Name: _____   Class: _____

JURONG PIONEER JUNIOR COLLEGE

JC2 Preliminary Examination 2024

PHYSICS   **9749/02**

Higher 2   **27 August 2024**

Paper 2   Structured Questions   **2 hours**

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your name, class and index number in the spaces at the top of this page.
Write in dark blue or black pen on both sides of the paper.
You may use an 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.
Answer **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	
1	/ 6
2	/ 8
3	/ 6
4	/ 10
5	/ 10
6	/ 9
7	/ 11
8	/ 20
Total	/ 80

This document consists of **20** printed pages.   [**Turn over**

Data

speed of light in free space $\qquad c = 3.00 \times 10^8 \text{ ms}^{-1}$

permeability of free space $\qquad \mu_0 = 4\pi \times 10^{-7} \text{ Hm}^{-1}$

permittivity of free space $\qquad \varepsilon_0 = 8.85 \times 10^{-12} \text{ Fm}^{-1}$

$\qquad = \left(1/(36\pi)\right) \times 10^{-9} \text{ Fm}^{-1}$

elementary charge $\qquad e = 1.60 \times 10^{-19} \text{ C}$

the Planck constant $\qquad h = 6.63 \times 10^{-34} \text{ Js}$

unified atomic mass constant $\qquad u = 1.66 \times 10^{-27} \text{ kg}$

rest mass of electron $\qquad m_e = 9.11 \times 10^{-31} \text{ kg}$

rest mass of proton $\qquad m_p = 1.67 \times 10^{-27} \text{ kg}$

molar gas constant $\qquad R = 8.31 \text{ JK}^{-1}\text{mol}^{-1}$

the Avogadro constant $\qquad N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$

the Boltzmann constant $\qquad k = 1.38 \times 10^{-23} \text{ JK}^{-1}$

gravitational constant $\qquad G = 6.67 \times 10^{-11} \text{ Nm}^2\text{kg}^{-2}$

acceleration of free fall $\qquad g = 9.81 \text{ ms}^{-2}$

Formulae

uniformly accelerated motion	$s = ut + \dfrac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
gravitational potential	$\varphi = -\dfrac{GM}{r}$
temperature	$T/K = T/{}^\circ C + 273.15$
pressure of an ideal gas	$p = \dfrac{1}{3}\dfrac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas molecule	$E = \dfrac{3}{2}kT$
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	$R = R_1 + R_2 + ...$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + ...$
electric potential	$V = \dfrac{Q}{4\pi\varepsilon_0 r}$
alternating current/voltage	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \dfrac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \dfrac{\mu_0 NI}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 nI$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \dfrac{\ln 2}{t_{\frac{1}{2}}}$

[Turn over

4

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

1 **(a)** The intensity I of a sound wave moving through a gas is given by

$$I = f^2 A^2 v k$$

where f is the frequency of the wave,
A is the amplitude of the wave,
v is the speed of the wave
and k is a constant that depends on the gas.

Determine the SI base units of k.

SI base units = ... [3]

(b) The maximum useful output power P of a car travelling on a horizontal road is given by

$$P = v^3 b$$

where v is the maximum speed of the car and b is a constant.

For the car,

$$P = 84 \text{ kW} \pm 5\%$$
and $b = 0.56 \pm 7\%$ in SI units.

Determine the absolute uncertainty in the value of v.

absolute uncertainty = ... m s⁻¹ [3]

2 (a) Fig. 2.1 shows a helicopter of mass 4.98×10^3 kg and carrying a load of 4.0×10^3 kg. It is accelerating vertically upwards at 0.32 m s^{-2}.
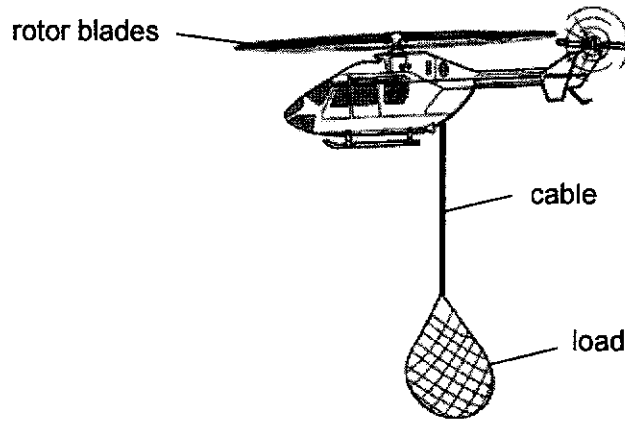
rotor blades

cable

load

Fig. 2.1

(i) Determine the tension in the cable.

tension = ... N [2]

(ii) The rotor blades generate a total thrust of 9.1×10^4 N by imparting a downward velocity v to the air. The length of each rotor blade is 10 m and the density of air is 1.3 kg m^{-3}.

1. Show that the mass of air per unit time passing through the rotor is 410v kg s^{-1}, where v is in m s^{-1}.

[2]

[Turn over

2. Calculate the value of *v*.

$v =$ .... m s^{-1} [2]

(b) The helicopter and its load are now travelling horizontally with a constant acceleration. Fig. 2.2 shows the cable making an angle of 65° to the vertical. The air resistance acting on the load is 6.0×10^3 N.
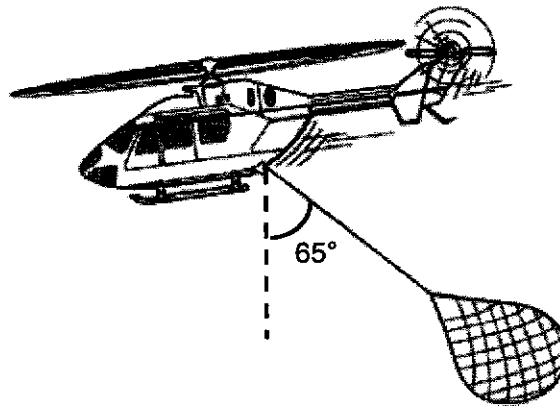

