ELECTRIC CIRCUITS AND CELLS

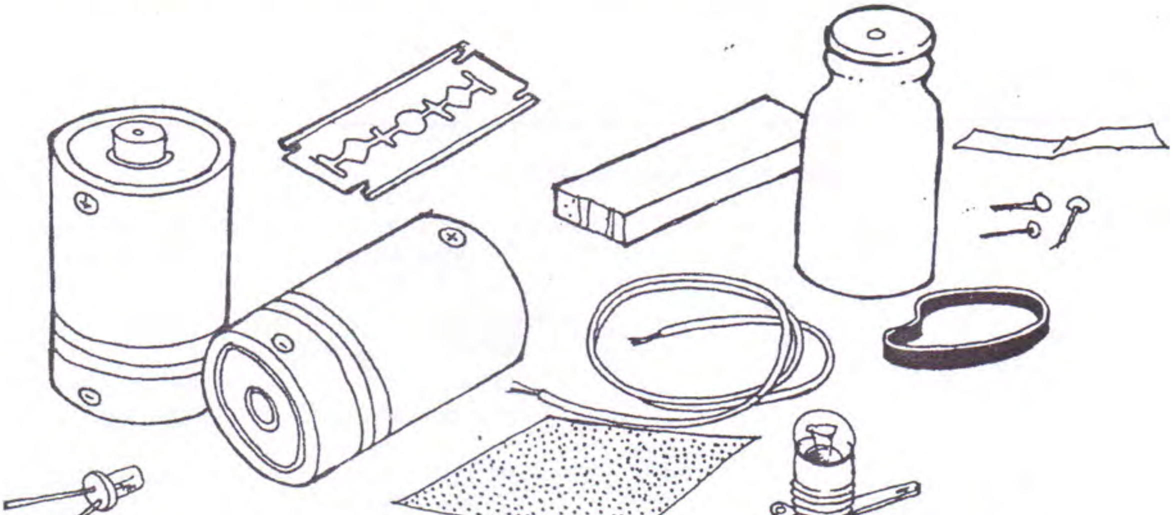
Chapter 16

The day: September 4, 1882. The place: New York, USA.

A crowd has gathered at Pearl Street in the city. The air is filled with excitement and curiosity. Thomas Alva Edison and his coworkers are busy, trying to fulfill a promise that seems impossible to fulfill. They have been working on the problem for the past few months and have fixed a time in the evening to show their wonder to the world.

As evening nears, the excitement rises. The crowd watches as Edison turns on a switch at the scheduled time. Some 14,000 bulbs light up simultaneously in around 9,000 houses. The crowd roars with joy. Edison has succeeded in keeping his promise. For the first time in human history, electricity from a powerhouse has been supplied to people's homes. A new age of progress and development has been ushered in.

Many countries began using electricity for domestic purposes after that day. Today electricity is a common household commodity.



You, too, must have used different kinds of electrical appliances at home in your daily life. Have you ever thought how electricity makes these appliances work? You learned something about electricity in Class 6. Let us learn a little more by performing a few experiments. But, first, let us try and remember all that we learned during the previous year, before we go ahead with our experiments.

Answer the following questions. You could look up your last year's exercise book and workbook, if you can't remember the answers.

Draw a diagram to show how you can light a bulb with the help of a cell and wire. (1)

Try and light your bulb in the way you have shown in your diagram. Did the bulb glow? If it did not, discuss the matter with your friends, find your mistake and correct it.

Fill in the blanks:

(a) The bulb glows when current from the cell reaches it through the ....

(b) This path of electricity is called a ....

(c) When current flows in a circuit it is called a .... or .... circuit. Otherwise, it is called an .... or .... circuit. (2)

How can you test whether or not a current is flowing in a circuit? (3)

Don't ever do these things

Always bear the following precautions in mind. We discussed these precautions in Class 6, but we are repeating them here because they are very important.

1. All our electricity experiments will be performed with the cells we use in torches and radios. Never experiment with the electric current flowing in the wires at your home, school or fields. Doing so could be dangerous. You could be killed.
2. Never connect the positive (+) terminal of a cell directly to its negative (-) terminal. The cell gets discharged quickly if you do so.

Make your own switch

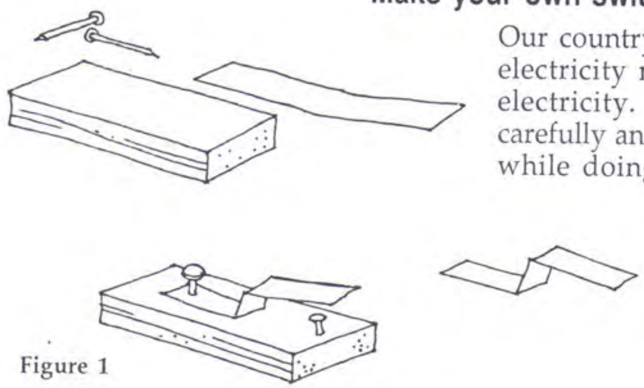


Figure 1

Our country faces a shortage of electricity. So wasting electricity means you are depriving someone else of electricity. Your bill also goes up. So use electricity carefully and only when it is needed. Keep this in mind while doing the following experiments. You should let current flow in a circuit only as long as it is needed. If you allow current to flow continously and unnecessarily, the cell gets discharged very fast. So let the current flow only as long as you need to make your observations.

