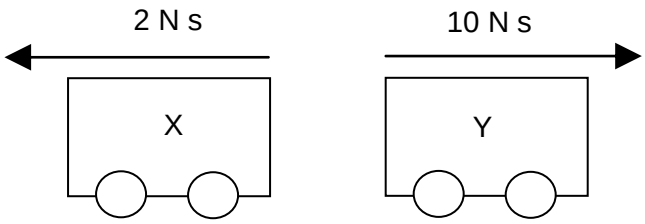
A $\frac{mg}{k}$ **B** $\frac{mg^2}{2k^2}$ **C** $\frac{m^3g^2}{k^2}$ **D** $\frac{m^3g^2}{2k^2}$

11 Two bodies P and Q, having masses M_p and M_Q respectively, exert forces on each other and have no other forces acting on them. The force acting on P is F, which gives P an acceleration a.

Which of the following pairs is correct?

	Magnitude of force on Q	Magnitude of acceleration of Q
A	$\frac{M_Q}{M_P}F$	a
B	$\frac{M_P}{M_Q}F$	a
C	F	a
D	F	$\frac{M_P}{M_Q}a$

12 The diagram shows the momenta of two trolleys, X and Y, after they have collided with each other. During the collision, the directions of motion of both trolleys are reversed. The magnitude of momentum of X is 22 N s before the collision.



What is the magnitude of the corresponding momentum of Y before collision?

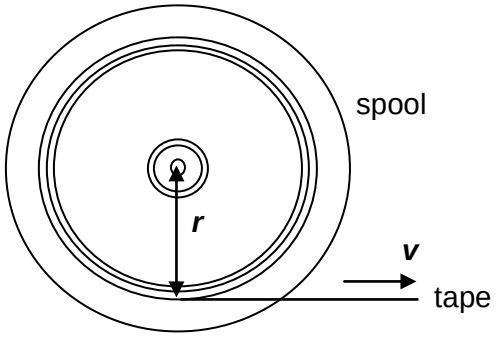
A 8 N s

B 10 N s

C 12 N s

D 14 N s

13 In a tape cassette, the tape leaves one spool at a constant speed ***v*** and at a variable distance ***r*** from the centre.



The angular velocity of the spool

A is proportional to $\boldsymbol{1/r^2}$

B is proportional to ***1/r***

C is proportional to ***r***

D does not depend on ***r***

14 Two planets, A and B of masses m_A and m_B move in circular orbits of radius r_A and r_B respectively around a star of mass M. If the time taken for planet A to make one complete revolution around the star is T_A, the time taken for the planet B to move around the star is

A $T_A \dfrac{m_A}{m_B}\left(\dfrac{r_A}{r_B}\right)^{\frac{3}{2}}$

B $T_A \dfrac{m_B}{m_A}\left(\dfrac{r_A}{r_B}\right)^{\frac{3}{2}}$

C $T_A\left(\dfrac{r_B}{r_A}\right)^{\frac{3}{2}}$

D $T_A\left(\dfrac{r_A}{r_B}\right)^{\frac{3}{2}}$

15 A satellite of mass 50 kg moves from a point where the gravitational potential due to the Earth is -20 MJ kg^{-1}, to another point where the gravitational potential is -60 MJ kg^{-1}.

In which direction does the satellite move and what is its change in potential energy?

A closer to the Earth and a loss of 2000 MJ of potential energy.

B closer to the Earth and loss of 40 MJ of potential energy.

C further from the Earth and a gain of 2000 MJ of potential energy.