Fig. 2.2

Calculate the magnitude of the acceleration of the helicopter.

acceleration = ... m s^{-2} [2]

3 A student attempts to build a cantilever structure in a school laboratory. Using a rigid uniform metre rule of mass 0.11 kg, a uniform block of mass 1.2 kg and several uniform 5.0 g masses, he sets up the cantilever structure shown in Fig. 3.1.
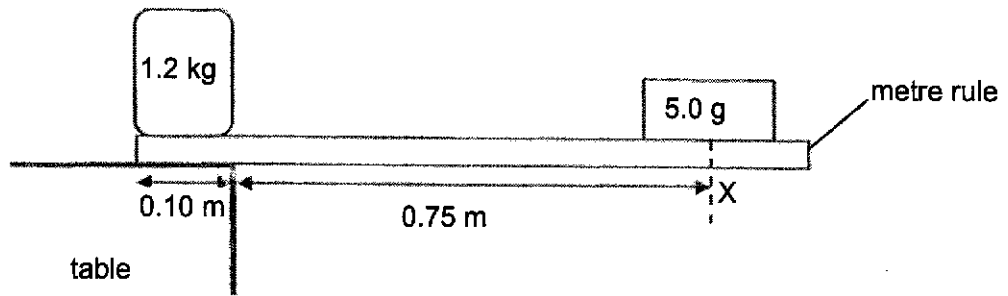

Fig. 3.1

(a) (i) Define the moment of a force.

....

.... [1]

(ii) Determine the maximum number of 5.0 g masses that he can stack at point X before the structure topples.

number of masses = ... [2]

[Turn over

(b) Fig. 3.2 shows the student modifying the structure by adding a string with one end attached to the ceiling and the other end to the centre of the metre rule. Assume that the table surface is rough and no slipping occurs.

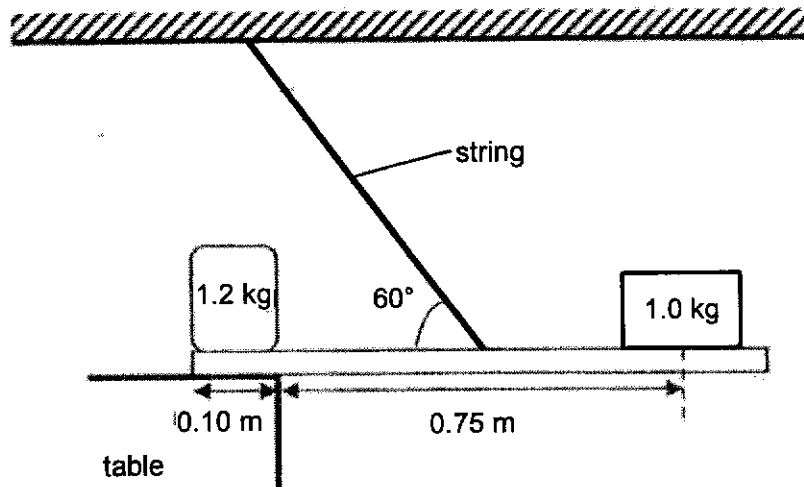He then replaces the 5.0 g mass by a load of 1.0 kg.

Fig. 3.2

(i) On Fig. 3.2, draw an arrow to indicate the tension acting in the string for the system to be in equilibrium. Label the tension T. [1]

(ii) Determine the tension acting in the string if the ruler is just about to topple.

tension = ... N [2]

4 **(a)** Explain why an object moving with uniform speed in a circle must experience a resultant force towards the centre of the circle.

....

....

....

.... [2]

(b) Fig. 4.1 shows a pendulum bob of mass m, attached to the end of a light rigid rod of length L, moving in a vertical circle at a constant speed v.

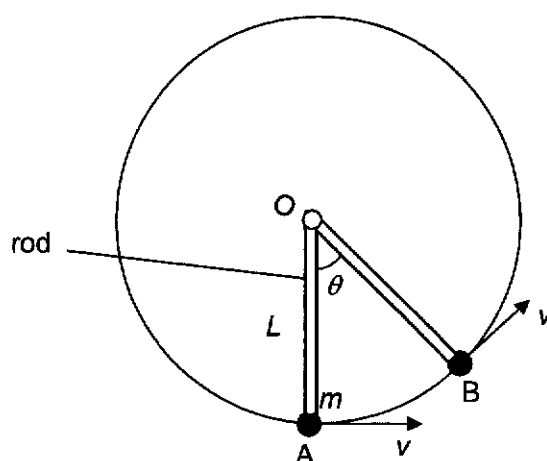The rod starts from position A and sweeps through an angle θ in moving to position B.

Fig. 4.1

(i) Show that the tension T in the rod at position B is

$$T = mg\cos\theta + \frac{mv^2}{L}.$$

[2]

[Turn over

(ii) As the bob moves in the vertical circle, the force in the rod can change from being in tension to being compressed at certain points in the circle.

For a rod of length $L = 0.80$ m and the bob moving at $v = 2.0$ m s^{-1}, determine the angle θ beyond which the rod is under compression.

