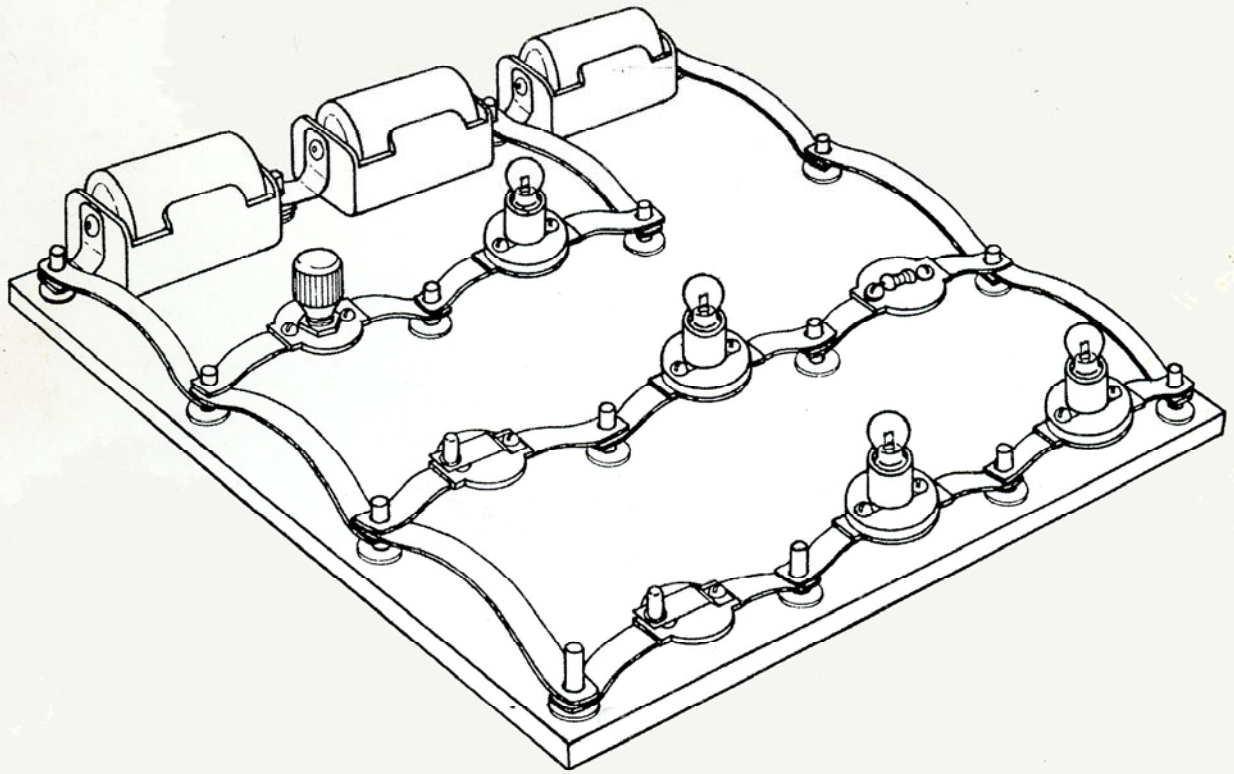
CIRCUIT BOARD KIT

Cat. No. 1092001



WORCESTER CIRCUIT BOARD KIT

(1/16 NUFFIELD KIT)

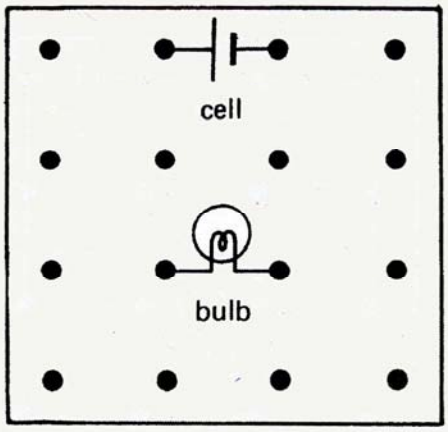
This is an improved version which allows students to investigate the nature and properties of electricity. The battery holders which are detachable, enable the construction of simple series and parallel circuits. The phosphor-bronze connectors ensure long life and good electrical conduction. The diode and resistor are mounted as the switch and bulb holder so as to provide an easy and quick construction of circuits. The plugs and crocodile clips allow extention to outboard experiments.

