EUNOIA JUNIOR COLLEGE
JC2 PRELIM EXAMINATIONS 2024
General Certificate of Education Advanced Level
Higher 2

| | |
|---|---|
| CANDIDATE NAME | |
| CIVICS GROUP | 2 3 - |
| REGISTRATION NUMBER | |

# PHYSICS

**9749/01**

Multiple Choice

**September 2024**

**1 hour**

Additional Materials: Multiple Choice Answer Sheet

**READ THESE INSTRUCTIONS FIRST**

Write your name, civics group and registration number on all the work you hand in.
The use of an approved scientific calculator is expected where appropriate.
Answer **all** questions.

There are **thirty** questions in this section.
For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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.

This document consists of **20** printed pages.

**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, | $h = 6.63 \times 10^{-34}$ 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$^{-2}$ |

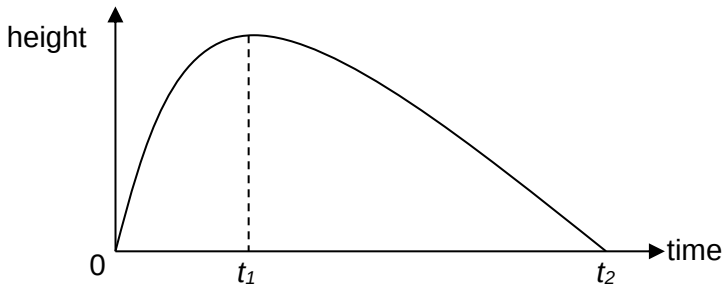
**Formulae**

| | |
|---|---|
| uniformly accelerated motion, | $s = ut + \frac{1}{2}at^2$<br>$v^2 = u^2 + 2as$ |
| work done on/by a gas, | $W = p\Delta V$ |
| hydrostatic pressure, | $p = \rho gh$ |
| gravitational potential, | $\phi = -\frac{Gm}{r}$ |
| temperature, | $T\ /\ \mathrm{K} = T\ /\ ^\circ\mathrm{C} + 273.15$ |
| pressure of an ideal gas, | $p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$ |
| mean translational kinetic energy of an ideal gas molecule | $E = \frac{3}{2}kT$ |
| displacement of particle in s.h.m. | $x = x_0 \sin \omega t$ |
| velocity of particle in s.h.m. | $v = v_0 \cos \omega t$<br>$= \pm\ \omega \sqrt{(x_0^2 - x^2)}$ |
| 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, | $V = \frac{Q}{4\pi\varepsilon_0 r}$ |
| alternating current/voltage, | $x = x_0 \sin \omega t$ |
| magnetic flux density due to a long straight wire | $B = \frac{\mu_0 I}{2\pi d}$ |
| magnetic flux density due to a flat circular coil | $B = \frac{\mu_0 NI}{2r}$ |
| magnetic flux density due to a long solenoid | $B = \mu_0 nI$ |
| radioactive decay, | $x = x_0 \exp(-\lambda t)$ |
| decay constant | $\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$ |

**1** A radio aerial of length *L*, carrying a current $I$, emits a signal of wavelength $\lambda$ and power *P*. These quantities are related by $P = k\,I^2\left(\frac{L}{\lambda}\right)^2$ where *k* is a constant. What unit, if any, should be used for the constant *k*?

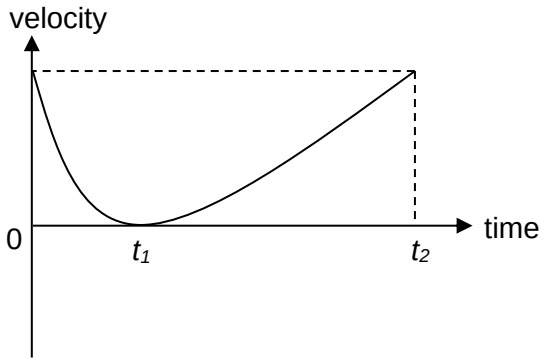
**A** ohm **B** watt **C** volt **D** no unit

**2** A ball is thrown vertically upwards and returns along the same path. The graph shows how its height from the ground varies with time.

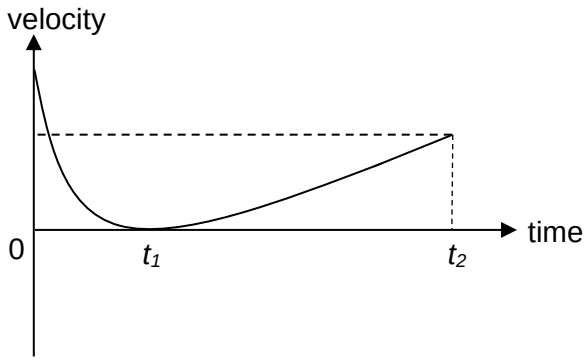



Which velocity-time graph best describes this motion?

