BEDOK SOUTH SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024

4EXP

CANDIDATE NAME

CLASS

REGISTER NUMBER

PHYSICS

6091/02
22 August 2024

Paper 2 Structured and Free Response

1 hour 45 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Marks	80

Setter: Ms Toh QM

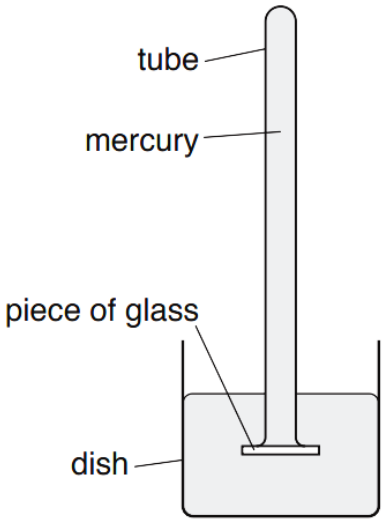
This document consists of **24** printed pages.

[Turn Over

Section A

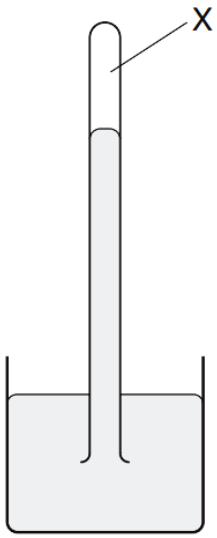
Answer **all** the questions.

1 Fig.1.1 shows a tube full of mercury placed upside down in a dish of mercury. A small piece of glass closes the open end of the tube.



with piece of glass

Fig. 1.1



without piece of glass

Fig. 1.2

The piece of glass is removed and the level of mercury in the inverted tube falls, as shown in Fig. 1.2.

(a) **(i)** Explain why the level of mercury in the tube falls.

……

……

……

……[2]

(ii) State what is found at point X in Fig. 1.2.

……[1]

(b) Describe how the tube of mercury in Fig. 1.2 is used to determine a value for the atmospheric pressure in pascals (Pa). You may draw on Fig. 1.2 to aid in your description.

……..……..……..…

……..……..……..…

……..……..……..…

……..……..……..…[2]

[Total: 5]

2 Fig. 2.1 shows a young boy lying on his back on the bottom of a swimming pool. He is holding his breath and his eyes are open. A red light is positioned on the ground at Q. At first the boy's head is touching the pool wall. He notices that, as he slides away from the pool wall, his eye reaches a point P where he first sees the light at Q.

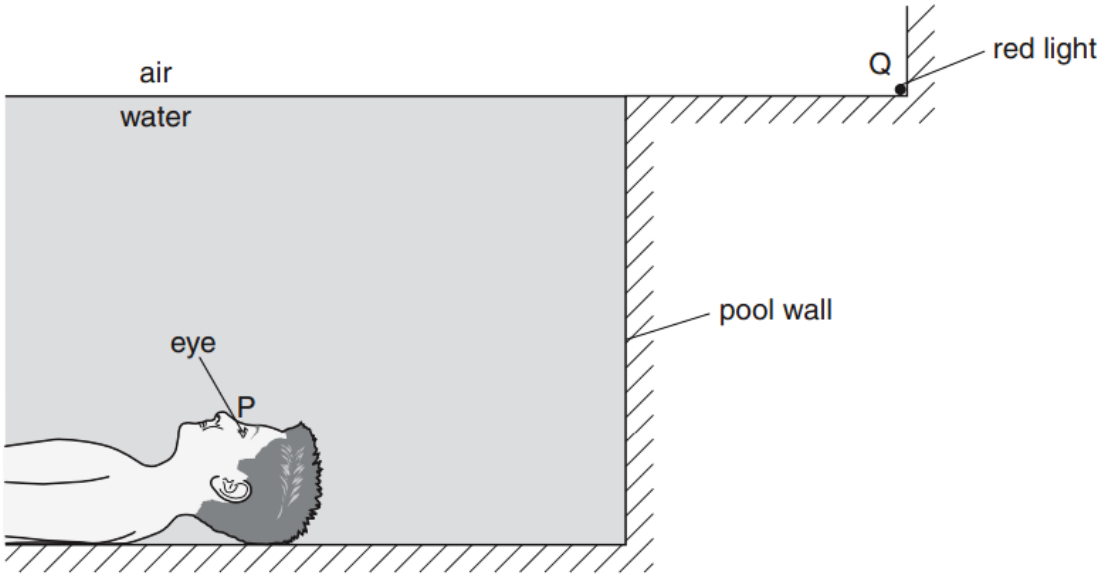


Fig. 2.1

(a) On Fig. 2.1, draw the ray of light travelling from Q to P.

Mark the critical angle for light in water and label it C. [2]

(b) Explain why the boy is unable to see the red light at Q when his eye is closer to the pool wall than at point P.

