SECTION A [70 marks]

Answer **all** questions in this section.

1 Fig. 1.1 shows three forces acting on an object and keeping it in equilibrium.

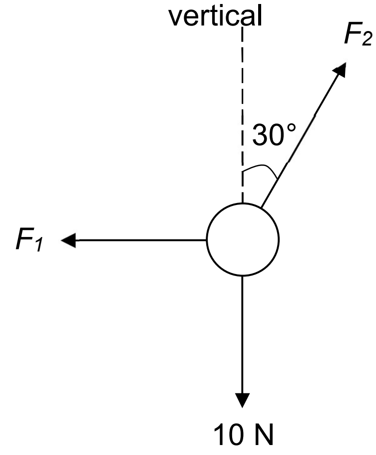

Fig. 1.1

Given that F_1 is perpendicular to the vertical, determine the forces F_1 and F_2.
Include a labelled scaled vector diagram in your answer.

scale: …………………………………..

F_1 = ………………………..

F_2 = ………………………..[4]

2 Car A is travelling at a uniform speed of 10 m/s. The driver sees an obstacle at time = 0 s and applies the brakes.

Fig. 2.1 shows the speed time graph of car A, starting from the time he first sees the obstacle.

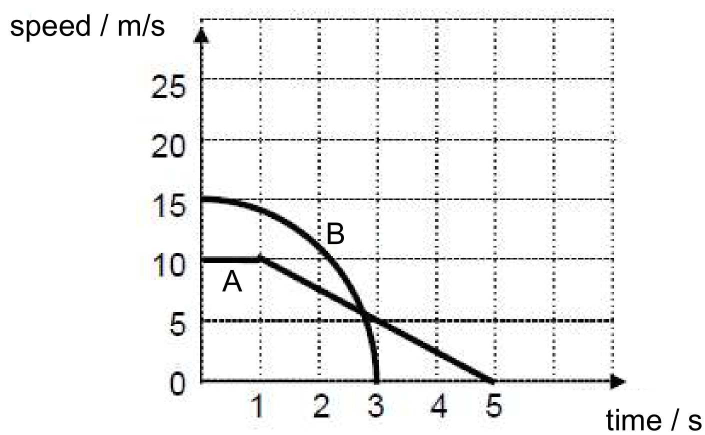

Fig. 2.1

(a) Determine

(i) the reaction time of the driver in car A,

reaction time = …………………..[1]

(ii) the deceleration of car A.

deceleration = ……………………[2]

For examiner's use

(b) At time = 0 s, the driver of car B, travelling at an initial speed of 15 m/s applies the brakes immediately when he first sees the obstacle. The speed-time graph of car B is shown in Fig. 2.1.

(i) State which car travelled a longer distance before coming to a complete stop.

Give an explanation for your answer.

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……………………………………………………..……………………[2]

(ii) Using the graph in Fig. 2.1, explain the changes in the braking force exerted by car B.

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For examiner's use

3 Fig. 3.1 shows the presence of gas molecules, in a cylinder.

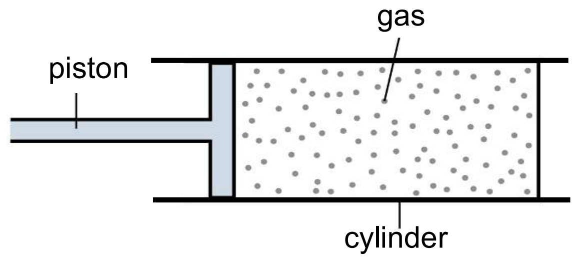

Fig. 3.1

Using the kinetic model of matter, explain the following:

(a) When the piston is pushed into the cylinder, the gas pressure increases.

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....[2]

(b) The piston is pushed out of the cylinder as temperature of the cylinder increases.

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....[2]

For examiner's use

4 Fig. 4.1 shows ultrasound being used to find the distance between a submarine and an underwater object.

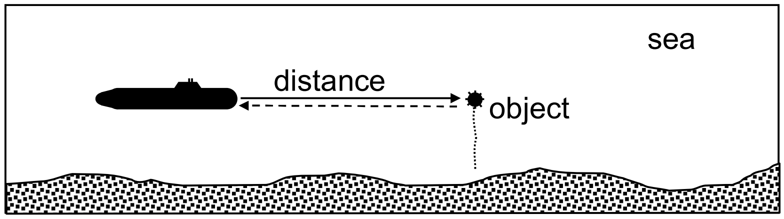

Fig. 4.1

Fig. 4.2 shows the trace of the pulse sent from the submarine and the reflected pulses that returns.

