H

NATIONAL JUNIOR COLLEGE

SENIOR HIGH 2 PRELIMINARY EXAMINATION

Higher 2

CANDIDATE NAME

SUBJECT CLASS

REGISTRATION NUMBER

PHYSICS
Paper 3 Structured Questions
Candidate answers on the Question Paper.

No Additional Materials are required.

9749/03

31 August 2021
2 hours

READ THE INSTRUCTION FIRST
Write your subject class, registration number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.

Answers **all** questions.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	
1	/ 8
2	/ 8
3	/ 8
4	/ 8
5	/ 8
6	/ 10
7	/ 10
Section B	
8	/ 20
9	/ 20
Total (80m)	

This document consists of **24** printed pages and **no** blank pages.

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Data

speed of light in free space	$c = 3.00 \times 10^{8}\,\mathrm{m\,s^{-1}}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\,\mathrm{H\,m^{-1}}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\mathrm{F\,m^{-1}}$
	$(1/(36\pi)) \times 10^{-9}\,\mathrm{F\,m^{-1}}$
elementary charge	$e = 1.60 \times 10^{-19}\,\mathrm{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\,\mathrm{J\,s}$
unified atomic mass constant	$u = 1.66 \times 10^{-27}\,\mathrm{kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27}\,\mathrm{kg}$
molar gas constant	$R = 8.31\,\mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant	$N_A = 6.02 \times 10^{23}\,\mathrm{mol^{-1}}$
the Boltzmann constant	$k = 1.38 \times 10^{-23}\,\mathrm{J\,K^{-1}}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall	$g = 9.81\,\mathrm{m\,s^{-2}}$

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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	$p = \rho gh$
gravitational potential	$\phi = -Gm/r$
temperature	$T/\text{K} = T/{}^\circ\text{C} + 273.15$
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.	$v = v_0 \cos\omega t$ $= \pm\,\omega\sqrt{x_0^2 - x^2}$
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	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

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Section A

Answer **all** the questions in this Section in the spaces provided.

1 An object is launched at a speed of 30 m s^{-1} at an angle of 30° from a horizontal surface, as shown in Fig. 1.1.

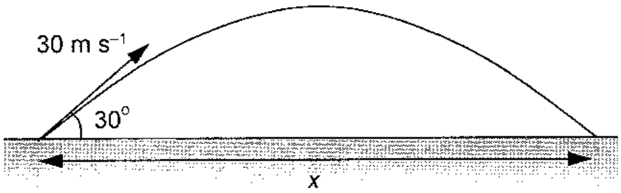

Fig. 1.1

Assume air resistance is negligible.

(a) **(i)** Determine the time taken for the object's entire journey.

time = ... s [2]

(ii) Hence, determine the range x of the launch.

x = ... m [1]

(b) On Fig. 1.2 below, sketch the graphs that show the variation with time of the vertical component of the velocity when

(i) air resistance is negligible and label it as **A**, [3]

(ii) air resistance is **not** negligible and label it as **B**. [2]

