Name:		Centre/Index Number:		Class:	

DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H2 PHYSICS

9749/01

Paper 1 Multiple Choice

25 September 2023

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your centre number, index number, name and class at the top of this page.
Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

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.

This document consists of **14** printed pages and **0** blank page.

Data

speed of light in free space,	c =	3.00×10^{8} m s^{-1}
permeability of free space,	μ_o =	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_o =	8.85×10^{-12} F m^{-1}
	=	$(1/(36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge,	e =	1.60×10^{-19} C
the Planck constant,	h =	6.63×10^{-34} J s
unified atomic mass constant,	u =	1.66×10^{-27} kg
rest mass of electron,	m_e =	9.11×10^{-31} kg
rest mass of proton,	m_p =	1.67×10^{-27} kg
molar gas constant	R =	8.31 J K^{-1} mol^{-1}
the Avogadro constant,	N_A =	6.02×10^{23} mol^{-1}
the Boltzmann constant,	k =	1.38×10^{-23} J K^{-1}
gravitational constant,	G =	6.67×10^{-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	=	ρgh
gravitational potential,	ϕ	=	$-Gm/r$
temperature,	T/K	=	T/°C + 273.15
pressure of an ideal gas,	p	=	$\frac{1}{3}\frac{Nm}{V}<c^2>$
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	=	$v_0 \cos \omega t$
		=	$\pm\omega\sqrt{x_o^2 - x^2}$
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	=	$x_0 \sin \omega t$
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,	λ	=	$\frac{\ln 2}{t_{\frac{1}{2}}}$

1 A power station generates power at 3.0 GW.

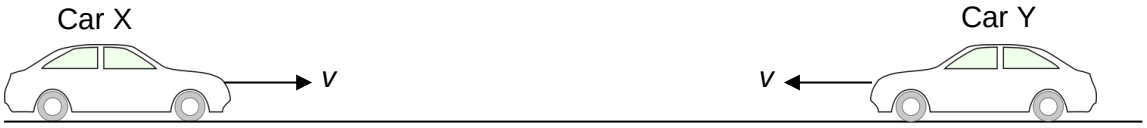
What is the energy produced in a time interval of 2.0 ps?

A 6.0×10^{-15} TJ **B** 6.0×10^{-6} MJ **C** 6.0×10^{3} nJ **D** 6.0×10^{6} μJ

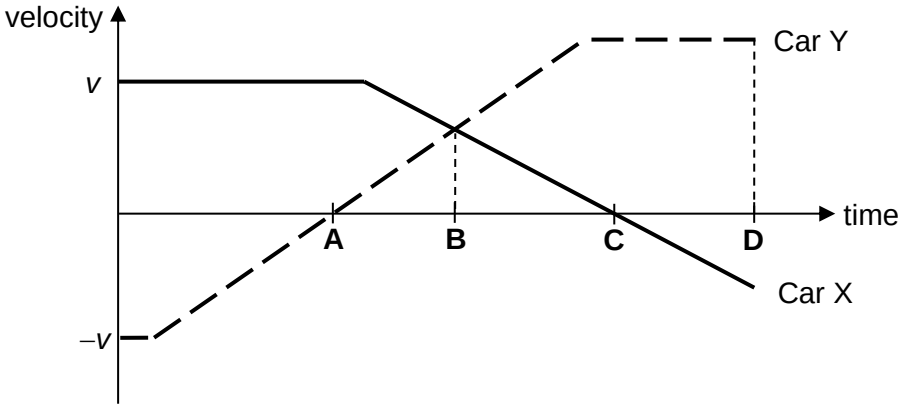
2 A stone is thrown with a velocity of 12 m s^{-1} at an angle of 25° above the horizontal. What is the magnitude of the change in velocity from its starting point to the highest point in its path?

