**HWA CHONG INSTITUTION**
**JC2 Preliminary Examinations**
**Higher 1**

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|---|---|---|---|
| **CANDIDATE NAME** | | **CT GROUP** | **23S** |
| **CENTRE NUMBER** | | **INDEX NUMBER** | |

# PHYSICS

**8867/01**

**Paper 1 Multiple Choice**

**17 September 2024**

**60 minutes**

Additional Materials: Optical Mark Sheet

**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.

**Data**

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

permeability of free space,

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, $s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

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

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

.

**1** A thermometer can be read to an accuracy of ±0.5 °C. This thermometer is used to measure a temperature rise from 20 °C to 80 °C.

What is the percentage uncertainty in the measurement of the temperature rise?

**A** 0.5 % **B** 0.8 % **C** 1.3 % **D** 1.7%

**2** The intensity of a beam is defined as the power delivered per unit area.

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

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

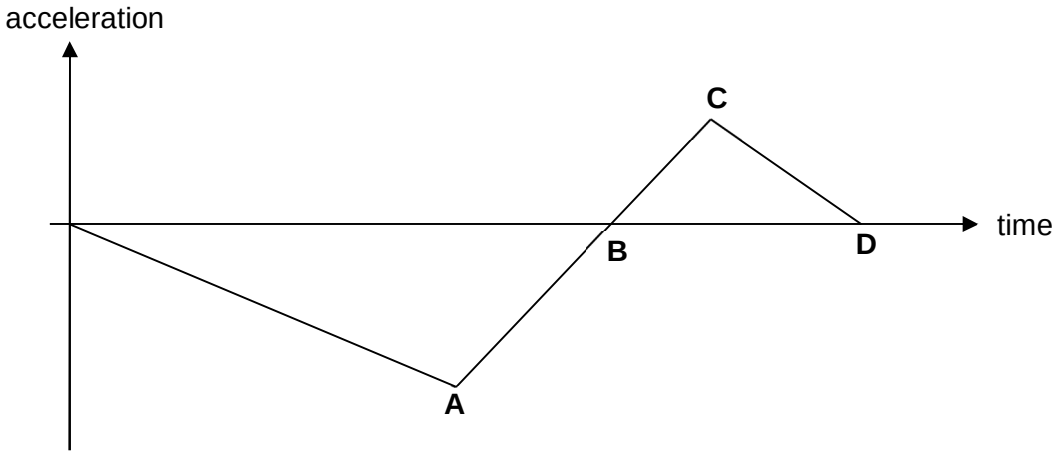
**3** Which one of the following groups contains three vector quantities?

**A** displacement, velocity, energy **B** displacement, velocity, momentum

**C** velocity, acceleration, power **D** force, work, energy

**4** The acceleration−time graph of an object moving along a straight line is shown below. The object was initially at rest.

At which point on the graph is the object at the largest distance from the starting point?




**5** An elevator is moving downwards with a downward acceleration of 5.8 m $s^{-2}$. A ball, held 2.0 m above the floor of the elevator and at rest with respect to the elevator, is released.

How long does it take for the ball to reach the floor of the elevator?

**A** 0.51 s **B** 0.64 s **C** 0.83 s **D** 1.00 s

**6** A tennis ball is projected with an initial speed of 10.0 m $s^{-1}$ at an angle of 30° above the horizontal. The ball is moving towards a vertical wall, which is located a horizontal distance 10.0 m away from the initial point.

What is the speed of the ball when it hits the wall?

**A** 1.15 m $s^{-1}$ **B** 6.33 m $s^{-1}$ **C** 8.06 m $s^{-1}$ **D** 10.7 m $s^{-1}$

**7** A thruster is used to launch a 500-kg rocket vertically upward from rest. This thruster ejects exhaust at a speed of 1000 m $s^{-1}$.

What should be the minimum rate, in kg $s^{-1}$, at which the exhaust should leave the thruster at the instant of launch?