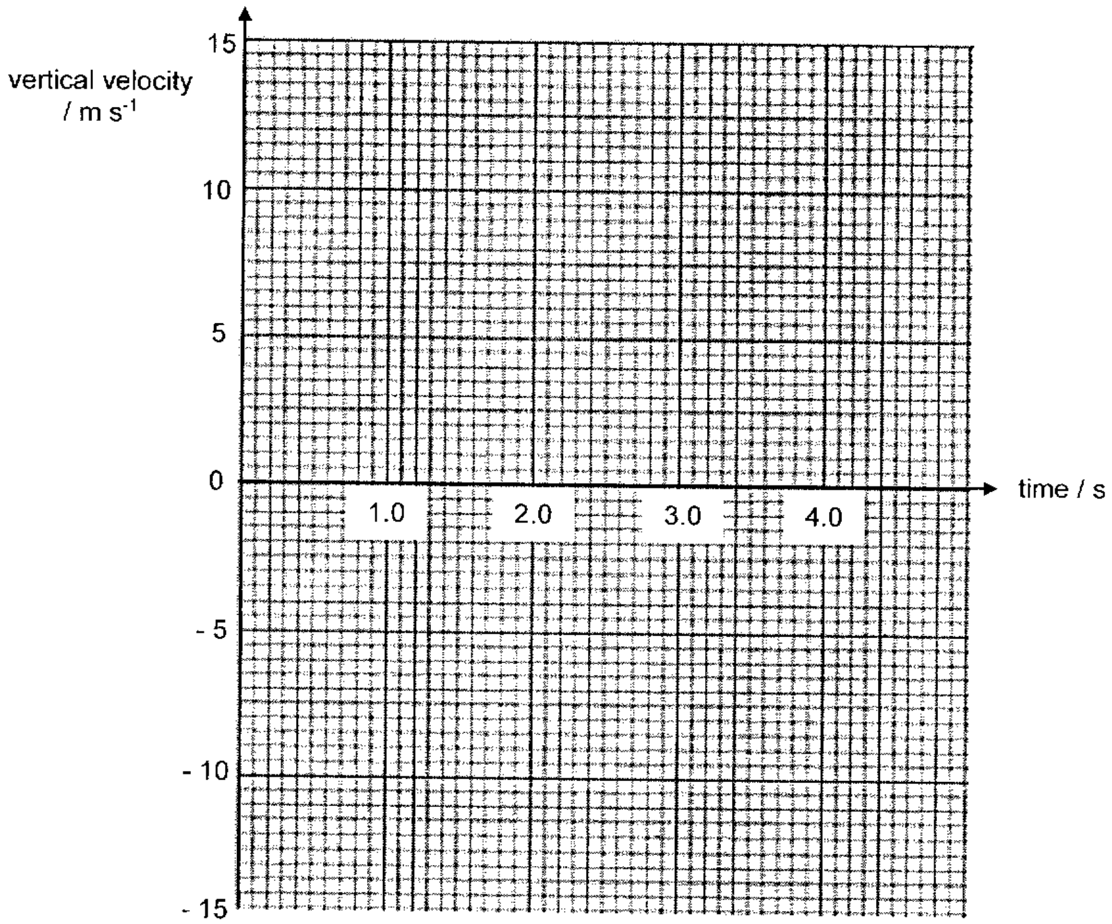

Fig. 1.2

[Total: 8]

2 **(a)** Fig. 2.1 shows a liquid in a cylindrical container.

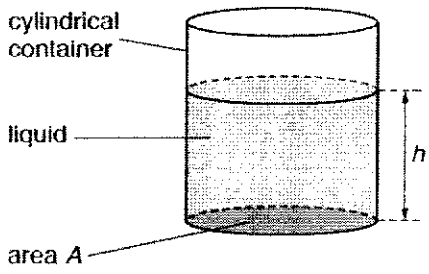

Fig. 2.1

The cross-sectional area of the container is A. the height of the column of liquid is h and the density of the liquid is ρ.

Show that the pressure p due to the liquid at the base of the cylinder is given by

$$p = h\rho g$$

[2]

(b) The variation with height h of the total pressure P on the base of the cylinder is shown in Fig. 2.2.

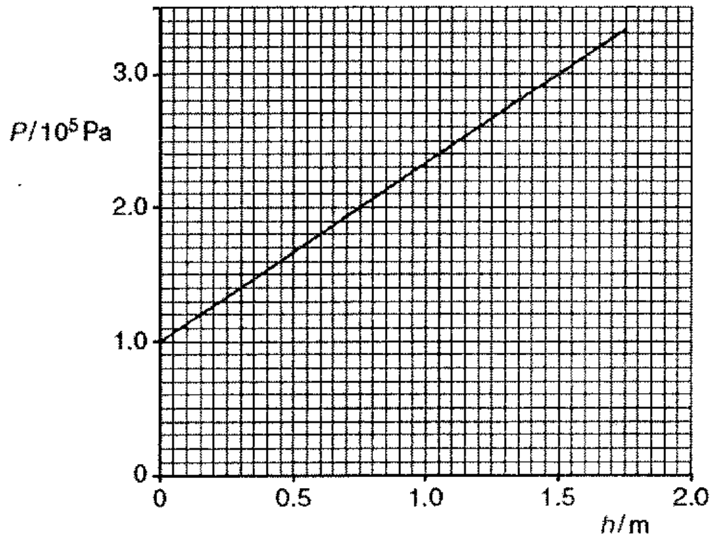

Fig. 2.2

(i) Explain why the line of the graph in Fig. 2.2 does not pass through the origin (0,0).

....

.... [1]

(ii) Use data from Fig. 2.2 to calculate the density of the liquid in the cylinder.

density = ... kg m^{-3} [3]

(c) An object is dropped into the liquid and it floats. Explain why the density of the object is lower than that of the liquid.

....

....

....

.... [2]

[Total: 8]

3 A system comprising the star Musica and its exoplanet Arion can be considered as isolated in space. The centres of the two bodies are separated by a constant distance d, as illustrated in Fig. 3.1.