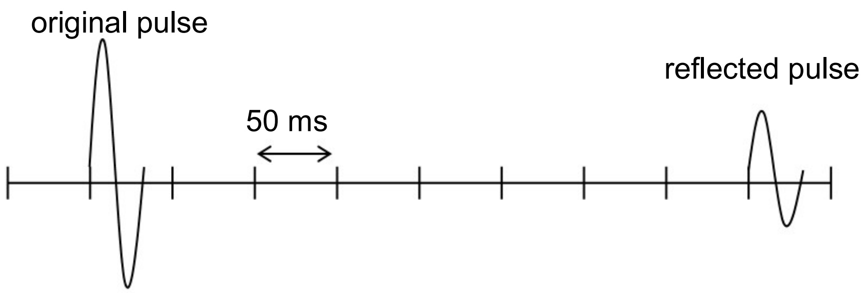

Fig. 4.2

(a) Explain why the amplitude of the reflected pulse is different from the original pulse.

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……………………………………………………………………………………[2]

(b) Given that the speed of sound in water is 1500 m/s, calculate

(i) the time taken for the first pulse to travel from the submarine to the object,

time = ……………..[1]

(ii) the distance between the object and the submarine.

distance = ……………..[2]

For examiner's use

5 "Cat's eyes" are glass prisms set in rubber mould mounted in a box. They are often used on roads to mark out lanes by reflecting light from the head lamp of cars at night.

Fig. 5.1 shows the diagram of a "Cat's eye".

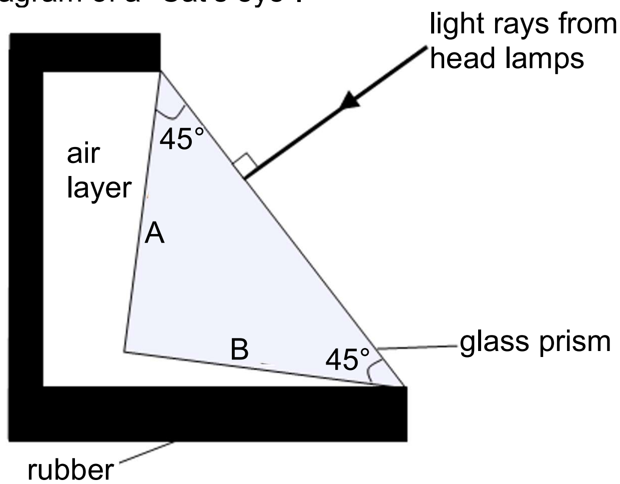

Fig. 5.1

The refractive index of the glass prism is 1.8.

(a) The speed of light in air is 3.0×10^8 m/s.

Calculate the speed of light in the glass prism.

speed of light in prism = ………………………[2]

(b) Calculate the critical angle of the glass prism.

critical angle = ……………………[2]

For examiner's use

(c) Describe, with a reason, what happens to the light ray from the head lamps when it hits the glass prism at sides A and B.

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……………………………………………………………………………………[2]

