RIVER VALLEY HIGH SCHOOL
JC2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749
PAPER 1

23 SEP 2022

1 HOUR

CANDIDATE NAME											
CENTRE NUMBER	S					**INDEX NUMBER**					
CLASS	2	1	J								

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, class and index number above.

There are **thirty** questions in this section. Answer **all** questions. For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and shade your choice in **soft pencil** on the separate **Optical Answer Sheet**.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done on the Question Paper.

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

Hand in the Optical Answer Sheet.

This document consists of 15 printed pages.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_0	=	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	$p = \rho gh$
gravitational potential	$\phi = -Gm/r$
temperature	$T / \text{K} = T / {}^\circ\text{C} + 273.15$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
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	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

For each question, there are four possible answers, **A**, **B**, **C** and **D**. Choose the **one** you consider correct and shade your choice in **soft pencil** on the separate **Answer Sheet**.

1 A period T of a type of pendulum is given by

$$T = 2\pi\sqrt{\frac{I}{K}}$$

If I has a unit of kg m^2, which of the following can be a unit of K?

A N m

B N m^{-1}

C kg m^2

D s^{-2}

2 Two stones, X and Y, of different masses are dropped from the top of a cliff. Stone Y is dropped a short time after stone X. Air resistance is negligible. Whilst the stones are falling, the distance between them will

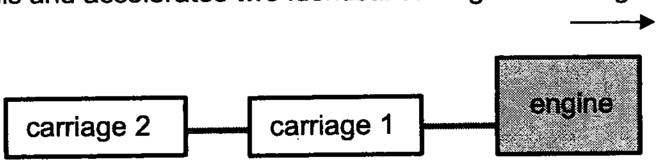
A decrease if the mass of Y is more than the mass of X.

B increase if the mass of X is more than the mass of Y.

C decrease regardless if the mass of X is more than or less than the mass of Y.

D increase regardless if the mass of X is more than or less than the mass of Y.

3 An engine pulls and accelerates two identical carriages to the right as shown below.



If the tension in the towbar between the engine and carriage 1 is T, what is the tension between carriages 1 and 2? Ignore drag and resistive forces.

A T

B $\frac{T}{2}$

C $2T$

D $\frac{T}{3}$

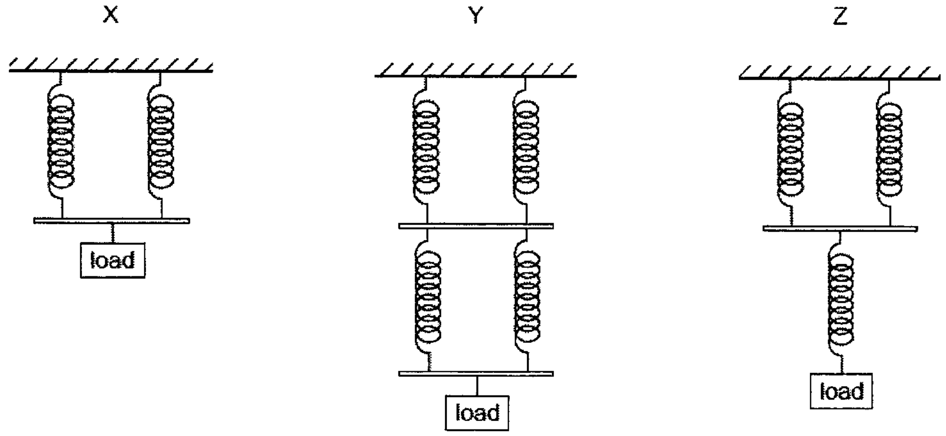
4 A man stands on a weighing scale in a lift moving upwards. When the lift accelerates upwards at 2.0 m s^{-2}, the weighing scale reads W.

What is the reading on the weighing scale when the lift decelerates at 2.0 m s^{-2}?

A 1.5W **B** 1.0W

C 0.83W **D** 0.66W

5 A number of similar springs, each having the same spring constant, are joined in three arrangements X, Y and Z. The same load is applied to each.



What is the order of increasing extension for these arrangements?

	smallest	⟶	largest
A	X	Y	Z
B	X	Z	Y
C	Z	Y	X
D	Y	Z	X

6 A 100 kg block is pulled at a constant speed of 5.0 m s^{-1} across a rough horizontal floor by an applied force of 120 N directed 37° above the horizontal.

What is the rate at which the applied force does work on the block?

A 0 **B** 360 W

C 480 W **D** 600 W

7 Air is enclosed in a cylinder by a gas-tight, frictionless piston of cross-sectional area 3.5×10^{-3} m^2. When atmospheric pressure is 100 kPa, the piston settles 80 mm from the end of the cylinder as shown in Fig. 1.

The piston is then pulled out until it is 160 mm from the end of the cylinder as shown in Fig. 2 and is held there. The temperature of the air in the cylinder is now maintained at half of the original value.

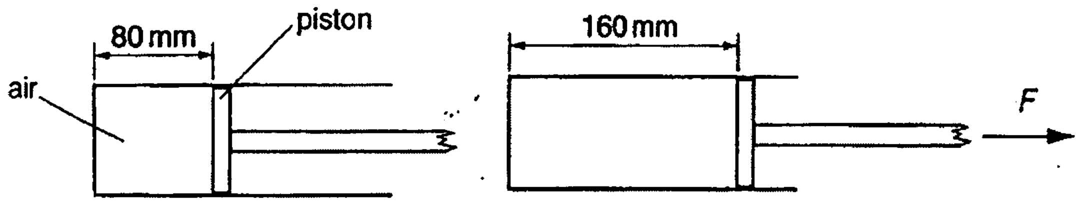


Fig. 1 **Fig. 2**

What is the force *F* required to hold the piston in its new position?

A 88 N **B** 260 N

C 350 N **D** 440 N

8 Two equal masses of an ideal gas initially at the same temperature and pressure are compressed to half of their initial volumes, one of them isothermally, and the other while thermally isolated from its surroundings.

Which of the following must be the same for both samples of the gas?

A The heat given during compression.

B The internal energy of the compressed gas.

C The density of the compressed gas.

D The work done on the gas during compression.

9 When a frictionless and well-insulated bicycle pump is used to pump up a tyre, the air in the tyre becomes hotter than the surrounding air.

Which of the following statements best explains this observation?

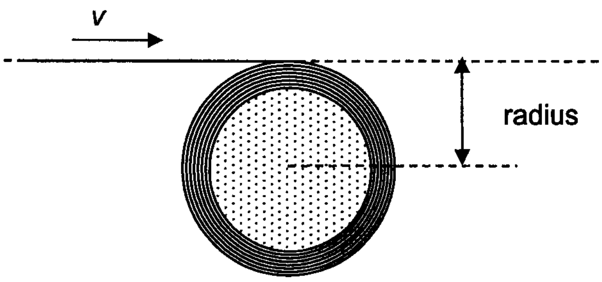
A The internal energy increases because thermal energy is supplied and work is done on the air.

B Work is done on the air and since little thermal energy escapes, the internal energy increases.

C Work is done on the air and the internal energy remains unchanged.

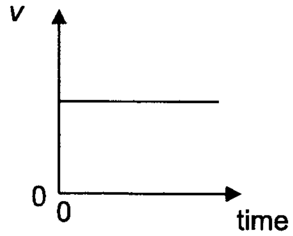
D After compression the air collide more frequently.

10 A straight length of tape winds onto a roll rotating about a fixed axis with constant angular velocity, the radius of the roll increasing at a steady rate.

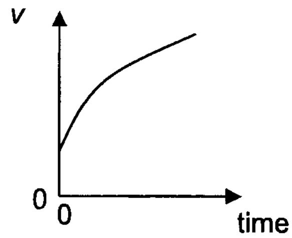


Which of the graphs below correctly shows how the speed v at which the tape moves towards the roll varies with time?

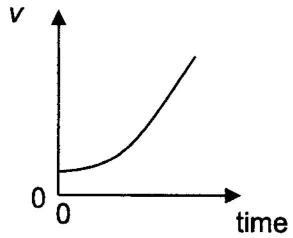
A



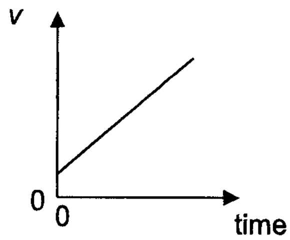
B



C



D



11 A 3.0 kg rock is thrown vertically upwards near the surface of Planet X of mass *m* with a velocity of 45 m s^{-1} and it comes to an instantaneous rest 5.2 s later.

The same rock is now thrown vertically upwards for 15 m near the surface of Planet Y. The difference in gravitational potential between two points that are 4.0 m vertically apart and near the surface of Planet Y is 6.0 J kg^{-1}.

The gravitational field strength can be assumed to be uniform near at the surfaces of both Planet X and Planet Y. If both planets do not have atmosphere, the ratio of the gravitational field strength near the surface of Planet Y to that of Planet X is

A 13

B 5.8

C 0.17

D 0.077

12 Two satellites, A and B, orbiting around Earth have the same kinetic energy. Satellite A has a larger mass than satellite B. Which of the following statements is false?

A Satellite A has a smaller total energy.

B Satellite A has a larger orbital radius.

C Satellite A has a larger period.

D Satellite A has a smaller angular velocity.

13 A mass of 8.0 g oscillates in simple harmonic motion with an amplitude of 5.0 mm at a frequency of 40 Hz.

What is the total energy of this simple harmonic oscillator?

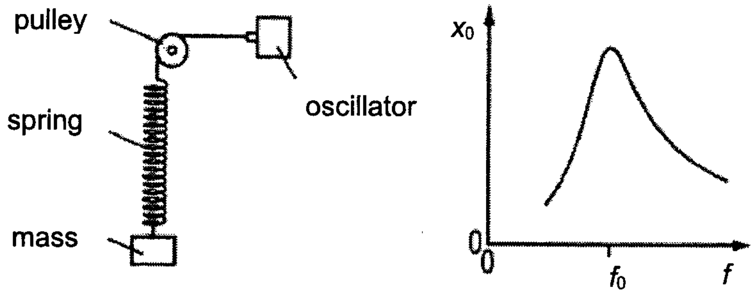
A 0.16 mJ   **B** 6.3 mJ

C 13 mJ   **D** 640 mJ

14 A mass, suspended from a helical spring, is made to oscillate.

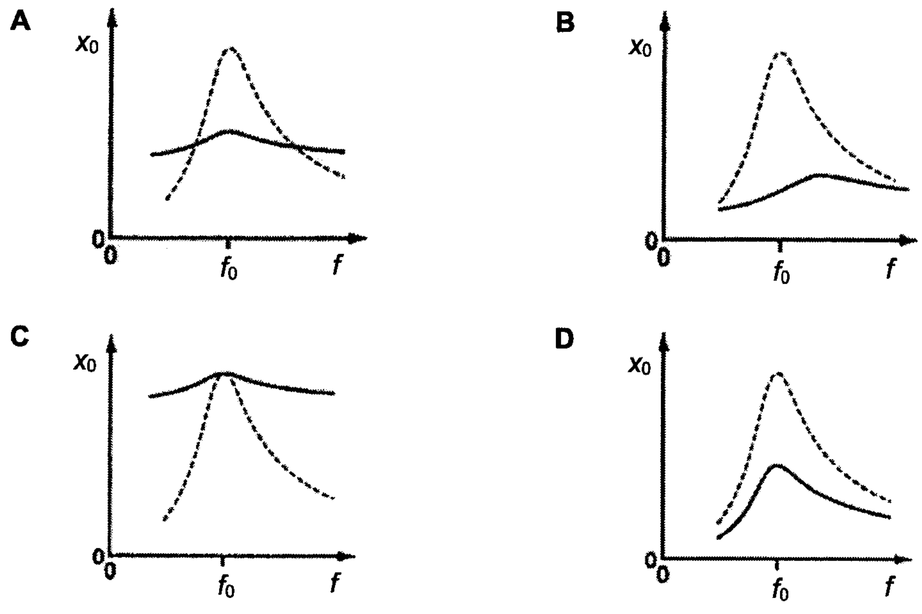
The graph shows the variation with frequency f of the amplitude x_0 of vibration of the mass.

f_0 is the natural frequency of the spring-mass system.