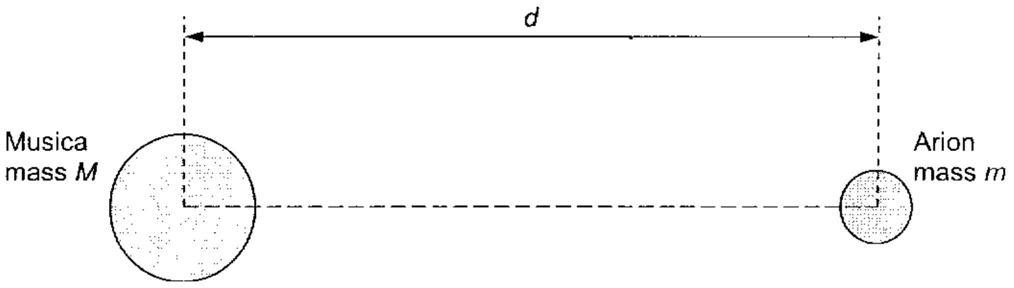

Fig. 3.1

Musica, of mass M, has a larger mass than Arion of mass m, such that $\frac{M}{m} = 240$.

The two bodies are in circular orbits about each other such that the centre of their orbits is at a fixed point.

Over a period of time equal to T of the orbits, the positions of the bodies are shown in Fig. 3.2.

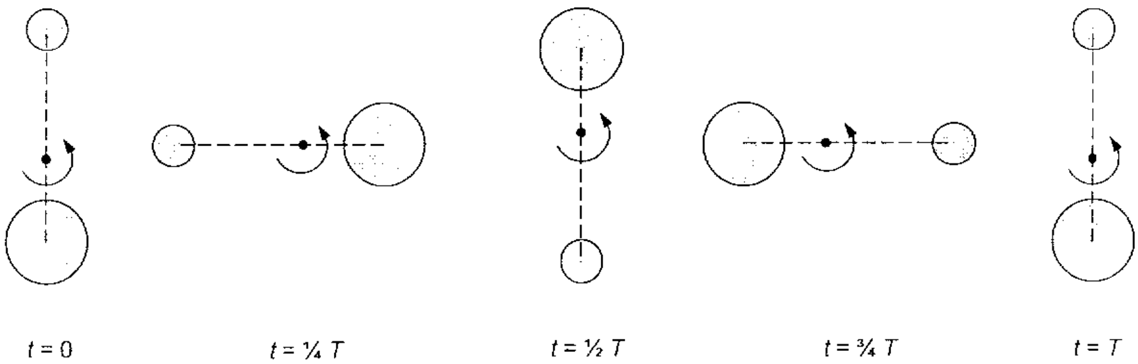

Fig. 3.2

The period T of each orbit is 2.7 years.

The separation d of the centres of Musica and Arion is 3.9×10^{11} m.

(a) **(i)** Explain why the centripetal forces acting on Musica and Arion are equal in magnitude.

....

....

....

.... [2]

(ii) Determine the radius of the orbit of Musica. Explain your working.

radius = ... m [3]

(b) Use your answers in **(a)** to determine the mass of Musica.

mass = ... kg [3]

[Total: 8]

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4 **(a)** State what is meant by *simple harmonic motion*.

....

....

....

.... [2]

(b) A spring hangs vertically from a fixed point.

A mass of 1.2 kg is attached to the free end of the spring, as shown in Fig. 4.1.

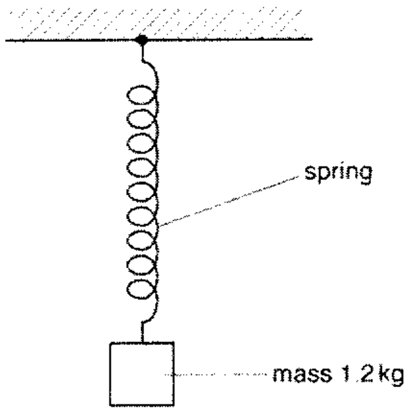

Fig. 4.1

The mass undergoes vertical simple harmonic motion with frequency 1.5 Hz and amplitude 3.4 cm.

(i) Determine the maximum resultant force on the mass.

maximum resultant force = ... N [2]

(ii) Determine the maximum kinetic energy of the mass.

maximum kinetic energy = ... J [2]

(c) A luggage weighing sensor measures the weight of a luggage using a spring. The luggage is hung in the same manner as how the mass in Fig. 4.1 is hung.

Suggest the advantages for the luggage weighing sensor to be **critically** damped.

....

....

....

.... [2]

[Total: 8]

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5 **(a)** State what is meant by an *electric current*.

....

.... [1]

(b) A metal wire has length L and cross-sectional area A, as shown in Fig. 5.1.

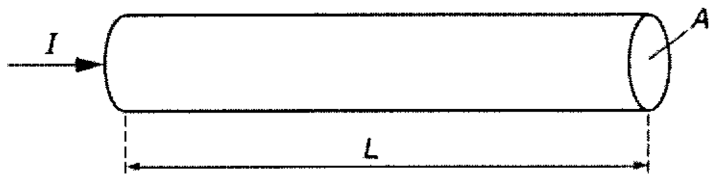

Fig. 5.1

I is the current in the wire,
n is the number of free electrons per unit volume in the wire,
v is the average drift speed of a free electron,
e is the charge on an electron.