The kit consists of the following items:

1 pc	Base board with aluminium pegs
3 pcs	Cell holder with phosphor-bronze connector
20 pcs	MES bulb 2.5V
10 pcs	Bulb holder with connector
12 pcs	Phosphor-bronze connector
1 pc	Rheostat with connector
1 pc	3.9 Ohm Resistor with connector
1 pc	Diode with connector
2 pcs	Crocodile clips
2 pcs	Crocodile clips with flexible leads
2 pcs	Flexible leads with 4mm plug and crocodile clip
2 pcs	Switch with connector
2 pcs	Soft iron nails
1 reel	Bare copper wire SWG 24
1 pk	Pencil leads
1 pk	Steel wool
1 sheet	Copper foil
1 coil	Eureka wire SWG 34
1 coil	2.5m PVC coated copper wire
1 pc	Electrode support disc

Activity 1

Electricity in motion : Current



1. Here is a circuit board. Connect the 2 pieces of equipments so that the bulb lights. Complete the diagram to show how you have done this.

2a. Make a gap in your circuit and insert various materials. Complete the table below from your observations.

Conductors (Bulb lights)	**Insulators (Bulb does not light)**

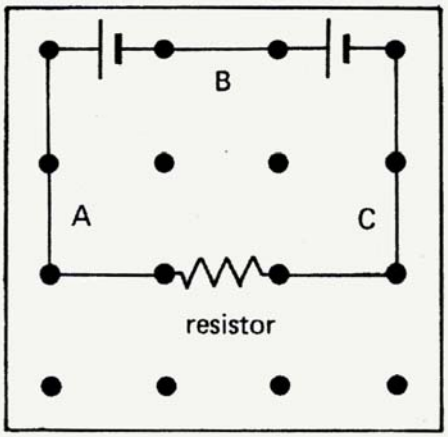
b. What type of substance makes a conductor, metal or non-metal?

SUMMARY

Current can only flow when there is a COMPLETE circuit. Materials that ALLOW currents to flow through them are called CONDUCTORS. INSULATORS are materials which DO NOT ALLOW currents to flow through them.

Activity 2

Current In Series Circuit



1. Set up a circuit as shown in the above diagram. Break a circuit at A and insert a bulb. Note brightness.

   Close the gap at A and insert the bulb at B. Note brightness.

   Close the gap at B and insert the bulb at C. Note brightness.

   Compare the brightness of the bulb at the 3 different points. What do you observe?

   _____

2. What do the results of the above experiment tell you about the electric current in a circuit?

   _____

3. Current can be measured by using an instrument called an Ammeter. It measures current in amperes (A).

NOTE THAT + ON THE METER MUST BE CONNECTED TO + OF BATTERY

Repeat experiment 1 using Ammeter in place of the bulb. Take the readings and complete the following table.

Position	Current in Amperes (A)
A	
B	
C	

4. Do the readings in 3 tally with your suggestions in 2?

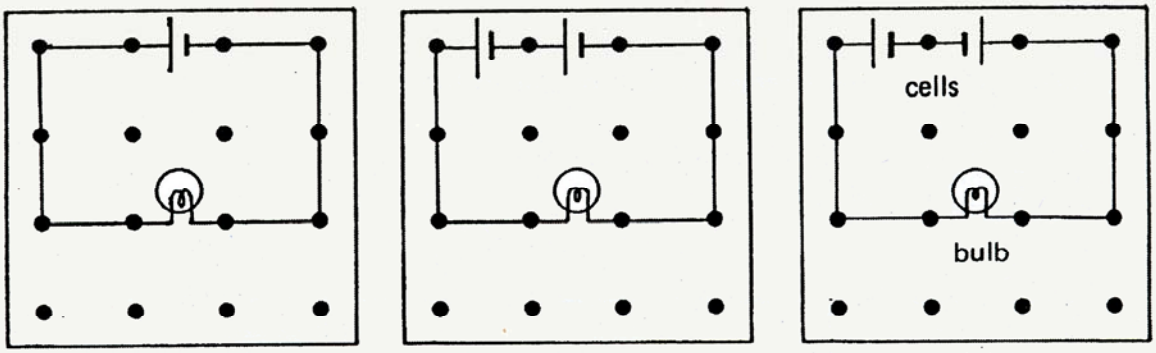
_____

Why do you think so?

