VICTORIA JUNIOR COLLEGE
2024 JC2 PRELIMINARY EXAMINATION
Higher 1

PHYSICS 8867/01

Paper 1 Multiple Choice **20 September 2024**

FRIDAY

Additional Materials: Multiple Choice Answer Sheet **2.30 pm to 3.30 pm (1 hour)**

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name and Civics Group on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE ON ANY BARCODES.

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 Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

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}
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's 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. Which one of the following estimates is unrealistic?

A The potential energy of a man at the top of Bukit Timah Hill is 100 kJ.
B The volume of air in a classroom is 150 m^3.
C The mass of an apple is 100 g
D The average temperature of fire is 300 K.

2. The rate of energy transfer, *H* through a conducting slab is found experimentally to be given by

$$H = kA\frac{\Delta T}{l}$$

where the proportionality constant *k* is the thermal conductivity of the material, *A* is the cross-sectional area of the slab, *l* is the length of the slab and ΔT is the temperature difference at opposite faces of the slab. Which of the following are the base units of k?

A kg m^2 s^{-2} K^{-1}
B kg m s^{-3} K^{-1}
C kg m s^{-2} K^{-1}
D unitless

3. Two projectiles are fired from a gun as shown in Fig. 3.

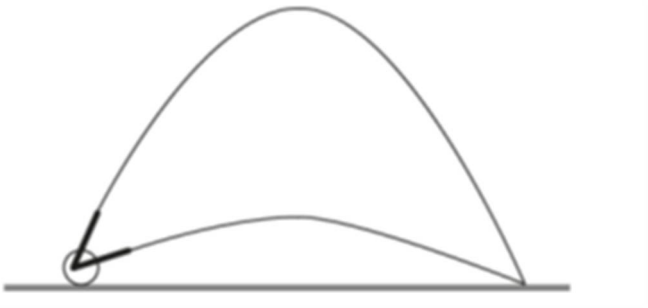


Fig. 3

The first projectile leaves the gun at a velocity of 140 m s^{-1} at an angle to the horizontal of 75°. The second projectile is fired from the gun at the same position with the same speed but at an angle of 15°. How much time later should the second projectile be fired so that both projectiles land at the same point on the ground at the same time? Ignore the effects of air resistance.

A 10 s **B** 15 s **C** 20 s **D** 30 s

4. The velocity- time graph of a particle moving in a straight line is shown in Fig. 4

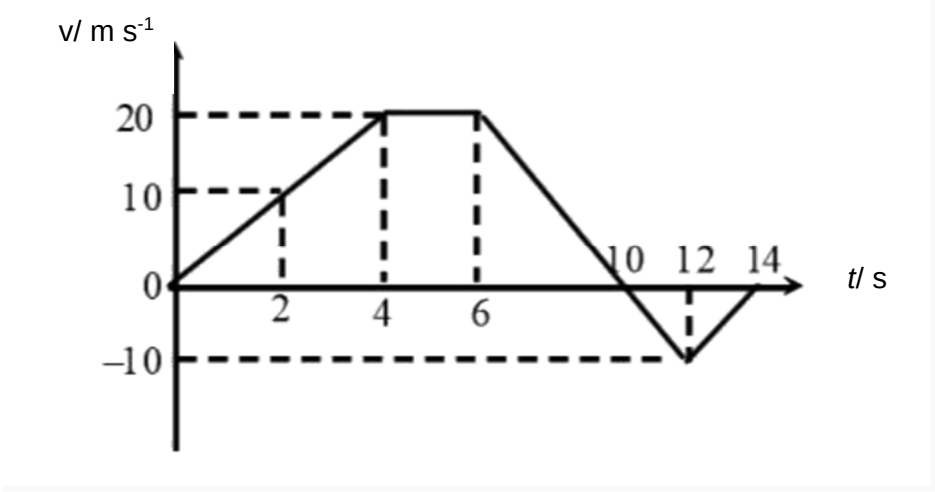


Fig. 4

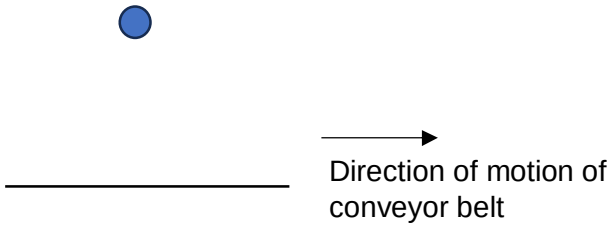
What are the average speed and velocity of the particle between time t = 0 and t = 14 s?