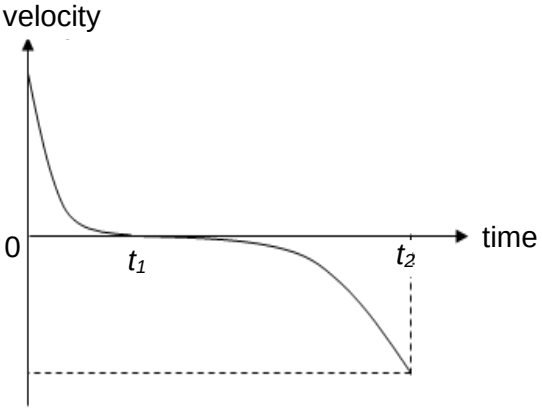
**A**



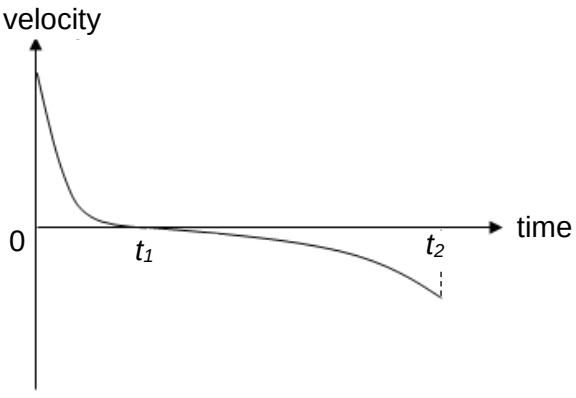

**B**



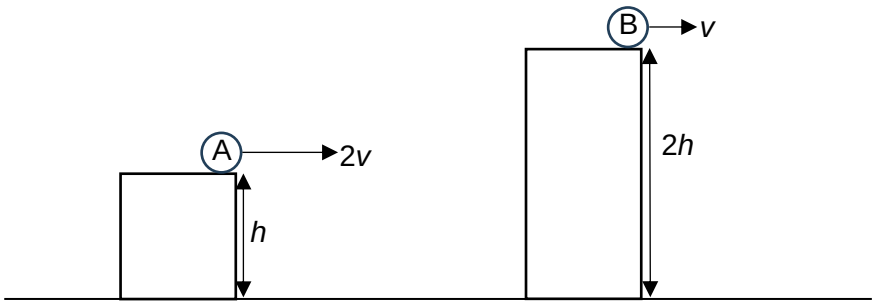

**C**




**D**



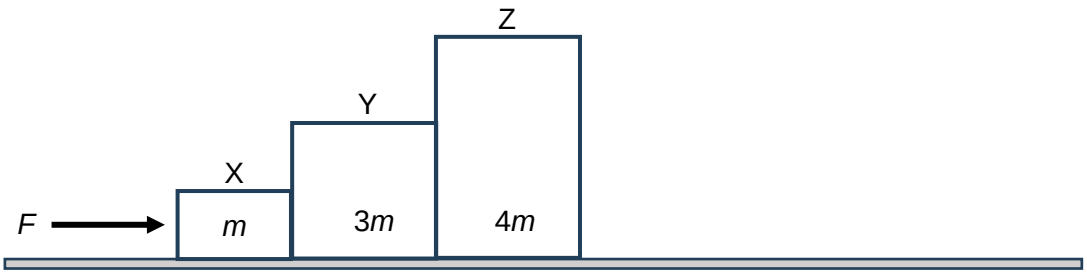
**3** Ball A is projected horizontally with an initial velocity $2v$ from a height $h$ above ground, while ball B is projected horizontally with an initial velocity $v$ from a height $2h$ above ground.




If $x_A$ is the horizontal displacement of ball A from the point of projection to the point of landing and $x_B$ is the corresponding quantity for ball B, what is the ratio $\frac{x_A}{x_B}$?

**A** 0.35 **B** 1.00 **C** 1.41 **D** 2.83

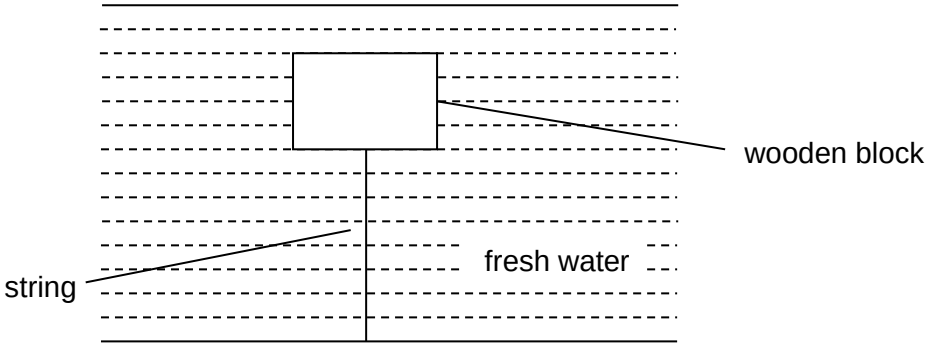
**4** Three blocks X, Y and Z, of masses $m$, $3m$ and $4m$ respectively, are accelerated along a smooth horizontal surface by a force $F$ applied to block X as shown.




What is the ratio $\frac{\text{force exerted on block X by block Y}}{\text{force on block Y by block Z}}$?

**A** $\frac{1}{4}$ **B** $\frac{3}{8}$ **C** $\frac{7}{8}$ **D** $\frac{7}{4}$

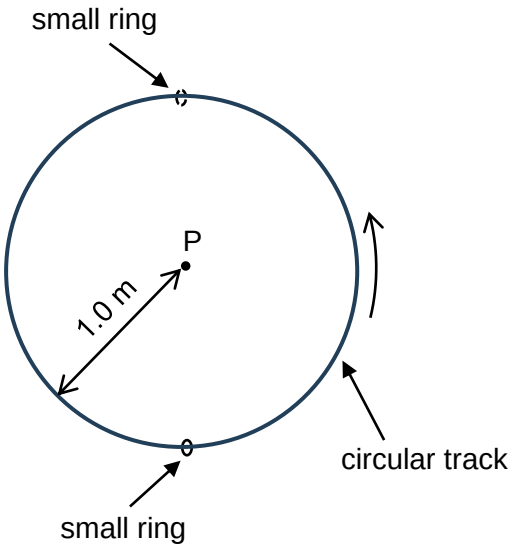
**5** A wooden block of density 800 kg $m^{-3}$ and volume 1.0 $m^3$ is fastened to the bottom of a freshwater pond by a string as shown below. The density of the freshwater is 1000 kg $m^{-3}$.