Can you remember what you did last year to turn the current in a circuit on or off? (4)

This time we shall use a **switch** to turn the current on or off. You may have used different kinds of switches to turn your household electric appliances on or off. Switches help us to start or stop these appliances safely and easily.

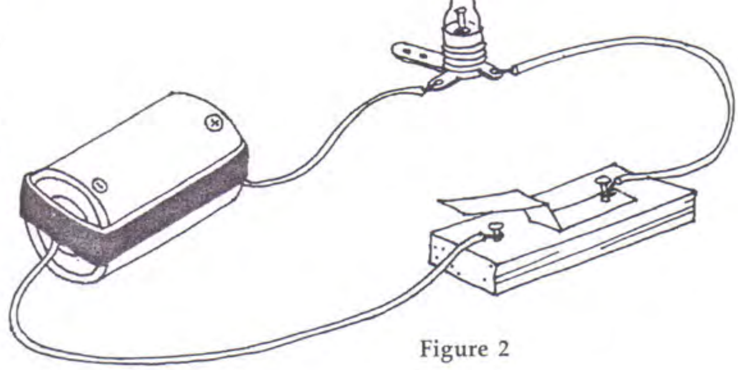


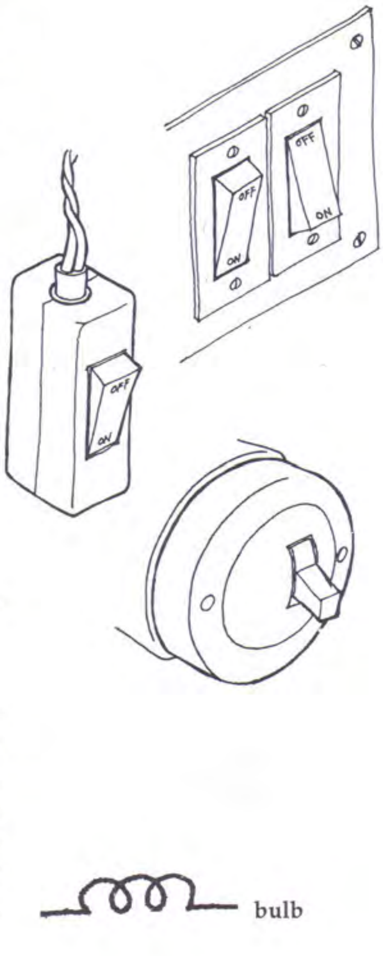
Figure 2

Let us make a switch for our circuits. Take a 10 cm-long iron strip. Bend it twice as shown in Figure 1. Now drive a nail into one end of a wooden block. Nail one end of the iron strip to the other end of the wooden block so that its free end rests just above the first nail without touching it. Your switch is ready.

Would you like to test your switch? To do so, first set up the circuit shown in Figure 2.

How would you use the switch to open or close the circuit? (5)

If the bulb in your circuit glows when the metal strip of your switch is pressed on the nail, and turns off when it is not, then your switch is working. You can use it in any circuit.



The switch you made is a simple one. You may have seen many different types of switches on switchboards and appliances at home and school. These switches are designed according to their usage, convenience and safety. But all of them work on the same principle.

Your teacher will show you different kinds of switches.

Find out how a circuit is closed or opened with these switches. (6)

Circuit diagram

The circuit you made with your switch is a simple circuit. It is not difficult to draw a realistic diagram of this circuit. Maybe you can even draw a better picture than the one in Figure 2. However, later on in this chapter we shall make more complicated circuits. The electrical appliances you use at home have even more difficult circuits. Can you draw realistic diagrams of such circuits which contain many bulbs, cells, switches and other components? It isn't easy.

Scientists have tried to make the job easier. They have adopted simple symbols for different components in a circuit. We can easily draw circuit diagrams using these symbols.

The symbols for bulbs, cells and switches are shown in Figure 3.

For a cell, the longer line denotes the **positive (+) terminal** and the short line the **negative (-) terminal**.