**A** 0.5 **B** 2.0 **C** 4.9 **D** 20

**8** Two steel balls X and Y are suspended on strings. Ball X is pulled one side as shown.

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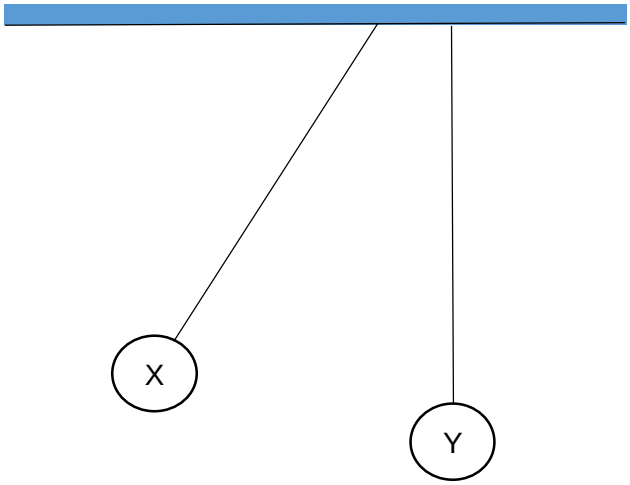



After ball X is released, the balls collide.

Which quantities must be conserved in the collision?

**A** kinetic energy, total energy and momentum

**B** kinetic energy and momentum only

**C** kinetic energy and total energy only

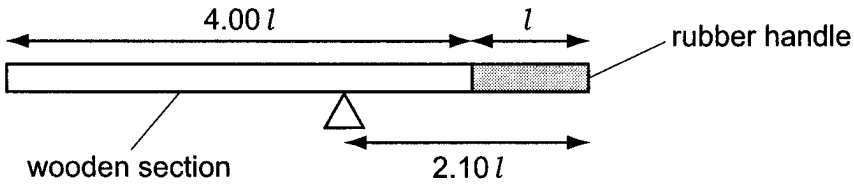
**D** total energy and momentum only

**9** Two bodies, P and Q, are travelling towards one another on a level frictionless track at speeds 4.0 m $s^{-1}$ and 2.0 m $s^{-1}$ respectively. Body P has a mass of 2.0 kg and body Q has a mass of 3.0 kg.


If the collision between the bodies is perfectly elastic, what is the speed of P, in m $s^{-1}$, after the collision?

**A** 0 **B** 2.0 **C** 3.2 **D** 4.0

**10** A uniform rod has a wooden section and a solid rubber handle as shown in the diagram below.

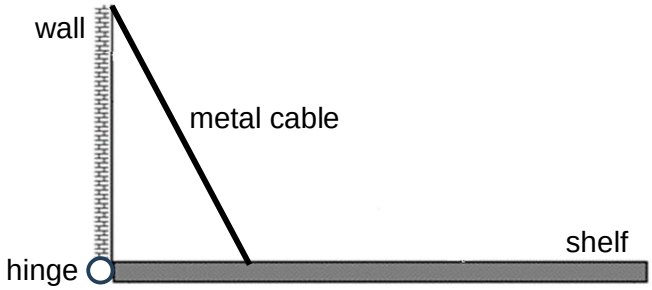



The length of the handle is $l$ and the length of the wooden section is 4.00 $l$. The rod balances a distance 2.10 $l$ from the rubber end.

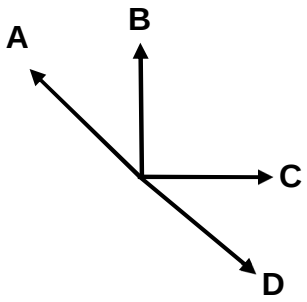
What is the ratio $\frac{\text{density of rubber}}{\text{density of wood}}$ ?

**A** 1.71 **B** 2.25 **C** 2.50 **D** 3.27

**11** A shelf made of uniform material is held horizontally against a wall by a metal cable as shown in the diagram below. The forces acting on the shelf are its weight, the force exerted by the metal cable, and the force exerted by the hinge.




Which arrow could represent the direction of the force the hinge exerts on the shelf?



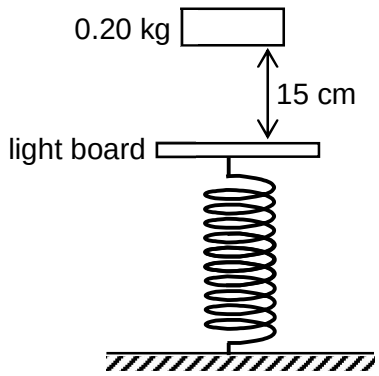

**12** The spring suspension system of a car obeys Hooke's Law.

The following data are provided:
Mass of passengers: 450 kg
Mass of car and passengers: 2000 kg
Difference in height of car when passengers alight: 0.10 m

What is the force constant *k* of the spring suspension system?

