H2 PHYSICS

Exam papers with worked solutions

(Selected from Top JC)

SET D

PAPER 1

Compiled by

THE PHYSICS CAFE

INSTRUCTIONS TO CANDIDATES

Do Not Open This Booklet Until You Are Told To Do So.

1. Write your name and class at the top of the question paper.
2. **Shade your NRIC/FIN number using a 2B pencil on the optical mark sheet (OMS).**
3. Check that you have 19 printed pages (including this cover page) for this question booklet.
4. There are 40 multiple-choice questions in this paper. For each multiple-choice question, there are four possible answers. Choose the one you consider correct and shade your answer using a 2B pencil in the boxes provided in the OMS.
5. **Answer ALL questions.**
6. A data and formula list is provided on page 2.
7. The total marks for this paper is 40 marks.
8. Hand in *only* your OMS at the end of the test.

Data

speed of light in a vacuum,
$c = 3.00 \times 10^{8}$ m s^{-1}

permeability of free space,
$\mu_o = 4\pi \times 10^{-7}$ H m^{-1}

permittivity of free space,
$\varepsilon_o = 8.85 \times 10^{-12}$ 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 Avogrado constant,
$L = 6.02 \times 10^{23}$ 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., $x = x_o \sin \omega t$

velocity of particle in s.h.m., $v = v_o \sin \omega t$
$= \pm\, \omega \sqrt{(x_o^2 - x^2)}$

resistors in series, $R = R_1 + R_2 + \ldots$

resistors in parallel, $1/R = 1/R_1 + 1/R_2 + \ldots$

electric potential, $V = \frac{Q}{4\pi\varepsilon_o r}$

alternating current / voltage, $x = x_o \sin \omega t$

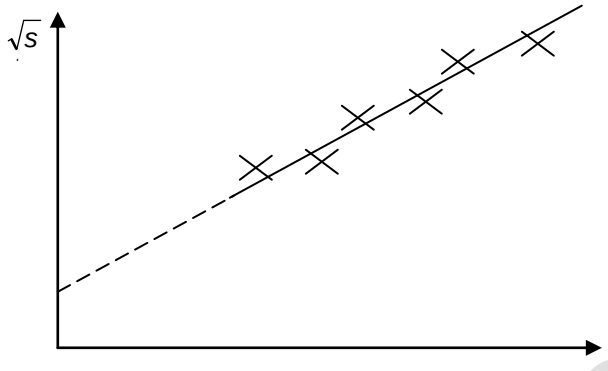
transmission coefficient, $T = \exp(-2kd)$

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

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

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

1 A student measures the time t for a ball to fall from rest through a vertical height s. Applying the formula $s = ut + \frac{1}{2} gt^2$, where u is the initial velocity and g is the acceleration due to free fall, the student plots the following graph.



Which of the following is an explanation for the intercept on the $\sqrt{s}$ -axis?

A Air resistance has not been taken into consideration.

B There is an error in the timer that consistently makes it run faster.

C There is a constant delay between releasing the ball and starting the timer.

D The student should have plotted s against t^2.

2 Which of the following situations describes the largest amount of energy?

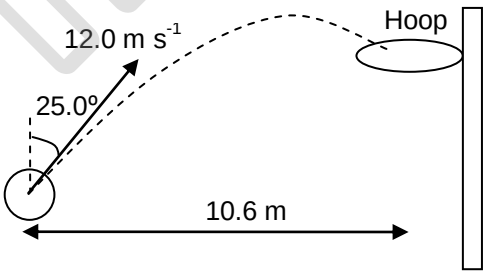
A The electrical potential energy between 2 protons in a nucleus.

B Kinetic energy of a man chasing after a bus.

C Total energy of an oscillating pendulum in a typical school experiment.

D Total electrical energy consumed by a light bulb that has been kept on for 2 hours.

3 A basketball player throws a ball with an initial velocity of 12.0 m s^{-1} at an angle of 25.0^o to the vertical. Assuming that air resistance is negligible and the horizontal distance the ball travels to the hoop is 10.6 m, determine the speed at which the ball enters the hoop.

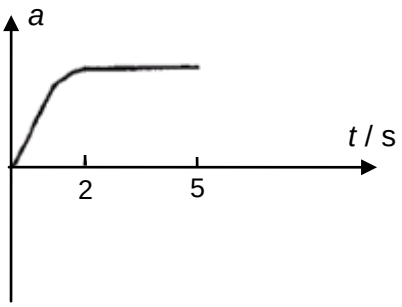


A 4.49 m s^{-1} **B** 9.63 m s^{-1} **C** 10.9 m s^{-1} **D** 11.8 m s^{-1}

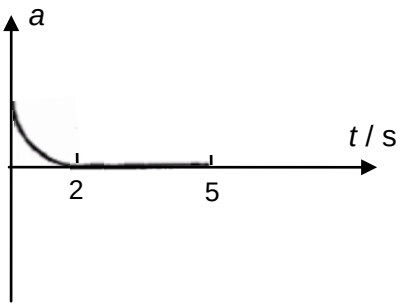
4 A parachutist steps from an aircraft, falls without air resistance for 2 s and then opens his parachute.

Which graph best represents how *a*, his vertical acceleration, varies with time *t* during the first 5 s of his decent?