If the string suddenly breaks, what is the initial acceleration of the block?

**A** 0.25 m $s^{-2}$ **B** 1.25 m $s^{-2}$ **C** 2.5 m $s^{-2}$ **D** 12.5 m $s^{-2}$

**6** A small ring, of mass *m*, moves along a smooth circular track in the vertical plane, as shown in the figure below. P is the centre of the circular track.



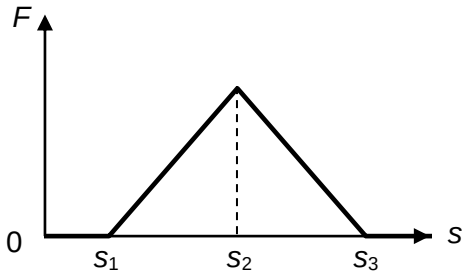

The radius of the track is 1.0 m.

At the bottom of the track, an upward normal force of magnitude 5.5*mg* acts on the small ring.

Which row correctly describes the magnitude and direction of the normal force acting on the small ring when it is at the top of the track?

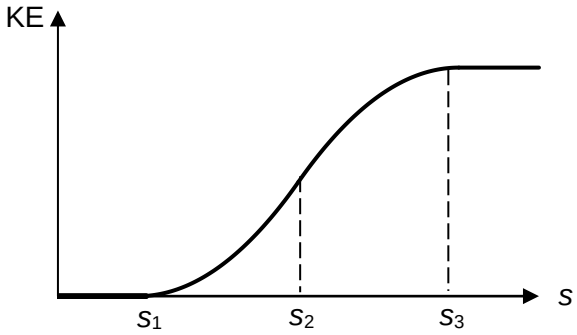
| | magnitude | direction |
|---|---|---|
| **A** | 0.5*mg* | upwards |
| **B** | 0.5*mg* | downwards |
| **C** | 1.5*mg* | upwards |
| **D** | 1.5*mg* | downwards |

**7** The diagram shows the variation with displacement $s$ of the net force $F$ acting on an object moving along a straight line. The intial velocity of the object is zero.

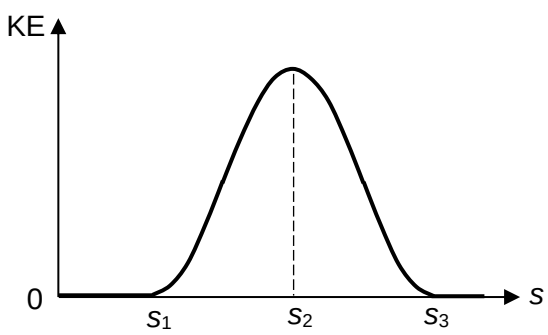



Which graph shows the variation with displacement $s$ of the kinetic energy (KE) of the object?

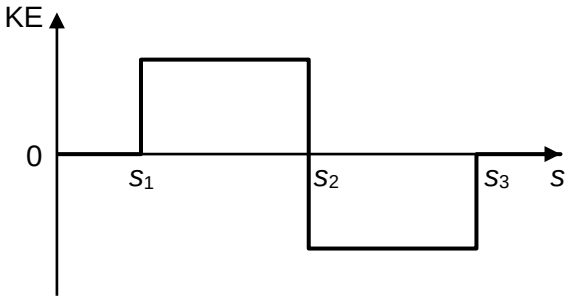
**A**



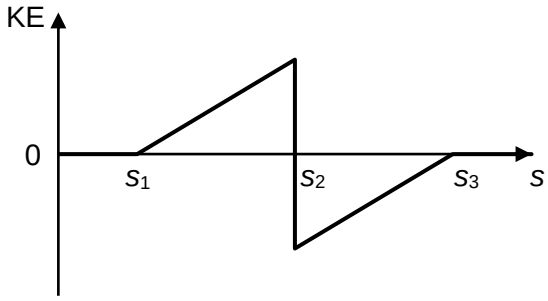

**B**




**C**




**D**




**8** The radius of the Earth is $6.371 \times 10^6$ m. The gravitational field strength on the surface of the Earth is 9.81 N kg$^{-1}$.

What is the gravitational potential at a point 80 000 m above the Earth surface?

**A** –5.0 kJ kg$^{-1}$

**B** –5.0 MJ kg$^{-1}$

**C** –62 MJ kg$^{-1}$

**D** –62 GJ kg$^{-1}$

**9** Earth has a radius of $r$. A satellite of mass $m$ is in circular orbit around Earth, at a height $r$ above the Earth and with a period $T$. The satellite is moved to a new orbit with height $3r$ above the Earth.

What is the new period in terms of $T$?

**A** $\sqrt{2}\,T$ **B** $2\sqrt{2}\,T$ **C** $\sqrt{3}\,T$ **D** $3\sqrt{3}\,T$

**10** The displacement $x$ of a molecule undergoing simple harmonic motion in a sound wave is given by

$$x = x_0 \sin 2\pi ft$$

where $x_0$ = 0.32 mm and $f$ = 10 000 Hz.

What is the magnitude of the maximum acceleration experienced by the molecule?

