Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

7644893203

PHYSICS **5054/22**

Paper 2 Theory **October/November 2020**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Section A: answer **all** questions.
- Section B: answer **two** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

INFORMATION

- The total mark for this paper is 75.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Blank pages are indicated.

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Section A

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

1 A glass beaker has a mass of 50 g. A liquid of density 1.8 g / cm^3 is poured into the beaker until it reaches the 200 cm^3 mark.

(a) Calculate the total mass of the beaker and its contents.

mass = ... [3]

(b) The centre of mass of a metre rule is at the 50 cm mark.

(i) State what is meant by *centre of mass*.

.....

..... [1]

(ii) The metre rule is placed on a pivot. The tip of the pivot is under the 80 cm mark on the rule.

The beaker with its contents is then placed at different positions along the rule until the rule is balanced.

Fig. 1.1 shows the arrangement with the rule balanced.

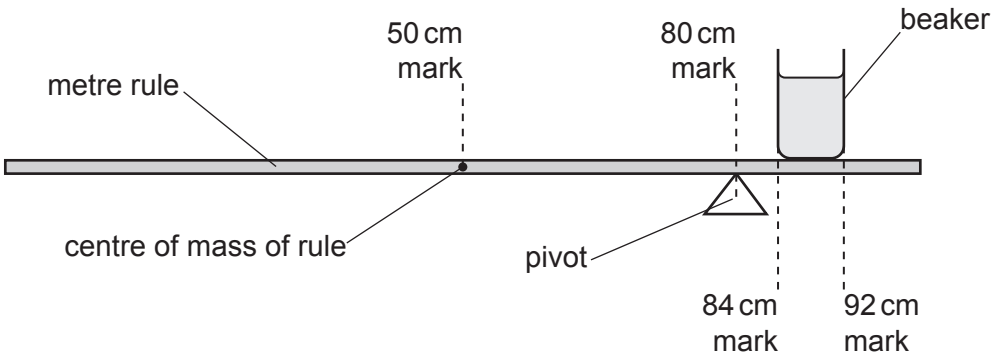


Fig. 1.1

One side of the beaker is at the 84 cm mark and the other side is at the 92 cm mark.

Calculate the mass of the rule.

mass = ... [3]

[Total: 7]

2 The total mass of a wheelbarrow and its load is 90 kg. A worker pushes the wheelbarrow and load up a plank of length 2.0 m on to a platform, as shown in Fig. 2.1. The platform is at a height of 0.60 m above the ground.

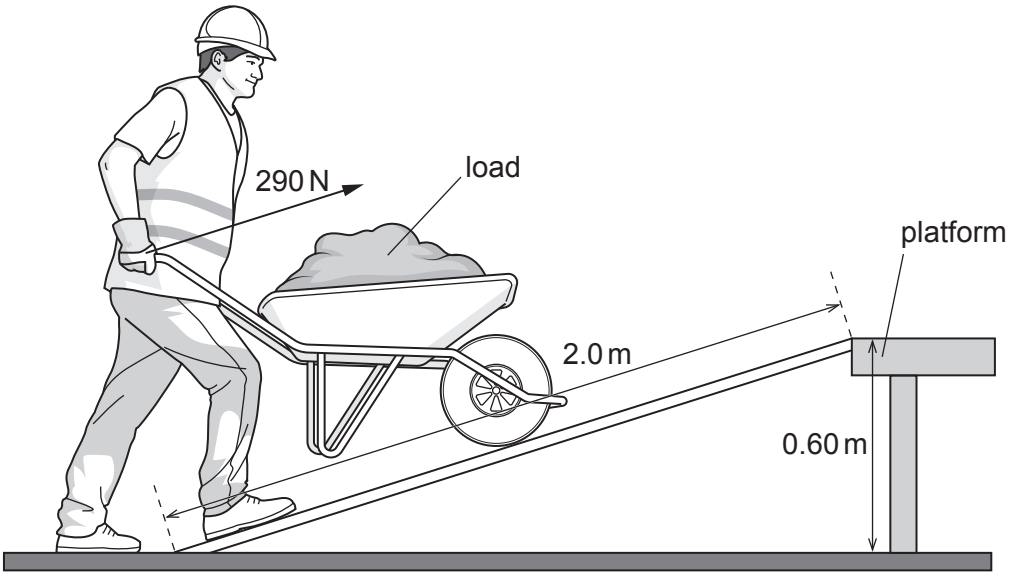


Fig. 2.1

The worker exerts a force of 290 N on the wheelbarrow in the direction in which the wheelbarrow moves.