6 Fig. 6.1 shows the graph of resistance of a thermistor against temperature.

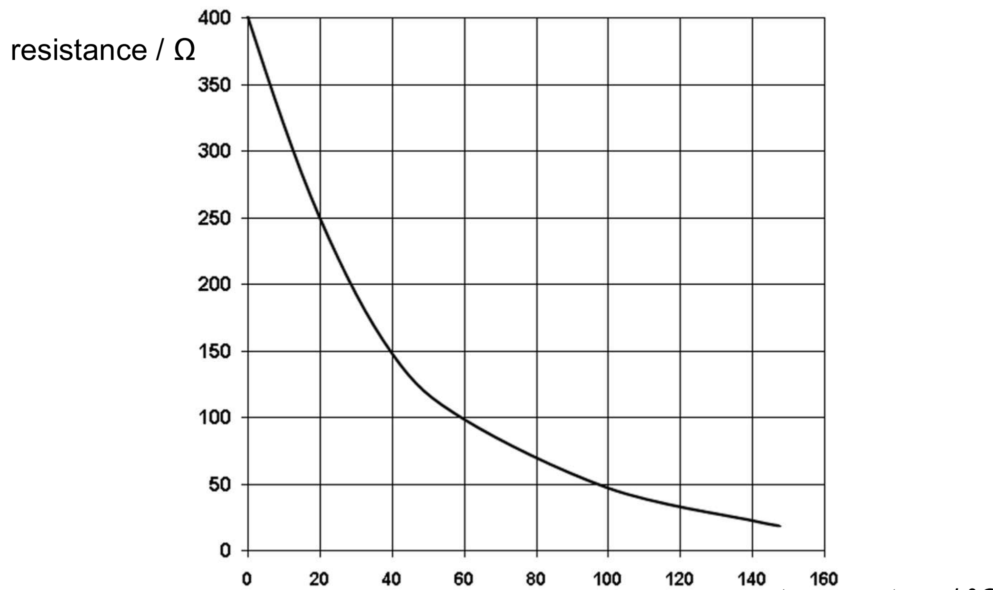

Fig. 6.1

A student sets up the circuit in Fig. 6.2. The heating filament is mounted close to the thermistor.

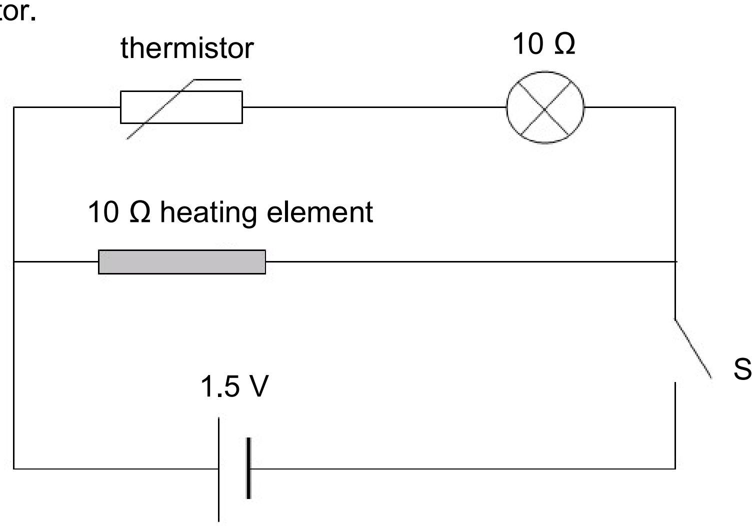

Fig. 6.2

For examiner's use

(a) When switch S is closed, the lamp fails to light up at first, but does so at a later time.

Explain why this happens.

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…………………………………………………………………………………….[2]

(b) The lamp barely lights up when a current of 13.6 mA flows through it.

Using the information from Fig. 6.1, determine the minimum temperature required for the lamp to light up.

minimum temperature = ………………………[3]

For examiner's use

7 A student sets up a circuit to investigate the strength of an electromagnet as shown in Fig. 7.1.

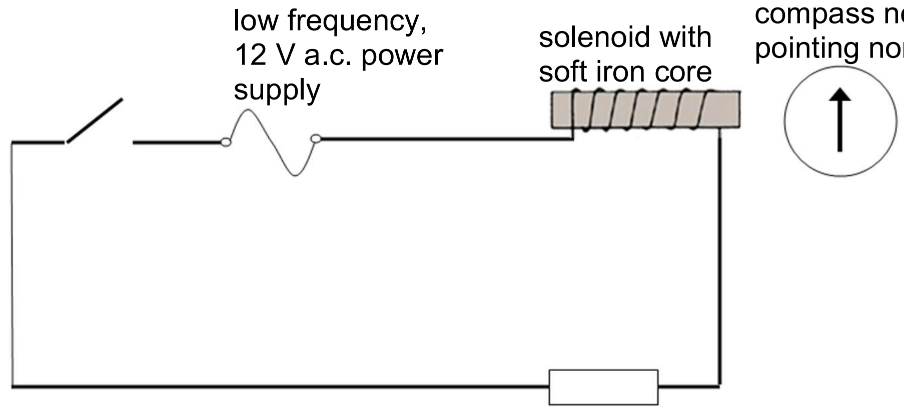

Fig. 7.1

(a) **(i)** State what happens to the compass needle when the switch is closed.

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…………………………………………………………………………….[1]

(ii) Explain your answer in **(a)(i)**.

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For examiner's use

To protect the coil, the student adds a fuse to the circuit and changes the power supply to a battery, as shown in Fig. 7.2.

