Topical Practice

IGCSE PHYSICS

Paper 4

Chapters 11 – 12

EDITION • Volum • STUDENT

CONTENTS

1 (a) Fig. 7.1 shows a conducting sphere A, initially uncharged, mounted on an insulating base. The positively-charged, non-conducting sphere B is brought close to sphere A without touching the sphere.

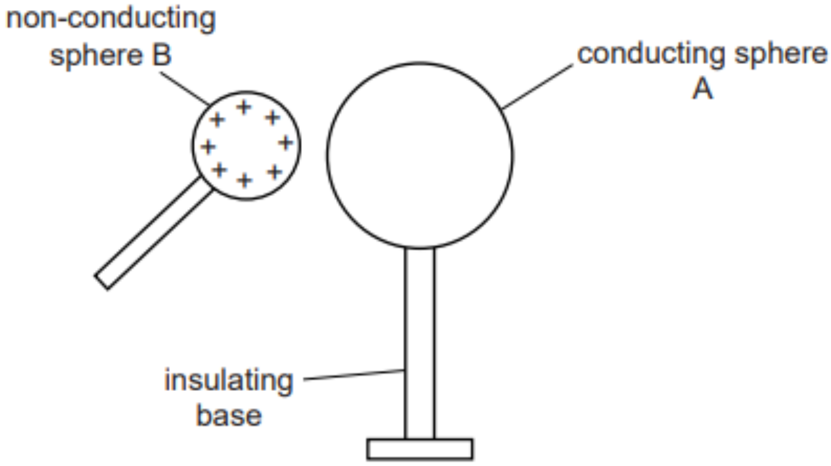

Fig. 7.1

(i) On Fig. 7.1, draw the resulting distribution of any positive and negative charges on sphere A. [2]

(ii) The sphere A is now earthed as shown in Fig. 7.2.

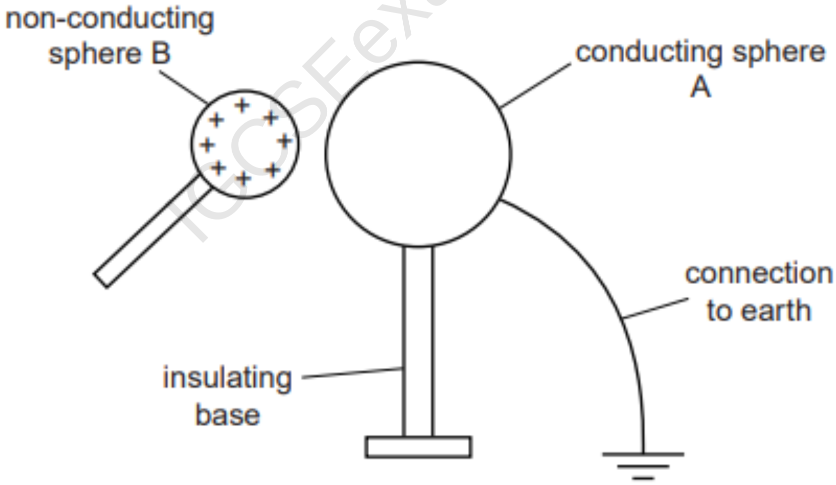

Fig. 7.2

On Fig. 7.2, draw the distribution of any positive and negative charges on sphere A after it is earthed. [1]

(b) (i) On Fig. 7.3, draw lines of force with direction arrows to represent the electric field pattern in the plane of the paper around a negative point charge at point X.

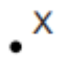

Fig. 7.3

(ii) State what is represented by the directions of the arrows on the lines.

....

.... [2]

[Total: 5]

2 40 lamps, each of resistance 8.0 Ω, are connected in series to a 240 V supply in order to decorate a tree.

(a) Calculate

(i) the current in each lamp,

current = ... [2]

(ii) the power dissipated in each lamp.

power = ... [2]

(b) The lamps are designed to "fail-short". If a filament fails, the lamp shorts so that it has no resistance. The other lamps continue to light and the current increases.

The lamps are connected through a fuse that blows when the current rises above 0.9 A. At this current, the resistance of each lamp is 5% greater than its normal working resistance.

Calculate the maximum number of lamps that can fail before the fuse blows.

number of lamps = ... [4]

[Total: 8]

3 **(a)** In Fig. 8.1, S is a metal sphere standing on an insulating base. R is a negatively charged rod placed close to S.

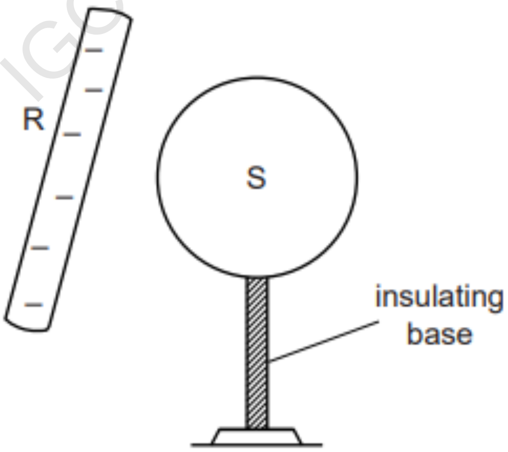

Fig. 8.1

(i) Name the particles in S that move when R is brought close to S.

.... [1]

(ii) On Fig. 8.1, add + signs and – signs to suggest the result of this movement. [1]

(iii) Describe the actions which now need to take place so that S becomes positively charged with the charge distributed evenly over its surface. A positively charged object is **not** available.

....

....

.... [3]

(b) During a thunderstorm, the potential difference between thunderclouds and the ground builds up to 1.5×10^6 V. In each stroke of lightning, 30 C of charge passes between the thunderclouds and the ground. Lightning strokes to the ground occur, on average, at 2 minute intervals.

Calculate

(i) the average current between the thunderclouds and the ground,

average current = ... [2]

(ii) the energy transferred in each stroke of lightning.

energy = ... [2]

[Total: 9]

4 This question refers to quantities and data shown on the circuit diagram of Fig. 9.1.

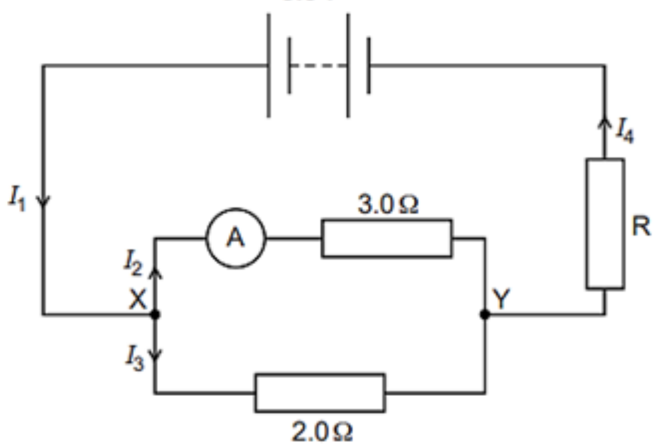

Fig. 9.1

(a) State the relationship between

(i) the currents I_1, I_2 and I_3, ...[1]

(ii) the currents I_1 and I_4. .... [1]

(b) The ammeter reads 0.80 A. Assume it has zero resistance.

Calculate

(i) the potential difference between X and Y,

p.d. = ... [1]

(ii) the current I_3,

current = ... [2]

(iii) the resistance of R.

resistance = ... [4]

[Total: 9]

5 An electric heater is connected to a 230 V mains supply. The heater circuit includes two resistors R_1 and R_2, and two switches S_1 and S_2. Fig. 8.1 is the circuit diagram.

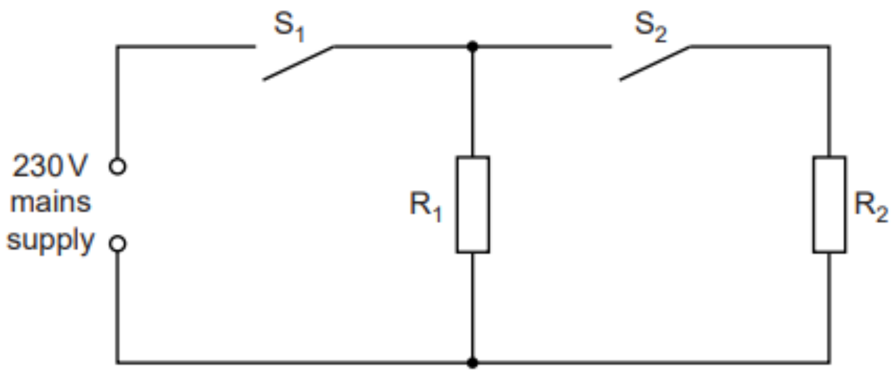

Fig. 8.1

The resistance of R_1 is 46 Ω and the resistance of R_2 is also 46 Ω.

Switch S_1 is closed and switch S_2 remains open.

(a) Calculate

(i) the current from the mains supply,

current = ... [2]

(ii) the power dissipated in the heater.

power = ... [2]

(b) Switch S_2 is now closed.

State the current in R_2.

current = ... [1]

[Total: 5]

6 **(a)** A student rubs one side of an inflated balloon on her hair. This side of the balloon becomes positively charged. Explain this.

....

....

.... [2]

(b) The charged side of the balloon is now brought close to a stream of water flowing from a pipe. The original position of the stream of water is shown in Fig. 8.1.

On Fig. 8.1, write in the boxes to indicate how each side of the stream of water is electrically charged.

Choose your answer in each case from: positive, negative or neutral.

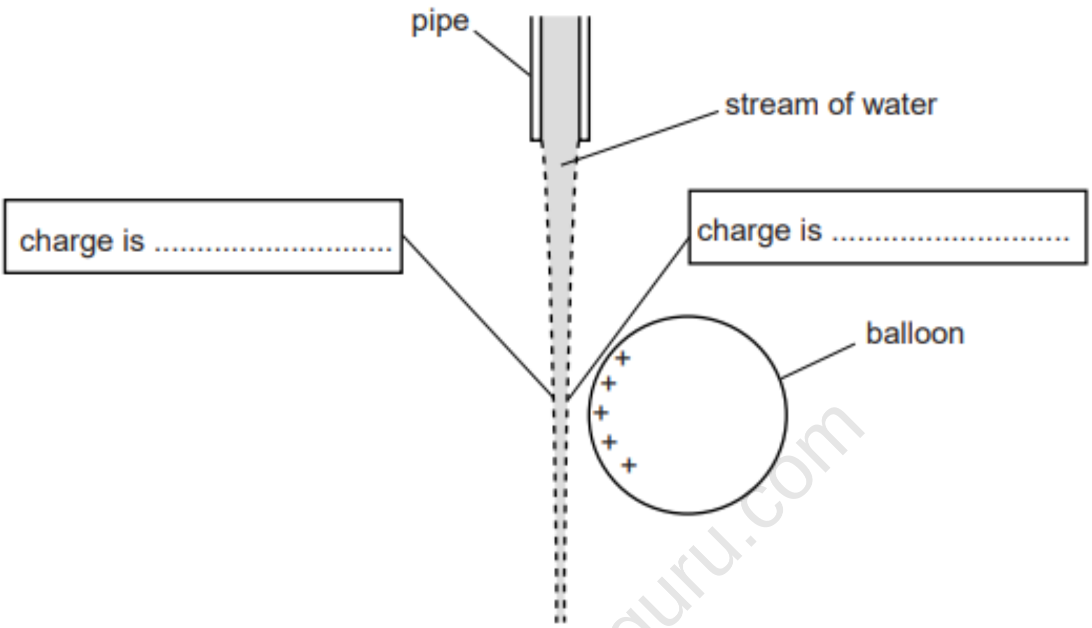

Fig. 8.1

[2]

(c) On Fig. 8.1, draw the new position of the stream of water. Explain this new position.

....

....

....

.... [2]

(d) Explain why rubbing one side of a metal sphere does not cause it to become charged.

....

.... [1]

[Total: 7]

7 (a) Determine which **one** of the following resistors, connected in parallel with a 24.0 Ω resistor, would give a total resistance of 8.0 Ω. Show your working.

Available resistors: 2.0 Ω, 4.0 Ω, 6.0 Ω, 8.0 Ω, 12.0 Ω, 16.0 Ω, 18.0 Ω, 32.0 Ω

value of resistor = ... [3]

(b) (i) In the space below, draw the parallel combination of resistors from **(a)** connected in a circuit with a 6.0 V battery. The circuit should also include an ammeter to measure the current in the 24.0 Ω resistor.

