EUNOIA JUNIOR COLLEGE
JC2 PRELIM EXAMINATIONS 2024
General Certificate of Education Advanced Level
Higher 1

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

# PHYSICS

**8867/01**

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$^{-1}$ |
| elementary charge | $e = 1.60 \times 10^{-19}$ C |
| 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 |
| the Avogadro constant | $N_A = 6.02 \times 10^{23}$ mol$^{-1}$ |
| 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>$v^2 = u^2 + 2as$ |
| resistors in series | $R = R_1 + R_2 + \ldots$ |
| resistors in parallel | $1/R = 1/R_1 + 1/R_2 + \ldots$ |

**1** When a beam of light is incident on a surface, it delivers energy to the surface. The intensity of the beam is defined as energy delivered per unit area per unit time.

What is the unit of intensity, expressed in SI base units?

**A** kg $m^{-2}s^{-1}$ **B** kg $m^{2}s^{-3}$ **C** kg $s^{-2}$ **D** kg $s^{-3}$

**2** To find the resistivity of a semiconductor, a student makes the following measurements of a cylindrical rod of the material.

Length = $25 \pm 1$ mm
Diameter = $5.0 \pm 0.1$ mm
Resistance = $68 \pm 1\ \Omega$

He calculates the resistivity to be $5.34 \times 10^{-2}\ \Omega$ m.

How should the uncertainty be included in his statement of the resistivity?

**A** $(5.3 \pm 0.1) \times 10^{-2}\ \Omega$ m

**B** $(5.3 \pm 0.5) \times 10^{-2}\ \Omega$ m

**C** $(5.34 \pm 0.07) \times 10^{-2}\ \Omega$ m

**D** $(5.34 \pm 0.09) \times 10^{-2}\ \Omega$ m

**3** What is the approximate volume of a typical inflated rubber party balloon?

**A** 0.001 $m^3$ **B** 0.01 $m^3$ **C** 0.1 $m^3$ **D** 1 $m^3$

**4** The acceleration of free fall on the Moon is one-sixth of that on Earth.

On Earth it takes time *t* for a stone to fall from rest a distance of 2 m.

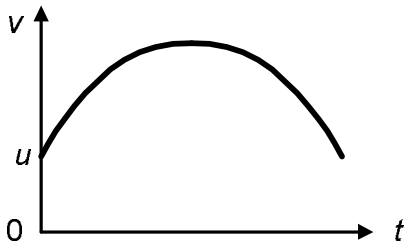
What is the time taken for a stone to fall from rest the same distance on the Moon?

**A** $\frac{1}{6}t$ **B** $\frac{1}{\sqrt{6}}t$ **C** $\sqrt{6}t$ **D** $6\,t$

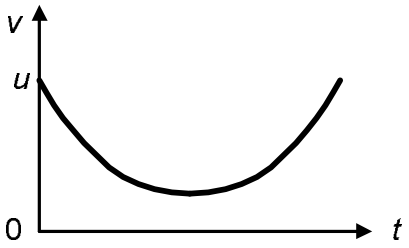
**5** A projectile is fired at an angle above the horizontal with an initial speed $u$.

Which one of the following graphs best represents the subsequent variation of speed $v$ of the projectile with time $t$?