D further from the Earth and a gain of 40 MJ of potential energy

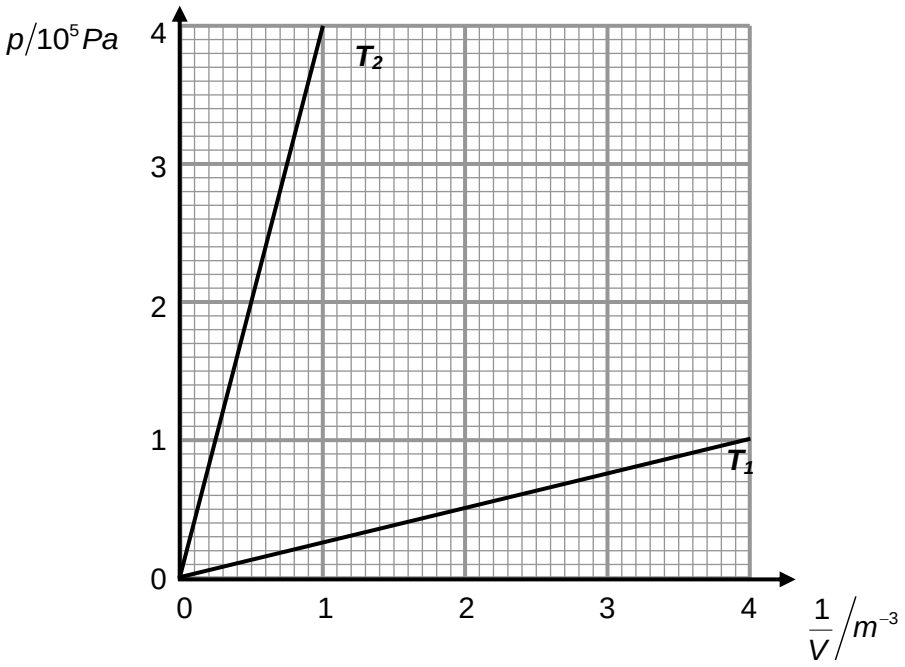
16 A fixed amount of ideal gas undergoes the following changes.

Process 1: The gas is heated at constant volume.
Process 2: The gas is compressed at constant pressure.

How does the internal energy of the gas for each process change?

	Process 1	**Process 2**
A	increase	increase
B	increase	decrease
C	decrease	Increase
D	decrease	decrease

17 The two curves shown below are isotherms for a fixed mass of an ideal gas.



What is the ratio $\frac{\text{mean kinetic energy of the molecules at temperature } T_2}{\text{mean kinetic energy of the molecules at temperature } T_1}$?

A 2 **B** 4 **C** 8 **D** 16

18 Which one of the following statements gives the definition of simple harmonic motion?

A The to and fro linear motion of a particle about an equilibrium position such that the velocity is given by $v = \pm\omega\sqrt{(x_0^2 - x^2)}$.

B The to and fro linear motion of a particle about an equilibrium position such that the acceleration is always directed towards that position and that displacement is always given by $x = x_0 \sin\omega t$.

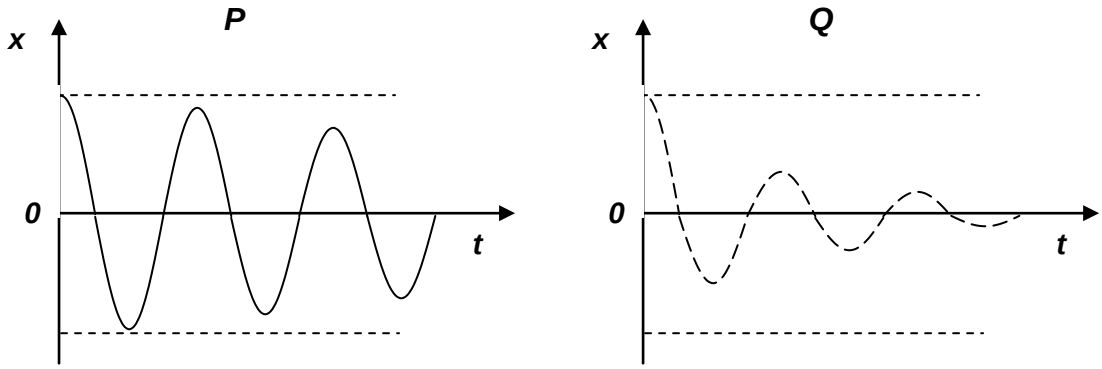
C The to and fro linear motion of a particle about an equilibrium position such that the acceleration $a = -\omega^2 x$, displacement is always given by $x = x_0 \sin\omega t$ and velocity is given by $v = \pm\omega\sqrt{(x_0^2 - x^2)}$.

D The to and fro linear motion of a particle about an equilibrium position such that its acceleration *a* is equal to $-\omega^2 x$ and is always directed to the equilibrium position.

19 A stationary sound wave exists in a horizontal tube which is closed on one end and opened on the other end. The sound wave can be described in terms of the amplitude of oscillation Δx of the air molecules from their mean positions and of the fluctuation of pressure Δp above and below the average pressure. Which of the following correctly describes the situation at each end of the tube when the tube is in resonance?