[2]

(ii) Calculate the current in each of the resistors when connected as in **(b)(i)**. Show your working.

current in 24.0 Ω resistor = ...

current in the other resistor = ...
[3]

[Total: 8]

8 **(a)** State the electrical quantity that has the same value for each of two resistors connected to a battery

(i) when they are in series, ...

(ii) when they are in parallel. ....

[1]

(b) Fig. 10.1 shows a circuit with a 1.2 kΩ resistor and a thermistor in series. There is no current in the voltmeter.

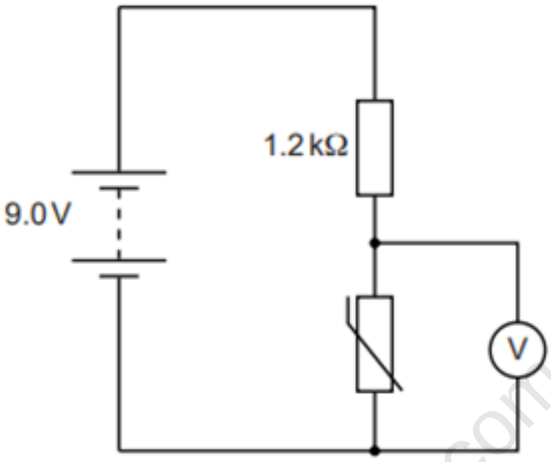

Fig. 10.1

Calculate the voltmeter reading when the resistance of the thermistor is 3.6 kΩ.

voltmeter reading = ... [3]

(c) Fig. 10.2 shows a fire-alarm circuit. The circuit is designed to close switch S and ring bell B if there is a fire.

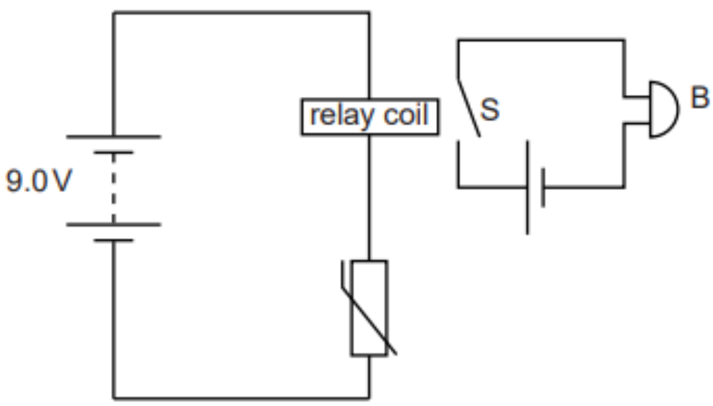

Fig. 10.2

Explain the operation of the circuit.

....

....

....

....

....

....

.... [3]

[Total: 7]

9 Fig. 8.1 shows a small, uncharged copper sphere suspended from a nylon thread, and a plastic rod being rubbed with a woollen cloth.

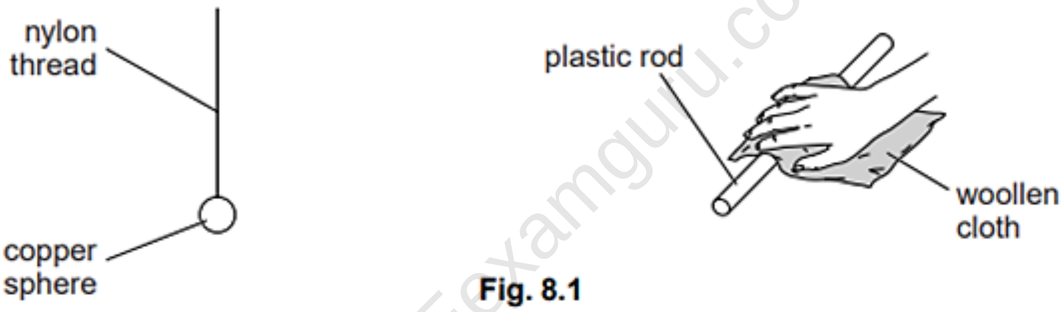

Fig. 8.1

The rod becomes negatively charged as it is rubbed.

(a) Explain, in terms of electrons, why copper is a conductor but nylon is an insulator.

....

....

.... [2]

(b) Describe how the negatively charged rod may be used to induce a positive charge on the copper sphere.

....

....

....

.... [3]

(c) The copper sphere is given a positive charge, as shown in Fig. 8.2.

Fig. 8.2

On Fig. 8.2, draw arrows to indicate the direction and pattern of the electric field that surrounds the positively charged sphere. [2]

[Total: 7]

10 A remote ski lodge receives 18 kW of electric power from a 120 V supply.

(a) Calculate

(i) the current that the ski lodge draws from the supply,

current = ... [2]

(ii) the electrical energy supplied to the ski lodge in 30 minutes.

energy = ... [2]

(b) The power supply to the ski lodge is from a nearby transformer that is connected to long-distance transmission cables. The voltage of the transmission cables is very much larger than 120V.

Explain why energy losses in the transmission cables are lower when the voltage is high.

....

....

....

....

.... [3]

[Total: 7]

11 The solar charger shown in Fig. 7.1 is used to charge portable electronic devices in a part of the world without any other electricity supply.

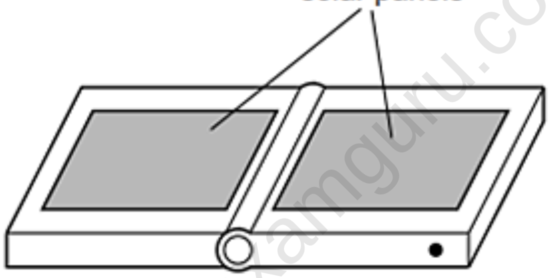

Fig. 7.1

The dimensions of each of the solar panels are 0.25m × 0.20m. The solar power incident on 1.0 m^2 of flat ground in this part of the world is 260W.

(a) Calculate the total solar power incident on the two panels of the charger.

solar power = ... [2]

(b) The output of the charger is 0.95A at 20V.

Calculate the efficiency of the charger.

efficiency = ...[3]

12 Three devices A, B and C are connected together and then connected to the 20V charger. The potential difference (p.d.) across A is measured as 14V, across B it is 14V and across C it is 6V.

Complete Fig. 7.2 to show the arrangement of the devices connected to the charger. Draw devices B and C as similar boxes to the box shown for device A.

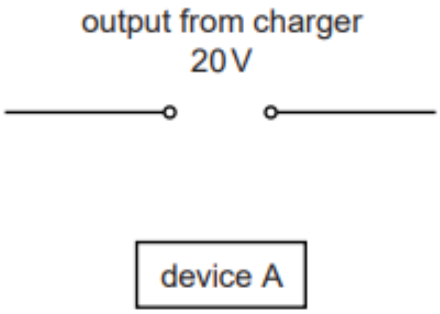

Fig. 7.2 [2]

(d) Two other devices, D and E, have resistances of 20 Ω and 30 Ω.

Calculate the total resistance of D and E when they are connected in parallel.

total resistance = ... [2]

[Total: 9]

13 Fig. 9.1 shows the circuit that operates the two headlights and the two sidelights of a car.

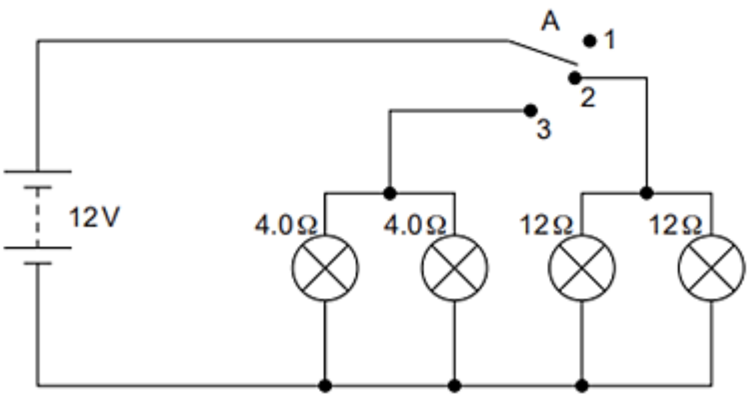

Fig. 9.1

Two of the lamps have resistances of 4.0 Ω when lit. The other two lamps have resistances of 12 Ω when lit. Switch A can be connected to positions 1, 2 or 3.

(a) State what happens when switch A is connected to

(i) position 1, ...

(ii) position 2, ...

(iii) position 3. ....
[1]

(b) **(i)** State the potential difference across each lamp when lit.

potential difference = ...[1]

(ii) Calculate the current in each 12 Ω lamp when lit.

current = ...[2]

(c) Show, with reasons for your answer, which type of lamp, 4.0 Ω or 12 Ω, has the higher power.

....

....

....

....[3]

[Total: 7]

14 **(b)** There are energy losses in the transmission cables.

(i) Explain why the energy losses become greater when the length of the transmission cables is greater.

....

....

.... [2]

(ii) Discuss the advantages and disadvantages of using transmission cables of greater cross-sectional area.

....

....

.... [2]

[Total: 8]

15 **(a)** A piece of wire has a resistance of 0.45 Ω.

Calculate the resistance of another piece of wire of the same material with a third of the length and half the cross-sectional area.

resistance = ... [3]

(b) Fig. 8.1 shows a circuit with three resistors, a power supply and four voltmeters.

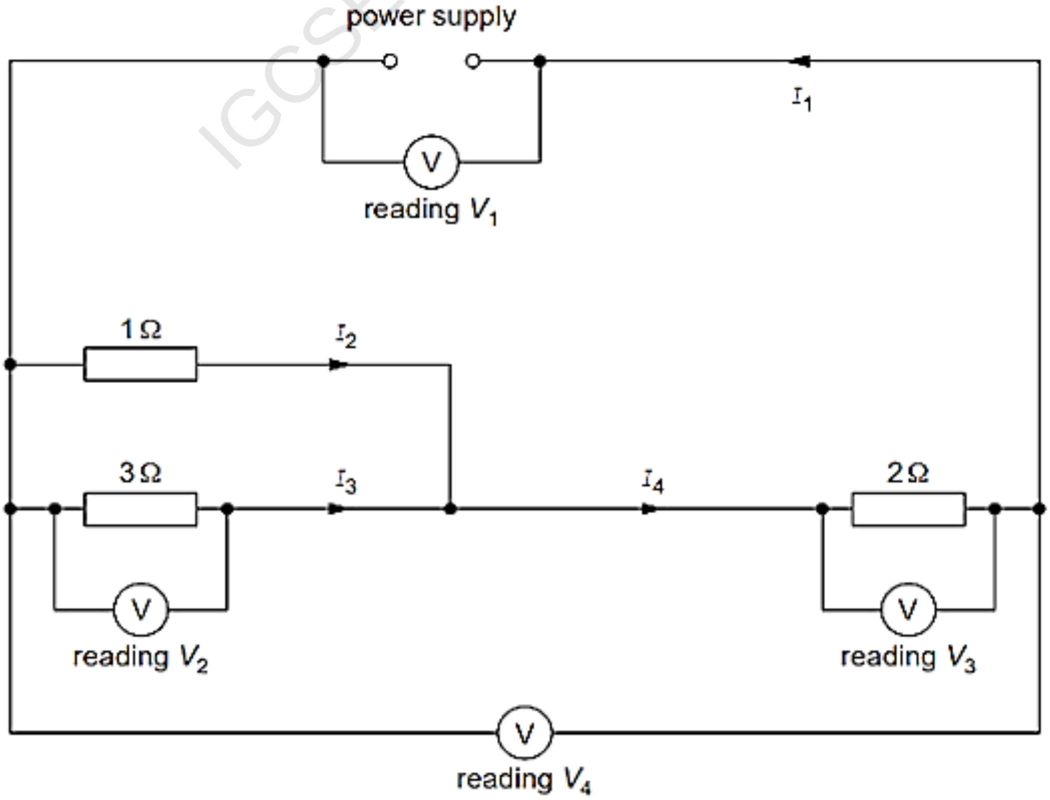

Fig. 8.1

(i) Calculate the combined resistance of the three resistors.

resistance = ... [3]

(ii) Write down **two** relationships for the currents in the circuit.

[2]

(iii) Write down **two** relationships for the voltmeter readings in the circuit.