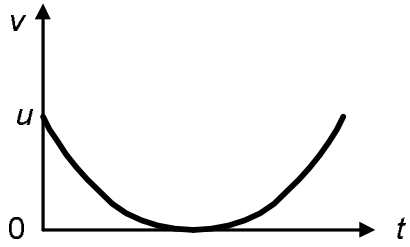
**A**



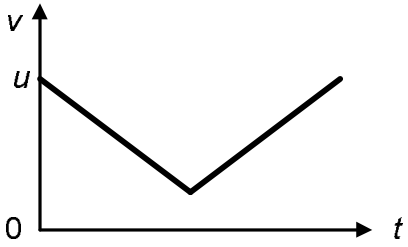

**B**



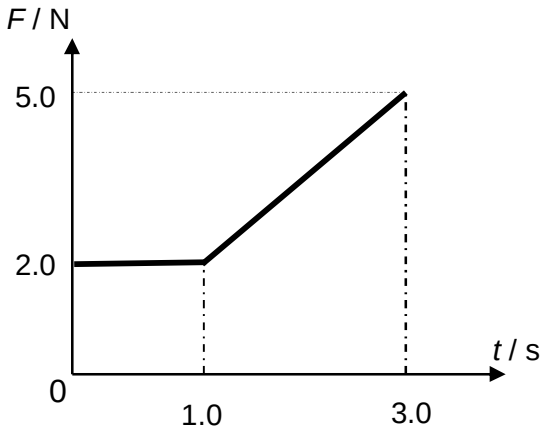

**C**




**D**



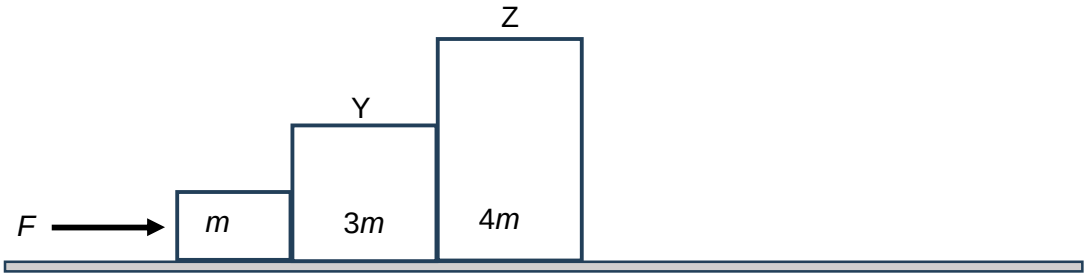
**6** The graph below shows how the force acting on a 2.0 kg body varies with time.




The body is initially moving in a straight line at 2.0 m $s^{-1}$, and the force is applied on the body in the direction of its motion. What is the speed of the body at the end of 3.0 s?

**A** 4.0 m $s^{-1}$ **B** 6.5 m $s^{-1}$ **C** 9.0 m $s^{-1}$ **D** 11.0 m $s^{-1}$

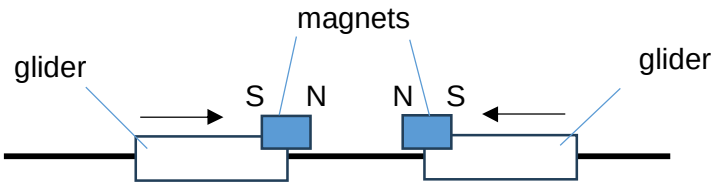
**7** Three blocks X, Y and Z, of masses *m*, 3*m* and 4*m* respectively, are accelerated along a smooth horizontal surface by a force *F* applied to block X as shown.




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

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

**8** Two gliders of equal mass, each fitted with a magnet, move along a linear air track without friction.




They move towards each other with equal initial speeds. As they approach, the magnets repel each other. Each glider decelerates to rest, then accelerates and moves off in the opposite direction.

Which statement is true throughout the whole motion?

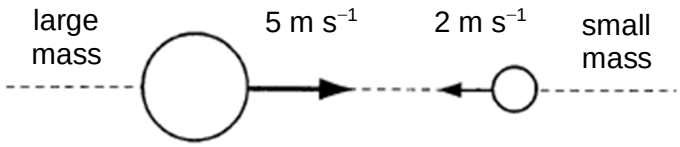
**A** Momentum is conserved because no external force acts on the gliders.

**B** Momentum is not conserved because, at the instant of the closest approach, both gliders are at rest.

**C** Kinetic energy is conserved because none is converted to heat.

**D** Kinetic energy is not conserved because neither moves at constant speed.

**9** A large mass moving at a velocity of 5 m $s^{-1}$ collides head-on with a small mass moving at a velocity of 2 m $s^{-1}$ in the opposite direction.



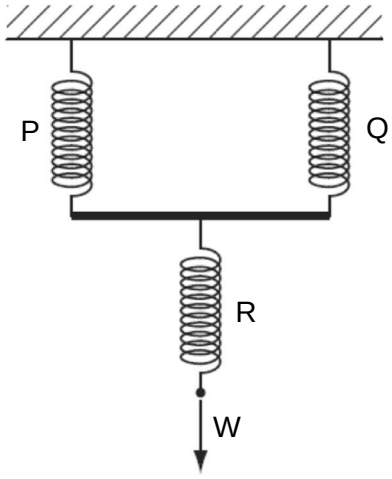

The collision is elastic.