**A** 4500 N $m^{-1}$ **B** 15500 N $m^{-1}$ **C** 44100 N $m^{-1}$ **D** 152000 N $m^{-1}$

**13** A block of 0.20 kg is dropped from a height of 15 cm above a light spring of spring constant 85 N m$^{-1}$, as shown in the diagram below. The block lands on the light board and compresses the spring.




What is the maximum compression of the spring?

**A** 2.4 cm **B** 4.6 cm **C** 8.3 cm **D** 11 cm

**14** A speed boat with two engines, each of power 32 kW, can travel at a maximum speed of 14 m s$^{-1}$. The total drag force on the boat is directly proportional to the speed of the boat.

What is the maximum speed of the boat when only one engine is working?

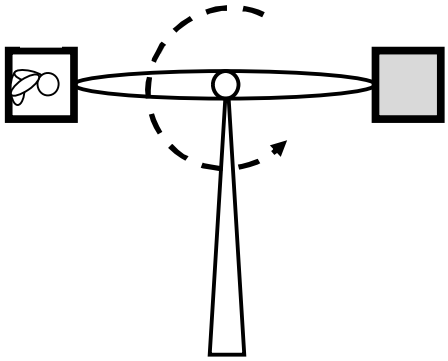
**A** 3.5 m s$^{-1}$ **B** 7.0 m s$^{-1}$ **C** 9.9 m s$^{-1}$ **D** 11 m s$^{-1}$

**15** The driving force $F$ on a car of mass $m$ causes the car to accelerate. In a time $t$ it travels a distance $s$ and its speed increases from $u$ to $v$.

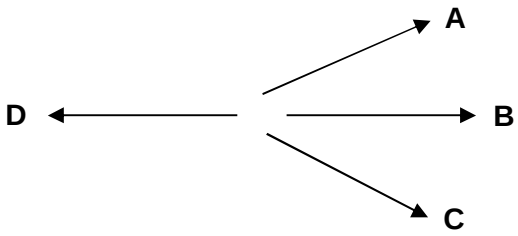
What is the useful work done by the car engine?

**A** $\frac{Fs}{t}$ **B** $m(v-u)$ **C** $Ft$ **D** $\frac{m(v^2-u^2)}{2}$

**16** In an amusement park ride, a person sits in a cage which moves in a vertical circle at a constant speed. The person stays stationary with respect to the cage.



At the instant shown, what is the direction of the force exerted by the cage on the person?




**17** Which statement about a geostationary satellite is true?

**A** It can remain vertically above any chosen fixed point on the Earth.

**B** Its linear speed is equal to the speed of a point on the Earth's equator.

**C** It has the same angular velocity as the Earth's rotation on its axis.

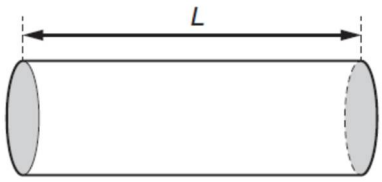
**D** It is always travelling from east to west.

**18** The radius of the Earth's orbit about the Sun is $1.50 \times 10^{11}$ m. The Earth takes 365 days to orbit the Sun.

What is the mass of the Sun?

**A** $6.40 \times 10^{29}$ kg **B** $2.01 \times 10^{30}$ kg **C** $1.16 \times 10^{33}$ kg **D** $3.31 \times 10^{33}$ kg

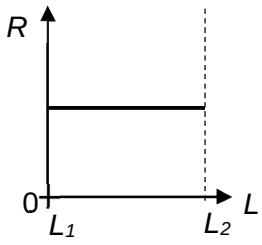
**19** A piece of conducting modelling clay of constant resistivity is formed into a cylindrical shape. The resistance $R$ between its flat ends (shaded) is measured.



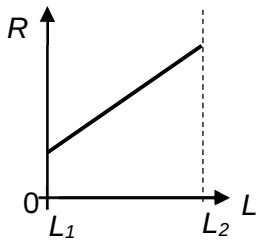

The same volume of modelling clay is re-formed into cylinders of different lengths $L$ in the range of $L_1$ to $L_2$ and the resistance $R$ between the flat ends is measured for each value of $L$.

