1 A student walks across a thick carpet and becomes positively charged as his shoes rub on the carpet. When he touches the metal handle of a door, negative charge flows to him and a spark occurs.

(a) Explain, in terms of the movement of electrons, why
  (i) he becomes positively charged.
  (ii) negative charge flows to him from the door handle.

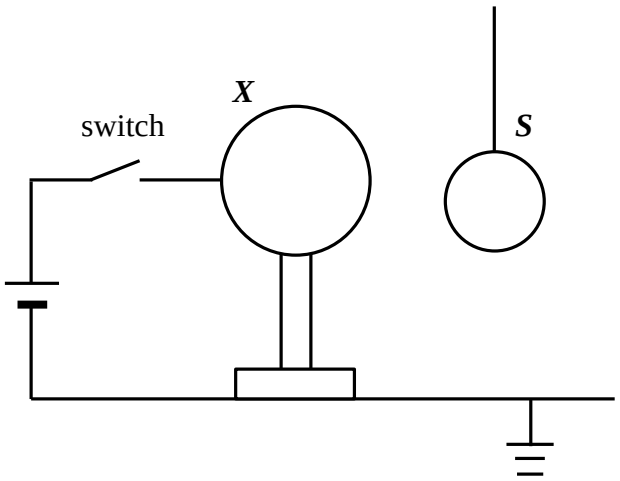
(b) Calculate the charge that flows to the student if a current of 0.015 A flows for 20 ms.

2 The diagram shows a large conducting sphere ***X*** connected through a switch to the positive terminal of a supply of high voltage. A light conducting sphere ***S*** hangs from an insulating thread as shown. Both spheres are uncharged initially.

(a) Describe the movement of charges that takes place and state what happens to the sphere ***X*** when the switch is closed.

(b) State and explain the effect produced by the charge on sphere ***X*** on the conducting sphere ***S***.

(c) Sphere ***S*** is now connected to earth. Describe the effect of this on the
  (i) charge on sphere ***S***
  (ii) position of sphere ***S***.

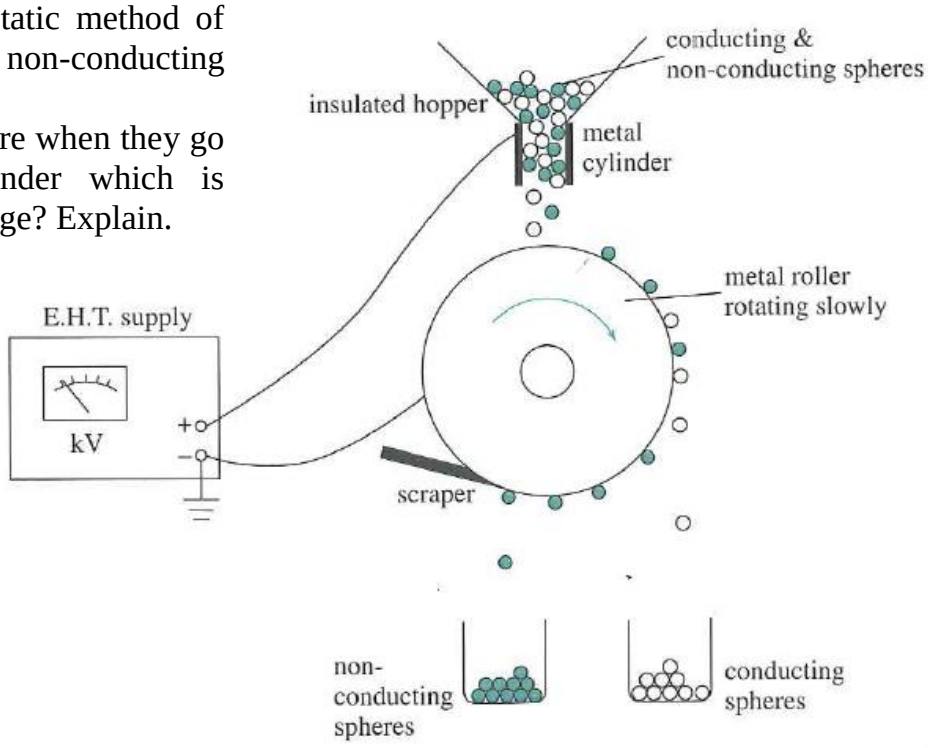


3 The diagram shows an electrostatic method of separating conducting and non-conducting spheres.

(a) What happens to the sphere when they go through the metal cylinder which is maintained at a high voltage? Explain.

(b) Why did the conducting spheres fall off from the roller while the non-conducting spheres need to be scrapped off? Explain.

(c) Explain why the roller need to be earthed.



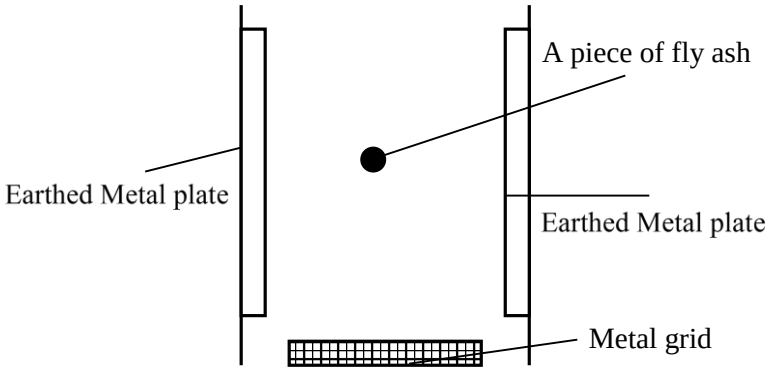
4 In power stations and some factories, a large amount of fly ash is produced every day. Electrostatic precipitation can be used to remove the fly ash from the gas released. To do so, the metal grid at the bottom of the chimney is connected to high voltages. When the fly ash in the released gas passes through the grid, they become charged.

(a) If the metal grid is charged positively, what will be the polarity of the fly ash?

