H2 PHYSICS

Exam papers with worked solutions
(Selected from Top JC)

SET A

PAPER 1

Compiled by

THE PHYSICS CAFE

READ THESE INSTRUCTIONS FIRST

Write your name and PDG in the spaces provided above.

Write your name and PDG on the Multiple Choice Answer Sheet.
Shade the 7 digits of your NRIC/FIN.

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 Multiple Choice 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.

Data

speed of light in free space,	$c = 3.00 \times 10^{8}$ m s^{-1}
permeability of free space,	$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	$\varepsilon_0 = 8.85 \times 10^{-12}$ F m^{-1}
	$(1/(36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge,	$e = 1.60 \times 10^{-19}$ C
the Planck constant,	$h = 6.63 \times 10^{-34}$ Js
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, $W = p\Delta V$

hydrostatic pressure, $p = \rho gh$

gravitational potential, $\phi = -\frac{Gm}{r}$

displacement of particle in s.h.m., $x = x_0 \sin \omega t$

velocity of particle in s.h.m., $v = v_0 \cos \omega t$

$v = \pm\omega\sqrt{x_0^2 - x^2}$

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, $x = x_0 \sin \omega t$

transmission coefficient, $T = exp(-2kd)$

where $k = \sqrt{\frac{8\pi^2 m(U-E)}{h^2}}$

radioactive decay, $x = x_0 exp(-\lambda t)$

decay constant, $\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

1 In the determination of the electro-chemical equivalent *z* of copper by electrolysis, the following equation is employed: $z = \frac{m_1 - m_2}{It}$ where

$m_1 = (24.78 \pm 0.01) \times 10^{-3}$ kg
$m_2 = (20.91 \pm 0.01) \times 10^{-3}$ kg
$I = (3.00 \pm 0.05)$ A
$t = (7400 \pm 1)$ s

The value of *z* calculated from these readings will have an error of at most

A 1.7% **B** 1.8% **C** 1.9% **D** 2.2%

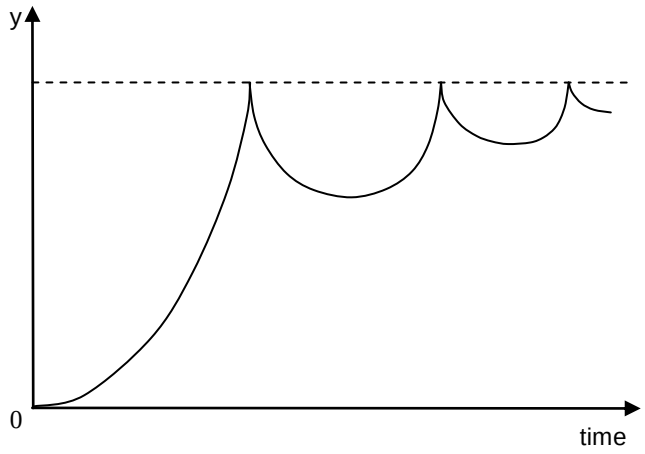
2 The estimated number of ping pong balls that can completely fill a classroom with dimensions 20.0 m by 10.0 m by 3.50 m, without being crushed is

A 10^3 **B** 10^6 **C** 10^7 **D** 10^8

3 A man kicks a rock horizontally off a cliff of height 40.0 m into a pool of water below. If he hears the sound of splash 3.00 s after he kicked the rock, find the initial speed of the rock. Assume speed of sound in air to be 343 m s^{-1}.

A 10.2 m s^{-1} **B** 13.3 m s^{-1} **C** 17.3 m s^{-1} **D** 343 m s^{-1}

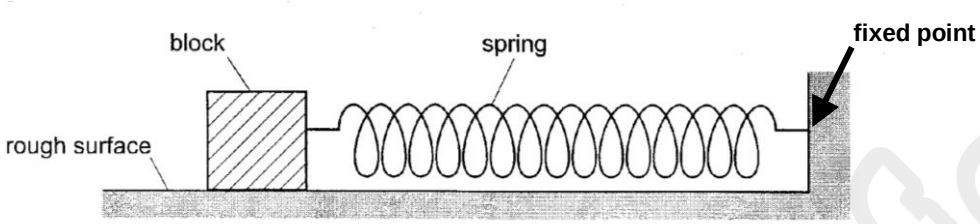
4 The sketch below describes the motion of an object rebounding from a horizontal surface after being released from a point above the surface.