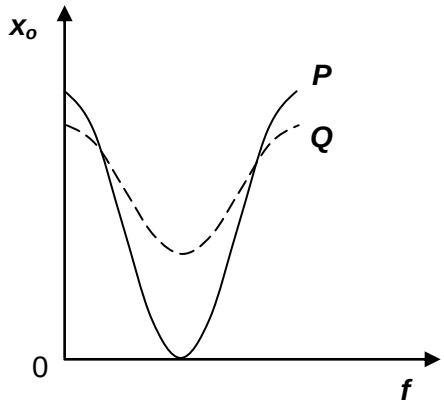
	at closed end		at open end	
	Δx	Δp	Δx	Δp
A	zero	maximum	zero	maximum
B	zero	maximum	maximum	zero
C	maximum	zero	maximum	zero
D	maximum	zero	zero	maximum

20 Two objects **P** and **Q** are given the same initial displacement and are then released. The graphs below show the variation with time ***t*** of their displacement ***x***.

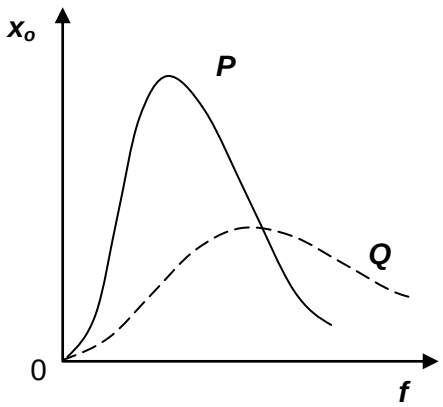


P and **Q** are then subjected to driving forces of the same constant amplitude and of variable frequency ***f***.

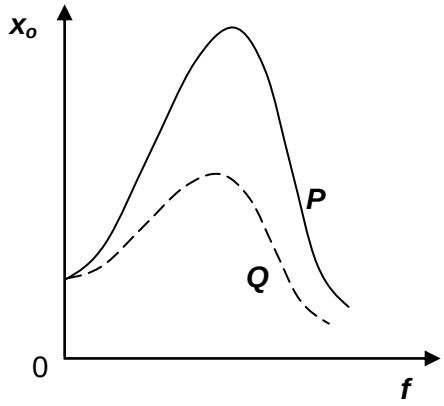
Which graph represents the variation with frequency ***f*** of the amplitudes x_o of **P** and **Q**?



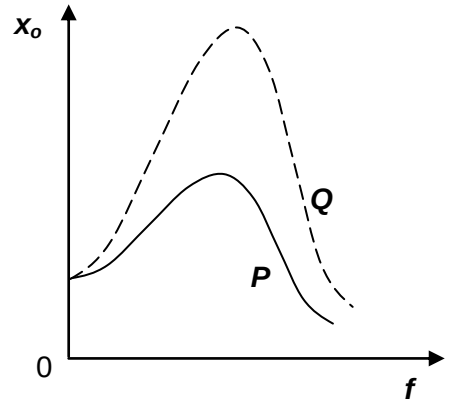
A



B

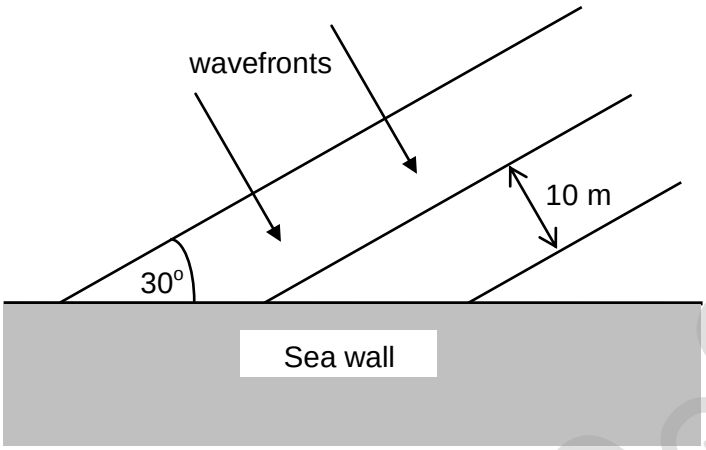


C



D

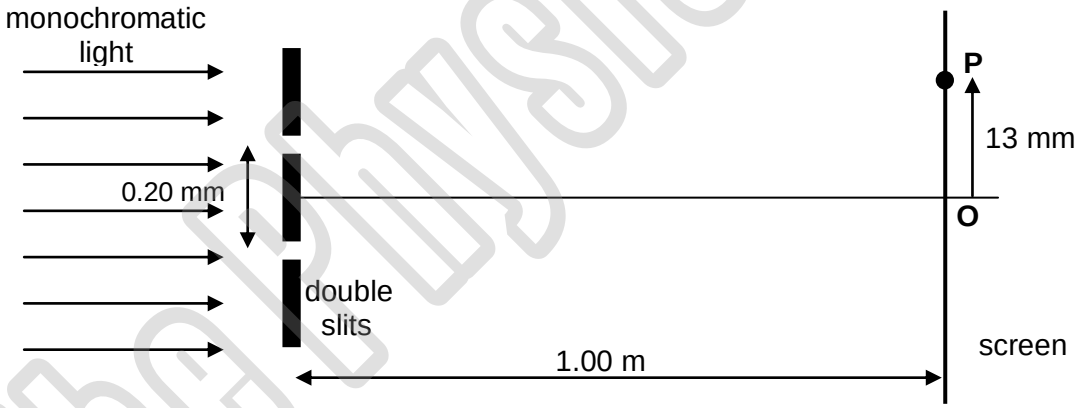
21 Parallel water waves of wavelength 10 m strike a straight sea wall. The wavefronts make an angle of 30^o with the wall as shown.