A 1.1 m s^{-1} **B** 5.1 m s^{-1} **C** 5.8 m s^{-1} **D** 12 m s^{-1}

3 Car X and Car Y are at a distance apart and they move towards each other with the same initial speed *v*.

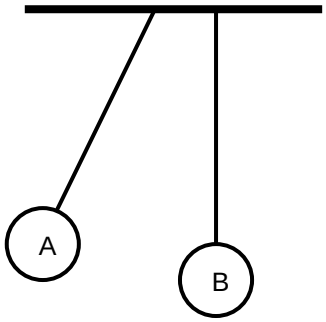


The graph shows the variation of velocity of the cars with time.



At which time are the cars at their distance of closest approach?

4 Two steel bobs A and B are suspended on strings. Bob A is displaced leftwards as shown. After bob A is released, the bobs collide.



Which quantities must be conserved in the collision?

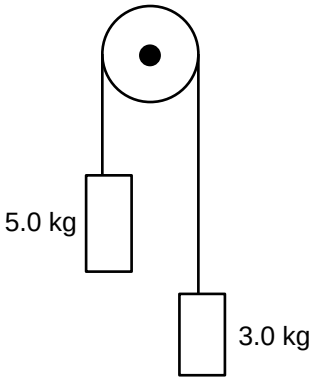
A momentum, kinetic energy, and total energy.

B kinetic energy and total energy only.

C momentum and kinetic energy only.

D momentum and total energy only.

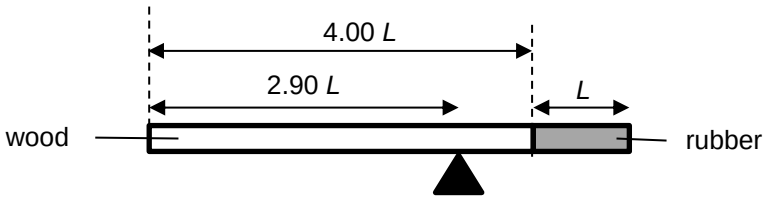
5 The pulley in the diagram below is frictionless.



What is the magnitude of the acceleration of the system, assuming that air resistance is negligible?

A 2.5 m s^{-2} **B** 3.7 m s^{-2} **C** 6.3 m s^{-2} **D** 9.8 m s^{-2}

6 A uniform rod has a wooden section and a solid rubber handle as shown.

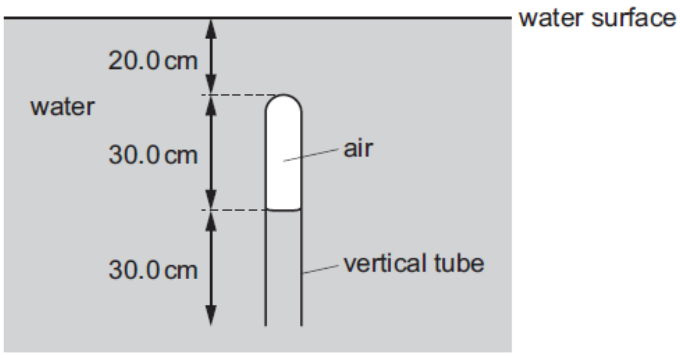


The length of the handle is L, and the length of the wooden section is 4.00 L. The rod balances at 2.90 L from the wooden end.

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

7 A vertical tube, closed at one end, is immersed in water. A column of air is trapped inside the tube as shown.



The density of water is 1000 kg m^{-3}.

What is the difference between the pressure of the air in the tube and the atmospheric pressure?

A 1960 Pa **B** 2940 Pa **C** 4910 Pa **D** 7850 Pa

8 The driving force F of a car of mass m causes the car to accelerate. During a time interval of t, it travelled a distance of s and its speed increases from u to v.

What is the useful work done by the car's engine?