A sheet of cardboard of negligible mass is now fixed to the mass on the spring to cause light damping of the oscillations.

Which graph shows how x_0 will vary with f over the same frequency range?



15 The diagram below shows an instantaneous position of a string as a transverse progressive wave travels along it from left to right.

Which one of the following correctly shows the directions of the velocities of the points 1, 2 and 3 on the string?

	1	2	3
A	→	→	→
B	↓	↓	↓
C	↓	↑	↓
D	↑	↓	↑

16 A taut wire is set into resonance with a node at either end as well as another single node at the centre of the wire.

Which one of the following statements is *not* correct?

A The wavelength of the wave on the wire is equal to the length of the wire.

B All points to one side of the centre vibrate in phase with one another.

C Any two points on either side of the centre have a phase difference of 90°.

D Two points equidistant from the centre on either side of the centre have the same amplitude of vibration.

17 Fringes of separation x are observed in a plane 1.00 m away from a Young's double-slit arrangement illuminated by yellow light of wavelength 600 nm.

At what distance from the slits would fringes of the separation $2x$ be observed when using blue light of wavelength 400 nm?

A 1.00 m **B** 1.50 m

C 1.33 m **D** 3.00 m

18 A car battery of e.m.f. 12 V and internal resistance 0.20 Ω is connected to a load of 4.0 Ω. If the potential difference across the load is 10 V, what is the power lost in the connecting wires?

A 3.0 W **B** 3.8 W

C 4.2 W **D** 6.0 W

19 An alpha particle and a proton are moving perpendicularly to a uniform electric field. The speed of alpha particle is 4.0 times the speed of proton.

Determine the ratio $\frac{\text{component of speed of alpha particle parallel to electric field}}{\text{component of speed of proton parallel to electric field}}$ after time *t*. Ignore the effects due to gravitation field.

A 0.5 **B** 1.0

C 1.5 **D** 2.0

20 In the direction opposite of an electric field line, which of the following must be true?

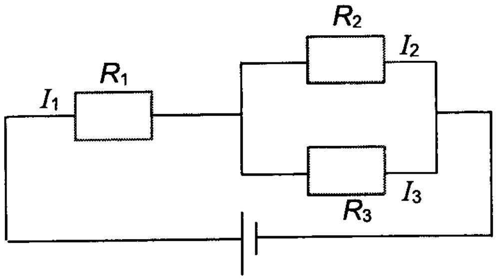
A The potential must decrease.

B The potential must increase.

C The electric field strength must decrease.

D The electric field strength must increase.

21 Three resistors are connected to a battery with negligible internal resistance as shown below. The current through R_1, R_2 and R_3 are I_1, I_2 and I_3 respectively.



What is the ratio $\frac{I_3}{I_1}$?

A $\frac{R_3}{R_1}$

B $\frac{R_2}{R_3}$

C $\frac{R_3}{R_2 + R_3}$

D $\frac{R_2}{R_2 + R_3}$

22 An overhead power cable carries an alternating current of 2000 A r.m.s.

At what perpendicular distance would the peak magnetic flux density due to the current in the cable be 100 μT?

A 2.8 m

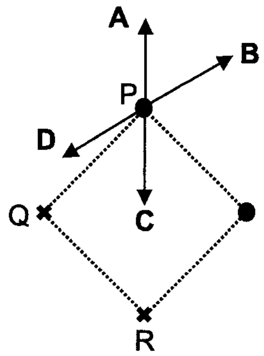
B 4.0 m

C 5.7 m

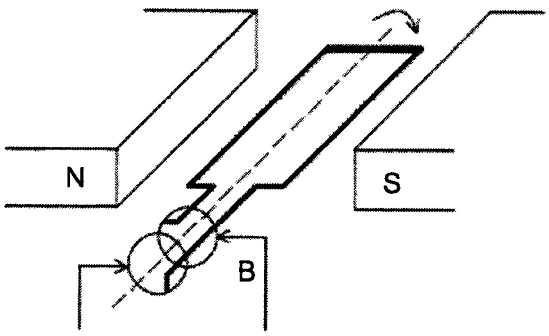
D 8.0 m

23 Four parallel wires, carrying equal currents either into or out of the plane of the page, pass vertically through the four corners of a square.

Which of the vectors denote the resultant force acting on the wire placed at P?



24 A simple electric generator is shown below. A single coil is rotated as indicated between magnetic poles N and S. Electrical contact between coil and external circuit is maintained through brushes B touching the rings.



At the instant when the rotating coil is oriented as shown, the output of the generator

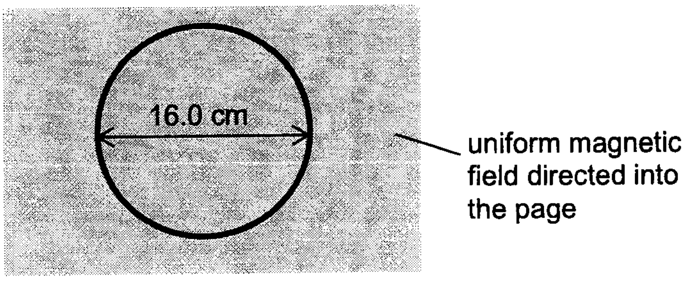
A has its maximum value.

B reverses its direction.

C has the same value as in any other orientation of the coil.

D is zero.

25 A circular coil of diameter 16.0 cm and resistance 4.00 Ω is placed in a uniform magnetic field of flux density 5.00 T directed perpendicularly into the coil.



If the magnetic flux density is reduced to zero at a constant rate over 10.0 ms, what can be deduced about the current flowing in the coil during this change?

	magnitude of current / A	direction
A	2.51	clockwise
B	2.51	anticlockwise
C	10.1	clockwise
D	10.1	anticlockwise

26 A transformer has 500 primary turns and 10 secondary turns. A resistor of 15 Ω is connected in the secondary coil.

If the root-mean-square voltage across the primary coil is 120 V, what is the root-mean-square current in the primary coil?

A 0.0032 A **B** 0.16 A

C 2.4 A **D** 8.0 A

27 Which of the following phenomenon provides the evidence for wave nature of electrons?

A photoelectric effect

B x-ray diffraction

C electron diffraction

D deviation of electrons by electric and magnetic fields

28 An electron and a proton are accelerated across a potential difference of 15.0 kV.

What is the ratio $\frac{\text{de Broglie wavelength of the proton}}{\text{de Broglie wavelength of the electron}}$?

A 5.45×10^{-4} **B** 2.34×10^{-2}

C 42.8 **D** 1.83×10^{3}

29 A detector of ionising radiation gives a background count rate of 24 per minute.

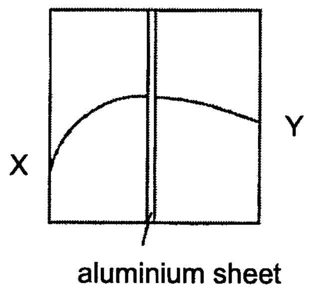
A radioactive source is placed near the detector and the reading is 532 counts per minute.

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

A 127 **B** 133

C 151 **D** 157

30 Radiation from a radioactive source enters an evacuated region in which there is a uniform magnetic field perpendicular to the plane of the diagram. This region is divided into two by a sheet of aluminium about 1 mm thick. The curved path followed by the radiation is shown in the figure below.



Which of the following correctly describes the type of radiation and its point of entry?

	type of radiation	point of entry
A	alpha	X
B	alpha	Y
C	beta	X
D	beta	Y

END OF PAPER

RIVER VALLEY HIGH SCHOOL
JC 2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749 / 2
PAPER 2

12 SEPTEMBER 2022

2 HOURS

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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.

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

*Answer **all** questions.*

The number of marks is given in brackets [ ] at the end of each question or part question.

FOR EXAMINERS' USE	
Paper 2	
1	/ 5
2	/ 7
3	/ 10
4	/ 6
5	/ 12
6	/ 8
7	/ 12
8	/ 20
Deduction	
Paper 2	**/ 80**

This document consists of **22** printed pages.

Data

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velocity of particle in s.h.m.,	$v = v_0 \cos \omega t$ $= \pm \omega\sqrt{(x_0^2 - x^2)}$
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decay constant,	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

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

1 **(a)** State what is meant by a *random error*?

....

.... [1]

(b) A ship at sea is travelling with a velocity of 13 m s^{-1} in a direction 35° east of north in still water, as shown in Fig. 1.1.

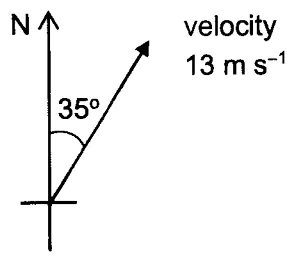


Fig. 1.1

(i) Calculate the north component of the ship's velocity.

north component of velocity = ... m s^{-1} [1]

(ii) The ship's velocity is measured with an uncertainty of ± 10 %. Its direction is measured with an uncertainty of ± 1°.

Determine the north component of the velocity with its associated uncertainty.

north component of velocity = ... ± .... m s^{-1} [3]

2 **(a)** Explain what is meant by a system is in *equilibrium*.

....

....

.... [2]

(b) In a children's game, small balls are thrown at wood blocks in order to turn them over. One such block, of mass 300 g, with each side of length 10 cm, is shown in Fig. 2.1 below.

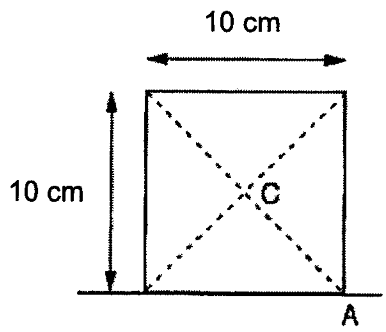


Fig. 2.1

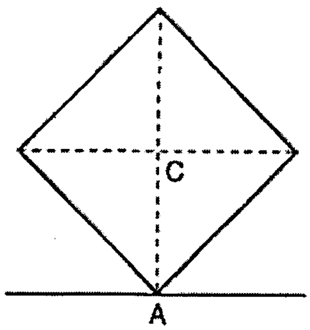


Fig. 2.2

In order to turn the block over, the centre of gravity C must be raised such that that C is vertically above the corner A, as shown in Fig. 2.2.

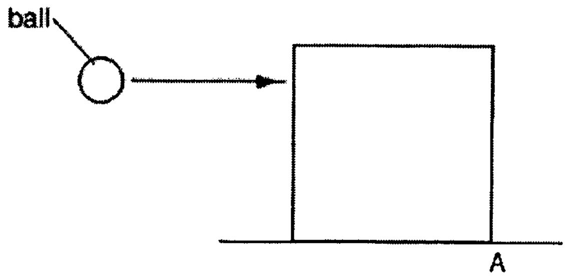


Fig. 2.3

The block is struck by a ball of mass 15 g travelling horizontally 1.0 cm below the top surface of the block as shown in Fig. 2.3. The collision is perfectly elastic and, without sliding, the block turns about the corner A.

(i) Label on Fig. 2.3, the forces acting on the block when the ball just hits the block causing it to turn about corner A.

[2]

(ii) Hence or otherwise, determine the minimum force needed for ball to act on the block in order for the block to turn about A.

force = ... N [3]

3 Fig. 3.1 shows a frictionless piston-cylinder with a built-in heater.

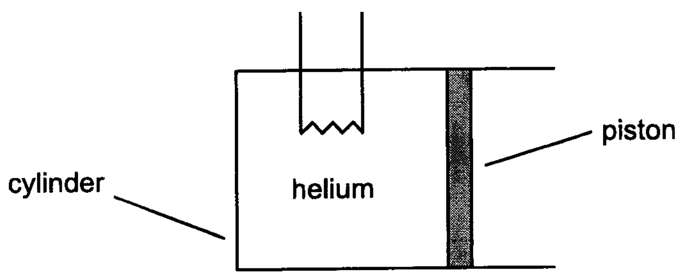


Fig. 3.1

Before the heater is switched on, the cylinder contains 0.60 m^3 of helium gas at pressure 101 kPa and temperature of 28 °C. When the heater is switched on for 15 minutes, the gas expands at constant pressure and its temperature rises to 57 °C. A heat loss of 7000 J to the surrounding occurs during the process.