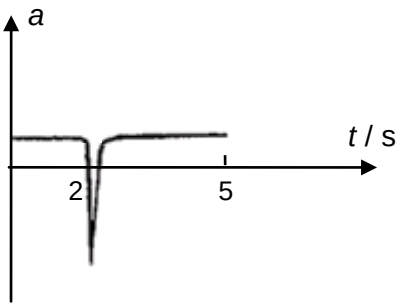
A



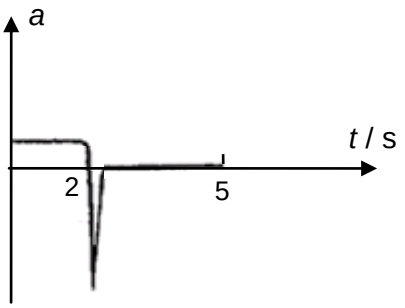
B



C

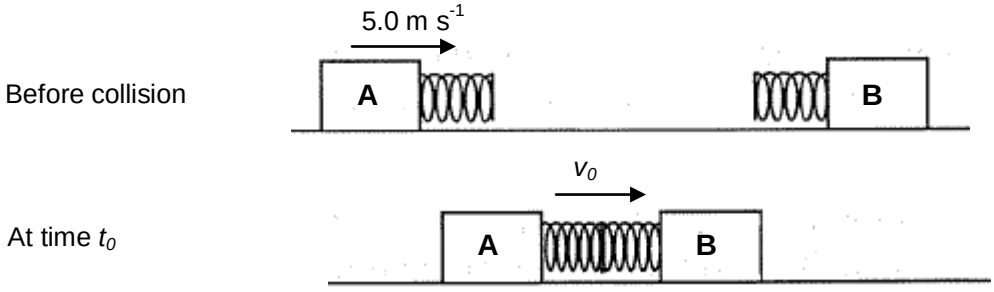


D



5 Two bodies A and B have identical light springs attached as shown. The spring constant is 6.0×10^4 N m^{-1}. Body A is of mass 3.0 kg and is moving with a velocity of 5.0 m s^{-1} over the frictionless plane towards body B which has a mass of 2.0 kg and is at rest.

At a particular time t_0 during the collision, the springs undergo maximum compression and the two bodies move at a common velocity v_0.



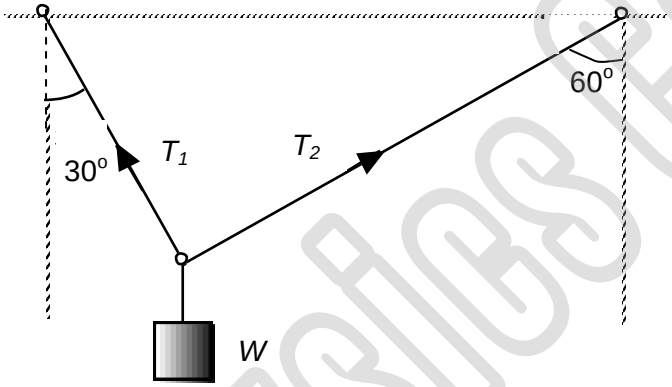
Determine the compression of each spring at time t_0.

A 1.1 cm **B** 1.6 cm **C** 2.2 cm **D** 3.0 cm

6 A 4.0 kg trolley runs down a slope with a constant acceleration a. A mass of 12.0 kg is added onto the trolley and the trolley with the mass is allowed to run down the same slope. In both cases, the effects of friction and air resistance are negligible. What is the acceleration of the trolley with the mass down the slope?

A $3a$
B a
C $\frac{1}{3}a$
D $\frac{1}{4}a$

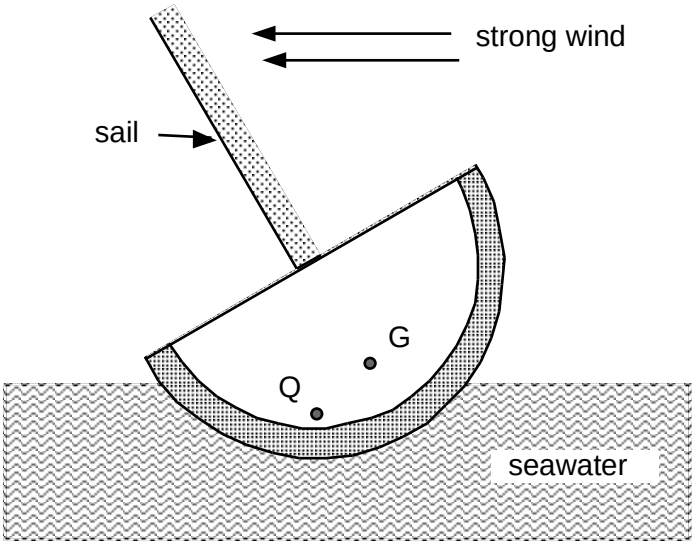
7 A weight W is supported by two light strings inclined at 30° and 60° to the vertical. The tensions in the strings are T_1 and T_2.



If the forces are in equilibrium, the ratio T_1 / T_2 would be

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

8 The diagram shows the cross-section of a sail-boat. Point *G* is the centre of gravity of the boat, including its sail. The upthrust on the boat acts through point *Q*, the centre of gravity of the seawater that is displaced by the boat.



A strong gust of wind tilts the boat off its upright position as shown in the diagram. When the gust subsides,

A the boat will continue to roll anticlockwise and topple due to the moment from the weight of its sail.

B the boat will continue to roll over and capsize because of its rounded cross-section.

C the boat will roll back to its upright position because upthrust acts upwards on the boat.

D the boat will roll back to its upright position because its weight and upthrust form a couple whose torque is clockwise.