……

……

……

……[2]

(c) The critical angle is 49°.

Calculate the refractive index of water.

refractive index = ... [2]

[Total: 6]

3 A small, very brightly illuminated display is located at the back of a projector. The projector lens produces an image of the display on a white classroom wall.

Fig. 3.1 shows the position and size of both the display and the image on the wall. R is a point on the display.

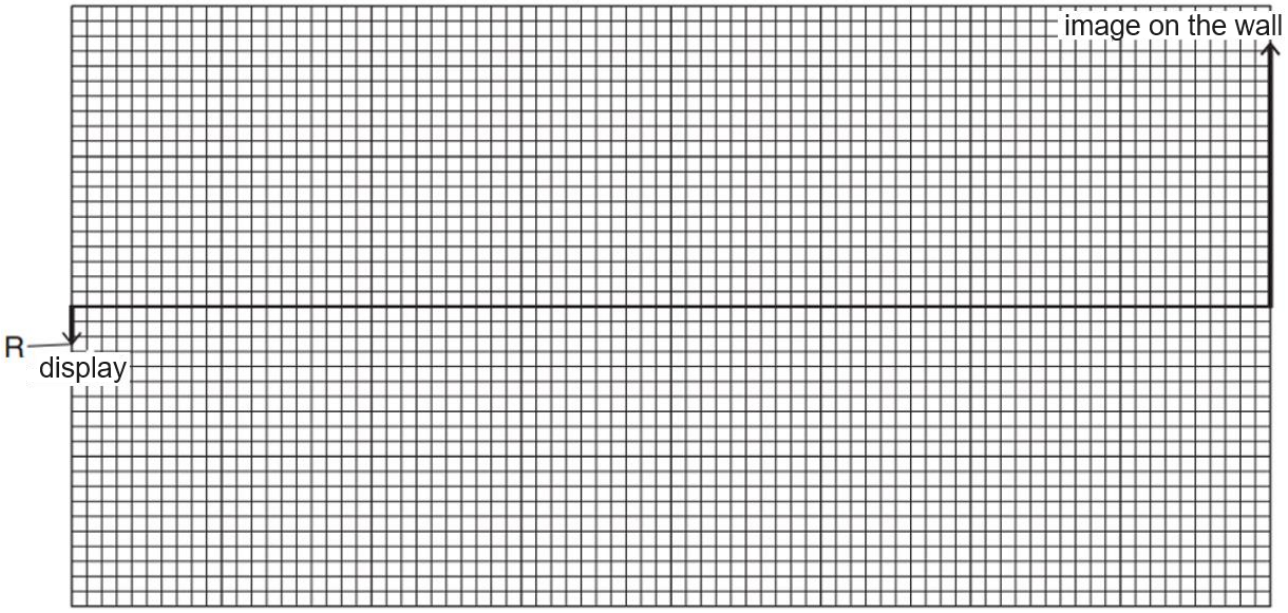


Fig. 3.1

(a) State three characteristics of the image.

.....

.....[1]

(b) On Fig. 3.1,

(i) draw two rays from R to the image,

(ii) draw a vertical line representing the lens and label it L, and

(iii) mark the position of a focal point F.

[4]

[Total: 5]

4 Fig. 4.1 shows a circuit that contains a direct current (d.c.) power supply, a light-dependent resistor (LDR), two fixed resistors, M and N, and two ammeters. The reading on ammeter 1 is 1.6 mA.

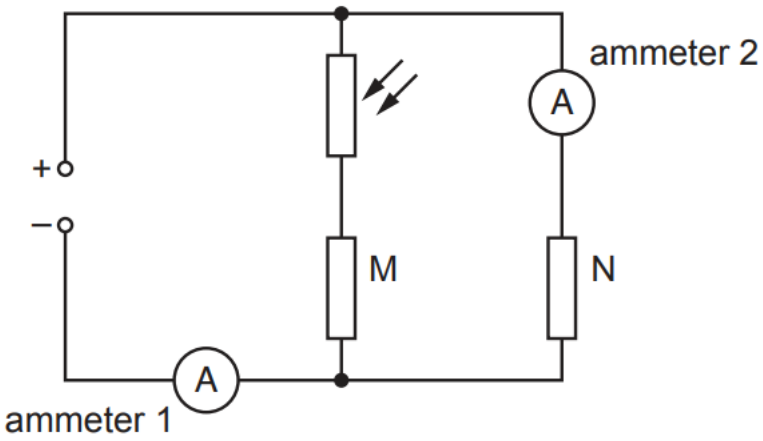


Fig. 4.1

(a) Calculate the time taken for a charge of 7.2 C to pass through ammeter 1.

time taken = …….. [2]

(b) Some time later, the brightness of the light incident on the LDR decreases.

(i) Explain what happens, if any, to the reading on ammeter 2.

.....

.....

.....