Assume the gas behaves like an ideal gas and the heater is rated at 24 W and 120 V.

(a) **(i)** Using the kinetic theory of gases, explain why the volume of the gas expands when it is heated at constant pressure.

....

....

....

....

.... [2]

(ii) On Fig. 3.2, sketch the pressure-volume graph for the process. Label the graph with appropriate values of pressure and volume.

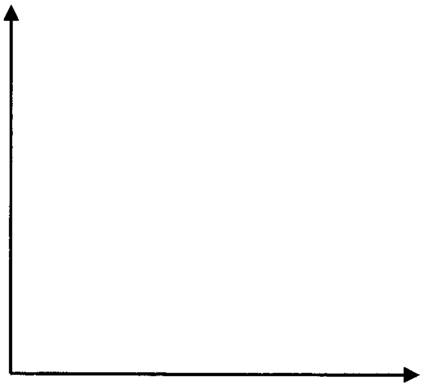


Fig. 3.2

[2]

(iii) Using *first law of thermodynamics*, determine the change in internal energy of the helium gas.

change in internal energy = ... J [3]

(b) The thermodynamic temperature of a gas T is a measure of the average translational kinetic energy of a molecule in the gas. The pressure p of an ideal gas is related to its microscopic quantities by the relationship $pV = \frac{1}{3}Nm\langle c^2 \rangle$ where

V : volume occupied by the gas
N : total number of gas molecues
m : mass of each gas molecule
$\langle c^2 \rangle$: mean square speed of the gas molecules.

(i) By comparing the above relationship with $pV = Nkt$, where k is the Boltzmann constant, show that the average kinetic energy of the molecules is $E = \frac{3}{2}kT$.

[1]

(ii) Hence, calculate the root-mean-square speed of a helium molecule at 57.0 °C. The mass of one mole of helium molecules is 4.00 g.

root-mean-square speed = ... m s^{-1} [2]

4 **(a)** Define *progressive waves.*

....

.... [1]

(b) A sound wave is sent from a speaker operating at 1500 W in all directions at a frequency of 850 Hz in a gas.

(i) Fig. 4.1 shows the position of some gas molecules at a particular instant of time. The distance between particles P and Q is 0.600 m.

Fig. 4.1

Calculate the speed of sound in this gas.

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

(ii) Assume that the sound from the speaker strikes the surface of the ear of an adult perpendicularly which has a surface area of 2.1×10^{-3} m^2.

Determine how much power is intercepted by the ear of an adult standing 80.0 m away from the speaker.

power = ... W [3]

5 **(a)** Explain what is meant by *destructive interference*.

....

....

.... [2]

(b) Fig. 5.1 shows two coherent loudspeakers S_1 and S_2 placed 4.0 m apart in an open field on a calm day. D is a detector placed in the same horizontal plane as the loudspeakers. D is placed 12.0 m away from S2. When the loudspeakers are switched on, sound of frequency 1780 Hz is emitted from the two loudspeakers in antiphase. The lines S_1S_2 and S_2D are perpendicular to each other.

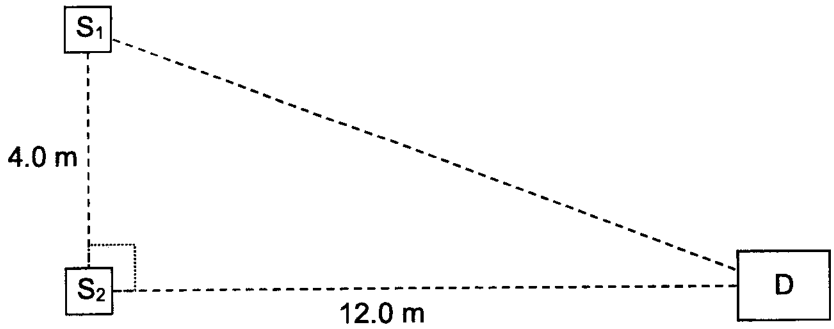


Fig. 5.1

(i) Given that the speed of sound in air is 330 m s^{-1}, calculate the wavelength λ of the sound emitted from S_1 and S_2.

λ = ... m [1]

(ii) Calculate the path difference, in terms of λ, between the sound waves reaching D from S_1 and S_2. You may assume that the two loudspeakers and the detector are point objects.

path difference = ... λ [2]

(iii) Hence, state and explain whether a loud sound would be heard at D.

....

....

....

.... [2]

(c) Light of wavelength 590 nm is incident on a diffraction grating with slits of separation 1.6×10^{-6} m.

(i) Determine the maximum order of the interference pattern that will be observed on a screen placed in front of the grating.

maximum order =...................... [2]

(ii) Another diffraction grating of the same slit separation is placed in front of the original grating such that their slits are perpendicular to one another as shown in Fig. 5.2. A 2-dimensional pattern of bright spots is formed on the screen.

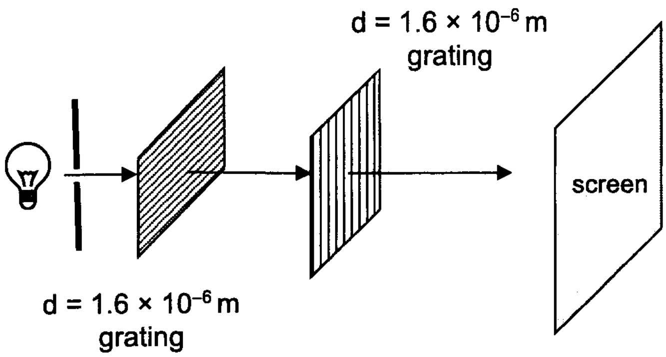


Fig. 5.2

On Fig. 5.3, sketch the pattern obtained, showing clearly the relative separation of the spots.

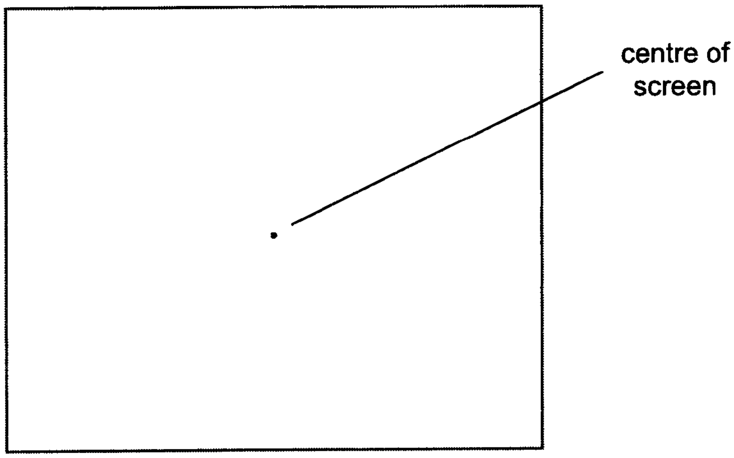


Fig. 5.3

[2]

(iii) State how your answer in **(c)(ii)** will change when a blue light source is used.

....

.... [1]

6 A load resistor R and a diode are connected to an alternating current (a.c.) source as shown in Fig. 6.1.

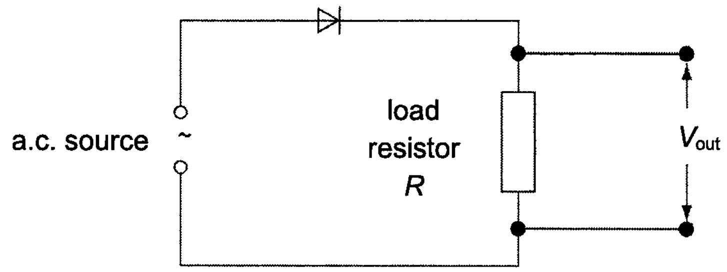


Fig. 6.1

The a.c. source supplies a voltage V, where

$$V = V_0 \sin 100\pi t$$

(a) **(i)** Determine the period of variation of V.

period = ... s [1]

(ii) On Fig. 6.2, sketch the variation with time of V_{out}. Label the time axis.

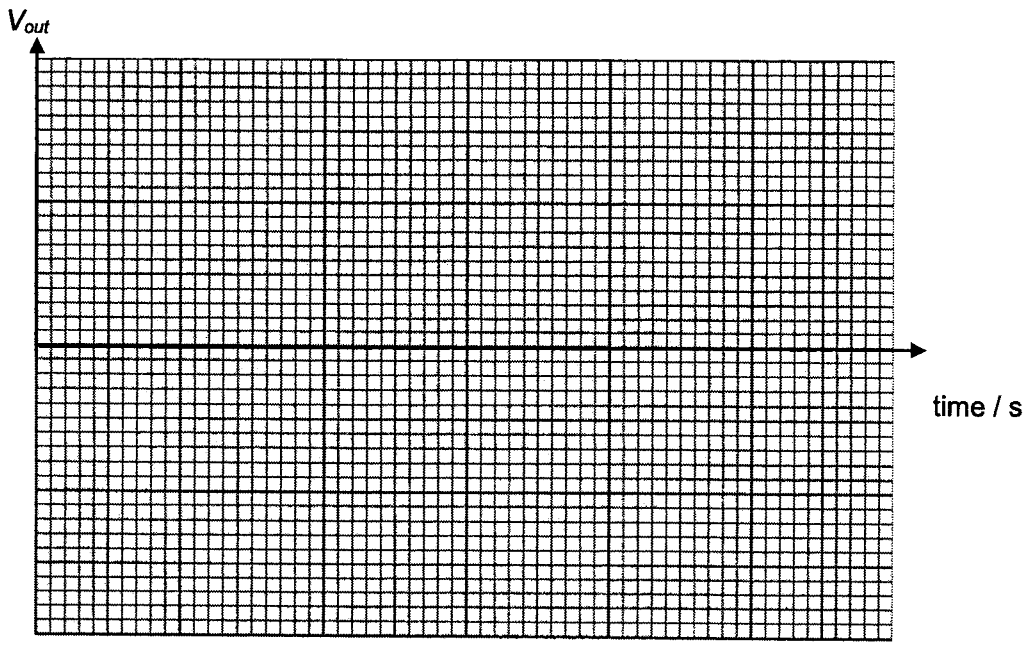


Fig. 6.2

[2]

(b) **(i)** The mean power dissipated in load resistor R is found to be 40 W.

If R = 640 Ω, determine the value of V_0.

V_0 = ... V [3]

(ii) On Fig. 6.3, sketch the variation with time of power dissipated across the load resistor R. Label both axes.

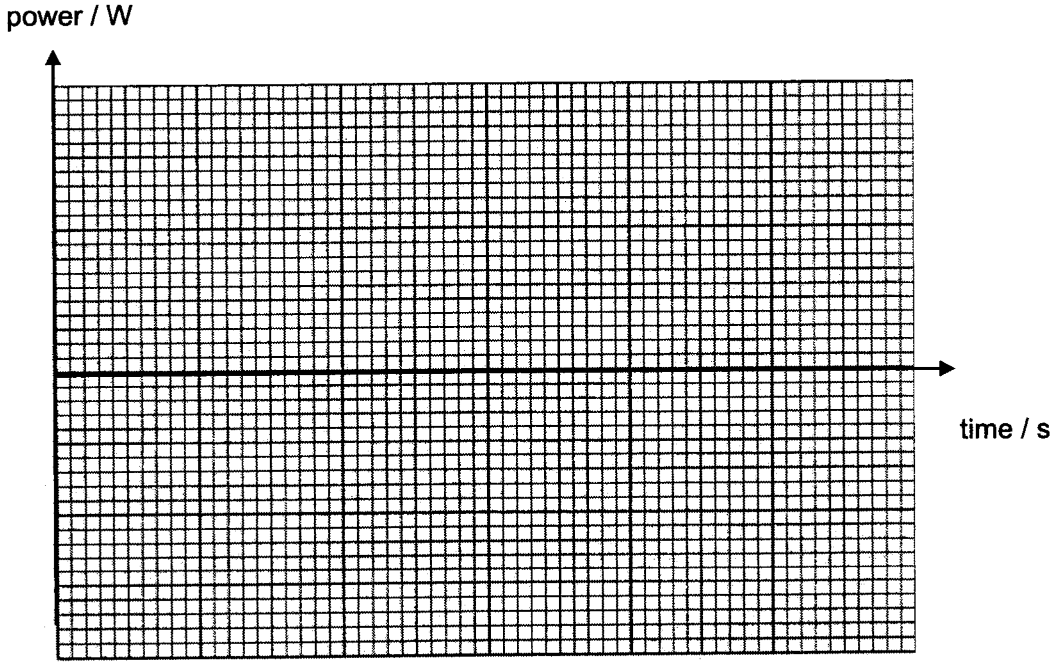


Fig. 6.3

[2]

7 (a) In an experiment to investigate the photoelectric effect, a student measures the wavelength λ of the light incident on a metal surface and the maximum kinetic energy E_{max} of the emitted electrons.