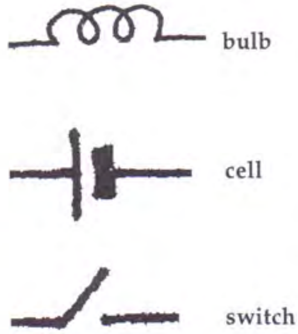
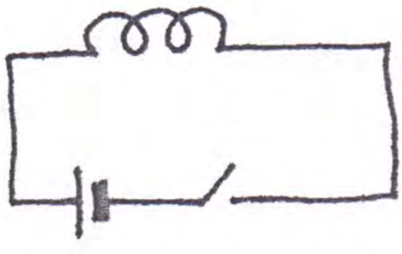


Figure 3

How can you identify the positive and negative terminals of a cell? (7)



Circuit 1

We shall use these symbols to show components in the circuits we draw. Such diagrams are called **circuit diagrams**. If we redraw the circuit diagram given in Figure 2 with symbols, it would look like the figure at the left.

An exercise: Draw circuit diagrams

You saw how a circuit diagram is drawn using symbols. Let us practice drawing a few such diagrams.

Figure 4 shows some circuits. Draw their circuit diagrams using the symbols you have learned.

Understanding a circuit

A teacher asked her class to make a circuit. All the groups used the same components to make their circuits. However, the circuits looked different. In some, the cell was erect, while in others it lay flat. One group used short wires to join the bulb while another used longer wires. One group kept the cell on the left side of the bulb while another kept it on the right.

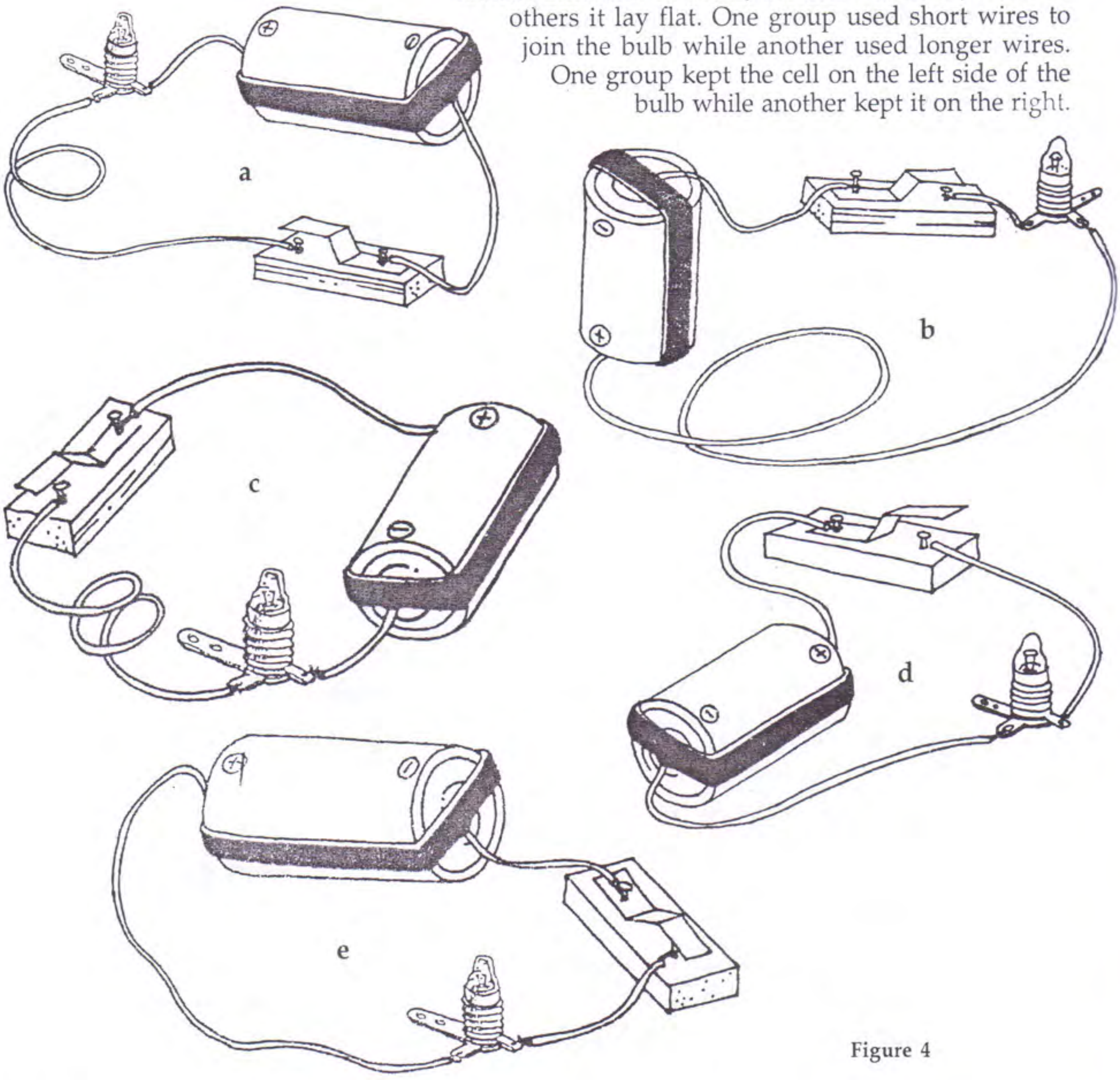


Figure 4

But were all the circuits actually different? How would you spot the differences between circuits? Let us try and understand this point by performing an experiment.