_____

Activity 3

Cells In Series



(a) (b)

1. Set up a circuit with a cell and a bulb in series. Note the brightness of the bulb.

   Then put in a second cell as shown.

   a) (+) to (–) of the first.
   b) (+) to (+) of the first.

Note the brightness of cases (a) and (b) and fill in the table below.

		Brightness
1 bulb	1 cell	
	2 cells (+ −)	
	2 cells (+ +)	

2. Use 2 bulbs in series in the above circuit. Note the brightness using

a) 1 cell
b) 2 cells

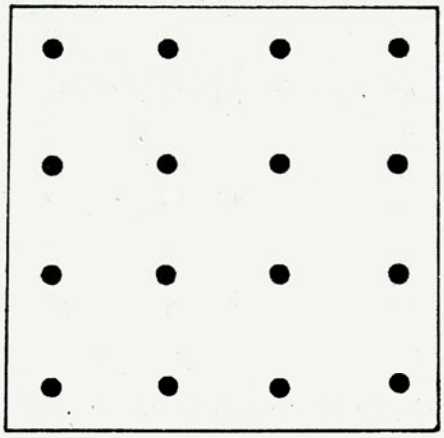
		Brightness
2 bulbs	1 cell	
	2 cells	

Repeat using 3 bulbs in series and note brightness from

a) 1 cell
b) 2 cells
c) 3 cells

		Brightness
3 bulbs	1 cell	
	2 cells	
	3 cells	

3. Draw the circuit used for three cells and three bulbs in series.

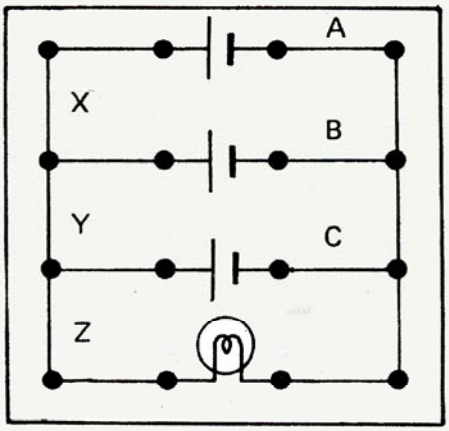


SUMMARY

In these experiments we have learned that a LARGER CURRENT will cause a bulb to light up MORE/LESS brightly.

Activity 4

Cells In Parallel



1. Set up a circuit with a cell at A and a bulb. Note the brightness.

   Now put in a second cell at B parallel to the first cell. Note the brightness.

   Then put a third cell at C parallel to A and B. Note the brightness.

	Brightness
1 cell	
2 cells	
3 cells	

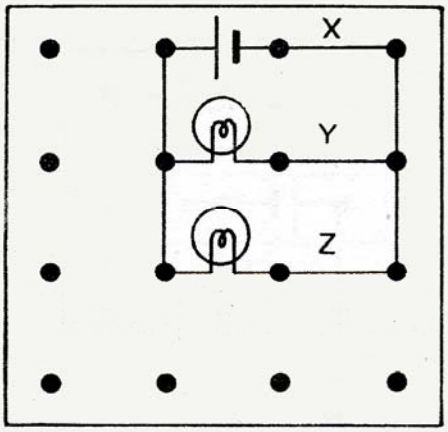
2. Repeat the above experiments by connecting an Ammeter at positions X, Y and Z respectively. Fill in the table below.

Position	Current in Amperes (A)
X	
Y	
Z	

3. Can you draw a conclusion from the results of the above experiments?

Activity 5

Current In Parallel Branches



1. Set up the circuit as shown above. The two bulbs are alike.
(Note: Add 1 more cell in series if the bulbs do not light)

   Compare the brightness of the bulbs. Are they equally bright?

---

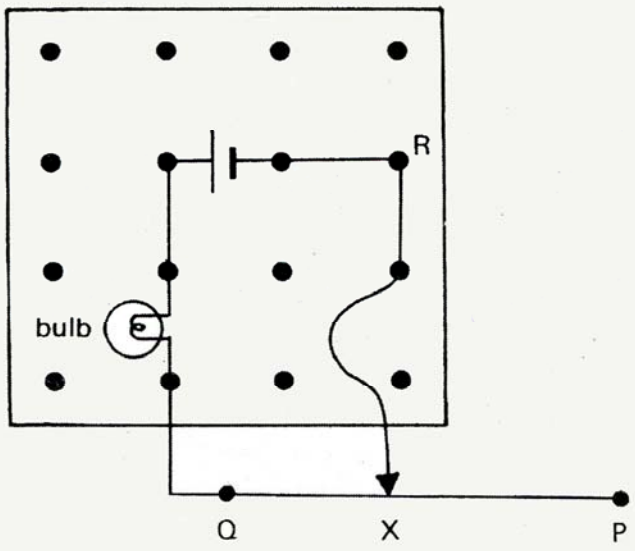
2. Break the circuit at X and insert an Ammeter. Repeat with the Ammeter at points Y and Z respectively. Compare the table below.