.....[2]

(ii) Explain what happens to the time taken for a charge of 7.2 C to pass through ammeter 1.

.....

.....

.....

.....[2]

[Total: 6]

5 Fig. 5.1 shows the circuit with a 12 V battery, three resistors and two open switches, S_1 and S_2. YZ is a straight, horizontal section of connecting wire that lies between two magnets.

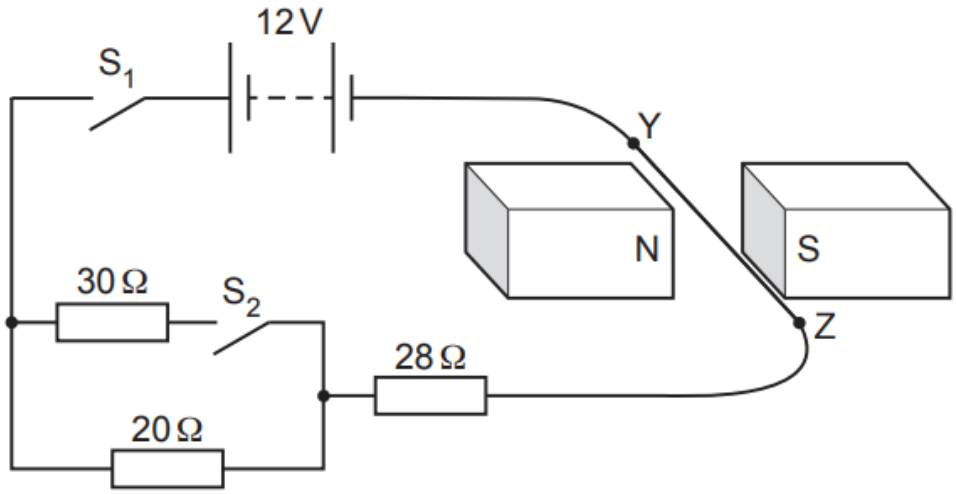


Fig. 5.1

(a) Switch S_1 is now closed while switch S_2 remains open.

(i) Calculate the current in YZ.

current in YZ = ... [2]

(ii) Explain why YZ experiences a force.

.....

.....[1]

(iii) State and describe how the direction of the force on YZ is determined.

.....

.....

.....

.....[2]

(b) Switch S_2 is now closed too.

Explain what happens, if any, to the force on YZ as switch S_2 is closed.

.....

.....

.....

.....[2]

[Total: 7]

6 Fig. 6.1 shows the coil of a loudspeaker attached to a cardboard cone. One pole of a stationary cylindrical magnet lies near to the coil.

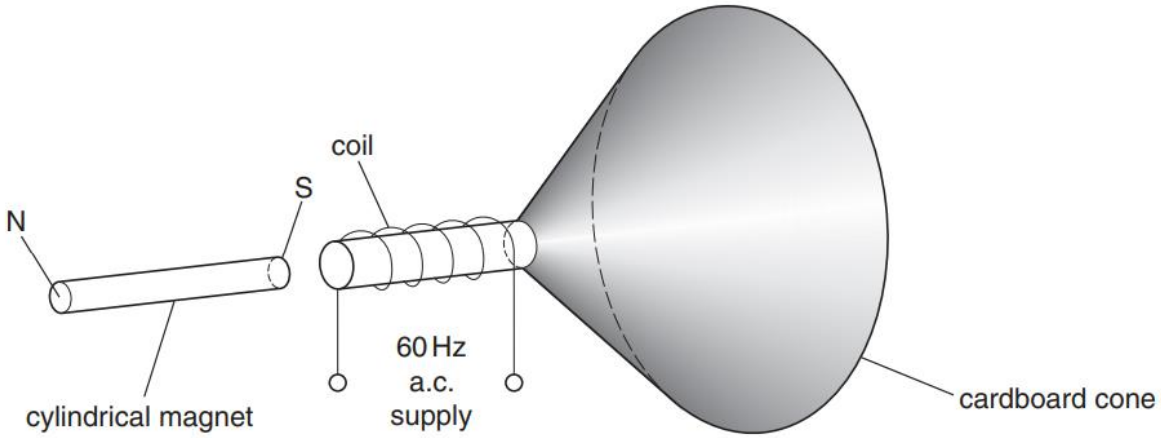


Fig. 6.1

There is an alternating current in the coil of the loudspeaker. A student hears the note produced.

(a) **(i)** Explain why the cone of the loudspeaker vibrates.

.....

.....

.....

.....[2]

(ii) Explain how the vibrating cone produces sound in the air.

.....

.....

.....

.....[2]

(b) A stronger cylindrical magnet is now used.

State the difference in the note heard.

.....

.....[1]

[Total: 5]

[Turn Over

7 A smoke detector contains a radioactive source that emits α-particles. Fig. 7.1 shows the structure of a simple smoke detector. The α-particles ionise the air between the plates. Positive ions and negative ions are created in the air and as a result a current is produced in the circuit. When smoke is present, the flow of ions is disrupted and current decreases.