Experiment 1

Make a circuit like the one shown in Figure 2.

Does the bulb light up when the switch is turned on? (8)

Draw a circuit diagram of your circuit. (9)

Observe the sequence in which the cell, bulb and switch are connected in your circuit. To do so, place your finger on the positive terminal of the cell and move it along the wire across the entire circuit. Note the sequence of components as your finger crosses them and list them in your exercise book. For example, the sequence of components in Figure 2 will be as follows:

> positive terminal of the cell → wire → bulb → wire → switch → wire negative terminal of the cell → positive terminal of the cell

Now move the bulb to the other side of the cell without disconnecting the wires. The wires, cell, bulb and switch should remain firmly connected.

Does the bulb still light up as before? (10)

Did the place of the bulb in the sequence change because its position was shifted? What is the sequence of components in the circuit after shifting the bulb to its new position? (11)

Draw the circuit diagram again. (12)

Is your diagram different from the one you had drawn earlier? (13)

Now shift the cell to the left, then to the right, front and back of the bulb.

Was there any difference in the glow of the bulb when you shifted the cell?

Was there any change in the sequence of components in the circuit?

Draw a new circuit diagram every time you shift the cell. Compare each diagram you draw with the earlier one?

Does the circuit change when you merely shift its components here and there? (14)

How can you tell whether two circuits which look different are actually the same or different? (15)

Different kinds of circuits

In the last experiment we made a circuit with a bulb and a cell. We can make only one kind of circuit with a cell and a bulb. But we can make many types of circuits if we have more than one bulb or cell by connecting these components in different ways. The properties of different circuits are different.

In the following experiments we shall examine the properties of different types of circuits and compare them.

You should remember some points before we begin our experiments. Remember to connect a switch in all your circuits. Your cells will last longer if you use a switch. Also, make sure that the cell and bulb are properly connected to the wires. Remember what you learned in your earlier classes about connecting wires firmly. Your observations could be incorrect if your connections are loose.

Experiment 2

A series circuit with two bulbs

Two kinds of circuits can be made with two bulbs and a cell. In this experiment we shall make one of them and study it.

Look at the circuit with two bulbs, a cell and a switch given here (Figure 5).

It is clear from the circuit diagram (Circuit 2) that the two bulbs are connected one after the other. The circuit diagram shows the sequence of the bulbs and cell, not their real position. The way in which the bulbs have been connected in this circuit is called a series connection.

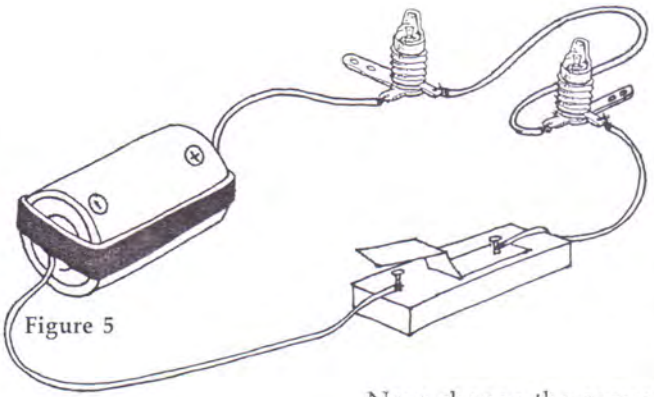


Figure 5

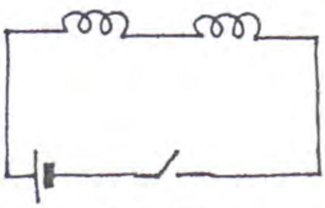
Now make this circuit by joining the two bulbs and cell.

Do both bulbs light up? Do both glow equally brightly? (16)

If one glows less brightly, will it shine more brightly if we change its place in the sequence? Take a guess. (17)

Now change the sequence of bulbs and judge whether your guess was correct or not.

Does changing the order of bulbs in a circuit affect their brightness? (18)



Circuit 2: Series Circuit

Sometimes, bulbs that appear to be similar can differ from each other. So similar looking bulbs do not always glow equally brightly when connected in series.

This circuit can be broken at several places. For example, between the cell and bulb, between the two bulbs etc. Try breaking the circuit at different places.

