## HWA CHONG INSTITUTION
## JC2 Preliminary Examinations
## Higher 2

| CANDIDATE NAME | | CT GROUP | 24S |
|---|---|---|---|
| CENTRE NUMBER | | INDEX NUMBER | |

# PHYSICS
**Paper 1 Multiple Choice**

Additional Materials: Optical Mark Sheet

**9749/01**

**23 September 2025**

**1 hour**

## INSTRUCTIONS TO CANDIDATES

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, CT, NRIC or FIN number on the optical mark sheet (OMS). Shade your NRIC or FIN in the spaces provided.

There are **thirty** 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 OMS.

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.

This paper consists of **17** printed pages.

| **Data** | **Formulae** | |
|---|---|---|

**Data**

speed of light in free space,
$c = 3.00 \times 10^8$ 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 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
$$p = \rho g h$$

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

temperature
$$T/K = T/°C + 273.15$$

pressure of an ideal gas
$$P = \frac{1}{3}\frac{Nm}{V}<c^2>$$

mean kinetic energy of a molecule of an ideal gas
$$E = \frac{3}{2}kT$$

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

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

electric current
$$I = Anvq$$

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

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

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

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

magnetic flux density due to a long straight wire
$$B = \frac{\mu_o I}{2\pi d}$$

magnetic flux density due to a flat circular coil
$$B = \frac{\mu_o N I}{2r}$$

magnetic flux density due to a long solenoid
$$B = \mu_o n I$$

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

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

**1** What is a reasonable estimate for the volume of a typical basketball?

**A** 70 cm$^3$ **B** 700 cm$^3$ **C** 7000 cm$^3$ **D** 70000 cm$^3$

**2** A sandbag is released from a hot air balloon when it is 10 m above ground and ascending at a velocity of 4.0 m s$^{-1}$. Which of the following graphs best shows how its displacement will vary with time?

**A**

displacement/ m

**B**

displacement/ m

**C**

displacement/ m

**D**

displacement/ m
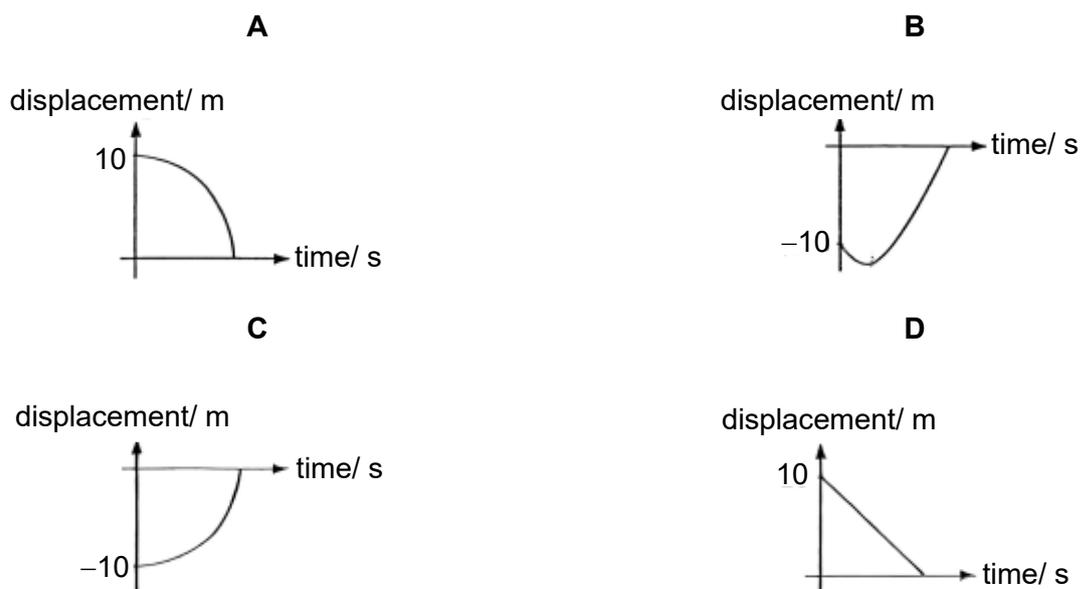
**3** Two identical frictionless trolleys A and B approach each other along a horizontal straight line, as illustrated in the figure below. Trolley A is moving faster than B. The trolleys collide and are in contact for a short period of time before separating.

Which of the following statements is false?

