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IGCSE PHYSICS 0625 · TOPICAL PAST PAPERS

Electromagnetism

Paper 2 — Theory / Structured Questions (topical compilation)

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QUESTION # 1: M/J 08 P02 Q7 5054/02/M/J/08/Q7

1 **(a)** Fig. 7.1 shows a straight wire between the poles of a magnet. The wire carries a current into the page.

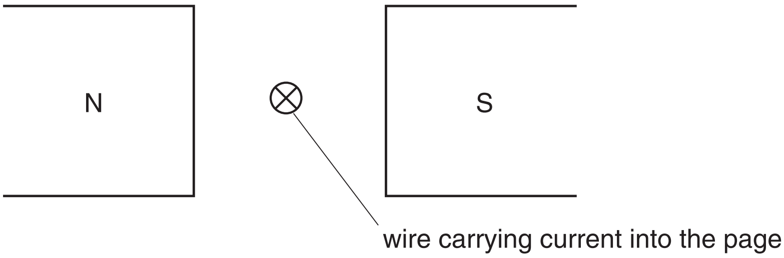

Fig. 7.1

(i) State the direction of the magnetic field between the poles of the magnet.

.... [1]

(ii) On Fig. 7.1, draw an arrow to show the direction of the force acting on the wire. [1]

(b) Fig. 7.2 shows two wires.
Each wire carries a current into the page.

Fig. 7.2

(i) On Fig. 7.2, draw the magnetic field due to the currents in the wires. [3]

(ii) There is a force on each wire due to the current in the other wire.

On Fig. 7.2, draw an arrow on each wire to show these forces. [1]

QUESTION # 2: M/J 11 P21 Q8

2 **(a)** A wire carrying a current in a magnetic field experiences a force due to the current. On Fig. 8.1, insert the words **current**, **field** and **force** in the boxes to show the relative directions of the current, the magnetic field and the force.

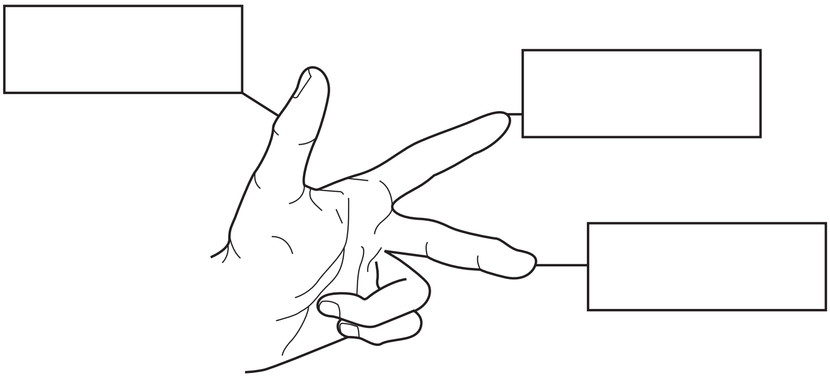

Fig. 8.1

[1]

(b) Fig. 8.2 shows a current-carrying coil ABCD in a magnetic field.

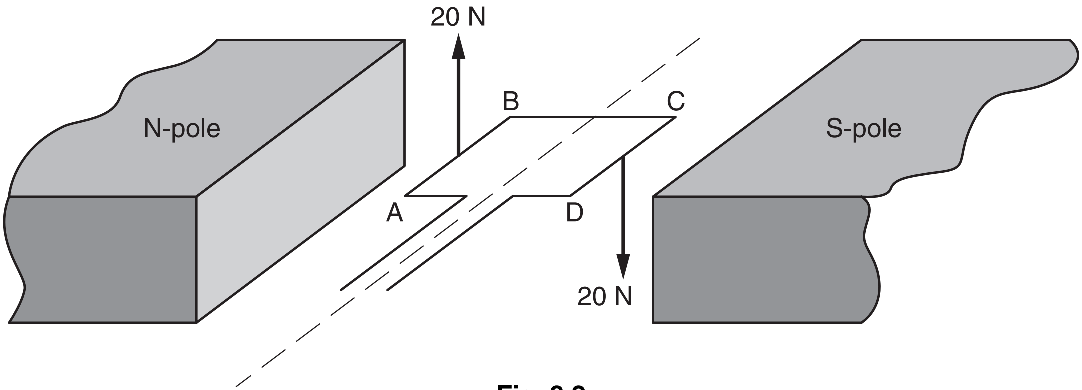

Fig. 8.2

Each side of the coil is 4.0 cm in length. The force on AB is 20 N and the force on CD is 20 N.

(i) Calculate the total moment caused by these forces.

moment = ... [2]

(ii) The moment is increased by using a stronger magnetic field.

State two other ways to increase the moment.

1. ....

2. ....

[2]

QUESTION # 3: M/J 13 P22 Q7

3 Fig. 7.1 shows a view, from above, of two wires X and Y. These wires carry equal currents vertically downwards through a piece of card.