9 The drag force against the motion of an object in a liquid is proportional to the square of its speed. The engine of a motorboat delivers 30 kW to the propeller while the boat is cruising at a constant velocity of 15 m s^{-1}. When its engine failed, it is towed to the shipyard at a velocity of 20 m s^{-1}. The average tension in the towline would be

A 1100 N **B** 1500 N **C** 2000 N **D** 3600 N

10 Which of the following statements is ***not*** an application of the law of conservation of energy?

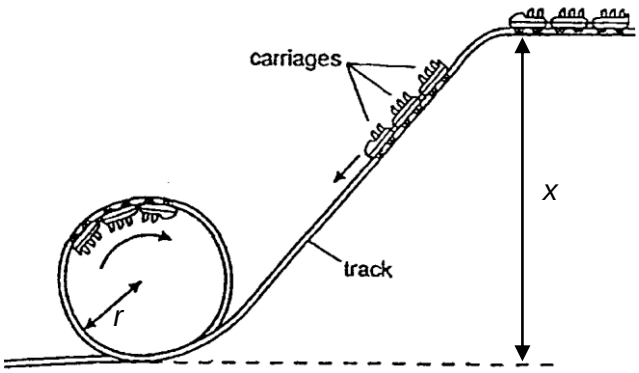
A The first law of thermodynamics

B The inverse-square law of Coulomb's law of electrostatics

C Lenz's law of electromagnetic induction

D Einstein's equation of photoelectric effect

11 A theme park ride is illustrated in the figure below. The carriages accelerate down the slope from rest and then loop through the loop on a circular section of track with radius *r*.



If the carriage is to remain in contact with the track in the loop at all times, the minimum height *x* is

A $\frac{9}{2}r$ **B** $\frac{5}{2}r$ **C** $\frac{3}{2}r$ **D** $\frac{1}{2}r$

12 A body of mass *m* travels at a constant speed in a circular path of radius *r*. If its kinetic energy is *E*, its frequency will be

A $\sqrt{\frac{E}{2\pi^2 mr^2}}$ **B** $\sqrt{\frac{E}{\pi^2 mr^2}}$

C $\sqrt{\frac{2E}{mr^2}}$ **D** $\sqrt{\frac{E}{4\pi^2 mr^2}}$

13 At the Earth's surface, the gravitational field strength is about 10 N kg^{-1}. At a point outside the Earth and a distance *x* from its centre, the gravitational field strength is about 5 N kg^{-1}. Which expression gives an approximate value for the radius of the Earth?

A $\frac{x}{\sqrt{2}}$ **B** $\frac{x}{2}$ **C** $\frac{x}{2\sqrt{2}}$ **D** $\frac{x}{5}$

14 Two satellites, A and B, orbiting around Earth have the same kinetic energy. Satellite A has a larger mass than satellite B. Which of the following statements is false?

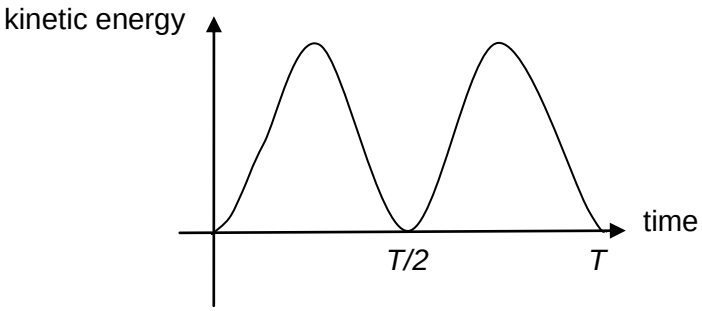
A Satellite A has a larger period.

B Satellite A has a larger orbital radius.

C Satellite A has a smaller total energy.

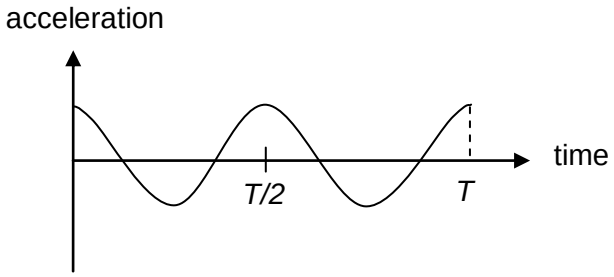
D Satellite A has a smaller angular velocity.

15 A body moves with simple harmonic motion about a point P. The graph shows the variation with time of its kinetic energy.

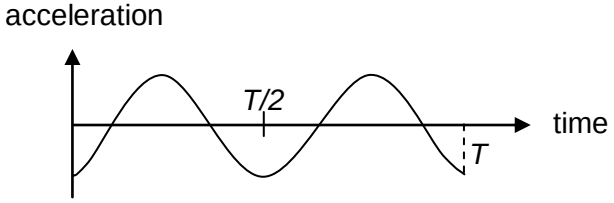


Which graph shows the variation with time of its acceleration?