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

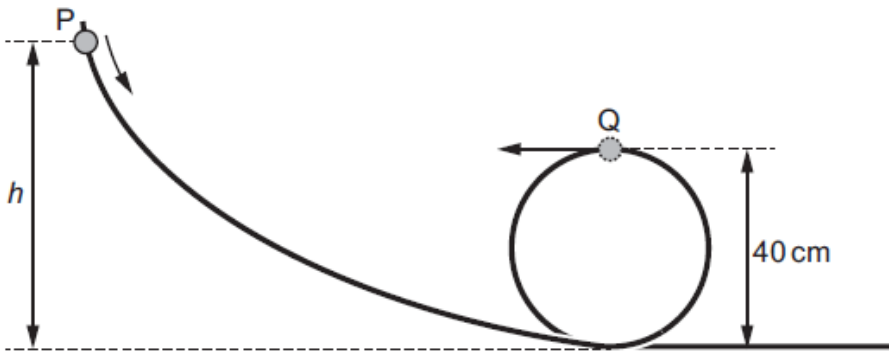
9 A speed boat with two engines, each of power output of 36 kW, can travel at a maximum speed of 12 m s^{-1}. The total drag force D on the boat is related to the speed v of the boat by the following equation:

$$D \propto v^2$$

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

A 3.0 m s^{-1} **B** 6.0 m s^{-1} **C** 8.5 m s^{-1} **D** 9.5 m s^{-1}

10 A bead is released from rest at point P and slides along a wire, as shown.



not to scale

The wire loops around and forms a vertical circle of diameter 40 cm. At point Q, the bead is just in contact with the wire. Air resistance and friction on the wire are negligible.

What is the height h from which the bead is released?

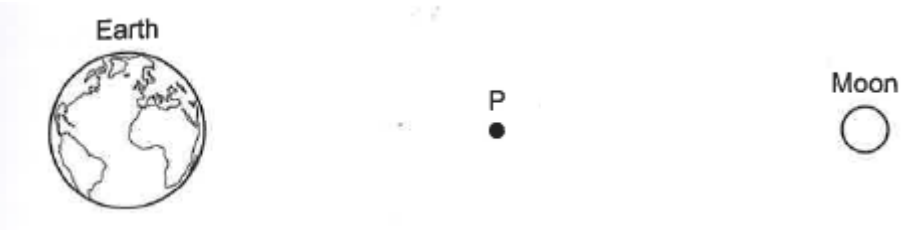
A 0.30 m **B** 0.40 m **C** 0.50 m **D** 0.60 m

11 What is the mean speed and the mean angular velocity of the Earth in its orbit around the Sun?

The mean radius of the orbit is 1.50 x 10^{11} m.

	speed / m s^{-1}	angular velocity / rad s^{-1}
A	2.99 x 10^{4}	1.99 x 10^{-7}
B	2.99 x 10^{4}	7.27 x 10^{-5}
C	1.09 x 10^{7}	7.27 x 10^{-5}
D	1.09 x 10^{7}	1.99 x 10^{-7}

12 The diagram shows a point P midway between the centre of the Earth and the centre of the Moon.



Which statement is true at point P?

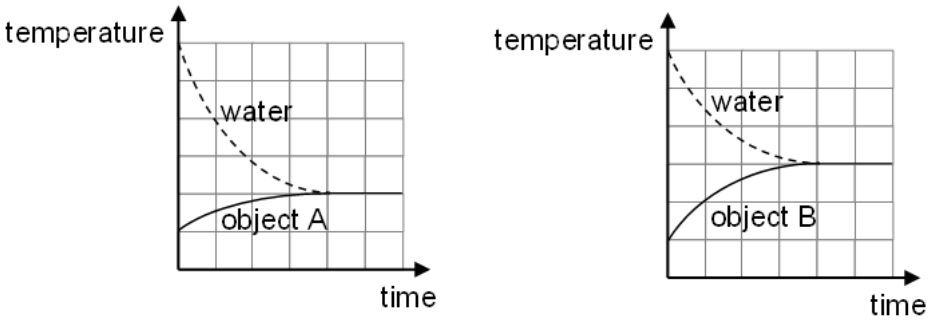
A The gravitational field points towards the Moon.

B The gravitational field strength is zero.

C The gravitational potential is negative.

D The gravitational potential is zero.

13 Object A is dropped into a thermally insulated container of water and allowed to come to thermal equilibrium with the water. The experiment is repeated with a different object B. The mass and initial temperature of water are the same in the two experiments. The mass and initial temperature of objects A and B are also the same. The following graphs show the variation with time of the temperature of the objects and the water.