**A** It is not possible for both trolleys to be at rest simultaneously.

**B** During the collision, the two trolleys exert equal and opposite forces on each other.

**C** Trolley B must be moving to the right after the collision.

**D** The collision must be elastic as trolley A remains in contact with trolley B for only a short period of time

**4** A metre rule of mass 50 g is suspended horizontally from the ceiling by two springs at its ends, as shown.
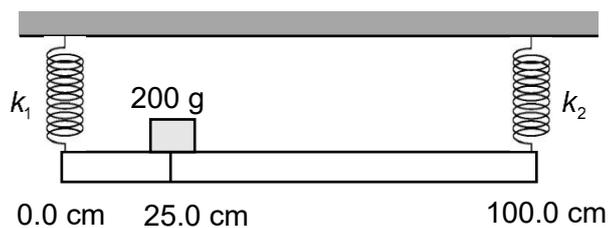


The spring at the 0.0 cm mark has spring constant $k_1$, while the spring at the 100 cm mark has spring constant $k_2$.

The springs have the same length when they are unstretched.

A 200 g mass is placed at the 25.0 cm mark.

What is the ratio $\dfrac{k_2}{k_1}$ such that the ruler is horizontal?

  **A** 0.33         **B** 0.43         **C** 2.3         **D** 3.0

**5** A cube of density $\rho_0$ of side $L$ floats in a beaker of water of density $\rho_1$. The depth of the cube submerged in water is $h$.
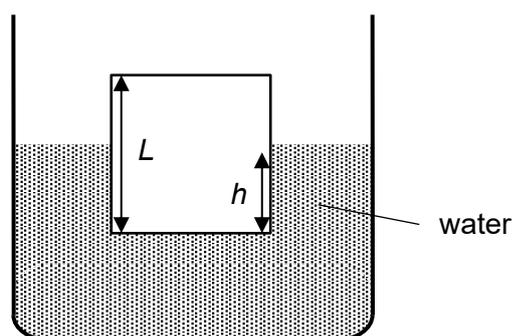


What is the magnitude of the upthrust on the cube?

  **A** $\rho_0 gh$         **B** $\rho_1 gh$         **C** $\rho_0 gL^3$         **D** $\rho_1 gL^3$

**6** The figure below shows a light shelf attached to the wall by a rope. A heavy book is on the shelf at the position shown. What is the direction of the force of the wall on the shelf?
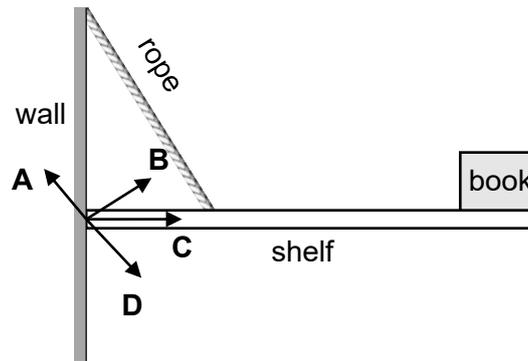


**7** The potential energy of a body when it is at point P a distance $x$ from a reference point O is given by $U = kx^2$, where $k$ is a constant.

What is the force acting on the body when it is at P?

**A** magnitude of $2kx$ from O to P

**B** magnitude of $kx$ from O to P

**C** magnitude of $kx$ from P to O

**D** magnitude of $2kx$ from P to O

**8** A small sphere is set into circular motion in a horizontal plane within a smooth cone as shown.
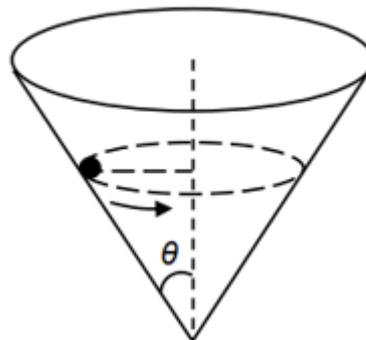


If the sphere is moving with a centripetal acceleration of $0.8g$, what is the angle $\theta$?

**A** 37° **B** 39° **C** 51° **D** 53°

**9** Which of the following statements regarding the gravitational field strength and acceleration of free fall at the surface of the Earth is true?

**A** The gravitational field strength and the acceleration of free fall are always exactly equal at the Earth's surface, approximately 9.8 m s⁻², regardless of location.

**B** The acceleration of free fall is larger at the Equator than at the North and South Poles.

**C** The gravitational field strength varies significantly from the Poles to the Equator, while the acceleration of free fall is constant across the Earth's surface.

**D** The gravitational field strength is numerically greater than or equal to the acceleration of free fall.

**10** The diagram shows two circular orbits around the Earth.
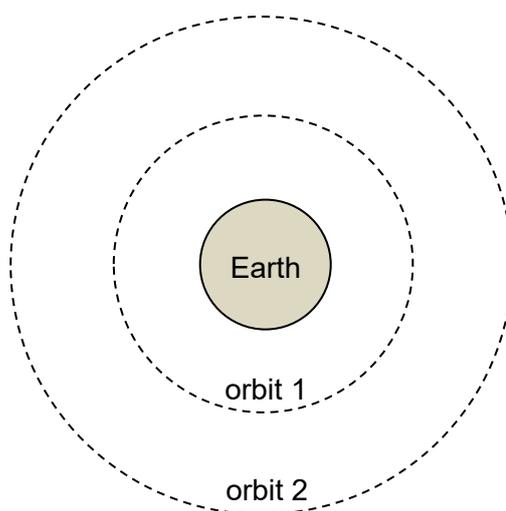


How would the kinetic energy and gravitational potential energy of a satellite change if it is moved from orbit 1 to orbit 2?