(i) State, in terms of A, L, n and e, an expression for the total charge of free electrons in the wire.

.... [1]

(ii) Use your answer in **(b) (i)** to show that the current I is given by the equation

$$I = nAve$$

[2]

(c) A metal wire in a circuit is damaged. The resistivity of the metal is unchanged but the cross-sectional area of the wire is reduced over a length of 3.0 mm, as shown in Fig. 5.2.

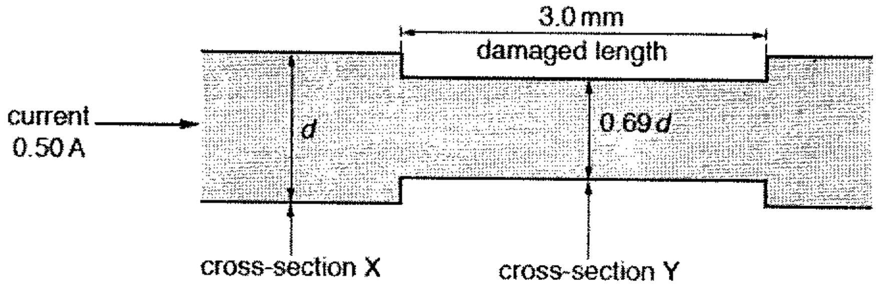

Fig. 5.2

The wire has a diameter d at cross-section X and diameter 0.69 d at cross-section Y. The current in the wire is 0.50 A.

(i) Determine the ratio

$$\frac{\text{average drift speed of free electrons at cross-section Y}}{\text{average drift speed of free electrons at cross-section X}}$$

ratio = ... [2]

(ii) The diameter of the damaged length of wire is further decreased. Assume that the current in the wire stays constant at 0.50 A.

State and explain qualitatively the change, if any, to the power dissipated in the damaged length of the wire.

....

....

....

.... [2]

[Total: 8]

6 **(a)** State Faraday's law of electromagnetic induction.

....

....

.... [2]

(b) An iron-core transformer is illustrated in Fig. 6.1.

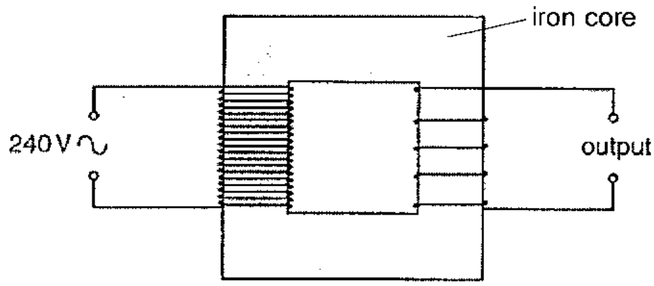

Fig. 6.1

The input potential difference is 240 V r.m.s. The **maximum** output potential difference is 24 V. There are 260 turns of wire on the secondary coil.

(i) Explain what is meant by an ideal transformer.

....

.... [1]

(ii) Calculate the number of turns of wire on the primary coil.

number of turns = ... [3]

(iii) There is power loss in the transformer.

If the input rms current is 350 mA and the output rms current is 3.5 A, calculate the efficiency of this transformer.

efficiency = ... % [2]

(iv) Suggest and explain one way to reduce the power loss of the transformer.

....

....

....

.... [2]

[Total: 10]

7 (a) Fig. 7.1 shows some spectral lines emitted from a discharge tube filled with low pressure mercury vapour.

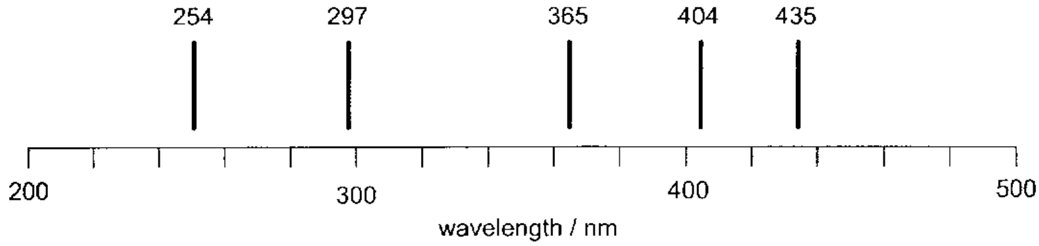

Fig. 7.1

Explain how the line spectrum of atoms, such as those shown in Fig. 7.1, provides evidence for the existence of discrete electron energy levels.

....

....

....

....

....

.... [3]

(b) The photons emitted from the discharge tube in **(a)** are incident on a metal surface in a vacuum tube, as shown in Fig. 7.2.