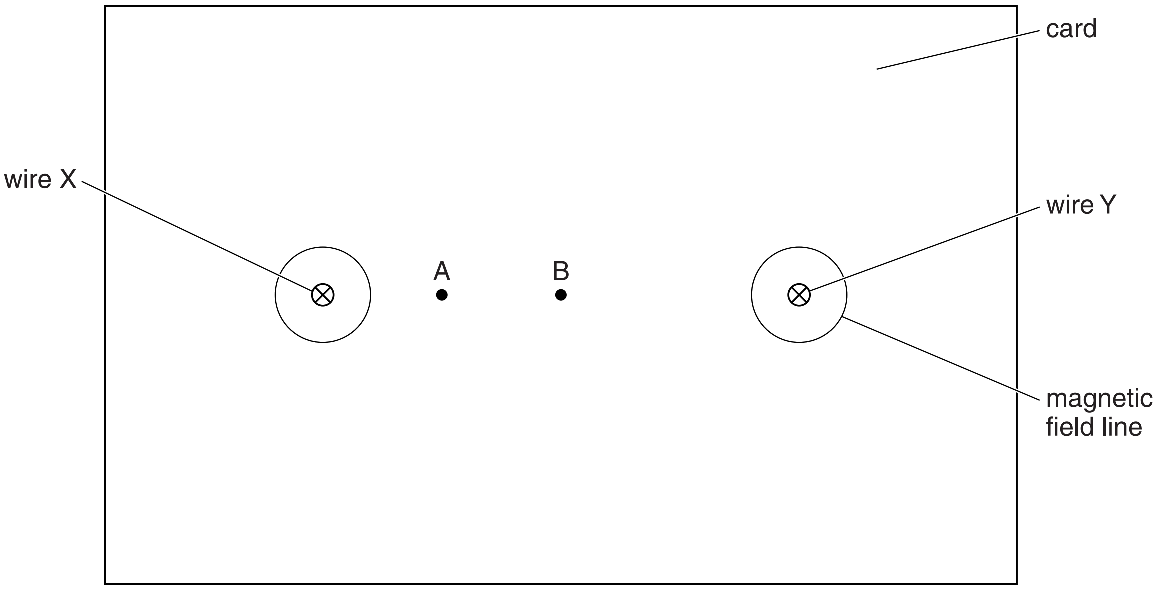

Fig. 7.1

One complete magnetic field line is drawn around each wire.

In this question, ignore the effects of the Earth's magnetic field.

(a) On Fig. 7.1, draw the complete magnetic field line due to the current in wire X that passes through point A.
Mark the direction of this field line. [2]

(b) Point B is midway between the two wires. Explain why the magnetic field at B is zero.

....

.... [1]

(c) There is a force on wire Y due to the current in wire X.

(i) State the direction of the force on wire Y.

.... [1]

(ii) Explain why there is a force on wire Y.

....

.... [1]

QUESTION # 4: M/J 14 P21 Q6

4 Fig. 6.1 shows a coil of wire connected by flexible leads to a switch and a battery.

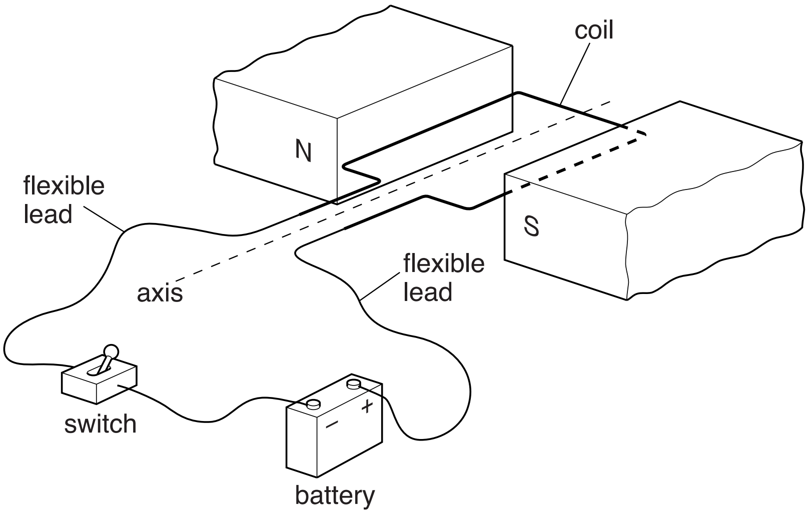

Fig. 6.1

The coil is placed between the poles of a permanent magnet and is free to turn about the axis.

When the switch is closed, forces due to the current act on the sides of the coil. The coil starts to turn.

(a) On Fig. 6.1, draw arrows to show the directions of the forces. [2]

(b) The coil stops when it is vertical. Explain why the turning effect of the forces is zero at this position.

....

.... [1]

(c) In order for the coil to rotate continuously, a split-ring commutator is connected between the battery and the coil.

Explain how the split-ring commutator enables the coil to rotate continuously. Include a diagram in your answer.

....

....

....