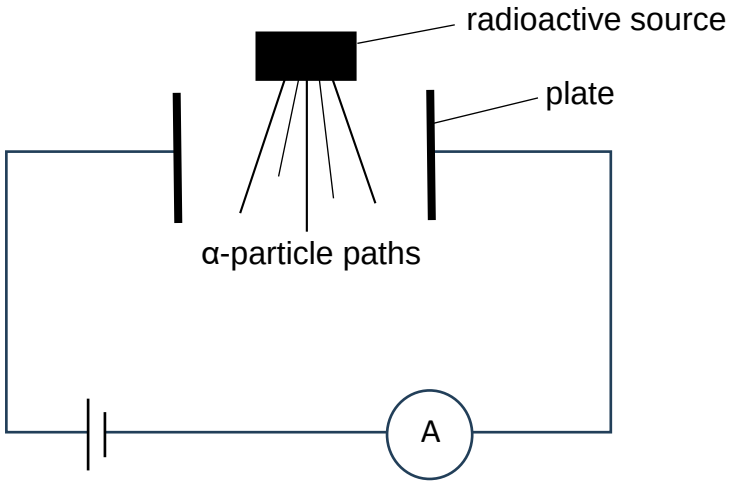


Fig. 7.1

(a) State the nature of an α-particle.

……

……[1]

(b) Explain why a source that emits β-particles is not used in this detector.

……

……[1]

(c) Describe how a current is produced between the plates.

……

……[1]

(d) The radioactive source that emits α-particles contains Americium-241 which has 95 protons. The chemical symbol for americium is Am. It decays into a nucleus of Neptunium-237. The chemical symbol for neptunium is Np.

Write down the equation involving nuclide notation that represents the changes in the composition of the nucleus of Americium-241 when radioactive emission occurs.

……[2]

[Total: 5]

8 One type of alternating current generator uses a rotating magnet and two fixed coils wound on an iron core, as shown in Fig. 8.1.

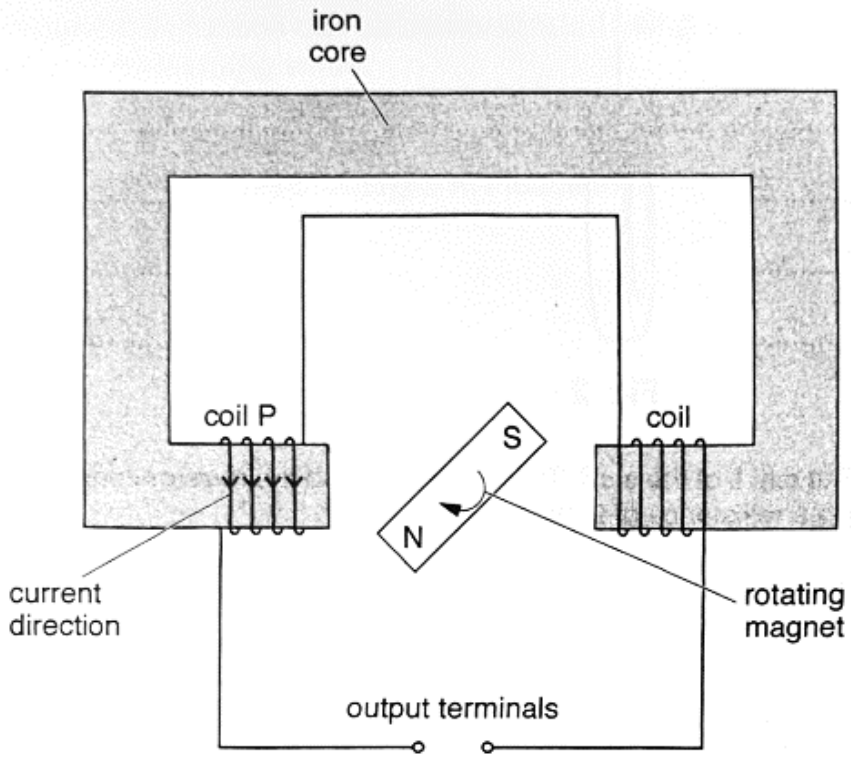


Fig. 8.1

(a) When the magnet rotates, an electromotive force (e.m.f.) is induced in the coils.

(i) Explain why an e.m.f. is induced.

.....

.....[1]

(ii) Suggest one reason for using an iron core in the a.c. generator.

.....

.....[1]

(b) The output terminals are connected to a resistor and there is current in the coil as the magnet turns. When the N-pole of the magnet approaches coil P in Fig. 8.1, the direction of the current in coil P is shown by the arrows.

Explain why the current is in the direction shown.

…….....

…….....

…….....