What is the difference in phase at any instant between the waves at two points that are 2.5 m apart along the wall?

A 45^o **B** 90^o **C** 55^o **D** 180^o

22 Figure below shows monochromatic light of wavelength 650 nm incident on a double slit of slit separation 0.20 mm. Interference fringes are observed on a screen 1.00 m away.



How would the fringe separation and light intensity at point **P**, 13 mm away from **O**, the centre of the fringe system change if monochromatic light of wavelength 400 nm is used?

	Fringe separation	**Intensity**
A	Increase	Increase
B	Increase	Decrease
C	Decrease	Increase
D	Decrease	Decrease

23 A high potential is applied between the electrodes of a gas discharge tube so that the gas is ionised. The gas carries a current of 8.16 mA and the number of electrons passing any point in the gas per unit time is 2.58×10^{16} s^{-1}.

If the charge on each positive particle is 3.2×10^{-19} C, what is the number of positively charge particles passing any point in the gas per unit time?

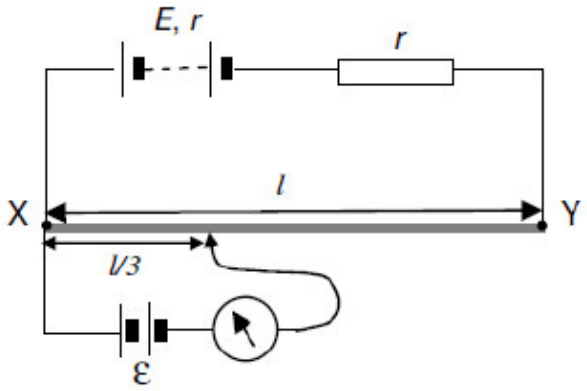
A 1.26×10^{16} s^{-1}

B 2.58×10^{16} s^{-1}

C 3.84×10^{16} s^{-1}

D 10.3×10^{16} s^{-1}

24 A potentiometer has a wire XY of length ***l*** and resistance ***R***. It is powered by a battery of e.m.f. ***E*** and internal resistance ***r*** in series with another resistor of resistance ***r***. The balanced point obtained with a standard cell of e.m.f. ***ε*** is found to be $\frac{l}{3}$ from X as shown below.



The value of ***ε*** is

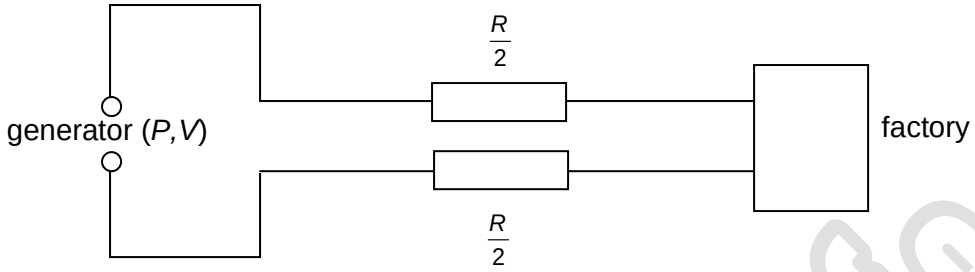
A $\varepsilon = \dfrac{Er}{3(R+2r)}$

B $\varepsilon = \dfrac{ER}{3(R+2r)}$

C $\varepsilon = \dfrac{E(R+2r)}{3R}$

D $\varepsilon = \dfrac{E(R+2r)}{3r}$

25 A generator, with output power P and output voltage V, is connected to a factory by cables of total resistance R as shown below.



What is the power input to the factory?