Position	Current in Amperes (A)
X	
Y	
Z	

Discuss your results briefly.

Activity 6

Opposing The Current : Resistance



1. Set up the circuit shown above on your circuit board. Slide the clip X along the wire, PQ from P towards Q. (PQ is a long resistance wire). Note the changes in the brightness of the bulb as you slide the clip.

	Brightness
P to Q	Increase/Decrease
Q to P	Increase/Decrease

Repeat the above experiment by connecting an Ammeter in place of the Bulb. What is the result?

_____

2. Which resists the flow of current more, the shorter or the longer length of wire?

_____

3. Using the same circuit, replace with wires of different THICKNESS but made of the SAME MATERIAL and of the SAME LENGTH, between PQ.

Place the slide at P each time and read the Ammeter.

Size of wire	Current in Amperes (A)
Thick	
Thin	

What effect does the thickness of wire have on the resistance to current flow?

---

4. Why do you have to use wires of the same length and of the same material in the last exercise?

SUMMARY

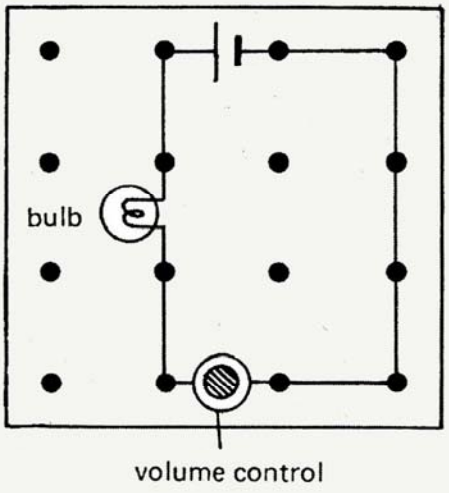
The longer the wire, the HIGHER/LOWER the resistance.
The thicker the wire, the HIGHER/LOWER the resistance.

EXTRA ACTIVITIES

Wires can be made of different materials. Devise and carry out experiments to discover if the **type of material** affects resistance. Tabulate your results and draw a conclusion from it. Draw diagram of any circuits used.

Activity 7

Controlling The Current : Variable Resistance



1. Connect a cell, a bulb and a "volume control" in series on your circuit board.

   What is the effect on the light from the bulb?

   _____

2. What do you think is inside the "volume control"?

   _____

3. The device used to vary the resistance is called a rheostat. Examine this rheostat and suggest a use for it. Connect it accordingly to the circuit board.

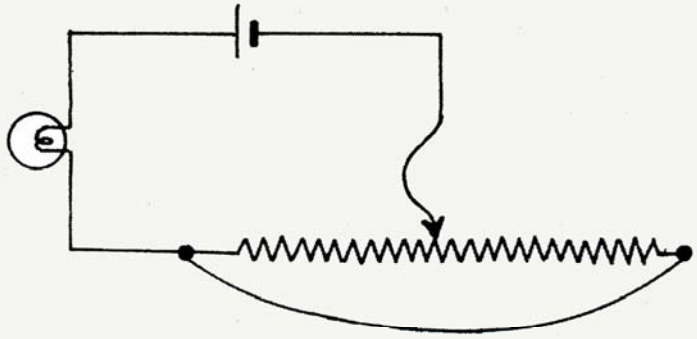
4. Make a list of uses for rheostat.

   _____

   _____

   _____

EXTRA ACTIVITIES



Join P to Q by an extra connecting wire. Observe the brightness of the bulb as the clip slides along PQ.