[2]

[Total: 10]

16 (a) An electrical safety expert is inspecting a laundry. The main workroom has a very hot and damp atmosphere.

The safety expert recommends that normal domestic light switches, as shown in Fig. 9.1, are replaced.

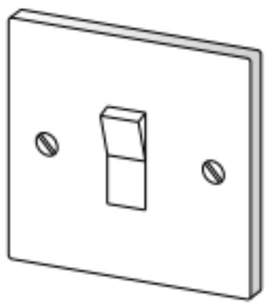

Fig. 9.1

(i) Explain why this recommendation is made.

....

....

....

.... [2]

(ii) Suggest how the lights should be switched on and off.

....

....

....

.... [1]

(b) Fig. 9.2 shows an aircraft being refuelled through a rubber hose.

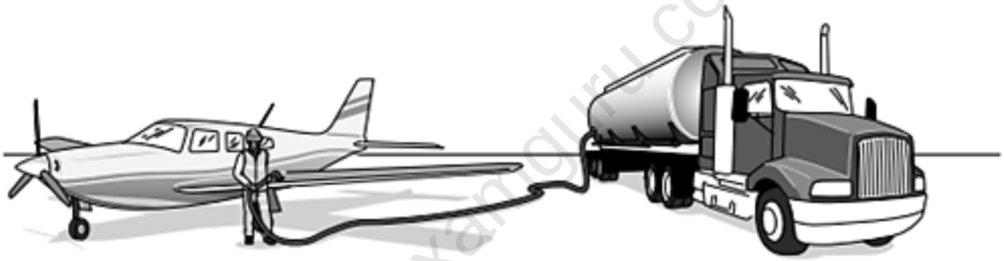

Fig. 9.2

(i) Suggest how fuel flowing through the hose can cause a large build-up of electric charge on the aircraft.

....

....

....

.... [2]

(ii) The aircraft is refuelled on a particular day when the tyres and wheels are wet.

Explain why there will be no large build-up of charge in this case.

....

....

....

.... [1]

[Total: 6]

17 **(a)** State the relationship between

(i) the resistance *R* and the length *L* of a wire of constant cross-sectional area,

....

(ii) the resistance *R* and the cross-sectional area *A* of a wire of constant length.

....

[1]

(b) A 60W filament lamp X is connected to a 230V supply, as shown in Fig. 9.1.

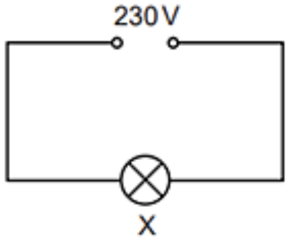

Fig. 9.1

Calculate the current in the filament.

current = ... [2]

(c) Lamp Y has a filament made of the same metal as the filament of lamp X in **(b)**.

This filament has half the length and one-third of the cross-sectional area of the filament of X.

Lamp Y is also connected to a 230V supply.

Calculate the ratio $\frac{\text{current in filament of Y}}{\text{current in filament of X}}$. Show your working.

ratio = ... [4]

[Total: 7]

18 Fig. 9.1 represents two identical metal plates, positioned horizontally, one above the other in a vacuum.

Fig. 9.1

A negative charge of 0.000 000 042 C (4.2×10^{-8} C) is transferred to the upper plate, leaving the lower plate with a positive charge of the same size.

(a) On Fig. 9.1, draw the pattern of the electric field between the two plates and indicate the direction of the lines of force. [3]

(b) **(i)** A conducting copper wire is used to connect the two plates and this leaves the plates uncharged. Charge flows in the wire for 0.000 000 035 s (3.5×10^{-8} s).

Calculate the average current in the wire during this time.

current = ... [3]

(ii) State, in terms of its atomic structure, why the copper wire is an electrical conductor.

....

....

.... [2]

[Total: 8]

19 The electric circuit in a clothes dryer contains two heaters X and Y in parallel. Fig. 10.1 shows the circuit connected to a 230 V power supply.

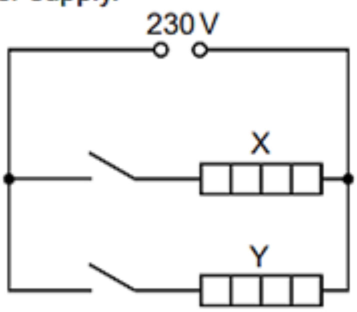

Fig. 10.1

When both switches are closed, the current in X is 3.5 A.

(a) Calculate the power developed in heater X.

power = ... [2]

(b) The resistance of X is double that of Y.

Determine the total resistance of X and Y in parallel.

resistance = ... [4]

[Total: 6]

20 Overhead power cables supply electrical power to a town that is a considerable distance from the power station.

The voltage at which the power is transmitted in the cables is very much greater than the voltage at the power station and the voltage of the mains supply in the town.

(a) Explain the advantage of transmitting electrical power at a very high voltage.

....

....

....

....

.... [3]

(b) It is suggested that the resistance of the cables can be changed by doubling their diameter.

(i) Explain the effect of this change on the resistance of the cables.

....

....

.... [2]

(ii) Suggest one disadvantage of doubling the diameter of the cables.

....

.... [1]

[Total: 6]

21 Fig. 8.1 shows three cells each with e.m.f. 1.5V connected in series.

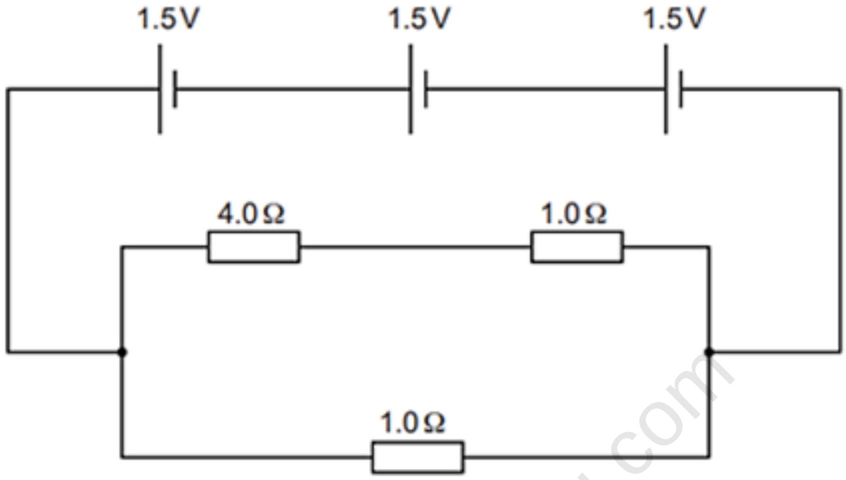

Fig. 8.1

(a) Calculate the combined e.m.f. of the cells.

e.m.f. = ... [1]

(b) Calculate the combined resistance of the three resistors shown in Fig. 8.1.

resistance = ... [2]

(c) Calculate the current in the 4.0 Ω resistor in Fig. 8.1.

current = ... [3]

(d) Calculate the combined e.m.f. of the cells if one cell is reversed.

e.m.f. = ... [1]

[Total: 7]

22 Fig. 9.1 shows a positively charged plastic rod, a metal block resting on an insulator, and a wire connected to earth.

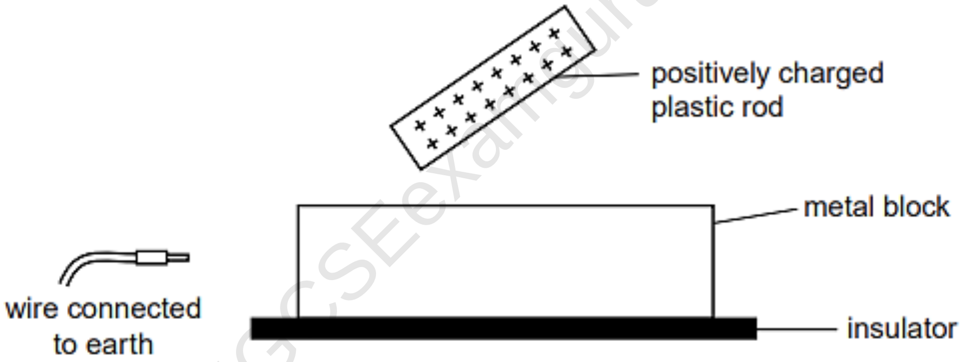

Fig. 9.1

(a) On Fig. 9.1, draw the charge distribution in the metal block. [2]

(b) The earth wire is held against the metal block, as shown in Fig. 9.2.

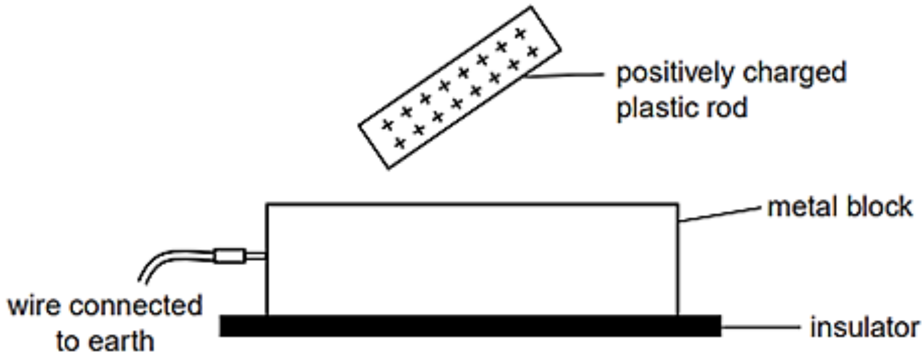

Fig. 9.2

On Fig. 9.2, draw the new charge distribution. [1]

(c) The charged rod and the earth wire are removed and the metal block is left charged.

State the order in which the rod and the wire were removed. Explain your answer.

....

....

....

.... [2]

(d) Name this charging process.

.... [1]

[Total: 6]

23 In the circuit shown in Fig. 9.1, resistors can be connected between terminals P and Q. The e.m.f. of the battery is 6.0V.

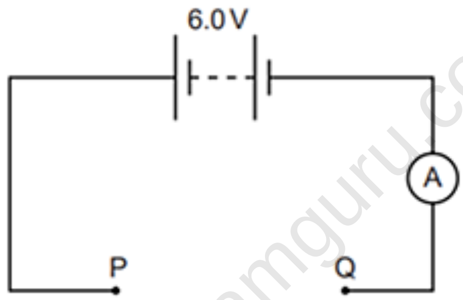

Fig. 9.1

(a) Calculate the current shown by the ammeter when a 12.0 Ω resistor and a 4.0 Ω resistor are

(i) connected in series between P and Q,

current = ... [2]

(ii) connected in parallel between P and Q.

current = ... [3]

(b) State the relationship between

(i) the resistance *R* and the length *l* of a wire of constant cross-sectional area,

....

(ii) the resistance *R* and the cross-sectional area *A* of a wire of constant length.

....

[2]

(c) The 12.0 Ω and 4.0 Ω resistors in **(a)** are wires of the same length and are made of the same alloy.

Calculate the ratio: $\frac{\text{cross-sectional area of } 12.0\,\Omega \text{ resistor}}{\text{cross-sectional area of } 4.0\,\Omega \text{ resistor}}$

ratio = ... [1]

[Total: 8]

24 **(a)** Explain why

(i) metals are good conductors of electricity,

....

....

(ii) insulators do not conduct electricity.

....

....

[3]

(b) The battery of an electric car supplies a current of 96 A at 120 V to the motor which drives the car.

(i) State the useful energy change that takes place in the battery.

....[1]

(ii) Calculate the energy delivered to the motor in 10 minutes.

energy = ... [2]

(iii) The motor operates with an efficiency of 88 %.

Calculate the power output of the motor.

power = ... [2]

[Total: 8]

25 A student sets up a circuit containing three identical cells. Each cell has an e.m.f. (electromotive force) of 2.0 V.

Fig. 8.1 shows the cells in series with a length of uniform metal wire connected between two terminals K and L, an ammeter and a resistor X.