$\theta =$ ....° [2]

(iii) On the axes of Fig. 4.2, sketch the variation with θ of T (for $0° \leq \theta \leq 180°$). Label the maximum and minimum T in terms of m, v, L and g.
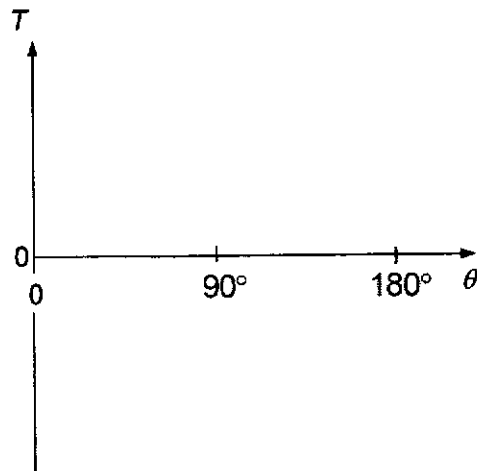

Fig. 4.2

[2]

(iv) Using energy considerations, discuss how the mass can move at a constant speed in a vertical circle.

....

....

....

.... [2]

5 (a) (i) State what is meant by a *longitudinal* wave.

....

.... [1]

(ii) State and explain whether sound waves can be polarised.

....

....

....

.... [2]

(b) A tube is fitted with a movable piston at one end and open at the other end, as shown in Fig. 5.1. This forms an air column in the tube of length L.

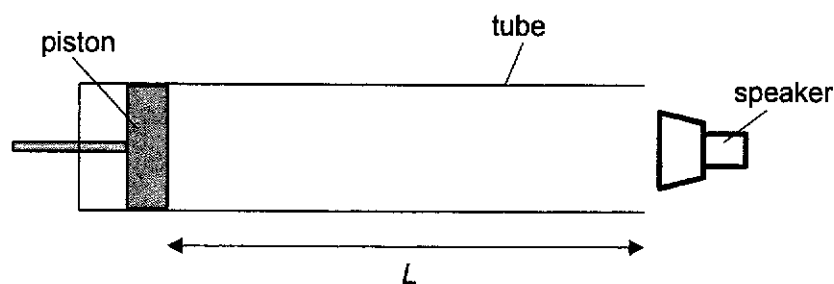Fig. 5.1

A speaker emitting sound waves of velocity 330 m s^{-1} and frequency 440 Hz is placed near the open end of the tube. The piston is pushed rightwards such that L decreases. A total of two loud sounds are heard, indicating that stationary waves are formed at these two instances.

(i) Explain how stationary waves are formed in the tube.

....

....

.... [2]

(ii) At the value of L where the first loud sound is heard,

   1. sketch a diagram representing the stationary sound wave in Fig. 5.1,   [1]

   2. determine L.

$L = $ .... cm   [2]

(iii) Explain why loud sounds are only heard at specific values of L.

....

....

....

.... [2]

6 The variation with potential difference V of current I in a resistor X is shown in Fig. 6.1.
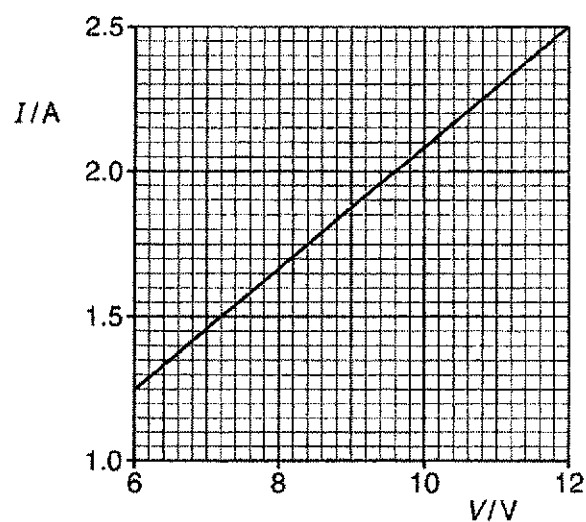
Fig. 6.1

(a) Use data from Fig. 6.1 to show that I is proportional to V.

[2]

(b) The resistor X is connected in the circuit shown in Fig. 6.2.
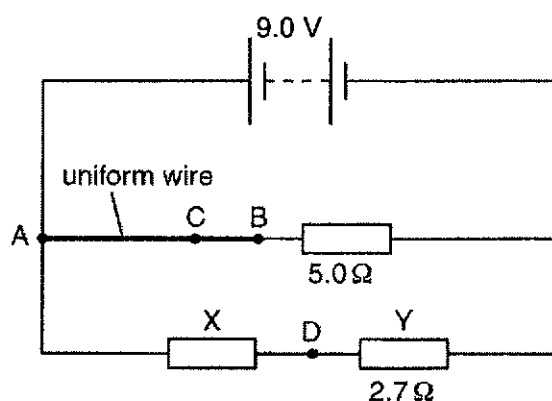

Fig. 6.2

A power supply of e.m.f. 9.0 V and negligible internal resistance is connected across a uniform resistance wire AB and a resistor of resistance 5.0 Ω.
The wire AB has length 1.0 m and resistance 4.0 Ω.
Resistor X and a resistor Y of resistance 2.7 Ω is connected in series across the power supply.

[Turn over

(i) Determine the resistance of the resistor X.

resistance = ... Ω [1]

(ii) Calculate the current in

 1. the wire AB,

current = ... A [1]

 2. the resistor X.

current = ... A [1]

(iii) On Fig. 6.2, point C is at a distance 70 cm from point A on the wire AB. Point D is between resistor X and Y.

Calculate the potential difference between the points C and D.

potential difference = ... V [3]

(iv) If the internal resistance of the power supply is not negligible, state and explain the change (if any) to answer in (iii).

....

