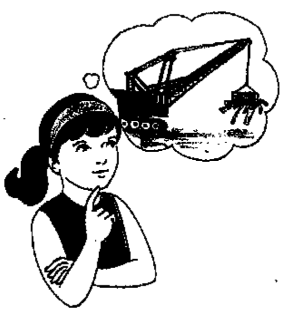
7 Magnetism and Electricity

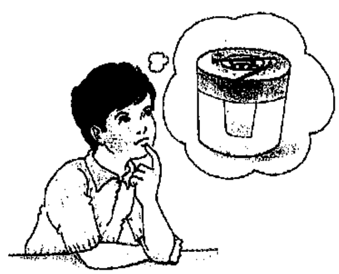
LEARNING OUTCOMES

- Properties of magnets
- Magnetic field
- Earth's magnetism
- Electromagnetism
- Solenoid
- Uses of electromagnets: electric bell
- Electromagnetic induction

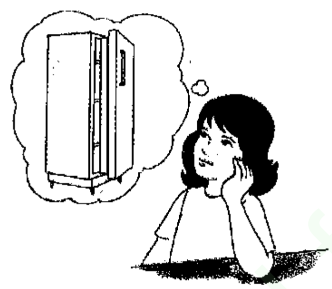
Read the following questions that Sheena and her friends have in mind. See if you can answer them.



Sheena: *How do such huge pieces of iron stick to the block on the crane?*



Rohit: *How do the pins stick to the middle rod in the pin holder?*



Sharmila: *Hey! If I leave the door of the refrigerator open, it closes by itself. How?*

What particular thing are Sheena and her friends talking about? Yes! They are talking about magnets. You might have seen magnets and enjoyed playing with them. You might have seen that some pencil boxes close by themselves if you leave their lid free? Try to locate the magnet in them.

In this chapter, you will study about magnets, their properties, how magnetism is related to electricity, and its everyday applications.

According to a legend, the first magnet was discovered by a Greek shepherd named Magnes. The Greek named this strange type of rock 'magnetite'.

Ancient people believed that magnets had magical properties, like the ability to scare away ghosts. Ancient navigators also used magnets for navigation.

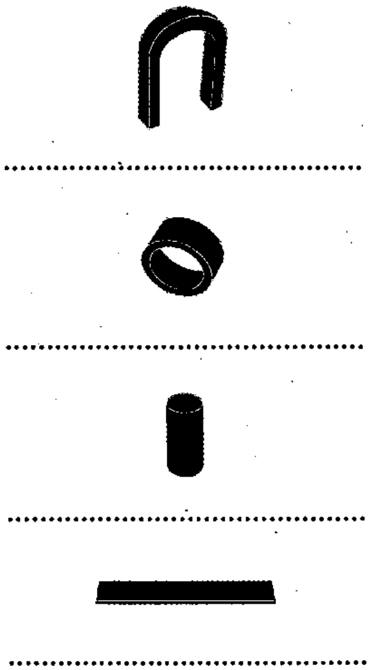


Fig. 7.1 *Different types of magnets*

More than 2,500 years ago, it was discovered that certain rocks had the property of attracting iron. It was also found out that small pieces of these rocks also have directive property. These naturally occurring materials are called *magnets*. Later on artificial magnets were made from steel, an alloy of iron.

Do you know that not all materials are attracted by magnets? Materials like iron, nickel, and cobalt that are attracted by magnets are called *magnetic materials*. On the other hand, materials like aluminium, copper, and silver that are not attracted by magnets are called *non-magnetic materials*.

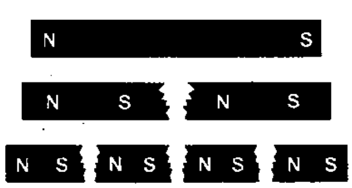
Now-a-days magnets are made in different shapes and sizes, depending on their usage. Can you name the different types of magnets that you see alongside?