.... [4]

QUESTION # 5: M/J 17 P21 Q7

5 Fig. 7.1 shows a metal rod placed between the poles of a magnet.

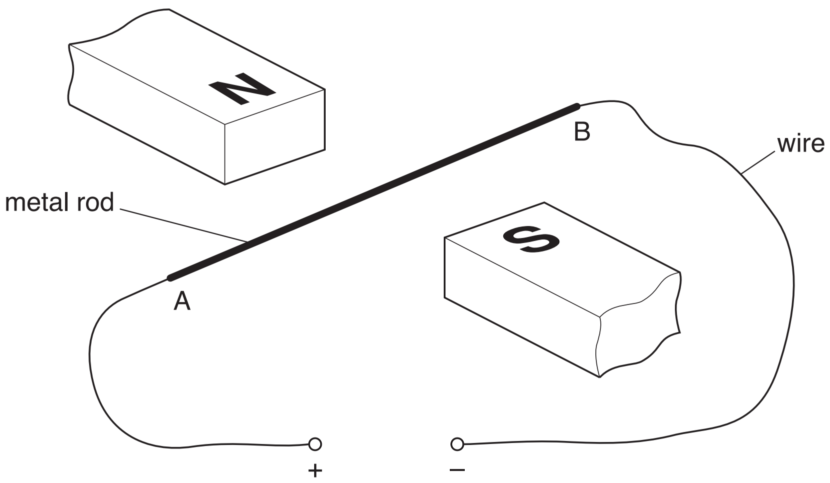

Fig. 7.1

(a) End A of the rod is connected to the positive terminal of a d.c. power supply and end B is connected to the negative terminal. The current in the rod and the magnetic field produce a force on the rod.

On Fig. 7.1 draw arrows to show

(i) the direction of the current in the metal rod; label this arrow C,

(ii) the direction of the magnetic field that acts on the metal rod; label this arrow M,

(iii) the direction of the force on the rod; label this arrow F.

[3]

(b) The power supply is removed and a sensitive voltmeter is connected between the ends A and B.

When the rod is moved upwards or downwards there is a reading on the voltmeter.

(i) Explain why there is a reading on the voltmeter.

....

....

....[2]

(ii) The reading on the voltmeter is increased by using a stronger magnetic field.

State one other way of producing a larger reading on the voltmeter.

....

....[1]

QUESTION # 6: M/J 19 P22 Q7

6 Fig. 7.1 shows a copper wire placed on two copper rods in the magnetic field between the poles of a magnet.

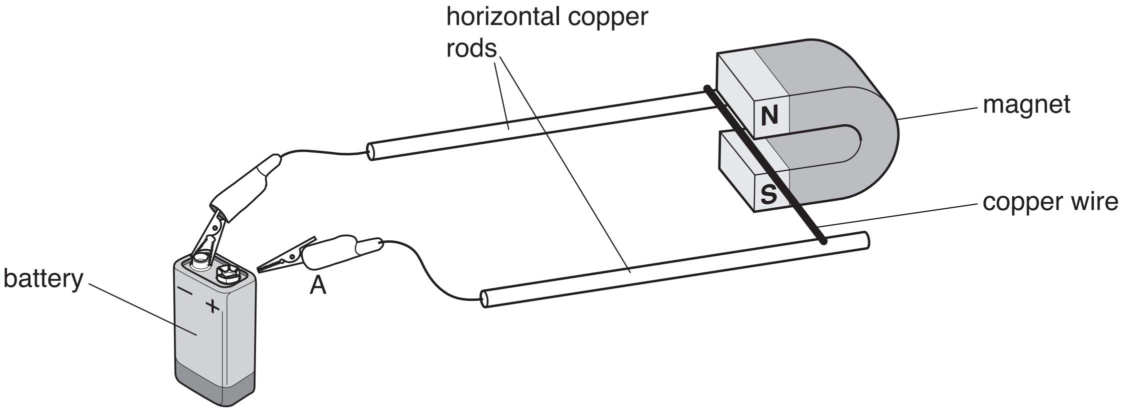

Fig. 7.1

The crocodile clip A touches the positive terminal of the battery. This causes the copper wire to move.

(a) On Fig. 7.1, mark with an arrow the direction of the current in the copper wire. [1]

(b) Explain why the copper wire moves along the copper rods.

....

....

....

.... [2]

(c) Name **two** different devices that use this effect.

1. ....

2. ....
[2]

[Total: 5]

QUESTION # 7: M/J 20 P21 Q8

(d) Fig. 8.3 shows a relay used to switch on a car headlamp.