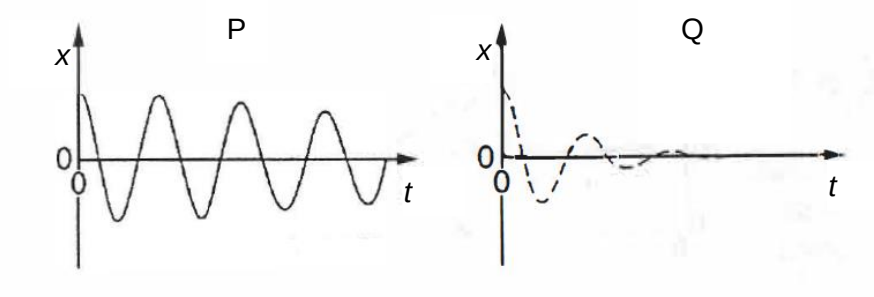
**A** $20.1\,\text{m s}^{-2}$

**B** $2.01\times10^{4}\ \text{m s}^{-2}$

**C** $1.26\times10^{6}\ \text{m s}^{-2}$

**D** $1.26\times10^{9}\ \text{m s}^{-2}$

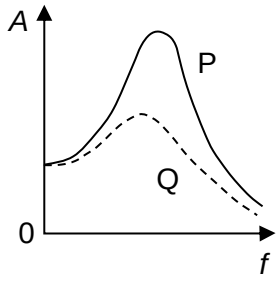
**11** Two oscillating systems P and Q are of the same natural frequency. They are given the same initial displacement before being released. The graphs below show the variation with time *t* of their displacement *x*.



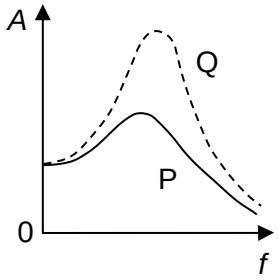

P and Q are then subjected to driving forces of the same constant amplitude and of variable frequency *f*.

Which graph best represents the variation with *f* of the amplitude *A* of P and Q?

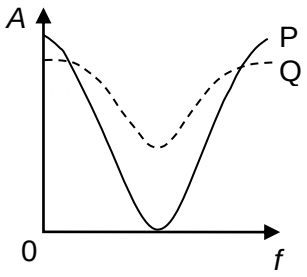
**A**



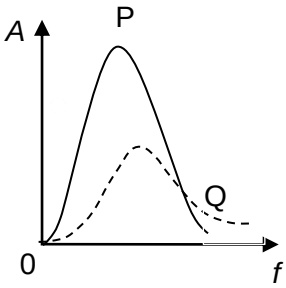

**B**




**C**




**D**



**12** A liquid is maintained at boiling point by means of an electric heater.

The constant rate at which the liquid boils is measured for two different powers of the heater as shown.

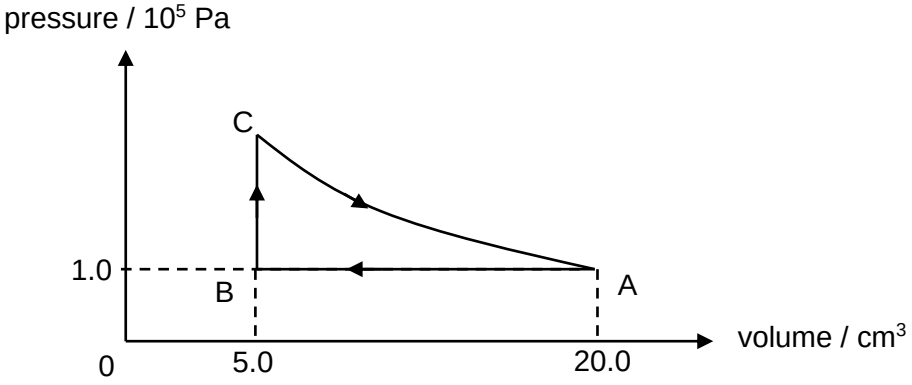
| power of heater | rate of loss of mass of liquid |
|---|---|
| $P_1$ | $m_1$ |
| $P_2$ | $m_2$ |

For each power of the heater, $P_1$ or $P_2$, the rate of heat loss to the environment is the same.

Which expression is the correct expression for rate of heat loss to the environment?

**A** $\frac{P_1 - P_2}{m_2 - m_1}$ **B** $P_1 - P_2$ **C** $\frac{P_1}{m_1}$ **D** $\frac{P_1 m_2 - P_2 m_1}{m_2 - m_1}$

**13** An ideal gas undergoes a cycle of changes A → B → C → A, as shown below.

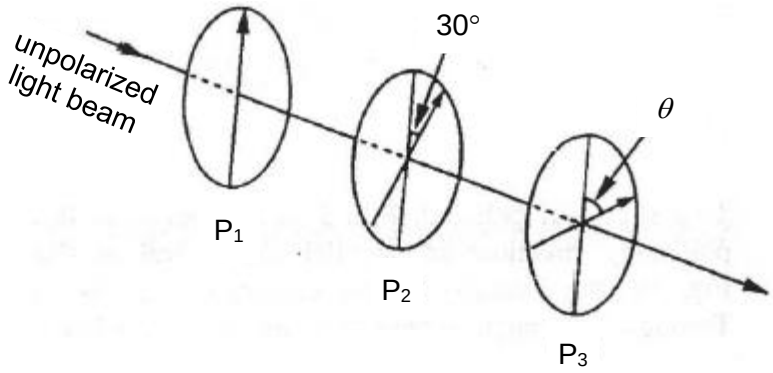



Work done by gas from C to A is 4.2 J.

What is the overall heat gain in process A → B → C → A?

**A** –5.7 J **B** –2.7 J **C** 2.7 J **D** 5.7 J

**14** The figure below shows a beam of initially unpolarised light passing through 3 polarisers $P_1$, $P_2$ and $P_3$. The polarising axis of each polaroid is shown by an arrow. Polaroids $P_1$ and $P_2$ are fixed, with their polarising axes at 30° to each other, and $P_3$ can be set with its polarising axis at a variable angle $\theta$ to that of $P_1$.