(i) The student observes that the emission of electrons is almost instantaneous.

Explain how this observation supports the particulate nature of photon.

....

....

.... [1]

(ii) Suggest why the emitted electrons have a range of energies, from very low to a maximum value of E_{max}.

....

....

.... [1]

(iii) The variation with E_{max} of $\frac{1}{\lambda}$ is shown in Fig. 7.1.

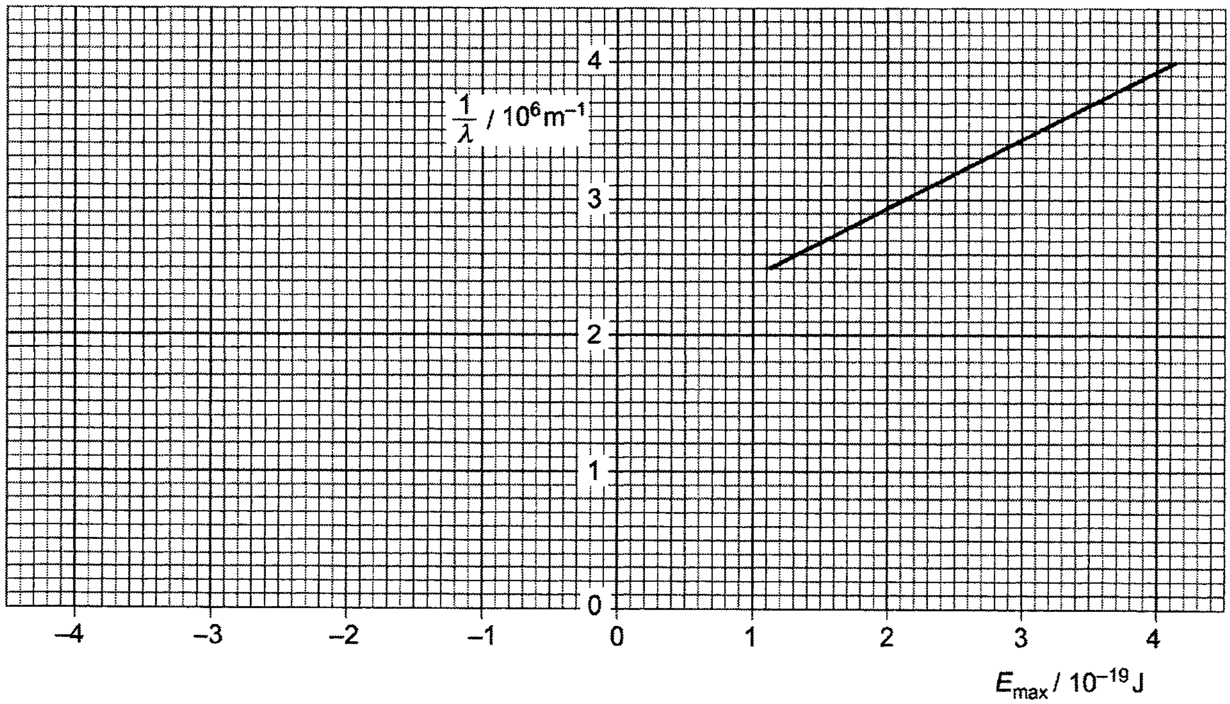


Fig. 7.1

1. Use Fig. 7.1 to determine work function of the metal the student used.

work function = ... J [1]

2. Use Fig. 7.1 to determine a value for the Planck's constant obtained by the student.

Planck's constant = ... J s [2]

(iv) In a separate experiment, the student increases the intensity of a monochromatic light incident on the metal.

State and explain the effect, if any, on E_{max}.

....

....

....

.... [2]

(b) Fig. 7.2 shows three of the energy levels in an isolated hydrogen atom. The lowest energy level is known as the ground state.

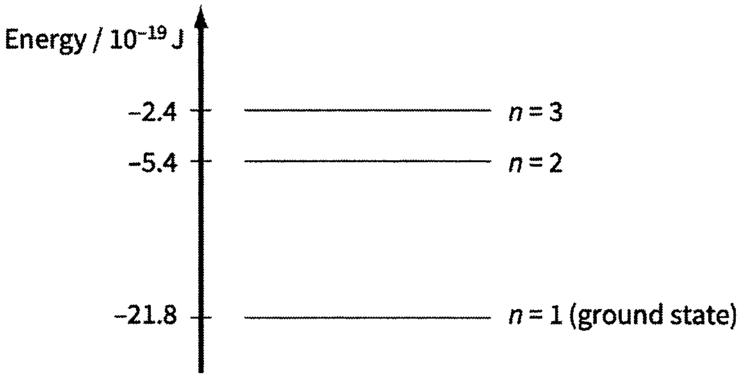


Fig. 7.2

(i) A particular dark spectral line of the hydrogen absorption spectrum has wavelength 663 nm.

Determine the transition that results in this dark line. Show your working clearly.

n = ... to n = ... [3]

(ii) The energy E in each energy levels are labelled with n, the principal quantum number.

Use Fig. 7.2 to show that E is inversely proportional to n^2. Show your working clearly.

[2]

8 While the first nuclear explosion occurred on July 1945, when a plutonium implosion device was tested in New Mexico, it relied on nuclear fission in order to produce the explosive energy. Nuclear fusion on the other hand, is something that laboratories all around the world are still working on for the last few decades. Scientists have managed to produce working nuclear reactors which managed to combine deuterium and tritium for a short period of time. However, they have not yet succeeded in having a working nuclear reactor that is self-sustaining.

Our Sun is the nearest nuclear fusion reactor. To fuse on our Sun, nuclei need to collide with each other at very high temperatures and pressures within the core.

One of two known sets of nuclear fusion reactions by which stars convert hydrogen to helium is the proton-proton chain. It starts with the fusion of two protons into a deuteron which then goes through further reactions as shown in Fig. 8.1.

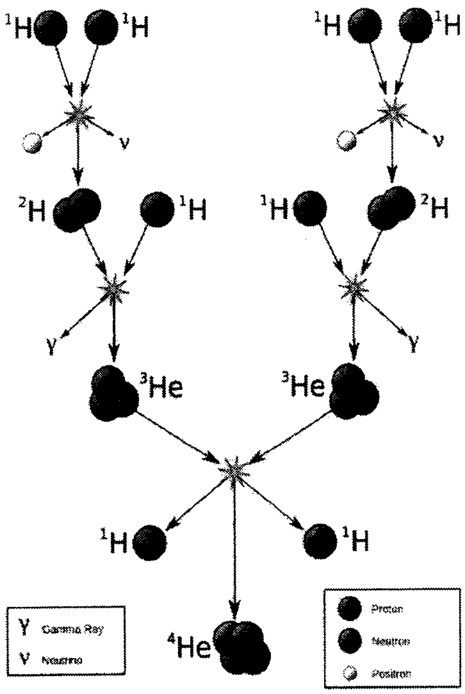


Fig. 8.1

The overall equation is as follows.

$$4{}^{1}_{1}H \rightarrow {}^{4}_{2}He + 2{}^{0}_{+1}e$$

Our Sun will continue to fuse hydrogen into helium via the proton-proton chain and other reactions until the amount of hydrogen in the core is depleted. Scientists have calculated that based on our Sun's luminosity of about 3.8×10^{26} W and its mass of 2.0×10^{30} kg, it has a predicted lifetime of 10 billion years. When our Sun nears the end of its lifetime, our Sun will grow into in size to become a red giant where it will be become 100 times as large in radius and 1000 times as bright in luminosity.

When our Sun becomes a red giant, it will be able to fuse helium into carbon in its core. Stars that are even more massive will be able to fuse carbon into neon, and into other heavier elements. However even the most massive stars stop fusion when they have an iron core.

(a) **(i)** State one similarity and one difference between nuclear fusion and fission.

Similarity: ....

.... [1]

Difference: ....

.... [1]

(ii) Explain what is meant by the term self-sustaining.

....

.... [1]

(iii) Suggest one benefit of nuclear fusion over nuclear fission in terms of power generation.

....

.... [1]

(b) The passage states that nuclei need to collide with each other at very high temperatures and pressure.

Explain why the following are necessary.

(i) High temperatures

....

....

.... [2]

(ii) High pressures

....

....

.... [1]

(c) Given that the masses of the atomic particles involved are

m_H = 1.007825 u
m_{He} = 4.002604 u
m_e = 0.000549 u

(i) Determine the difference in mass between the reactants and products in the fusion reaction stated in the passage.

mass = ... kg [2]

(ii) Hence, determine the net energy released in the fusion of four hydrogen nuclei into one helium nuclei.

energy released = ... MeV [1]

(iii) Determine the percentage loss in mass during the fusion.

percentage loss = ... [1]

(iv) Using the mass of the Sun and its luminosity as well as your answers in part **(c)(iii)**, determine the lifespan of our Sun.

Assume that the Sun contained 100% hydrogen at the start and that its core contains 10 % of its mass. Leave your answers to the relevant number of significant figures.

lifespan = ... years [3]

(d) (i) In Fig. 8.2, sketch a graph for variation of binding energy per nucleon with nucleon number *A*.

State an approximate value, in MeV for the maximum binding energy per nucleon as well as the corresponding nucleon number.

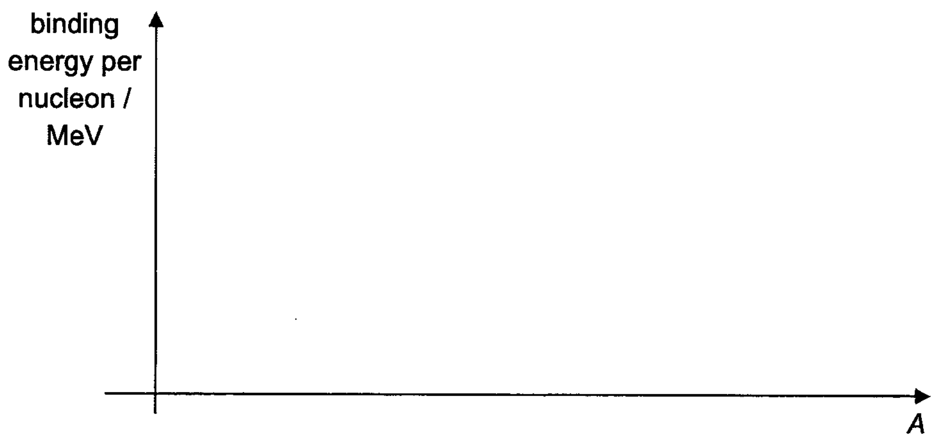


Fig. 8.2

[3]

(ii) With reference to Fig. 8.2, explain why is it that even the most massive stars stop fusion when they have an iron core.

....

....

....

.... [2]

(iii) However in our universe, it is still possible to find elements with nucleon number higher than iron. Suggest how this is possible.

....

....

.... [1]

END OF PAPER

RIVER VALLEY HIGH SCHOOL
JC 2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749 / 3
PAPER 3
13 SEPTEMBER 2022

2 HOURS

CANDIDATE NAME					
CENTRE NUMBER	S				
INDEX NUMBER					
CLASS	2	1	J		

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, centre number, index number and class in the spaces at the top of this page and on all work you hand in.
Candidates answer on the Question Paper.

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.

Section A
Answer all questions.

Section B
Answer **one** question only.

You are advised to spend one and half hours on Section A and half an hour on Section B.

The number of marks is given in brackets [ ] at the end of each question or part question.