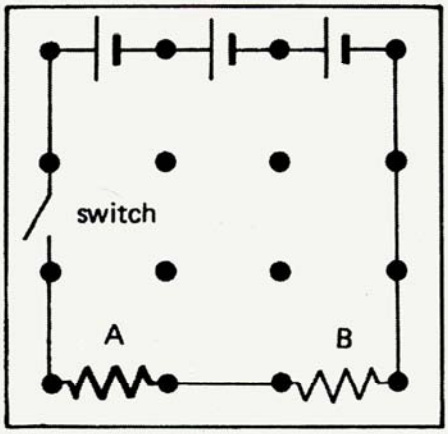
Explain your observations.

_____

_____

Activity 8

Heating By Current



1. Set up a circuit as shown. A is thicker than B but of the same material and length. Turn on the switch to let the current flow for a short while.

   Which wire becomes hotter?

   _____

2. What energy conversion has taken place in the wires?

_____

3. In which wire does this conversion take place more quickly? Give a brief reason for it.

_____

_____

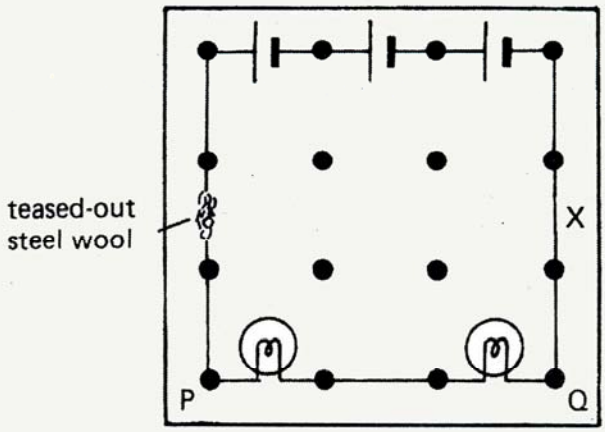
4. Design an experiment to measure how much hotter one wire becomes than the other. Draw a diagram of your apparatus and connections.

SUMMARY

When all other characteristic being equal, a THIN wire becomes hot FASTER/SLOWER when current flows through it. The THINNER the wire the HIGHER/LOWER the resistance. Hence, the HIGHER its resistance the HOTTER/LESS HOT will the wire become when a current flows through it.

Activity 9

Fuses



1. Set up the apparatus as shown. Use 3 new cells for a better result. Short circuit the bulbs with a conductor joining P to Q. What happens to the

   a) Bulbs

   b) Steel wool

2. Test whether the bulbs are still in working condition.

3. Repeat experiment 1 by connecting an Ammeter at X. What happens to the current?

4. Connect a 0.25A fuse link in series with 3 good cells, a meter and a rheostat. Slowly increase the current. What is the final result of this?

More to discover

1. Examine the various fuses that can be inserted in a 13A plug. What is the use of fuse?

2. Why should the fuse wire has low melting point?

_____

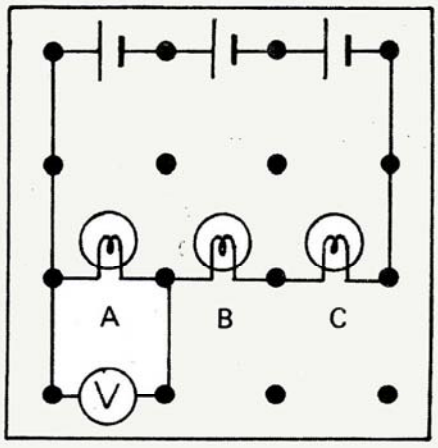
3. Suppose the bare wires in the lead to an electric iron touched each other, what would happen?

_____

_____

Activity 10

Driving The Current : Voltage



voltmeter

1. Connect 3 identical bulbs A, B and C in series with 3 cells. Place a voltmeter across:-

   a) Bulb A, Bulb B and Bulb C in turn.
   b) Bulbs A and B together, bulbs B and C together.
   c) Bulbs A, B and C together.

Complete the following table with the readings.