After the collision, both masses move to the right. The large mass has a velocity $v_1$ and the small mass has a velocity $v_2$.

Which pair of values of $v_1$ and $v_2$ is possible?

| | $v_1$ / m $s^{-1}$ | $v_2$ / m $s^{-1}$ |
|---|---|---|
| **A** | 2 | 5 |
| **B** | 3 | 10 |
| **C** | 4 | 4 |
| **D** | 5 | 12 |

**10** Three springs are arranged vertically as shown.

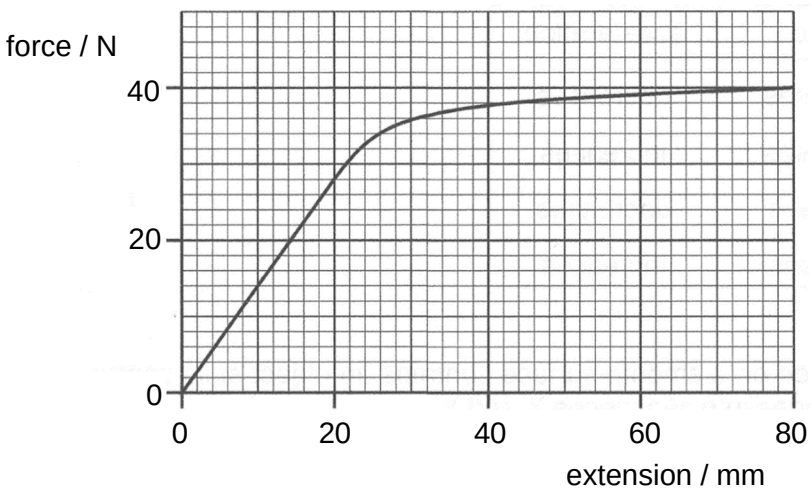



Springs P and Q are identical and have spring constant $k$. Spring R has spring constant $3k$.

What is the increase in the overall length of the arrangement when a force $W$ is applied as shown?

**A** $\frac{5W}{6k}$ **B** $\frac{4W}{3k}$ **C** $\frac{7}{2}kW$ **D** $4\,kW$

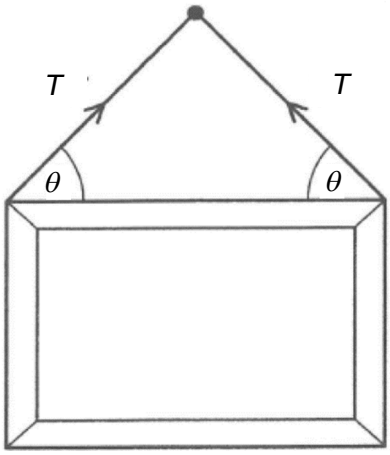
**11** A wire is stretched by an increasing force. A graph of force against extension is shown.




What is the work done in stretching the wire to the first point where it no longer obeys Hooke's Law?

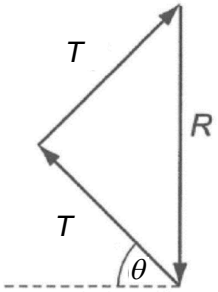
**A** 0.28 J **B** 0.56 J **C** 280 J **D** 2500 J

**12** A picture is hung by a cord from a nail.

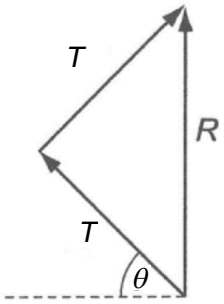



Which vector triangle represents the resultant force *R* of the two tension forces *T* in the cords?

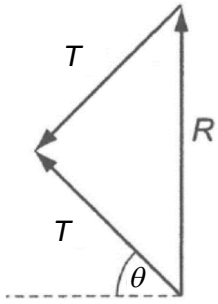
**A**



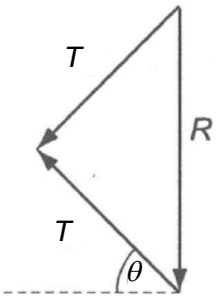

**B**




**C**




**D**



**13** A raindrop of mass m is falling vertically through the air with a steady speed *v.* The raindrop experiences a retarding force *kv* due to the air, where *k* is a constant. The acceleration of free fall is *g.* Which expression gives the kinetic energy of the raindrop?