|  | kinetic energy | gravitational potential energy |
|---|---|---|
| **A** | increase | increase |
| **B** | increase | decrease |
| **C** | decrease | decrease |
| **D** | decrease | increase |

**11** Two vessels Y and Z are of the same volume.

Vessel Y contains 8 moles of hydrogen gas molecules of molar mass 2 g mol$^{-1}$ while vessel Z contains 8 moles of oxygen gas molecules of molar mass 32 g mol$^{-1}$.

The gas pressure is the same in both vessels.

What is the ratio of the root-mean-square speed of the gas molecules in vessel Y to that in vessel Z?

**A**   256                **B**   16                **C**   4                **D**   1

**12** Which statement about internal energy is correct?

**A**   The internal energy of a system can be decreased without transfer of energy by cooling.

**B**   When the internal energy of a system is decreased, its temperature always drops.

**C**   When two systems have the same internal energy, they must be at the same temperature.

**D**   The internal energy of a system is the summation of microscopic kinetic energy due to random motion of the molecules of the system.

**13** A chamber containing gas is sealed by a movable piston of mass 0.75 kg.
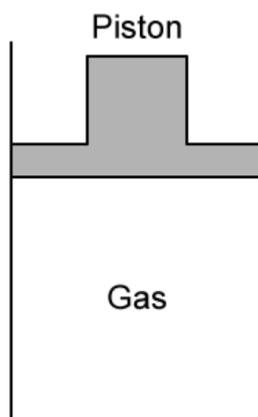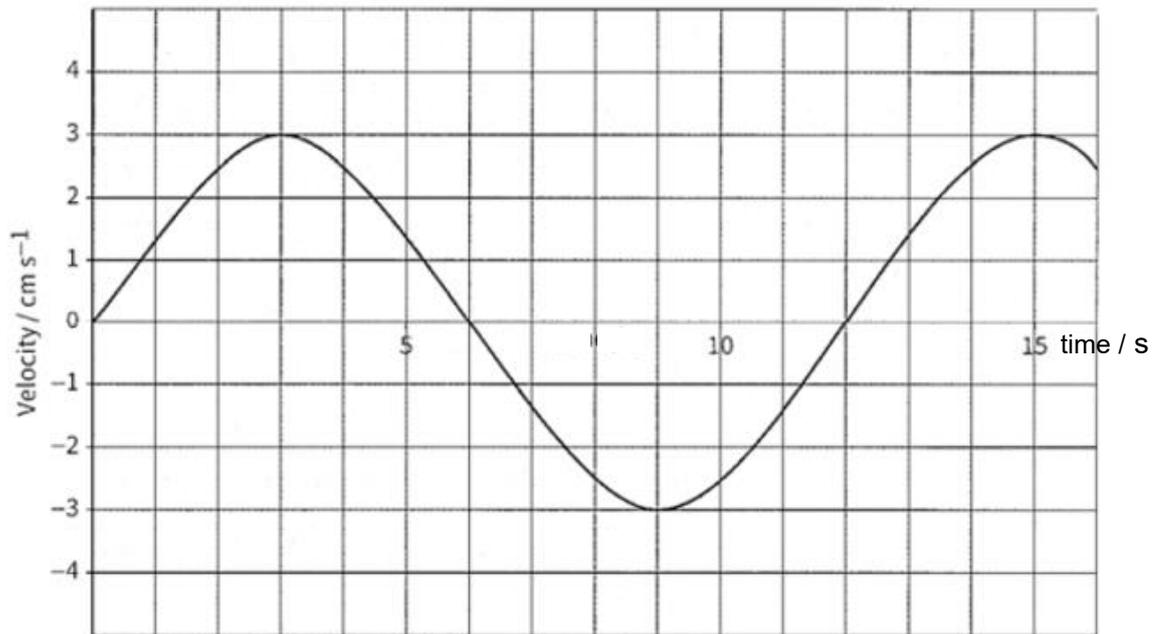


When the gas is heated, there is a short period in which the piston experiences an average upward acceleration of 3.5 m s$^{-2}$ over a distance of 12 cm.

Calculate the work done by the gas during this period.

**A**   0.315 J                **B**   1.20 J                **C**   2.18 J                **D**   32.4 kJ

14 The graph below shows the variation with time of the velocity of a 3.0 kg mass oscillating in simple harmonic motion.



What is the maximum restoring force acting on the mass as it oscillates?