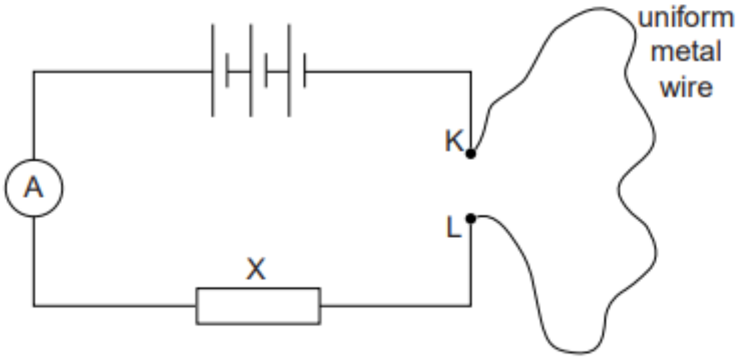

Fig. 8.1

(a) State the total e.m.f. of the three cells in series.

total e.m.f. = ... [1]

(b) The ammeter reading is 0.25 A.

(i) State the name of the unit in which electric charge is measured.

....[1]

(ii) Calculate the charge that flows through the circuit in twelve minutes.

charge = ... [2]

(iii) The metal wire has a resistance of 16 Ω.

Calculate the resistance of resistor X.

resistance = ... [2]

(c) The student removes the 16 Ω wire from the circuit and cuts it into two equal lengths.

He then connects the two lengths in parallel between K and L, as shown in Fig. 8.2.

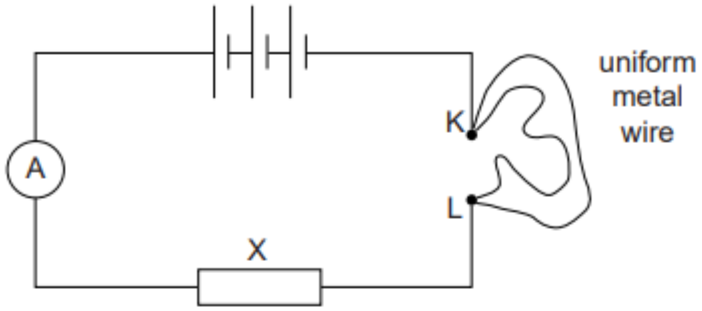

Fig. 8.2

Calculate the resistance of the two lengths of wire in parallel.

resistance = ... [3]

[Total: 9]

26 (a) Fig. 8.1 shows two resistors **X** and **Y** in series.

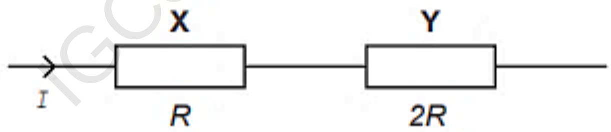

Fig. 8.1

Complete the table below, using only the symbols I and R, alone or in combination.

resistor	resistance	current	potential difference	power
X	R	I		I^2R
Y	$2R$		$2IR$	

[3]

(b) Fig. 8.2 represents the system used to transmit electricity from a power station to a factory.

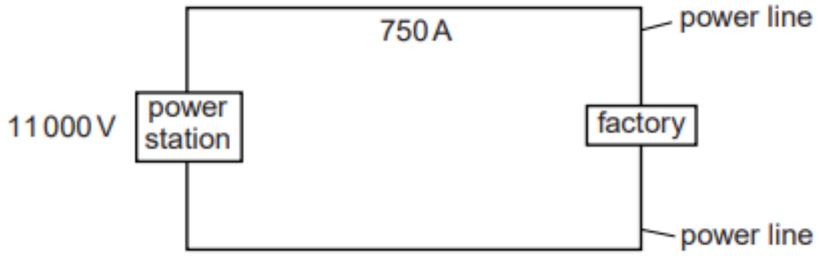

Fig. 8.2

The power station generates 11 000 V and supplies a current of 750 A. The total resistance of the power lines between the power station and the factory is 1.5 Ω.

Calculate

(i) the power output of the power station,

power = ... [1]

(ii) the potential difference across the 1.5 Ω of the power lines,

potential difference = ... [1]

(iii) the power supplied to the factory.

power = ... [3]

[Total: 8]

27 A charger for a cellphone (mobile phone) is marked:

input: a.c. 240 V, 50 Hz, 80 mA.
output: d.c. 5.3 V, 500 mA.

(b) Calculate

(i) the output power of the charger,

output power = ...[2]

(ii) the energy transferred in the output circuit when the cellphone is charged for 1.5 hours.

energy = ...[2]

(c) In the following list, underline the quantity that is stored in the battery of the cellphone.

voltage current power energy [1]

[Total: 7]

28 **(a)** In a room in a house there are four electric lamps in parallel with each other, controlled by a single switch.

With all the lamps working, one of the lamp filaments suddenly breaks.

What, if anything happens to the remaining lamps? Explain your answer.

....

....

....

....[2]

(b) Fig. 10.1 shows the circuit diagram for the lamp in another room. X and Y are 2-way switches.

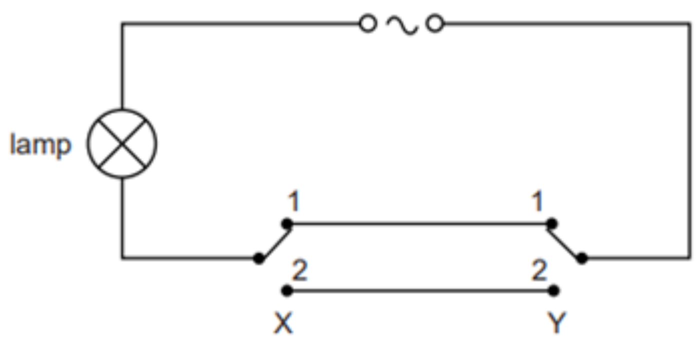

Fig. 10.1

(i) Complete the table, by indicating whether the lamp is on or off for each of the switch positions.

position of switch X	position of switch Y	state of lamp
1	1	
1	2	
2	1	
2	2	

[2]

(ii) Explain why this arrangement of switches is useful.

....

....[1]

[Total: 5]

29 (a) A student determines the resistance of a length of aluminium wire.

She connects the wire in series with a battery and a variable resistor. The circuit is shown in Fig. 8.1.

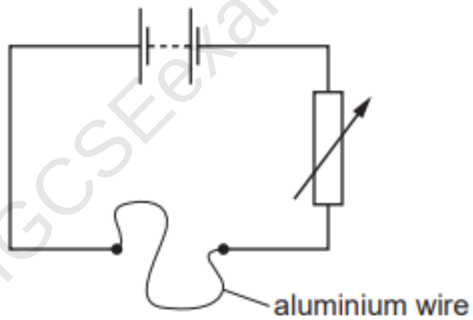

Fig. 8.1

She knows that an ammeter and a voltmeter are needed in the circuit.

(i) On Fig. 8.1, draw the circuit symbol for an ammeter connected in a suitable position. [1]

(ii) A variable resistor is included so that the current in the circuit may be changed.

Suggest an advantage of being able to change the current.

....

....[1]

(b) Electricity is transmitted from a power station to a distant city using an aluminium cable of resistance 1.2 Ω. Power loss occurs because of the resistance of the cable.

The current in the cable is 250 A.

(i) Calculate the power loss in the cable.

power loss = ...[3]

(ii) The aluminium cable is replaced with a new aluminium cable of the same length. The current remains at 250 A. The diameter of the new cable is double the diameter of the original cable.

State and explain how the power loss is affected by this change.

....

....

....[3]

[Total: 8]

30 Fig. 8.1 shows a circuit containing a battery of electromotive force (e.m.f.) 12V and a heater of resistance 6.0 Ω.

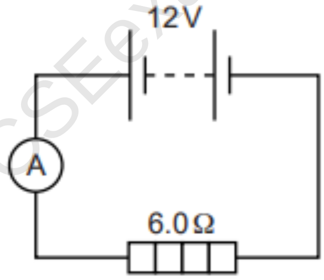

Fig. 8.1

(a) State what is meant by electromotive force (e.m.f.).

....

....[1]

(b) **(i)** Calculate the current in the heater.

current = ...[2]

(ii) State the name of the particles that flow through the heater.

....[1]

(iii) On Fig. 8.1, draw an arrow next to the heater symbol to show the direction of flow of these particles through the heater. [1]

(c) Calculate the thermal energy produced in the heater in 10 minutes.

thermal energy = ...[2]

[Total: 7]

31 In Fig. 9.1, a 12 V battery supplies a current I to a circuit. The circuit contains a thermistor and a 1000 Ω resistor in parallel, with a 500 Ω resistor in series.

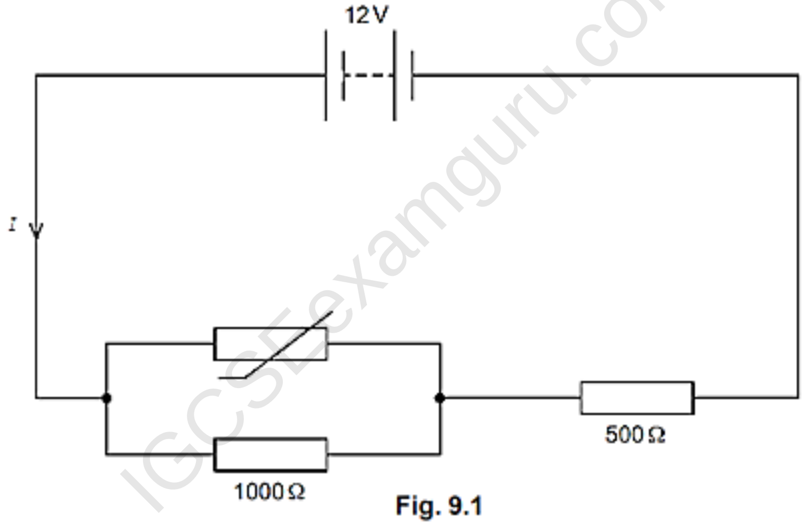

Fig. 9.1

(a) At a certain temperature, the thermistor has a resistance of 1000 Ω.

Calculate

(i) the combined resistance of the thermistor and the 1000 Ω resistor,

resistance = ... [2]

(ii) the current I,

current = ... [1]

(iii) the potential difference across the 500 Ω resistor.

potential difference = ... [2]

(b) The temperature of the thermistor is increased so that its resistance decreases.

State the effect of this change in resistance on the current through the 500 Ω resistor. Explain your answer.

....

....

.... [2]

[Total: 7]

32 Fig. 10.1 shows two parallel conducting plates connected to a very high voltage supply.

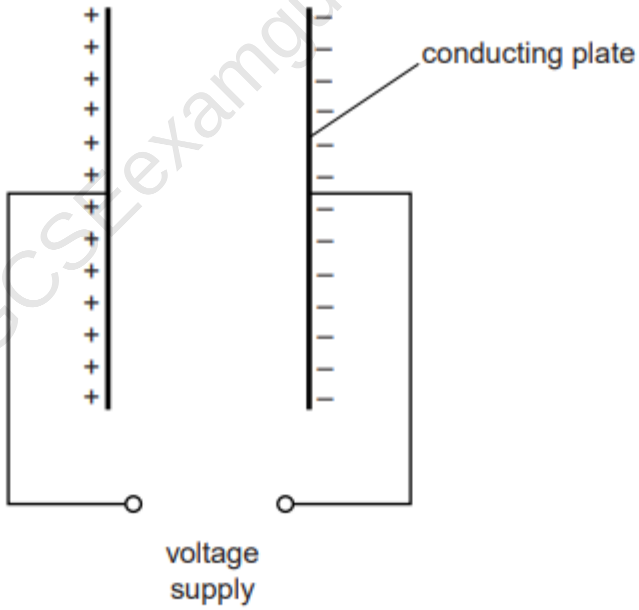

Fig. 10.1

The left-hand plate is positively charged and the right-hand plate is negatively charged.

(a) On Fig. 10.1, draw the electric field pattern produced between the charged plates. Use arrows to show the direction of the field. [2]

(b) A light, conducting ball is suspended by an insulating string. Fig. 10.2 shows the ball in the middle of the gap between the plates.

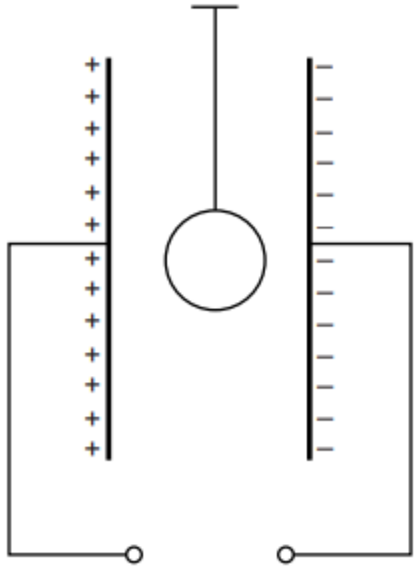

Fig. 10.2

On Fig. 10.2, show the distribution of charge on the ball. [2]

(c) The ball is displaced to the left and then oscillates backwards and forwards between the two plates.