Arrangement	Volts (V)
A	
B	
C	
A and B	
B and C	
A, B and C	

2. What is the correlation between the voltage and the number of bulbs?

_____

3. Draw the circuit for (c) in experiment 1.

4. Connect a voltmeter across

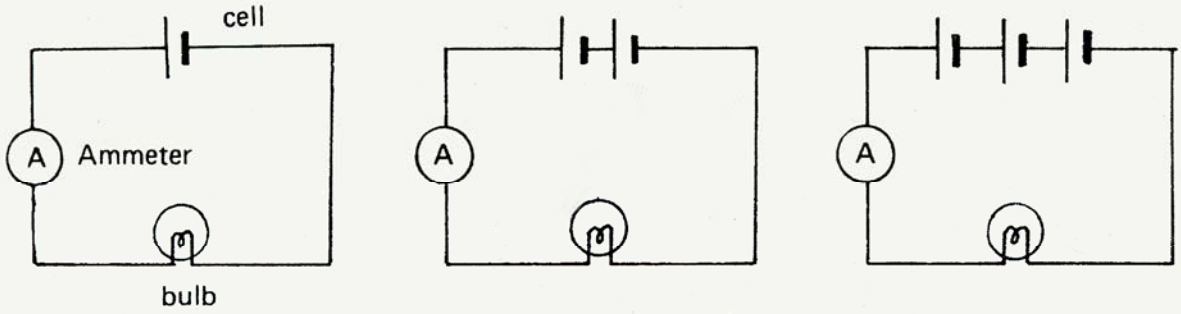
   a) 1 cell
   b) 2 cells in series
   c) 3 cells in series

Number of cells	Volts (V)
1	
2	
3	

5. If we wanted 9 volts, how many cells would we need?

Activity 11

Voltage and Current



1. Connect 1, 2 and 3 cells in series to a bulb and an Ammeter which reads up to at least 3A. Measure the current in each case.

   Complete the table below.

Voltage Units	Current in Amperes (A)
1 cell	
2 cells	
3 cells	

2. What is the correlation between the current and the voltage?

The higher the voltage the _____ the current

a) Voltage (V) ↑ , Current (I) ?

b) I ↓ , V ?

3. Find the voltage supplied by the various sources set out in the laboratory.

Source	Volts
Large dry cell	
Accumulator	
Car battery	
Transistor radio	
Battery	
Battery charger	

4. What would happen if a 12 volt battery were to be used to light a 6 volt bulb? Explain your observation.

_____

_____

More to discover

If cells are connected in parallel instead of in series, how does this affect the voltage? Draw the circuit used in your experiment.

Activity 12

Electricity — Conductors and Insulators

1. Using your circuit tester, test for conductors and non-conductors from available materials.

   Draw your circuit diagram, using the usual symbols for battery and bulb.

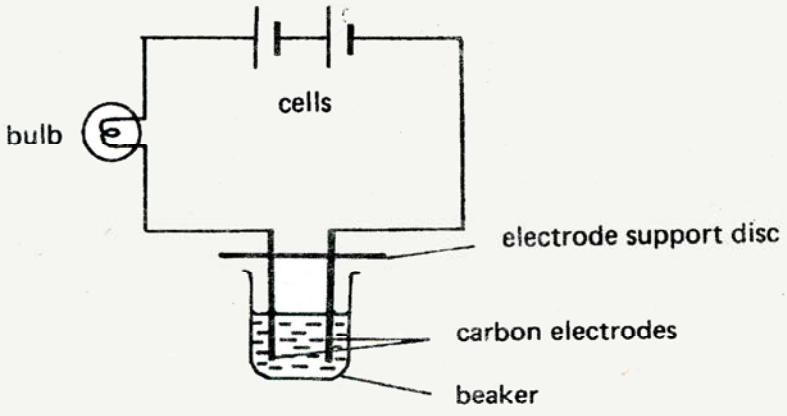
Conductors	Insulators

2. List out the uses of conductors and insulators.

_____

_____

3.



Set up a circuit as shown above on your circuit board and find out whether the following can conduct electricity.

a) Distilled (or deionised) Water _____

b) Tap water _____

c) Sea water _____

How would you explain the difference in your observation between (a) and (c) ?

More to discover

1. Find out why metals are good conductors of electricity.

---

2. Can you name a non-metal which is also a good conductor of electricity?

---

3. Can you name a metal which is in the liquid form at room temperature and also a good conductor of electricity?

Can you give an important use of this liquid metal?

Activity 13

Electricity In The Home : Wiring

1. On a circuit board, connect one cell to

   a) 1 bulb
   b) 2 bulbs in series
   c) 3 bulbs in series

   What do you observe about the brightness of the bulbs?

---

2. How is this related to the current through the bulbs?

---

3. Join one cell to

   a) 1 bulb

   b) 2 bulbs in parallel.
   Is one bulb brighter than the other?

---

   c) 3 bulbs in parallel
   Are they all equally bright?