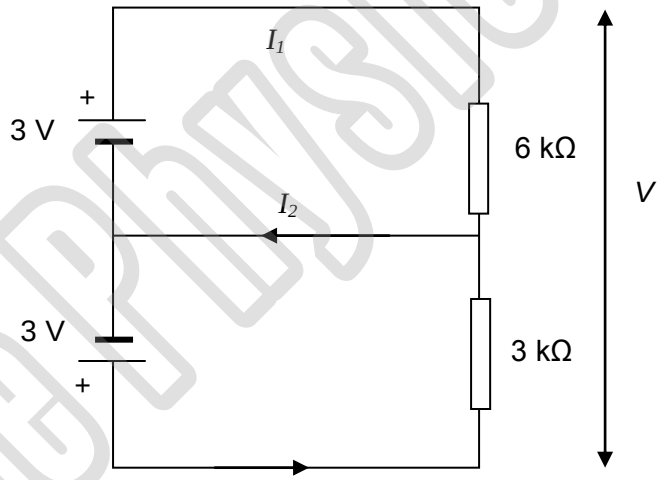
A $P-\left(\frac{P}{V}\right)\frac{R}{2}$

B $P-\left(\frac{P}{V}\right)^2\frac{R}{2}$

C $P-\left(\frac{P}{V}\right)R$

D $P-\left(\frac{P}{V}\right)^2 R$

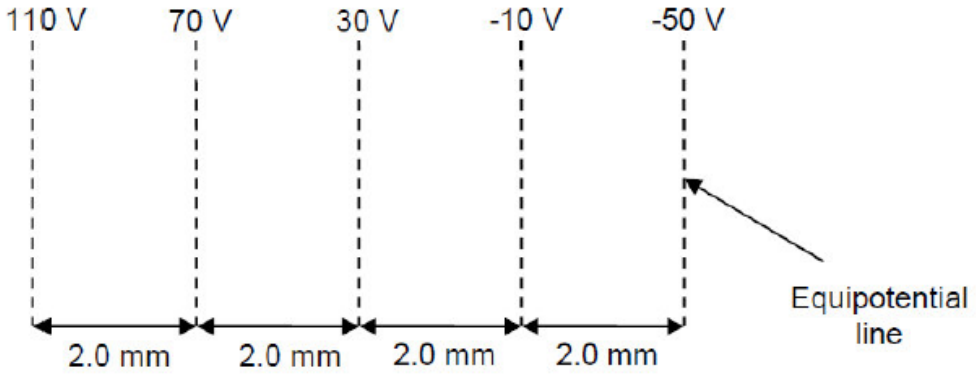
26 In the circuit, two 3 V cells are connected to resistors of resistance 3 kΩ and 6 kΩ.



Given that I_1 is 0.5 mA, what are the correct values for the current I_2, and the total potential difference V across the pair of resistors?

	I_2/mA	V/V
A	0.5	6
B	0.5	0
C	1.5	0
D	1.5	6

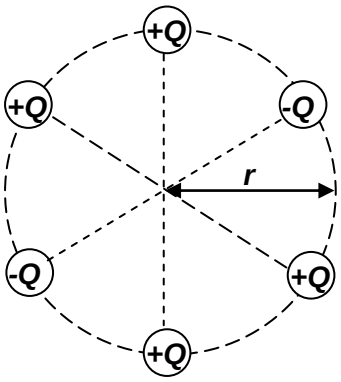
27 The diagram shows a uniform electric field in which the lines of equal potential are spaced 2.0 mm apart. What is the magnitude and direction of the electric field?



	magnitude	direction
A	20 kN C^{-1}	Towards the right
B	20 kN C^{-1}	Towards the left
C	7.5 kN C^{-1}	Towards the right
D	7.5 kN C^{-1}	Towards the left

28 The figure shows 4 positive and 2 negative point charges fixed at distance ***r*** from the centre of a circle. All the charges have magnitude ***Q***.

How much work will be done against electrostatic forces when a positive point charge of magnitude ***Q*** is brought from infinity to the centre of the circle?



A $-\frac{Q^2}{4\pi\varepsilon_o r}$ **B** $-\frac{Q^2}{\pi\varepsilon_o r}$ **C** $+\frac{Q^2}{4\pi\varepsilon_o r}$ **D** $+\frac{Q^2}{\pi\varepsilon_o r}$

29 An ion of mass *m* and charge *q* enters a region of uniform magnetic field acting perpendicularly to the original line of flight. The resulting path is

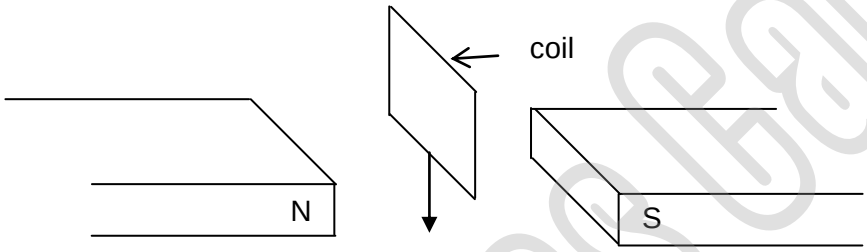
A circular and of radius proportional to *m/q.*