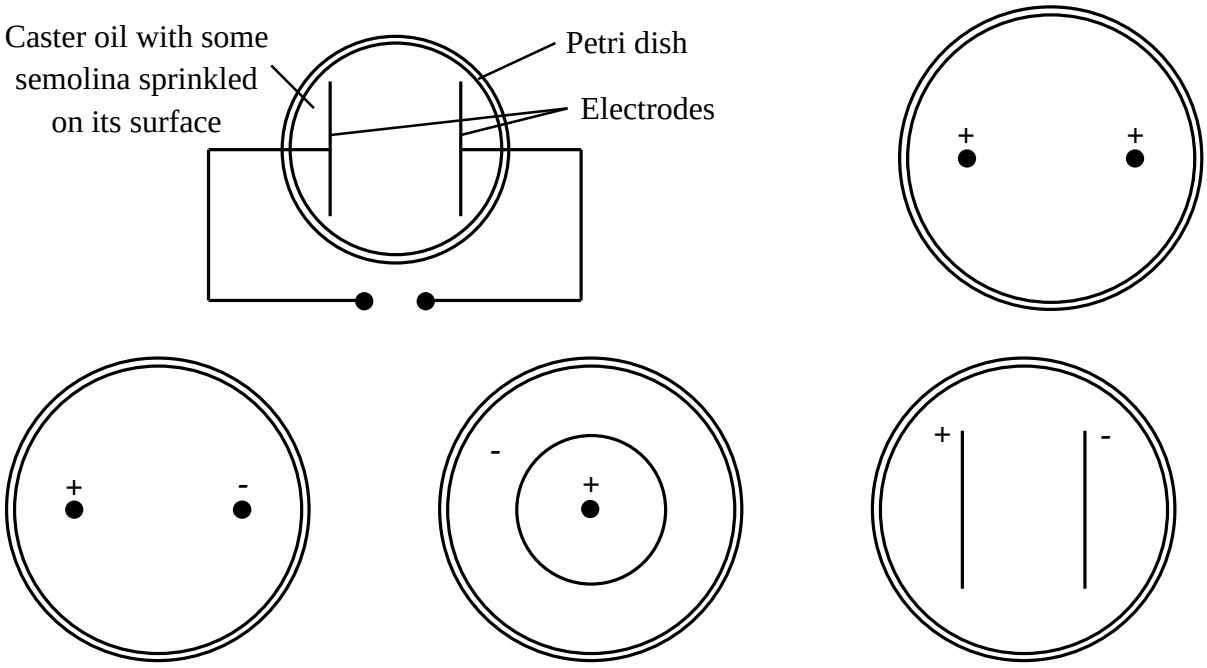
(b) Show, with an arrow, the direction of movement of the piece of fly ash that is shown in the diagram.

(c) Explain why the piece of fly ash moves in the direction you have shown.

(d) From time to time the earthed metal plates are hit with a hammer. Suggest a reason for this.



5 The figure shows the apparatus used to demonstrate the electric field pattern in school laboratories. Sketch the electric field patterns observed for the following electrodes.



6 A piece of constantan wire of length 4.0 m has a resistance of 8.0 Ω. What is the resistance of a piece of constantan wire of

(a) the same thickness but of length 50.0 cm

(b) half the cross-sectional area and twice the length?

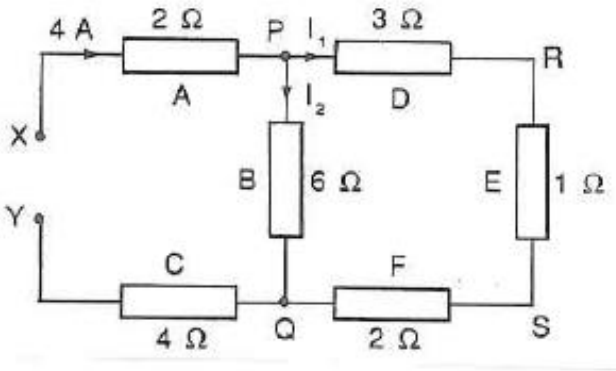
7 Consider the circuit shown, calculate the

(a) overall resistance of the circuit

(b) e.m.f. of the battery across ***XY***

(c) currents I_1 and I_2

(a) potential difference across resistor ***E***.

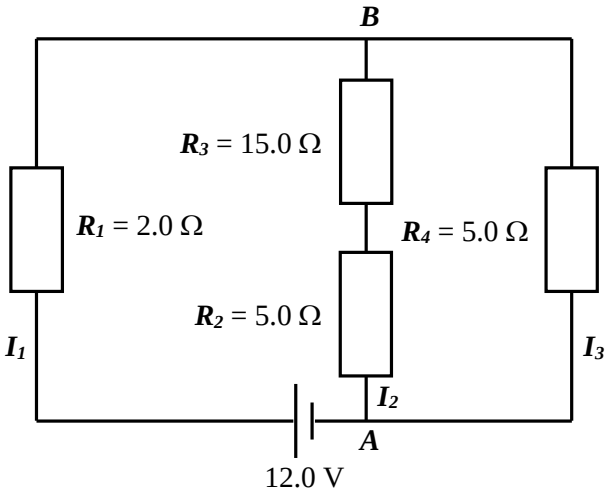


8 The diagram shows four resistors R_1, R_2, R_3 and R_4 connected to a 12 V battery of negligible internal resistance.

(b) Find the combined resistance of the 4 resistors.

(c) Calculate I_1, I_2 and I_3.

(d) Determine the potential difference across R_2.



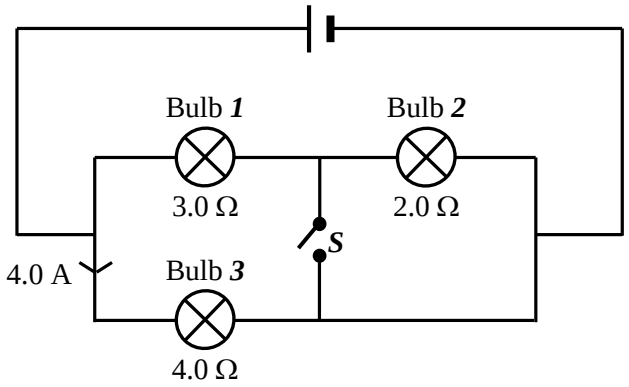
9 Three non-identical light bulbs are connected in a circuit as shown.

(a) Determine the effective resistance of the three bulbs connected in this manner.

(b) What is the voltage across the power supply?

(c) Calculate the current flowing through bulb ***1***.

(d) If the switch ***S*** is now closed, state and explain what will happen to the brightness of bulb ***1***, ***2*** and ***3***.