(a) The gravitational field strength *g* is equal to 10 N / kg.

(i) Calculate the gravitational potential energy gained by the wheelbarrow and its load.

energy = ... [2]

(ii) The worker pushes the wheelbarrow 2.0 m along the plank.

Calculate the work done on the wheelbarrow by the worker.

work done = ... [2]

(iii) Suggest one reason why the answer to **(a)(ii)** is not equal to the answer to **(a)(i)**.

.....

..... [1]

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(b) The worker finds that walking up the plank pushing the wheelbarrow is even more inefficient than the answers in **(a)** suggest.

(i) State what is meant by *efficiency*.

.....

..... [1]

(ii) Suggest **one** reason why this method of lifting the load onto the platform is so inefficient.

.....

..... [1]

[Total: 7]

3 Fig. 3.1 shows a hot water tank that contains two electric heaters X and Y.

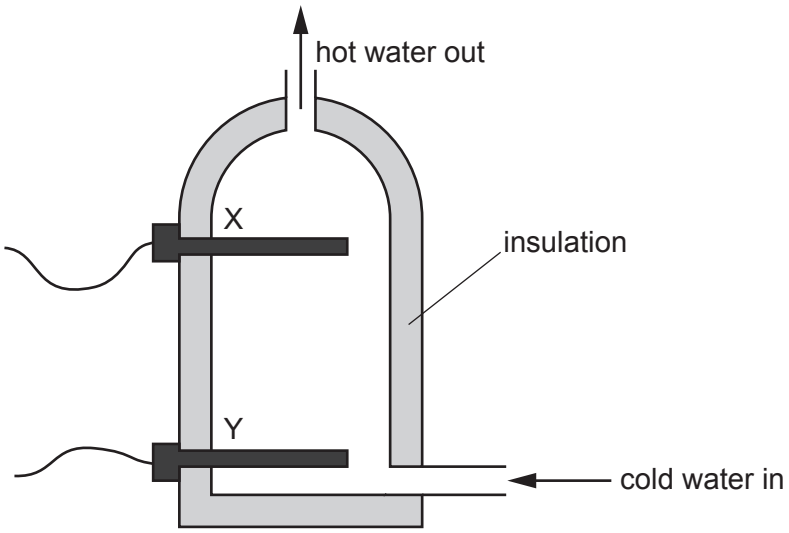


Fig. 3.1

Heater X is used during the daytime but heater Y is only used at night when electricity is cheaper.

(a) The tank is full of cold water and X is switched on.

The temperature of **all** the water above X increases very quickly but the temperature of the water below X increases much more slowly.

(i) Explain the process that causes the water above X to increase in temperature.

.....

.....

.....

.....

..... [3]

(ii) Heater Y remains switched off. Explain why the temperature of the water below heater X increases much more slowly than the temperature of the water above heater X.

.....

.....

.....

..... [2]

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(b) The hot water tank is covered in a thick layer of insulating material. The material is a plastic that contains a large number of small pockets of trapped air.

Explain why this material is a good insulator.

.....

.....

.....

..... [2]

[Total: 7]

4 **(a)** Describe, in terms of molecules, the structure of a solid.

.....

.....

.....

..... [3]

(b) Fig. 4.1 shows a metal-worker heating a horseshoe to a high temperature before shaping it.