B circular and of radius proportional to *q/m.*

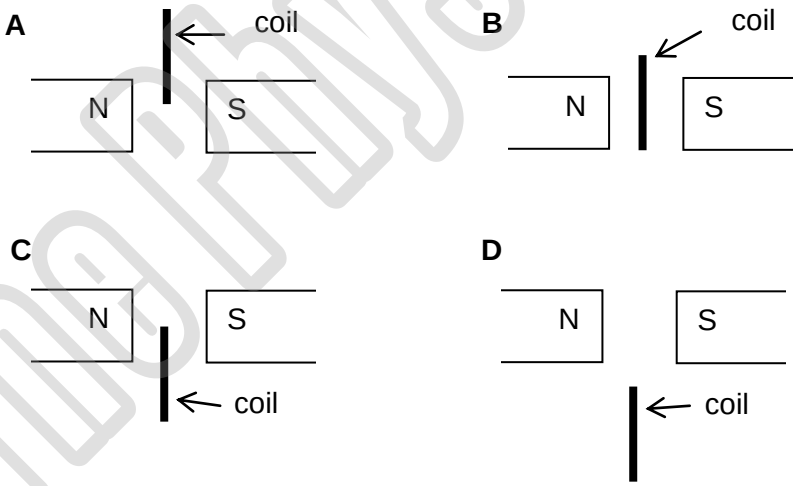
C curved with a displacement from the original line of flight proportional to *m/q.*

D spiraling along the original line of flight with a radius proportional to *q/m.*

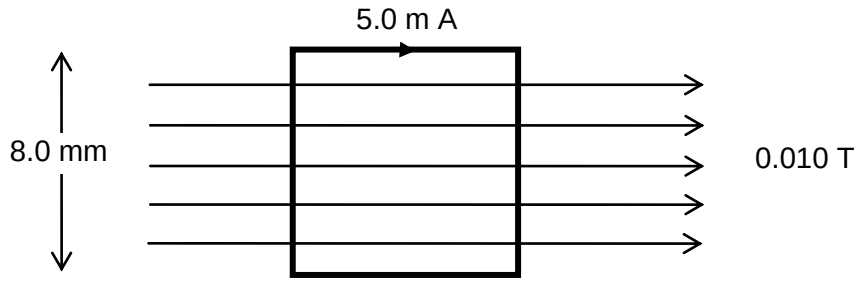
30 A rectangular coil id dropped between the poles of a magnet as shown below.



The coil is shown at four instants as it passes through between the poles of the magnet. At which instant will the e.m.f. produced be the largest?



31 A square coil of side 8.0 mm containing 20 turns is suspended at the centre of a long horizontal solenoid so that two sides of the coil are vertical and the other two sides parallel to the magnetic field of 0.010 T as shown in the figure below.



If the current through one turn of the square coil is 5.0 mA, what is the moment of the couple acting on the coil?

A 1.3×10^{-4} N m

B 6.4×10^{-8} N m

C 8.0×10^{-8} N m

D 3.2×10^{-9} N m

32 The sinusoidal potential difference V_1 shown in Fig. A is applied across a resistor R and produces heat at a mean rate W. What is the mean rate of production of heat when the square-wave potential difference V_2 as shown in Fig. B is applied across the same resistor?