The quantity represented on the y-axis is the ball's

A displacement **B** velocity **C** acceleration **D** momentum

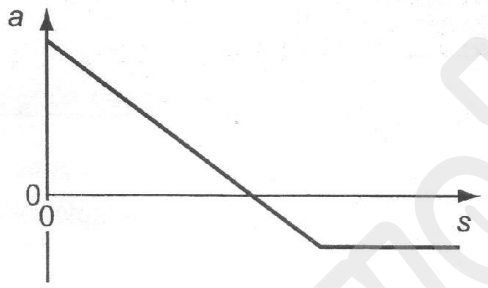
5 One end of a light spring is attached to a fixed point and the other end to a block that rests on a rough, horizontal surface that provides a constant source of friction.



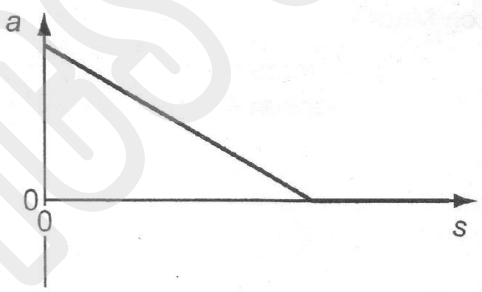
The spring obeys Hooke's law when under tension but does not provide any compressive force. The block is pulled and the spring is stretched. At the position where the block is released, the displacement is zero.

Which graph shows the variation with displacement *s* of the acceleration *a* of the block?