Which graph best shows the variation of $R$ with $L$?

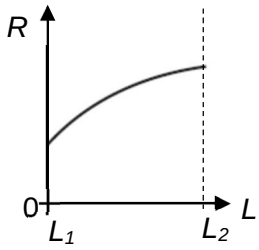
**A**



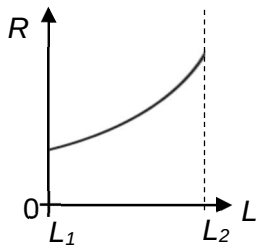

**B**



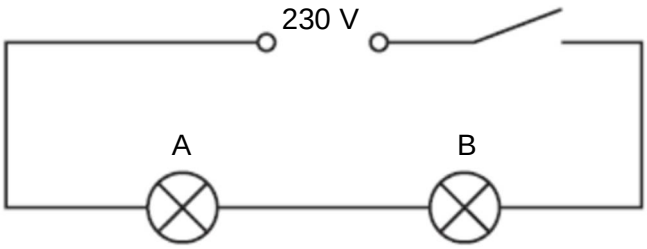

**C**




**D**




**20** In the circuit shown, lamp A is rated 230 V, 10 W, and lamp B is rated 230 V, 40 W. The two lamps are connected in series to a 230 V power supply.




Assume that the resistance of each lamp remains constant.

Which statement most accurately describes what happens when the switch is closed?

**A** Lamp A emits twice as much power as lamp B.

**B** Lamp A emits four times as much power as lamp B.

**C** Lamp B emits twice as much power as lamp A.

**D** Lamp B emits four times as much power as lamp A.

**21** A cell of e.m.f. $E$ delivers a charge $Q$ to an external circuit.

Which statement is correct?

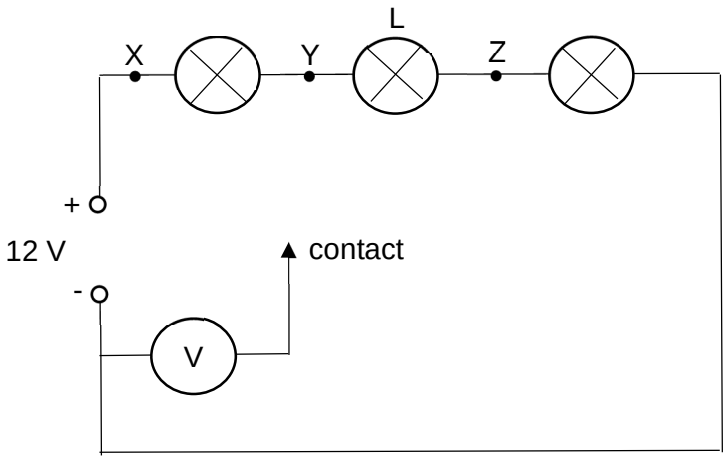
**A** The energy dissipation in the external circuit is $EQ$.

**B** The energy dissipation within the cell is $EQ$.

**C** The external resistance is $EQ$.

**D** The total energy dissipation in the cell and the external circuit is $EQ$.

**22** The diagram shows three lamps in series with a 12 V supply.

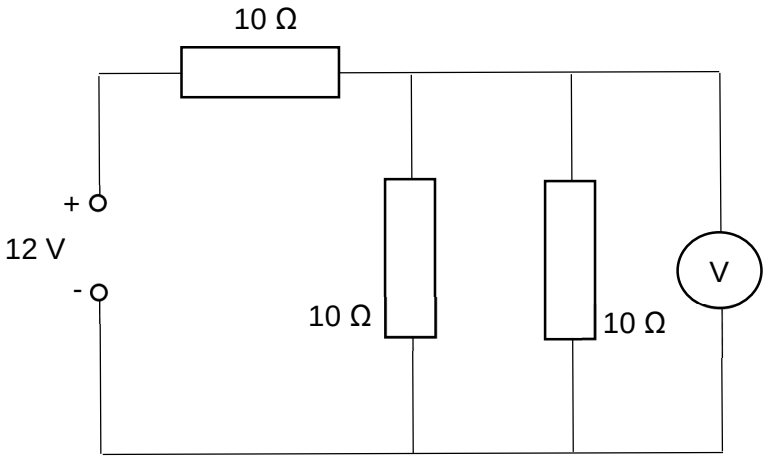



To test the circuit, the contact is connected in turn to points X, Y and Z. The lamps **do not light up** because lamp L has a broken filament.