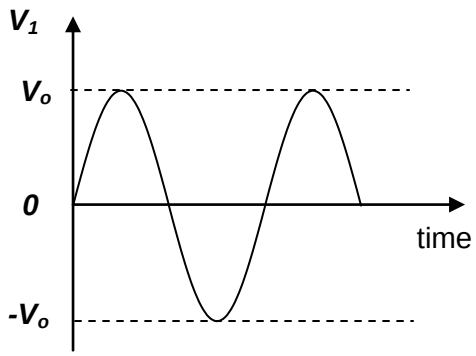


Fig. A

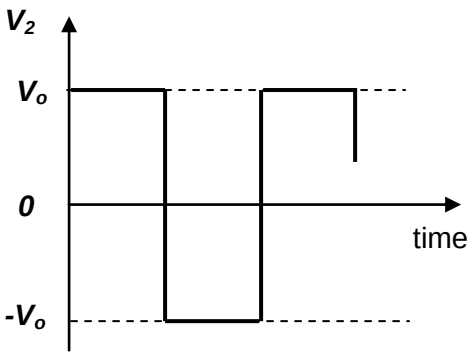


Fig. B

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

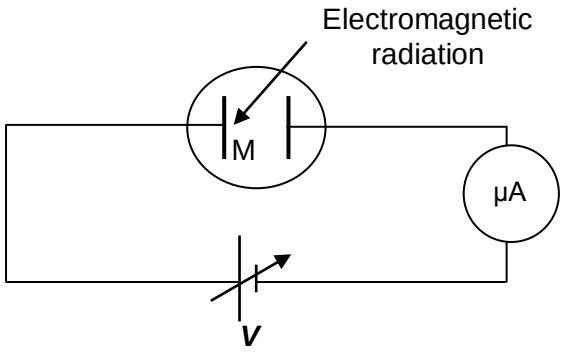
33 The intensity of a beam of monochromatic light is doubled. Which one of the following represents the corresponding change, if any, in the momentum of each photon of the radiation?

A increased four-fold **B** halved

C doubled **D** remained the same

34 In the figure below, a beam of electromagnetic radiation of wavelength 400 nm was

incident on a clean metal plate M. The potential difference *V* was varied until the microammeter read a constant current of 2.0 μA.



Given that the efficiency of production of photoelectrons by the electromagnetic radiation was 2 %, what was the intensity of the radiation if the beam had a cross sectional area of 5.0 mm^2?

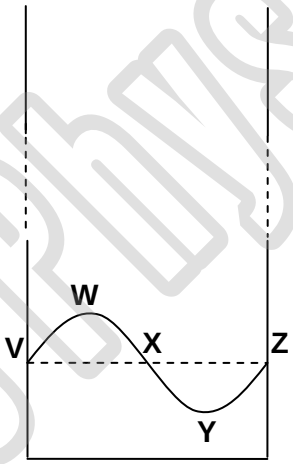
A 0.062 W m^{-2}

B 1.24 W m^{-2}

C 62 W m^{-2}

D 1.24 x 10^3 W m^{-2}

35 The diagram shows the wave function of an electron confined in an infinite potential well.



Which of the statements is correct?

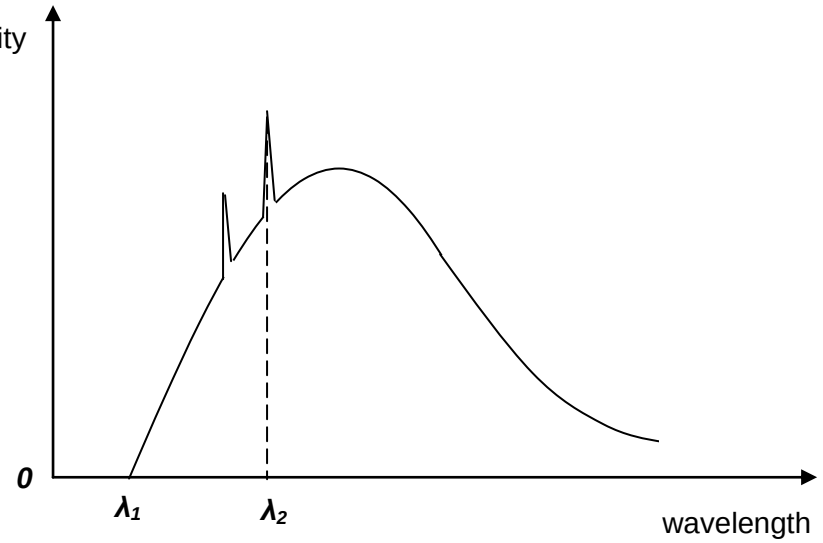
A The electron is most likely to be found at **W** or **Y**.

B The electron may be found at **V**, **X** and **Z**.

C The electron may only be found between **V** and **X**.

D The electron is most likely to be found at only **W**.

36 The diagram below shows a typical X-ray spectrum produced by an X-ray tube.



The operating voltage across the X-ray tube is increased. Which of the following gives the corresponding changes, if any, in λ_1 and λ_2?

	λ_1	λ_2
A	Increase	No change
B	No change	Decrease
C	Decrease	No change
D	Decrease	Decrease

37 Which statement about conduction of electricity in semiconductors is correct?

A The presence of impurities in a semiconductor is used to decrease its resistance.

B In a semiconductor, there is a large energy gap between the conduction and valence bands.

C At absolute zero, free electrons are found both in the conduction band and in the valence band.

D In an intrinsic semiconductor, electrons travel in the same direction as the holes.