You might have studied about some basic properties of magnets in your earlier classes. Do you remember some of them? Let us briefly revise them before going any further in this chapter.

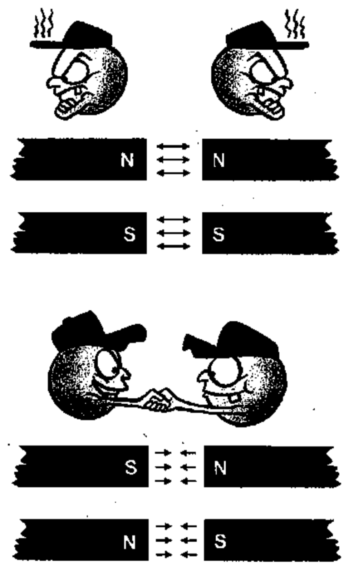
Property of attraction: You might have experienced that when you dip a magnet in a bowl of steel ball pins, maximum number of pins are attracted at the two ends of the magnet, which are called the *poles* of a magnet. This means that the *magnetic force is stronger at the poles and weaker at the centre of a magnet*. When a magnetic material (soft iron) is brought close to, or touches, the pole of a magnet, the magnetic material becomes a magnet itself and gets attracted. Here, we say that magnetism is *induced* in it. The end of the magnetic material nearer to the north pole of the magnet gets south pole and the farther end gets north pole induced in it. This magnetic induction depends on the strength of the magnet, the type of the magnetic material, and the distance between the two.

Fig. 7.2 *Magnetism induced in a piece of soft iron*

Property of direction: If you tie a magnet to a string and suspend it freely, or place a magnet on a thermocole in a bowl of water and allow it to float, you will find that the magnet comes to rest in a particular direction, i.e., in the north–south direction. If you further disturb the magnet it will again come to rest in the same direction. This shows that *a freely-suspended magnet always comes to rest in the north–south direction*. The pole/end of the magnet facing north is called the *north pole* (N) of the magnet and the other facing south is called the *south pole* (S). These two poles cannot exist independently and always remain in pair. If a bar magnet is broken in the middle, the two pieces that we get have both north and south poles. If we continue breaking the magnet into still smaller pieces, every piece of magnet that we get will have both north and south poles.



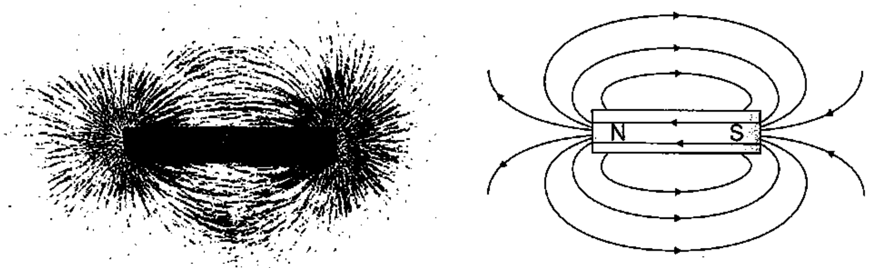
Just like in electric charges, like charges repel and unlike charges attract; similarly, in magnets ***like poles repel and unlike poles attract***. This can be verified by bringing two magnets close together. Since repulsion happens only between like poles of two magnets, repulsion is considered to be a sure test for magnetism. After having studied about the properties of magnets, can you answer a simple question? Can the attractive property of a magnet be felt at any distance from the magnet? Place some iron nails near a magnet so that they experience a force of attraction. Now gradually increase the distance between the magnet and the iron nails. At one point you will find that the magnet no longer attracts the iron nails. What does this show?



This shows that there is a specific region around a magnet where its magnetic effect is felt. This region is called the *magnetic field* of the magnet.

MAGNETIC FIELD

*The space around a magnet where its influence (effect) is felt is called the **magnetic field***. Any magnetic material placed inside the magnetic field of a magnet experiences a force, and the direction of this force is given by closed continuous curves called *magnetic lines of force*. Let us look at Figure 7.3 to understand the magnetic lines of force.