A    0.025 N          B    0.047 N          C    0.057 N          D    0.090 N

15  A wave pulse travels through a medium from left to right. The graph below shows the variation with time of the displacement of a particle P as the pulse passes it.
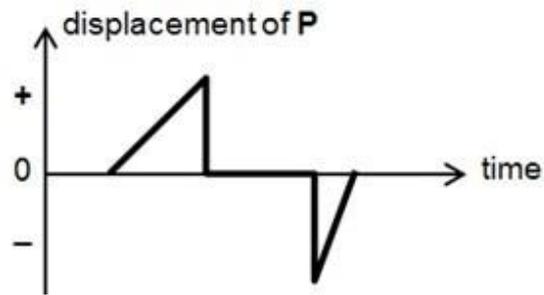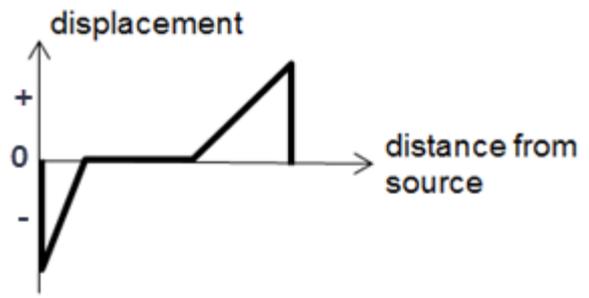


Which one of the following graphs best represents the variation of the displacement with positions of the particles along the path of the wave pulse at a certain instant?
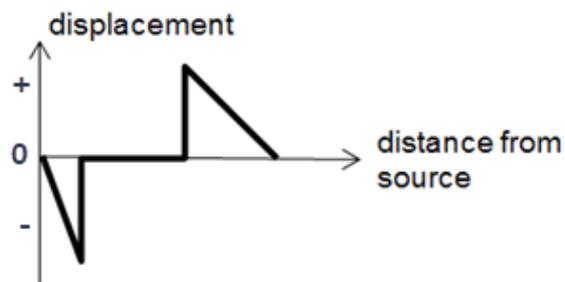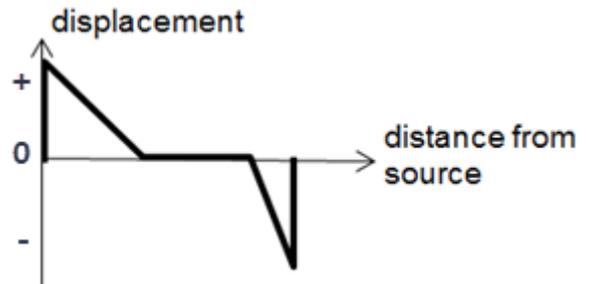
**A**
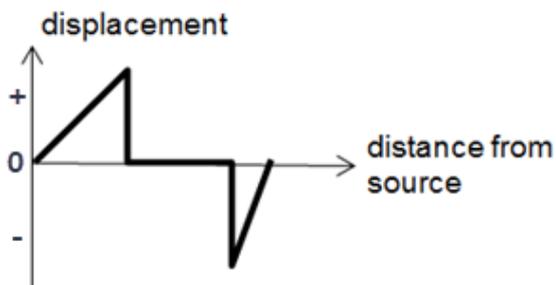


**B**



**C**



**D**

**16** Unpolarised light of intensity $I_o$ is incident on the first of two polarising sheets. Initially the axis of polarisation of the sheets are perpendicular to each other.

Which of the following should be done so that light intensity of $0.25I_o$ can emerge from the second polarising sheet?

   **A** Rotate either sheet by 45°.

   **B** Rotate either sheet by 60°.

   **C** Add a third sheet in between with same plane of polarisation as the first sheet.

   **D** Remove one of the 2 sheets.

**17** A telescope with an aperture of 45 cm receives light of wavelength 630 nm from a binary star system which can just be resolved by the telescope.

The two stars are 5.9 x $10^{16}$ m from the telescope.

How far apart are the two stars?

   **A** 2.4 x $10^{10}$ m   **B** 8.3 x $10^{10}$ m   **C** 2.4 x $10^{13}$ m   **D** 8.3 x $10^{13}$ m

**18** A stationary sound wave is formed inside an open tube of length 0.68 m.

A small microphone is inserted into the tube. It detects the first node at a distance of 0.17 m from the end. The microphone is then fixed in this position.