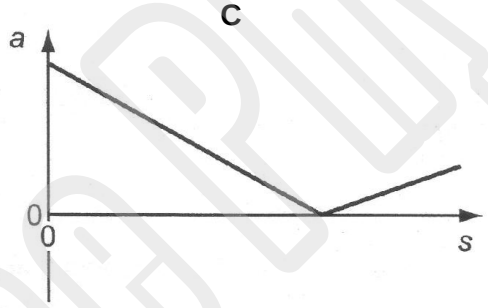
A



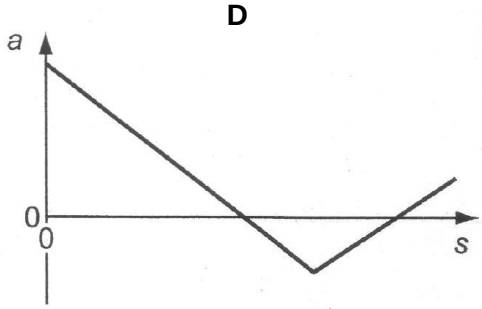
B



C

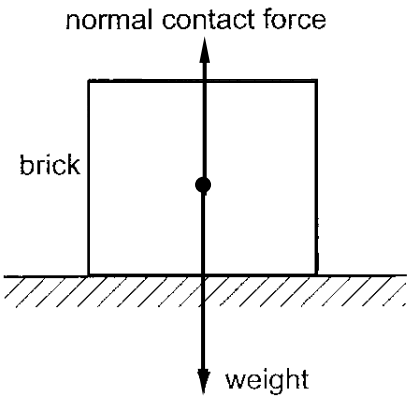


D

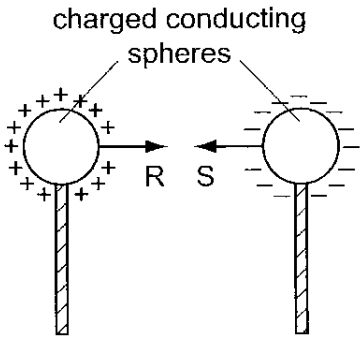


6 Which diagram shows a pair of forces that are **not** related to one another by Newton's third law?

A

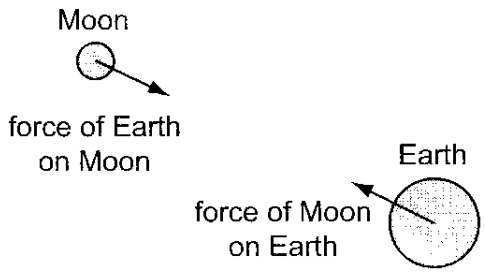


B

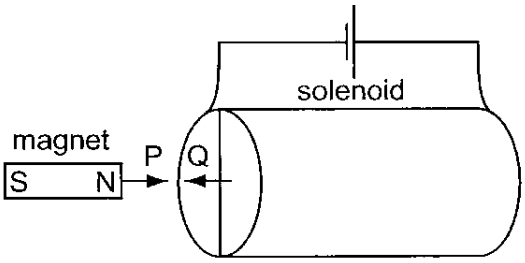


R = force on positive sphere
S = force on negative sphere

C

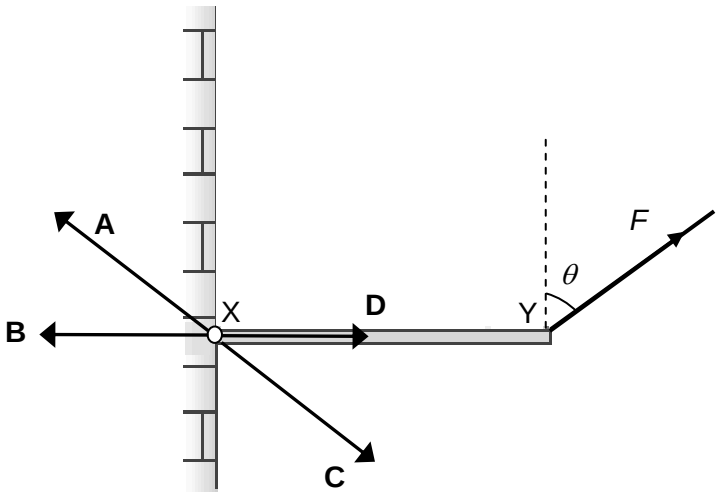


D

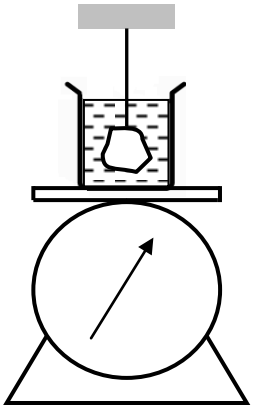


P = force of solenoid on magnet
Q = force of magnet on solenoid

7 A uniform rod XY is freely hinged to the wall at X. It is held horizontal by a force *F* acting from Y at an angle θ to the vertical as shown in the diagram. Which arrow shows the direction of the reaction force exerted by the wall on the rod?



8 When a beaker of water rests on a balance, the weight indicated is *X*. A solid object of weight *Y* in air displaces weight *Z* of water when immersed.



What will be the balance reading when the object is suspended in the beaker of water so that it is totally immersed as shown in the diagram above?

A *X* **B** *X* + *Z* **C** *X* + *Y* **D** *X* + *Y* – *Z*

9 A 1.0 kg ball is released from a certain height. When it is 0.70 m above the floor, its potential energy is exactly equal to its kinetic energy. The speed of the ball just before it hits the floor is

A 3.7 m s^{-1} **B** 5.2 m s^{-1} **C** 14 m s^{-1} **D** 27 m s^{-1}

10 A car of mass *m* is accelerated horizontally from rest to a speed *v* by a constant force *F.* How much work is done on the car during this acceleration?

A ½ *Fv* **B** *Fv* **C** *mv* **D** ½ mv^2

11 The maximum safe speed of a car rounding an unbanked corner is 16 m s^{-1} when the road is dry. The maximum frictional force between the road surface and wheels of the car is halved when the road is wet.

What is the maximum safe speed for the car to round the corner when the road is wet.

A 4.0 m s^{-1} **B** 6.0 m s^{-1} **C** 8.0 m s^{-1} **D** 11 m s^{-1}

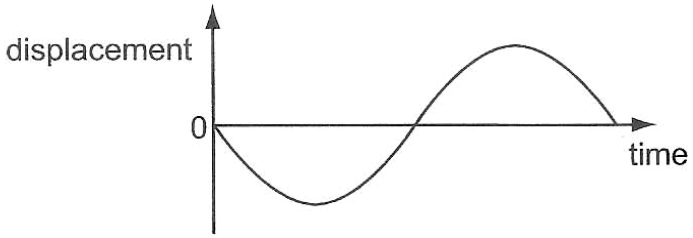
12 A small mass is situated at a point on a line joining two large masses m_1 and m_2 such that it experiences no resultant gravitational force. If its distance from the mass m_1 is r_1 and its distance from the mass m_2 is r_2, what is the value of the ratio $\frac{r_1}{r_2}$?

A $\frac{m_1^2}{m_2^2}$ **B** $\frac{m_2^2}{m_1^2}$ **C** $\sqrt{\frac{m_1}{m_2}}$ **D** $\sqrt{\frac{m_2}{m_1}}$

13 A 2000 kg spacecraft is in orbit at height *R* above the Earth's surface. The radius of the Earth is also given as *R*. Gravitational potential at the Earth's surface is –60 MJ kg^{-1}. The change in gravitational potential energy, in joules, for the spacecraft as it returns to the Earth's surface is

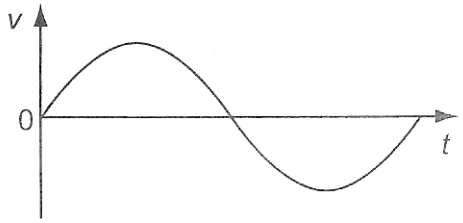
A 6×10^7 **B** 9×10^7 **C** 6×10^{10} **D** 12×10^{10}

14 One cycle of the displacement-time graph for an oscillating simple pendulum is shown below.

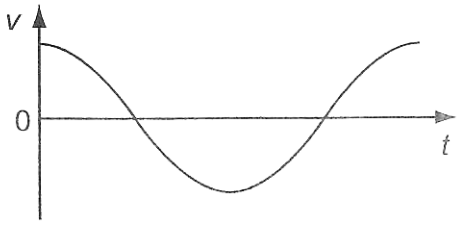


Which graph shows the corresponding variation with time *t* of the velocity *v* of the pendulum?