The ball touches a plate once every 0.05 s. Every time it touches a plate, a charge of 2.8×10^{-8} C (0.000 000 028 C) is transferred.

Calculate the average current produced by the repeated transfer of charge.

current = ... [2]

[Total: 6]

33 A metal sphere, mounted on an insulating plastic stand, is positively charged.

(a) State the name of the unit in which electric charge is measured.

....[1]

(b) A smaller metal sphere, also mounted on an insulating plastic stand, is uncharged.

This smaller sphere is moved close to the positively charged sphere. Fig. 8.1 shows the two spheres.

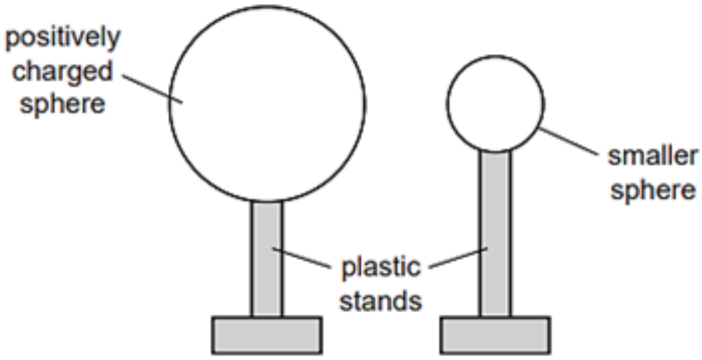

Fig. 8.1

(i) On Fig. 8.1, draw the distribution of charge on the smaller sphere. [2]

(ii) An earthed metal wire is touched against the smaller metal sphere.

State and explain what happens to the charge on the smaller sphere.

....

....

....[2]

(c) Explain, in terms of their structures, why the metal wire is an electrical conductor but the plastic stand is an electrical insulator.

....

....

....[2]

[Total: 7]

34 The output of an a.c. generator in a power station is 5000V.

A transformer increases the voltage to 115000V before the electrical power is transmitted to a distant town.

(a) State and explain, using a relevant equation, one advantage of transmitting electrical power at a high voltage.

....

....

....

....

....[3]

(d) The combined resistance of the two resistors shown in Fig. 9.3 is 4.0 Ω.

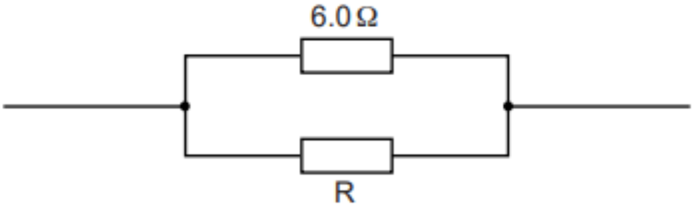

Fig. 9.3

Calculate the resistance of resistor R.

resistance of R = ...[2]

[Total: 9]

35 A digital watch is powered by a 1.3V cell. The cell supplies a current of 4.1×10^{-5} A (0.000041 A) for 1.6×10^{7} s.

Calculate

(a) the charge that passes through the cell in this time,

charge = ...[2]

(b) the resistance of the electrical circuit in the watch,

resistance = ...[2]

(c) the output power of the cell.

power = ...[2]

[Total: 6]

Chapter 12: Electromagnetism

1 A student holds a magnet above a solenoid, which is connected to a centre-zero milli-ammeter as shown Fig. 8.1.

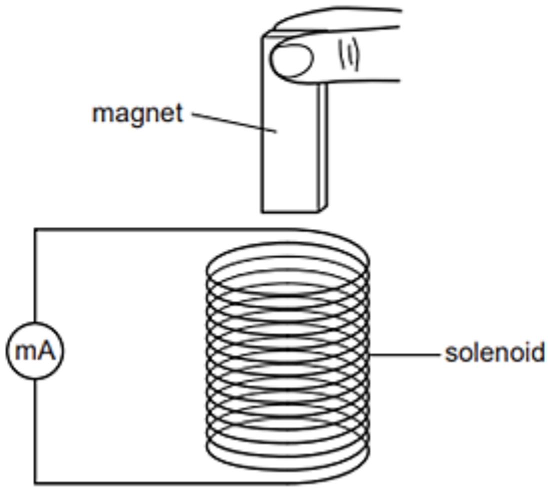

Fig. 8.1

(a) The student drops the magnet so that it falls through the solenoid.

State and explain what would be observed on the milliammeter

(i) as the magnet enters the solenoid,

....

....

.... [2]

(ii) as the magnet speeds up inside the solenoid.

....

....

.... [2]

(b) As the magnet passes into the coil in part **(a)**, the coil exerts a force on the magnet even though there is no contact between them.

(i) State the direction of this force.

....

(ii) Explain how this force is caused.

....

....

....

[3]

[Total: 7]

2 **(a)** Fig. 10.1 shows a wire PQ placed between the poles of a magnet. There is a current in wire PQ.

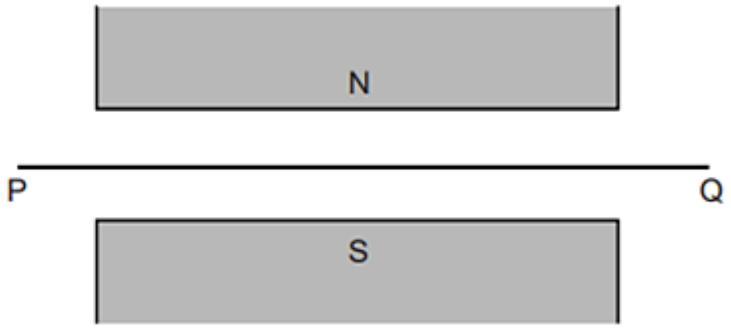

Fig. 10.1

(i) On Fig. 10.1, sketch lines with arrows to show the direction of the magnetic field between the poles of the magnet. [1]

(ii) The force on PQ is into the paper.

Draw an arrow on PQ to show the direction of the current. [1]

(b) The wire PQ in Fig. 10.1 is replaced by a narrow beam of β-particles travelling from left to right.

(ii) State the direction of the force on the β-particles.

.... [1]

(iii) Describe the path of the β-particles in the space between the poles of the magnet.

....

.... [1]

3 **(a)** A very sensitive, centre-zero voltmeter is connected to the two terminals of a solenoid (long coil). Fig. 9.1 shows the S pole of a cylindrical magnet being inserted into the solenoid.

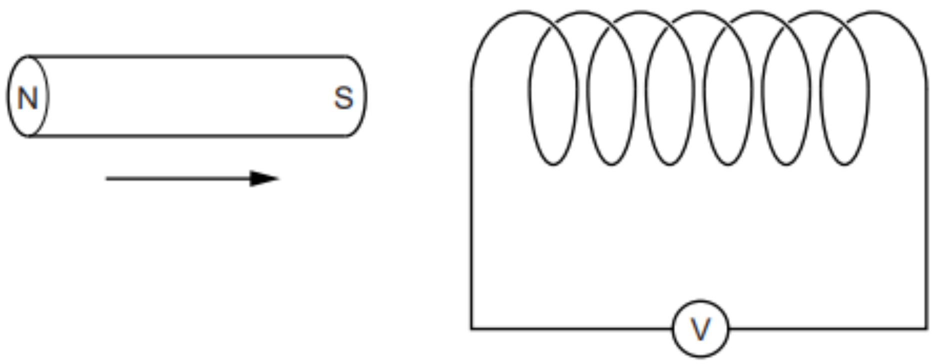

Fig. 9.1

As the magnet is inserted into the left-hand end of the solenoid, the needle of the voltmeter deflects.

(i) Explain why the needle deflects as the magnet is inserted.

....

.... [2]

(ii) State and explain the effect of inserting the magnet more slowly.

....

.... [2]

(iii) State what is observed when the magnet is withdrawn from the left-hand end of the solenoid.

.... [1]

(b) A transformer consists of a primary coil and a secondary coil on an iron core. An alternating voltage is connected to the primary coil.

Describe and explain the operation of the transformer.

....

....

....

....

....

.... [4]

[Total: 9]

4 Fig. 9.1 shows a thin, straight rod XY placed in the magnetic field between the poles of a magnet. The wires from the ends of XY are connected to a centre-zero voltmeter.

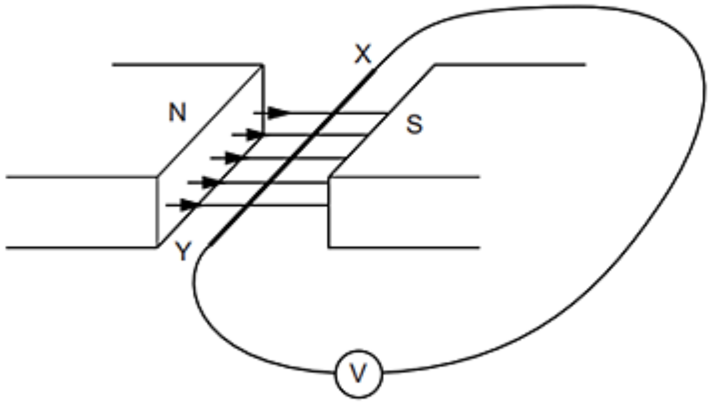

Fig. 9.1

(a) When XY is moved slowly upwards the needle of the voltmeter shows a small deflection.

(i) State how XY must be moved to produce a larger deflection in the opposite direction.

....

.... [2]

(ii) XY is now rotated about its central point by raising X and lowering Y. Explain why no deflection is observed.

....

....

.... [2]

(b) The effect of moving XY can be seen if the wires are connected to the terminals of a cathode-ray oscilloscope instead of the voltmeter.

(i) State the parts inside the oscilloscope tube to which these terminals are connected.

.... [1]

(ii) The spot on the oscilloscope screen moves up and down repeatedly. State how XY is being moved.

.... [1]

(iii) State the setting of the time-base of the oscilloscope during the process described in **(ii)**.

.... [1]

[Total: 7]

5 Fig. 8.1 shows a vertical current-carrying wire passing through a card at point X.

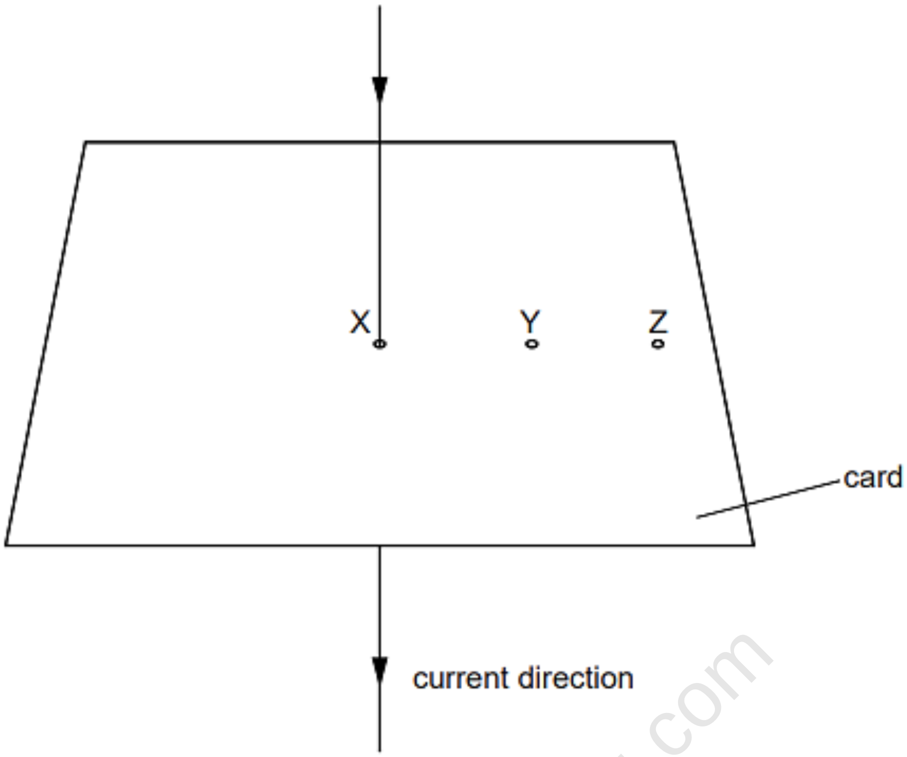

Fig. 8.1

(a) On Fig. 8.1, sketch on the card the pattern of the magnetic field produced by the current in the wire. The detail of your sketch should suggest the variation in the strength of the field. Show the direction of the field with arrows. [3]

(b) Using your knowledge of investigating the magnetic field around a bar magnet, suggest an experiment or experiments to confirm that you have drawn the correct pattern and direction in **(a)**.