.... [1]

7 Fig. 7.1 shows an electron with a horizontal velocity of 1.5×10^7 m s^{-1} entering the region between two horizontal plates which are 40 mm apart and 80 mm long. The upper plate is at a potential of +40 V and the lower plate is at a potential of –40 V.
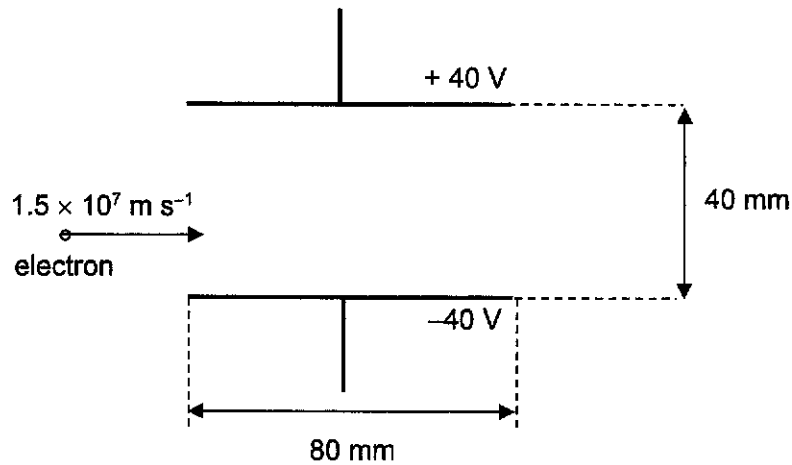

Fig. 7.1

(a) Determine the magnitude of the electric field strength in the region between the plates.

field strength = ... V m^{-1} [1]

(b) Determine the magnitude of the acceleration of the electron in the region between the plates.

acceleration = ... m s^{-2} [2]

(c) Show that the vertical component of the velocity of the electron as it emerges from the plates is 1.9×10^6 m s^{-1}.

[2]

(d) Determine the angle θ through which the electron has been deflected as a result of passing between the plates.

angle θ = ... ° [1]

(e) After passing through the plates, the electron enters the region of magnetic field B of flux density 1.62×10^{-4} T at an angle θ, as found in **(d)**, and goes into helical motion of radius R, as shown in Fig. 7.2.
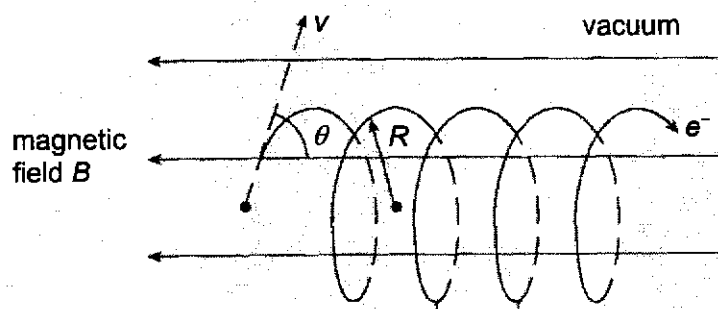

Fig. 7.2

(i) Calculate the radius R of the helical path.

R = ... m [3]

(ii) Calculate the time taken for the electron to complete one revolution of the helical motion.

time = ... s [2]

8 The large amount of energy released in a nuclear fission reaction, together with the emission of more than one neutron, makes it possible for neutron-induced fission to be used as a source of useful energy for the shipping industry. An example of a nuclear-powered cargo ship is Sevmorput, which has a mass of 3.40×10^7 kg and a maximum speed of 20.8 knots (1 knot = 0.514 m s^{-1}). Sevmorput is powered by a nuclear fission reactor that produces thermal power for a steam turbine. A single propeller is mechanically coupled to the steam turbine which has a maximum output of 29400 kW. The propeller turns at 115 rounds per minute.

In a nuclear fission reactor, a neutron is captured by a Uranium-235 nucleus, and this causes the nucleus to fission. On average, 2.5 neutrons are emitted in these fission reactions. This is illustrated in Fig. 8.1.
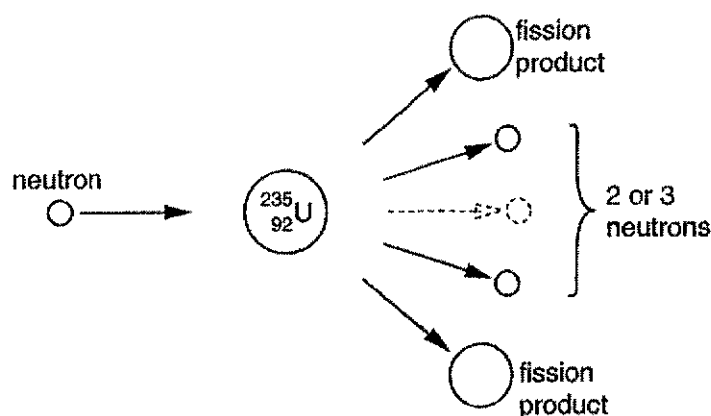

Fig. 8.1

When the conditions are suitable, a chain reaction can occur. If this chain reaction is not controlled, an explosion is likely. However, if the chain reaction is controlled, as in a nuclear fission reactor, a source of continuous power may be created.

The induced fission reaction of Uranium-235 may be represented by a nuclear equation of the form

$$^{235}_{92}U + {}^1_0n \rightarrow {}^a_bP + {}^c_dQ + (2 \text{ or } 3){}^1_0n + 198 \text{ MeV}.$$
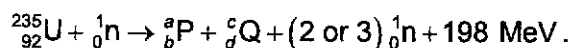
The fission products P and Q have approximately equal masses. However, when any two nuclei are fissioned, the fission products may not be the same. If a large sample of Uranium-235 is fissioned, many different fission products will be produced. The percentage amount of each fission product in the fissioned material is referred to as percentage yield.