	Average speed / m s^{-1}	Average velocity / m s^{-1}
A	7.1	7.1
B	7.1	10
C	10	7.1
D	10	10

5. An aeroplane, flying in a straight line at a constant height of 500 m with a speed of 200 m s^{-1}, drops an object. The object takes a time t to reach the ground and travels a horizontal distance d in doing so. Ignoring air resistance, which one of the following gives the values of t and d?

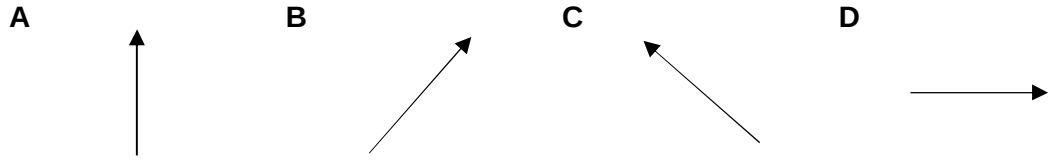
	t /s	d /km
A	25	10
B	25	5
C	10	5
D	10	2

6. A ball falls vertically and bounces on a moving conveyor belt.

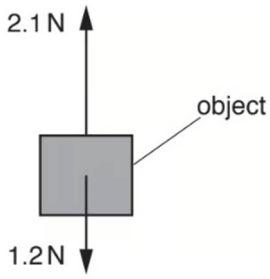


What is the direction of the resultant force due to the conveyor belt acting on the ball?

A **B** **C** **D**



7. The diagram shows two opposite vertical forces of magnitude 1.2 N and 2.1 N acting on an object.



Which of the following statements is wrong?

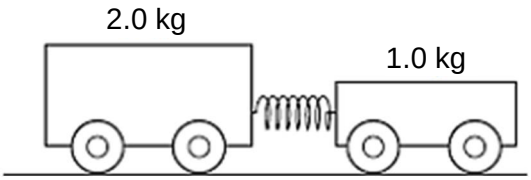
A The magnitude of the resultant force is 0.9 N.

B The object is accelerating and moving up.

C The object is decelerating and moving up.

D The object is decelerating and moving down.

8. Two trolleys are placed together on a horizontal runway with a compressed spring between them.



When they are released, the 2.0 kg trolley moves to the left at 2.0 m s^{-1}.

How much energy was stored in the spring?

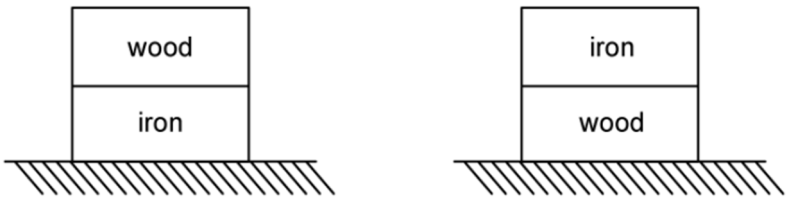
A 4.0 J **B** 6.0 J **C** 8.0 J **D** 12 J

9. A steel spring was stretched to a length of 58 cm when a 30 N weight was hung from it. The same spring was stretched to a length of 72 cm when a 51 N weight was hung from it.

What was the original length of the spring?

A 15 cm **B** 38 cm **C** 44 cm **D** 61 cm

10. Two blocks, one made of wood and the other of iron, are arranged at rest on the ground.



(1) (2)

Which of the following statements is correct?