A



B



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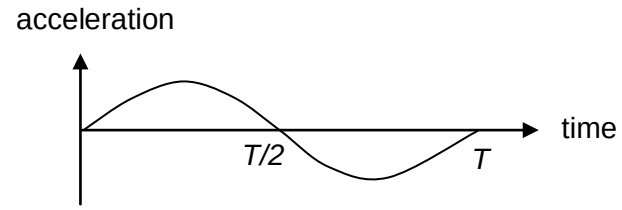
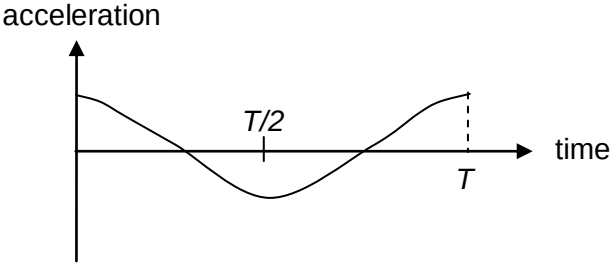
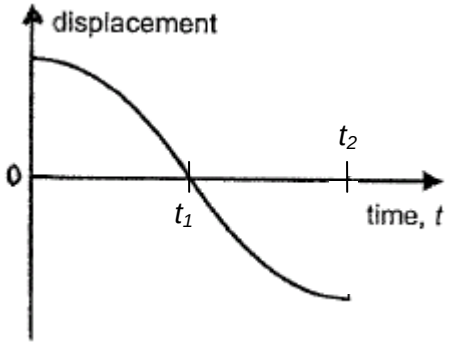


D

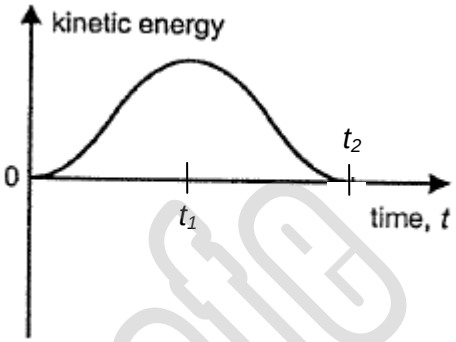


16 A body is undergoing simple harmonic motion. The graphs below show the variation of displacement, velocity, kinetic energy and force with time *t* during part of the motion. Which one of the following graphs must be **wrong** because it is not consistent with the others?

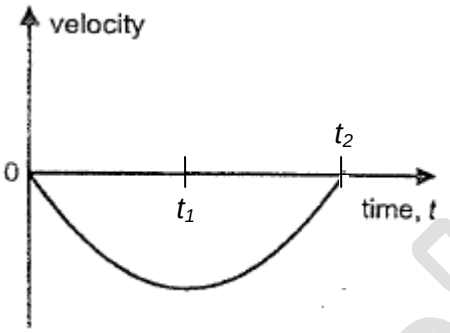
A



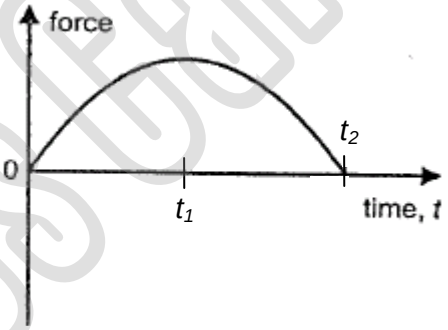
B



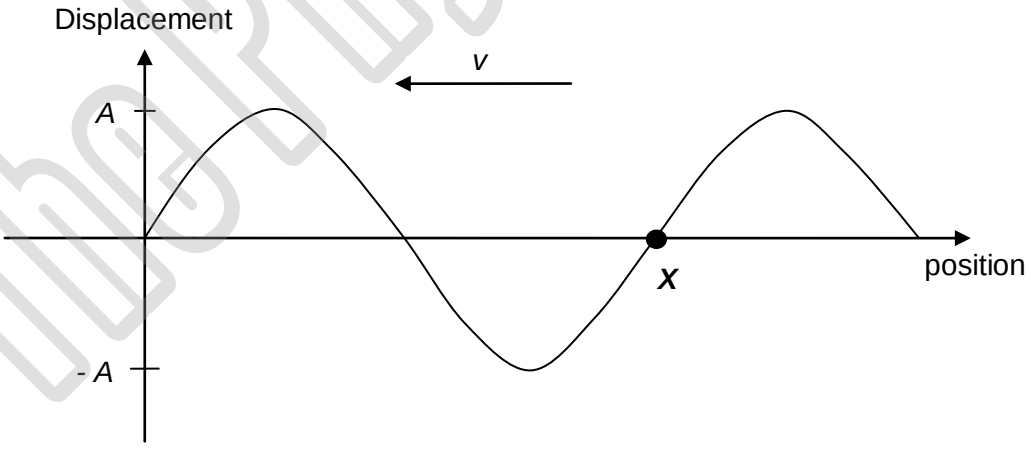
C



D



17 Consider a sound wave traveling from right to left. The speed of the sound wave is *v* and the period is *T*. The figure shows the displacement against position graph for air molecules along the wave at time *t* = 0.0 s. What is the displacement and velocity of the air molecule marked ***X*** at time *t* = 0.75 *T*?



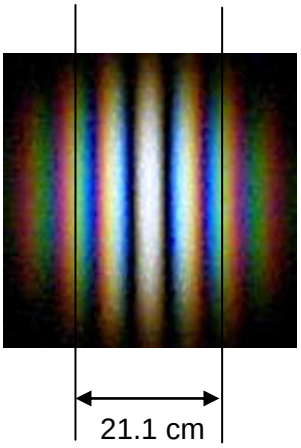
	Displacement	Velocity
A	*A*	0
B	*A*	*v*
C	*-A*	0
D	*-A*	*v*

18 A person sees light from a distance on a dark night. If the power of the light received by the pupil of an eye of area 0.50 cm^2 is 8.0×10^{-11} W at a distance of 10 km, calculate the power of the light source, assuming it is a point source.