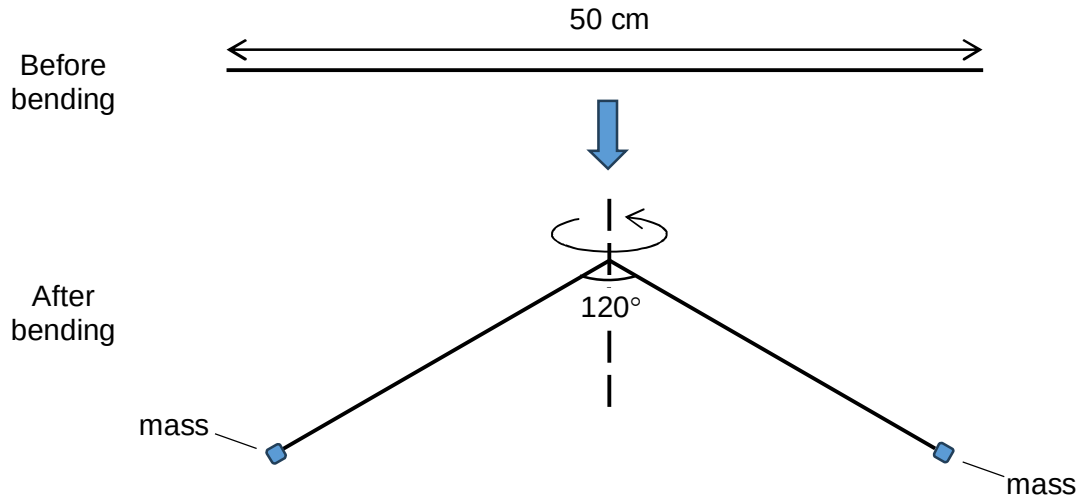
**A** $\frac{mg}{k}$ **B** $\frac{mg^2}{2k^2}$ **C** $\frac{m^3g^2}{k^2}$ **D** $\frac{m^3g^2}{2k^2}$

**14** A car travels along a road at a constant speed of 20 m $s^{-1}$. Its power output is 23 kW. The total frictional force on the car is proportional to the square of its speed.

What power will be required to travel at a constant speed of 40 m $s^{-1}$?

**A** 46 kW **B** 92 kW **C** 184 kW **D** 368 kW

**15** A 50 cm long metal wire is bent at its centre, with an angle 120° between the two halves. Two objects, of equal mass, are attached to the wire, one on each end, as shown in the diagram below. The two masses are on the same level.

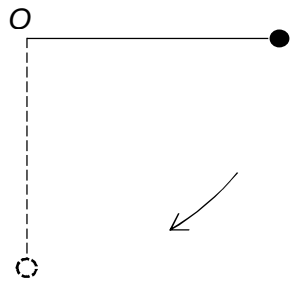



The setup is made to rotate about the vertical axis through the centre of wire, with an angular speed 5.0 rev $min^{-1}$.

What is the acceleration of the masses?

**A** 0.034 m $s^{-2}$ **B** 0.059 m $s^{-2}$ **C** 3.1 m $s^{-2}$ **D** 5.4 m $s^{-2}$

**16** A small ball is attached to one end of a string. The other end of the string is fixed at point *O*, as shown in the diagram below. The mass of the ball is *m*.

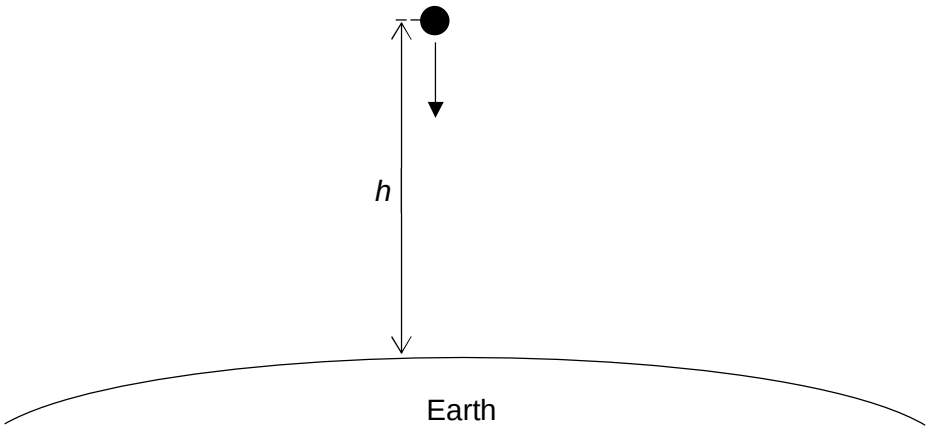



The ball is lifted to the same level as point *O*, with the string being just taut. It is then released from rest.