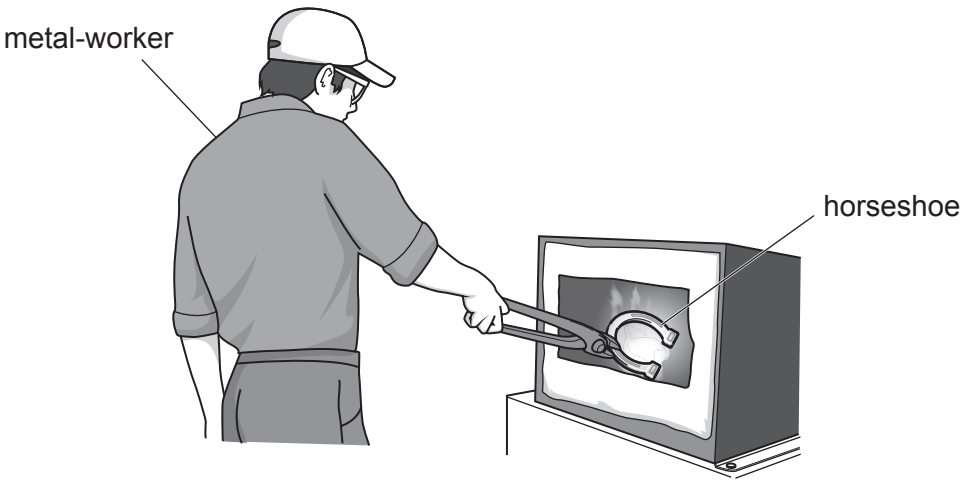


Fig. 4.1

The metal-worker then cools the horseshoe by dropping it into 8.0 kg of water at 18 °C. The final temperature of the water is 43 °C.

The specific heat capacity of water is 4200 J / (kg °C).

(i) Calculate the thermal energy transferred to the water as the horseshoe cools.

energy = ... [2]

(ii) The heat capacity of the horseshoe is 850 J / °C.

Calculate the temperature of the horseshoe immediately before it is dropped into the water.

temperature = ... [3]

[Total: 8]

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5 The cable of a washing machine contains three separate wires. There is a fuse in one of the wires.

(a) Explain how the earth wire and the fuse work together to make the washing machine safer.

.....

.....

.....

.....

..... [3]

(b) **(i)** State the name of the wire in which the fuse is connected.

..... [1]

(ii) Explain why the fuse is connected into this wire.

.....

..... [1]

(c) The cable of a hair-dryer contains only **two** wires.

(i) State the name of each of these wires.

1. .....

2. .....
[1]

(ii) Suggest why the hair-dryer does not need an earth wire.

.....

..... [1]

[Total: 7]

6 Phosphorus-32 ($^{32}_{15}P$) is an isotope of phosphorus that undergoes radioactive decay.

(a) The most common isotope of phosphorus is phosphorus-31.

(i) Describe the structure and composition of a neutral atom of phosphorus-31.

.....

.....

..... [2]

(ii) State how an atom of phosphorus-32 differs from an atom of phosphorus-31.

.....

..... [1]

(b) Phosphorus-32 decays by beta-particle emission to a stable isotope of sulfur. The half-life for this decay is 2.0 weeks.

(i) State how a nucleus of this isotope of sulfur is different to a nucleus of phosphorus-32.

.....

..... [1]

(ii) At time $t = 0$, a radioactive sample contains 3.2×10^{11} atoms of phosphorus-32.

At the same moment, the sample contains no atoms of sulfur. This is shown by the cross on Fig. 6.1.

On Fig. 6.1, plot a graph to show how the total number of sulfur atoms in the sample changes with t and draw a suitable curve. [3]

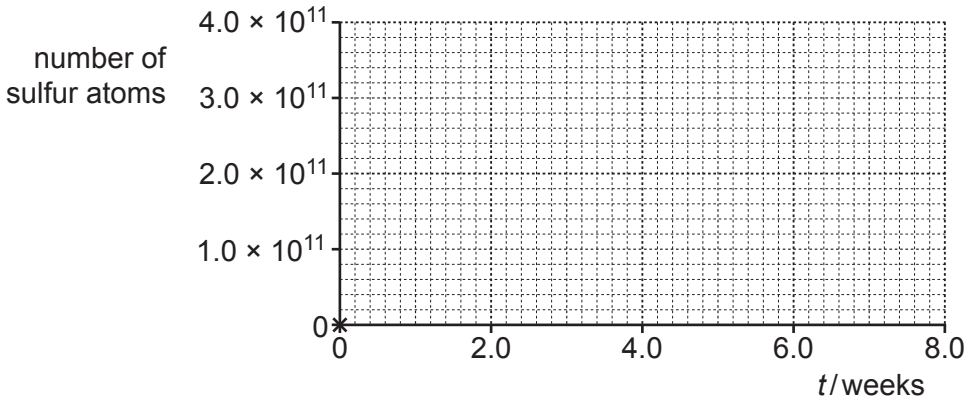


Fig. 6.1

(c) State **two** precautions taken when storing or moving radioactive materials.