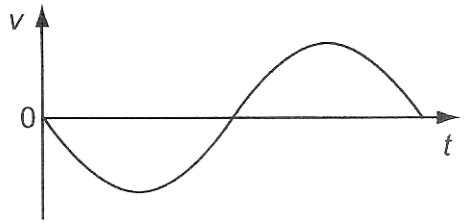
A



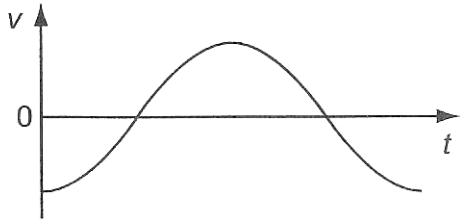
B



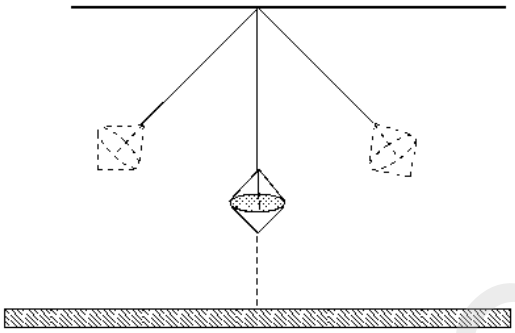
C



D

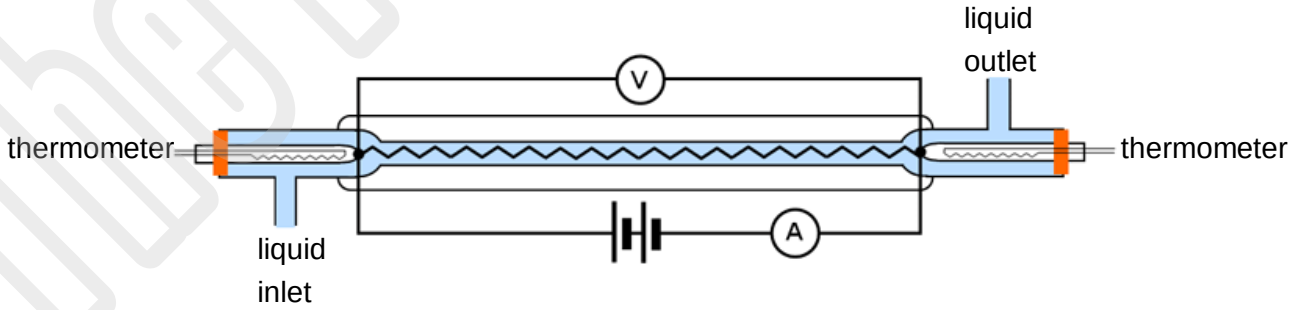


15 A light conical funnel initially filled with sand is suspended by a rope and set to oscillate in simple harmonic motion as shown in the diagram below



If sand leaks from the bottom of the funnel at a constant rate, which of the following profiles shows the distribution of the sand on the floor after some time?

16 The specific heat capacity of a liquid is to be found using a continuous flow calorimeter as shown. Initially, the experiment was carried out with an input power of 5 W. When the experiment was repeated with an input power of 10 W, it was found that the liquid flow rate must be tripled to give the same temperature rise. What is the rate of heat loss to the surroundings?



A 1.3 W **B** 1.7 W **C** 2.5 W **D** 5.0 W

17 If a fixed mass of ideal gas undergoes changes of pressure and volume, the increase in its internal energy ΔU can be given by the following equation:

$$\Delta U = \Delta Q + \Delta W$$

where ΔQ is the heat supplied to the gas and ΔW is the work done on the gas.

Which set of changes is correct if the gas is cooled at constant pressure?

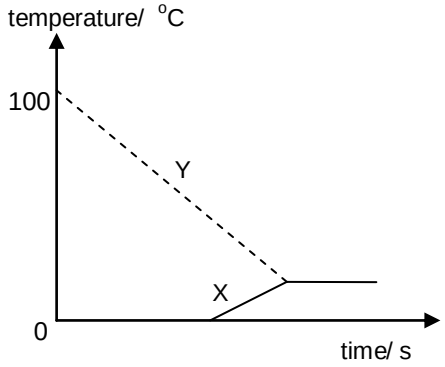
	ΔU	ΔQ	ΔW
A	–	–	–
B	0	+	–
C	+	–	+
D	–	–	+

18 80 g of X is mixed with 100 g of Y in an insulated container. The initial state of X is ice at 0 °C and that of Y is boiling water at 100 °C.