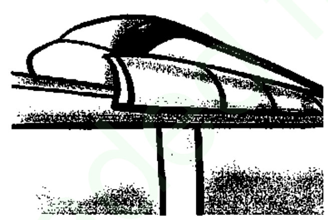
(a) (b)

Fig. 7.3 *(a) Iron filings around a bar magnet; and (b) Magnetic lines of force around a bar magnet*

If you scatter iron filings on a piece of paper, where a bar magnet is placed, you will see that the iron filings arrange themselves in specific curves around the bar magnet. These curves are called *magnetic lines of force*. The direction of these lines is always from the north pole to the south pole outside the magnet and from the south pole to the north pole inside the magnet [Fig. 7.3 (b)].

An important property of these lines of force is that *they never intersect each other*. This is because at each point in the magnetic

TECH FILE



Today magnets are used in many devices such as doorbells, telephones, television, computers, electric motors, and generators. They are also used in special trains called Maglev. These trains can run very fast without wheels because magnets allow them to float above the track.

TECH FILE

A magnetic compass is a device that uses magnets to find directions. It has a small magnetic needle at its centre, which rotates freely and always points in the north–south direction. Magnetic compasses are of immense use to sailors and navigators.

field of a magnet, the force of the magnet acts in only one direction. Also, you can see that the lines of force are highly concentrated near the poles, where the magnetic field is strong.

Our earth also behaves like a huge bar magnet and has its own magnetic field. Let us study about it.

Magnetic field of the earth

We have studied that a freely suspended magnet always comes to rest in a particular direction. This happens because this magnet is under the influence of another magnet, which is our earth. The earth acts like a giant bar magnet. It influences all the magnets so that they align themselves along the north–south direction of the earth.

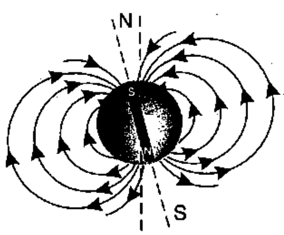


***Fig. 7.4** Magnetic field of the earth*

Look at Figure 7.4. The bar magnet shows the magnetic effect of the earth. One interesting thing to note is that the bar magnet is aligned in the north–south direction, but its north pole points towards the earth's geographic south pole, and its south pole points towards the earth's geographic north pole. Hence, when a magnet is freely suspended, the north pole of that magnet always points towards the earth's magnetic south pole (which is the geographic north pole) and vice versa. The magnetic compass is based on this principle. Do you notice in the figure that the magnetic and geographic poles do not coincide? There is a difference of some degrees, and navigators need to calculate this difference to reach the correct destination during navigation.

ACTIVITY

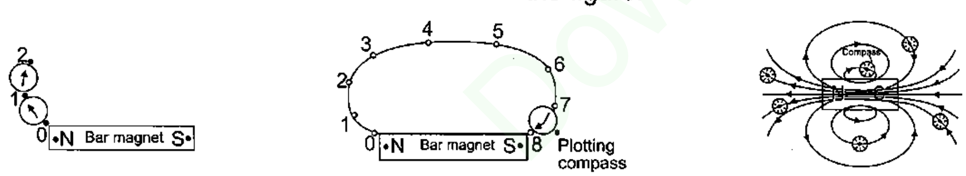
Aim: To plot magnetic lines of force using a compass needle.

Materials required: A bar magnet, a compass needle, a sheet of paper, and pencil.

Procedure: 1. Place the bar magnet on a piece of paper and the compass needle near one pole of this magnet. Mark the positions taken up by the poles **N** and **S** of the compass as dots 0 and 1. Move the compass so that pole **S** is exactly over 1, and mark the new position of **N** as dot 2.

2. Continue the process until the **S** pole of the bar magnet is reached. Join the dots together to get a single magnetic line of force.

3. Other magnetic lines of force can be plotted by starting at different points around the magnet. Like this you will get a typical field pattern as shown in the figure.