1. .....

.....

2. .....

.....

[2]

[Total: 9]

Section B

Answer **two** questions from this section. Answer in the spaces provided.

7 A bus leaves a bus-stop at time $t = 0$ and travels along a horizontal road until it reaches a second bus-stop. Fig. 7.1 is the distance-time graph for the bus between $t = 0$ and $t = 60$ s.

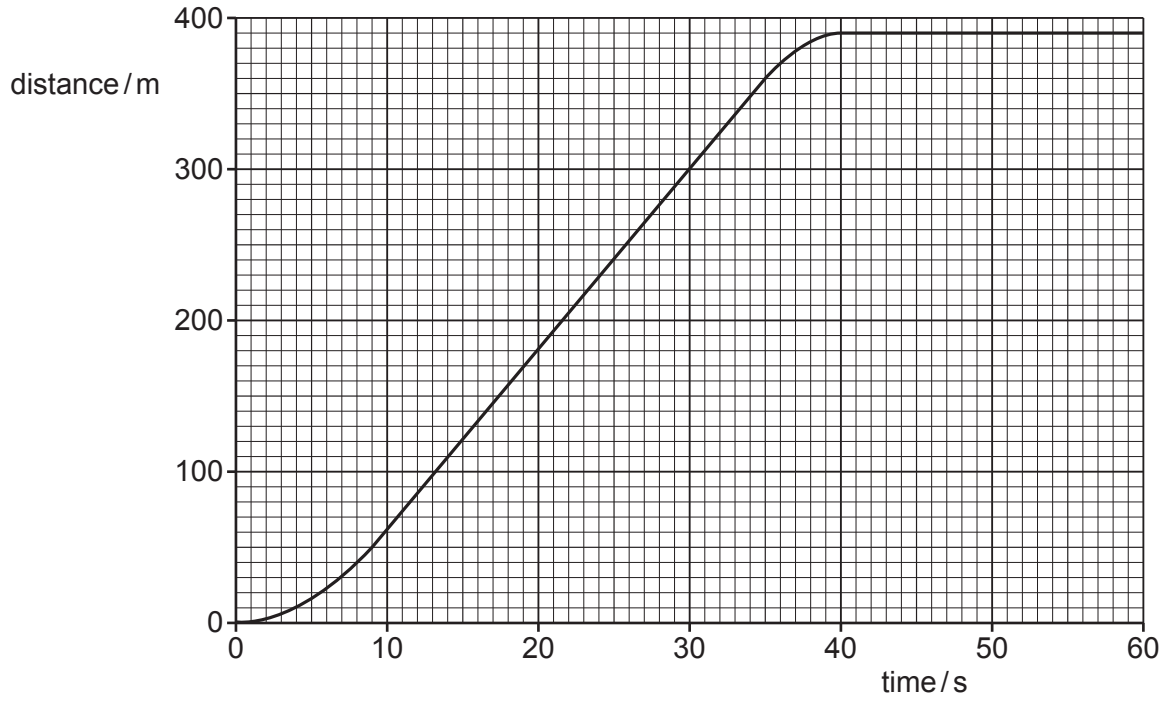


Fig. 7.1

The road on which the bus is travelling is straight except for a short, curved section. The bus travels around this circular curve between $t = 21$ s and $t = 24$ s.

(a) Describe how the motion of the bus between $t = 0$ and $t = 10$ s differs from its motion between $t = 35$ s and $t = 40$ s.

.....

.....

.....

.....

..... [3]

(b) Determine:

(i) the maximum speed of the bus during these 60 s

maximum speed = ... [3]

(ii) the average speed of the bus between leaving the first bus-stop and arriving at the second bus-stop.

average speed = ... [2]

(c) **(i)** State how *velocity* differs from *speed*.