The polarised light beam incident on $P_2$ has an intensity of 30 W $m^{-2}$ while the light beam emerging from $P_3$ has an intensity of 14 W $m^{-2.}$

What is a possible value of $\theta$ for the light emerging from $P_3$?

**A** 38° **B** 52° **C** 57° **D** 68°

**15** A camera with a lens diameter of 10 cm captures images using light of wavelength 550 nm.

What is the minimum separation between two objects that can be resolved if they are located 100 meters from the camera?

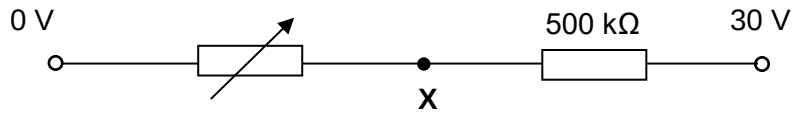
**A** 0.25 mm **B** 0.37 mm **C** 0.55 mm **D** 0.65 mm

**16** Light of wavelengths 480 nm and 640 nm are incident on a diffraction grating with 5000 lines per cm.

What is the angle at which the maxima for one wavelength of light overlaps with a maxima for other wavelength of light?

**A** 0.22° **B** 16° **C** 37° **D** 74°

**17** Two resistors form a potential divider with outer junctions maintained at potentials of 0 V and 30 V. The variable resistor can be adjusted from 100 kΩ to 500 kΩ.




What range of potentials can be obtained at point X?

**A** 3 V to 15 V

**B** 5 V to 15 V

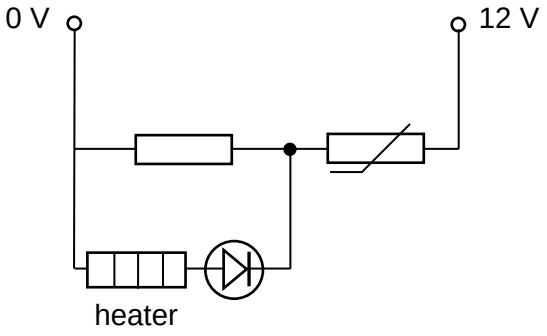
**C** 5 V to 25 V

**D** 15 V to 25 V

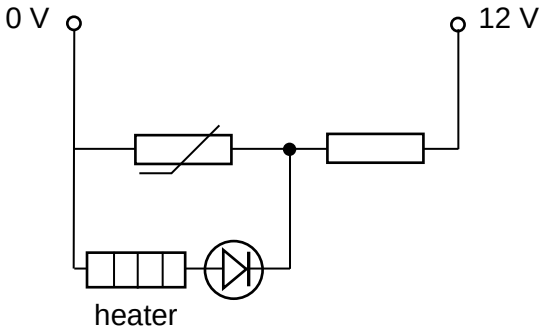
**18** A circuit consists of a negative-temperature-coefficient (NTC) thermistor, a fixed resistor and a heater.

Which of the following arrangements allows the heater to be turned on when the temperature is low?

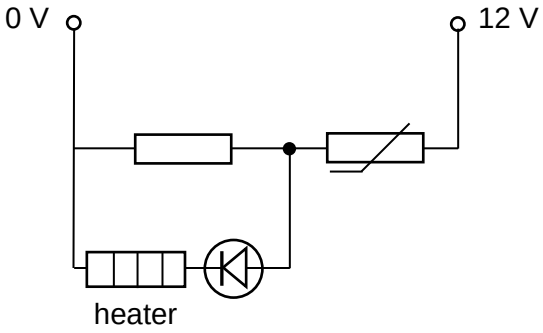
**A**



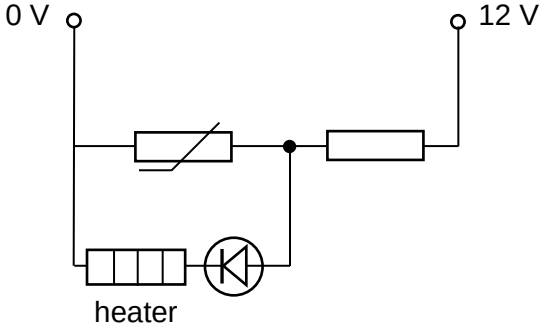

**B**



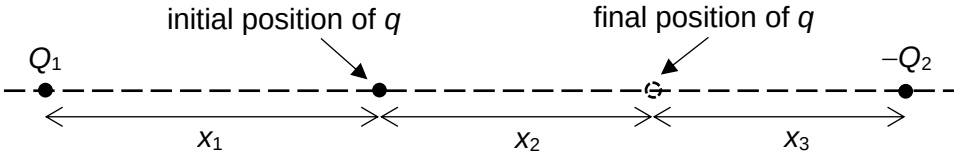

**C**




**D**



**19** A test charge $q$ is moved from one position to another along the line joining a positive charge $Q_1$ and a negative charge $-Q_2$. The distances between the positions of the charges are $x_1$, $x_2$ and $x_3$, as shown in the diagram below.




What is the work done by the electric field?