FOR EXAMINERS' USE	
Section A – do all questions	
1	/ 6
2	/ 9
3	/ 7
4	/ 8
5	/ 9
6	/ 5
7	/ 8
8	/ 8
Section B – do ONE question only	
9	/ 20
10	/ 20
Deduction	
TOTAL	/ 80

This document consists of **25** printed pages.

Data

speed of light in free space,	c	=	3.00×10^{8} m s^{-1}
permeability of free space,	μ_0	=	$4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space,	ε_0	=	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	$p = \rho gh$
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,	$R = R_1 + R_2 + \dots$
resistors in parallel,	$1/R = 1/R_1 + 1/R_2 + \dots$
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,	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

Section A

Answer **all** the questions in the space provided

1 The velocity-time graph in Fig. 1.1 shows the first 1.6 s of the motion of a ball which is thrown vertically downwards at an initial speed of 4.0 m s^{-1}.

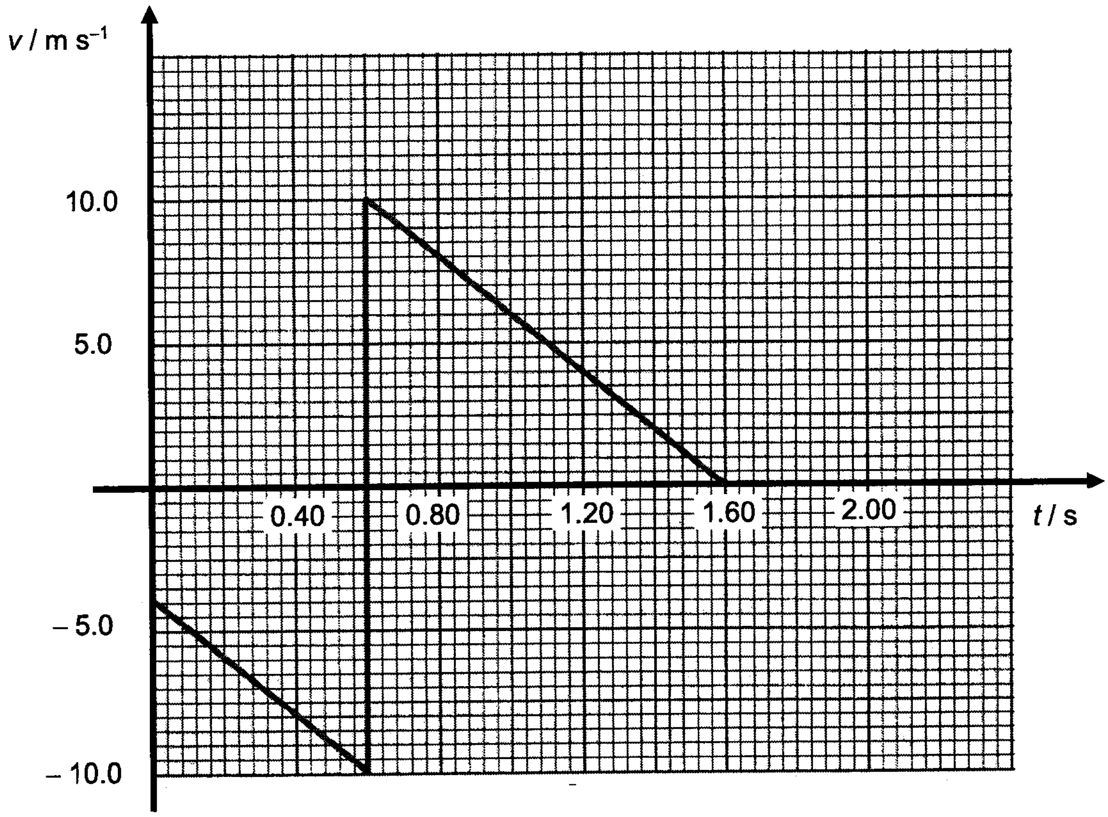


Fig. 1.1

(a) Calculate the distance travelled by the ball before hitting the ground.

distance travelled .... m [2]

(b) Determine the maximum height attained by the ball above its original release position after it hits the ground.

height = ... m [2]

(c) With reference to Fig. 1.1, determine the magnitude of the acceleration of the ball when it is in the air.

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

(d) Determine the time at which the ball next reaches the ground.

time = ... s [1]

2 Block A with mass *m* and speed of 10 m s^{-1} collides head-on with block B of mass 5*m* that has a speed of 2.0 m s^{-1} in the same direction.

(a) After the collision, the block B travels in the original direction with a speed of 4.5 m s^{-1}.

(i) Calculate the velocity of the block A immediately after the collision.

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

(ii) Consider block A and block B as a system.

Determine the percentage of kinetic energy lost by the system after the collision.

percentage = ... % [3]

(b) If no kinetic energy were lost during the collision, determine the velocity of block A and block B immediately after they have collided.

velocity of block A = ... m s^{-1}

velocity of block B = ... m s^{-1} [4]

3 Block P of mass 2.0 kg is connected to a spring of spring constant 200 N m^{-1} that has one end fixed to the wall as shown in Fig. 3.1. Block P is in turn connected to block Q of mass 4.0 kg via an inextensible string.

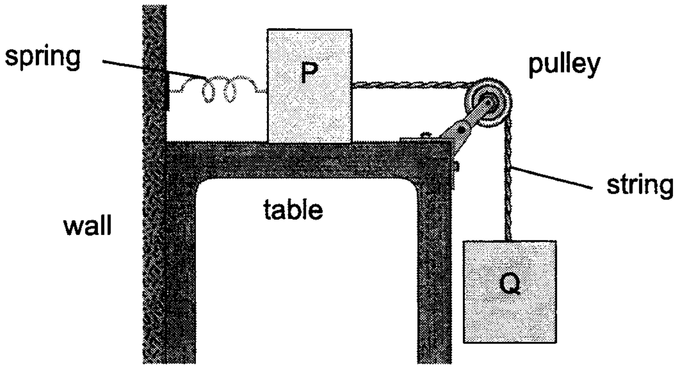


Fig. 3.1

The horizontal surfaces between block P and the table, and the pulley are frictionless. The pulley has negligible mass.

The blocks are released from rest with the spring being unstretched.

(a) Consider the spring, mass P and Q as a system.

State the energy conversion in the system just after block Q starts to move downwards.

....

....

.... [1]

(b) **(i)** Calculate the combined kinetic energy of the two blocks when block Q has fallen by 9.0 cm.

kinetic energy = ... J [2]

(ii) Calculate the kinetic energy of the block Q after it has fallen by 9.0 cm.

kinetic energy = ... J [2]

(c) Determine the distance that block Q has fallen before it first comes to rest.

distance = ... cm [2]

4 A cyclist made a left turn on a rough level road surface at a constant speed *v*, as shown in Fig. 4.1. The total mass of the bicycle and rider is *m* and their combined centre of gravity is at G.

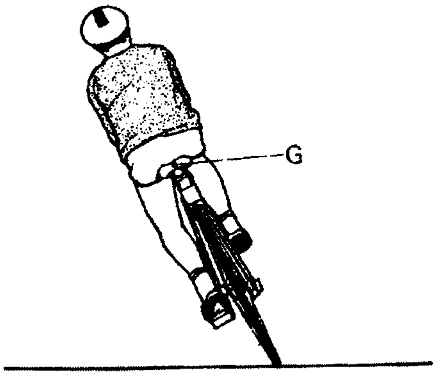


Fig. 4.1

(a) In Fig. 4.1, draw and label all the forces acting on the system of the cyclist and his bicycle. Ignore forces parallel to the direction of motion.

[2]

(b) If the rider is negotiating a turn with a radius of curvature of 55 m, the total mass of the rider and bicycle is 80 kg, and the friction provided by the road surface is 70 N, calculate the speed with which he is turning.

speed = ... m s^{-1} [1]

(c) The rider now makes the same left turn on a rough surface banked at 20° to the horizontal as shown in Fig. 4.2.

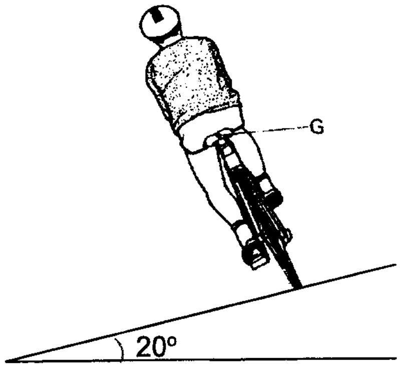


Fig. 4.2

Assuming that the frictional forces remain as 70 N, and radius of curvature is still 55 m,

(i) Explain how the banked surface assists the cyclist in travelling around the corner at a higher speed.

....

....

.... [2]

(ii) Calculate the new maximum speed with which the rider may negotiate the turn.

maximum speed = ... m s^{-1} [3]

5 **(a)** A 5.0 mg particle rotates counterclockwise in a circle of radius 3.00 m with a constant period of 0.785 s.. At t = 0, the particle has an x-coordinate of +2.00 m and is moving to the right.

Take rightward as positive.

(i) The x-coordinate of the particle can be expressed in the form of

$$A\cos(\omega t - B)$$

Determine the values of A, ω and B.

A = ... m

ω = ... rad s^{-1}

B = ... rad [3]

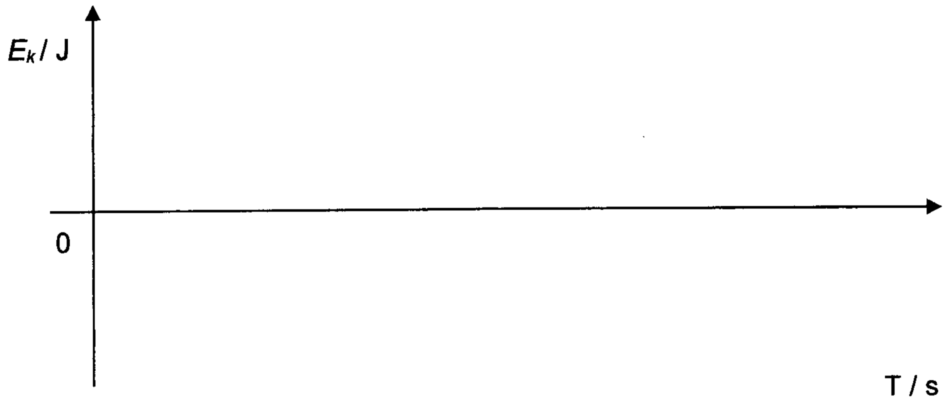
(ii) Hence or otherwise, determine the maximum velocity and acceleration of the particle.

maximum velocity = ... m s^{-1}

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

(iii) In Fig. 5.1. sketch the variation with time of the kinetic energy E_k of the particle along the x-axis.

Indicate in your sketch, the magnitude of the maximum kinetic energy.



[2]

(b) With reference to the energy of the system, state and explain how the amplitude of a damped oscillating system will vary with time when at resonance.

....

....

.... [2]

6 A lamp has a value of 100 W and 240 V marked on it.

(a) Explain what is meant by "100 W and 240 V" when applied to the lamp.

....

....

.... [1]

(b) Calculate the number of electrons that enter and leave the filament of the lamp every second when a D.C. supply of 280 V is connected across the filament.

number of electrons per second =...................... s^{-1} [2]

(c) Explain in terms of the movement of charged particles whether the resistance of the electric filament lamp changes when connected to an external power supply for 30 minutes.

....

....

....

....

.... [2]

7 Many radioisotopes have important industrial, medical and research applications. One of these is ^{60}Co, which has a half-life of 5.2 years and each ^{60}Co nucleus decays by emission of a beta particle (energy of 0.31 MeV) and two gamma photons (energies of 1.17 MeV and 1.33 MeV respectively).

A scientist wishes to prepare a ^{60}Co sealed source that will have an activity of at least 3.7×10^{11} Bq after 30 months of use.

(a) Show that the initial minimum activity of ^{60}Co when the scientist is preparing the radioisotopes is 5.2×10^{11} Bq

[2]

(b) Hence, calculate the minimum initial mass of ^{60}Co required.

minimum initial mass =...................... g [3]

(c) Determine the rate at which the source will emit energy after 30 months.

rate of energy emission =...................... W [3]

8 Fig. 8.1 shows a potential divider circuit with a 9.0 V supply. A variable resistor of resistance R_1 is connected in series with a fixed resistor of resistance R_2. A voltmeter is connected across the fixed resistor.