....

....

....

....

....

....

....

....
[4]

(c) A second current-carrying wire is inserted vertically through the card at Y.

Suggest why there is now a force on the wire at X.

....

....

....

....[2]

(d) The wire at Y is moved to Z. It still carries the same current.

Tick the appropriate box to indicate whether the force on the wire at X is now smaller, greater or the same.

smaller ☐

greater ☐

same ☐ [1]

[Total: 10]

6 There is an alternating current in the primary coil of the transformer shown in Fig. 9.1.

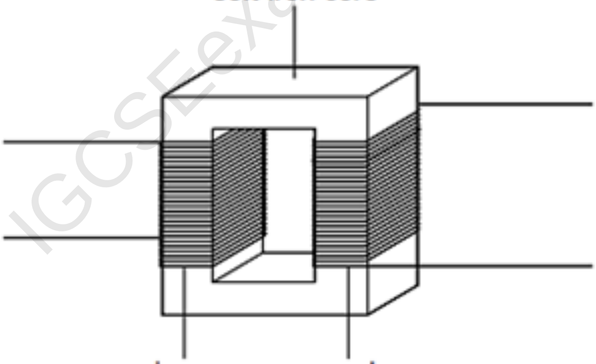

Fig. 9.1

(a) Tick **one** box in each line of the table that best describes the magnetic field in the core and the magnetic field in the secondary coil.

	magnetic field			
	continually increasing and decreasing	continually increasing	continually decreasing	zero
soft-iron core				
secondary coil				

[2]

(b) State and explain the effect on the output from the secondary coil of

(i) increasing the voltage across the primary coil,

output ....

explanation ....

....

....

....
[2]

(ii) replacing the alternating current in the primary coil with direct current from a battery.

output ....

explanation ....

....

....

....
[2]

[Total: 6]

7 **(a)** Fig. 10.1 shows the cross-section of a wire carrying a current into the plane of the paper.

Fig. 10.1

On Fig. 10.1, sketch the magnetic field due to the current in the wire. The detail of your sketch should suggest the variation in the strength of the field. Show the direction of the field with arrows. [3]

(b) Fig. 10.2 shows part of a model of a d.c. motor.

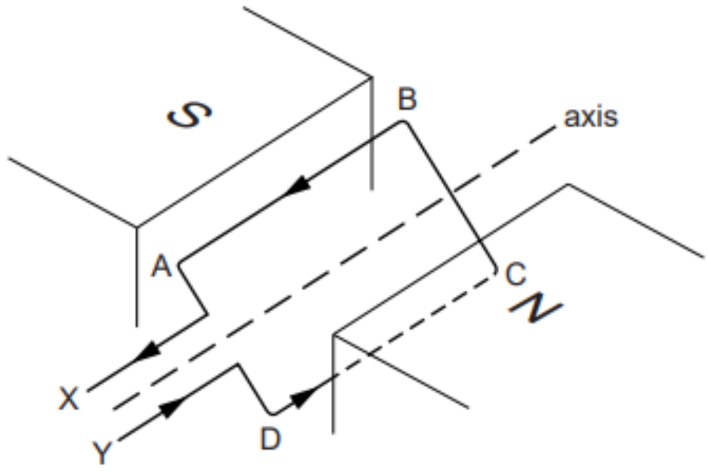

Fig. 10.2

A loop of wire ABCD is placed between the poles of a magnet. The loop is free to rotate about the axis shown. There is a current in the loop in the direction indicated by the arrows.

(i) On Fig. 10.2, draw arrows to show the directions of the forces acting on side AB and on side CD of the loop. [1]

(ii) With the loop in the position shown in Fig. 10.2, explain why the forces on AB and CD cause the loop to rotate about the axis.

....

....

....

....[1]

(iii) The ends X and Y of the loop are connected to a battery using brushes and a split-ring commutator.

State why a split-ring commutator is used.

....

....

....

....[2]

[Total: 7]

8 The a.c. supply from a power station is connected to the primary coil of a transformer. The secondary coil is connected to long-distance transmission cables.

(a) The output voltage of the transformer is greater than the input voltage.

Explain how a transformer produces this output voltage.

....

....

....

....

....

.... [4]

(b) There are energy losses in the transmission cables.

(i) Explain why the energy losses become greater when the length of the transmission cables is greater.

....

....

.... [2]

(ii) Discuss the advantages and disadvantages of using transmission cables of greater cross-sectional area.

....

....

.... [2]

[Total: 8]

9 Fig. 10.1 shows a variable resistor (rheostat) and a solenoid (long coil) connected to a battery.

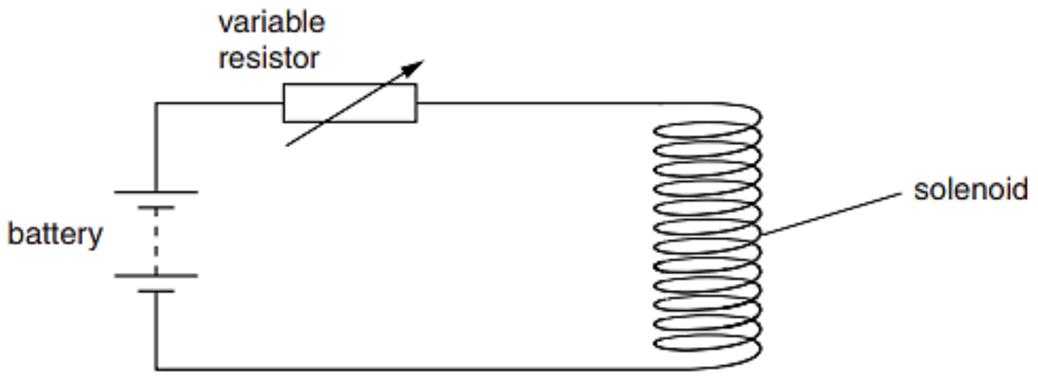

Fig. 10.1

The current in the solenoid produces a magnetic field.

(a) **(i)** On Fig. 10.1, draw lines to show the pattern of the magnetic field due to the current. [2]

(ii) State the feature of the pattern of the magnetic field lines that indicates the strength of the magnetic field at particular points.

....

.... [1]

(b) State and explain the effect on the magnetic field of increasing the resistance of the variable resistor.

....

....

....

.... [2]

(c) In a laboratory vacuum chamber, some current-carrying coils produce a very strong magnetic field near a source of α-particles.

Fig. 10.2 shows the arrangement.

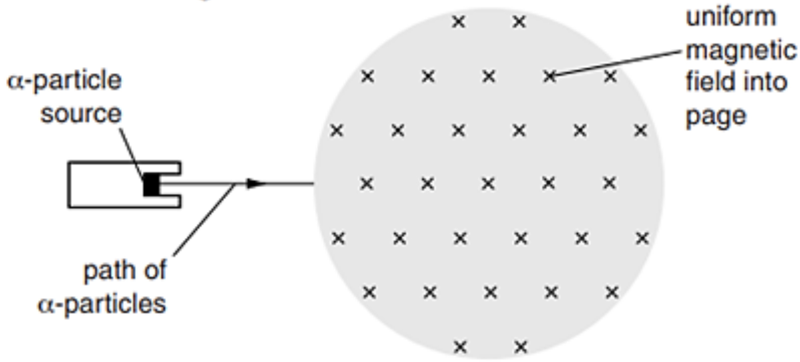

Fig. 10.2

(i) In the shaded region of Fig. 10.2, draw a possible path for the α-particles in the magnetic field. [2]

(ii) State and explain the effect on this path of reversing the current in the coils.

....

....

.... [2]

[Total: 9]

10 (a) Describe an experiment that shows how a magnet can be used to produce a current in a solenoid by electromagnetic induction. Sketch and label the arrangement of apparatus you would use.

....

....

.... [3]

(b) Fig. 8.1 represents a transformer with primary coil P and secondary coil S, wound on an iron core.

There is an alternating current in coil P.

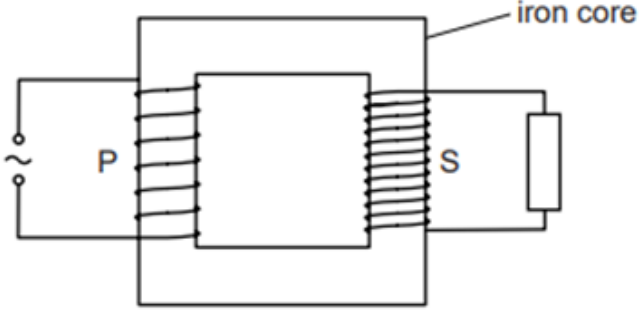

Fig. 8.1

(i) State what happens in the iron core as a result of the alternating current in P.

....

.... [2]

(ii) Tick the box next to the correct description of the current in S.

☐ higher frequency a.c.

☐ same frequency a.c.

☐ lower frequency a.c.

☐ rectified d.c.

☐ constant d.c. [1]

(iii) Coil P has 50 turns of wire, an applied voltage of 12 V, and a current of 0.50 A. Coil S has 200 turns.

Calculate the current in S. Assume the transformer is 100 % efficient.

current = ... [3]

[Total: 9]

11 A battery charger includes a transformer and a rectifier.

Fig. 11.1 represents the transformer, consisting of an iron core with two coils P and Q wound on to the core.

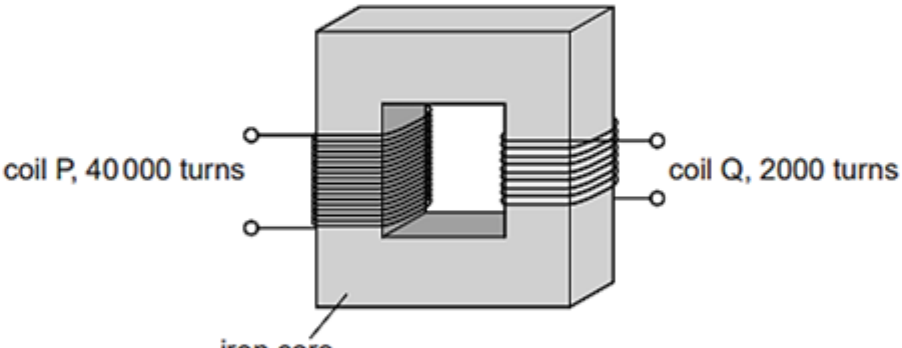

Fig. 11.1

P consists of 40 000 turns and Q consists of 2000 turns.

When P is connected to a 230 V a.c. supply, there is an e.m.f. across the terminals of Q.

(a) **(i)** Calculate the size of this e.m.f.

e.m.f. = ... [2]

(ii) Explain how this e.m.f. is generated.

....

....

....

....

.... [3]

12 **(a)** A solenoid connected to a battery produces a magnetic field. The wires are then connected to the battery terminals the other way round.

Tick **one** box in the table to indicate the effect on the magnetic field.

decreases but not to zero	
decreases to zero	
reverses direction	
increases	
stays the same	

[1]

(b) Fig. 7.1 shows a top view of two bar magnets and a vertical rigid conducting rod carrying a current. The direction of the current in the rod is coming **out of the paper**.

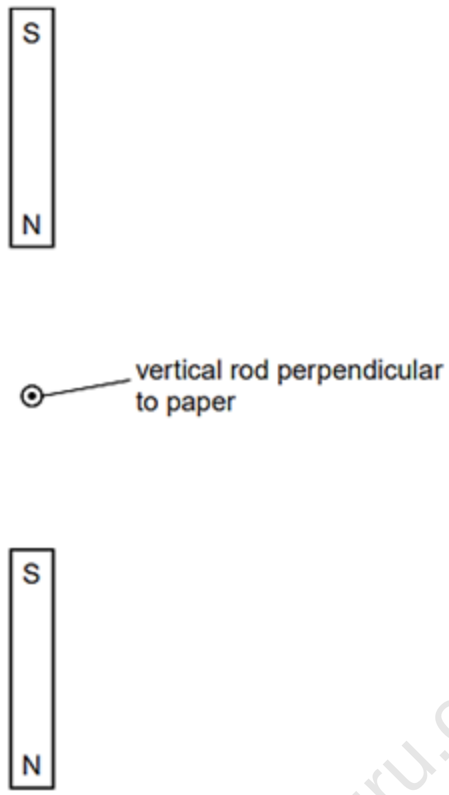

Fig. 7.1

(i) On Fig. 7.1, draw a single line with an arrow to show the direction of the magnetic field due to the bar magnets at the position of the rod. [2]

(ii) State the direction of the force exerted on the vertical rod.