If c_A and c_B are the specific heat capacities of object A and object B respectively, what is the ratio of $\frac{c_A}{c_B}$?

A 0.38 **B** 1.5 **C** 2.0 **D** 2.7

14 What is the internal energy of a system?

A The total kinetic energy of the system.

B The energy of the atoms of the system.

C The total potential energy of the system.

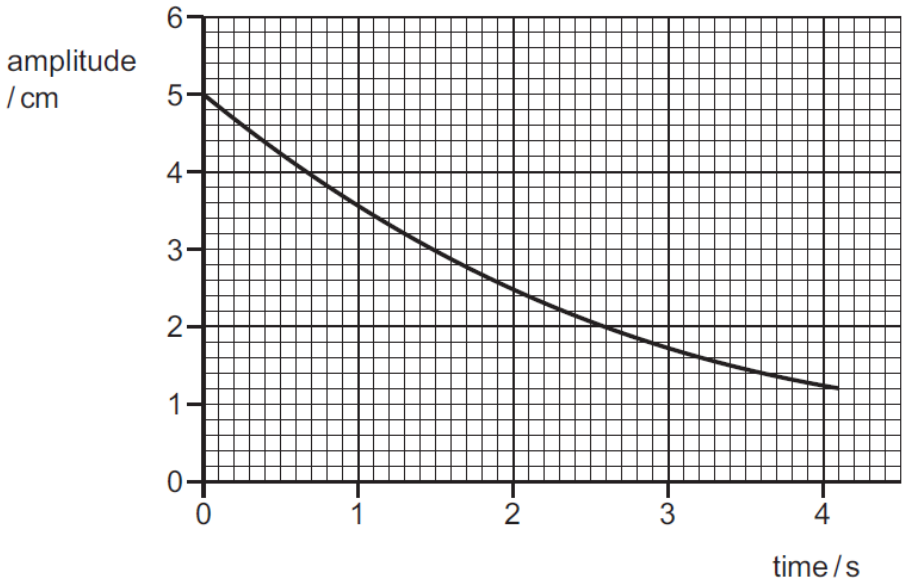
D The amount of heat supplied to the system.

15 An ideal gas has a volume of 3.7 m^3 and contains 1.5 kg of neon-20 atoms. Its temperature is 25 ^oC.

What is the pressure of the gas?

A 4.2 Pa **B** 50 Pa **C** 4.2 kPa **D** 50 kPa

16 The graph shows how the amplitude of a simple pendulum decays with time from an initial amplitude of 5.0 cm.



What is the fraction of the initial energy that has been lost in the first 4.0 s?

A $\frac{1}{16}$ **B** $\frac{1}{4}$ **C** $\frac{3}{4}$ **D** $\frac{15}{16}$

17 Plane polarised light of amplitude A is incident on a polarising filter aligned so that no light is transmitted. The filter is now rotated through an angle of 30^{o}.

What is the amplitude of the transmitted light?

A $0.25A$ **B** $0.50A$ **C** $0.75A$ **D** $0.87A$

18 A standing wave is set up on a rope of length 1.0 m fixed at both ends.

Which statement is correct?

A A harmonic of wavelength 0.40 m may be set up on the rope.

B There are five nodes on the rope for the 5^{th} harmonic.

C The fundamental mode has a wavelength of 1.0 m.

D The midpoint of the rope is always stationary.

19 A sound wave of wavelength 0.50 m passes through a doorway of width 1.0 m.

Which change increases the amount of diffraction that takes place?

A Double the amplitude of the sound wave.

B Halve the frequency of the sound wave.

C Halve the period of the sound wave.

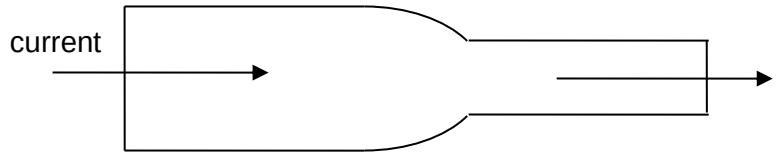
D Double the width of the doorway.