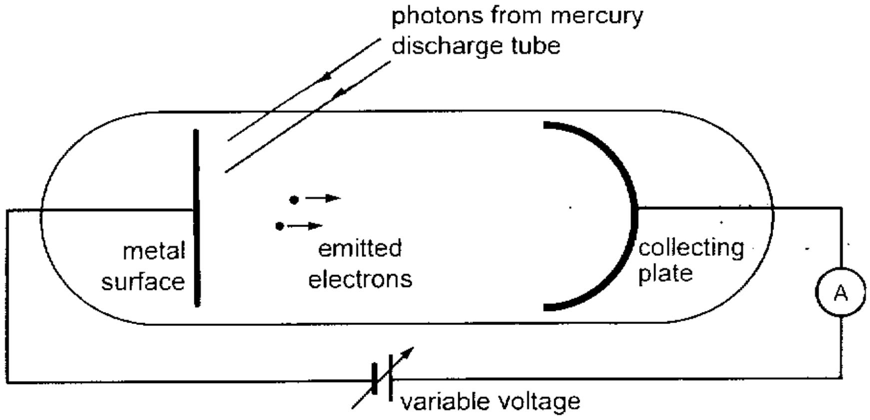

Fig. 7.2

The metal surface that has a work function of 3.2 eV.
Electrons are emitted from the metal surface.

Photons from the mercury discharge tube corresponding to the shortest wavelength of 254 nm cause emission of electrons from the metal surface with different kinetic energies.

(i) Explain why the electrons are emitted with different kinetic energies.

....

....

....

....

....

....

.... [3]

(ii) **1.** Deduce the other wavelengths from the mercury discharge tube that can also cause emission of electrons.

wavelengths .... [2]

2. Explain whether your answer to **(b)(ii)1.** is affected by the intensity of the electromagnetic radiation from the mercury discharge tube.

....

....

....

.... [2]

[Total: 10]

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Section B

Answer **one** question from this Section in the spaces provided

8 **(a)** **(i)** The pressure p of an ideal gas is related to the density ρ of the gas by

$$p = \frac{1}{3}\rho\langle c^2\rangle$$

State what is meant by the symbol $\langle c^2\rangle$. [1]

....

....

(ii) Use the expression in **(a)(i)** to show that the mean kinetic energy E_k of an ideal gas molecule is given by

$$E_k = \frac{3}{2}kT$$

where k is the Boltzmann constant and T is the thermodynamic temperature.

[3]

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(b) State the first law of thermodynamics.

....

....

.... [2]

(c) Use the first law to explain whether the internal energy increases, decreases or remains constant when

(i) the gas in a balloon expands suddenly when the balloon bursts,

....

....

....

....

....

.... [3]

(ii) ice melts at constant temperature and constant atmospheric pressure into water that is denser than the ice.

....

....

....

....

....

.... [3]

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(d) 1.0 mol of an ideal gas is heated at constant volume.

(i) Use the first law and the mean kinetic energy E_k of an ideal gas molecule in **(a)(ii)** to show that the thermal energy required to raise the temperature of the gas by 1.0 K is $\frac{3}{2}R$ (where R is the molar gas constant).

[3]

(ii) Nitrogen may be assumed to be an ideal gas.
The molar mass of nitrogen gas is 28 g mol^{-1}.

Calculate the specific heat capacity at constant volume for nitrogen.

specific heat capacity = ... J kg^{-1} K^{-1} [2]

(e) A fixed mass of an ideal gas undergoes the cycle of changes ABCA, as shown in Fig. 8.1.

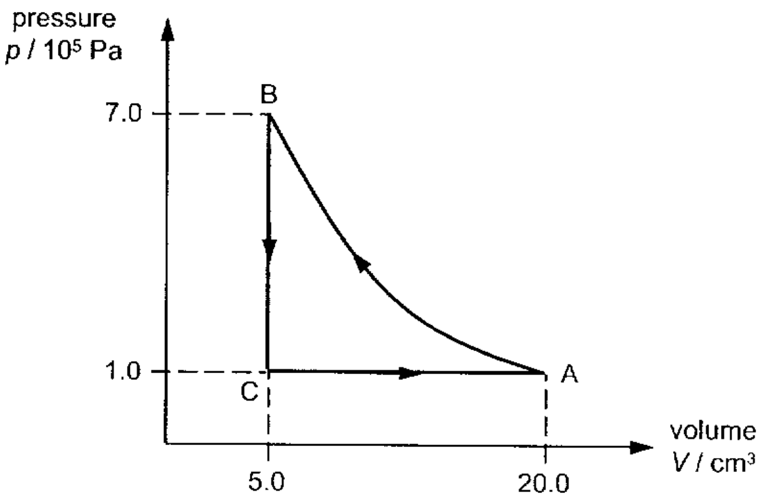

Fig. 8.1

Some energy changes during one cycle of ABCA are shown in Fig. 8.2.

change	heating supplied to gas / J	work done on gas / J	increase in internal energy / J
A → B	0	4.2	
B → C	– 8.5		
C → A			

Fig. 8.2

Complete Fig. 8.2.