38 The rest masses of deuteron ${}^{2}_{1}H$, proton and neutron are 2.0150 u, 1.0086 u and 1.0097 u respectively.

A deuteron may disintegrate to give a proton and a neutron if it

A emits a photon of energy 2.0 MeV.

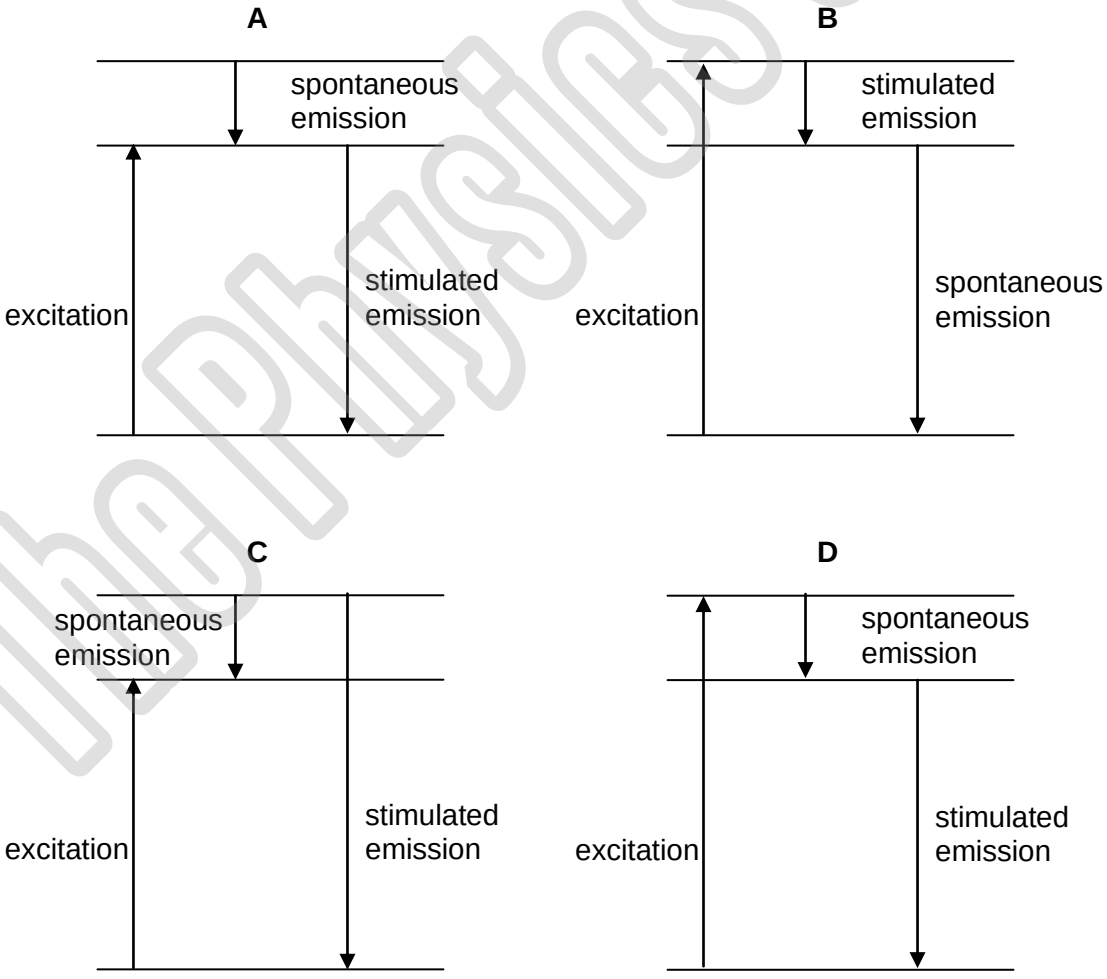
B emits a photon of energy 3.1 MeV.

C captures a photon of energy 2.0 MeV.

D captures a photon of energy 3.1 MeV.

39 In a helium-neon laser, helium atoms collide with neon atoms and excite them. This produces a population inversion which allows stimulated emission.

Which neon energy level diagram correctly shows the excitation of the neon atoms by the helium atoms, the spontaneous infra-red emission from the neon, and the stimulated emission of red light?



40 Which of the following has the lowest initial decay rate?

A 0.7 mole of $^{241}_{94}Pu$; half-life 4800 days

B 1.0 mole of $^{230}_{90}Th$; half-life 400 days

C 0.001 mole of $^{228}_{88}Ra$; half-life 3.5 days

D 0.004 mole of $^{225}_{89}Ac$; half-life 10 days