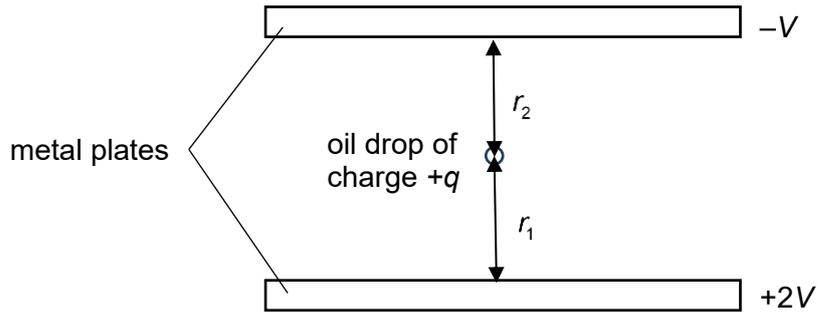The speed of sound in the tube is 340 m s$^{-1}$.
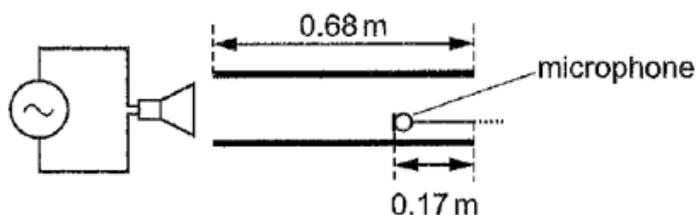


The frequency of the signal generator is now increased until the microphone again detects a node.

Which of the following is **not** one of such frequencies?

   **A** 2500 Hz   **B** 3000 Hz   **C** 3500 Hz   **D** 5500 Hz

**19** A small oil drop of charge +$q$ is suspended between two metal plates, as shown below.



The small oil drop is a distance $r_1$ from the lower plate and $r_2$ from the upper plate. The lower plate has a charge $Q_1$ and is held at a potential of +$2V$, while the upper plate has charge $Q_2$ and is held at a potential of −$V$.

What one of the expressions gives the magnitude of the electric force on the oil drop?

**A**   $\dfrac{Q_1 q}{4\pi\varepsilon_0 r_1^{\,2}} - \dfrac{Q_2 q}{4\pi\varepsilon_0 r_2^{\,2}}$    **B**   $\dfrac{Q_1 q}{4\pi\varepsilon_0 r_1^{\,2}} + \dfrac{Q_2 q}{4\pi\varepsilon_0 r_2^{\,2}}$    **C**   $\dfrac{2Vq}{r_1} + \dfrac{Vq}{r_2}$    **D**   $\dfrac{3Vq}{r_1 + r_2}$

**20** Two point charges +$2q$ and −$q$ are arranged as shown below. An external force moves a third point charge +$q$ along the paths shown, without any change in kinetic energy.

Along which path is the net work done on the third charge by the external force the greatest?
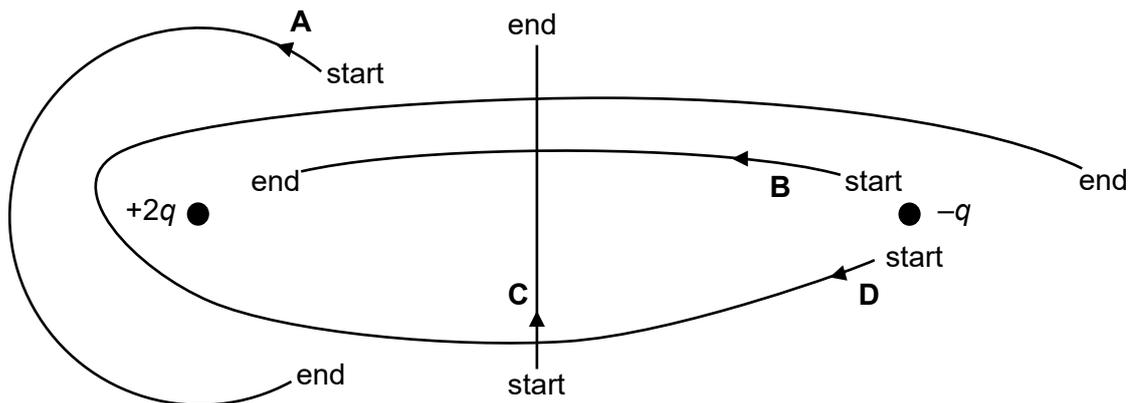
21  An electrical component has a potential difference $V$ across it and a current $I$ through it. A graph of $I$ against $V$ is drawn and is marked in three sections WX, XY and YZ.
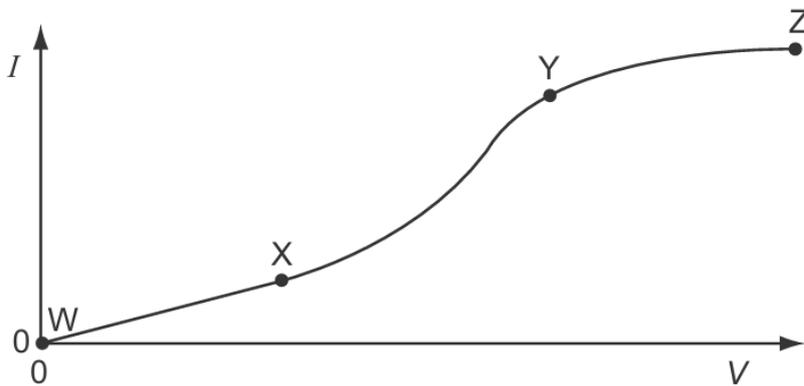