A 5.03×10^{-6} W **B** 5.03×10^{-2} W

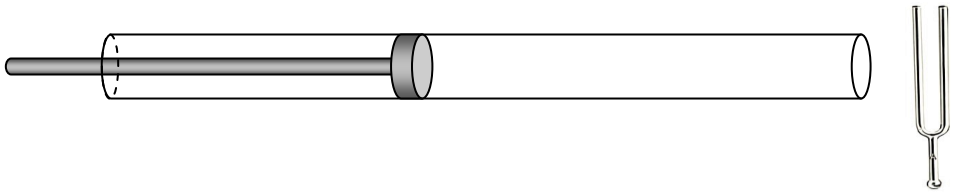
C 0.201 W **D** 2010 W

19 The figure below shows the pattern on a detector behind a diffraction grating with 80 lines per mm. The detector is 1.20 m behind the grating. Determine the wavelength of electromagnetic radiation incident on the grating.



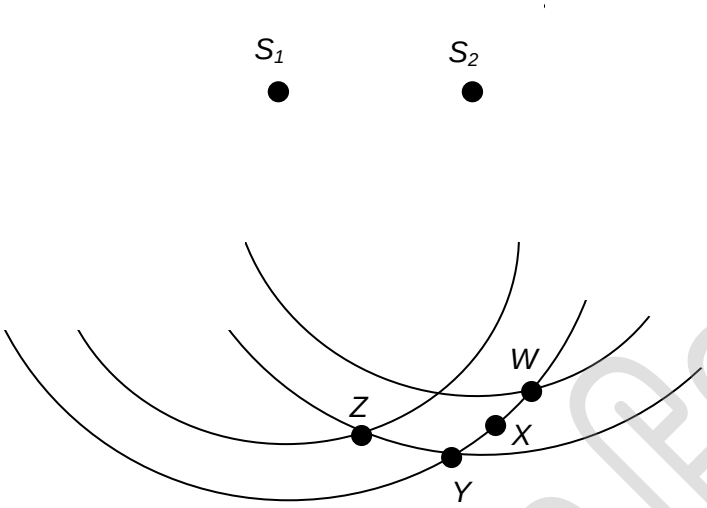
A 270 nm **B** 360 nm **C** 550 nm **D** 1100 nm

20 An air column in a glass tube is open at one end and closed at the other by a movable piston. A 512 Hz tuning fork is held at the open end. Resonance is heard when the piston is 83 cm from the open end. The piston is withdrawn such that the air column becomes longer and the next resonance is obtained. Calculate the new distance between the piston and the open end. Take the speed of sound in air to be 340 m s^{-1} and ignore end corrections in your calculations.



A 116 cm **B** 133 cm **C** 166 cm **D** 249 cm

21 S_1 and S_2 are two identical sources of waves that are in phase. The instantaneous positions of two wave crests from each source are shown below. Which of the following is true?



A X is a point of constructive interference.

B W is a point of destructive interference.

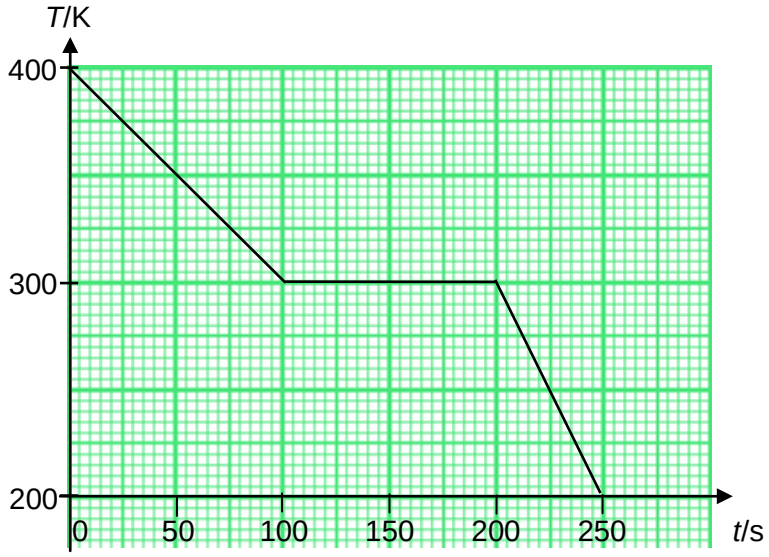
C $S_1Y - S_2Y = n\,\lambda$ where n is an integer.

D $S_1Z - S_2Z = (2n - 1)\,\lambda/2$ where n is an integer.

22 Fringes of separation y are observed in a plane 1.00 m from a Young's double-slit arrangement illuminated by yellow light of wavelength 600 nm. At what distance from the slits would fringes of the same separation y be observed when using blue light of wavelength 400 nm and slits of half the original separation?

A 0.75 m **B** 1.33 m **C** 1.50 m **D** 3.00 m

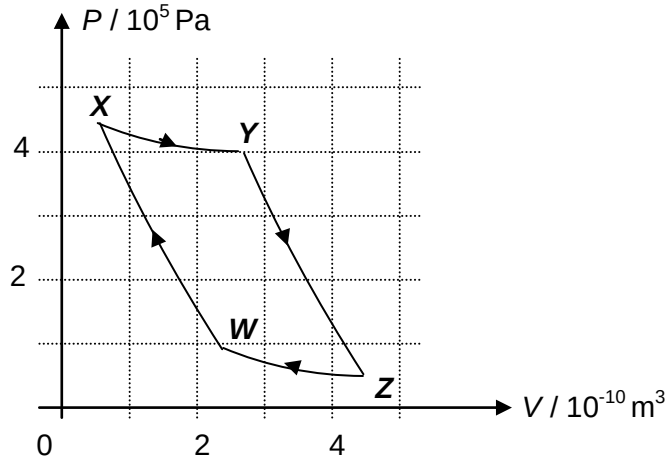
23 The graph shows the variation of temperature T against time t of a certain substance which was originally a liquid at t = 0 s. Heat was removed from it at a constant rate until it became a solid.