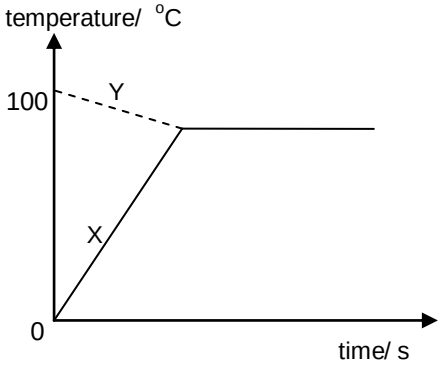
specific heat capacity of water = 4200 J kg^{-1} K^{-1}
specific latent heat of ice = 340 000 J kg^{-1}
specific latent heat of vaporization of water = 2 260 000 J kg^{-1}

Which one of the following graphs would best represent the variation of temperature with time of the mixture?

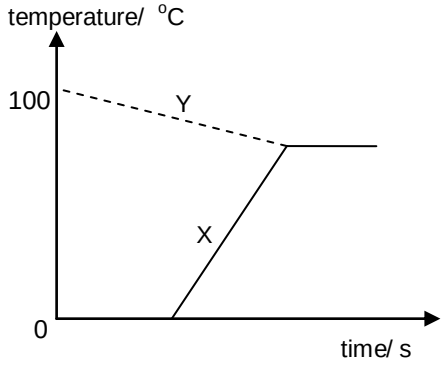
A



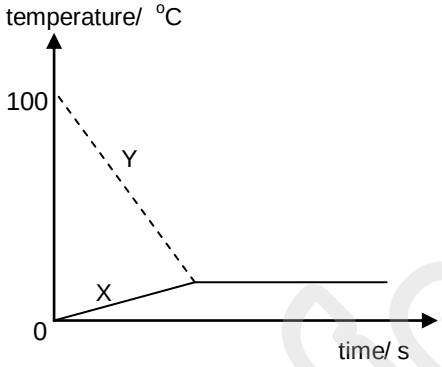
B



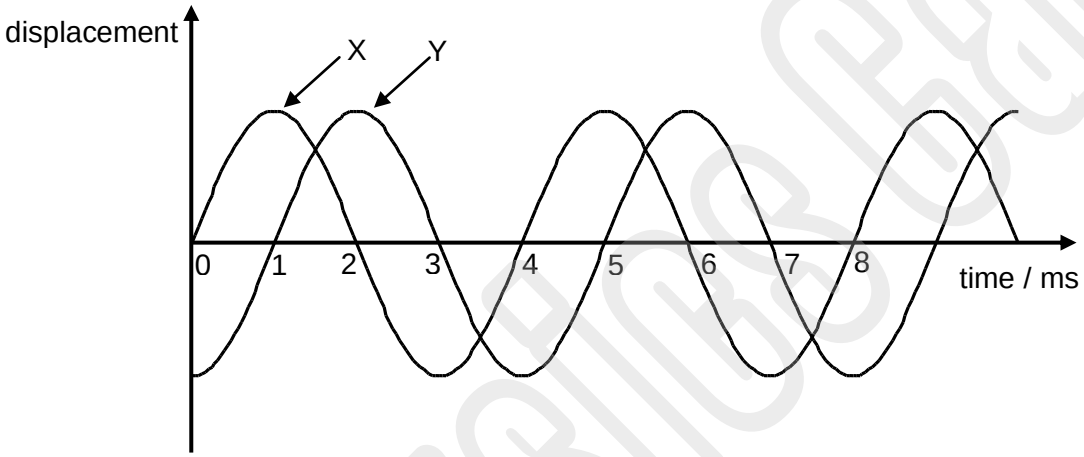
C



D



19 The diagram shows the displacement-time graphs for two waveforms X and Y.



What is the phase difference between X and Y?