.... [2]

(c) The rod has a mass of 350 g and the resultant force acting on the rod is 0.21 N. The rod is free to move.

Calculate the initial acceleration of the rod.

acceleration = ... [2]

[Total: 7]

13 Fig. 10.1 shows a coil of wire rotating steadily in the magnetic field between the poles of a permanent magnet. The current generated in the coil is to pass through resistor R.

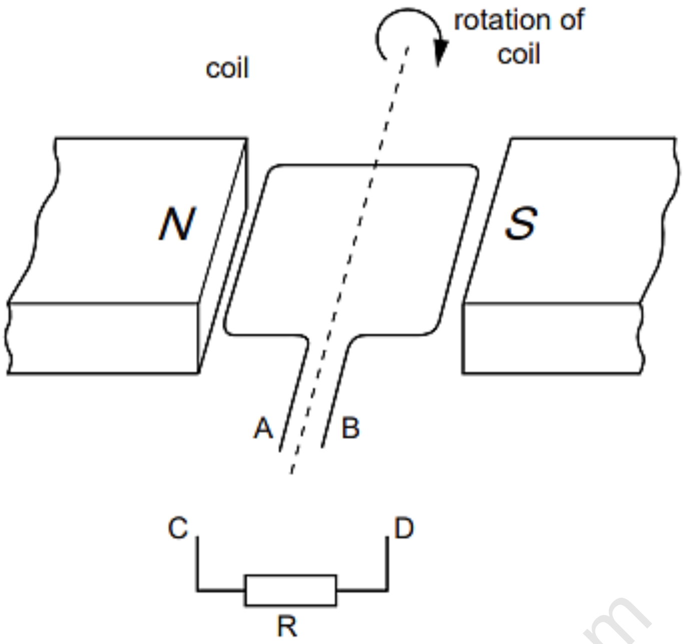

Fig. 10.1

(a) The apparatus in Fig. 10.1 is part of an a.c. generator. What is connected between the ends A and B of the coil and the connections C and D?

.... [1]

(b) **(i)** On Fig. 10.2, sketch a graph to show the variation with time of the current through R. [1]

Fig. 10.2

(ii) On Fig. 10.2, show the time *T* corresponding to one complete rotation of the coil. [1]

(iii) State **two** ways in which the graph would be different if the coil spins at a faster rate.

1. ....

2. .... [2]

(c) Suggest what could be connected between C and R so that the current in R is always in the same direction.

.... [1]

[Total: 6]

14 A circuit contains a battery, a variable resistor and a solenoid. Fig. 9.1 shows the magnetic field pattern produced by the current in the solenoid.

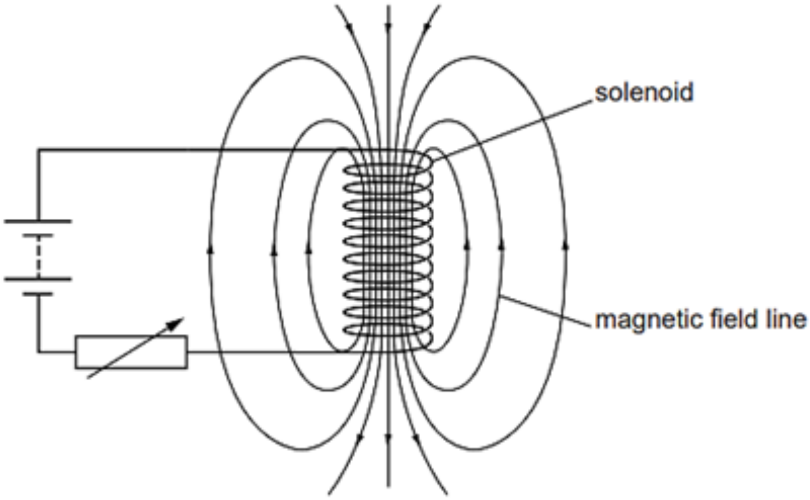

Fig. 9.1

(a) **(i)** State how the magnetic field pattern indicates regions where the magnetic field is stronger.

....

....[1]

(ii) State what happens to the magnetic field when the current in the circuit is reversed.

....

....[1]

(b) A second solenoid is placed next to the first solenoid.

Fig. 9.2 shows the second solenoid connected to a very sensitive ammeter.

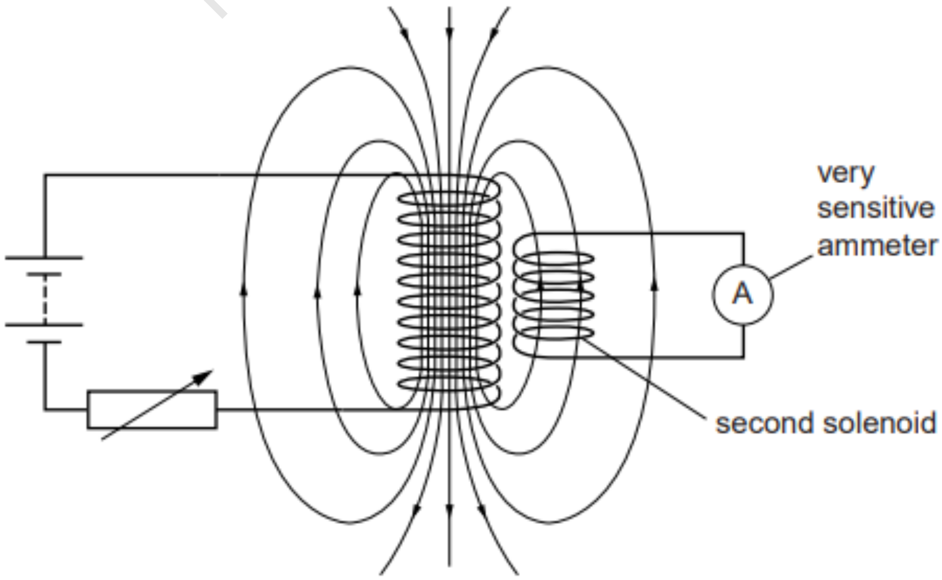

Fig. 9.2

(i) The variable resistor is adjusted so that its resistance changes quickly.

State and explain what is seen to happen in the circuit of the second solenoid.

....

....

....

....

....[3]

(ii) The variable resistor is adjusted much more slowly than in **(i)**.

State and explain the difference in what is seen to happen in the circuit of the second solenoid.

....

....

....[2]

[Total: 7]

15 A transformer is used to reduce the voltage of a supply from 120V a.c. to 12V a.c.

(a) Explain how a transformer works. Your answer should include an explanation of why a transformer would not work with a d.c. supply voltage.

....

....

....

....

....

....

.... [3]

(b) The output current is 1.2A.

(i) Calculate the input current.

input current = ... [2]

(ii) State an assumption you made in your calculation for **(b)(i)**.

....

.... [1]

[Total: 6]

16 **(a)** Name the process that causes a potential difference across a solenoid due to the movement of a nearby magnet.

....[1]

(b) Fig. 11.1 shows a solenoid connected to a centre-zero voltmeter, M.

A bar magnet is held with its N-pole close to one end of the solenoid.

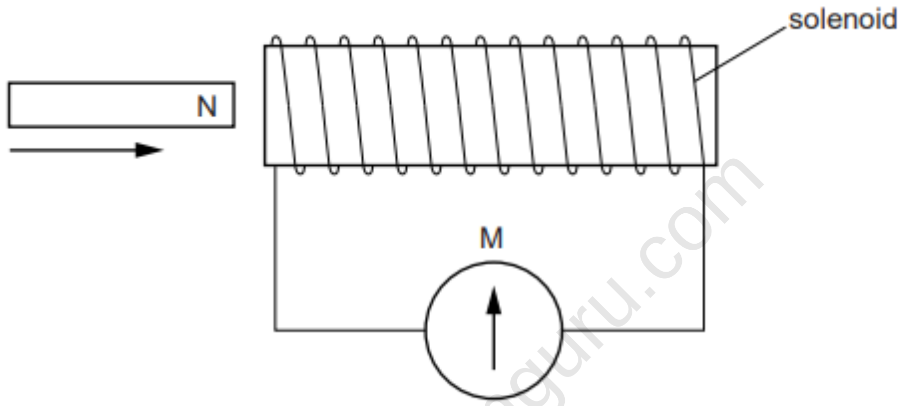

Fig. 11.1

(i) The magnet is pushed into the solenoid, and then brought to rest with its N-pole just inside the solenoid.

Describe the movement of the pointer of the meter M.

....

....[2]

(ii) The magnet is now pulled to the left out of the solenoid, at a higher speed than in **(i)**.

Compare the movement of the pointer of the meter with that seen in **(i)**.

....

....[2]

[Total: 5]

17 An extremely violent nuclear reaction is taking place at the centre of the Sun. It is this reaction that enables the Sun to emit both a very large quantity of energy and an extremely large number of charged particles.

(a) Name the type of nuclear reaction taking place in the Sun.

....[1]

(b) Many of the charged particles produced by the Sun are emitted from its surface at high speeds and travel out into space.

(i) Explain why these particles constitute an electric current.

....

....[1]

(ii) State the equation that relates the electric current I to the charge Q that is flowing. Define any other terms in the equation.

....

....[1]

(c) Some of the particles emitted by the Sun travel straight towards the Earth until they enter the Earth's magnetic field. Because they constitute a current, they experience a force and are deflected.

(i) Describe the relationship between the direction of the force and

1. the direction of the current,

....[1]

2. the direction of the magnetic field.

....[1]

(ii) A negatively charged particle is travelling in a magnetic field. This is represented in Fig. 9.1. The direction of the magnetic field is into the page.

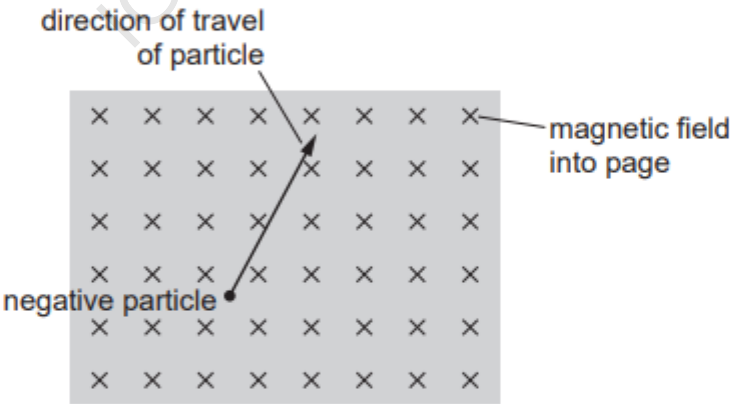

Fig. 9.1

On Fig. 9.1, draw an arrow, labelled F, to show the direction of the force that acts on the particle. [1]

[Total: 6]

18 A solenoid is held in a vertical position. The solenoid is connected to a sensitive, centre-zero ammeter.

A vertical bar magnet is held stationary at position X just above the upper end of the solenoid as shown in Fig. 10.1.

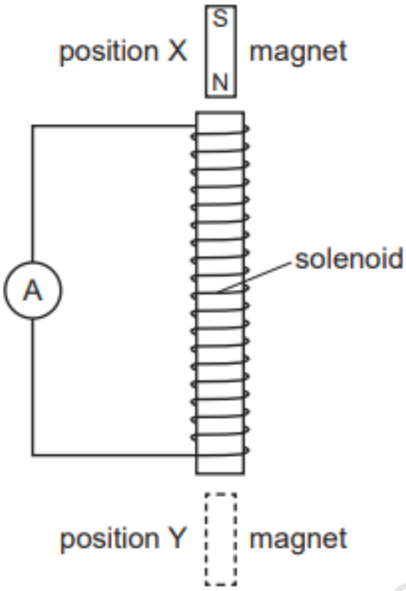

Fig. 10.1

The magnet is released and it falls through the solenoid. During the initial stage of the fall, the sensitive ammeter shows a small deflection to the left.