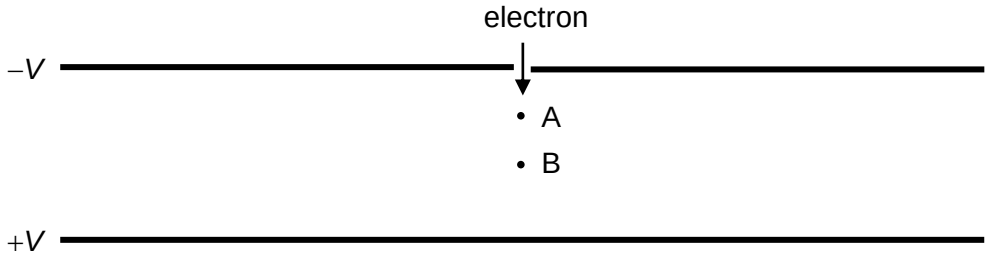
**A** $\frac{qQ_1}{4\pi\varepsilon_0}\left(\frac{1}{x_1}-\frac{1}{x_1+x_2}\right)+\frac{qQ_2}{4\pi\varepsilon_0}\left(\frac{1}{x_3}-\frac{1}{x_2+x_3}\right)$

**B** $\frac{qQ_1}{4\pi\varepsilon_0}\left(\frac{1}{x_1+x_2}-\frac{1}{x_1}\right)+\frac{qQ_2}{4\pi\varepsilon_0}\left(\frac{1}{x_2+x_3}-\frac{1}{x_3}\right)$

**C** $\frac{qQ_1}{4\pi\varepsilon_0}\left(\frac{1}{x_1+x_2}-\frac{1}{x_1}\right)+\frac{qQ_2}{4\pi\varepsilon_0}\left(\frac{1}{x_3}-\frac{1}{x_2+x_3}\right)$

**D** $\frac{qQ_1}{4\pi\varepsilon_0}\left(\frac{1}{x_1}-\frac{1}{x_1+x_2}\right)+\frac{qQ_2}{4\pi\varepsilon_0}\left(\frac{1}{x_2+x_3}-\frac{1}{x_3}\right)$

**20** An electron enters the region between two charged parallel plates through a small opening, in the direction as shown in the diagram below. A and B are two points on the path of the electron.




The two plates are at electric potentials $-V$ and $+V$.

Which row correctly describes the relations between the electric forces $F$, potentials $V$ and potential energies $U$ at A and B?

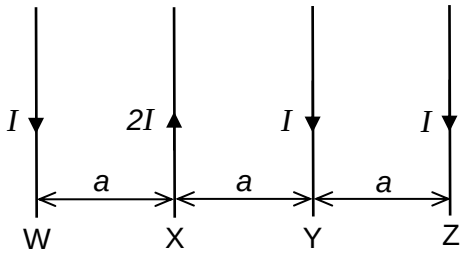
**A** $F_A > F_B$, $V_A > V_B$, $U_A < U_B$

**B** $F_A > F_B$, $V_A < V_B$, $U_A > U_B$

**C** $F_A = F_B$, $V_A > V_B$, $U_A < U_B$

**D** $F_A = F_B$, $V_A < V_B$, $U_A > U_B$

**21** Four parallel wires W, X, Y and Z carry currents of magnitudes and directions shown in the digram below. The spacing between wires are identical.

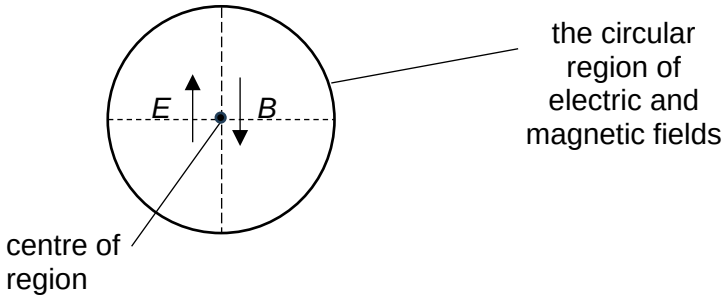



Which wire has the largest resultant force acting on it?

**A** W **B** X **C** Y **D** Z

**22** An electron beam initially passes through the centre of a region in a direction out of the plane of the paper.

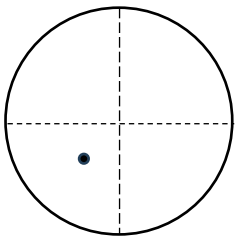
Subsequently, the electric and magnetic fields are directed within a circular region in directions as shown by the arrows in the diagram below.



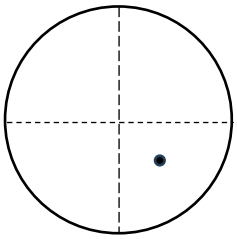

The deflections of the beam from the centre of the region produced by the electric field *E* and the magnetic field *B* acting separately are equal in magnitude.

Which diagram shows a possible position of the beam in the circular region when both fields are operating together?

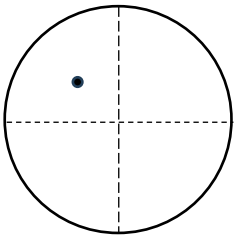
**A**



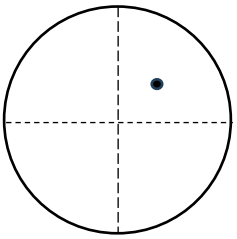
**B**



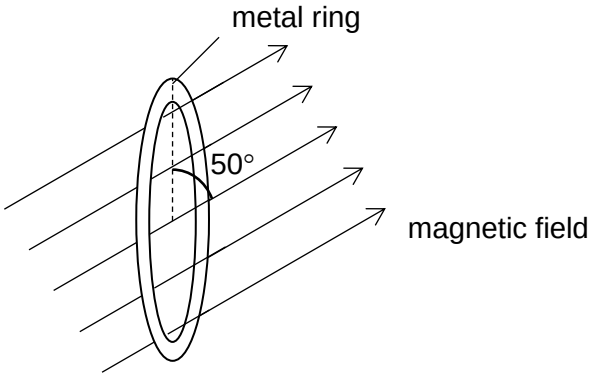
**C**



**D**



**23** A uniform magnetic field directed at 50° to the plane of a circular metal ring passes through the ring of diameter 0.50 m and resistance 3.0 Ω, as shown in the diagram.