Which one of the options below correctly indicates the variation of the resistance of the component within each of the three sections of the $I$-$V$ graph?

|   | WX | XY | YZ |
|---|---|---|---|
| A | constant | decreases | increases |
| B | constant | increases | increases |
| C | increases | decreases | constant |
| D | increases | increases | decreases |

22  A circuit consisting of a battery, two ideal diodes and three identical resistors is shown below. The potential difference across each component is measured using ideal voltmeters.
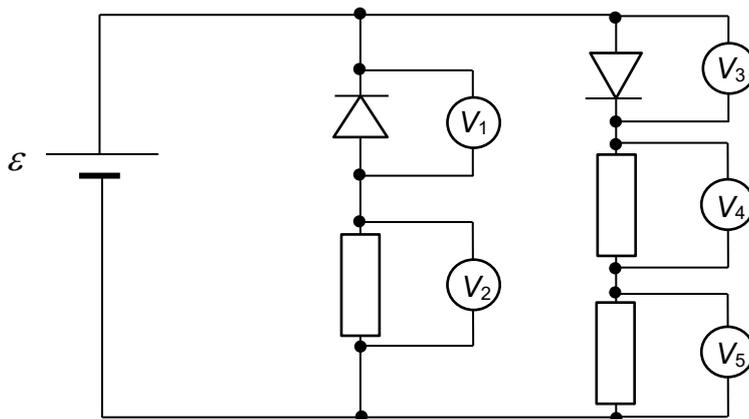


Which statement is correct?

A   The reading in $V_1$ is zero.

B   The reading in $V_2$ is equal to the sum of the readings in $V_4$ and $V_5$.

C   The readings in $V_2$ and $V_3$ are the same.

D   The readings in $V_3$, $V_4$ and $V_5$ are the same.

**23** In the potentiometer circuit shown, the reading on the ammeter is initially zero.
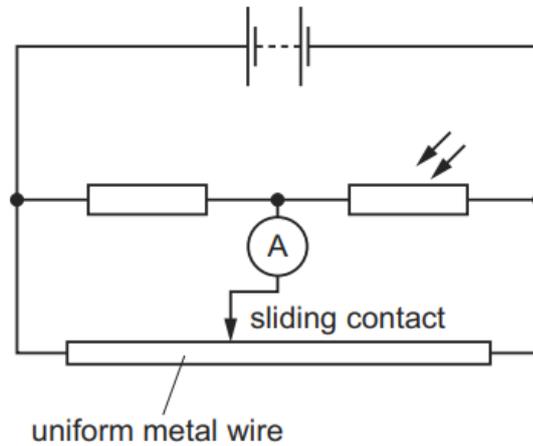


The light-dependent resistor (LDR) is then covered up and the ammeter gives a non-zero reading.

Which change could return the ammeter reading to zero?

**A** Move the sliding contact to the left.

**B** Move the sliding contact to the right.

**C** Increase the supply voltage.

**D** Decrease the supply voltage.

**24** A long straight wire P is placed along the central axis of a flat circular coil Q. The wire and coil each carry a current as shown.
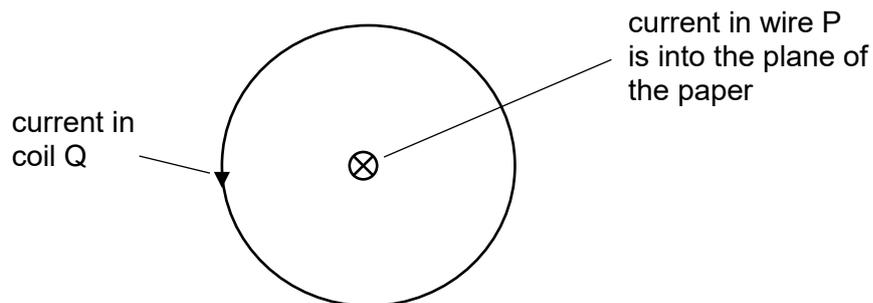


Which statement about the force acting on each part of coil Q due to the current in wire P is correct?