What is the tension in the string, when the ball is at its lowest position?

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

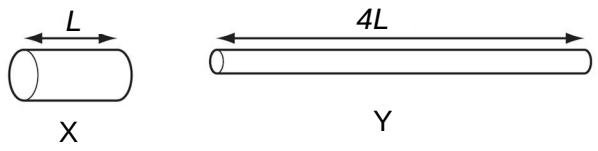
**17** A small object falls vertically from a distance *h* above the surface of the earth, as shown in the diagram below. The gravitational acceleration at each point is *g*, and the radius of the Earth is *R*.




Which expression must be a constant?

**A** $g$ **B** $gh$ **C** $g(h+R)$ **D** $g(h+R)^2$

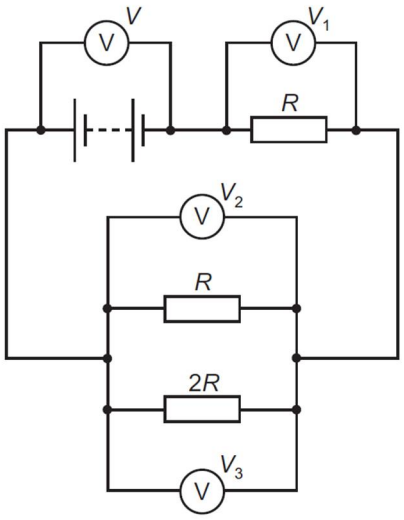
**18** Two copper wires X and Y have the same volume. Wire Y is four times as long as wire X.




What is the ratio $\frac{\text{resistance of wire Y}}{\text{resistance of wire X}}$?

**A** 4 **B** 8 **C** 16 **D** 64

**19** The diagram shows a circuit with four voltmeter readings $V$, $V_1$, $V_2$ and $V_3$.




Which equation relating the voltmeter readings must be true?

**A** $V = V_1 + V_2 + V_3$

**B** $V + V_1 = V_2 + V_3$

**C** $V_3 = 2\ (V_2)$

**D** $V - V_1 = V_3$

**20** The potential difference across a resistor is 12 V. The current in the resistor is 2.0 A.

What is the rate of energy dissipated in the resistor?

**A** 6.0 W

**B** 24 W

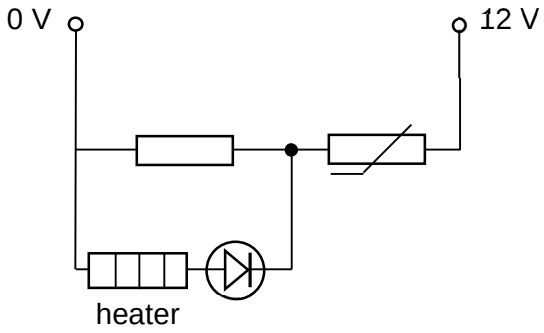
**C** 48 W

**D** 72 W

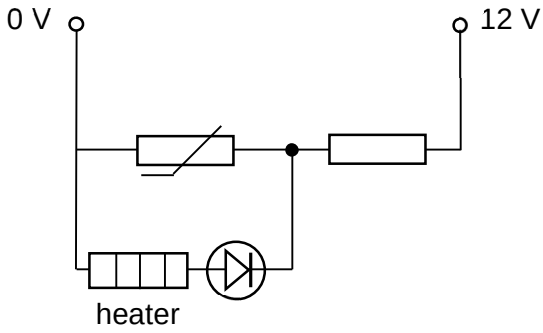
**21** A circuit consists of a negative-temperature-coefficient (NTC) thermistor, a fixed resistor and a heater.