Can you break the circuit in such a way that one bulb continues to glow while the other does not? (19)

How is the current affected when the circuit is broken at any place? (20)

How many paths are there in this circuit for the current to flow? (21)

You have made and observed a series connection. Let us explore another type of connection.

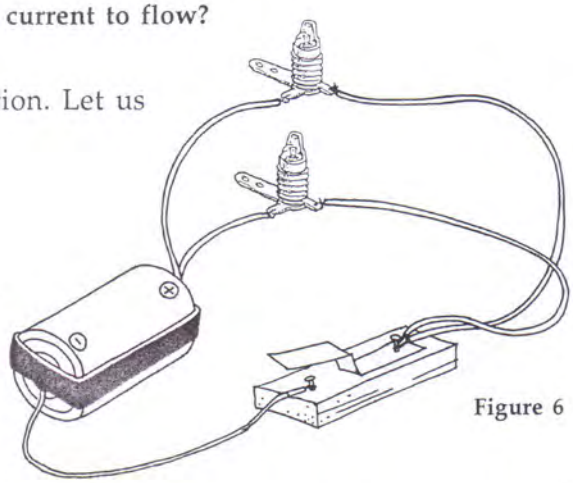


Figure 6

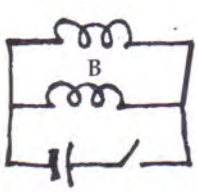
Experiment 3

Parallel circuit

Circuit Diagram 3 (Figure 6) shows a circuit in which two bulbs are connected in a different way. This is a second type of circuit.

The bulbs in this circuit are said to be connected in **parallel**, and such circuits are called parallel circuits.

Take the bulbs you used to make the series connection and connect them in a parallel circuit.



Circuit 3: Parallel Circuit

Did both bulbs light up when the switch was turned on? (22)

Is there any difference in the brightness of the bulbs as compared to the previous experiment? (23)

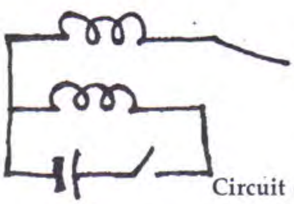
If the connection of Bulb A in Circuit 3 is broken (as shown in Circuit 4), will the bulb still light up? Take a guess and then test to see whether your guess was correct. (24)

What would happen if the connection of Bulb B is broken at one end? Test your answer by actually breaking the connection. (25)

Is it correct to say that if a parallel circuit is broken at any point, at least one bulb will always continue to glow? (26)

Examine the parallel circuit and find out if there are places where current flows through more than one path. (27)

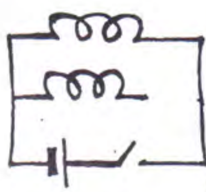
What similarities and differences did you notice between a series circuit and a parallel circuit? List them in your exercise book. (28)



Circuit 4

The lights and fans in your home are connected to a single main connection. You can switch any one of these on or off, whenever you wish, while the others continue to work.

Can you guess how these electrical appliances are connected to each other, in series or parallel? (29)



Circuit 5

A puzzle

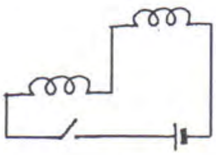
Some circuit diagrams are shown below. Observe them carefully and say which ones are series and which are parallel. (30)

Experiment 4

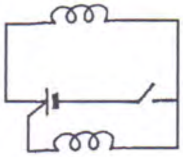
A circuit with two cells

Figure 7 shows two circuits, each with two cells.

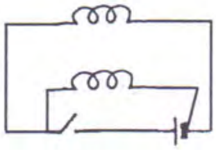
In Circuit Diagrams 11 and 12, are the cells connected in series or parallel? (31)