The variation with nucleon number of the percentage yield of different fission products is referred to as a 'fission yield curve' and is illustrated in Fig. 8.2.
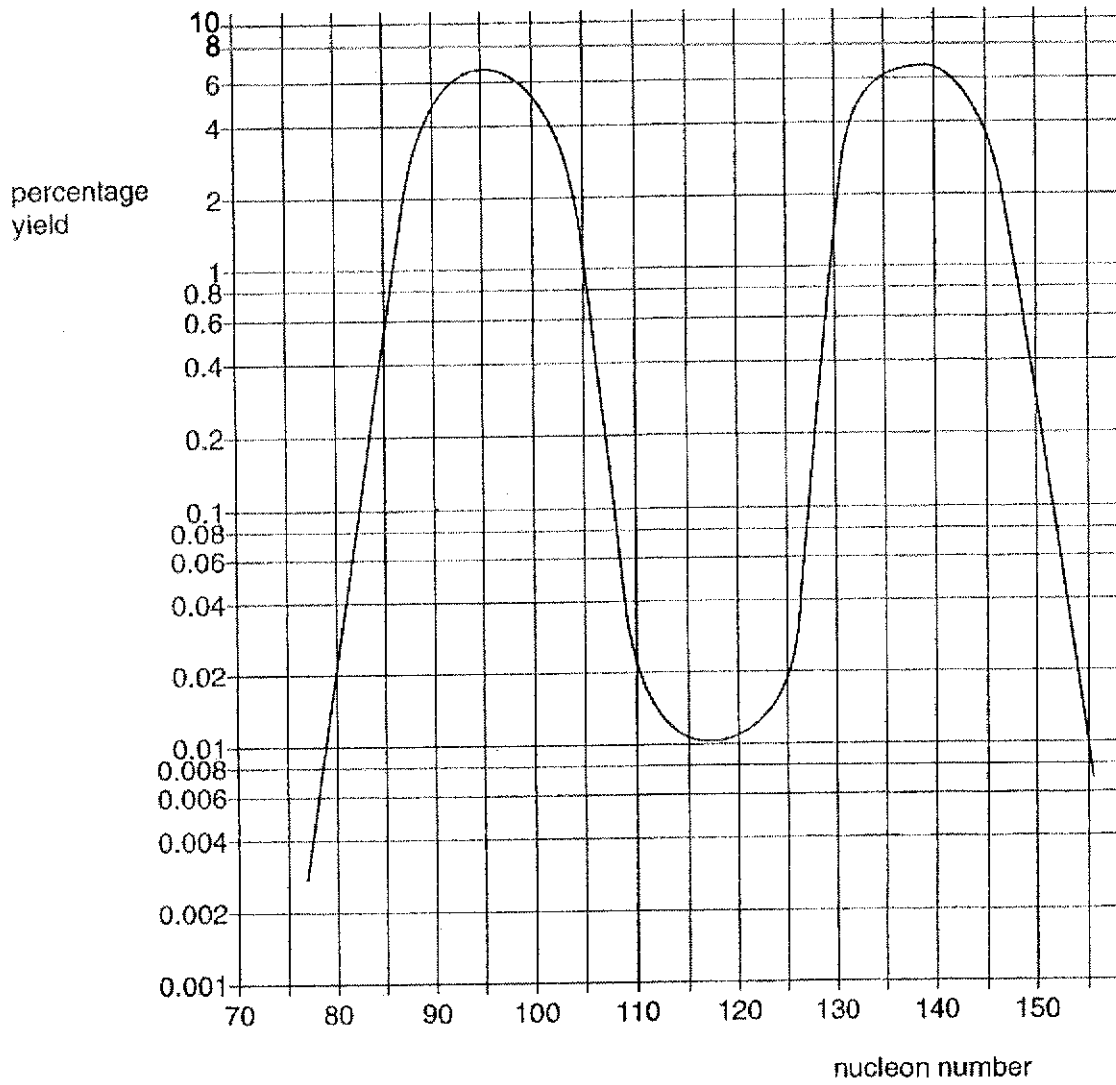
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Fig. 8.2

(a) Calculate

(i) the maximum kinetic energy of Sevmorput,

kinetic energy = ... J   [2]

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(ii) the angular speed of the propeller.

angular speed = ... rad s^{-1} [2]

(b) The nuclear fission reactor converts 2.15×10^5 kg of water at 100 °C to steam at 100 °C every hour, to be used by the steam turbine.

Calculate the maximum efficiency of the steam turbine. The specific latent heat of vaporisation of water is 2.26×10^6 J kg^{-1}.

efficiency = ... % [3]

(c) (i) Explain what is meant by a *chain reaction*.

....

....

.... [1]

(ii) Suggest why, in an uncontrolled chain reaction where all neutrons are captured by Uranium-235 nuclei, the majority of the energy is released during the final stages of the fission of a sample of the uranium.

....

....

.... [1]

(iii) The energy released in the reaction occurs partly as kinetic energy of the fission products and of the neutrons.

Suggest one other mechanism by which energy is released in the fission reaction.

.... [1]

[Turn over

(d) (i) Use Fig. 8.2 to determine the nucleon numbers of those fission products that have the same percentage yield as the nuclide with a nucleon number of 82.

....

.... [2]

(ii) By reference to the nuclear equation, and your answer in **(i)**, suggest the nucleon number of the nuclide that would be produced in the same fission reaction as the nuclide with nucleon number 82.

nucleon number = ... [1]

(iii) Use Fig. 8.2 to determine the percentage yield of fission products having nucleon numbers of 95 and 139.

percentage yield = ... [1]

(iv) Hence show that the fission products in **(iii)** are about 600 times more likely to be produced than those having masses equal to each other.

[2]

(e) A sample of Molybdenum-99 which decays by the emission of β^--particles is stored in a lead container having walls approximately 5 mm thick.