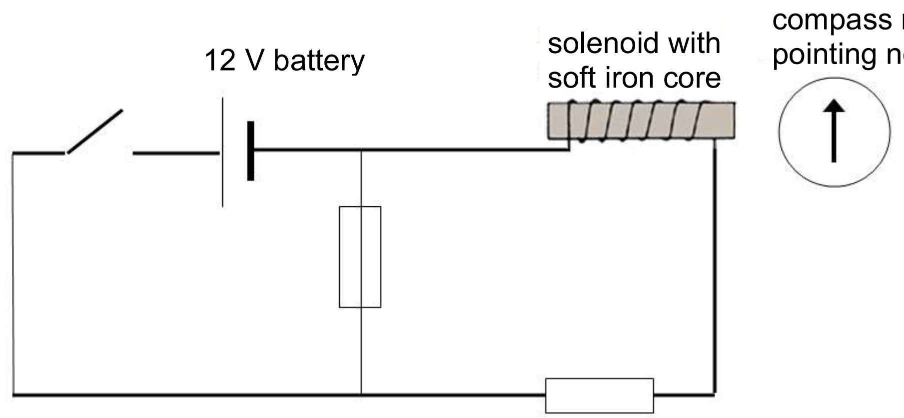

Fig. 7.2

This time, when he closes the switch, the fuse 'blows' and the compass needle turns.

(b) **(i)** Explain why the fuse 'blows'.

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……………………………………………………………………………..[1]

(ii) Suggest why does the needle move after the fuse 'blows'.

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……………………………………………………………………………..[1]

(iii) State the direction which the compass needle points to.

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For examiner's use

8 Fig. 8.1 shows the setup of an experiment to test the free fall of a magnet through a one metre long pipe made of half plastic and half copper.

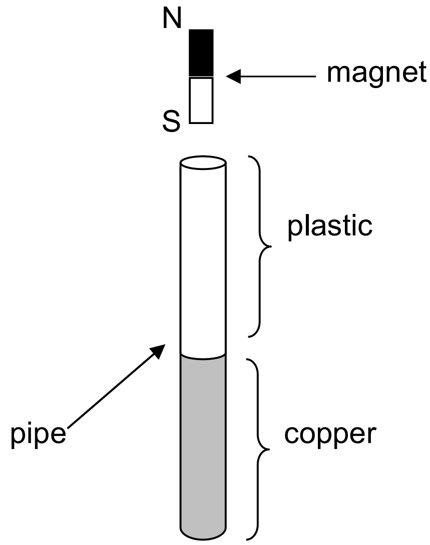

Fig. 8.1

A student drops the magnet through the pipe and observes that the magnet falls with constant acceleration through the plastic portion of the pipe, but falls with decreasing acceleration through the copper portion of the pipe.

(a) Explain the motion of the magnet when it falls through

(i) the plastic portion of the pipe,

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……………………………………………………………………………..[1]

(ii) the copper portion of the pipe,

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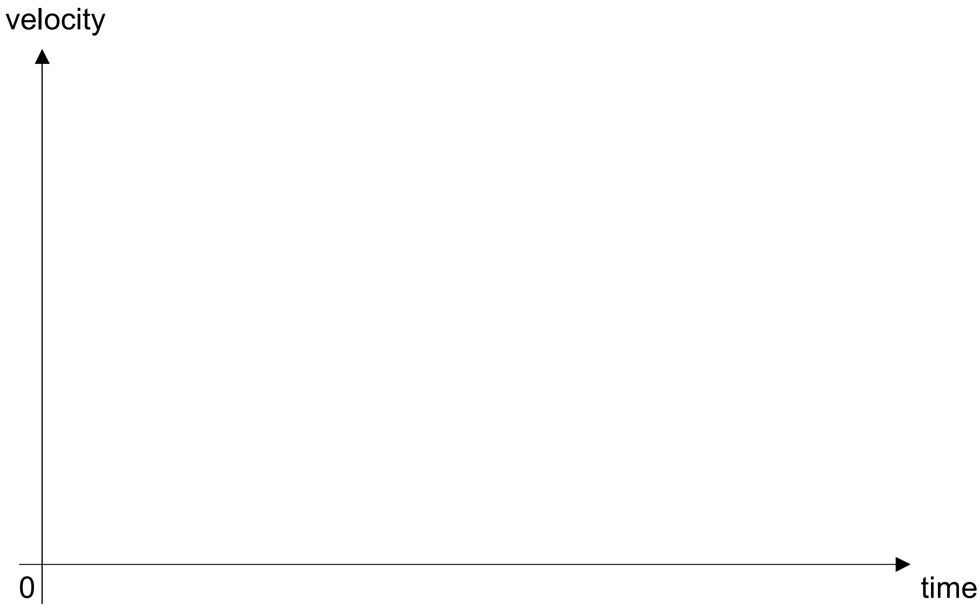
……………………………………………………………………………..[2]