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

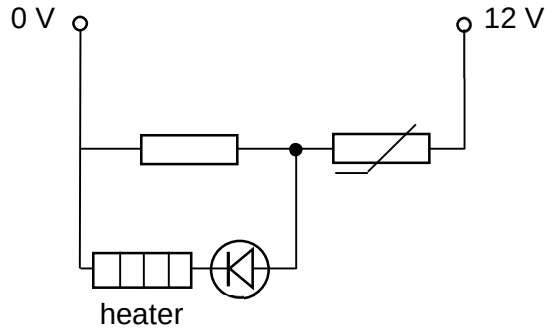
**A**



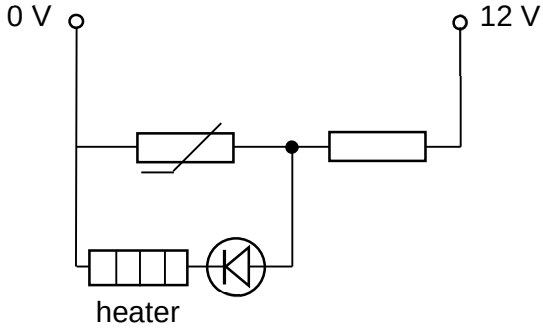

**B**




**C**



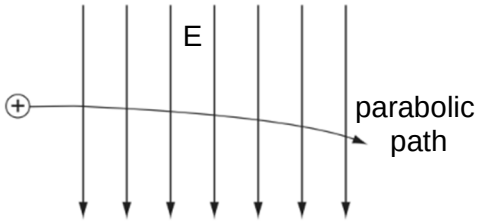

**D**



**22** A positively charged particle is projected into a region of uniform electric field E. Which diagram represents the motion of the particle in the electric field?

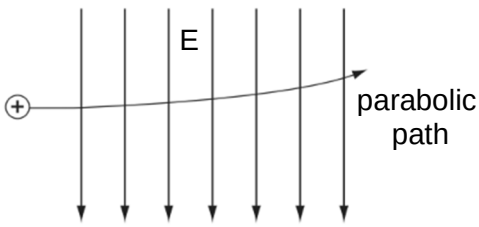
**A**

electric field in the plane of the paper



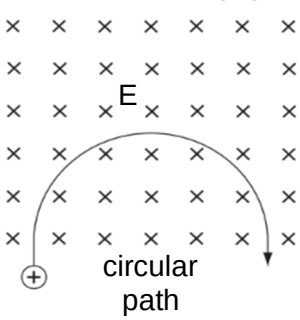

**B**

electric field in the plane of the paper



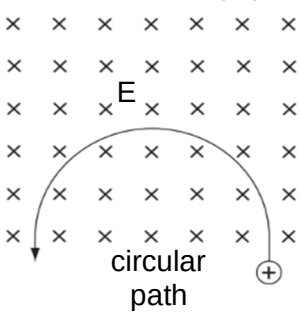

**C**

electric field into paper

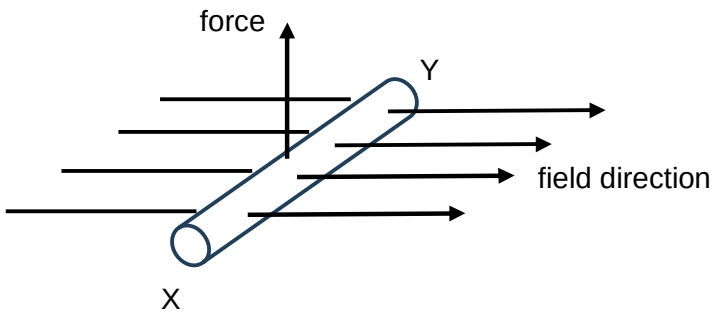



**D**

electric field into paper



**23** A current-carrying conductor is placed at right-angles to a uniform magnetic field of flux density 0.5 T. A 10 cm length of the conductor lies within the field and the experiences a force of $2.4 \times 10^{-2}$ N in the direction as shown.