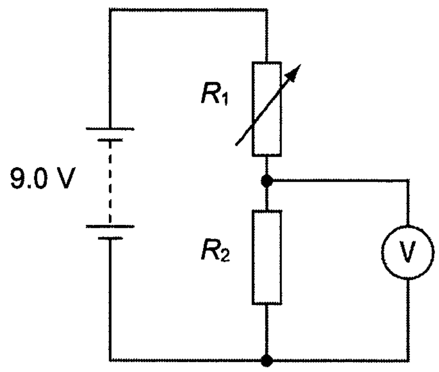


Fig. 8.1

(a) **(i)** The battery has negligible internal resistance and the voltmeter has infinite resistance.

If the fixed resistor R_2 has a resistance of 470 Ω, determine the reading in the voltmeter if the variable resistor is adjusted to 1650 Ω.

voltmeter reading = ... V [1]

(ii) The variable resistance R_1 has a range of 0 to 2.0 kΩ.

In Fig. 8.2, sketch the variation of the voltmeter reading with resistance R_1. Label the appropriate values in your axes.

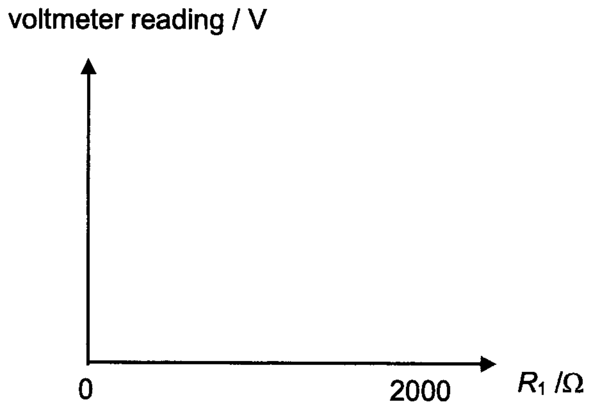


Fig. 8.2

[2]

(b) **(i)** In practice, the voltmeter does not have infinite resistance.

If the voltmeter has a resistance of 0.10 MΩ, determine the percentage change in your answer in **(a)(i)**. You may assume the battery to have negligible internal resistance.

percentage change = ... % [3]

(ii) Over time, the battery may develop some internal resistance usually in the order of a few ohms.

Suggest an explanation why the effect of internal resistance can be ignored in the calculation in **(a)(i)**.

....

....

.... [2]

Section B

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

9 **(a)** In an electron microscope, an electron lens has two cylinders which are at potentials of +500 V and −100 V respectively. An electron beam passes at high speed into the lens from the top.

A cross-section of the two cylinders is shown in **full scale in Fig. 9.1**. The dotted lines are equipotential lines.

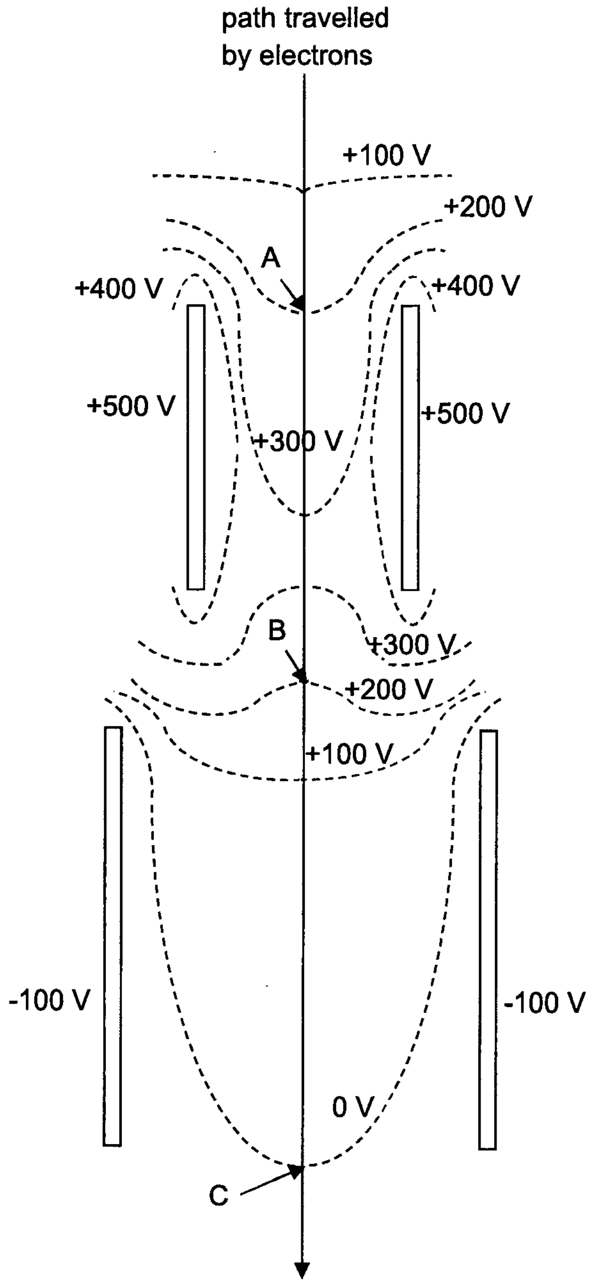


Fig. 9.1 Equipotential lines drawn to scale

(i) Define *electric field strength*.

....

....

.... [1]

(ii) With reference to Fig. 9.1, describe how the speed of an electron changes while moving from A to B.

....

....

....

.... [2]

(iii) Calculate the change in kinetic energy of an electron moving from A to C.

change in kinetic energy =....................... J [2]

(iv) Estimate the electric field strength at B.

electric field strength =....................... N C^{-1} [2]

(v) Show the direction of electric field strength at B in Fig. 9.1. [1]

(vi) Hence, determine the magnitude and direction of the electric force on an electron at B.

magnitude of electric force =...................... N

direction of electric force =...................... [2]

(b) The space observatory SOHO orbits the Sun in a circular orbit as shown in Fig. 9.2.

Fig. 9.2

(i) Show that the angular speed ω of an object in a circular orbit of radius R about the Sun is given by

$$\omega = \sqrt{\frac{GM}{R^3}}$$

where M is the mass of the Sun. Explain your working clearly.

[1]

(ii) On Fig. 9.2, draw and label arrows showing all the forces acting on SOHO. [1]

(iii) SOHO has the same angular speed as Earth about the Sun

Using your answer in **(b)(i)** and **(b)(ii)**, explain how this is possible.

....

....

....

.... [2]

(iv) *"A SOHO with larger mass will have a longer orbital period about the Sun."*

By considering the forces on SOHO, explain whether the above statement is true. Clearly define any symbols that are used in the explanation.

....

....

.... [1]

(c) Another space observatory satellite orbits the Earth in a circular orbit at a height of 7.0×10^3 km above Earth's surface. The mass of the Earth is 6.0×10^{24} kg.

(i) Determine the orbital speed of this satellite.

orbital speed =...................... m s^{-1} [2]

(ii) A stone of mass 12 kg is to be projected directly opposite to the motion of satellite as shown in Fig. 9.3 such that it can totally escape from Earth's gravitational field.

Determine the minimum speed of projection of the stone.

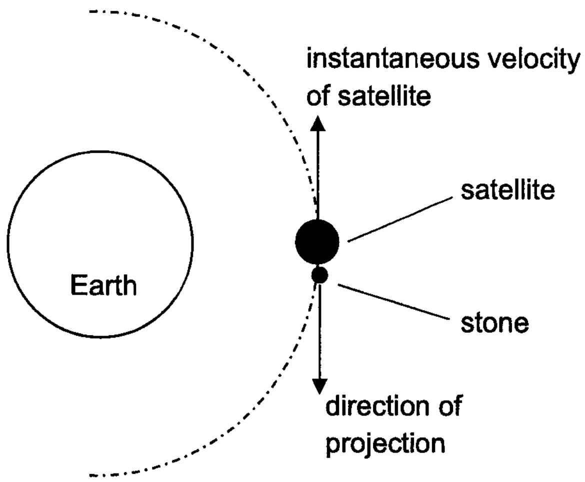


Fig. 9.3

minimum speed of projection =...................... $m\ s^{-1}$ [2]

(iii) Explain whether projecting the stone from the satellite in a direction away from the centre of the Earth will result in the lowest speed to escape from the Earth's gravitational field.

....

....

.... [1]

10 **(a)** A cyclotron is a device used to accelerate ions to very high speeds. Fig. 10.1 shows a diagram of a cyclotron viewed from above.

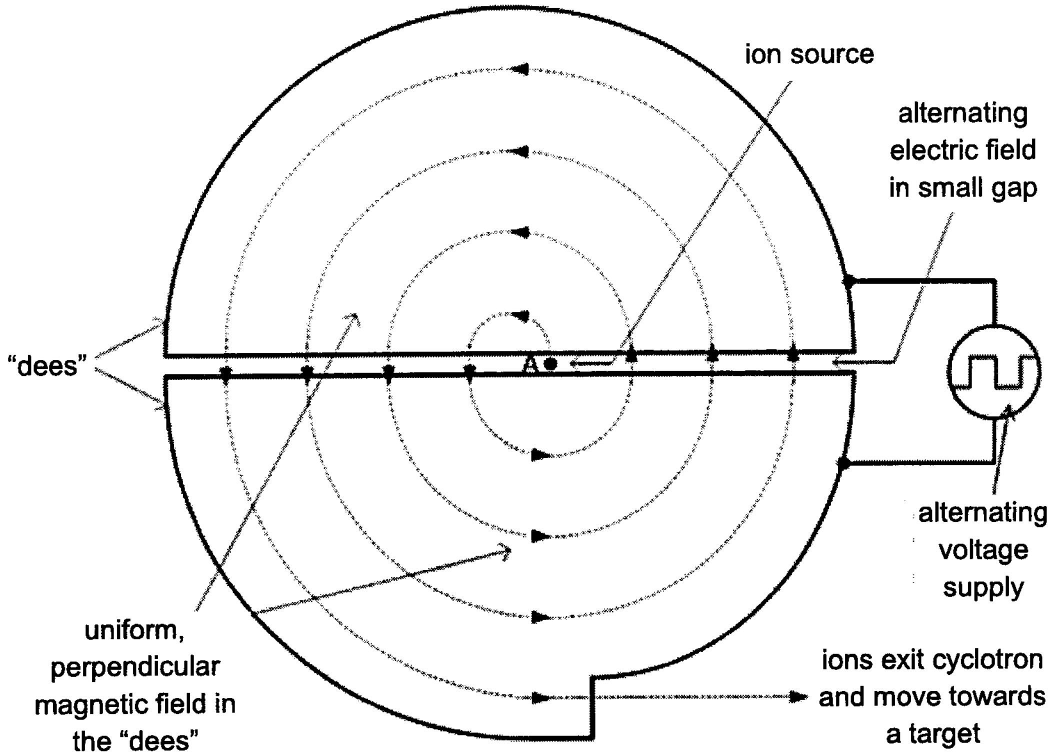


Fig. 10.1

During operation, the voltage supply provides an alternating potential difference to the small gap between the two semi-circular electrodes known as "dees". This will ensure that the ions are accelerated each time they cross the gap.

On entering the "dees", the uniform magnetic field caused the ions to move in a circular path. As the ions speed up, they travel in ever larger circles within the "dees". Once the ions reach a sufficiently large speed, they exit through an outlet in one of the "dees".

(i) Show that the time T for an ion to complete one revolution is $\frac{2\pi m}{qB}$.

[2]

A helium nucleus of mass 6.88×10^{-27} kg and charge $2e$ is accelerated in the cyclotron by applying an alternating potential difference of 450 V across the "dees". The magnetic flux density through the "dees" is 0.850 T.

(ii) State the direction of the magnetic field within the dees such as to produce a path as shown in Fig. 10.1.