…….....[2]

[Total: 4]

9 Fig. 9.1 shows a shaver socket. Fig. 9.2 is a diagram of the transformer inside the socket.

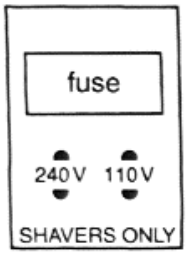


Fig. 9.1

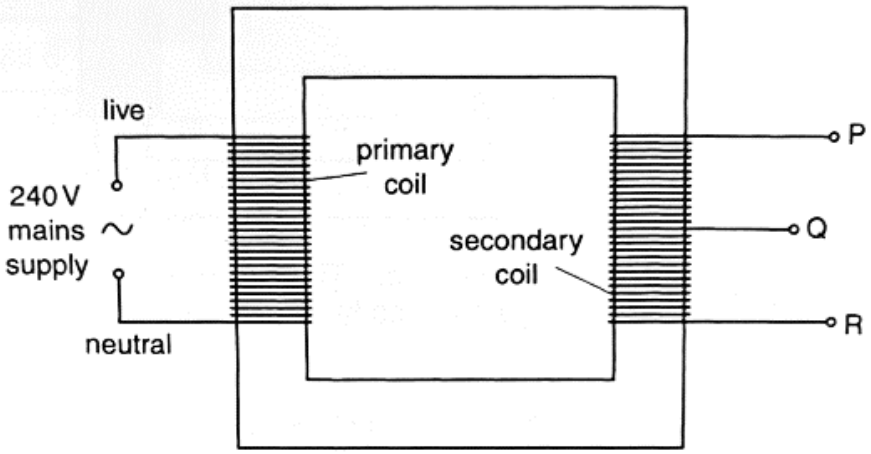


Fig. 9.2

The primary coil of the transformer is connected to the 240 V mains supply and has 6000 turns. There is an output of 240 V between P and R and an output of 110 V between P and Q.

(a) **(i)** State the number of turns on the secondary coil between P and R.

.....[1]

(ii) Calculate the number of turns on the secondary coil between P and Q.

number of turns = ……[2]

(b) The diagram in Fig. 9.2 does not show the mains fuse.

(i) On Fig. 9.2, mark an X to show the position of the fuse. [1]

(ii) Explain the position you marked in **(b)(i)**.

.....

.....

.....

.....[2]

(c) Explain why some electrical devices do not have an earth wire.

…….....

…….....[1]

[Total: 7]

10 A small glass measuring cylinder of oil is placed inside a freezer where the temperature is –18 °C.

Fig. 10.1 shows how the temperature of the oil varies with time t.

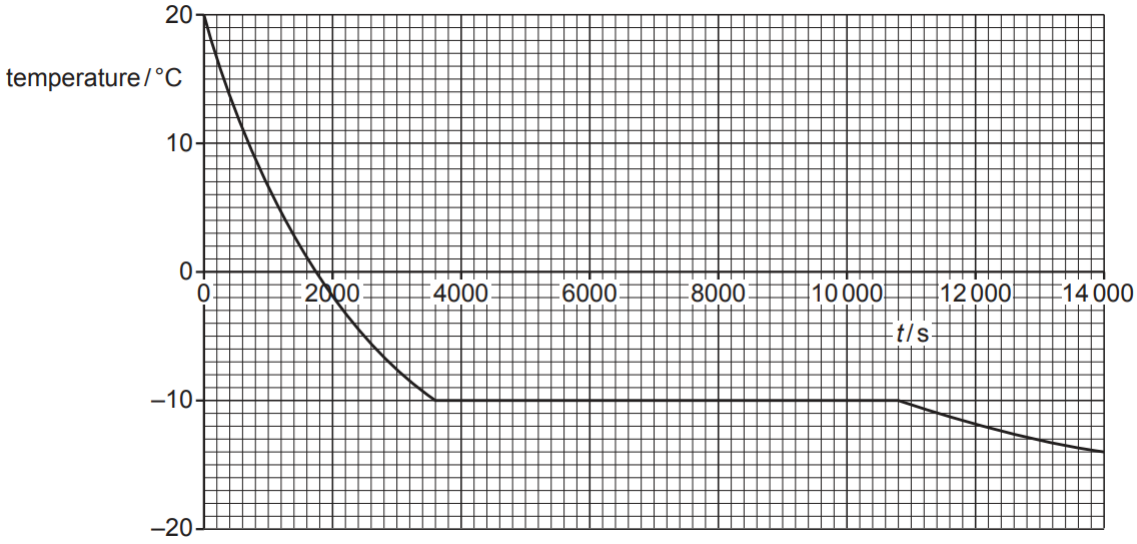


Fig. 10.1

Fig. 10.1 shows that it takes 700 s for the temperature to decrease from 20 °C to 10 °C but that it takes 1900 s to decrease from 0 °C to –10 °C.

(a) Suggest a reason for the difference in the times.

……

……[1]

(b) **(i)** State the melting point of the oil.