For examiner's use

(b) Sketch the velocity-time graph of the falling magnet, **labelling clearly** the parts of the graph when the magnet falls through the **plastic** and **coppe**r portion of the pipe.



[2]

9 A smoke detector containing an alpha-particle source is fixed to the ceiling in a room. The alpha particles ionise the air between two metal plates so that a battery produces a current between the plates.

If smoke enters the detector, it reduces the current between the plates and an alarm sounds.

Fig. 9.1 shows the arrangement.

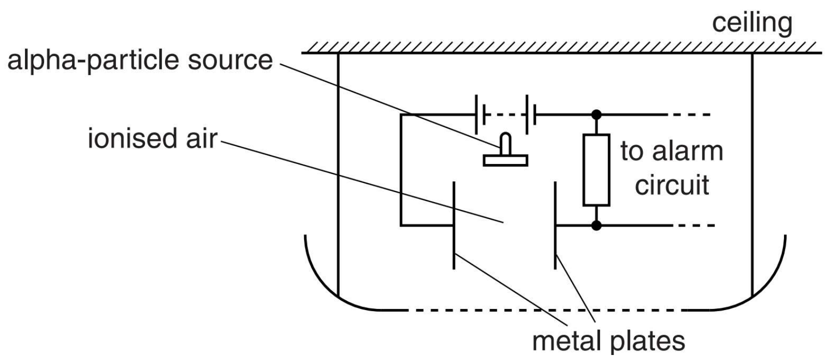


Fig. 9.1

(a) A technician removes the source from the smoke detector and measures the count rate of the source.

(i) Suggest one precaution the technician should take when working with the source.

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....[1]

(ii) The technician measures the count rate, in counts/s, five times. On each occasion, the arrangement of the equipment is the same.

The values obtained are: 81 77 80 83 and 79

Suggest why the values are different.

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....

....[1]

For examiner's use

(b) Suggest one reason why radioactive sources that emit beta-particles and gamma-rays are not used in smoke detectors.

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………………………………………………………………………………………

……………………………………………………………………………………[1]

10 Strontium-90 ($^{90}_{38}\mathrm{Sr}$) is a radioactive isotope. A nucleus of strontium-90 decays by the emission of a beta-particle (β).

(a) For an atom of strontium-90, determine the number of neutrons.

number of neutrons = …………………[1]

(b) When the nucleus of strontium-90 decays, it becomes a nucleus of yttrium (symbol Y).

Complete the equation for this decay.

$$^{90}_{38}\mathrm{Sr} \rightarrow \,^{\dots\dots\dots}_{\dots\dots\dots}\mathrm{Y} + \,^{\dots\dots\dots}_{\dots\dots\dots}\beta$$

[2]

(c) A sample initially contains 6.0 x 10^8 atoms of strontium-90.

The half life of strontium-90 is 29 years.

Calculate the number of strontium-90 atoms that remain in the sample after 87 years.

number of strontium-90 atoms = ……………………[2]

11 A student conducts an experiment to find the specific heat capacity and specific latent heat of water. He sets up the apparatus as shown in Fig. 11.1.