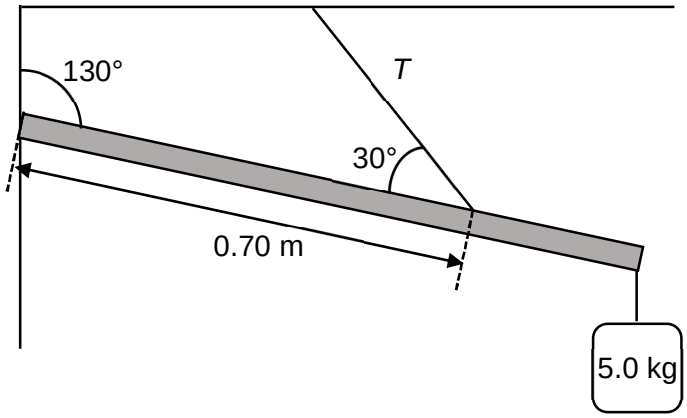
A The force exerted by the ground on the iron block in (1) is greater than the force exerted by the ground on the wooden block in (2) because the iron block, being denser than the wooden block, exerts more force on the ground.

B The force exerted by the wooden block on the iron block in (1) is equal to that exerted by the iron block on the wooden block in (2).

C The force exerted by the iron block on the wooden block in (1) is bigger than that exerted by the wooden block on the iron block in (2).

D The force exerted by the wooden block on the iron block in (1) is smaller than the force exerted by the ground on the wooden block in (2).

11. A 1.0 m long uniform beam has a mass of 2.0 kg and has a further mass of 5.0 kg attached at the end. It is in contact with a wall on one side and is supported by a wire at an angle of 30° to the beam. The beam is in equilibrium.



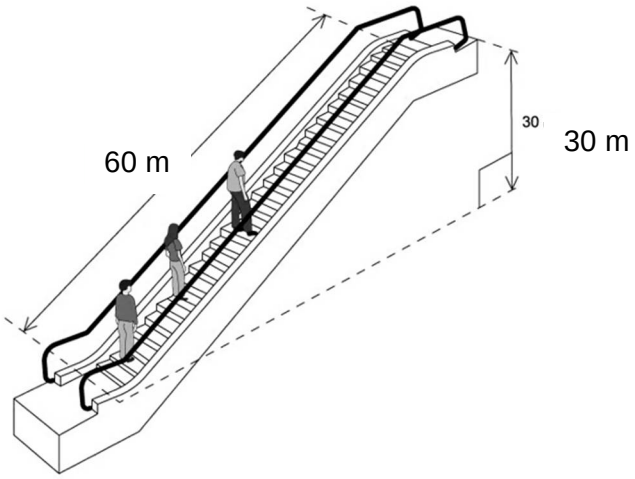
What is the tension, *T*, in the wire?

A 69 N **B** 84 N **C** 110 N **D** 130 N

12. Which row in the table gives the gravitational potential energy, the elastic potential energy and the kinetic energy of a bungee jumper during the first fall? Air resistance is negligible.

		Gravitational potential energy/ kJ	Elastic potential energy/ kJ	Kinetic energy/kJ
A	top middle bottom	120 60 0	0 10 120	0 50 0
B	top middle bottom	120 60 0	0 30 60	0 30 60
C	top middle bottom	120 60 0	0 30 120	0 60 0
D	top middle bottom	120 60 0	0 60 120	0 0 0

13. An escalator is 60 m long and lifts passengers through a vertical height of 30 m, as shown.



To drive the escalator against the forces of friction when there are no passengers requires a power of 2.0 kW.

The escalator is used by passengers of average mass 60 kg and the power to overcome friction remains constant.

How much power is required to drive the escalator when it is carrying 20 passengers and is travelling at 0.75 m s^{-1}?

A 4.4 kW

B 6.4 kW

C 8.8 kW

D 10.8 kW

14. A turntable is rotating at a constant number of revolutions per second. What is the relationship between the angular velocity of a point on the turntable and the distance of the point from the centre of the turntable?

A Angular velocity is directly proportional to the distance.

B Angular velocity is inversely proportional to the distance.

C Angular velocity is directly proportional to the distance squared.

D Angular velocity is independent of distance.

15. A bird is flying in a horizontal circular path at constant speed. Its wings are inclined at an angle to the horizontal as shown in the diagram.