.....[1]

(ii) Explain, in terms of molecules, why the temperature of the oil does not change between t = 3600 s and t = 10 800 s.

.....

.....

.....

.....[2]

(c) There is 45 g of oil in the glass measuring cylinder and the specific latent heat of fusion (melting) of the oil is 5.7×10^4 J / kg.

(i) Calculate the energy transferred from the oil between t = 3600 s and t = 10 800 s.

energy transferred = …….. [2]

(ii) Calculate the average rate at which energy is transferred from the oil between t = 3600 s and t = 10 800 s.

rate at which energy is transferred = …….. [1]

(d) The graph in Fig. 10.1 is steeper before the horizontal section than it is after.

Use this observation to compare the specific heat capacity of oil in the liquid and solid states and explain your reasoning.

……..……..……...…

……..……..……...…

……..……..……...…

……..……..……....[2]

[Total: 9]

11 A bungee jumper falls from a bridge above a river, as shown in Fig. 11.1.

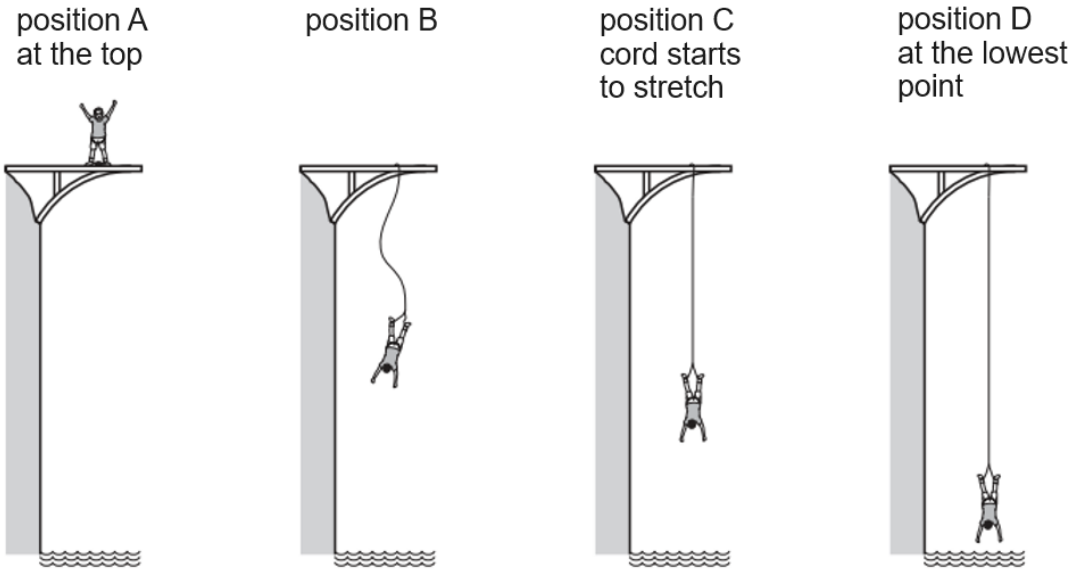


Fig. 11.1

The man starts from position A in Fig. 11.1. The elastic cord starts to stretch at position C and he stops for the first time at position D. He continues to rise and fall. Fig. 11.2 shows how the velocity of the man varies with time t.