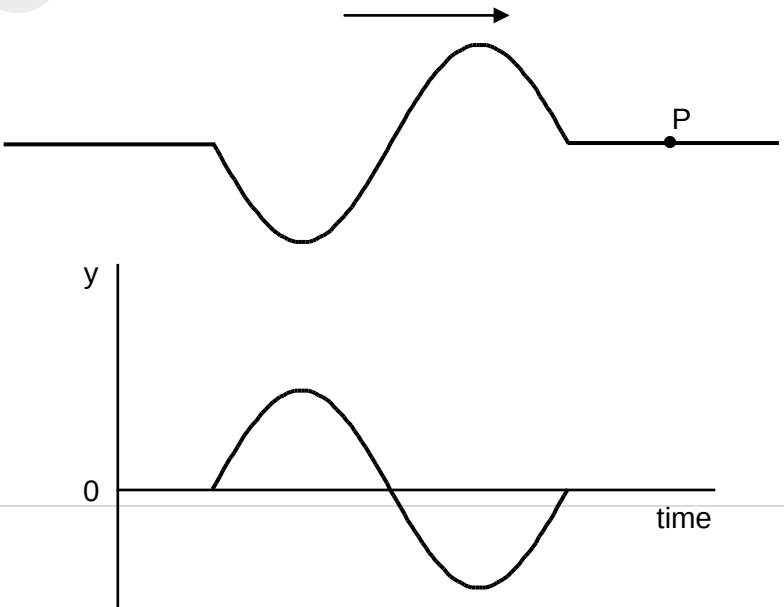
A 0.8 ms

B 1.0 ms

C $\pi/4$ radians

D $\pi/2$ radians

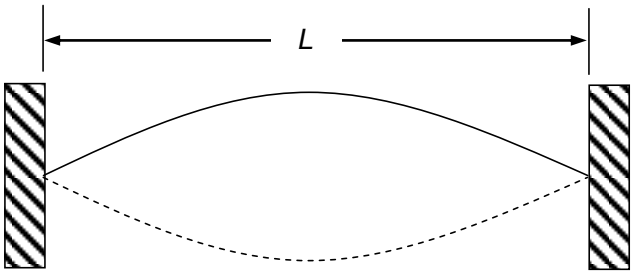
20 The diagram shows the profile of a pulse on a string travelling towards a point P. The graph shows the variation with time of a physical quantity measured at P while the pulse is passing.



Which one of the following quantities does the y-axis represent?

A displacement **B** velocity **C** acceleration **D** potential energy

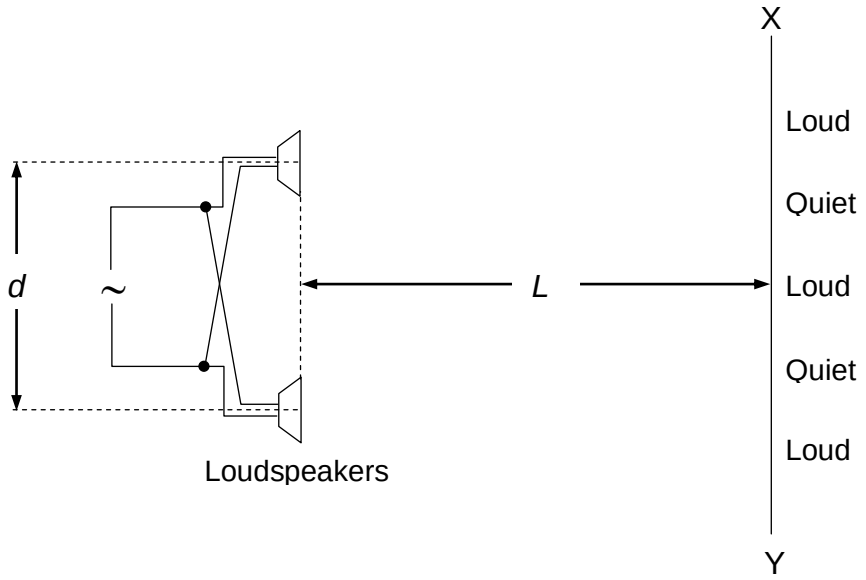
21 A wire of length L is stretched between two supports and plucked. The speed of transverse waves on the wire is c.



Which one of the following expressions, in which n has integral values 1, 2, 3, … etc, will give the frequencies of **all** stationary waves which can form on the wire?

A $\frac{nc}{L}$ **B** $\frac{nc}{2L}$ **C** $\frac{2nc}{L}$ **D** $\frac{(n+1)c}{2L}$

22 The diagram shows two identical loudspeakers driven in phase from a common audio-frequency source.



When a student moves along a line such as XY, he notices that there are regions in which the sound heard is alternately loud and quiet. Regions in which the sound is loud may be moved closer together by

A decreasing distance d

B increasing L

C increasing the frequency of the audio-frequency source

D increasing the power output from the audio-frequency source

23 A diffraction grating is placed at the centre of a circular 0 - 360° scale. A beam of laser light is incident normally on the grating. The zero order maximum occurs at a scale reading of 180° and the first order maximum occurs at a scale reading of 155°. A second order maximum would be observed at

A 205° **B** 223° **C** 230° **D** 238°

24 The diagram shows two point charges Q_1 and Q_2 of different magnitude. The net electric field strength at X is zero.

Which statement is correct?