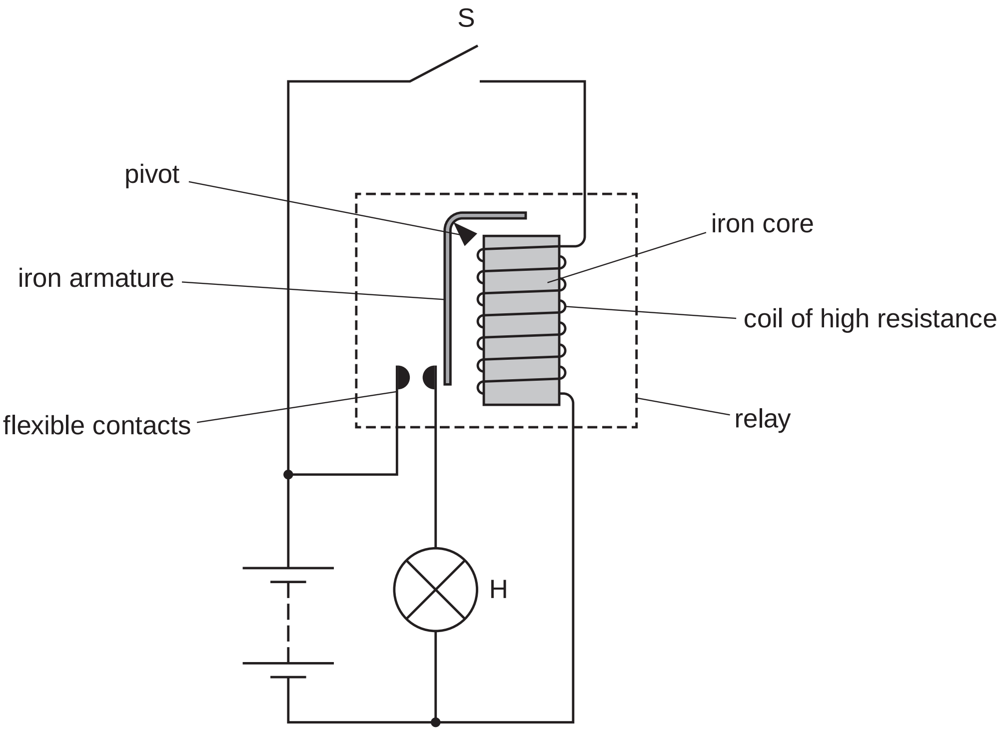

Fig. 8.3

Explain why headlamp H lights up when switch S is closed.

....

....

....

....

....

.... [4]

QUESTION # 8: M/J 20 P22 Q9

9 **(a)** Fig. 9.1 shows a simple relay used to switch a mains electric motor on and off.

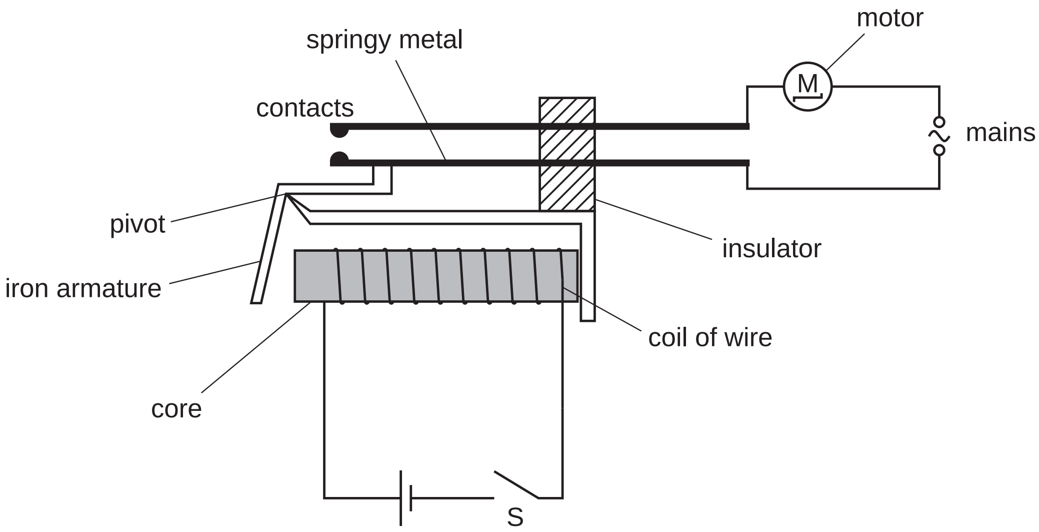

Fig. 9.1

(i) Explain why the motor switches on when switch S is closed.

....

....

....

.... [3]

(ii) Explain why the core is made of iron rather than steel.

....

....

.... [2]

(iii) A student suggests that the motor can be turned on and off without a relay.

He suggests connecting the mains to a simple switch in series with the motor.

Suggest **one** reason why, in some situations, using the relay is better.

....

.... [1]

5054/22/M/J/20

(b) Fig. 9.2 shows the coil of wire wrapped around a cardboard tube. There is no core.

There is an electric current in the wire in the direction shown by the arrows.