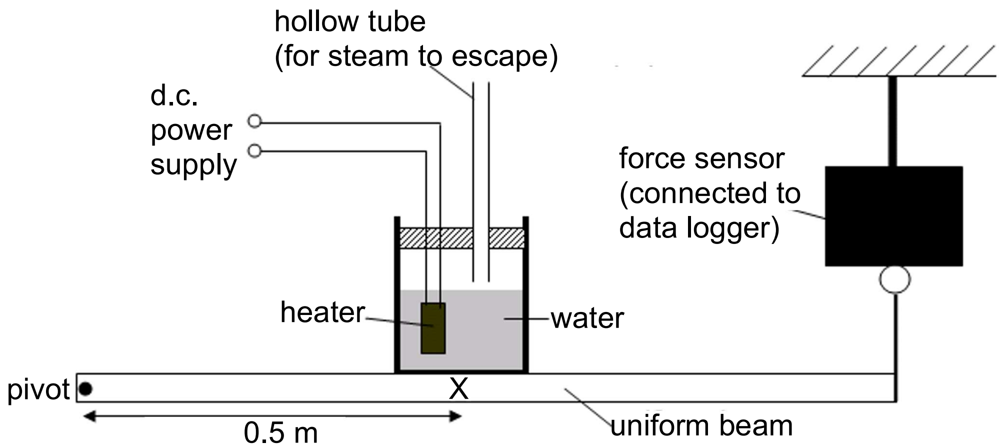


Fig. 11.1

Table 11.2 shows the data collected during the experiment.

weight of uniform beam	20 N
length of uniform beam	1.0 m
power of heater	2000 W
initial mass of water in container	1.0 kg
initial temperature of water	20 °C

Table 11.2

He noted that the weight of the container and its content acted on point X which is 0.5 m away from the pivot.

He started the experiment by switching on the heater and activating the data logger to obtain the force against time graph as shown in Fig. 11.3.

The water starts to boil at A and the heater is switched off at B.

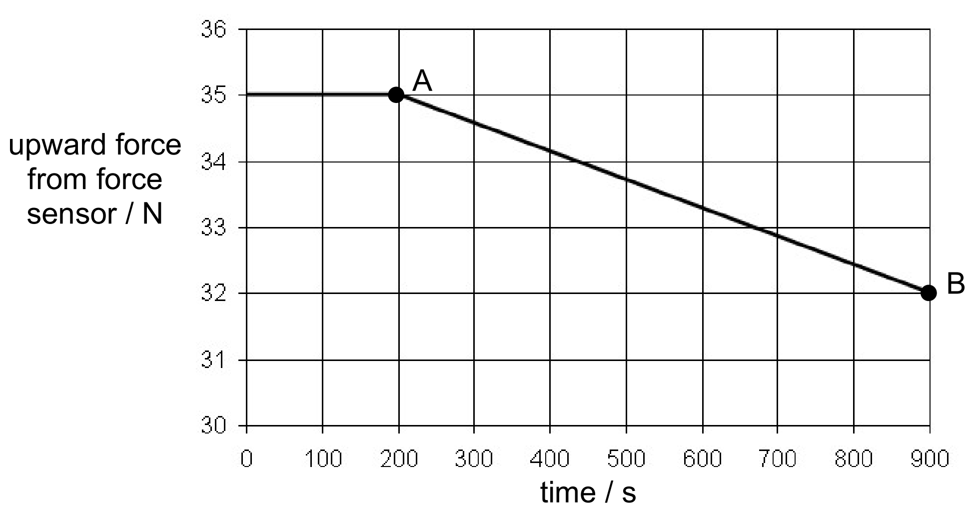
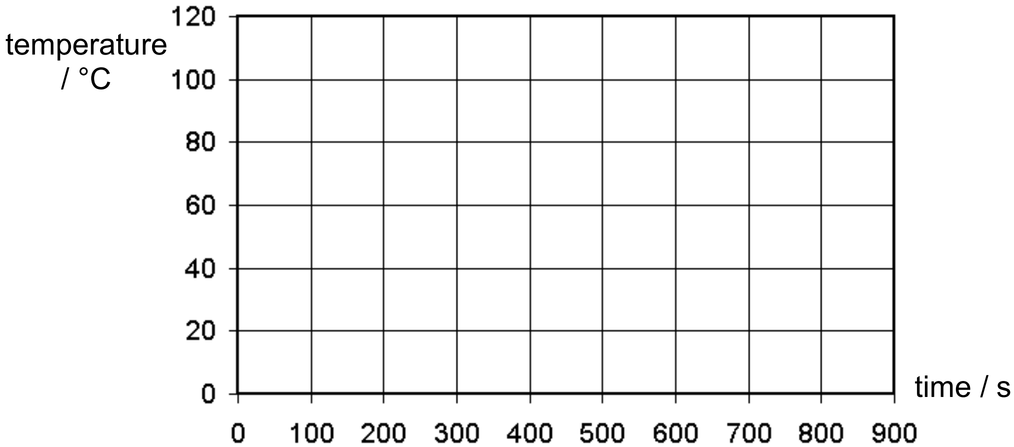


Fig. 11.3

(a) Sketch the temperature-time graph of the water for the experiment.