Explain why, although the lead container provides adequate shielding for the β^--particle emissions, some X-ray radiation may be detected outside the lead container.
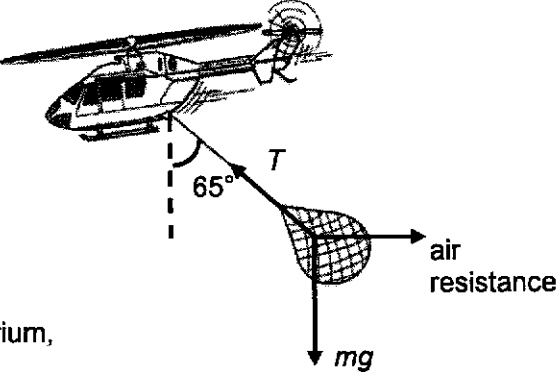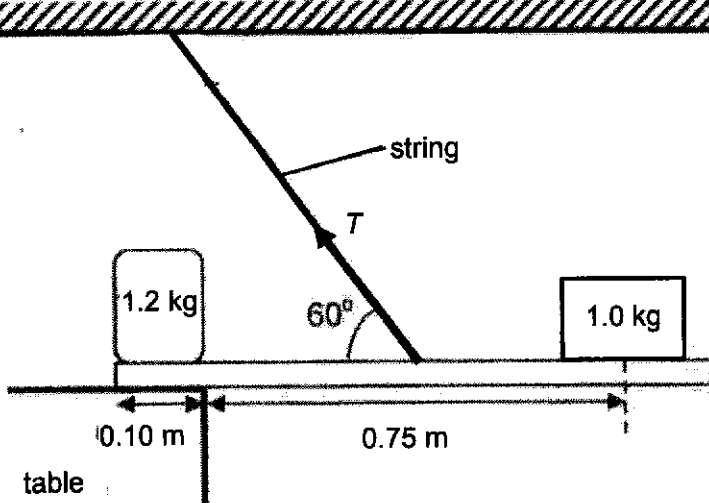
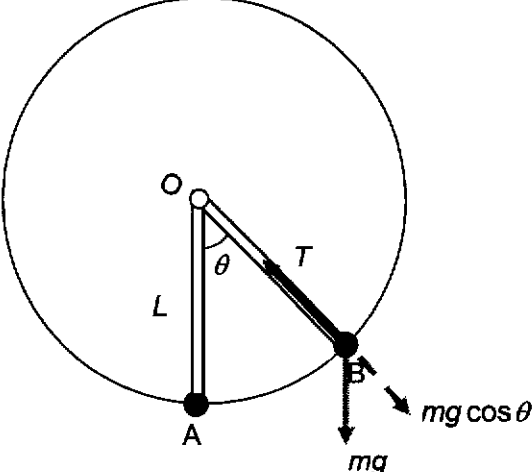...

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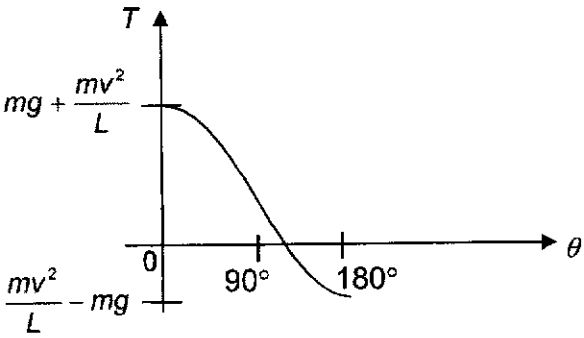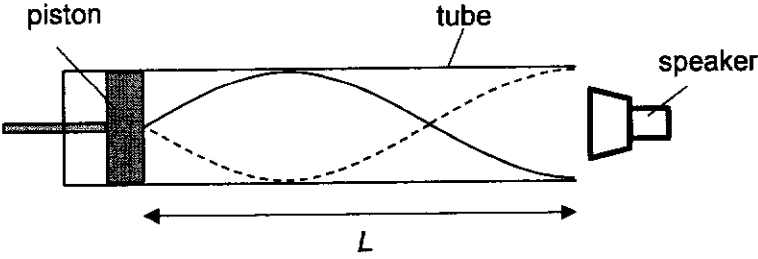.. [4]

End of paper

Answers to 2024 JC2 H2 Preliminary Examinations Paper 2

Suggested Solutions:

No.	Solution	Remarks
1(a)	$I = f^2 A^2 v k$ $k = \dfrac{I}{f^2 A^2 v}$ SI base units of k $= \dfrac{W\ m^{-2}}{s^{-2}\ m^2\ m\ s^{-1}} = \dfrac{kg\ m^2\ s^{-3}\ m^{-2}}{s^{-3}\ m^3} = kg\ m^{-3}$	[1] for correct units of frequency and amplitude [1] for correct base units of power [1] for correct answer
1(b)	$P = v^3 b$ $v = \sqrt[3]{\dfrac{P}{b}} = \sqrt[3]{\dfrac{84 \times 10^3}{0.56}} = 53.133\ m\ s^{-1}$ $P = v^3 b$ $v = \sqrt[3]{\dfrac{P}{b}}$ $\dfrac{\Delta v}{v} = \dfrac{1}{3}\dfrac{\Delta P}{P} + \dfrac{1}{3}\dfrac{\Delta b}{b}$ $\dfrac{\Delta v}{53.133} = \dfrac{1}{3}(0.05) + \dfrac{1}{3}(0.07)$ $\Delta v = 2.1253\ m\ s^{-1}$ $\Delta v \approx 2\ m\ s^{-1}$	[1] for correct value of v [1] for correct substitution [1] for correct answer to 1 s.f.
2(a)(i)	Applying Newton's second law, $T - (4 \times 10^3)(9.81) = (4 \times 10^3)(0.32)$ $T = 4.05 \times 10^4\ N$	[1] for correct substitution [1] for answer
2(a)(ii)1.	mass per unit time $= \rho(\text{vol per unit time})$ $= \rho(Av)$ $= (1.3)\left[\pi(10)^2\right]v$ $= 408v$ $= 410v$	[1] for correct substitution [1] for correct intermediate value
2(a)(ii)2.	Applying Newton's second law, $F_{net} = \dfrac{dp}{dt} = \left(\dfrac{dm}{dt}\right)v$ $9.1 \times 10^4 = (410v)v$ $v = 14.9\ m\ s^{-1}$	[1] for correct substitution [1] for correct answer