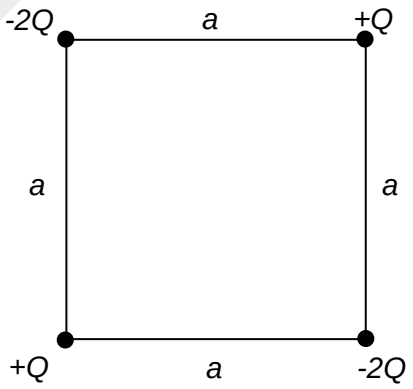
A The charges are of the same sign and Q_1 is numerically smaller than Q_2.

B The charges are of the same sign and Q_1 is numerically bigger than Q_2.

C The charges are of opposite signs and Q_1 is numerically smaller than Q_2.

D The charges are of opposite signs and Q_1 is numerically bigger than Q_2.

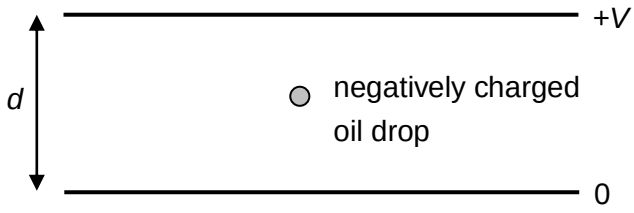
25 Four point charges are placed at the corners of a square of side a.



What is the work done in bringing a unit positive charge from infinity to the centre of the square?

A $-\frac{\sqrt{2}Q}{4\pi\varepsilon_o a}$ **B** $-\frac{\sqrt{2}Q}{2\pi\varepsilon_o a}$ **C** $\frac{\sqrt{2}Q}{4\pi\varepsilon_o a}$ **D** $\frac{\sqrt{2}Q}{2\pi\varepsilon_o a}$

26 A negatively charged oil drop is held in equilibrium between two parallel plates which have a potential difference *V*. The separation of the plates is *d*.

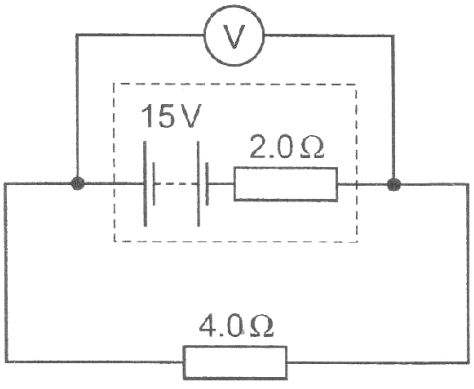


The oil drop is given an extra quantity of negative charge and it accelerates.

Which of the following will definitely enable the oil drop to achieve equilibrium again?

	V	*d*
A	increase	increase
B	decrease	decrease
C	increase	decrease
D	decrease	increase

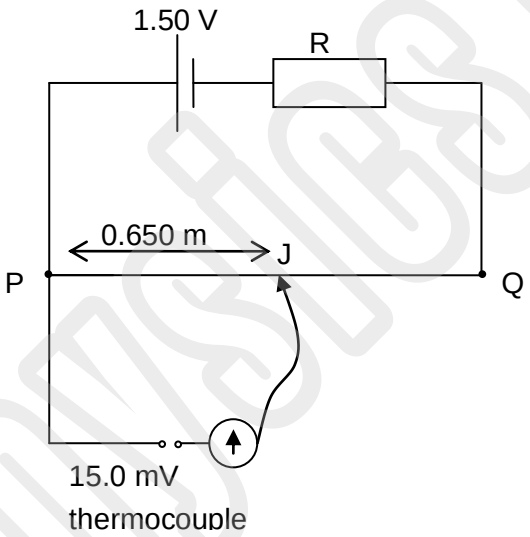
27 A battery has an e.m.f. of 15 V and an internal resistance of 2.0 Ω. It supplies current to a 4.0 Ω resistor.



What is the reading on the high resistance voltmeter?

A 5.0 V **B** 7.5 V **C** 10 V **D** 15 V

28 The diagram below shows a simple potentiometer circuit for measuring a small e.m.f. produced by a thermocouple. The potentiometer wire PQ is 1.000 m long and has a resistance of 10.0 Ω. The driver cell has an e.m.f. of 1.50 V. If a balance point is to be obtained at 0.650 m along PQ when measuring an e.m.f. of 15.0 mV, what is the value of the resistance R assuming that the driver cell has negligible internal resistance?



A 417 Ω **B** 427 Ω **C** 642 Ω **D** 652 Ω

29 A calibrated potentiometer is an accurate device for measuring an unknown e.m.f. of a direct current source because

A no current flows through the source being measured

B the internal resistance of the standard cell is zero

C the e.m.f. of the standard cell can be varied very accurately

D there is a constant flow of current through the source of unknown e.m.f.