[1]

(b) The setup is balanced with the uniform beam horizontal at all times.

Using principle of moments, calculate

(i) the initial combined weight of the container and its content (including water),

initial combined weight = …………………..[2]

(ii) the mass of the water that turned to steam.

mass of water = ………………………..[2]

For examiner's use

(c) Determine the value of

(i) the specific heat capacity of water in J/(kg °C),

specific heat capacity = ……………….. J/(kg °C) [2]

(ii) the specific latent heat of vaporisation of water in J/kg.

specific heat capacity = ……………….. J/kg [2]

(d) State an assumption used in the calculation of **(c)(i)** and **(c)(ii)**.

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For examiner's use

12 (a) Fig. 12.1 shows a horse-shoe magnet placed on a top-pan balance with a wire resting between the poles of the magnet.

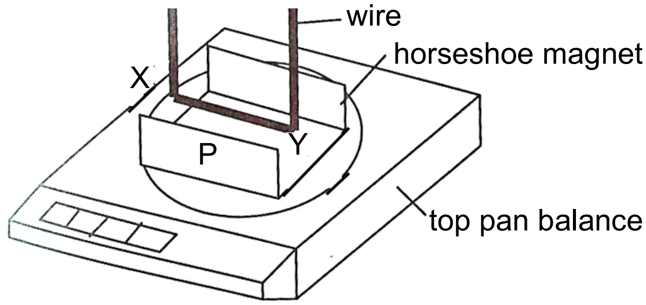

Fig. 12.1

A current is passed through the wire XY and the readings are recorded in Table 12.2.

Table 12.2

reading	I / A	direction of current	mass recorded / g
1^{st}	0.0	no current	142.0
2^{nd}	2.0	X → Y	144.6
3^{rd}	3.0	Y → X	138.1

(i) Circle the pole of the magnet at P.

north / south

[1]

(ii) Explain the reason for the differences in mass recorded

(I) between the 1^{st} and 2^{nd} reading,

……………………………………………………………………………………..

……………………………………………………………………………………..

………………………………………………………………………………..[2]

(II) between the 2^{nd} and 3^{rd} reading.

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(b) Fig. 12.3 shows the diagram of a simple d.c. motor.

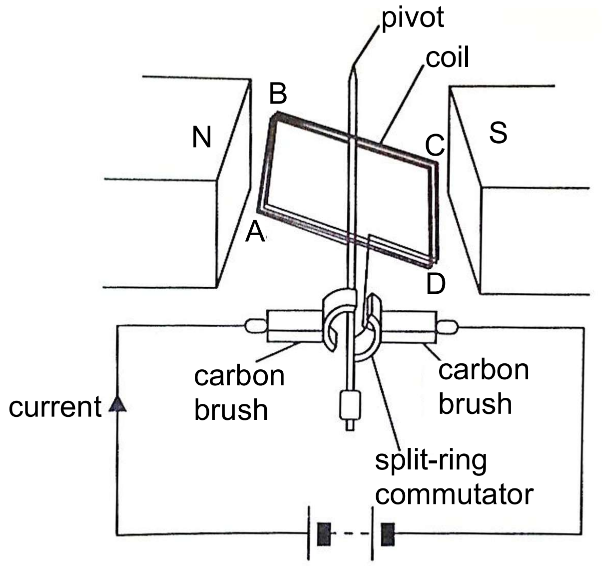

Fig. 12.3

(i) Draw arrows on Fig. 12.3 to show the direction of forces acting on sides AB and CD. [1]

(ii) Explain why sides AB and CD experience a force and how the direction of force is determined.

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....

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....[2]

(iii) When the coil ABCD is vertical, the brushes line up with the gaps in the split-ring commutator. The coil rotates past the vertical position.

Explain what happens to the current in the coil and the forces on sides AB and CD of the coil.

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....[2]

For examiner's use

Section B [10 marks]

Answer **one** question from this section.

13 Fig. 13.1 shows a children's ride. A carriage with children in it is pulled up the slope by a motor. The carriage stops at A, and then runs through B, C and D without further input of energy. Between D and E, the carriage turns through a bend at constant speed. Brakes applied at E causes the carriage to slow down to a stop at F. The height of the ride above ground is 30 m at A and 10 m at C.