10 In the circuit shown in diagram ***1***, a uniform wire of resistance 100 Ω is connected to a 70 Ω resistor by means of a sliding contact which can be moved along the whole length of the wire.

(a) Calculate the

(i) maximum and minimum currents delivered by the battery which has an e.m.f. of 10 V and negligible internal resistance.

(ii) current delivered by the battery when the sliding contact is at the mid-point of the wire.

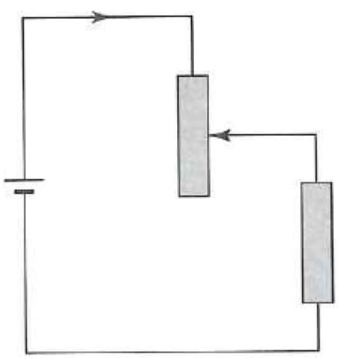


Diagram 1

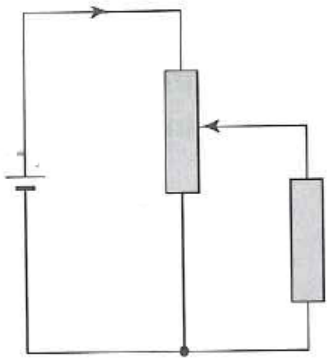


Diagram 2

(b) The circuit is reconnected like the one shown in diagram ***2***, calculate the

(i) maximum and minimum currents delivered by the battery which has an e.m.f. of 10 V and negligible internal resistance.

(ii) current delivered by the battery when the sliding contact is at the mid-point of the wire.

11 Four identical lamps rated "25 W, 200 V" are connected as shown. Calculate the

(a) resistance of each lamp

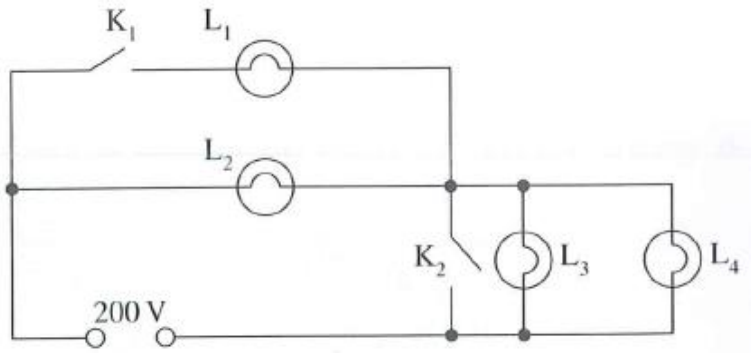
(b) power dissipated in each lamp when

(i) ***K₁*** and ***K₂*** are opened

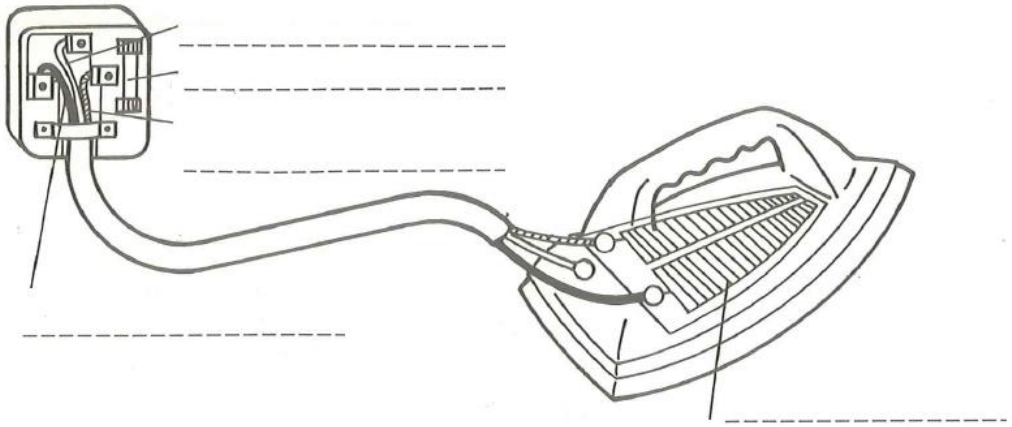
(ii) ***K₁*** is closed and ***K₂*** is opened

(iii) ***K₁*** is opened and ***K₂*** is closed

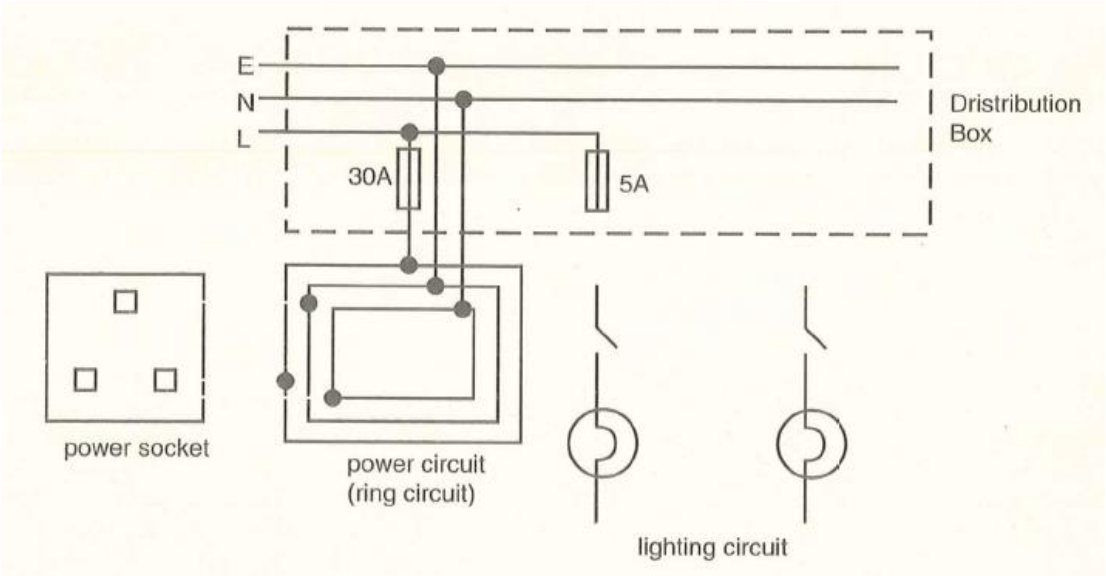
(iv) ***K₁*** and ***K₂*** are closed



12 The diagram shows the connection of an electric iron to a three-pin plug. Label the parts and indicate the colours of the wires used.