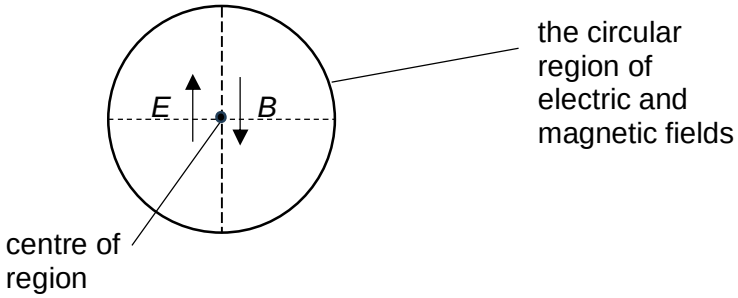



What is the magnitude and direction of the current in the conductor?

| | magnitude / A | direction |
|---|---|---|
| **A** | 0.0048 | X to Y |
| **B** | 0.0048 | Y to X |
| **C** | 0.48 | X to Y |
| **D** | 0.48 | Y to X |

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

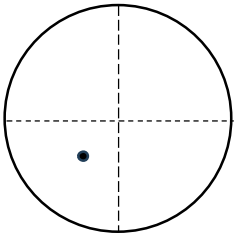
Subsequently, the electric and magnetic fields are directed within a circular region in directions as shown by the arrows in the diagram below.



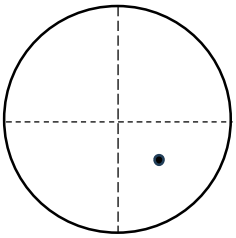

The deflections of the beam from the centre of the region produced by the electric field *E* and the magnetic field *B* acting separately are equal in magnitude.

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

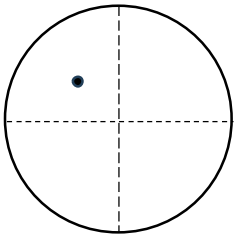
**A**



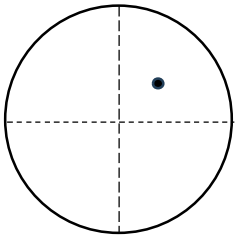
**B**



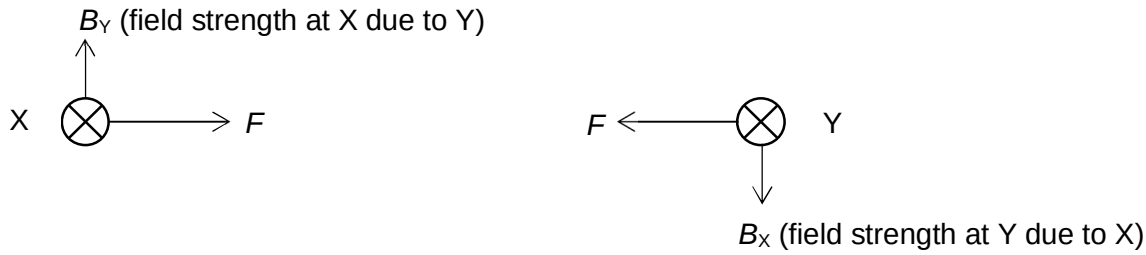
**C**



**D**

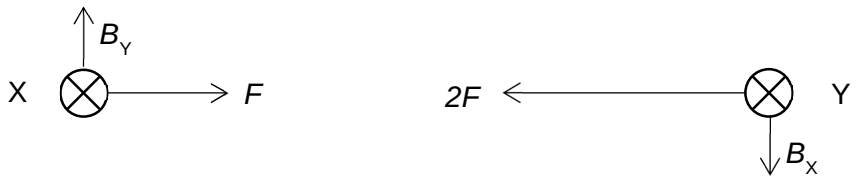


**25** Two long, parallel, straight wires X and Y carry equal currents into the plane of the page as shown. The diagram shows arrows representing the magnetic field strength $B$ at the position of each wire and the magnetic force $F$ on each wire.

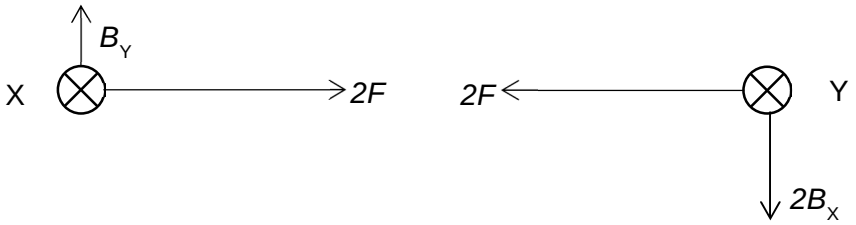



The current in wire Y is doubled. Which diagram best represents the magnetic field strengths and forces?