Which of the following statements about the motion of the bird is correct?

A The kinetic energy of the bird is constant because no work is done.

B The bird is in equilibrium because the upward lifting force on bird balances its weight.

C The momentum of the bird is conserved because there is no net force acting on it.

D The acceleration of the bird is zero because the bird is flying at constant speed.

16. A satellite of mass M is in circular orbit with radius r around the Earth with a period of T. A second satellite of mass $2M$ moves around the Earth with radius $4r$. What is the period of this second satellite in terms of T?

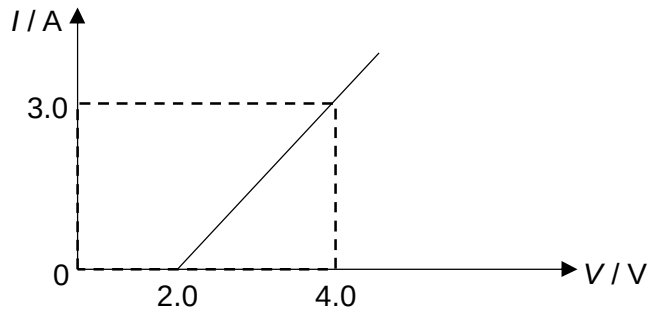
A $\frac{T}{4}$

B $2\,T$

C $4\,T$

D $8\,T$

17. The graph below shows how the current *I* flowing through an electrical device varies with the potential difference *V* applied across it:



What can be said about the resistance of the device as *V* increases?

A It is constant at 1.3 Ω
B It is constant at 0.67 Ω
C It increases
D It decreases

18. A cell is connected in series with a 4.0 Ω resistor and a switch. An ideal voltmeter is connected across the cell.

When the switch is opened, the voltmeter reads 6.0 V. When the switch is closed, the voltmeter reads 5.5 V.

What is the e.m.f. *E* and internal resistance *r* of the cell?

	E / V	*r* / Ω
A	5.5	0.33
B	5.5	0.36
C	6.0	0.33
D	6.0	0.36

19. 'A source has an e.m.f. of 3.0 V.'

What does the above statement mean?

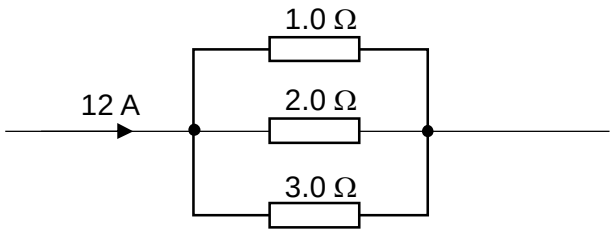
A For every coulomb of charge delivered by the cell, 3.0 J of other forms of energy is changed to electrical energy.

B For every coulomb of charge delivered by the cell, 3.0 J of electrical energy is changed to other forms of energy.

C For every coulomb of charge delivered by the cell, 3.0 J of other forms of energy is changed to electrical energy per second.

D For every coulomb of charge delivered by the cell, 3.0 J of electrical energy is changed to other forms of energy per second.

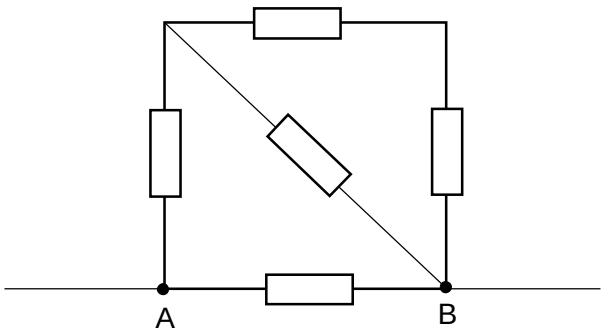
20. A network of 3 resistors is shown below. The total current flowing through the network is 12 A:



What is the current flowing through the 3.0 Ω resistor?