Now you know that every magnet has its own magnetic field. You have studied about electricity in class 7. Do you know that magnetism and electricity are inter-related?

When an electric current flows through a conductor, it creates a magnetic field around the conductor making it behave like a magnet. This forms the basis of *electromagnetism*. Let us study this in detail.

ELECTROMAGNETISM

The term electromagnetism comes from the fact that electric and magnetic forces are linked together. A Danish scientist, Hans Oersted, in 1820 noticed that when a compass needle is kept near a wire carrying electric current, the needle gets deflected. This means that a magnetic field can be produced by an electric current.

*The branch of physics that deals with the magnetic effect of electric current is called **electromagnetism**.*

When a wire is wound around a soft iron bar and electric current is passed through the wire, the soft iron bar behaves like a magnet, whose strength is much more than the magnetic effect produced by the wire alone. But is the magnetism of the soft iron permanent? No! the magnetism is soon lost when the current is switched off. This shows that the soft iron behaves like a magnet only when the wire around it carries current. A magnet of this kind is called an *electromagnet*.

After studying that a wire carrying current produces a magnetic field around it, let us see how this magnetic field is produced in a straight wire and in a circular coil, carrying current.

Magnetic field due to a straight wire carrying current

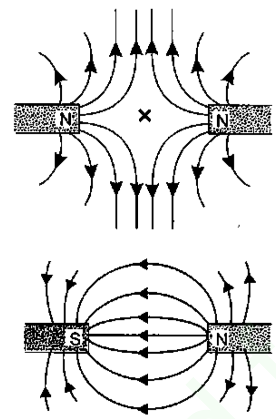
Figure 7.5 shows what happens when current is passed through a straight wire. A straight wire is passed through the centre of a cardboard, which has iron filings scattered on it. When a current of few amperes is passed through the wire and the cardboard is tapped, the iron filings are seen to arrange themselves in concentric magnetic lines of force with their centre lying on the wire.

The direction of the magnetic field produced like this can be found by *Maxwell's right-hand thumb rule*, if the direction of the current is known.

Maxwell's right-hand thumb rule states that if you hold the current-carrying wire in your right hand so that your thumb points in the direction of the current, then the direction in which your fingers

FACT FILE

The figures below show how magnetic lines of force can be plotted using two magnets placed side by side, once with like poles facing each other and then with unlike poles facing each other. The point X in the figure is called a neutral point because here the field due to one magnet cancels the field due to the other magnet and so this region has no lines of force.



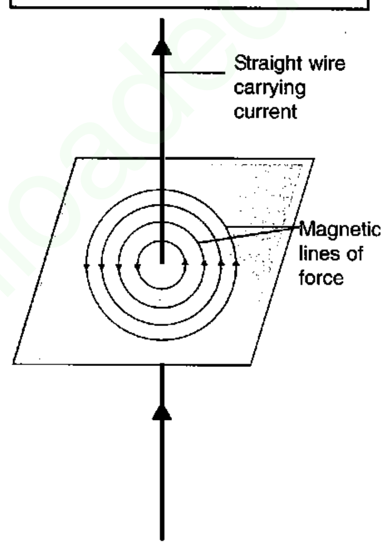


***Fig. 7.5** Magnetic field due to a straight wire carrying current*

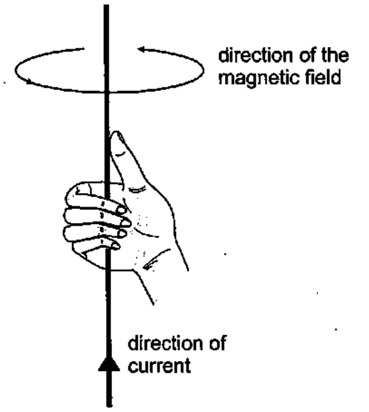


Fig. 7.6 Maxwell's right-hand thumb rule

encircle the wire gives you the direction of the magnetic lines of force around the wire. On reversing the direction of current in the wire, the direction of the magnetic lines of force is also reversed (Fig. 7.6).