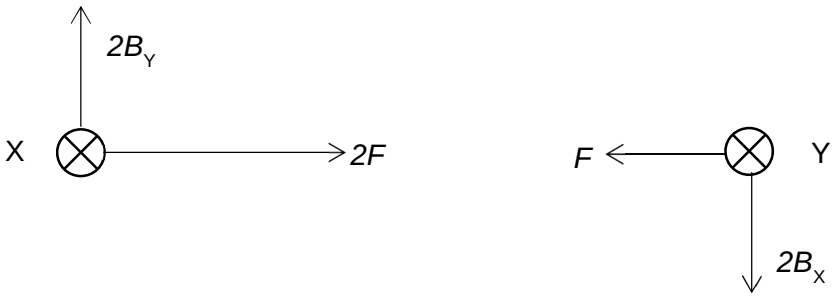
**A**



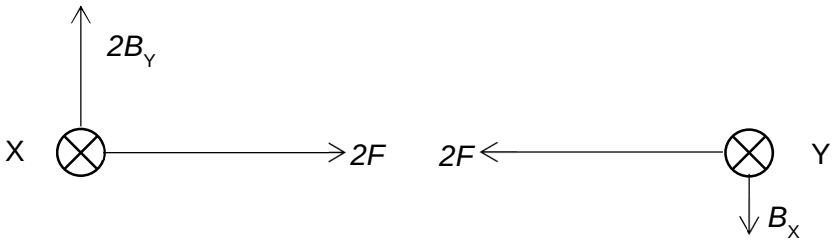

**B**



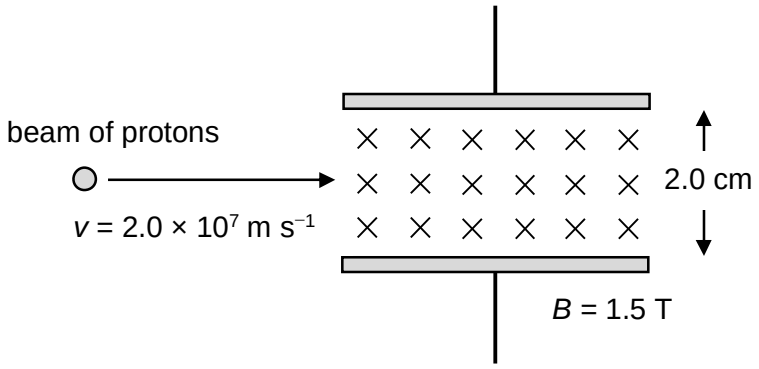

**C**




**D**



**26** A beam of protons passes through a cross field, set up by an electric field and a magnetic field that are perpendicular to each other. The electric field is set up by a pair of charged plates with a plate separation of 2.0 cm as shown in the diagram below. The magnetic flux density, $B$ is 1.5 T and directed into the plane of the paper.




If protons travelling at $2.0 \times 10^7$ m s$^{-1}$ pass through undeflected, what would be the direction and magnitude of the electric field?

| | direction | magnitude |
|---|---|---|
| **A** | downwards | $6.0 \times 10^5$ N C$^{-1}$ |
| **B** | upwards | $6.0 \times 10^5$ N C$^{-1}$ |
| **C** | downwards | $3.0 \times 10^7$ N C$^{-1}$ |
| **D** | upwards | $3.0 \times 10^7$ N C$^{-1}$ |

**27** Which of the following combinations of radioactive decay results in the formation of an isotope of the original nucleus?

**A** one $\alpha$ and four $\beta$ decays

**B** one $\alpha$ and two $\beta$ decays

**C** two $\alpha$ and two $\beta$ decays

**D** four $\alpha$ and one $\beta$ decays

**28** The nucleus Z has the notation ${}^{x}_{y}Z$.

The mass defect of this nucleus is $\Delta m$.

What is the binding energy per nucleon of the nucleus?

**A** $\frac{\Delta m}{x}$ **B** $\frac{\Delta m}{y}$ **C** $\frac{c^2 \Delta m}{x}$ **D** $\frac{c^2 \Delta m}{y}$

**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:

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

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

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

**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