13



The diagram shows an incomplete lighting and power circuit in a house.

(a) Complete the diagram by drawing wires to join the

(i) lighting circuit to the distribution box.

(ii) power socket to the ring circuit.

(b) Explain why the

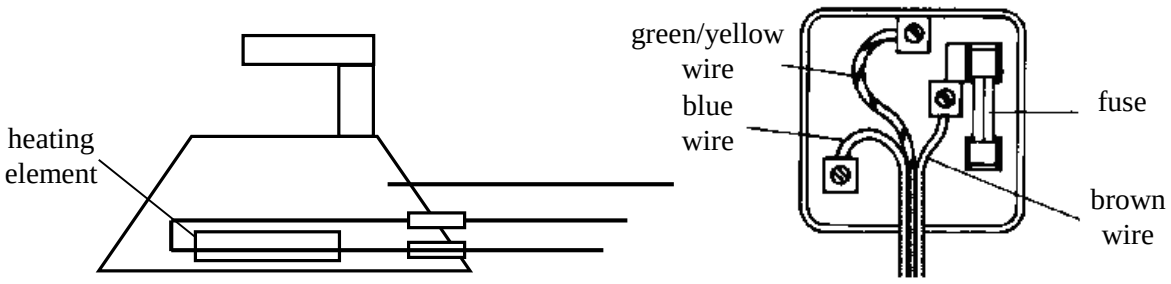
(i) lights in the household circuit are connected in parallel.

(ii) power circuit is arranged in a ring.

(c) The light bulbs in the diagram are rated at "100 W 230 V". A "1 kW 230 V" electric iron is connected to the power socket. All three appliances are switched on for two hours continuously. Calculate the cost of electricity for this usage if 1 kWh costs 20 cents.

(d) Calculate the maximum number of electric irons that can be connected in parallel to the socket without blowing the 30 A fuse.

14



The diagram on the left shows an iron and the diagram on the right shows a three pin plug that connects the iron to the household mains. When the iron is switched on, the time taken for the iron to heat up is 1 minute. The iron is rated 1.5 kW 240 V.

(a) The iron is rated 1.5 kW 240 V. Explain what this statement mean.

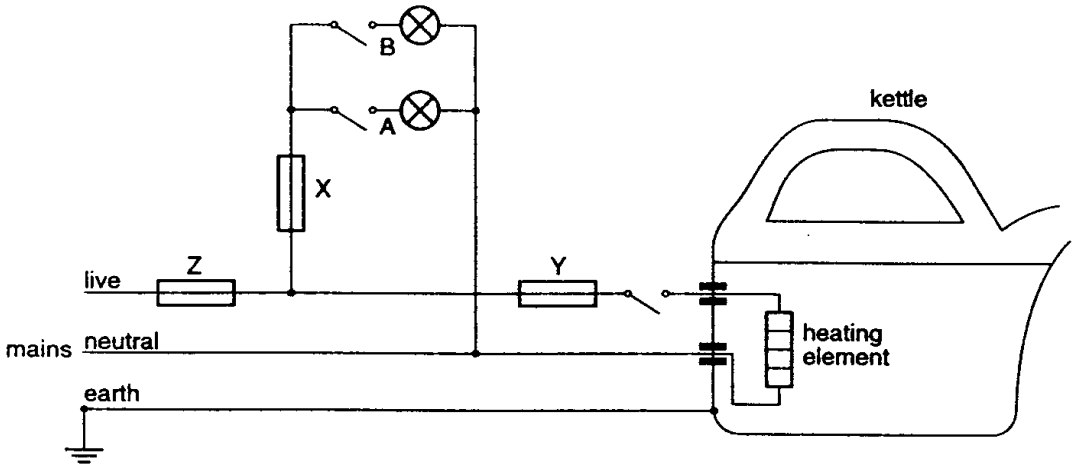
(b) Fuses of rating 3 A, 5 A and 10 A are easily available from any hardware store. What value fuse should be fitted to the plug? Justify your answer.

(c) Connect the three wires of the three pins plug to the iron.

(d) Why do you think it is necessary to connect an earth wire to the iron?

(e) How much electrical energy is transformed each time the iron is used?

15 The diagram shows part of the mains electrical circuit in a house. Two lamps ***A*** and ***B***, each rated at 60 W 230 V, are connected to the live wire through fuse ***X***. An electric kettle, rated at 750 W 230 V, is connected to the live wire through fuse ***Y***. Fuse ***Z*** protects the whole circuit. The electric kettle has a metal case which is connected to Earth. The mains supply voltage is 230 V.



(a) Calculate the current in each of the three fuses when the electric kettle and both of the lamps are all switched on.

(b) A fault develops in the electric kettle, causing a current of 10 A in fuse ***Y***. The lamps ***A*** and ***B*** remain switched on. The maximum current ratings of the fuses are shown in the table.

	fuse ***X***	fuse ***Y***	fuse ***Z***
I/A	3	5	15

Describe and explain what happens to each of the fuses ***X***, ***Y*** and ***Z*** when the fault develops.

(c) The switches and fuses to the lamps and the kettle are all in the live wire. Explain why this is necessary.

(d) With the electric kettle working normally, it is switched on for 15 minutes per day.

(i) Calculate how many kWh are used by the electric kettle in one week.

(ii) Given that 1 kWh costs \$0.15 in the country of use, calculate the cost of using the kettle for one week.

16 ***Fig A*** shows an electric fire for use on a 240 V mains supply. It has four heating elements, each rated at 0.75 kW.

(a) Two important features of the electric fire are the shiny surface and the wide, heavy base. Explain the purpose of these.

(b) The four heating elements are controlled by three switches. One of these controls the middle two elements and the others, control one element each.

(i) Complete the circuit diagram in ***Fig B*** to show how this can be done.

(ii) What is the power rating of the electric fire?

(iii) The electricity board charges 7 cents for each kilowatt hour of energy. What is the cost of using the electric fire from 6 pm to 11 pm?

(iv) When used on the 240 V mains supply, what is the current drawn by the electric fire?

(v) What value fuse should be fitted to the plug? Briefly explain your choice.