The magnetic flux density through the ring decreases by $4.0 \times 10^{-5}$ T at a constant rate in 2.0 s. During this change, what is the current induced in the ring?

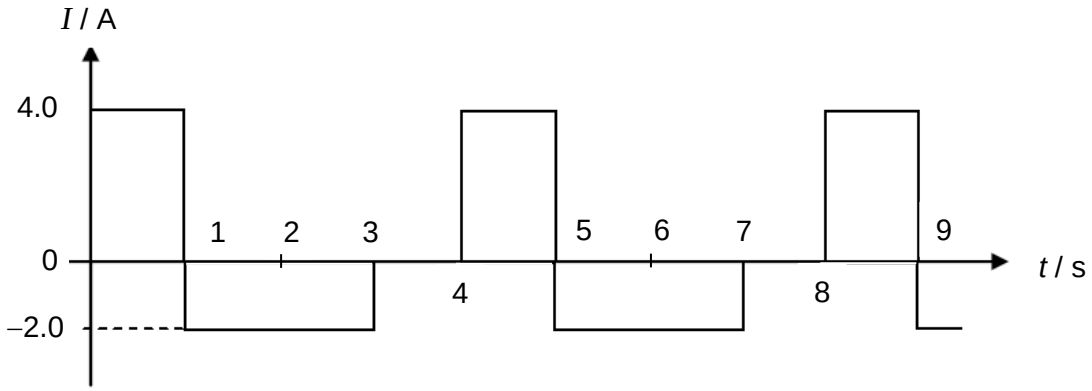
**A** It remains constant at 1.0 $\mu$A.

**B** It remains constant at 1.3 $\mu$A.

**C** It increases from zero to 1.0 $\mu$A at a constant rate.

**D** It increases from zero to 1.3 $\mu$A at a constant rate.

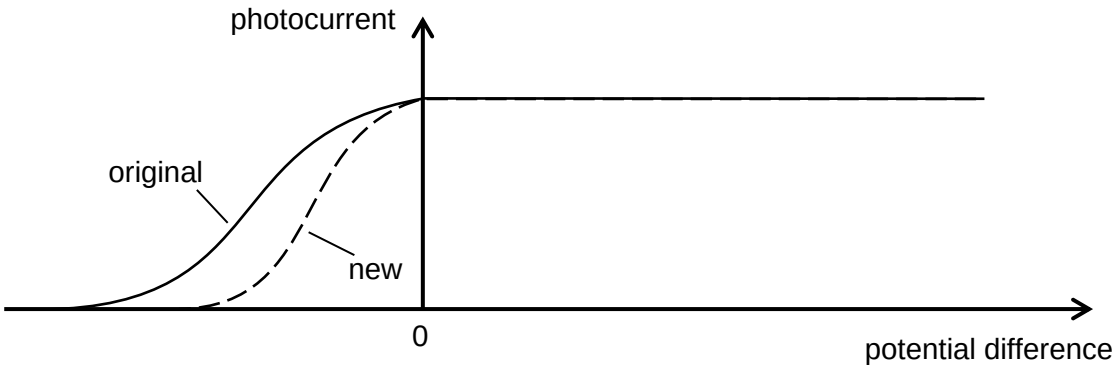
**24** An alternating current with a rectangular waveform as shown in the diagram below flows through a 11 Ω resistor.




What is the average power dissipated by the resistor?

**A** 0 W **B** 44 W **C** 66 W **D** 88 W

**25** In a photoelectric effect experiment, the variation of the photocurrent with the potential difference applied is shown in the diagram below, as the solid curve.



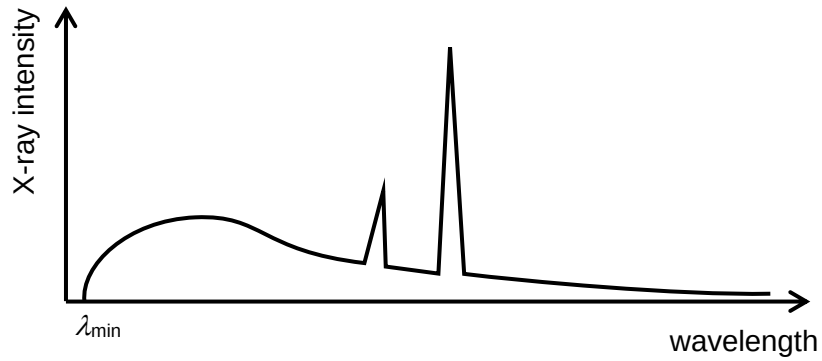

The light source is then replaced with a new one, and the dashed curve is obtained.

Which row correctly describes the new light source relative to the original source?

| | intensity | frequency |
|---|---|---|
| **A** | lower | higher |
| **B** | lower | lower |
| **C** | same | higher |
| **D** | same | lower |

**26** X-rays are produced when a beam of electrons, accelerated to a high speed by a potential difference, collides with a metal target.

The variation with wavelength of the intensity of the X-rays is illustrated in the diagram below.




Which feature of the X-ray graph remains unchanged when the accelerating potential changes?

**A** the wavelength $\lambda_{min}$

**B** the wavelengths at which the spikes occur

**C** the intensity of the spikes

**D** the intensity of the continuous spectrum

**27** The Heisenberg uncertainty principle is given by the relationship

$$\Delta p \Delta x \geq h$$

where $p$ = momentum

$x$ = position

$h$ = Planck constant.

Which statement about the interpretation of this relationship is correct?