20 The electric potential at point P a distance r from a point charge is V.

What is the electric field strength at P?

A $\frac{V}{r^2}$ **B** $\frac{V}{r}$ **C** Vr **D** Vr^2

21 The figure shows the top view of a metal strip of uniform thickness. The width of the narrow section is half the width of the wide section.



Which statement is correct?

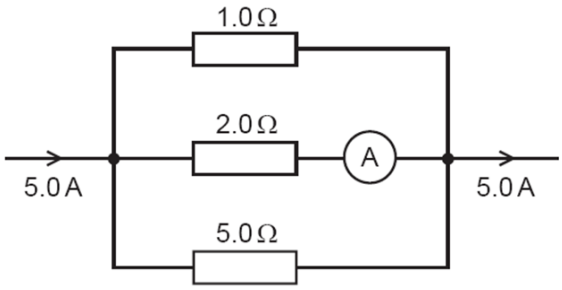
A The potential difference per unit length of the narrow section is the same as the potential difference per unit length of the wide section.

B The potential difference per unit length of the narrow section is smaller than the potential difference per unit length of the wide section.

C The resistance of the narrow section will be smaller and hence more current will flow through as compared to the wide section.

D The resistance per unit length of the narrow section is twice that of the wide section.

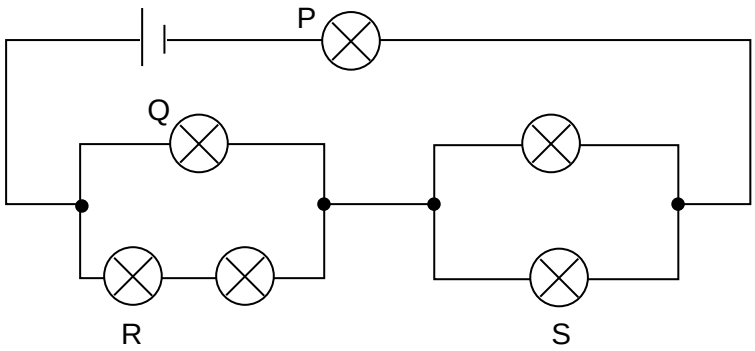
22 The diagram shows part of a current-carrying circuit. The ammeter has negligible resistance.



What is the reading on the ammeter?

A 0.70 A **B** 1.3 A **C** 1.5 A **D** 1.7 A

23 Six identical light bulbs are connected as shown.

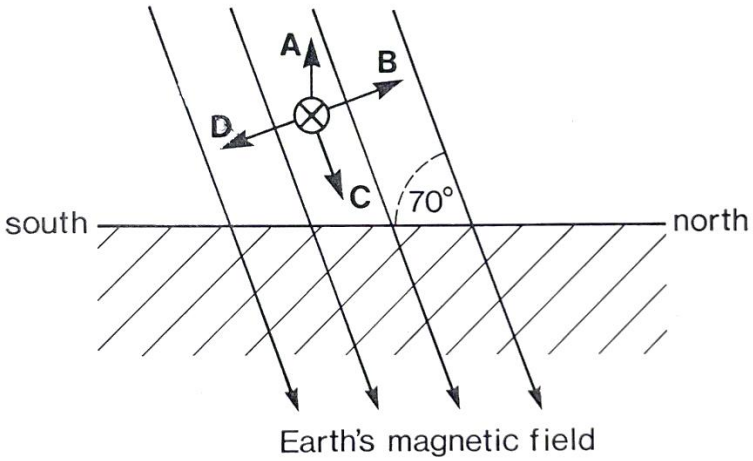


Which bulb is the brightest?