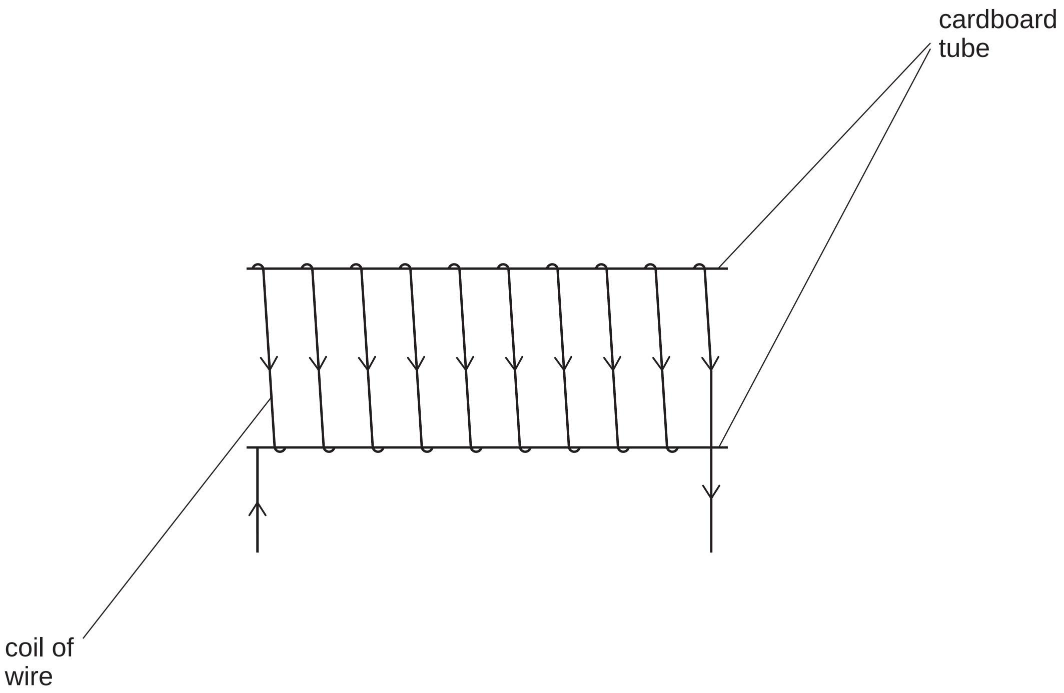

Fig. 9.2

(i) On Fig. 9.2, draw the pattern of the magnetic field inside and around the coil. Mark the direction of this magnetic field. [4]

(ii) On Fig. 9.2, mark the N-pole of the coil. [1]

QUESTION # 9: O/N 03 P02 Q7

7 Fig. 7.1 shows a coil ABCD that can turn between the two poles of a magnet. Bare metal paper clips support and pass current into and out of the coil.

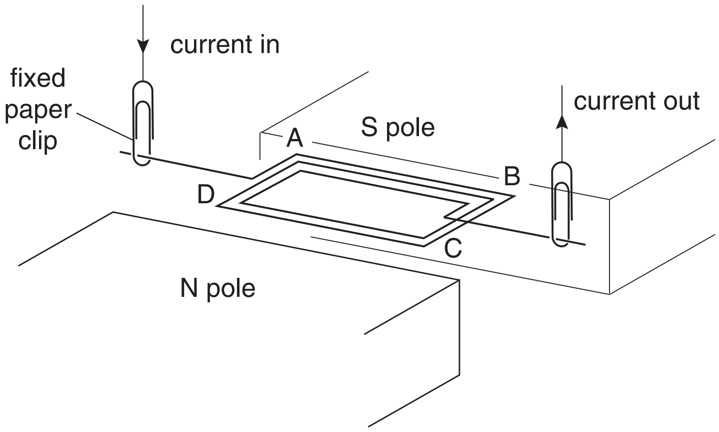

Fig. 7.1

(a) **(i)** State the direction of the force on the side AB.

....

(ii) Explain the reason for your choice of direction.

....

....

....
[2]

(b) A student turns the coil through 180° so that AB is close to the N pole of the magnet.

(i) State the direction of the force on side AB of the coil.

....

(ii) The student releases the coil. Explain why the coil does **not** rotate continuously.

....

....

....
[2]

(c) With the coil as shown in Fig. 7.1, the top half of the wire from C to the paper clip is coated with an insulator, as shown in Fig. 7.2. Explain why the coil can now rotate continuously.

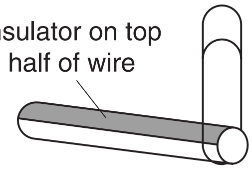

Fig. 7.2

....

....

....

....

....

.... [2]

QUESTION # 10: O/N 04 P02 Q9

8 Fig. 9.1 is a diagram of a simple d.c. motor.

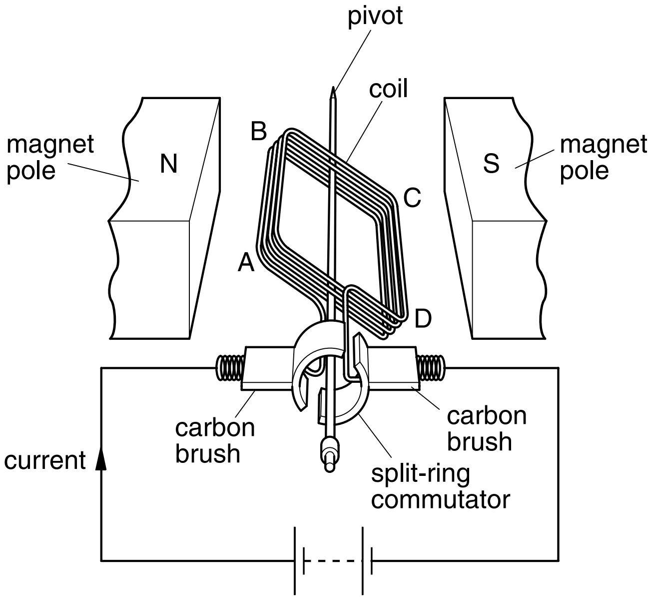

Fig. 9.1

The gap between the two halves of the split-ring commutator is so wide that a carbon brush can only touch one half of the split-ring at any time. This protects the circuit. It also means that sometimes the motor will not start when switched on.

The coil is rotated by vertical forces that act downwards on side AB and upwards on side CD. The current causes a constant force of 3.0 N on each side. The moment created by these forces varies as the coil turns. The moment is a maximum when the coil is horizontal.

The distances AD and BC are both 0.065 m.

(a) Explain why

(i) the carbon brushes must **not** be allowed to touch both halves of the split-ring at the same time,

(ii) sometimes the motor does **not** start when switched on, even if there is no friction.