2(b)	For vertical equilirium, $$T\cos 65° = mg = (4\times 10^3)(9.81) \quad --- (1)$$ Horizontally, $$T\sin 65° - 6\times 10^3 = ma = (4\times 10^3)a$$ $$T\sin 65° = (4\times 10^3)a + 6\times 10^3 --- (2)$$ $$\frac{(2)}{(1)} : \tan 65° = \frac{ma + 6\times 10^3}{mg}$$ $$a = 19.5 \text{ m s}^{-2} = 20 \text{ m s}^{-2}$$	[1] for correct substitution [1] for correct answer
3(a)(i)	The moment of a force about a pivot is the <u>product</u> of the <u>force</u> and the <u>perpendicular distance from the pivot to the line of action of the force</u>.	[1]
3(a)(ii)	Let N be the number of 5.0 g mass needed for equilibrium. Taking moments about the edge of the table, anti-clockwise moments = clockwise moments $$(1.2)g(0.05) = (0.11)g(0.40) + N(0.005)g(0.75)$$ $$N = 4.3$$ Since N is a whole number, the maximum number is 4.	[1] correct substitution [1] correct answer
3(b)(i)		[1] for T

3(b)(ii)	Taking moments about the edge of the table, anti-clockwise moments = clockwise moments $(1.2)g(0.05) + T\sin 60°(0.40) = (0.11)g(0.40) + (1.0)g(0.75)$ $0.346T = 7.2$ $T = 20.8 \text{ N} = 21 \text{ N}$	[1] correct substitution [1] correct answer
4(a)	Since the direction of motion of the body is always changing, its velocity is not constant and thus a resultant force acts on the body. Since the speed of the body is constant, the resultant force acts perpendicular to its velocity and thus, direction of motion, which is towards the centre of the circle.	[1] [1]
4(b)(i)	 The net force towards centre of the circle provides the centripetal force required to move in a circular path. $T - mg\cos\theta = \dfrac{mv^2}{r}$ $T = mg\cos\theta + \dfrac{mv^2}{L}$, as $r = L$.	 [1] for statement and equation [1] for $r = L$
4(b)(ii)	The point where the force in the rod changes from tension to compression is when $T = 0$ N. $T = mg\cos\theta + \dfrac{mv^2}{L} = 0$ $mg\cos\theta = -\dfrac{mv^2}{L}$ $\cos\theta = -\dfrac{v^2}{gL} = -\dfrac{(2.0)^2}{(9.81)(0.80)} = -0.51$ $\theta = 120.6° = 120°$	[1] for $T = 0$ N [1] for correct substitution and answer

4(b)(iii)		[1] graph is cosine and cuts at about 120° [1] correct values
4(b)(iv)	The K.E. of the mass is constant but its G.P.E. is constantly changing. So as the mass is moving upwards, an external device is needed to supply energy to increase its G.P.E. As the mass moves downwards, its G.P.E. is decreasing and the external device must absorb the lost in G.P.E.	[1] energy supply [1] energy absorb
5(a)(i)	A longitudinal wave is one where the oscillations of the wave particles is parallel to the direction of the wave propagation / energy transfer.	[1]
5(a)(ii)	Sound waves are longitudinal. Since there is no component of a sound wave's oscillation that is perpendicular to its direction of motion, sound waves cannot be polarised.	[1] [1]
5(b)(i)	Sound waves from the speaker travel leftward through the tube and gets reflected by the piston rightwards. The incident sound waves from the speaker superpose with the reflected sound waves by the piston to form stationary waves.	[1] [1]
5(b)(ii)1.		[1]
5(b)(ii)2.	wavelength, $\lambda = \dfrac{v}{f} = \dfrac{330}{440} = 0.75$ m $L = \dfrac{3\lambda}{4} = \dfrac{3}{4} \times 0.75 = 0.563$ m $= 56.3$ cm	[1] for wavelength [1] for correct answer
5(b)(iii)	Stationary waves can only form at specific lengths of the air column, such that a node and an antinode are formed at the closed and opened end of the tube respectively.	[1] [1]

	This can only occurs when <u>L is odd number multiples of quarter wavelength or $L = (\text{odd number})\dfrac{\lambda}{4}$</u>.	
6(a)	At $V = 12$ V, $I = 2.5$ A $\Rightarrow \dfrac{I}{V} = 0.208$ At $V = 6$ V, $I = 1.25$ A $\Rightarrow \dfrac{I}{V} = 0.208$ At $V = 9.6$ V, $I = 2.0$ A $\Rightarrow \dfrac{I}{V} = 0.208$ Since ratio of I to V is constant, I is proportional to V.	[1] show at least 2 values of ratio of $\dfrac{I}{V}$ or $\dfrac{V}{I}$. [1] conclusion
6(b)(i)	Resistance of resistor X $= \dfrac{12}{2.5} = 4.8\ \Omega$	[1] answer
6(b)(ii)1.	Current in wire AB $= \dfrac{9.0}{4.0 + 5.0} = 1.0$ A	[1] answer
6(b)(ii)2.	Current in resistor X $= \dfrac{9.0}{4.8 + 2.7} = 1.2$ A	[1] answer
6(b)(iii)	Resistance of wire AC $= \dfrac{0.70}{1.0} \times 4.0 = 2.8\ \Omega$ Potential difference across AC $= \dfrac{2.8}{4.0 + 5.0} \times 9.0 = 2.8$ V Potential difference across AD $= \dfrac{4.8}{4.8 + 2.7} \times 9.0 = 5.76$ V Potential difference between C and D $= 5.76 - 2.8 = 2.96$ V $= 3.0$ V	[1] value of V_{AC} [1] value of V_{AD} [1] answer
6(b)(iv)	With internal resistance, the <u>potential difference across the power supply would be less</u> than 9.0 V. The potential difference across AC and AD would also be less, and hence the <u>answer in (iii) would be less</u>.	[1]
7(a)	Electric field strength $E = \dfrac{V}{d} = \dfrac{40 - (-40)}{40 \times 10^{-3}} = 2.0 \times 10^3$ V m^{-1}	[1] answer
7(b)	Acceleration $a = \dfrac{F}{m} = \dfrac{eE}{m} = \dfrac{(1.6 \times 10^{-19})(2.0 \times 10^3)}{9.11 \times 10^{-31}}$ $= 3.51 \times 10^{14}$ m s^{-2}	[1] substitution [1] answer (2 or 3 s.f.)
7(c)	Duration of time for electron to stay in electric field is given by $t = \dfrac{s}{v} = \dfrac{80 \times 10^{-3}}{1.5 \times 10^7} = 5.333 \times 10^{-9}$ s	[1] for value of t