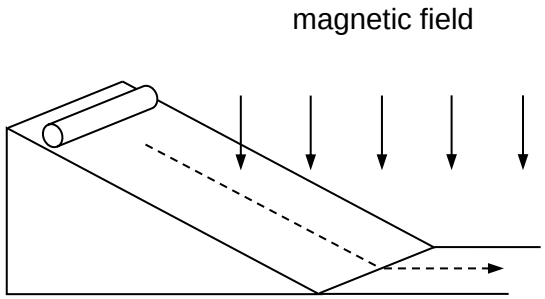
A P **B** Q **C** R **D** S

24 A horizontal power cable carries a steady current in an east-to-west direction, i.e. into the plane of the diagram.

Which arrow shows the direction of the force on the cable caused by the Earth's magnetic field, in a region where this field is at 70° to the horizontal?

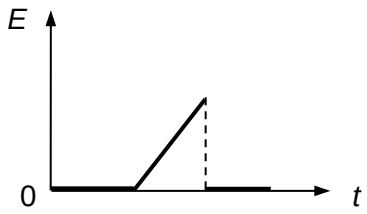


25 In a region of uniform magnetic field directed vertically downwards, a metal rod falls vertically from rest and lands on to a slope. It continues to roll down and off the slope as shown.

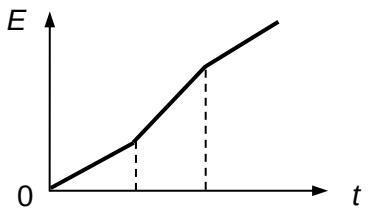


Which graph best shows the variation with time *t* of the e.m.f. *E* induced in the rod, from the time it is released?

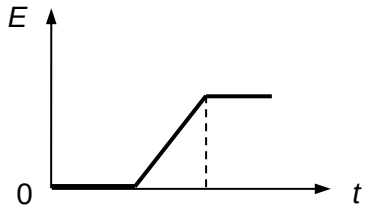
A



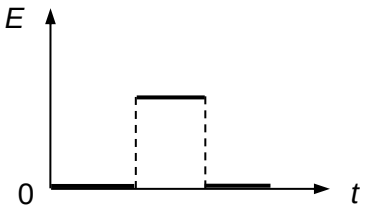
B



C



D



26 A sinusoidal alternating current of peak value I_o passes through a resistor of resistance *R*. The mean power developed by the current in the resistor is *P*.

Another sinusoidal alternating current passes through a resistor of resistance 2*R*. If the mean power developed by this current in it is 4*P*, what is the root-mean-square value of this current?

A 2.0 I_o **B** 1.4 I_o **C** 1.0 I_o **D** 0.70 I_o

27 The intensity of a beam of monochromatic light is doubled.

Which one of the following represents the corresponding change, if any, in the momentum of each photon of the beam?

A remained the same

B increased fourfold

C doubled

D halved

28 Heisenberg's Uncertainty Principle is a consequence of

A the wave-particle duality of physical entities.

B the existence of discrete energy levels in atoms.

C relativistic effects as particles move at speeds close to the speed of light.

D the fact that all measuring instruments have a minimum resolution which limits their precision.

29 In the following induced nuclear reaction, when one Lithium-7 nucleus reacts with one Hydrogen-1 nucleus, X number of Helium-4 nuclei are produced.

$$^{7}_{3}\text{Li} + {}^{1}_{1}\text{H} \rightarrow \text{X}\left({}^{4}_{2}\text{He}\right) + \text{energy}$$

During the reaction, 1.6×10^{12} J of energy is released when 1.0 g of Hydrogen-1 (mass of 1 Hydrogen-1 nucleus = 1.008 *u*) and sufficient Lithium-7 are used. The binding energy of a Helium-4 nucleus is 28.3 MeV.

What is the binding energy of a Lithium-7 nucleus?

A 11.6 MeV **B** 39.9 MeV **C** 56.6 MeV **D** 68.2 MeV

30 Nuclide X decays to stable nuclide Y with a half-life of *T* years.

Geologists discovered that nuclide Y found in a particular rock sample all came from nuclide X which was present when the rock was formed.

The rock is thought to be 3*T* years old.

What is the expected ratio $\frac{\text{number of atoms of X}}{\text{number of atoms of Y}}$ for this rock?

A $\frac{1}{2}$ **B** $\frac{1}{3}$ **C** $\frac{1}{6}$ **D** $\frac{1}{7}$