.... [1]

(iii) Determine the frequency of the alternating voltage supply so that the helium nucleus is accelerated each time it crosses the gap between the "dees".

f = ... Hz [2]

(iv) Determine the gain in kinetic energy of the helium nucleus after one revolution.

gain in K.E = ... J [2]

(v) Hence, determine the speed of v of the helium nucleus after three revolutions.

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

(vi) In Fig. 10.2, sketch the variation with time of the speed of the ion during the three revolutions. Note that values are not required.

Fig. 10.2

[2]

(vii) Suggest an advantage of a cyclotron over linear accelerators which uses straight tubes with potential differences applied across them to accelerate ions.

....

.... [1]

(b) A rolling axle of length 1.5 m is pushed along a pair of horizontal rails at a constant speed of 3.00 m s^{-1}. A 4.0 Ω resistor is connected to the rails at points a and b as shown in Fig. 10.3. A 0.080 T uniform magnetic field is acting vertically downwards.

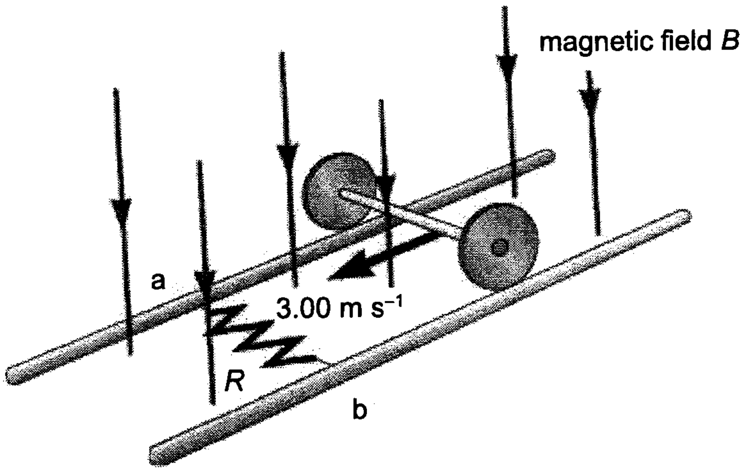


Fig. 10.3

(i) Assuming that the rails and axle have negligible resistance, determine the induced current flowing through the resistor.

current = ... A [2]

(ii) Label on Fig. 10.3, the end of the resistor with higher potential with a positive sign. [1]

(iii) With reference to Lenz's law, explain why a horizontal force is required to keep the rod moving at constant speed.

....

....

....

.... [2]

(iv) Hence, state how energy is conserved during the moving of the rod.

....
...

....

.... [1]

(v) Determine the horizontal force that needs to be applied to the axle to keep it moving at a constant speed.

force = ... N [2]

End of Paper

RIVER VALLEY HIGH SCHOOL
JC2 PRELIMINARY EXAMINATIONS

H2 PHYSICS 9749
PAPER 4

23 AUG 2022

2 HRS 30 MIN

CANDIDATE NAME										
CENTRE NUMBER	S					**INDEX NUMBER**				
CLASS	2	1	J							

INSTRUCTIONS TO CANDIDATES

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO.

Read these notes carefully.
Write your name, class and index number above.

Candidates answer on the Question Paper.
The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Give details of the practical shift and laboratory where appropriate in the boxes provided.

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.

Answer **all** questions.

The number of marks is given in brackets [ ] at the end of each question or part question.

SHIFT
LABORATORY

FOR EXAMINERS' USE	
1	/ 10
2	/ 11
3	/ 22
4	/ 12
TOTAL	/ 55

This document consists of **19** printed pages and **1** blank page.

1 This experiment is investigating the current in a circuit.

Set up the circuit as shown in Fig. 1.1.

The resistor r is used to model the effect of internal resistance in the two batteries. E is the sum of the electromotive force (e.m.f.) of the two batteries.

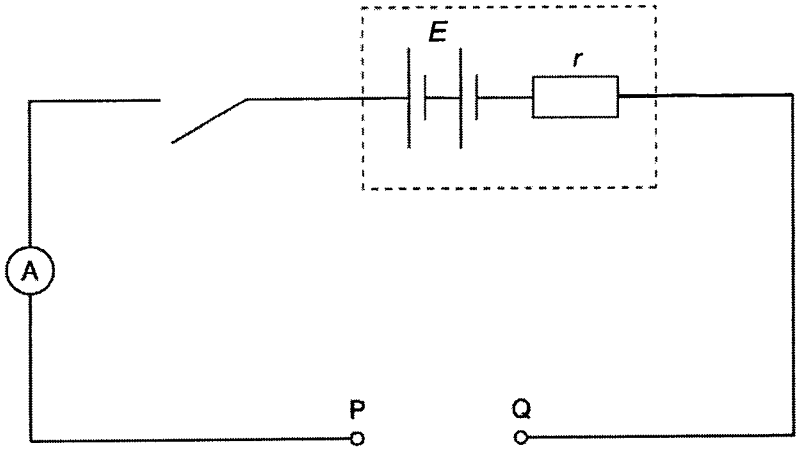


Fig. 1.1

Resistors, each of resistance R, are connected in parallel between P and Q. The current I is measured. The experiment is repeated for different numbers n of resistors between P and Q.

It is suggested that I and n are related by the equation

$$E = I\left(\frac{R}{n} + r\right)$$

(a) **(i)** Measure the current I for n = 2 and n = 3. Record your measurements in Fig. 1.2.

n	I / mA	$\frac{1}{n}$	$\frac{1}{I}$ / A^{-1}
2			
3			
4	70.4		
5	81.6		
6	87.2		
7	95.6		

Fig. 1.2

[1]

(ii) The values of current for n = 4 to n = 7 are given in Fig. 1.2.

Calculate and record the values of $\frac{1}{n}$ and $\frac{1}{I}$ / A^{-1} in Fig. 1.2.

[1]

(iii) The absolute uncertainty of the measurement of I can be taken to be ± 2 mA.

For your values of I when n = 3, determine the percentage uncertainty of $\frac{1}{I}$.

percentage uncertainty = ... [2]

(b) When $\frac{1}{I}$ is plotted against $\frac{1}{n}$, determine expressions for the gradient and the y-intercept.

gradient = ...

y-intercept = ... [1]

(c) **(i)** Plot a graph of $\frac{1}{I}$ on the y-axis against $\frac{1}{n}$ on the x-axis on Fig. 1.3.

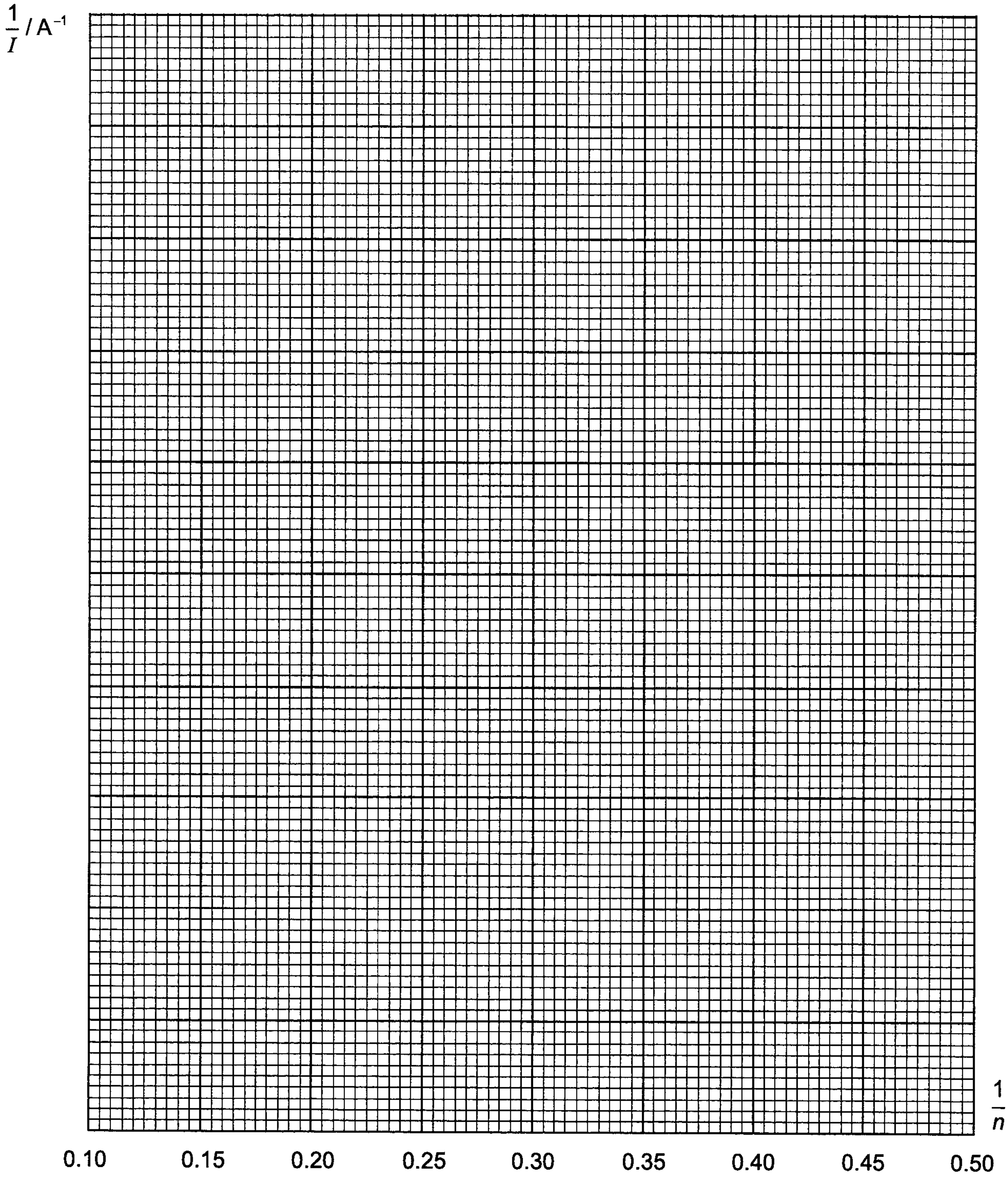


Fig. 1.3

[1]

(ii) Determine values for the gradient and the *y*-intercept.

gradient = ...

y-intercept = ... [2]

(iii) Use your answer in **(b)** and **(c)(ii)** to determine the ratio of $\frac{R}{r}$.

$\frac{R}{r}$ = ... [1]

(iv) Over time, the internal resistance *r* of the batteries may increase.

On Fig. 1.3, draw and label line Z to illustrate what would happen if internal resistance of the batteries increases with their e.m.f. remaining constant.

[1]

[Total: 10]

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2 In this experiment, you will investigate the equilibrium of a metre rule.

(a) You have been provided with a metre rule with a string attached to it.

Set up the apparatus as shown in Fig. 2.1.

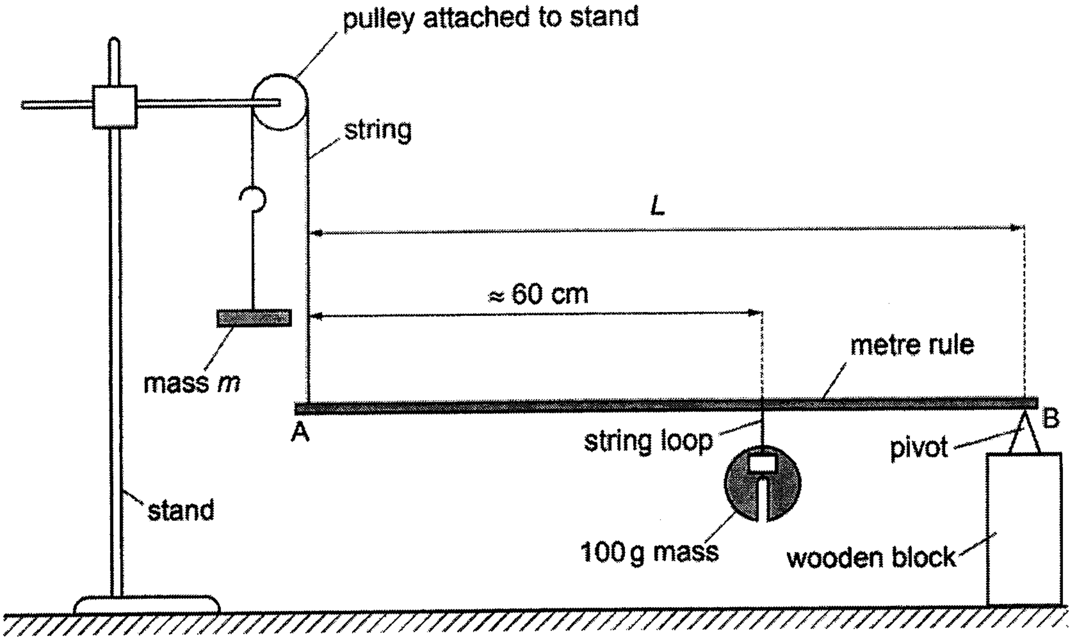

Fig. 2.1

Add masses to the mass hanger so that mass *m* is 80 g.