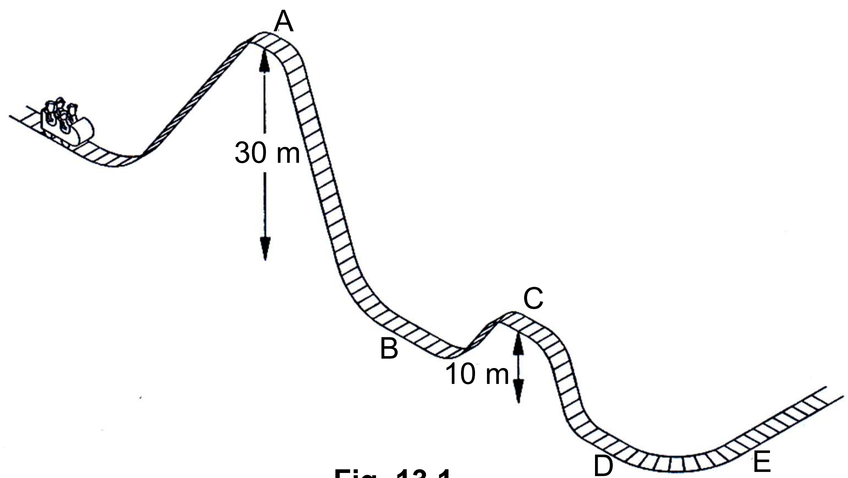

Fig. 13.1

The mass of the carriage with the children is 500 kg. The gravitational field strength, g is 10 N/kg.

(a) State what is meant by '*conservation of energy*'.

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……………………………………………………………………………………[1]

(b) Calculate the maximum potential energy of the carriage with the children.

maximum potential energy = …………………[2]

For examiner's use

(c) Assuming that there is no friction between A and C, determine the speed of the carriage with the children at C.

speed of carriage at C = ……………..[3]

(d) Between D and E, the carriage goes round part of a horizontal circle at a constant speed of 24.5 m/s.

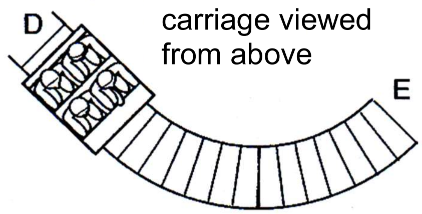

Fig. 13.2

State whether the carriage is moving at constant velocity.
Explain your answer.

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………………………………………………………………………………………

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………………………………………………………………………………………[2]

(e) Between E and F, a frictional force of 3000 N acts to slow the carriage to a stop.

Calculate the deceleration of the carriage.

deceleration = ………………….[2]

14 Fig. 14.1 shows a simple electricity transmission system. The power station generates electricity at 25 kV, 12 000 A. Transformer A and transformer B are assumed to be ideal transformers.

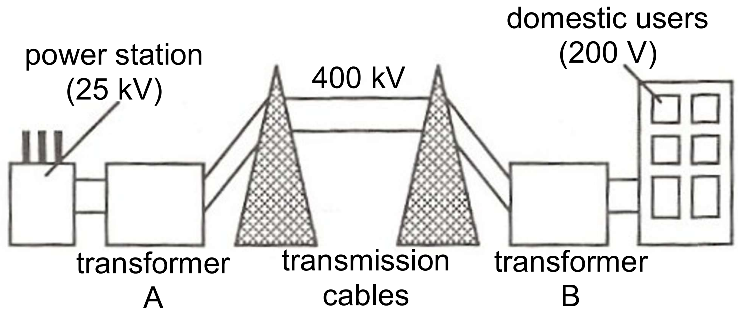

Fig. 14.1

(a) Describe and explain how transformer B works. In your account,

- draw a labelled diagram of transformer B,
- explain how the transformer operates to step down voltage from 400 kV to 200 V.

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…………………………………………………………………………………[4]

For examiner's use

(b) Calculate the turn ratio (primary to secondary) of transformer **A.**

turn ratio = ……………………..[1]

(c) Calculate the output current from transformer **A.**

output current = ……………………[2]

(d) Given that the total resistance of the transmission cables is 1000 Ω, calculate the power loss in the transmission cables.

power loss = …………………..[1]

(e) Explain why it is necessary to use high voltages and thick transmission cables for the efficient transmission of electrical energy.

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……………………………………………………………………………………[2]

END OF PAPER