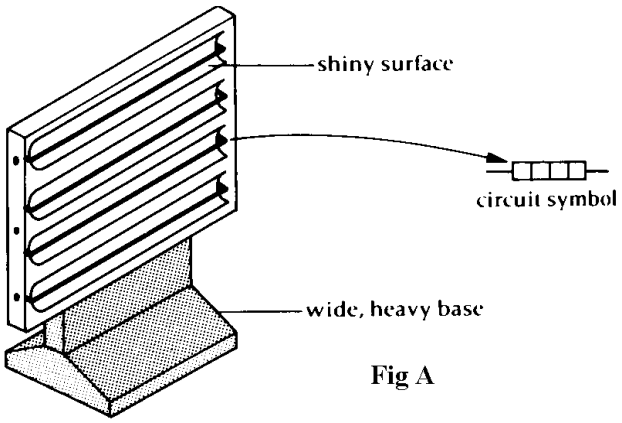
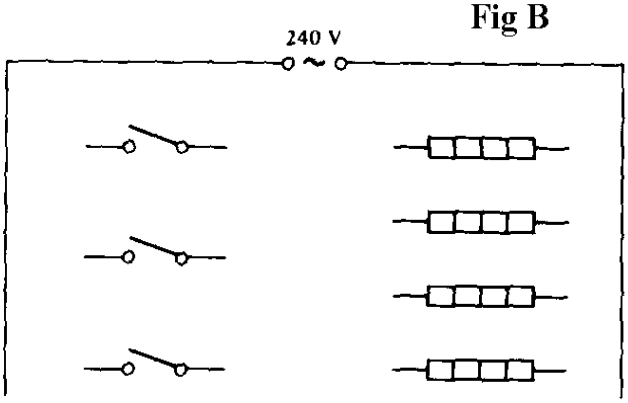


Fig A

Fig B



ALL FOUR ELEMENTS OF THE FIRE ARE SWITCHED ON

17 A current-carrying solenoid ***P*** is mounted on a stationary trolley ***A*** and their total mass is 1 kg. A bar magnet ***Q*** is mounted on another trolley ***B*** which is moving with a velocity of 2 m/s towards trolley ***A*** and their total mass is 1 kg.

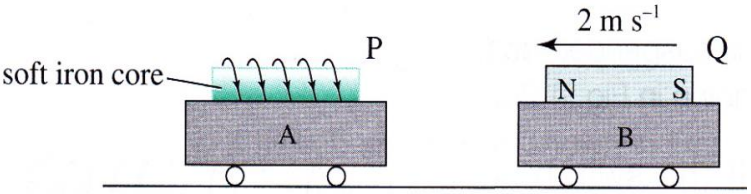
(a) Indicate the polarities of solenoid ***P***.

(b) It is observed that trolley ***A*** starts to move away from trolley ***B***. Explain.

(a) Describe and explain the motions of the trolleys if the

(i) current in the solenoid ***P*** is reversed.

(ii) poles of the bar magnet ***Q*** are reversed.

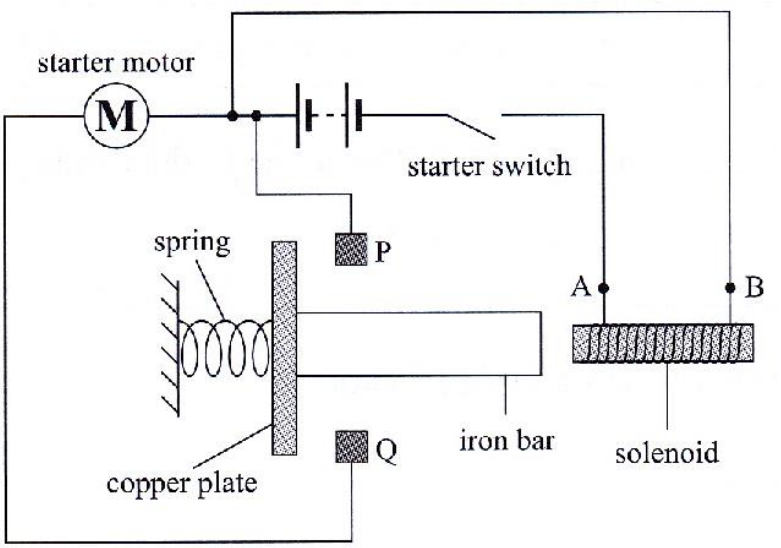


18 The starter motor of a car needs a very large current to operate. Hence, a magnetic relay switch is normally employed for safety reasons.

(a) When the starter switch is closed the iron bar moves to the right and the copper plate completes the circuit between the contacts ***P*** and ***Q***.

(i) Explain why the iron bar moves to the right.

(ii) What is the purpose of the spring?



(b) During repairs, a mechanic accidentally reverses the connections to the solenoid at ***A*** and ***B***. Describe and explain how this will affect the action of the circuit.

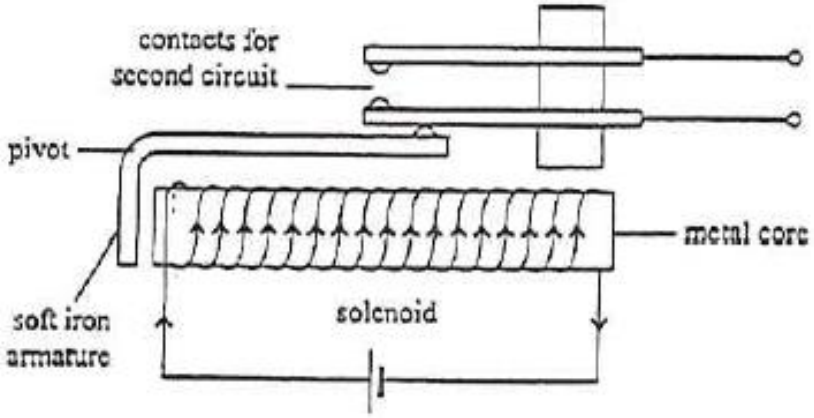
19 The diagram shows the circuit diagram for the switching of a high voltage circuit by a magnetic relay operated by a 12 V supply. The relay coil is wound on a metal core.

(a) State a suitable metal for the core of the solenoid.

(b) Explain why this metal is suitable.

(c) What would happen if the core was made of aluminium?

(d) Give one reason why the high voltage circuit is switched on this way rather than by direct switching.