Which one of the following could be correct?

	Specific heat capacity of liquid/ J kg^{-1} K^{-1}	Specific heat capacity of solid/ J kg^{-1} K^{-1}
A	1500	3000
B	1800	900
C	2500	2500
D	4500	3000

24 A fixed mass of an ideal gas of volume V and pressure p undergoes the cycle of changes as shown below.



At which points are the temperature of the gas the same?

A X and Y

B X and Z

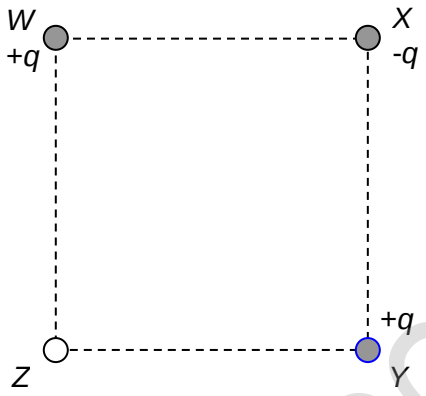
C W and Y

D Y and Z

25 Starting from rest, a proton and an α-particle are accelerated through potential differences of V and $2V$ respectively. If the final speed of the proton is v, determine the final speed of the α-particle.

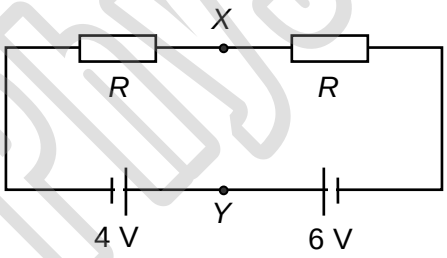
A v **B** $2v$ **C** $2\sqrt{2}v$ **D** $4v$

26 Three charges $+q$, $-q$ and $+q$ are placed at the corners W, X and Y of a square $WXYZ$, respectively. A fourth charge is placed at corner Z so that the charge at X experiences no net electrostatic force. What is the charge at Z?



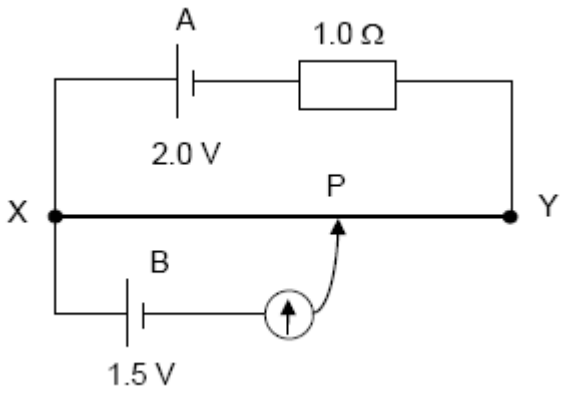
A $-2\sqrt{2}\,q$ **B** $+2\sqrt{2}\,q$ **C** $-4\sqrt{2}\,q$ **D** $+4\sqrt{2}\,q$

27 Determine the potential difference between points X and Y on the circuit below. The internal resistances of the two batteries are negligible.