Which line of the table below shows the readings of the voltmeter?

| | **reading at X** | **reading at Y** | **reading at Z** |
|---|---|---|---|
| **A** | 12 V | 8 V | 4 V |
| **B** | 8 V | 8 V | 0 V |
| **C** | 12 V | 12 V | 0 V |
| **D** | 8 V | 12 V | 4 V |

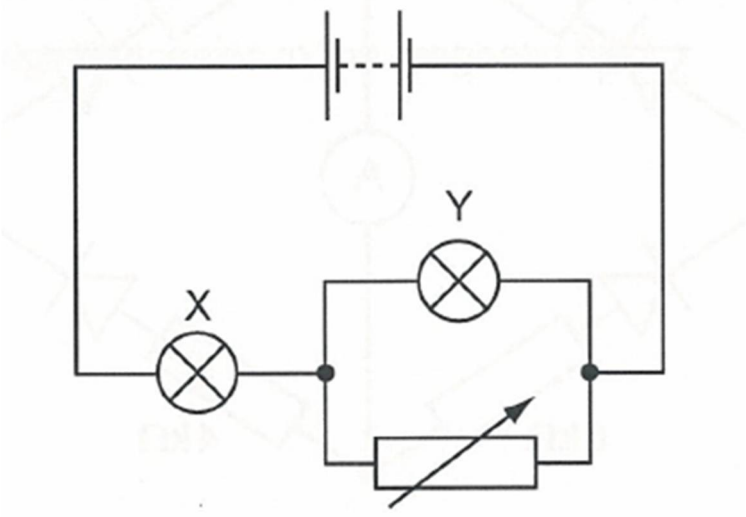
**23** In the circuit shown, the voltmeter has infinite resistance.




What is the voltmeter reading?

**A** 3 V **B** 4 V **C** 6 V **D** 8 V

**24** A circuit contains a battery, two identical lamps X and Y, and a variable resistor.

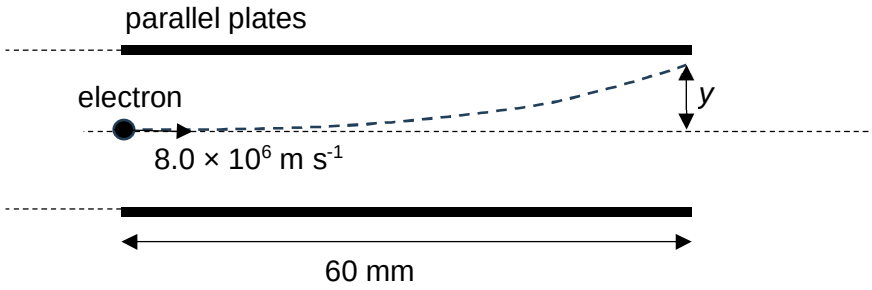



The resistance of the variable resistor is decreased.

What will happen to the brightness of the lamps?

| | **lamp X** | **lamp Y** |
|---|---|---|
| **A** | brighter | brighter |
| **B** | brighter | less bright |
| **C** | less bright | brighter |
| **D** | less bright | less bright |

**25** A uniform electric field of magnitude 1500 V $m^{-1}$ is set up between two parallel plates of length 60 mm. An electron is projected horizontally into the electric field with a speed of $8.0 \times 10^6$ m $s^{-1}$.

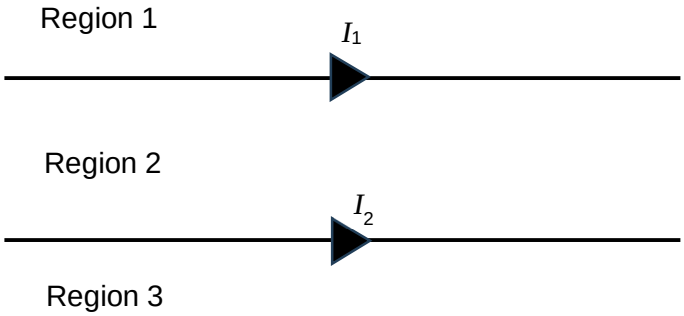



Calculate the vertical displacement *y* of the electron when it exits the plates.