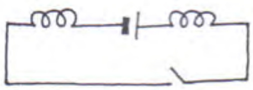
Circuit 6



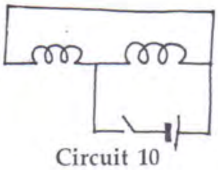
Circuit 7



Circuit 8



Circuit 9



Circuit 10

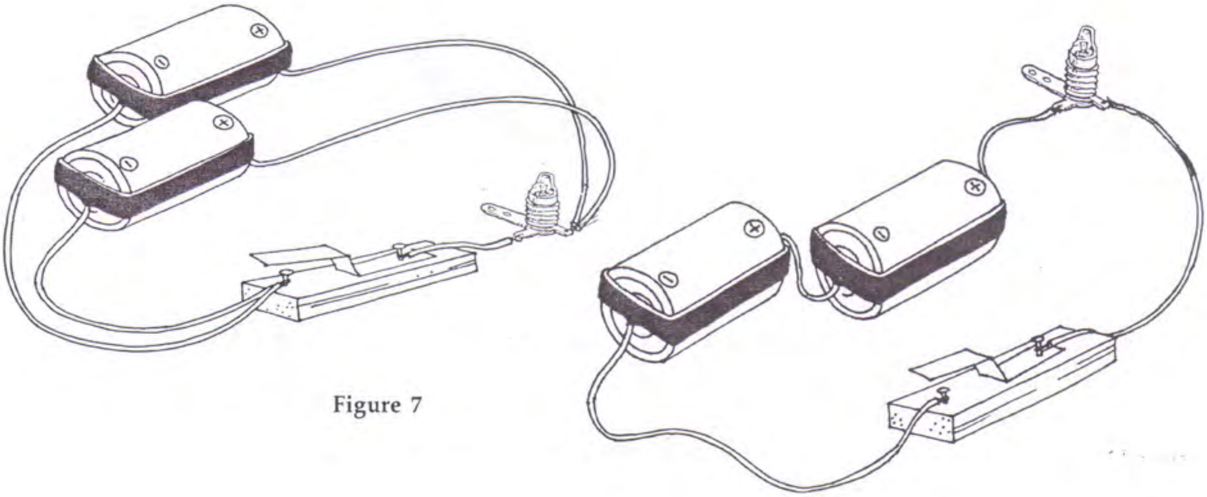


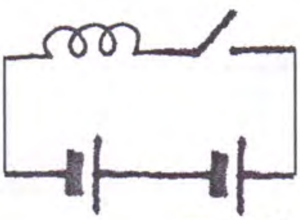
Figure 7

Will the bulbs in these circuits light up? Take a guess. (32)

Test whether your guess was correct by doing the experiment. Use the same bulb in both the circuits.

In a series circuit with two cells, current flows only when the positive terminal of one cell is connected to the negative terminal of the second cell, as shown in Circuit Diagram 11. This is known as a direct connection. If one cell is inverted, as shown in Circuit Diagram 12, and the same terminal of both cells are connected (positive to positive or negative to negative), then the cells are said to be connected in reverse order. No current flows in a circuit if cells are connected in reverse order.

Last year, you studied the circuit of a torch by opening it up.



Circuit 11

Do you remember how the cells in the torch were connected? (33)

When a torch is not used for some time, how should the cells be kept inside to protect them from getting discharged? (34)

Once again, make Circuit Diagrams 1 and 11 and light a bulb.

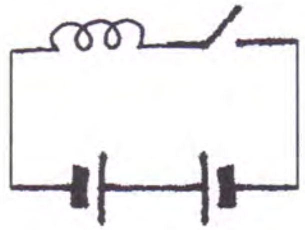
What is the difference in brightness of the bulbs in the two-cell Circuit 11 and the single-cell Circuit 1? (35)

In the above experiment, the cells were connected in **series**. The cells could also be connected in parallel, to give different results. You will learn more about parallel connections in later classes.

One more puzzle

If one of the two cells of Circuit 12 is reversed, the bulb starts glowing. But can you light the bulb without reversing the cells, with the help of a piece of wire? Pay attention to the second precaution given at the beginning of the chapter while doing so.

Make a diagram of this new circuit. (36)



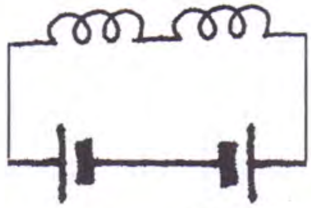
Circuit 12

Liquid: conductor or insulator

Last year, you did some experiments to find out whether a solid is a conductor of electricity or not. Do you remember these experiments?

In what way does a conductor differ from an insulator? (37)

On what basis did you decide whether a solid is a conductor or an insulator? (38)



Circuit 13

If you have forgotten the answers to these questions, refer to your Class 6 exercise book.

Can a liquid also be a conductor or insulator of electricity? Let us find out.

Experiment 5

In this experiment, we shall use the same test that we used for solids to determine whether a liquid is a conductor or an insulator. However, we shall use a new kind of bulb called an **LED**.

Observe the LED carefully. It has two thin wires sticking out. These are like the two terminals of the bulbs we used so far. An LED is connected to a circuit just like a bulb. Make a simple circuit with an LED and see if it glows. If it does not light up, ask your teacher to help you make the circuit.

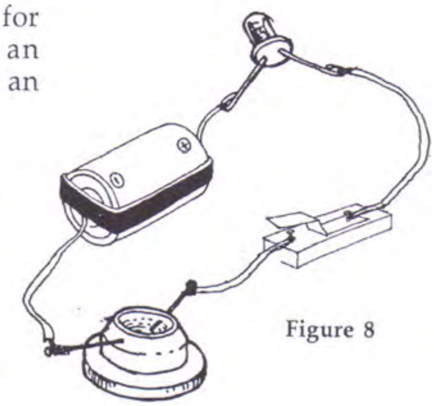


Figure 8

Take the rubber cap of an injection bottle. Invert it and pierce two pins into it so that their points are close to each other in the central hollow (Figure 8). Make sure that the points do not touch each other.