[3]

[Total: 20]

9 **(a)** Distinguish between a *nucleon*, a *nucleus* and a *nuclide*.

....

....

....

....

.... [3]

(b) When beryllium is bombarded with α-particles of energy 8.0×10^{-13} J, carbon atoms are produced, together with a very penetrating radiation. The nuclear reaction might be

EITHER **(1)** $^{9}_{4}Be + ^{4}_{2}He \rightarrow ^{13}_{6}C + \gamma$

OR **(2)** $^{9}_{4}Be + ^{4}_{2}He \rightarrow ^{12}_{6}C + ^{1}_{0}n$

(i) Explain what is meant by $^{13}_{6}C$.

....

.... [1]

(ii) The energy of the penetrating radiation is found to be at least 8.8×10^{-12} J for each γ or $^{1}_{0}n$ produced. Explain whether equations **(1)** and **(2)** are valid.

nuclide	mass / u
$^{9}_{4}Be$	9.0150
$^{4}_{2}He$	4.0040
$^{13}_{6}C$	13.0075

[4]

(c) Fig. 9.1 gives the activity of Dubnium-268 measured over a period of 15 days.

Time / day	Activity / Bq
0	76 300
1	44 490
2	25 940
3	15 120
4	8 815
5	5 140
6	3 000
7	1 747
8	1 018
9	594
10	346
11	203
12	120
13	67
14	40
15	20

Fig. 9.1

(i) 1. Explain what is meant by the term decay constant.

....

.... [1]

2. State the equation relating decay constant λ to half-life $t_{\frac{1}{2}}$.

....

.... [1]

(ii) Without plotting a graph, deduce the half-life of Dubnium-268.

half-life of B = ... days [3]

(iii) Suggest an appropriate graph to plot to deduce the half-life of Dubnium-268 and explain how the half-life can be deduced from the graph.

....

.... [3]

(iv) Explain why it is necessary to ensure that the readings are taken at the same time each day.

....

.... [1]

(v) Explain if the following statement is accurate:

"After 14 days, the activity of Dubnium-268 is 40 Bq. After 15 days, the activity is 20 Bq. The half-life of Dubnium-268 is therefore 1 day."

....

....

....

....

....

.... [3]

[Total: 20]

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Paper 3 Solutions

1	(a)(i)	$0 = 30 \sin 30° - (9.81)\, t$ $t = 1.529$ s time taken = 1.529 x 2 = 3.06 s	M1 A1
	(a)(ii)	$x = u_x t = 30 \cos 30° (3.06) = 79.5$ m	A1
	(b)(i)	A straight line between 0 and 3 s < t < 3.1 s with $v = 0$ at $t \approx 1.5$ s between –15 m s^{-1} and 15 m s^{-1}	M1 A1 A1
	(b)(ii)	curve with time taken moving upwards < time taken moving downwards (gradient at t = 0 s is approximately 9.81) approximately same area	B1 B1

2	(a)	pressure = force / area OR weight (of liquid) / area [B1] $p = \frac{\text{mass} \times g}{A} = \frac{\text{density} \times \text{volume} \times g}{A} = \frac{\rho A h g}{A}$ [M1] $= h\rho g$ [A0] *deduct 1 mark if any symbol used is not defined except for ρ, A, g and h* no marks if concept of upthrust used		
	(b)			
		(i)	Total pressure includes atmospheric pressure. [B1]	
		(ii)	$P = h\rho g + P_{atm}$ Gradient of the graph is ρg [C1] Gradient = $\frac{(3.0-1.0)\times 10^5}{1.5-0} = 133333$ $\rho = \frac{133333}{9.81}$ [M1] $= 13600\ kg\ m^{-3} \approx 14000\ kg\ m^{-3}$ [A1]	
	(c)	Upthrust is given by $V\rho_l g$ where V is volume of the object and ρ_l the density of the fluid The weight of the object is given by $V\rho_o g$ where ρ_o is the density of the object. [B1] To experience an <u>upwards net force</u> when the object is fully immersed such that it floats, <u>the upthrust is greater than the weight</u>. [M1] (or when object floats, weight = upthrust B1, water displaced < volume of object M1)		