Adjust the pivot so that it is 5 mm from end B of the rule. The distance between the string at end A and the pivot is *L*.

Measure and record *L*

L = ... [1]

(b) Adjust the string loop supporting the 100 g mass so that it is approximately 60 cm from end A.

Hold the rule at end A so that the rule is approximately horizontal.

Adjust the position of the string loop to find the position where end A is just about to move **upwards** when the rule is released. The distance between the string at end A and the string loop is y_1 as shown in Fig. 2.2.

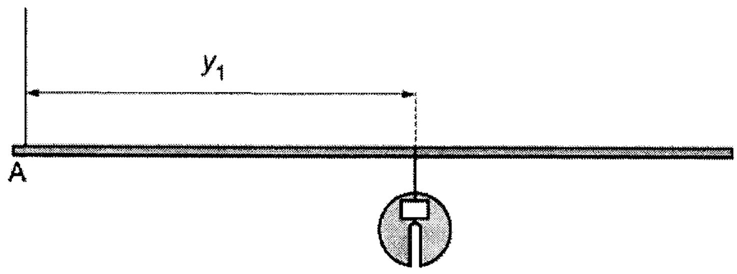

Fig. 2.2

Measure and record y_1.

y_1 = ...

Adjust the position of the string loop to find the position where end A is just about to move **downwards** when the rule is released. The distance between the string at end A and the string loop is y_2

Measure and record y_2.

y_2 = ...

Calculate y where

$$y = \frac{y_1 + y_2}{2}$$

y = ... [1]

(c) Increase *m* by adding the other masses. Measure the new values of y_1 and y_2.

Repeat until you have five sets of values of *m*, y_1 and y_2.

Record your results in a table. Include values of *y* in your table.

[4]

(d) **(i)** Plot a graph of *y* on the y-axis against *m* on the *x*-axis.

(ii) Draw the straight line of best fit..

(iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ... [5]

[Total: 11]

3 A designer for playground is exploring a new type of ride that is suitable for two users of similar masses.

In this experiment, you will investigate the model for such a ride.

(a) **(i)** Using the short wire, make a sharp bend at its centre so that the angle θ between the straight part of the wire is about 60° as shown in Fig. 3.1.

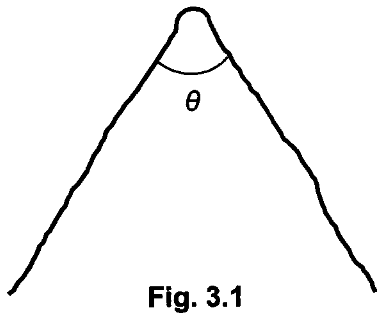

Fig. 3.1

(ii) Measure and record the diameter d of the short wire as shown in Fig. 3.1.

d = ... [1]

(iii) Measure and record the angle θ.

θ = ... [1]

(iv) Estimate the percentage uncertainty in this measurement of θ. Show your working clearly.

percentage uncertainty in θ = ... [1]

(v) Calculate $\sin^2\left(\frac{\theta}{2}\right)$.

$\sin^2\left(\frac{\theta}{2}\right)$ = ... [1]

(b) Set up the apparatus as shown in Fig. 3.2.

Secure the wooden rod to the boss of the retort stand. The top of the spring passes through the wooden rod. The sharp bend of the wire is resting at the bottom of the spring. **Secure the masses on the ends of the wire with sufficient tapes.**

Each mass represents a child on the ride.

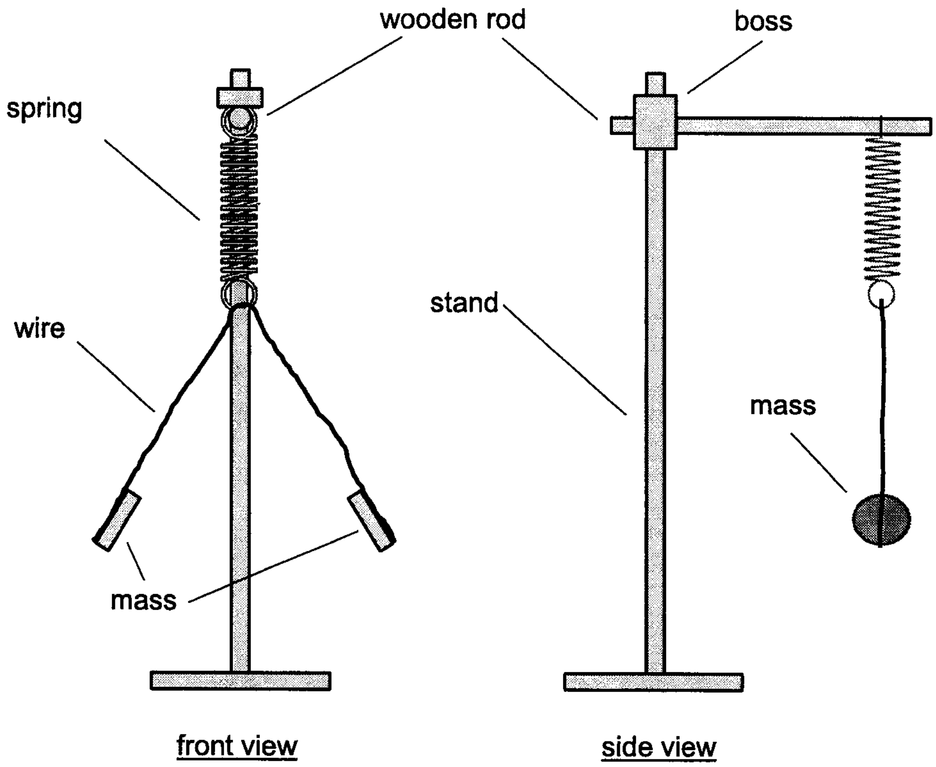

Fig. 3.2

(i) The extension *e* of the spring is the length of the spring when the wire with masses is loaded at the bottom of the spring minus the unstretched length of the spring.

Determine *e* and estimate the percentage uncertainty in your value of *e*.

e = ...

percentage uncertainty in *e* = ... [2]

(ii) Move one of the masses so that the wire turns through approximately 180° about vertical axis. Release the mass.

The wire will oscillate about a vertical axis as shown in Fig. 3.3.

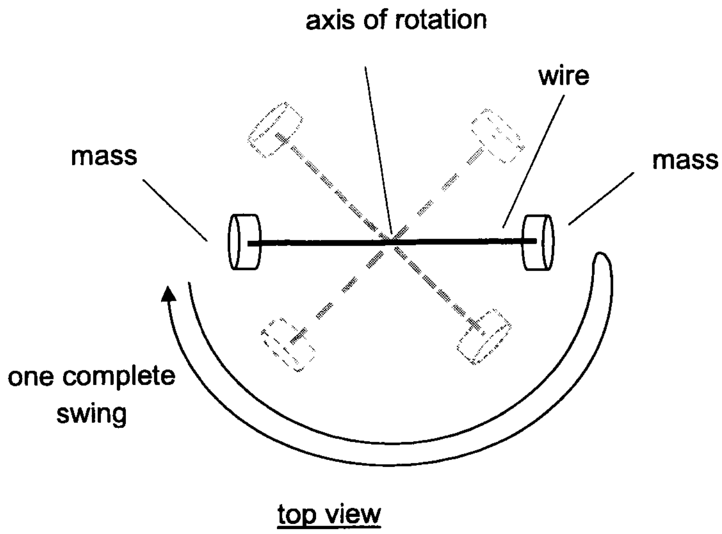

Fig. 3.3

(iii) Determine the time t for the wire to make 5 complete swings.

t = ... [1]

(c) Bend the wire such that $\theta = 30°$. The arms of the wire must remain straight.

Repeat **(a)(iii)**, **(a)(v)** and **(b)(iii)**.

θ = ...

$\sin^2\left(\frac{\theta}{2}\right)$ = ...

t = ... [2]

(d) It is suggested that the quantities t and θ are related by the equation

$$t^2 = p + ke\sin^2\left(\frac{\theta}{2}\right)$$

where k is a constant and p = 20 s^2.

(i) Use your values from **(a)(v)**, **(b)(i)**, **(b)(iii)** and **(c)** to determine two values of k. Give your values of k to an appropriate number of significant figures.

first value of k = ...

second value of k = ... [2]

(ii) State whether the results of your experiment support the suggested relationship in **(d)**.

Justify your conclusion by referring to your values in **(a)(iv)** and **(b)(i)**.

....

....

.... [1]

(iii) It is suggested that the masses attached to the wire affects the values of t.

Suggest one other factor that may affect the value of t.

....

.... [1]

(e) Plan an investigation to determine whether the time *t* is directly proportional to the masses attached to the end of the metal wire.

Your account should include:

- your experimental procedure
- control of variables
- how your results can be analysed to reach the conclusion.
- why you might have difficulties using masses with very small values and very large values.

....

....

....

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....

....

.... **[5]**

(f) **(i)** **Replace the short metal wire with a long metal wire** and set up the apparatus in Fig. 3.2. The angle θ between the straight parts of the wire is about 60°.

Lift up the mass at one end and release it so that it performs small oscillations in a vertical plane as shown in Fig. 3.4.

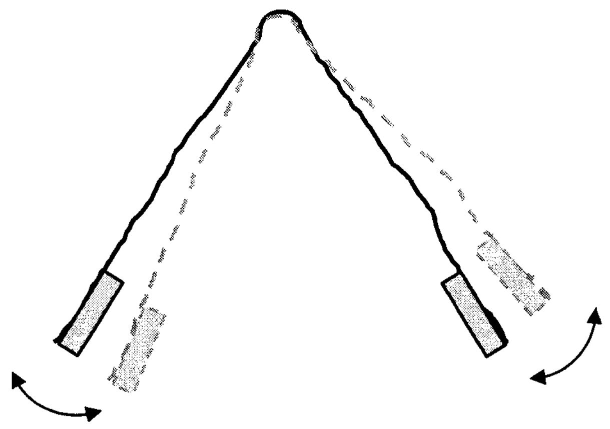

Fig. 3.4

Determine the period *T* with and without masses at the end of the wire.

Tabulate your results.

[3]

(ii) Suggest a reason for the trend observed in your results in **(f)(i)**.

....

.... [1]

[Total: 22]

4 When a thin capillary tube of radius r is inserted vertically into a liquid of density ρ, the liquid rises into the tube a distance h above the liquid level as shown in Fig. 4.1.

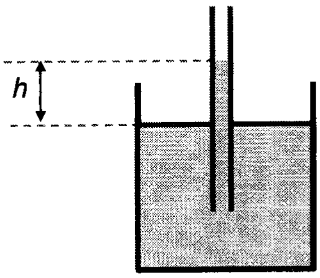

Fig. 4.1

It is suggested that h is related to r and ρ by the relationship

$$h = k\, r^{p} \rho^{q}$$

where k, p and q are constants.

You are given a number of capillary tubes of different dimensions.

Plan a laboratory experiment to test the relationship between h, r and ρ.
Explain how your results could be used to determine values of p and q.

You should draw a diagram showing the arrangement of your equipment. In your account you should pay particular attention to:

- the equipment you would use
- the procedure to be followed
- how the density of the liquid can be varied and measured
- the control of variables
- any precautions that should be taken to improve the accuracy and safety of the experiment.

[Total: 12]

End of Paper