FACT FILE

Pigeons are found to have multiple magnets within their skull, and bees have them in their abdomen. This allows them to have a magnetic sense to recognize direction along the earth's magnetic field. Monarch butterflies, some wasps, and sea turtles are also found to have a magnetic sense. Tiny magnetic crystals are found even in the human brain!

Magnetic field due to a circular coil carrying current

Take a cardboard piece with iron filings sprinkled on it. Bend a wire and form a circle by passing it through two holes on the cardboard (Fig. 7.7). When current is passed through this wire, the iron filings arrange themselves along the magnetic lines of force. You will observe that (i) the magnetic lines of force are concentric near the wire; and (ii) the lines of force become straight and parallel at the centre of the coil. Using the right-hand thumb rule, the direction of the magnetic fields at both the holes can be found out.

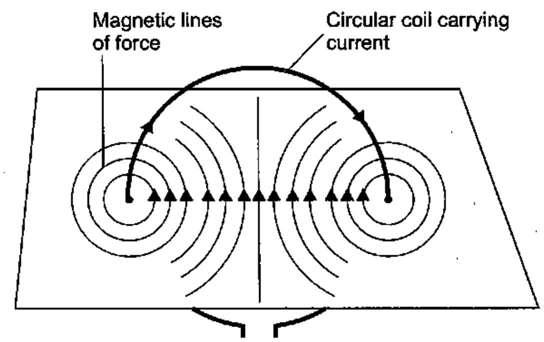


Fig. 7.7 Magnetic field due to a circular coil carrying current

The above arrangement shows a circular coil carrying current. What happens when current flows through a long wire, which can be bent into a number of close turns? Such an arrangement is called a *solenoid*. Let us learn a little more about it.

Solenoid

A solenoid is a long wire with a large number of close turns. Figure 7.8 shows a solenoid whose ends are connected to a battery.

When current flows through it, the solenoid behaves like a bar magnet, with opposite poles at the end of the long wire. End A behaves like the north pole and end B behaves like the south pole. Since the current in each circular turn of the solenoid flows in the same direction, the magnetic field produced by each turn of the solenoid adds up, giving a strong resultant magnetic field inside the solenoid.

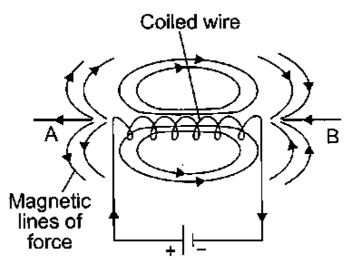


Fig. 7.8 A solenoid

The strength of the magnetic field produced by a solenoid depends on the following factors:

1. The strength of the current in the solenoid—more the current, stronger will be the magnetic field;
2. The number of turns in the solenoid—larger the number of turns, stronger will be the magnetic field; and
3. The nature of the core material used in making the solenoid—the strongest magnetic field is produced when the core is made of soft iron.

THINK QUEST

Why does a current-carrying solenoid point in a specific direction when suspended freely?

From Figure 7.8 can you tell which side of the solenoid acts as the north pole and which side acts as the south pole? In a solenoid, try facing the end of the coil from both the sides one by one. The side in which the current flows in the clockwise direction will be the south pole. The other side, where the current flows in the anticlockwise direction will be the north pole of the magnet (Fig. 7.9). The poles of a solenoid can be reversed if we reverse the battery connection.

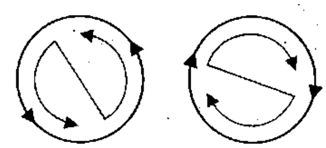


***Fig. 7.9** Determining the poles of a solenoid*

***Table 7.1** Differences between a permanent magnet and an electromagnet*

Electromagnet	*Permanent magnet*
1. It is made of soft iron.	1. It is made of steel.
2. The poles of an electromagnet can be reversed.	2. Poles cannot be reversed.
3. It produces a magnetic field as long as the current flows in the wire.	3. It produces a permanent magnetic field.
4. The strength of the magnetic field can be changed.	4. The strength of the magnetic field cannot be changed.