Now make the circuit shown in Figure 8. Pour the liquid to be tested in the central hollow of the rubber cap. Pour just enough liquid to immerse the pin-points. Turn the switch on to complete the circuit and see if the LED glows. If it does, the liquid is a conductor. If it does not, the liquid is an insulator. Begin by testing the conductivity of water.

Did the LED glow when the switch was turned on? (39)
On the basis of your observation, is water a conductor of electricity or an insulator? (40)

Repeat the process with the liquids listed in Table 1 on next page. Before you change the liquid in the cap hollow, clean it and the pins thoroughly. Find out which liquids are conductors and which are insulators.

Table 1

S. No.	Name of liquid	Conductor or insulator
1.	Water	
2.	Salt solution	
3.	Onion juice	
4.	Blue vitriol solution (Copper sulphate)	
5.	Mustard oil	
6.	Kerosene oil	
7.	Lemon juice	
8.		
9.		
10.		

Make this table in your exercise book and write down your observations.

How the first cell was made

You have used many cells in your experiments till now. Some of them may have been fully discharged by now. Would you like to know how the first cell was made? It is a very interesting story.

Some 400 years ago, scientists in Europe began experimenting with electricity. They generated electricity in different ways and conducted various experiments. However, they faced one major problem in studying and understanding electricity in depth. They did not have a stable and permanent source of electricity.

This may seem like a minor problem today, but it took scientists nearly 200 years to find a solution.

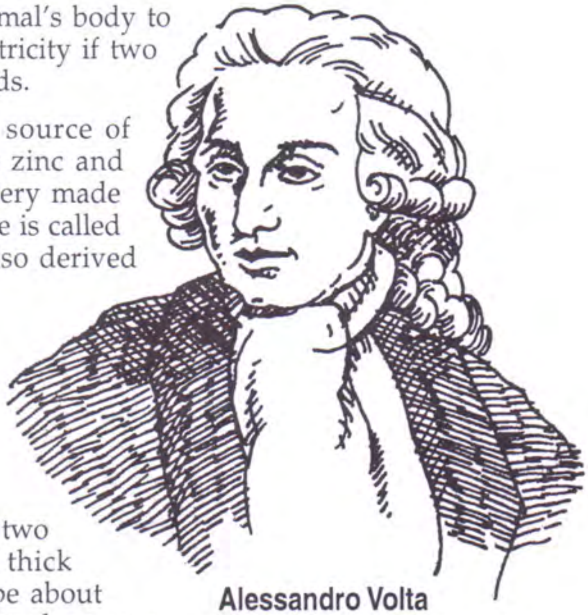
That solution came in 1780. And it came almost by chance. A biologist named Luigi Galvani from Bologna, Italy, once noticed a frog's leg hung from a copper hook twitching violently when it touched another metal. It seemed as if the frog's leg had suddenly come to life.

Galvani did many more experiments with the legs of dead frogs. He finally came to the conclusion that frogs' legs twitched every time electricity flowed through them. Galvani thought he had discovered living or biological electricity. He presented his theory to the world, saying that all living beings contained electricity and it was this electricity that was their main source of life.

Galvani's experiments took the whole of Europe by storm. Many scientists began performing similar experiments with various species of animals. Among them was Alessandro Volta of Italy. He, too, performed experiments with frogs' legs. However, he discovered that if a frog's leg hung from an iron hook and was touched with another iron rod, it did not twitch. Volta was a bit puzzled.

If the reaction in a frog's leg occurred because of the electricity in its body, why were two different metals required to make it twitch, he wondered? After a lot of thinking he arrived at the conclusion that electricity did flow through the frog's leg when two different metals touched it. However, this electricity was not contained in the leg of the frog but was generated by some other process.

Volta repeated his experiment using different liquids instead of frog's legs. He found that it did not require an animal's body to generate electricity. It was possible to generate electricity if two different metals were placed in some special liquids.



Alessandro Volta

These experiments showed the way to a steady source of electricity. Volta made his first cell in 1800 using zinc and copper plates dipped in sulphuric acid. His discovery made him famous in the realm of science. The cell he made is called a **Volta cell** in his honour. The word **voltage** is also derived from his name.

Let us make a cell with the same metals and chemicals used by Volta.