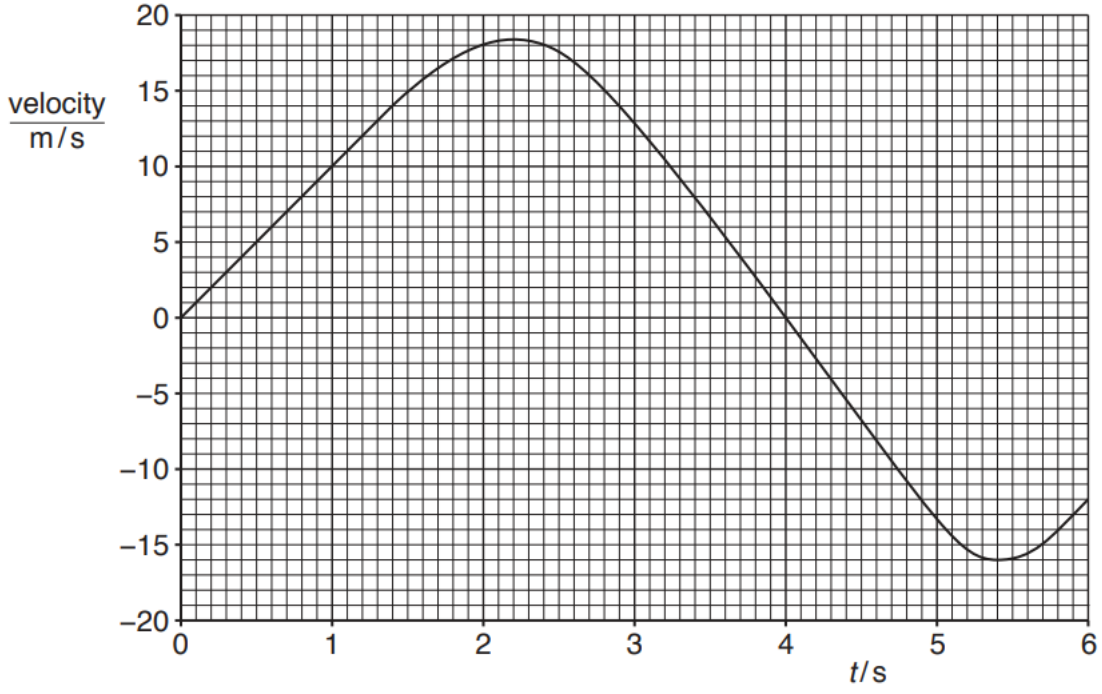


Fig. 11.2

(a) (i) State what is meant by velocity.

.....

.....[1]

(ii) State the difference between a positive velocity and a negative velocity.

.....

.....[1]

(iii) In the first 1.4 s the acceleration is uniform.

Using values from Fig. 11.2, determine the acceleration of the man in the first 1.4 s.

acceleration = ... [2]

(iv) State the value of t when the man is at position D.

.....[1]

(v) Explain, in terms of the forces acting, why the man is accelerating upwards at D.

.....

.....

.....

.....[2]

(b) Table 11.3 shows the values for the gravitational potential store of the man, the kinetic store of the man and the elastic potential store in the cord at A, C and D. You may ignore the effect of air resistance in this question.

Table 11.3

	gravitational potential store / J	kinetic store / J	elastic potential store / J
position A	20 000	0	0
position C	15 000		0
position D	0	0	

(i) Complete Table 11.3 to show the amount of kinetic store of the man at C and the elastic potential store in the cord at D. [2]

(ii) The man has a mass of 50 kg. The gravitational field strength g is 10 N / kg.

Using values from Fig. 9.3, calculate the vertical distance between A and C.

vertical distance between A and C = ……[2]

[Total: 11]

Section B

Answer **one** question from this section.

12 **(a)** Fig. 12.1 shows a force F acting on an object at point P. The object is free to rotate about pivot X.

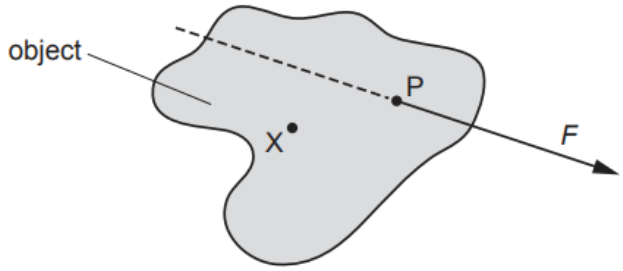


Fig. 12.1

Write down an expression for the moment of F about pivot X. Draw on Fig. 12.1 to represent any other term used in your expression.

……

……[2]

(b) State the principle of moments.

……

……

……

……[2]

(c) A worker carries a ladder on his shoulder. His shoulder acts as a pivot. Fig. 12.2 shows that the ladder is horizontal. The ladder is wider at one end than at the other end. The mass of the ladder is 8.0 kg. The gravitational field strength is 10 N / kg.

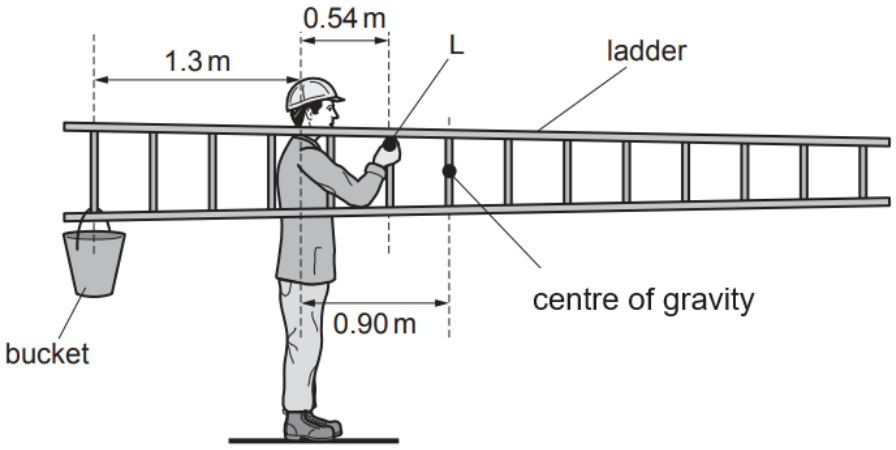


Fig. 12.2

(i) Calculate the weight of the ladder.

weight of the ladder = ... [1]

(ii) State what is meant by *centre of gravity*.