A 6 V **B** 5 V **C** 4 V **D** 3 V

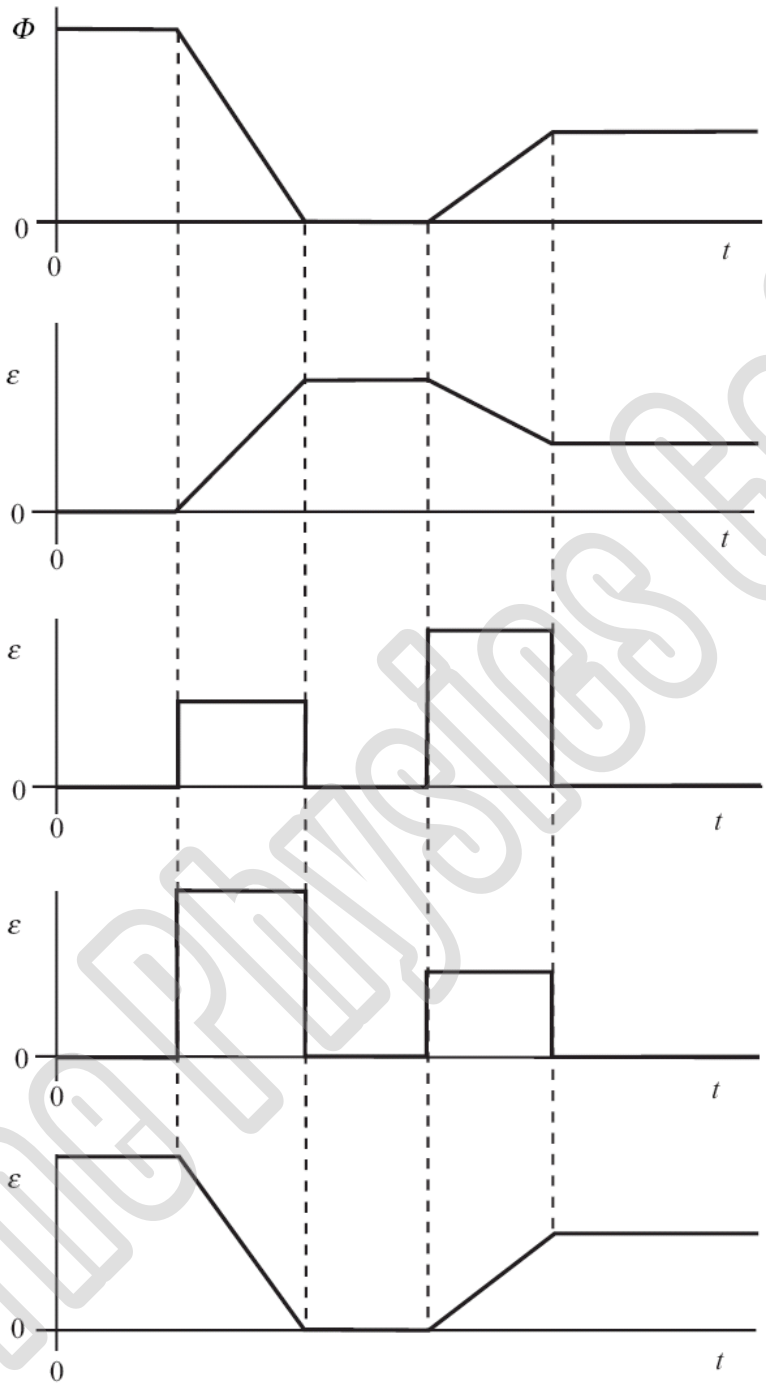
28 In the circuit as shown, cell A has an e.m.f. of 2.0 V and negligible internal resistance. Wire XY is 1.0 m long with a resistance of 4.0 Ω.



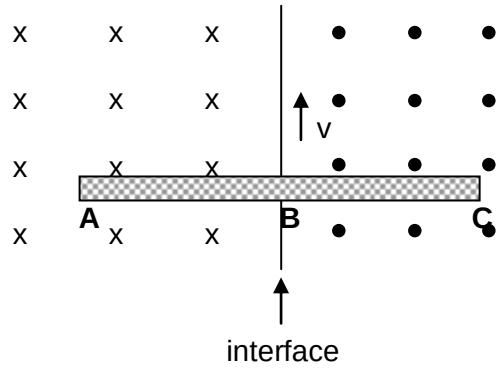
Cell B has an e.m.f. of 1.5 V and internal resistance 1.0 Ω. Calculate the length XP required to produce null deflection in the galvanometer.

A 0.66 m **B** 0.75 m **C** 0.90 m **D** 0.94 m

29 The magnetic flux, Φ, through a coil varies with time, t, as shown. Which one of the following graphs, A to D, best represents how ε, the magnitude of the induced e.m.f. varies with time?



30 A metal bar lies as shown with its midpoint at the interface between two regions of uniform magnetic fields of opposite directions as shown. The magnitude of the magnetic field is the same in both regions. The bar moves in the indicated direction. Which point or points is/are at the highest potential?



A Point A

B Point B

C Point C

D Points A and C

31 An alpha particle and a proton of equal speeds are moving perpendicularly to a uniform magnetic field. Determine the ratio of the period of revolution of the alpha particle to the period of revolution of the proton.

A 2.0 **B** 0.5 **C** 4.0 **D** 0.25

32 An alternating current I/A varies with time t/s according to the equation $I = 5 \sin (100\pi t)$.

Calculate the mean power, in watts, developed by the current in a resistive load of resistance 10 Ω.

A 62.5 **B** 50 **C** 125 **D** 250

33 Which of the following statements about photoelectric emissions is correct?

A No emission of electrons occurs at very low intensity of illumination.

B For any given type of metal, there is a maximum wavelength of radiation above which no emission of electrons occurs.

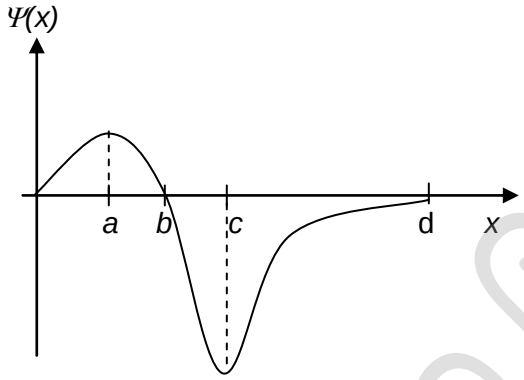
C The number of electrons emitted per second does not depend on the intensity of the incident radiation.

D The velocity of the emitted electrons is directly proportional to the intensity of the incident radiation.

34 Electron A has kinetic energy *E*. Electron B has kinetic energy 2*E*. Determine the ratio of the de Broglie wavelength of electron A to that of electron B?

A 1.4 **B** 2.0 **C** 0.50 **D** 0.71

35 A figure shows how the wave function of a particle varies with position.



At which position is the particle most likely to be found?

A $x = a$

B $x = b$

C $x = c$

D $x = d$

36 Which one of the following statements best describes stimulated emission in a laser?

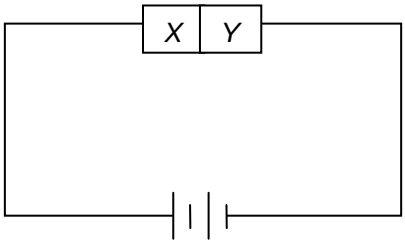
A Electrons collide with atoms in a metastable state and cause photons to be emitted.