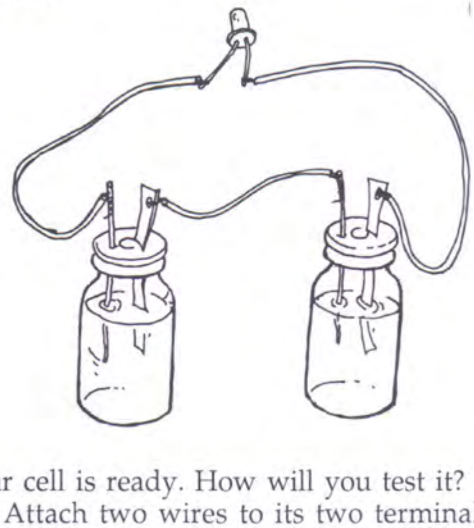
Experiment 6

Make your own cell

You will need a few things to make a cell. First get two injection bottles. Then cut two 3 cm-long bits of thick copper wire from your kit. Use sandpaper to scrape about 1 cm of the coating off both ends of the wires. Break open a discharged dry cell and remove its outer metal covering (made of zinc). Cut two 2 mm-wide and 3 cm-long strips from this zinc plate. Insert the copper wires and zinc strips separately into the rubber caps of the injection bottles as shown in Figure 9. Ensure that the copper wires and zinc strips do not touch each other.

Now take a wire and connect the zinc plate of one bottle with the copper wire of the other bottle.

Fill both bottles with sulphuric acid from your kit. Carefully close the bottles with the caps in which the copper wires and zinc strips are inserted.



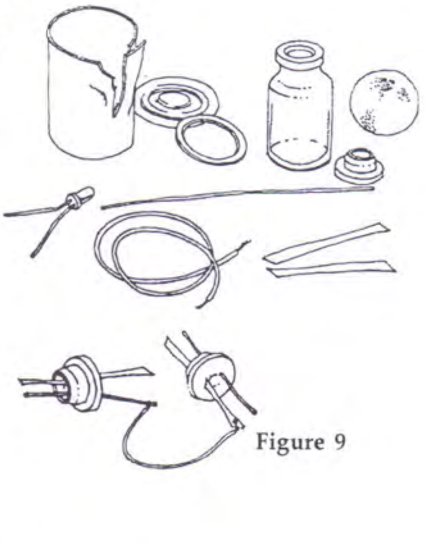


Figure 9

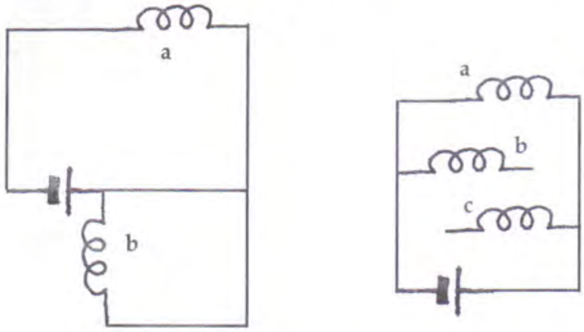
Your cell is ready. How will you test it? Take an LED from your kit. Attach two wires to its two terminals. Touch the wire from one terminal to the copper wire of the first bottle and the wire from the other terminal to the zinc plate of the second bottle. Did the LED light up? In case you face any problem, consult your teacher.

Do the following experiment

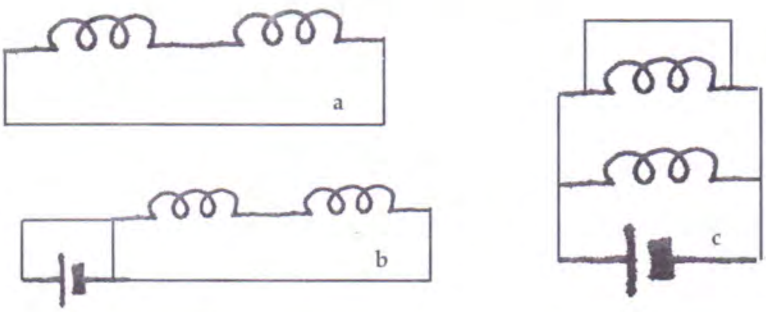
Repeat the previous experiment using lemon juice, tamarind juice and tomato juice, one by one, instead of sulphuric acid, to make your cells.

Questions for revision

1. **In which of the following circuits will the bulbs light up and in which will they not? Give reasons and verify your answers by making the circuits.**



2. **Find the mistakes in the following circuits and draw the correct circuit diagrams.**



3. **Harbhajan made a circuit by connecting a cell and two bulbs in series. One bulb glowed but the other did not. Sushma said the bulb was fused? Do you agree with her? Give reasons for your answer.**
4. **Find out how bulbs in the decorative lighting used during festivals are connected.**
5. **On what basis did Volta come to the conclusion that an animal's body is not needed to generate electricity?**
6. **You have seen and used many electrical appliances. List them. Each has some information written on it - for example, its voltage, wattage etc. Note these in your list as well. Consult your teacher or some knowledgeable person to find out their meaning, and what they tell you about the appliance.**

New words

Series	Parallel	Voltage	LED
Circuit diagram	Switch	Volta cell	