**A** 0.93 mm **B** 1.9 mm **C** 3.7 mm **D** 7.4 mm

**26** Two long straight and parallel wires carrying currents in the same direction separate the surrounding space into three regions 1, 2 and 3.

In which region(s) can there be a neutral point (i.e., a point of zero magnetic field strength)?



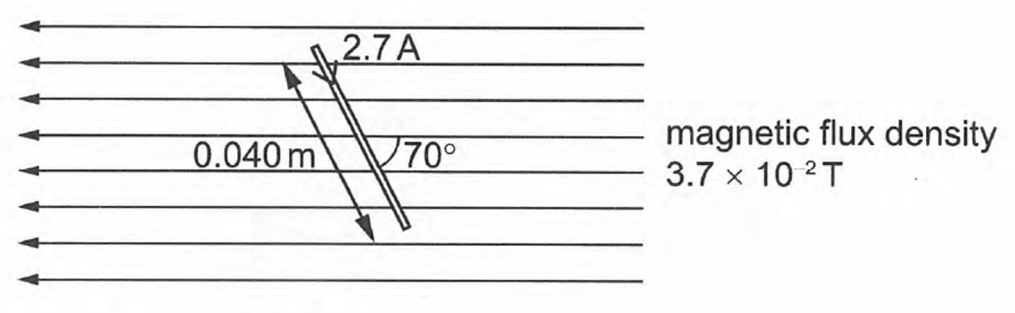

**A** Region 2 only

**B** Both regions 1 and 3

**C** Either region 1 or region 3 but not both

**D** There are no neutral points

**27** A wire of length 0.040 m is at an angle of 70° to a magnetic field of flux density $3.7 \times 10^{-2}$ T, as shown.




The current through the wire is 2.7 A.

What is the force on the wire and the direction in which the force acts?

| | force on the wire / N | direction in which the force acts |
|---|---|---|
| **A** | $1.4 \times 10^{-3}$ | into the paper |
| **B** | $1.4 \times 10^{-3}$ | out of the paper |
| **C** | $3.8 \times 10^{-3}$ | out of the paper |
| **D** | $3.8 \times 10^{-3}$ | into the paper |

**28** A detector of ionizing radiation gives a background count rate of 24 per minute. A radioactive source is placed close to the detector and the reading is 532 counts per minute.

What will be the reading after two half-lives of the source?

**A** 127 **B** 133 **C** 151 **D** 157

**29** Two deuterium nuclei undergo a fusion reaction to form a helium nucleus represented by

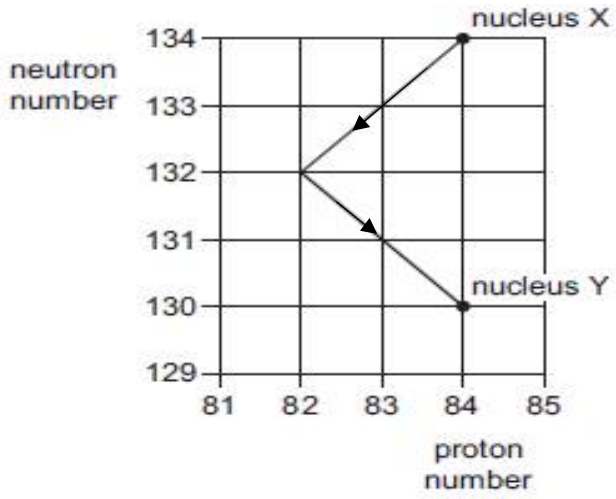
$$^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He} + \text{energy}$$

The binding energy per nucleon of helium is 2.54 MeV.
The minimum amount of energy released in this reaction is 3.26 MeV.

What is the binding energy per nucleon of deuterium?

**A** 1.73 MeV **B** 2.18 MeV **C** 2.72 MeV **D** 3.45 MeV

**30** The graph of neutron number against proton number represents a sequence of radioactive decays.




Nucleus **X** is at the start of the sequence and, after the decays have occurred, nucleus **Y** is formed.

What are emitted during the sequence of decays?

**A** one α-particle followed by one β-particle

**B** one α-particle followed by two β-particles

**C** two α-particles followed by two β-particles

**D** two β-particles followed by one α-particle

**END OF PAPER**