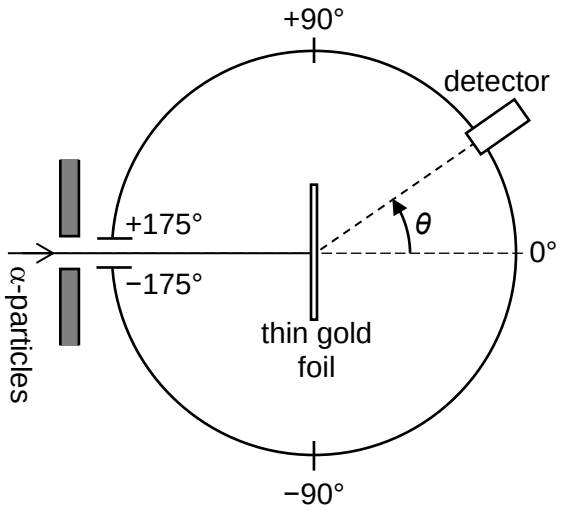
**A** The uncertainty in position $\Delta x$ is proportional to the reciprocal of the uncertainty in momentum $\Delta p$.

**B** If the position of a particle is changed by $\Delta x$, its momentum must change by at least $\Delta p = h / \Delta x$.

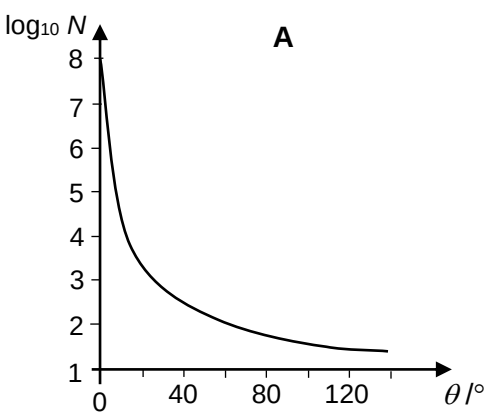
**C** If the position of a particle is measured with an uncertainty $\Delta x$, the minimum uncertainty of its momentum is $\Delta p = h / \Delta x$.

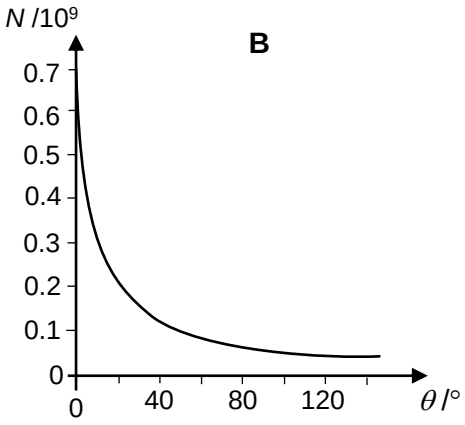
**D** The greater the uncertainty in the momentum $p$ of a particle, the greater is the uncertainty in its position $x$.

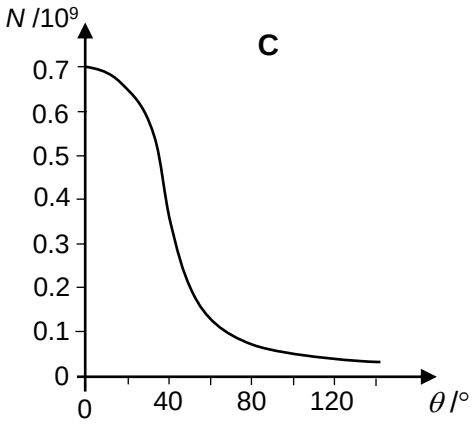
**28** In an $\alpha$-particle scattering experiment, a student set up the apparatus below to determine the number $N$ of $\alpha$-particle incident per unit time on a detector held at various angles $\theta$.

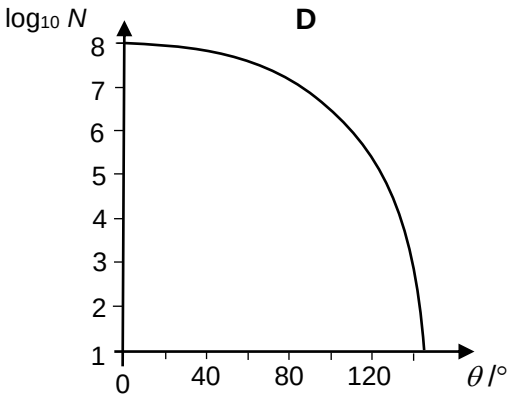



Which graph best represents the variation of $N$ with $\theta$?



**29** A radioactive source contains two species.

One has a half-life of 4 days and decays by the emission of alpha particles whilst the other has a half-life of 3 days and emits beta particles.

The initial count-rate is 352 $min^{-1}$, but when a sheet of paper is placed between the source and the detector this becomes 256 $min^{-1}$. The background count-rate is 16 $min^{-1}$.

What will be the count-rate after 12 days, without the paper present?

**A** 27 $min^{-1}$ **B** 28 $min^{-1}$ **C** 43 $min^{-1}$ **D** 44 $min^{-1}$

**30** Consider the following nuclear reaction:

$$^{7}_{3}\text{Li} + {}^{1}_{1}\text{H} \rightarrow 2\,{}^{4}_{2}\text{He}$$

The masses of the nuclei are as follow: $^{7}_{3}\text{Li}$ : 7.018*u*, $^{1}_{1}\text{H}$ : 1.008*u*, $^{4}_{2}\text{He}$ : 4.004*u*.

How much energy is released when 1.0 g of $^{1}_{1}\text{H}$ is fused with a sufficient amount of $^{7}_{3}\text{Li}$?

**A** $2.7 \times 10^{-12}$ J **B** $6.1 \times 10^{-10}$ J **C** $1.6 \times 10^{12}$ J **D** $3.6 \times 10^{14}$ J