**A** The force is towards wire P

**B** The force is away from wire P

**C** The force is perpendicular to the plane of coil Q

**D** There is no force in all directions

**25** A wire is tightly wound in a single layer to form a hollow solenoid of 4000 turns and resistance of 3.26 kΩ. The resulting solenoid resembles a tube of length 200 mm and diameter 30 mm.
The solenoid is connected in series to a battery of e.m.f. 6.0 V and has negligible internal resistance.
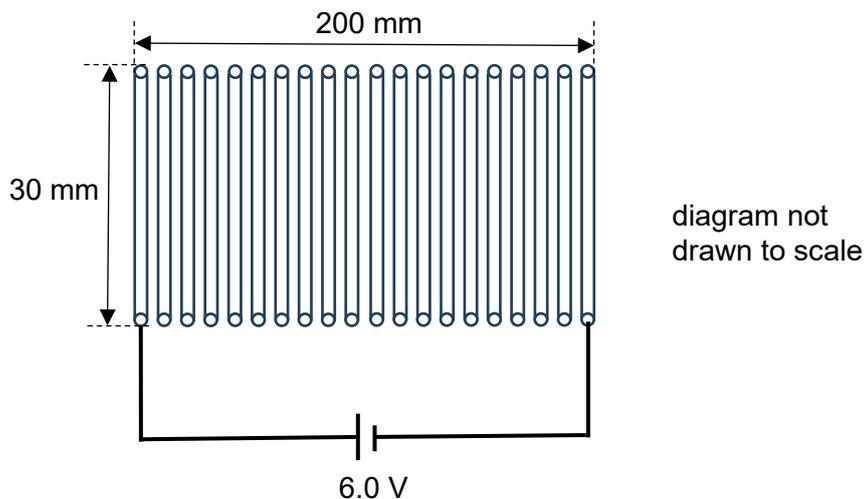


Determine the largest possible magnetic flux density at the center of the solenoid due to the current through the solenoid.

**A**    $4.6 \times 10^{-2}$ T

**B**    $4.6 \times 10^{-5}$ T

**C**    $9.3 \times 10^{-3}$ T

**D**    $9.3 \times 10^{-6}$ T

**26** A circular loop of wire is placed in a uniform magnetic field of 1.2 T that is normal to the plane of the loop. The loop shrinks from a radius of 0.2 m to a radius of 0.1 m in 0.1 s, at a rate which generates a steady e.m.f..

Which one of the following gives the induced e.m.f.?