A 2.0 A **B** 2.2 A **C** 4.0 A **D** 7.3 A

21. The diagram below shows a network of resistors, each of resistance 2.0 Ω:



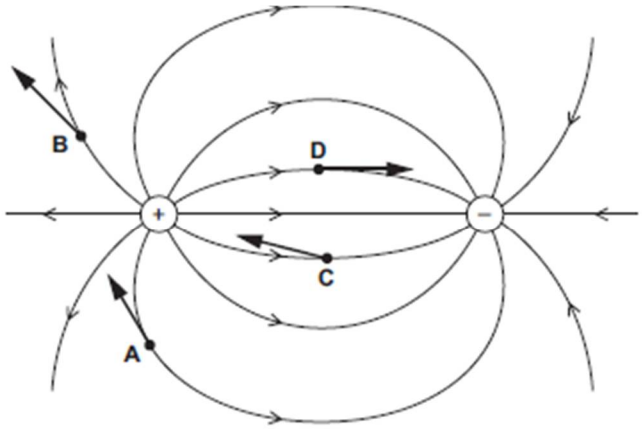
What is the total resistance between the points A and B?

A 1.0 Ω **B** 1.3 Ω **C** 2.0 Ω **D** 2.6 Ω

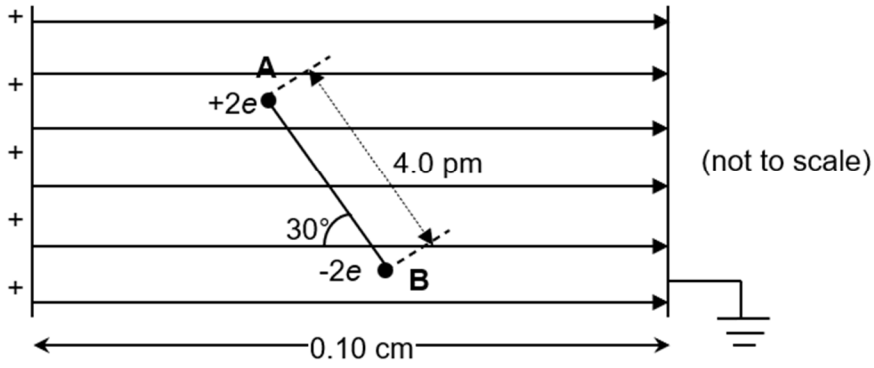
22. The diagram below shows the electric field near a positively charged sphere and a negatively charged sphere.

Four electrons, **A**, **B**, **C** and **D** are shown at different positions in the field.

On which electron is the direction of the force on the electron shown correctly?



23. Two ions **A** and **B,** at a distance of 4.0 pm apart, are linked to form a molecule. They are situated between a pair of charged parallel plates placed a distance of d = 0.10 cm apart. The line joining **A** and **B** is at an angle of 30° to the direction of the electric field as shown in the diagram below.

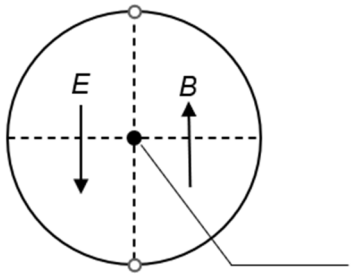


Given that the electric field strength between two parallel plates is 2.0×10^5 N C^{-1}, what is the torque on the molecule **AB**?

A 1.3×10^{-25} N m **B** 2.2×10^{-25} N m

C 2.6×10^{-25} N m **D** 5.1×10^{-25} N m

24. In a cathode-ray oscilloscope tube, the electron beam passes through a region where there is an electric field directed vertically downwards and a magnetic field directed vertically upwards as shown in the diagram below.

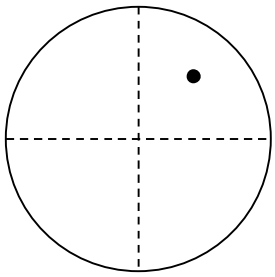


front view of screen

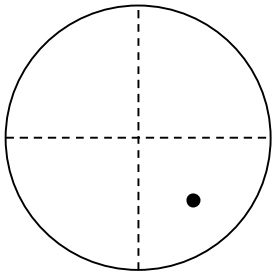
spot created by electron beam when *E* and *B* fields are **not** in operation

Which of the diagrams below shows a possible position of the spot on the screen when both fields are operating together?