[3]

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

(ii) Calculate the value of the maximum moment created on the coil.

(iii) Explain why the moment is a maximum when the coil is horizontal.

(iv) Sketch a graph to suggest how the moment acting on the coil varies with time as the coil rotates at constant speed. Label each axis. On the time axis, mark clearly the time taken for one revolution of the coil.

[7]

(c) **(i)** State the measurements you would make in order to find the electrical power input to the motor and state how your measurements are used to find the electrical power.

(ii) Draw a diagram of the circuit you would use to make these measurements.

[5]

QUESTION # 11: O/N 08 P02 Q10

9 Fig. 10.1 shows a wire passing through a hole in a horizontal, plastic board.

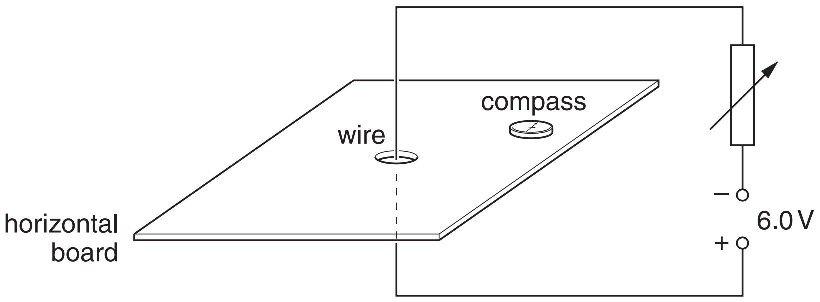

Fig. 10.1

The wire carries a current vertically upwards. A student moves a small compass around the board and plots the magnetic field lines due to the current.

(a) **(i)** Draw a diagram of the board as seen from above and mark on it the magnetic field lines due to the current. [3]

(ii) The current is increased. Describe how the magnetic field changes. [1]

(b) A 6.0 V power supply produces a current of 8.0 A in the wire. Calculate

(i) the total resistance of the circuit, [2]

(ii) the charge that flows through the wire in 2.0 minutes. [2]

(c) The north pole of a bar magnet is held on the left of the wire and the south pole of another bar magnet is held on the right, as shown in Fig. 10.2.

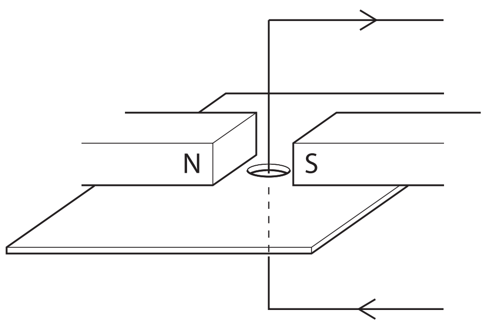

Fig. 10.2

(i) State the direction of the magnetic field at the wire due to these two poles. [1]

(ii) The wire is flexible. Describe the effect of this magnetic field on the current-carrying wire. [2]

(iii) The current in the wire is now reversed. State the effect of this on the wire. [1]

(iv) Describe how this effect is put to use in a d.c. motor. [3]

QUESTION #12: O/N 12 P21 Q7

10 **(a)** Fig. 7.1 shows a solenoid made from wire wound around a plastic cylinder.

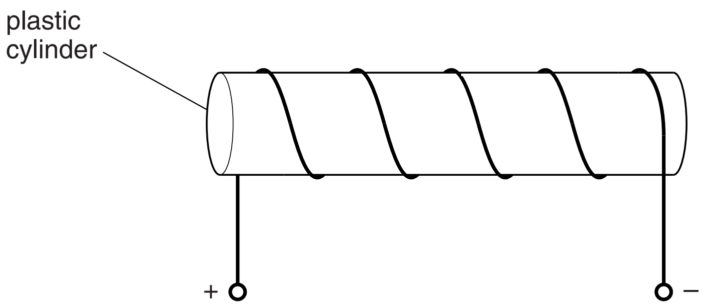

Fig. 7.1

A current in the solenoid produces a magnetic field.

On Fig. 7.1, draw the pattern of the magnetic field lines inside and outside the cylinder. [2]

(b) Fig. 7.2 shows a beam of beta-particles, in a vacuum, passing into a magnetic field.

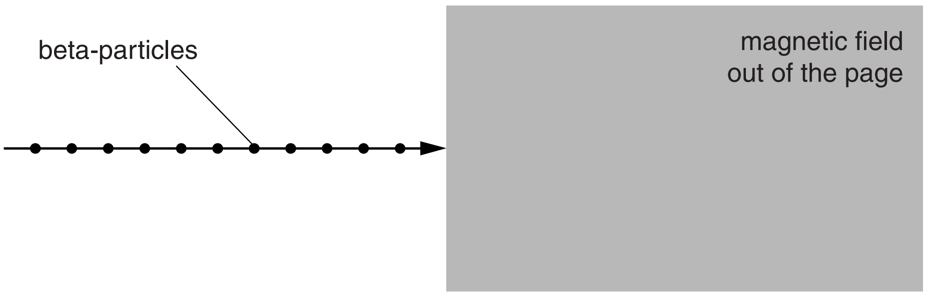

Fig. 7.2

The movement of the beta-particles from left to right is an electric current.