	Vertically, using $v = u + at$, $$v = 0 + (3.51 \times 10^{14})(5.333 \times 10^{-9})$$ $$= 1.87 \times 10^6 \text{ m s}^{-1}$$ $$= 1.9 \times 10^6 \text{ m s}^{-1}$$	[1] for velocity 1.87×10^6 m s^{-1}
7(d)	$\tan\theta = \dfrac{v_y}{v_x} = \dfrac{1.9 \times 10^6}{1.5 \times 10^7} \rightarrow \theta = 7.2°$	[1] answer
7(e)(i)	Magnetic force provides centripetal force $$Bev = \frac{mv^2}{R}$$ $$\rightarrow R = \frac{mv}{Be} = \frac{(9.11 \times 10^{-31})(1.9 \times 10^6)}{(1.62 \times 10^{-4})(1.60 \times 10^{-19})}$$ $$= 6.68 \times 10^{-2} \text{ m} = 6.7 \times 10^{-2} \text{ m}$$	[1] statement [1] substitution [1] answer
7(e)(ii)	$$Bev = \frac{mv^2}{R} \rightarrow Be = \frac{mv}{R} = m\omega = \frac{2\pi m}{T}$$ $$\rightarrow T = \frac{2\pi m}{Be} = \frac{2\pi(9.11 \times 10^{-31})}{(1.62 \times 10^{-4})(1.60 \times 10^{-19})}$$ $$= 2.21 \times 10^{-7} \text{ s} = 2.2 \times 10^{-7} \text{ s}$$	[1] substitution [1] answer
8(a)(i)	20.8 knots = 10.6912 m s^{-1} Maximum KE of ship $$= \frac{1}{2}\left(3.40 \times 10^7\right)(10.6912)^2$$ $$= 1.94 \times 10^9 \text{ J}$$	[1] for correct substitution [1] for correct answer
8(a)(ii)	Angular speed $$= \frac{115(2\pi)}{60}$$ $$= 12.0428 \text{ rad s}^{-1}$$ $$\approx 12.0 \text{ rad s}^{-1}$$	[1] for correct substitution [1] for correct answer
8(b)	Power required to convert water at 100 °C to steam at 100 °C every hour $$= \frac{\left(2.15 \times 10^5\right)\left(2.26 \times 10^6\right)}{3600}$$ $$= 1.3497 \times 10^8 \text{ W}$$ Maximum efficiency $$= \frac{29400 \times 10^3}{1.3497 \times 10^8} \times 100\%$$ $$= 21.8\%$$	[1] for correct substitution for power required [1] for correct substitution for efficiency [1] for correct answer

8(c)(i)	In the case of fission, <u>the neutrons produced by each reaction causes further neutron capture</u> by other uranium atoms. This in turn produces more neutrons to cause further reactions.	[1]
8(c)(ii)	At the beginning, the <u>number of neutrons</u> available for capture is small but this <u>escalates to a tremendous value towards the final stages</u>, when there are a large number of simultaneous reactions taking place at the same time.	[1]
8(c)(iii)	Electromagnetic radiation. One example is gamma radiation, light/photons.	[1]
8(d)(i)	108, 127, 152 (All have a percentage yield of 0.06% to 0.08%.)	[2] for all correct [1] for one or two correct
8(d)(ii)	By conservation of mass number 235 + 1 = 82 + c + 2 OR 235 + 1 = 82 + c + 3 Therefore c = 152 or 151 Based on **(d)(i)**, c = 152	[1]
8(d)(iii)	$6.1\% \leq$ percentage yield $\leq 6.9\%$	[1]
8(d)(iv)	For fission products to have the same masses, the nucleon number must be around $0.5(236 - 2) = 117$ (the subtraction of 2 takes into account the estimated number of neutrons produced). For the nucleus with nucleon number 117, the percentage yield is 0.01%. Taking the yield as 6.4%, the ratio is 6.4% divided by 0.01% = 640 times.	[1] [1] if use 0.012% incorrect
8(e)	β^--<u>particles are fast moving electrons</u> and the β^--particles emitted will <u>collide with the atoms</u> of the lead container. These collisions result in the β^--particles undergoing <u>deceleration</u>, either being slowed down <u>by collision (or by deflection)</u>. The electrons will then <u>release energy</u> in the form of the <u>continuous spectrum of the X-ray produced</u>, also called Bremsstrahlung radiation.	[1] for fast moving electrons [1] for collision with atoms [1] for deceleration of β^--particles [1] for releasing energy in the form of X-ray