B Atoms in a metastable state de-excite and cause electrons to be emitted.

C Photons interact with atoms in a metastable state and cause photons to be emitted.

D Photons interact with the atoms in a metastable state and cause electrons to be emitted.

37 A semiconductor *X* is made by doping germanium crystal with arsenic (donor). Another semiconductor *Y* is made by doping germanium with indium (acceptor). The two are joined end to end and connected to a battery as shown. Which of the following statements is correct?



A X is P-type, Y is N-type and the junction is forward biased.

B X is N-type, Y is P-type and the junction is forward biased.

C X is P-type, Y is N-type and the junction is reverse biased.

D X is N-type, Y is P-type and the junction is reverse biased.

38 A parent nucleus, initially at rest, decays into two particles of masses m_1 and m_2, moving away from each other in opposite directions. If E is the total energy of the two particles, what is the energy associated with the particle of mass m_1?

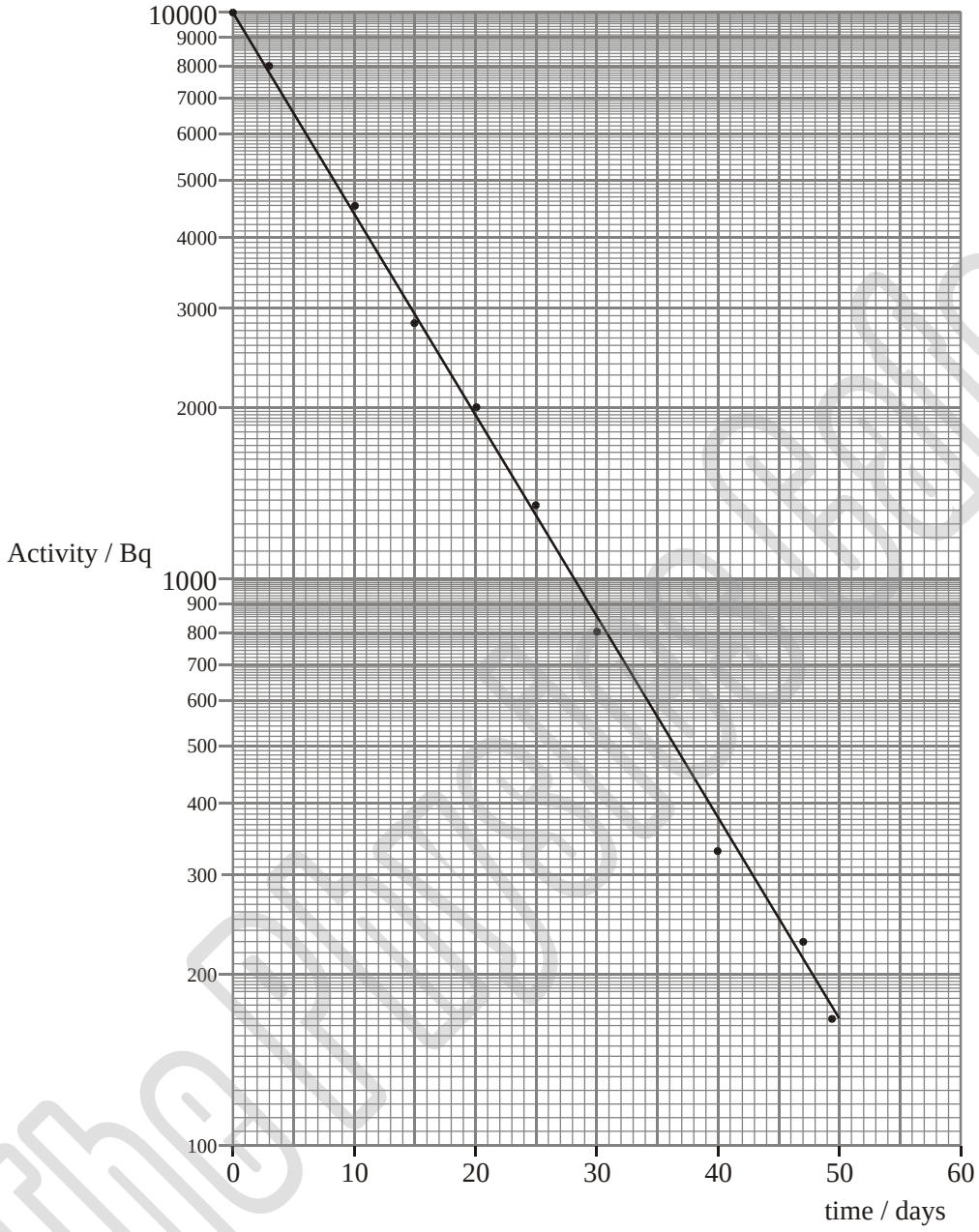
A $\frac{m_1}{m_2}E$ **B** $\frac{m_2}{m_1}E$ **C** $\frac{m_2}{m_1+m_2}E$ **D** $\frac{m_1}{m_1+m_2}E$

39 Which one of the following combinations of radioactive decay results in the formation of an isotope of the original nucleus?

A one α and four β **B** two α and one β

C four α and one β **D** one α and two β

40 The activity of a sample of Iodine-131 varies with time as shown. The activity scale is logarithmic.



The half-life of Iodine-131 is approximately

A 8 days

B 28 days

C 55 days

D 180 days

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