.....

.....[1]

(iii) The centre of gravity of the ladder is a horizontal distance of 0.90 m from the worker's shoulder.

Calculate the moment of the weight of the ladder about the worker's shoulder.

moment = ... [1]

(iv) A bucket of weight 87 N is suspended from the ladder at a horizontal distance of 1.3 m from the worker's shoulder. The worker keeps the ladder horizontal by exerting a vertical force at point L. L is at a horizontal distance of 0.54 m from his shoulder.

Determine the size and direction of the force exerted at L.

size of force = ……....

direction = ……..[3]

[Total: 10]

13 A hydraulic press is used at a recycling centre to compress waste material. Fig. 13.1 is a side view of the press. The cross-sectional area of piston 1 is 180 cm^2. The area of piston 2 that is in contact with the oil is 14 000 cm^2.

The density of the oil is 900 kg / m^3.

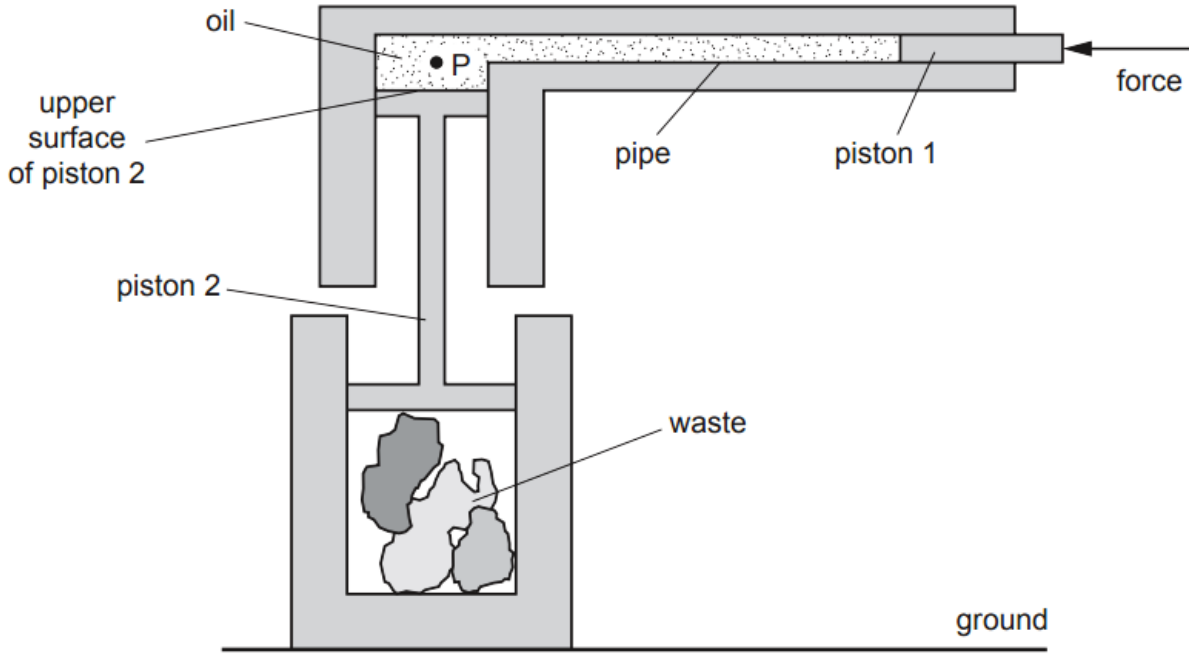


Fig. 13.1

A force to the left is exerted on piston 1. Oil is pushed along the pipe and this moves piston 2 downwards. Piston 2 compresses the waste.

(a) Explain, in terms of molecules, why liquid is chosen for use in a hydraulic system.

……

……

……

……[2]

(b) Piston 1 exerts a force of 4500 N on the oil.

(i) Calculate the pressure in Pascal of the oil due to this force.

pressure of the oil = ……. [2]

(ii) The pressure of the atmosphere is 1.0×10^5 Pa.

Calculate the total pressure in Pascal of the oil in the pipe.

pressure of the oil = ……. [1]

(iii) Initially, the upper surface of piston 2 is level with point P.

Calculate the force exerted on piston 2 due to the pressure calculated in **(b)(ii)**.

force exerted on piston 2 = ……. [1]

(c) Piston 1 moves along the pipe such that the upper surface of piston 2 is now 50 cm below the level of the pipe.

The gravitational field strength g is 10 N / kg

Calculate the increase in the pressure exerted at the upper surface of piston 2 by the oil.

increase in the pressure exerted at piston 2 = ……[2]

(d) There is air trapped in the plastic bags that contain the waste. The temperature of the air in the bags remains constant.

Explain, in terms of molecules, why the pressure of the trapped air increases as it is compressed.

……..……..……

……..……..……

……..……..……

..……..……..……..[2]

[Total: 10]

End of paper