What do you observe about the brightness of the bulbs in (a), (b) and (c)?

4a. What could you predict about the current in each bulb in experiment 3?

---

b. Check your prediction with an Ammeter.

---

5. One bulb out of three is faulty. Draw a circuit (including all three bulbs), which you could use to show up the faulty one immediately.

6. Test your circuit on a circuit board.

7. If a house has five lights, how do you think the circuit would be arranged?

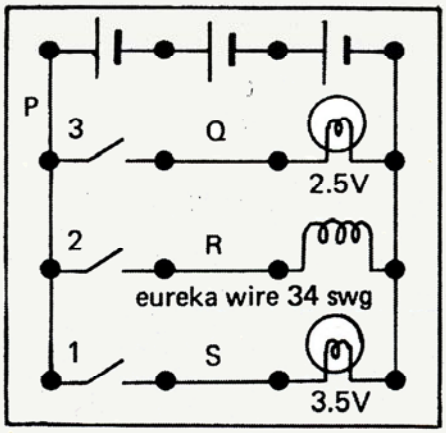
   Draw a diagram to show the circuit.

More to discover

When a plug is bought, it usually has a 13A fuse in it. If you are using it with an electric iron which should only use 5A, why should it be changed?

Activity 14

Electricity In The Home : Wiring



1. Set up the above circuit on your circuit board. Put an Ammeter at P and switch on switches 1, 2 and 3 as shown below. Note the reading each time.

Switches closed	Reading on Ammeter
1	
1 and 2	
1, 2 and 3	
1 and 3	

2. Connect the Ammeter at P, Q, R and then S in turn and close All switchtes each time.

Position of Ammeter	Current (A)
P	
Q	
R	
S	

3. How does the current at P relate to that at Q, R and S?

_____

4. What kind of circuit is that shown above?

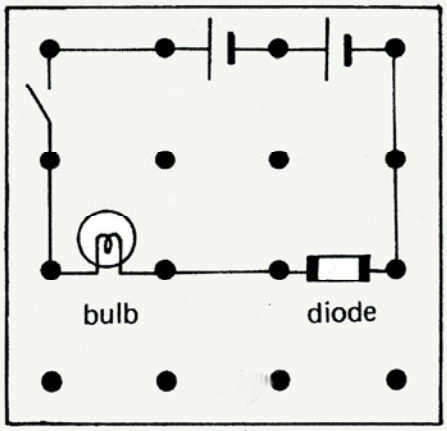
_____

5. Why is the electric wiring in the home in parallel?

_____

Activity 15

One-Way Conduction of Electrons : Diode



Set up the above circuit on your circuit board.

a) Close the switch. What do you observe?

_____

b) Reserve the diode in the circuit and close the switch. What do you observe?

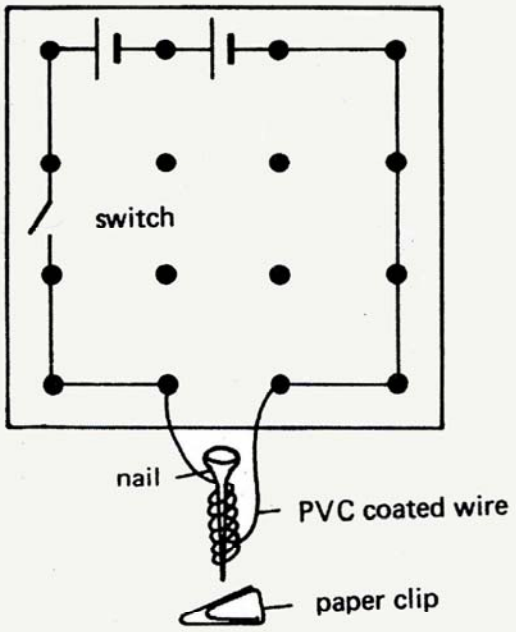
_____

c) Replace the diode with the 3.9Ω resistor. Find out whether it behaves like a diode.

_____

Activity 16

Electromagnetism



1. Set up the apparatus as shown above on your circuit board. Wind about 50 to 55 turns of PVC coated wire round the soft iron nail, firmly and closely, then connect it to the circuit out board.

2. Close the switch and bring a paper clip near to the nail. What do you observe?

_____

3. Open the switch. What happen to the paper clip? Explain briefly.

_____

4. Give some uses of electromagnet.

_____

_____