**A**    $1.2 \times \pi (0.2 - 0.1)^2 \times 10$ V

**B**    $1.2 \times \pi (0.2)^2 \times 10$ V

**C**    $1.2 \times 2\pi (0.2 - 0.1) \times 10$ V

**D**    $1.2 \times \pi (0.04 - 0.01) \times 10$ V

**27** This is a graph of the voltage against time for a power supply.
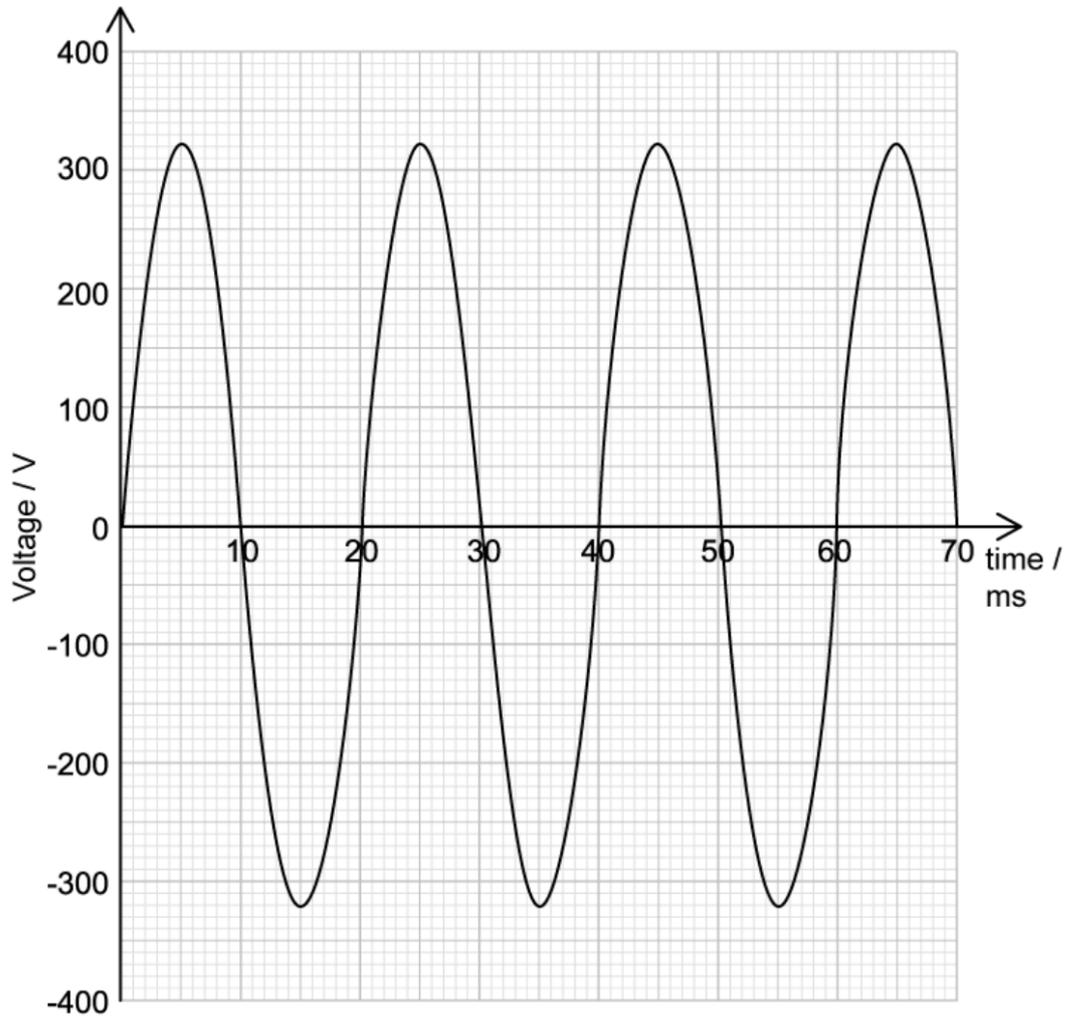


What is the d.c. voltage that gives the same mean power as produced by the alternating waveform of the power supply?

**A** 160 V

**B** 230 V

**C** 320 V

**D** 640 V

**28** A photocell is connected in a series circuit with a variable d.c. power supply and a sensitive ammeter.

The photocell is illuminated with ultra-violet radiation and photoelectrons are emitted. The electromotive force (e.m.f.) of the supply is then reduced and reversed and a graph is plotted of current against e.m.f. as shown.
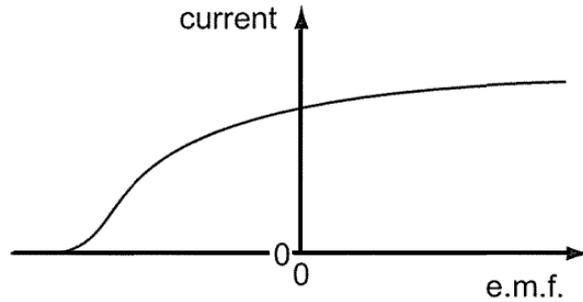


Which graph is obtained if the experiment is repeated with a lower intensity of the same ultra-violet source?
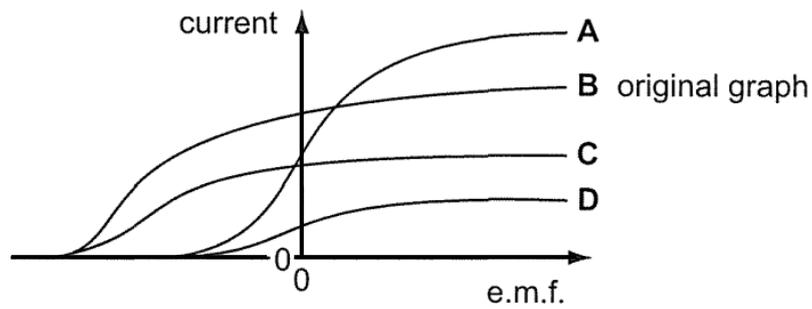
**29** The following graph shows the spectrum of X-rays emitted from an X-ray tube.
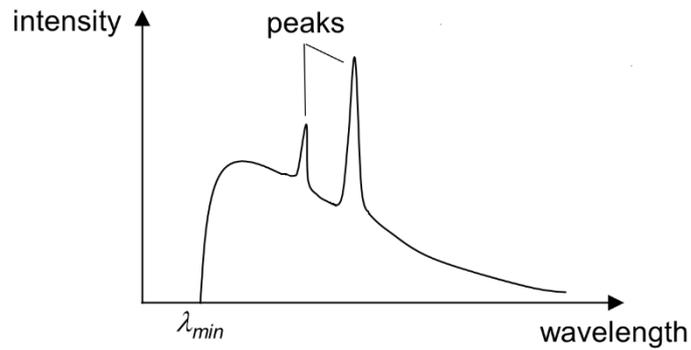


If the potential difference between the target and cathode is decreased, which one of the following combinations represents a possible change in the minimum wavelength, $\lambda_{min}$, and the intensity of the peaks?

| | Minimum Wavelength ($\lambda_{min}$) | Intensity |
|---|---|---|
| **A** | increase | decrease |
| **B** | increase | remain the same |
| **C** | decrease | decrease |
| **D** | decrease | remain the same |

**30** What is the decay constant of a radioactive substance?

**A** The number of disintegrations of nuclei in the substance occurring in one half-life of the substance.

**B** The number of disintegrations of nuclei in the substance occurring per unit time

**C** The average time taken for half the nuclei initially present in the substance to decay

**D** The constant proportionality in the equation relating the rate of decay of nuclei in the substance to the number of undecayed nuclei

**END OF PAPER**