20 The diagram shows a loudspeaker.

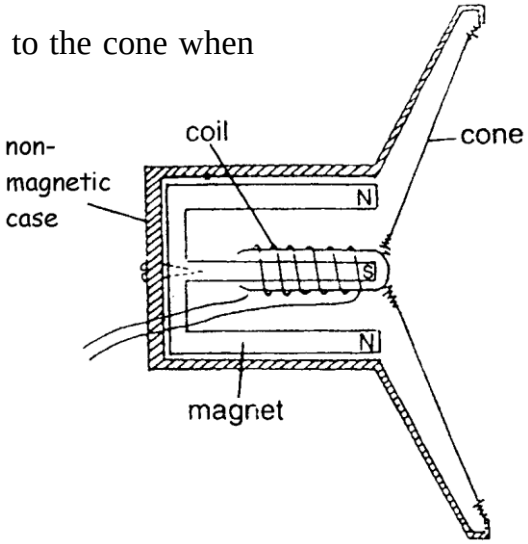
(a) The coil is connected to a d.c. supply. What happens to the cone when the current is switched on? Explain your answer.

(b) The coil is now connected to an a.c. supply of frequency 1 000 Hz.

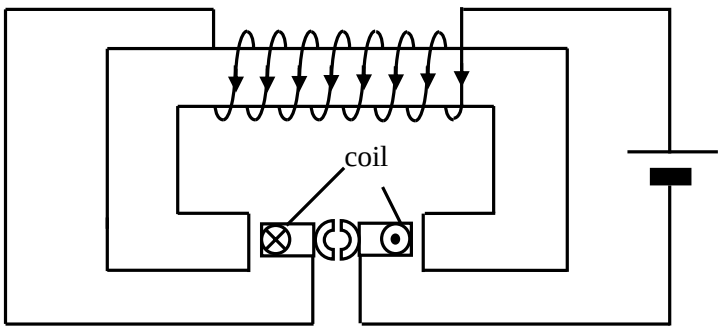
(i) In what way does an a.c. supply differ from a d.c. supply?

(ii) What happens to the cone when the a.c. supply is switched on? Explain.

(c) The frequency of the a.c. is reduced to 100 Hz. The amplitude of the a.c. is also reduced. In what ways does the sound produced from the loudspeaker change?



21 The diagram shows how an electric motor can be made using an electromagnet.



(a) Draw on the diagram, the pair of forces that act on the moving coil. Label the forces with the letter ***F***.

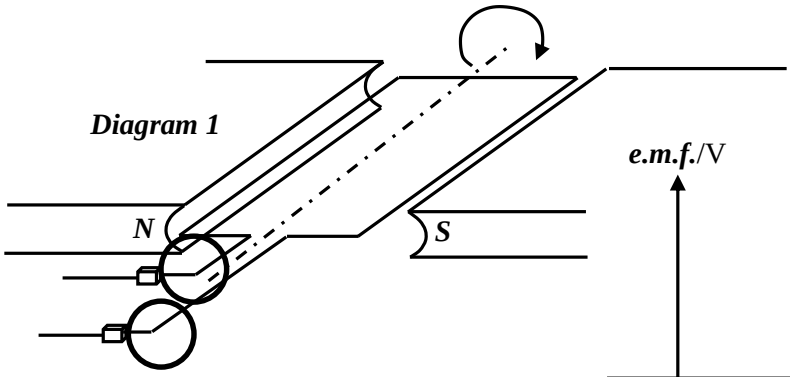
(b) The connection to the battery is now reversed. Describe the effect, if any, on the

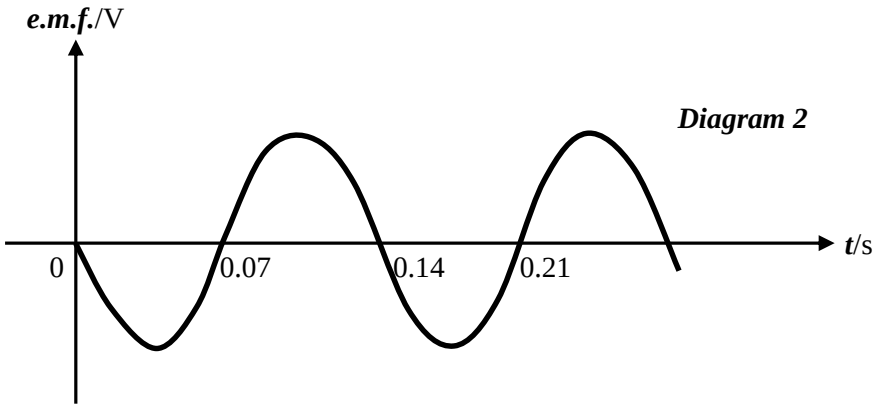
(i) polarity of the electromagnet;

(ii) forces acting on the coil.

(c) Would this work with an a.c. mains supply? Explain your answer.

22 ***Diagram 1*** shows the structure of a simple generator and the variation of the e.m.f. produced against time is shown in diagram ***2***.





(a) Indicate letter ***H*** to the e.m.f. produced when the coil is horizontal and ***V*** when the coil is vertical on diagram ***2***.

(b) As the energy conversion in a motor is just the reverse of that of a generator, a student concludes that their structures are totally different. Do you agree? Explain briefly.

23 A gold ring is suspended near a solenoid as shown.

(a) What is the purpose of the soft iron bar?

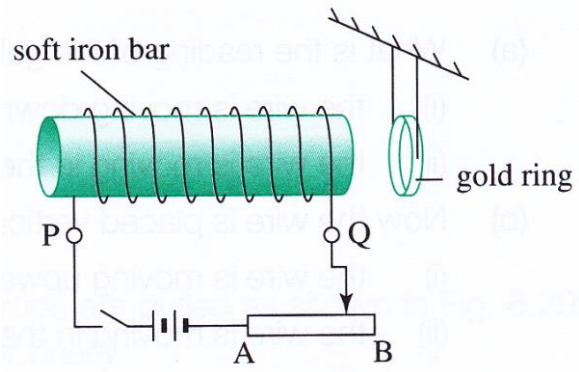
(b) What happens to the gold ring when the switch is closed? Explain.

(c) The switch remains closed. Explain what happens to the ring if the slide contact of the rheostat

(i) remains at ***A***?