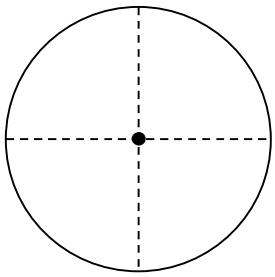
A



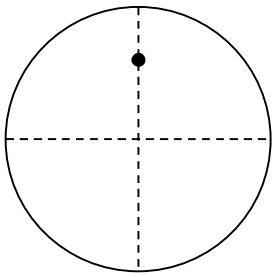
B



C

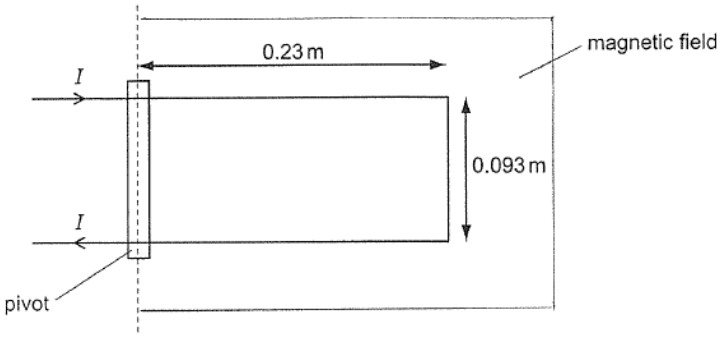


D



25. A current, *I* of magnitude 9.6 mA is passed into a current balance which consists of a U-shaped wire placed of negligible mass in a region of constant magnetic field which is in the plane of the paper and perpendicular to the pivot.

The U-shaped wire has length 0.23 m and the arms are 0.093 m apart, as shown in the diagram below.

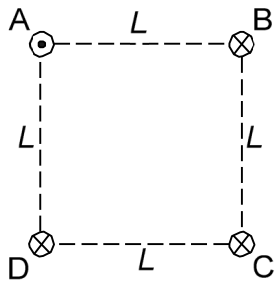


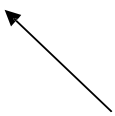
The U-shaped wire experiences a turning moment about the pivot of value 4.7×10^{-6} N m.

What is the magnitude of the magnetic flux density of the constant magnetic field?

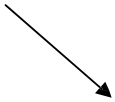
A 5.27 mT **B** 22.9 mT **C** 45.8 mT **D** 4.37 T

26. Four identical wires A, B, C and D carry currents, of equal magnitude, in the directions as shown in the figure below. What is the direction of the resultant magnetic force experienced by wire A?



A 

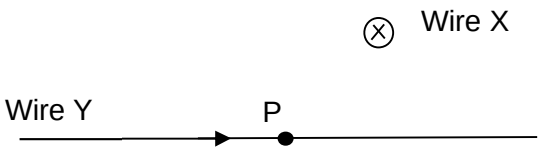
B

C 

D

27. Two long straight current carrying wires, X and Y are placed perpendicular to each other.

Current flows into the page in Wire X and from left to right in Wire Y, as shown in the figure below.



What is the direction of the force acting on wire Y at point **P** due to the magnetic field produced by wire X?

A Into the page **B** Out of the page

C Towards Wire X **D** Away from Wire X

28. Which of the following statements is true?

A α particles can be stopped by 1 m of lead.
B β particles can be deflected when travelling parallel to a magnetic field.
C γ particles can be stopped by paper.
D α, β and γ particles are all charged particles.

29. In the Rutherford α-scattering experiment, most of the α-particles pass through the gold foil with little or no deflection. This is because

A most of the atom is empty space.
B the nucleus is positively charged.
C the nucleus contains most of the mass of the atom.
D the α-particles are moving at high speeds.

30. A radioactive nuclide X with a half-life of 5.0 days decays into a stable nuclide Y.

Starting with an initially pure sample of X, what is the ratio $\frac{\text{number of nuclei of Y}}{\text{number of nuclei of X}}$ after 15 days?

A 1:8 **B** 1:7 **C** 7:1 **D** 8:1

End of paper