(i) On Fig. 7.2, draw an arrow to show the direction of the conventional current. [1]

(ii) A solenoid is used to produce the magnetic field that lies within the shaded region of Fig. 7.2. The direction of the field is out of the page.

1. On Fig. 7.2, draw the path followed by one of the beta-particles in the shaded region. [2]

2. The direction of the current in the solenoid is reversed. State what happens to the path of the beta-particle.

....

.... [1]

QUESTION # 13: O/N 12 P22 Q11

11 **(a)** A wire is wound around a soft-iron core forming a solenoid, as shown in Fig. 11.1.

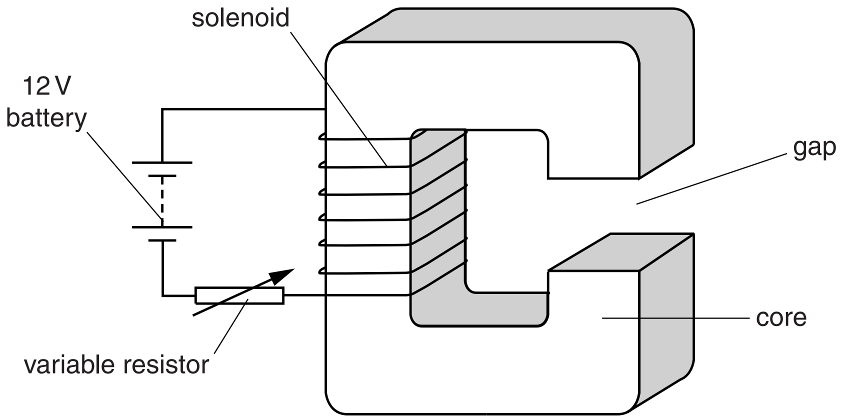

Fig. 11.1

There is a gap in the core. The solenoid is connected in series with a 12 V battery and a variable resistor (rheostat). The resistance of the solenoid is 0.30 Ω and the variable resistor is set so that it has a resistance of 4.5 Ω.

(i) Calculate the current in the solenoid.

current = ... [3]

(ii) The current in the solenoid magnetises the soft-iron core.

Explain how the electric circuit is used to increase the strength of the magnetic field.

....

....

.... [2]

(iii) Fig. 11.2 shows a horizontal, current-carrying wire PQ in the gap.

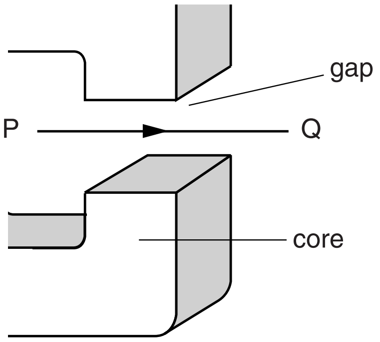

Fig. 11.2

1. The magnetic field in the gap is uniform and vertically upwards. The current in PQ is from left to right. Describe the effect of the magnetic field on PQ.

....

.... [2]

2. State the effect on PQ of increasing the strength of the magnetic field in the gap.

....

.... [1]

(b) The starter motor in a car is powered by a 12 V battery that is positioned next to the motor. The current in the motor is 75 A.

(i) Calculate the power supplied by the battery.

power = ... [2]

(ii) Suggest and explain why the wires that connect the motor to the battery are very thick.

....

....

.... [2]

(c) A relay is used to switch on a starter motor in a car. Describe how the relay works. You may include a diagram in your answer.

....

....

....

....[3]

QUESTION # 14: O/N 17 P21 Q7

12 An electric circuit consists of a battery, a variable resistor and connecting wires. Sections PQ and QR of the connecting wire are in a region of space where there is a uniform magnetic field.

In Fig. 7.1, the shaded area represents the magnetic field.

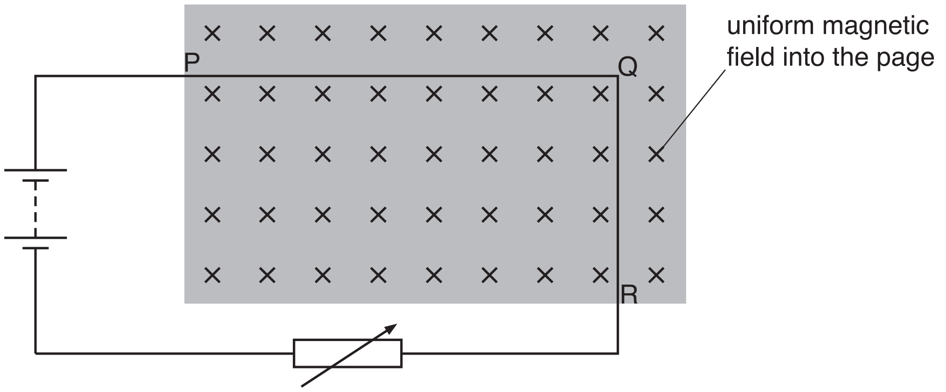

Fig. 7.1

The direction of the magnetic field is into the page.

A current-carrying wire in a magnetic field can experience a force.

(a) In the table, mark **one** tick (✓) in each column to indicate the force on PQ and the force on QR.

	section PQ	section QR
no force on this section		
a force towards the top of the page		
a force towards the bottom of the page		
a force out of the page		
a force into the page		
a force towards the left of the page		
a force towards the right of the page		

[2]

(b) The battery in the circuit in Fig. 7.1 is reversed.