3					
	(a)	(i)	bodies exert gravitational force on each other provides centripetal force equal in magnitude (and oppositely directed) from Newton's third law	B1 B1	
		(ii)	equal centripetal force, so $Mr\omega^2 = m(d-r)\omega^2$ $r = \frac{m}{M+m}d = \frac{1}{\frac{M}{m}+1}d$ $r = \frac{1}{240+1} \times 3.9 \times 10^{11}$ $r = 1.6(2) \times 10^9$ m	C1 M1 A1	
	(b)		angular velocity $= \frac{2\pi}{2.7\times365\times24\times60\times60}$ $(= 7.379 \times 10^{-8})$ rad s^{-1} gravitational force on Arion provides centripetal force $\frac{GMm}{d^2} = m(d-r)\omega^2$ $M = \frac{(3.9\times10^{11})^2\times(3.9\times10^{11}-1.618\times10^9)\times(7.379\times10^{-8})^2}{6.67\times10^{-11}}$ $M = 4.8(2) \times 10^{30}$ m	C1 M1 A1	

4	(a)		direction of acceleration opposite direction of displacement from equilibrium position (or directed to fixed point) (magnitude of) acceleration proportional to (magnitude of) displacement *from equilibrium position* (max 1 mark if missing from entire definition)	**B1** **B1**	
	(b)				
		(i)	$a = \omega^2 x_0 = (2\pi \times 1.5)^2 (0.034) = 3.0201$ m s^{-2} $F = ma = 1.2 \times 3.0201 = 3.6$ **or** 3.62 m s^{-2} (2 or 3 sf)	**M1** **A1**	
		(ii)	$v_0 = \omega x_0 = (2\pi \times 1.5)(0.034) = 0.32044$ m s^{-1} $E_k = \frac{1}{2} mv^2 = \frac{1}{2}(1.2)(0.32044)^2 = 0.062$ **or** 0.0616 J	**C1** **A1**	
	(c)		no oscillations of readings returns to equilibrium position (or actual measurement) in the shortest time	**B1** **B1**	

5	(a)	The electric current I (conventional current) at a particular point is the rate of flow of positive charges. [B1]		
	(b)			
		(i)	Total amount of charge due to the free electrons in the wire = $ALne$ [B1]	
		(ii)	Time taken for the total amount of charge to move through the wire = L/v [B1] Current = rate of flow of charge = $\frac{ALne}{\frac{L}{v}}$ [B1] $= nAve$ [A0] Alternative use I = Q/t [B1], explain v = L / t [B1]	
	(c)			
		(i)	Since current is the same throughout the wire $nA_Xv_Xe = nA_Yv_Ye$ [C1] $\frac{v_Y}{v_X} = \frac{A_X}{A_Y} = \frac{\pi(\frac{d_X}{2})^2}{\pi(\frac{d_Y}{2})^2} = (\frac{d_X}{d_Y})^2 = (\frac{1}{0.69})^2 = 2.1$ [A1] (student shows ratio of square of diameter suffice)	
		(ii)	As the diameter decreases, the resistance across the damaged part of the wire increases. [M1] As such, the power dissipated in the damaged length of wire increases. [A1]	

6	(a)	magnitude of induced electromotive force proportional to rate of change of magnetic flux linkage **or** rate of magnetic flux cutting		**B1** **B1**	
	(b)				
		(i)	input power/energy = output power/energy **or** no power/energy loss	**B1**	
		(ii)	rms output $V = 24 / \sqrt{2} = 16.97$ V **or** peak input $V = 240 \times \sqrt{2} = 339.4$ V $N_p / N_s = V_p / V_s$ (V_p and V_s either **both** rms or **both** peak) $N_p = 240 / 16.97 \times 260$ **or** $339.4 / 24 \times 260 = 3680$ **or** 3700 (3 or 2 sf)	**C1** **C1** **A1**	
		(iii)	mean input power = 0.35 × 240 = 84 W mean output power = 3.5 × 16.97 = 59.40 W Calculate input and output powers (either **both** peak or **both** mean) efficiency = (output power / input power) × 100% = 70.7 % or 71 %	 **M1** **A1**	
		(iv)	use soft iron as the core to reduce power loss due to repeated magnetisation (and demagnetisation) of the iron core (**or** hysteresis loss) **or** laminate the iron core to reduce power loss due to eddy currents induced in the core	**M1** **A1** **(M1)** **(A1)**	

7	(a)			
		photon (of energy equal to the energy difference) is emitted when electron de-excites from higher to lower energy level B1 each line corresponds to specific wavelength B1 energy of photon depends on frequency or wavelength only, such that E=hf, so energy change is discrete B1 these imply discrete electron energy levels exist in atoms		
	(b)			
		(i)	energy (depends on frequency) equal for each photon B1 maximum kinetic energy for electron emitted from surface = energy of photon – work function energy B1 lower energies (than maximum) when energy required to bring electron to surface B1	
		(ii)	**1.** $hf_{\min} = \frac{hc}{\lambda_{\max}} = 3.2e$ maximum wavelength = $\frac{6.63\times10^{-34}\times3\times10^{8}}{3.2\times1.6\times10^{-19}} = 388$ nm C1 wavelengths causing emission are 297 nm and 365 nm A1	
			2. intensity proportional/affect rate of photons arriving/incident on surface B1 photon energy remains the same B1 so, no effect	