.....

..... [1]

(ii) There are **three** periods during the 60 s when there is a non-zero resultant force acting on the bus.

Complete the statements to indicate these three time periods and state the direction of the resultant force in that period.

1. Between t = ... and t = ... the direction of the resultant force is

.....

2. Between t = ... and t = ... the direction of the resultant force is

.....

3. Between t = ... and t = ... the direction of the resultant force is

.....
[4]

(d) During the journey, the air resistance acting on the bus varies.

(i) State why the air resistance changes during the journey.

.....

..... [1]

(ii) On Fig. 7.1, mark and label with an M a time when the air resistance is a maximum value.
[1]

[Total: 15]

8 A thin converging lens is made of a transparent material of refractive index 1.4.

(a) A ray of light travelling in air strikes the surface of the lens at an angle of incidence of 55°.

(i) Calculate the angle of refraction.

angle of refraction = ... [2]

(ii) Place a tick (✓) in **one** of the boxes in the third column of Table 8.1 to indicate how the light ray deviates and what happens to the speed of the light in the ray as it enters the lens.

Table 8.1

direction of deviation	speed of light	
away from the normal	decreases	
away from the normal	does not change	
away from the normal	increases	
towards the normal	decreases	
towards the normal	does not change	
towards the normal	increases	

[1]

(iii) State what happens to the frequency of the light in the ray as it enters the glass.

..... [1]

(b) The focal length of the lens is 2.5 cm.

(i) State what is meant by *focal length*.

.....

..... [1]

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(ii) Fig. 8.1 is a full-scale diagram that shows an object O of height 3.0 cm and the lens.

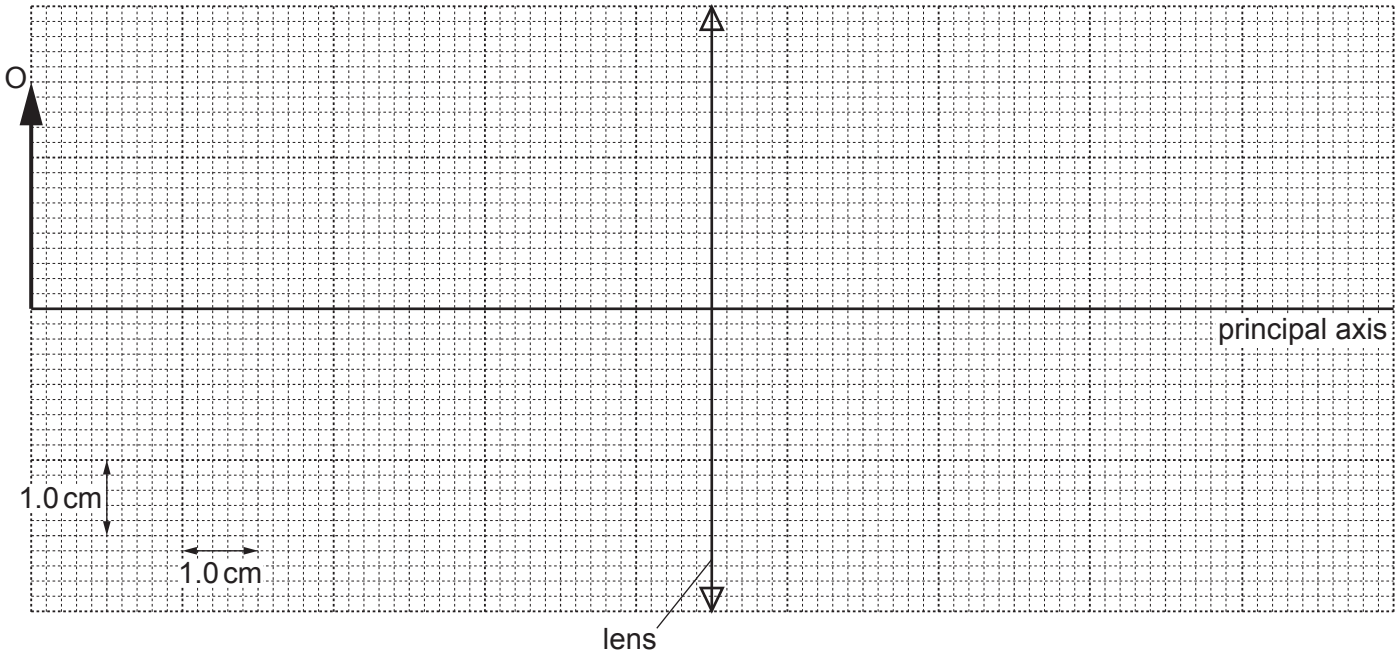


Fig. 8.1 (full scale)