(ii) moves from ***A*** to ***B*** quickly?

(iii) oscillates to and fro between ***A*** and ***B*** continuously with a frequency of 1 Hz?



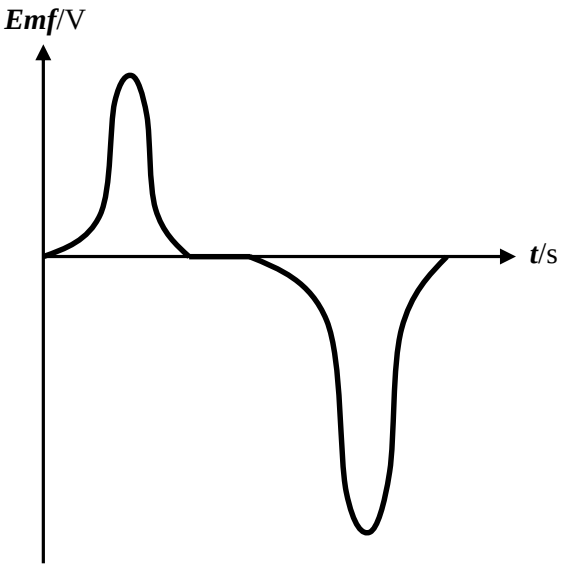
24 Three small magnets are dropped vertically from the same height through a copper pipe, an aluminium pipe and a plastic pipe.

(a) Explain in terms of forces why the magnet accelerates down the plastic pipe fastest.

(b) Will the magnet fall to the ground faster in the copper pipe or the aluminium pipe? Explain.

(c) (i) The graph shows how emf varies with time as the magnet falls through the copper pipe. Explain why the second peak is greater than the first.

(ii) Show on the graph how emf varies with time as the magnet falls through the aluminium pipe.



25 ***Fig A*** represents a transformer with a primary coil of 400 turns and a secondary coil of 200 turns.

(a) Explain the working principle of a transformer.

(b) If the primary coil is connected to the 240 V a.c. mains, what will be the secondary voltage?

(c) Calculate the efficiency of the transformer if the primary current is 3 A and the secondary current 5 A.

(d) Give two reasons why you would expect the efficiency to be less than 100%.

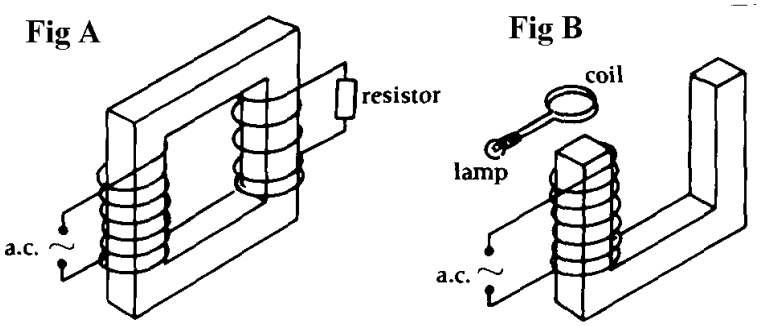
(e) The secondary coil is removed and a small coil connected to a low voltage lamp is placed as shown in ***Fig B***. Explain the following observations:

(i) The lamp lights up;

(ii) If the coil is moved upwards, the lamp gets dimmer;

(iii) If a soft-iron rod is placed through the coil, the lamp brightens again;

(iv) The lamp does not light when a d.c. supply is used instead of an a.c. one.

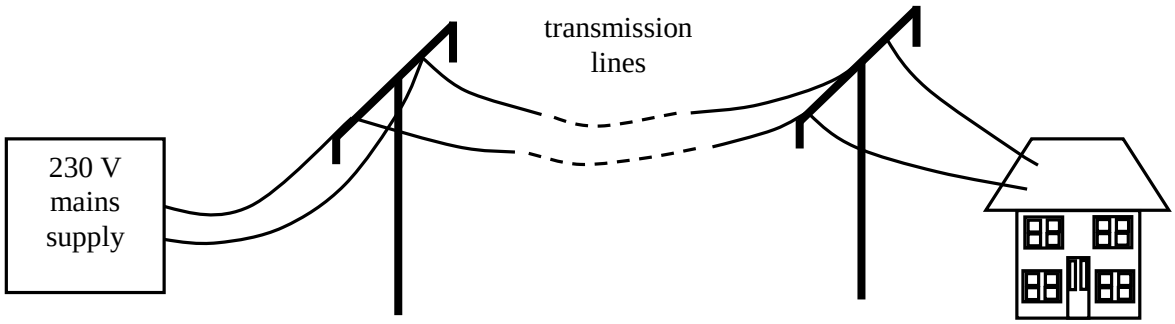


26 A farmer connects a house to the mains electricity. The house is a long distance from the nearest 230 V mains electricity supply. The diagram shows the mains supply connected to the house. The 230 V mains supply provides 690 W of power.

(a) Calculate the current in the transmission lines.

(b) If the resistance of the transmissions lines is 0.20 Ω, calculate the power lost in the lines.

(c) What is the power received at the farmer's house?



27 The circuit shown acts as a light sensitive switch.

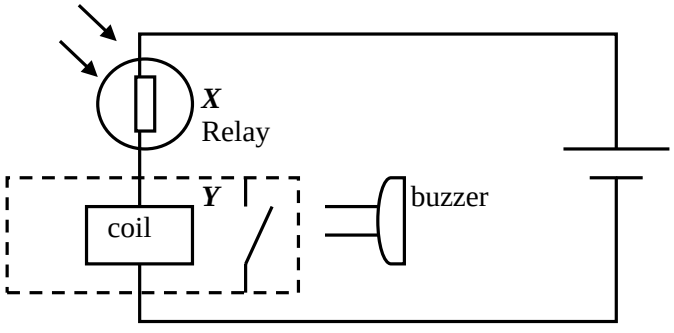
(a) Name the component ***X***.

(b) Draw the connections to the buzzer, the switch ***Y*** and the cell that will allow the buzzer to sound when the switch Y inside the relay closes.