State and explain the effect of this on PQ and QR.

....

....

....

.... [2]

(c) The variable resistor is adjusted and the current in the circuit decreases.

Suggest one effect of decreasing the current.

....

.... [1]

QUESTION # 15: O/N 19 P22 Q7

13 Fig. 7.1 shows a horizontal, rectangular coil ABCD placed between a magnetic N-pole and an S-pole.

There is a current in the coil.

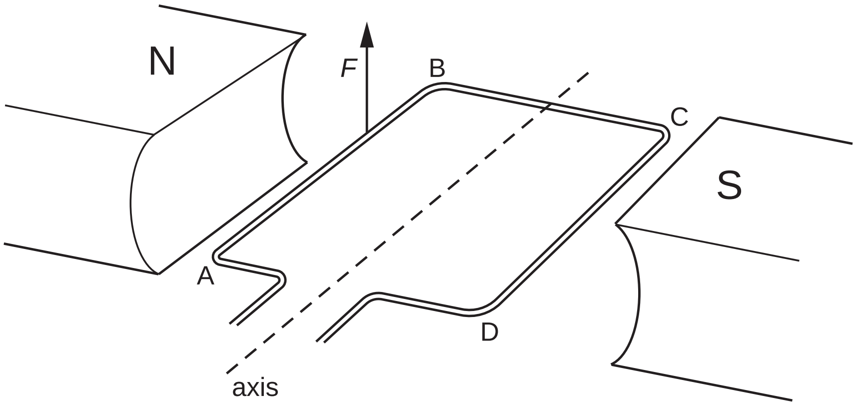

Fig. 7.1

An upward force *F* of size 9.6×10^{-3} N acts on side AB of the coil.

(a) (i) Explain why there is a force on side AB.

....

.... [1]

(ii) Determine the direction of the current in AB and state how the direction is deduced.

....

....

.... [2]

(b) Both side AB and side CD of the coil are 2.5 cm from the axis.

Determine the total moment acting on the coil.

moment = ... [2]

(c) The coil in Fig. 7.1 is part of a direct current (d.c.) motor.

(i) State the name of the device that connects the coil of a d.c. motor to the electricity supply.

.... [1]

(ii) State **one** change to the arrangement in Fig. 7.1 that produces a greater turning effect in coil ABCD.

.... [1]

QUESTION # 16: O/N 21 P22 Q9

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

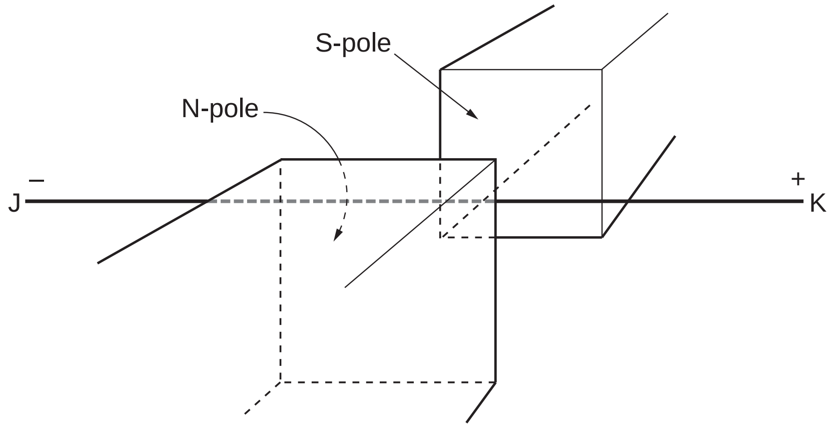

Fig. 9.2

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]

(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.

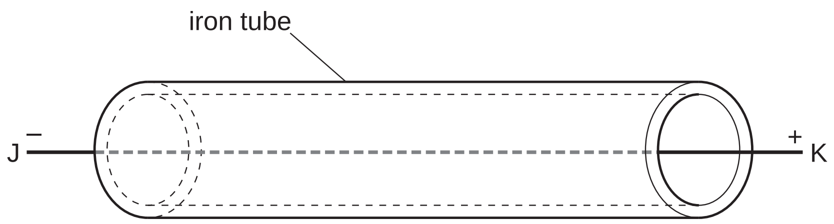

Fig. 9.3

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.

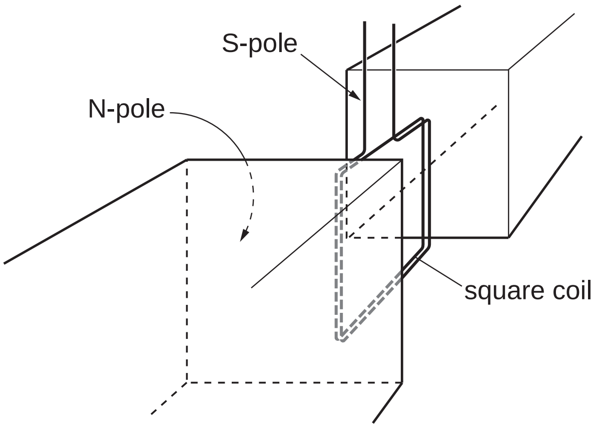

Fig. 9.4

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

....

....

....

.... [2]