By drawing on Fig. 8.1, locate and mark the image I of O. [4]

(iii) Determine the distance of I from the lens and calculate the magnification of O produced by the lens.

distance = ...

magnification = ...
[3]

(c) Describe how a converging lens is used in a camera.

.....

.....

.....

.....

..... [3]

[Total: 15]

9 Fig. 9.1 shows a permanent magnet lying on a piece of paper.

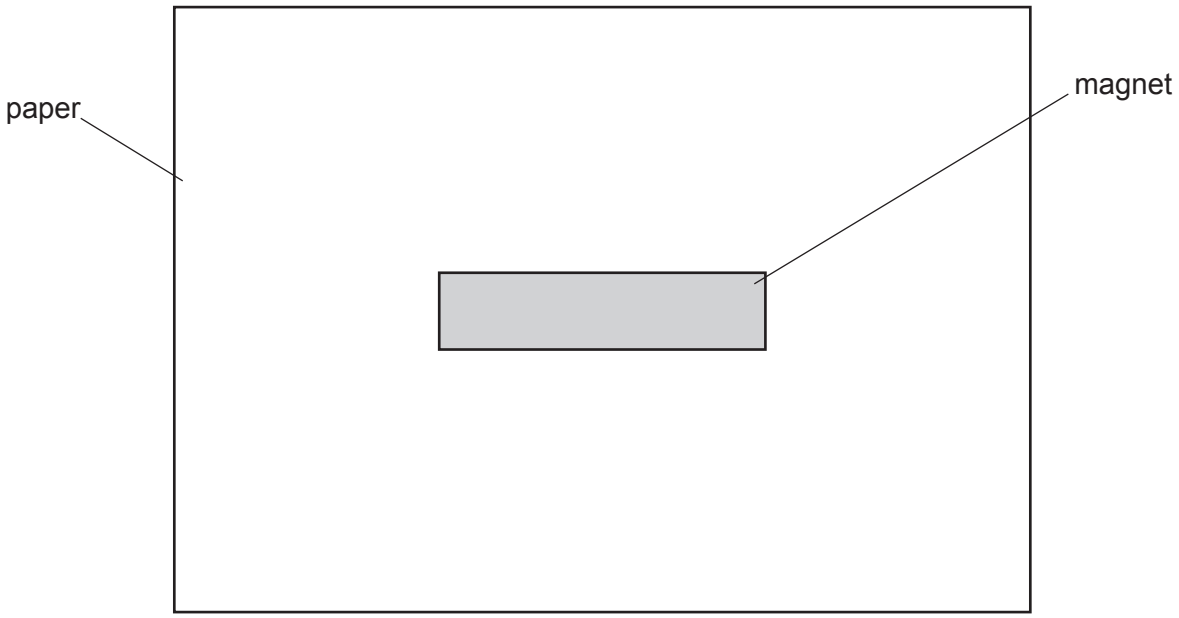


Fig. 9.1

(a) Underline the material in the list from which it is possible to make a strong, permanent magnet.

aluminium copper glass iron mercury plastic steel

[1]

(b) Describe an experiment to plot the pattern and the direction of the magnetic field surrounding the magnet. You may draw on Fig. 9.1, if you wish.

.....

.....

.....

.....

.....

.....

.....

..... [4]

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(c) Fig. 9.2 shows the N-pole of a magnet placed in front of the S-pole of a second magnet.