(c) Complete the table below stating whether the

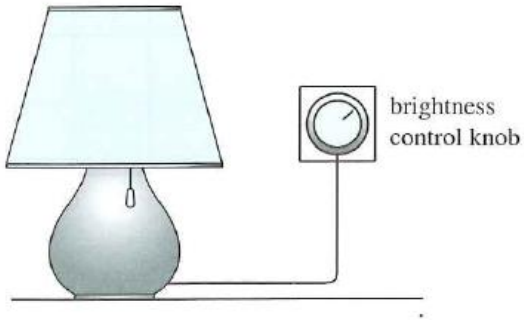
(i) resistance of the component ***X*** is high or low in the light and in the dark,

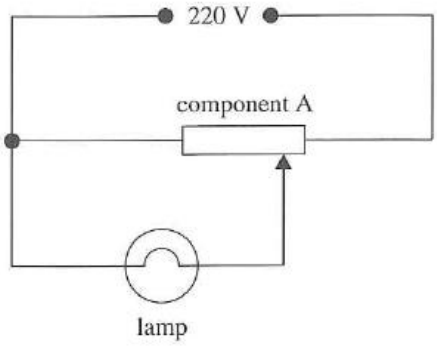
(ii) current in the coil through the relay coil is high or low in the light and in the dark.



	Resistance of ***X***	Current through relay coil	Relay switch ***Y***	buzzer
Light			Closed	***ON***
Dark			Open	***OFF***

28 In hotels, we can find lamps with brightness control knobs to control the brightness of the lamps.





A simplified circuit diagram of the brightness control knob is shown.

(a) Name component ***A***.

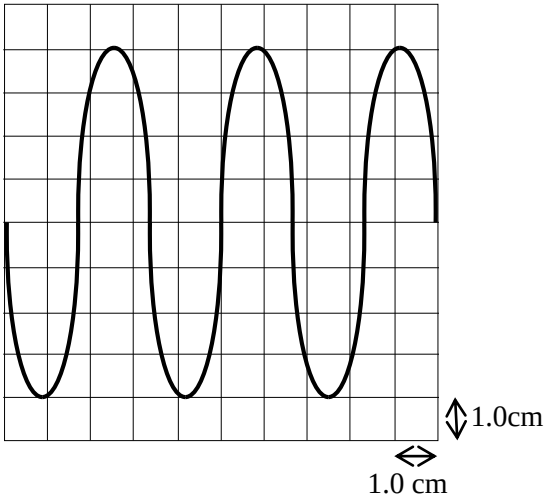
(b) How can we increase the brightness of the lamp? Explain.

(c) State and explain one precaution on using the brightness control knob.

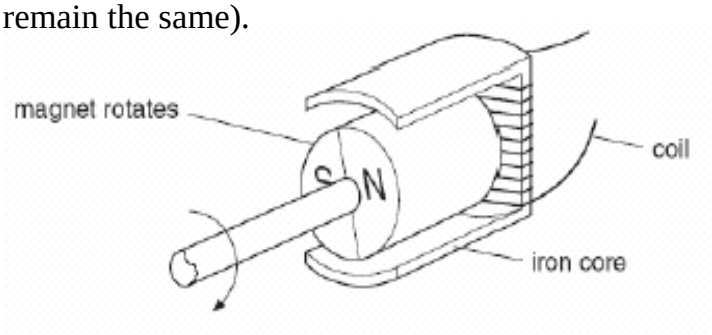
29 The diagram shows the waveform of a certain signal input to a C.R.O.

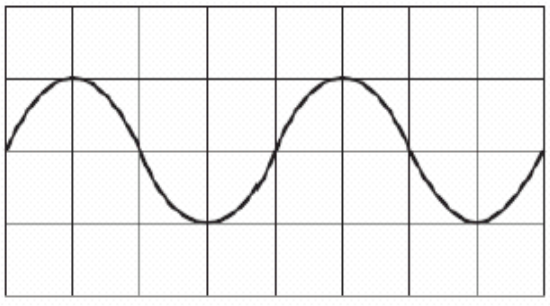
(a) If the ***Y***-gain control is set at 0.5 V/cm and the time base at 2 ms/cm, find the
  (i) peak voltage;
  (ii) period of the signal;
  (iii) frequency of the signal.

(a) How would the trace on the screen be affected if the time base is
  (i) changed to 5 ms/cm?
  (ii) switched off.



30 The diagram shows a model generator. The ends of the coil are connected to a cathode ray oscilloscope (CRO). The figure shows the trace on the screen as the magnet rotates.
Draw new traces for each of the following changes. (Assume the settings of the oscilloscope remain the same).





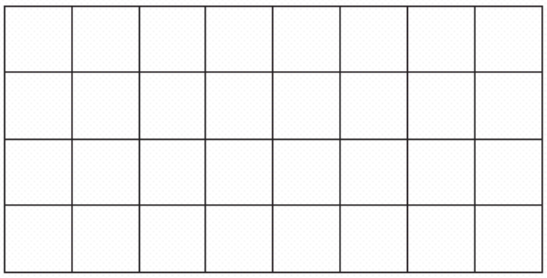
(a) ***A*** - The magnet rotates at the same speed, in the same direction as the original, but the number of turns of the coil is doubled.

(b) ***B*** - The magnet rotates at the same speed, in the opposite direction as the original, but the number of turns of the coil is halved.

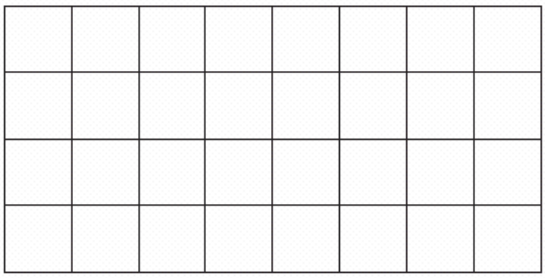
(c) ***C*** - The magnet rotates at twice the speed, in the same direction as the original with the same number of turns of the coil.

(d) ***D*** - The magnet rotates at twice the speed, in the opposite direction as the original, but with half the number of turns of the coil.

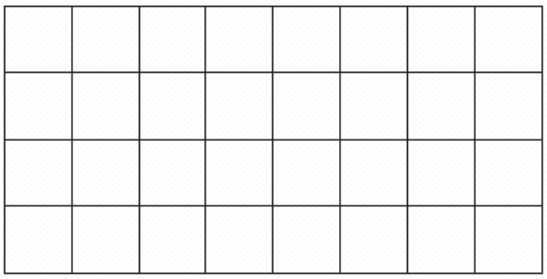
A



B



C



D