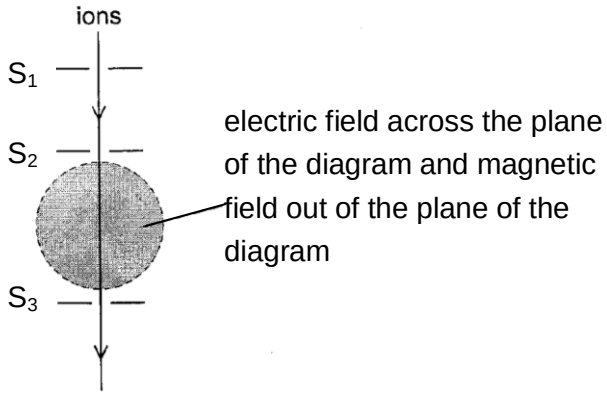
30 A flat, circular, single-turn loop of wire of radius *r* is placed with its plane at right angles to the direction of a uniform magnetic field. The magnetic flux density is *B* and the magnetic flux through the loop is ϕ.

What is the magnetic flux density and the magnetic flux through a loop of radius ½ *r* in the same

plane?

	magnetic flux density	magnetic flux through loop
A	B	$\frac{1}{4}\phi$
B	B	$\frac{1}{2}\phi$
C	$\frac{1}{4}B$	ϕ
D	$\frac{1}{2}B$	ϕ

31 The diagram shows part of an apparatus in which positive ions pass through slits S_1, S_2 and S_3.



Between S_2 and S_3, they pass through mutually perpendicular magnetic and electric fields, the intensities of which may be varied.

What is the function of the mutually perpendicular fields between S_2 and S_3?

A to accelerate the ions to high velocity

B to select ions of a particular charge

C to select ions of a particular mass

D to select ions of a particular velocity

32 An alternating current I/A varies with time t/s according to the equation

$$I = 5 \sin (100\pi t)$$

What is the mean power developed by the current in a resistive load of resistance 10 Ω?

A 125 W **B** 160 W **C** 250 W **D** 500 W

33 An ultra-violet source of radiation causes the emission of electrons from a zinc plate. What would be the effect of a less intense source of the same wavelength on the maximum energy per electron, and on the number of electrons emitted per unit time?

	maximum energy per electron	number of electrons emitted per unit time
A	less	the same
B	the same	less
C	the same	more
D	more	less

34 Transitions between three energy levels in a particular atom give rise to three spectral lines. The shortest and the longest wavelengths of these spectral lines are λ_1 and λ_2 respectively. The wavelength of the other spectral line is

A $\lambda_2 - \lambda_1$ **B** $\frac{\lambda_2 - \lambda_1}{2}$ **C** $\frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$ **D** $\frac{\lambda_1 \lambda_2}{\lambda_2 - \lambda_1}$

35 In an X-ray tube, electrons, each with a charge e, are accelerated through a potential difference V and are then made to strike a metal target. If h is the Planck constant and c is the speed of light, the minimum wavelength of the emitted radiation is given by

A $\frac{eV}{hc}$ **B** $\frac{eh}{Vc}$ **C** $\frac{hc}{eV}$ **D** $\frac{hcV}{e}$

36 Which of the following statements about laser is **false**?

A The laser beam is monochromatic because most electrons undergo the same transition.
B The laser beam is extremely unidirectional.
C When a laser beam passes through a small aperture, it undergoes diffraction.
D All photons in the laser cavity are generated by stimulated emission.

37 Which of the following statements is **true**?

A An n-type semiconductor has a net negative charge.
B A p-type semiconductor conducts through holes only.
C The p-n junction electric field always points from the n-type side to the p-type side across the depletion region.
D The p-n junction between the n-type side and the p-type side conducts electric current best.

38 Which of the following can be concluded from the experiment showing the scattering of α particles by gold foil?

A α particles can diffract

B structure of a gold nucleus

C gold nucleus contain protons and neutrons

D size of a gold nucleus

39 What is a β particle and its origin ?

	β particle	origin
A	helium nucleus	nucleus
B	helium nucleus	orbital shell
C	electron	nucleus
D	electron	orbital shell

40 A sample consists of a radioactive nuclide X while another consists of a radioactive nuclide Y. After an interval of time, it is found that $\frac{7}{8}$ of the atoms of X and $\frac{3}{4}$ of the atoms of Y have decayed. The ratio $\frac{\text{half life of X}}{\text{half life of Y}}$ is

A $\frac{2}{3}$ **B** $\frac{6}{7}$ **C** $\frac{7}{6}$ **D** $\frac{3}{2}$