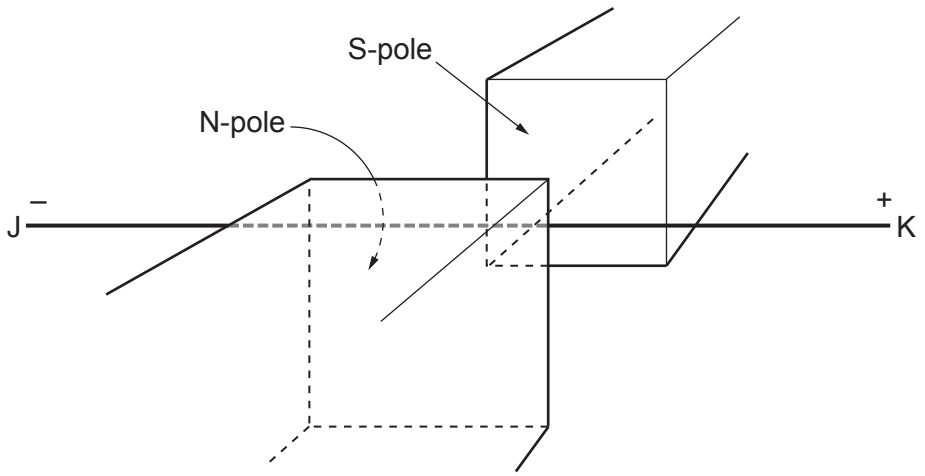


Fig. 9.2

A section of a horizontal, metal wire JK lies in the magnetic field between the two magnetic poles. End K of the metal wire is connected to the positive terminal of a battery and end J is connected to the negative terminal.

(i) Explain in terms of electrons, why there is a current in the wire and state the direction of the conventional current.

.....

.....

..... [2]

(ii) The part of JK that is in the magnetic field experiences a force F.

State the direction of F and describe how this direction is deduced.

.....

.....

.....

.....

..... [4]

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[Turn over

(iii) The equipment in Fig. 9.2 is used in a similar experiment.

The part of JK that lies between the poles of the magnets, now passes through a long iron tube that is fixed in position.

The tube is shown in Fig. 9.3.

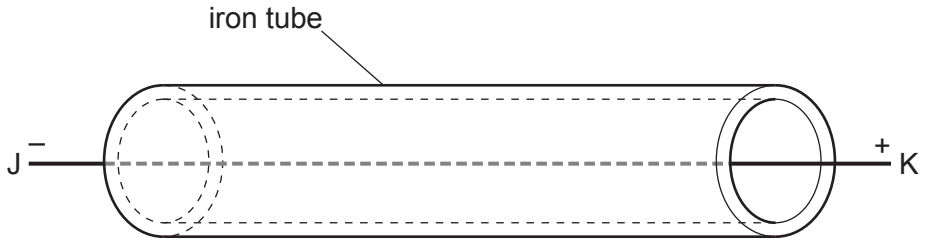


Fig. 9.3

JK is connected to the battery in the same way as before.

State what happens to force F on the wire.

Explain your answer.

.....

.....

..... [2]

(d) The iron tube and the wire JK are removed.

A square, vertical coil is placed between the poles so that the plane of the coil lies in the magnetic field as shown in Fig. 9.4.

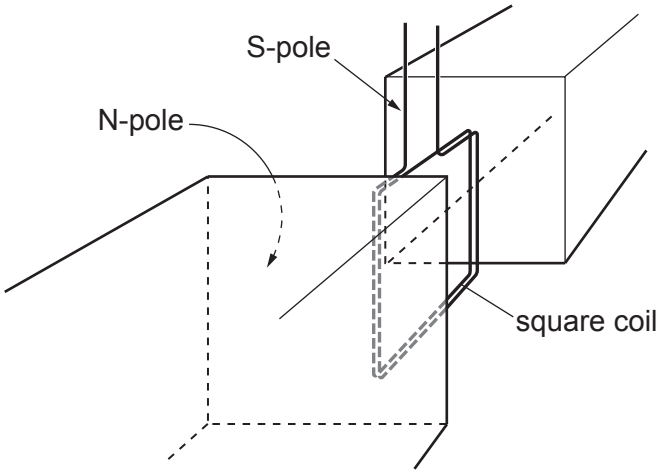


Fig. 9.4

Explain why the coil tries to rotate when there is a current in the coil.

.....

.....

.....

..... [2]

[Total: 15]

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