(a) Explain why the ammeter shows a deflection.

....

....[1]

(b) The magnet passes the middle point of the solenoid and continues to fall. It reaches position Y.

Describe and explain what is observed on the ammeter as the magnet falls from the middle point of the solenoid to position Y.

....

....

....

....

....

....[4]

(c) Suggest **two** changes to the apparatus that would increase the initial deflection of the ammeter.

1. ....

....

2. ....

....

[2]

[Total: 7]

19 A physics teacher suspends two pointers in a magnetic field. One pointer is made of brass and the other is a magnet.

She holds the pointers in the initial positions shown in the two upper circles of Fig. 7.1. She then releases the pointers.

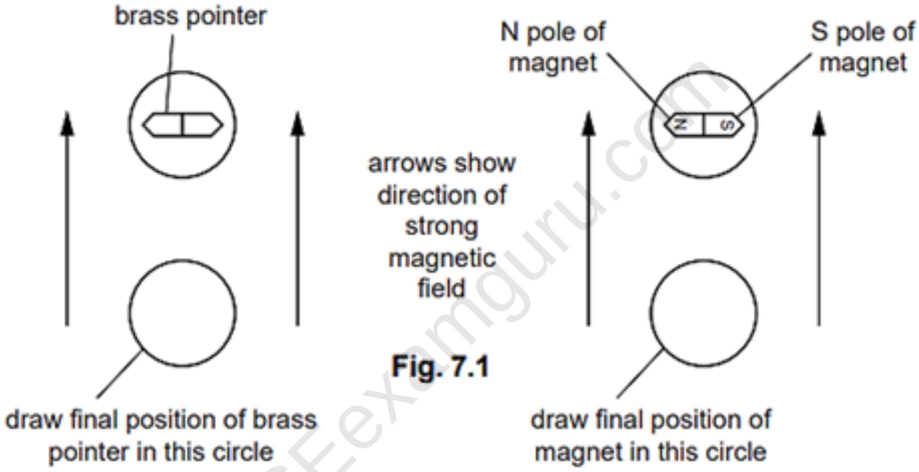

Fig. 7.1

(a) In the lower circles of Fig. 7.1, draw the settled final positions of the two pointers. [2]

(b) **(i)** Explain the final position of the brass pointer.

....

....

....

(ii) Explain the final position of the magnet.

....

....

....

[2]

(c) Suggest a material from which the magnet is made.

....[1]

[Total: 5]

20 Fig. 9.1 represents a transformer.

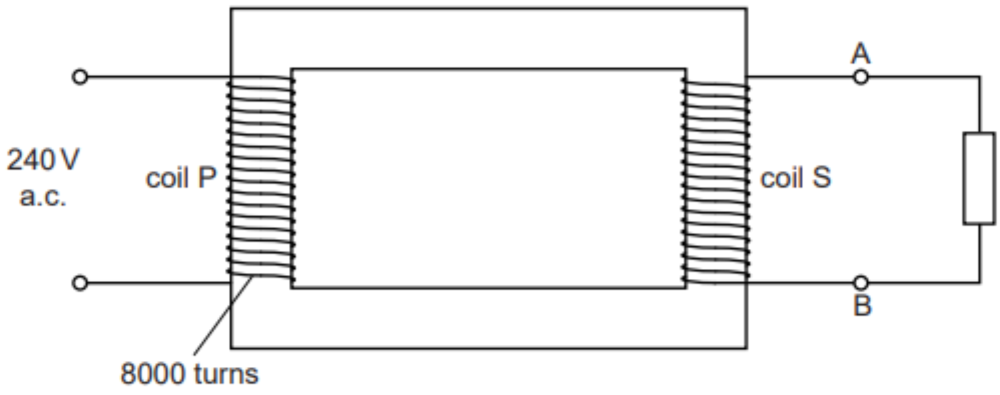

Fig. 9.1

(a) **(i)** Name the process by which a changing current in the primary coil P causes a changing current in the secondary coil S.

....[1]

(ii) Suggest a material used for the coils. Explain why this material is used.

....

....

....[2]

(b) The input to the primary coil P is 240V. This coil has 8000 turns of wire. The voltage obtained between terminals A and B is 12V.

(i) Calculate the number of turns of wire in the secondary coil S.

number of turns = ...[2]

(ii) The resistor connected between the terminals A and B is replaced by four 12V lamps connected in parallel. The current in each lamp is 1.5A.

Calculate the current in coil P. Assume the transformer is 100% efficient.

current = ...[3]

[Total: 8]

21 **(a)** Fig. 8.1 shows a bar magnet suspended by a spring over a coil. The coil is connected to a sensitive centre-zero millivoltmeter.

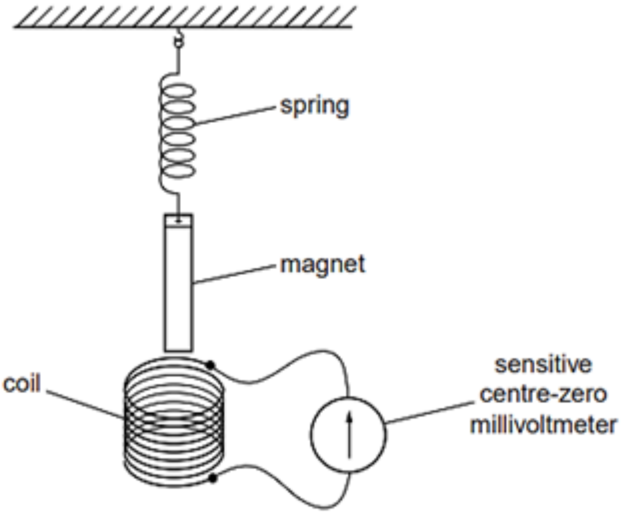

Fig. 8.1

(i) The lower end of the magnet is pushed down into the upper end of the coil and held at rest.

During the movement, an e.m.f. is induced in the coil. The meter shows a deflection to the right and then returns to zero.

Explain why this e.m.f. is induced.

....

.... [1]

(ii) State what happens to the needle of the meter when

1. the magnet is released from rest and is pulled up by the spring,

.... [1]

2. the magnet continues to oscillate up and down, moving in and out of the coil with each oscillation.

.... [1]

(b) Fig. 8.2 shows a transformer.

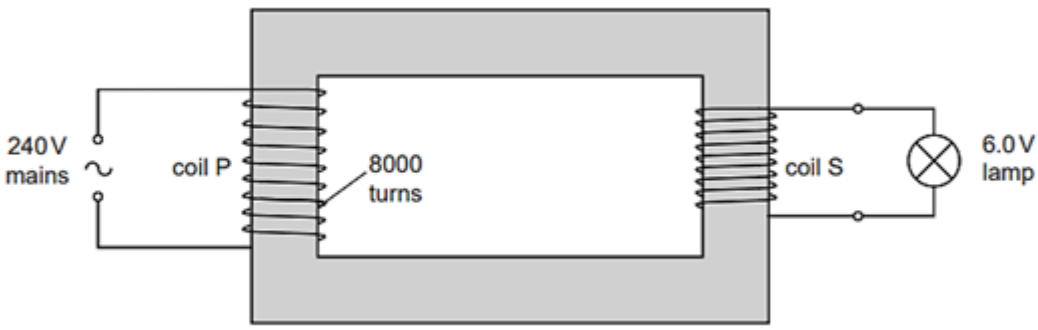

Fig. 8.2

The primary coil P, connected to the 240V mains supply, has 8000 turns. The secondary coil S supplies 6.0V to a lamp.

(i) Calculate the number of turns in the secondary coil.

number of turns = ... [2]

(ii) **1.** The current in the primary coil is 0.050A.

Calculate the power input to the transformer.

power = ... [1]

2. 90% of the power input to the transformer is transferred to the lamp.

Calculate the current in the lamp.

current = ... [2]

[Total: 8]

22 The output of an a.c. generator in a power station is 5000V.

A transformer increases the voltage to 115000V before the electrical power is transmitted to a distant town.

(a) State and explain, using a relevant equation, one advantage of transmitting electrical power at a high voltage.

....

....

....

....

....[3]

(b) The transformer contains two coils, the primary coil and the secondary coil.

(i) State the other main component of a transformer and the material from which it is made.

....

....[1]

(ii) State the component in the transformer to which the a.c. generator is connected.

....

....[1]

(iii) There are 400 turns on the primary coil of the transformer.

Calculate the number of turns on the secondary coil.

number of turns = ...[2]

(c) Transformers within the town reduce the voltage to 230V.

Suggest one reason for this.

....

....[1]

[Total: 8]

23 (a) Fig. 10.1 shows the gap between the N-pole and the S-pole of a magnet.

Fig. 10.1

The magnetic field in the gap is uniform.

On Fig. 10.1, draw four field lines to show the pattern and direction of the magnetic field in the gap. [2]

(b) Fig. 10.2 shows a horizontal copper wire PQ between two opposite magnetic poles.

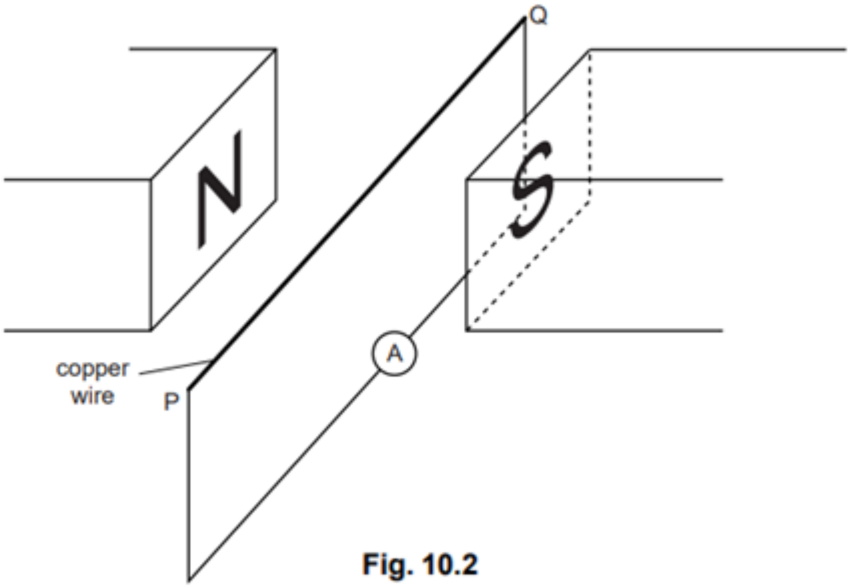

Fig. 10.2

A circuit is made by connecting a sensitive digital ammeter between P and Q. The wire PQ is then moved vertically downwards.

(i) State and explain what is observed on the ammeter.

....

....

....

....[3]

(ii) State what is observed on the ammeter when PQ is moved

1. vertically downwards at a greater speed,

....[1]

2. vertically upwards at the same speed as in **1**.

....[1]

[Total: 7]

24 Fig. 9.1 shows two separate coils of wire wound around an iron core.

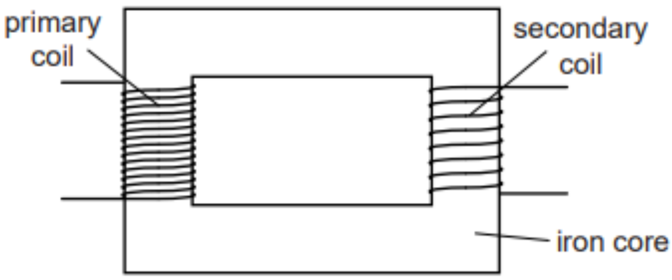

Fig. 9.1

An a.c. supply is connected across the primary coil and a 12V lamp is connected across the secondary coil. The lamp glows with normal brightness.

(a) State the name of the device shown in Fig. 9.1.

....[1]

(b) Explain why there is a current in the lamp.

....

....

....

....

....[4]

(c) (i) The coil connected to the lamp has 450 turns. The e.m.f. of the a.c. supply is 240V.

Calculate the number of turns on the coil connected to the a.c. supply.

number of turns = ...[2]

(ii) A 240V d.c. supply is used instead of the 240V a.c. supply. Tick **one** box to indicate what happens to the lamp.

☐ glows more brightly

☐ glows with the same brightness

☐ glows less brightly

☐ does not glow

[1]

[Total: 8]