8	(a)	(i)	<u>mean/average squared speed</u> of the gas molecules	B1
		(ii)	$\rho = \frac{\text{number of molecules } N \times \text{mass of one molecule } m}{\text{volume (of gas) } V}$	B1
			$pV = NkT$ or $pV = nRT$	B1
			correct algebra $p = \frac{1}{3}\frac{Nm}{V}\langle c^2\rangle \Rightarrow pV = \frac{1}{3}Nm\langle c^2\rangle \Rightarrow NkT = \frac{1}{3}\times\frac{2}{2}Nm\langle c^2\rangle$ to obtain $\frac{1}{2}m\langle c^2\rangle = \frac{3}{2}kT$	B1
			Deduct 1 mark if symbols used are not defined but are conventional (e.g. V for volume, m for mass) *Award zero if symbols used are not defined and unconventional.*	
	(b)		internal energy = heat + work done	B1
			direction of changes	B1
	(c)			
		(i)	<u>no heat enters/leaves (gas)/no heating (of gas)</u> due to "sudden expansion"	B1
			<u>negative work done / work done against atmosphere by expanding gas</u>	M1
			internal energy decreases	A1
		(ii)	*either* volume decrease during melting, work done on ice/water *or* change in volume is small, negligible work done on ice	B1
			<u>heating</u> of ice to <u>break bonds</u>	M1
			internal energy increases	A1
	(d)			
		(i)	Change in volume is zero hence zero work done, $Q = \Delta U$	B1
			$\Delta U = N_A E_k (= N_A \times \frac{3}{2}k \times 1)$ (because ideal gas, E_p is zero)	B1
			$Substitution\ of\ (1)R(1) = N_A k\ (1)$	B1
			so, $Q = \frac{3}{2}R$	
		(ii)	$q = mc\Delta T$	
			$c = \frac{\frac{3}{2}\times 8.31}{0.028\times 1}$	C1
			$c = 450$ J kg^{-1} K^{-1}	A1
	(e)		see table below	

change	heating supplied to gas / J	work done on gas / J	increase in internal energy / J
A → B	0	4.2	4.2
B → C	− 8.5	0	− 8.5
	5.8	− 1.5	4.3

		C → A		
9	(a)	A nucleon is a proton or neutron. [B1] A nucleus is the center of an atom consisting of protons and neutrons. [B1] Nuclides are nuclei that have the same number of protons and neutrons. (or same proton and nucleon number.) [B1]		
	(b)			
		(i)	It means a carbon nucleus/atom with 6 protons and 7 neutrons/13 nucleons [B1]	
		(ii)	Energy of γ = equivalent mass-energy of reactants – equivalent mass-energy of ${}^{13}_{6}C$ Energy of γ = (9.0150 + 4.0040 - 13.0075)u × c^2 [M1] = 1.71 × 10^{-12} J Equation 1 is not valid as energy of γ is lower than 8.8 × 10^{-12} J [A1] Energy of ${}^{1}_{0}n$ = (9.0150 + 4.0040 - 12)u × c^2 [M1] = 1.52 × 10^{-10} J Equation 2 is valid as ${}^{1}_{0}n$ has energy higher than 8.8 × 10^{-12} J. [A1]	
	(c)			
		(i)	Decay constant λ is the probability of decay per unit time of a nucleus [B1] $t_{\frac{1}{2}} = \frac{\ln 2}{\lambda}$ [B1]	
		(ii)	$A = A_0 e^{-\frac{\ln 2}{t_{1/2}}t}$ $44490 = 76300e^{-\frac{\ln 2}{t_{\frac{1}{2}}}(1)} \rightarrow t_{1/2} = 1.29\ days$ $25940 = 44490e^{-\frac{\ln 2}{t_{\frac{1}{2}}}(1)} \rightarrow t_{1/2} = 1.28\ days$ [M2 for each data point, if choose low activity such as day 14 and 15, will not get 1.29 days – penalize for poor choice of data] Average = (1.28 + 1.29)/2 = 1.29 days [A1 awarded only if average taken]	
		(iii)	$A = A_0 e^{-\frac{\ln 2}{t_{1/2}}t}$ $\ln A = -\frac{\ln 2}{t_{1/2}}t + \ln A_0$ [M1] Plot ln A against t [A1] The gradient is $-\frac{\ln 2}{t_{1/2}}$ and can be used to calculate the half-life. [A1]	
		(iv)	As the half-life is 1.29 days, a few hours difference will result in a significant change in the activity. [B1]	
		(v)	Radioactive decay is random. [B1] At such low activity, the actual activity might deviate from the expected activity by a large percentage, resulting in errors in calculation. [M1] Hence the statement is not accurate. [A1]	

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