Uses of electromagnets

Electromagnets have a wide range of uses. They are used in all sorts of devices. Here are a few examples:

1. **In cranes to lift weight**: some cranes use electromagnets to lift heavy metallic objects like cars or to separate iron scraps in scrapyards. They pick them up by turning on the current and let go of it by turning off the current.
2. **Relay**: a relay is an electromagnetic switch. Now-a-days, telephone exchanges and computers use relays.
3. **In an electric bell**: an electromagnet is used in an electric bell to pull a strip of iron so as to hit the gong to ring the bell. Let us study about the electric bell in detail.

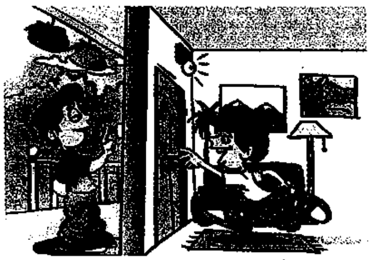
FACT FILE

Safety with electromagnets

Did you know that electromagnets can protect you in your home? If something goes wrong with the electric circuits in your homes, it's important to switch off the mains quickly. In many electric circuits used today, the current is switched off by an automatic circuit breaker that contains an electromagnet.

Electric bell

An electric bell is a very simple electric device in which an electromagnet plays a vital role. The construction of the electric bell is given in Figure 7.10. It consists of a battery, one terminal of which is connected to a screw (called the interrupter) through a switch. The other terminal of the battery is connected to a wire, which is wound around a soft iron piece shaped like a horseshoe. This is then connected to a strip made of soft iron with a small hammer at its end. There is a metal gong at its side, which this hammer can hit.



Do you ring the doorbell when you go to your friends'/ relatives' place? That doorbell is an *electric bell*.

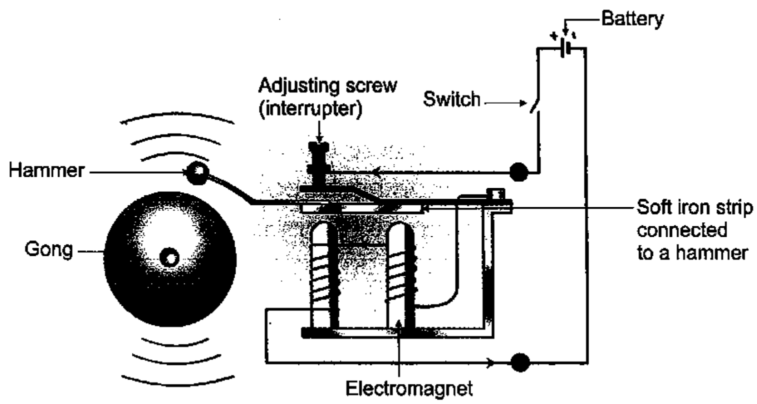


Fig. 7.10 *Working of an electric bell*

The working of an electric bell can be described in the following steps:

1. When the switch is turned on, current flows through the coil and the soft iron piece acts like a magnet and attracts the soft iron strip. The hammer attached to the strip then hits the gong.
2. When the soft iron strip gets attracted to the electromagnet, it no longer touches the screw (interrupter) and hence, the circuit is broken.
3. When the circuit breaks, there is no current through the coil, and the electromagnet is no longer magnetized. Thus, it no longer attracts the soft iron strip.
4. The soft iron strip then goes back to its initial position, touching the screw (interrupter). This results in the circuit being complete and current flows again.

Steps 1–4 go on again and again, as long as the switch in on. This is how we hear a continuous ring of the bell.

TECH FILE

An electronic bell does not have any electromagnet. Instead, it has an integrated circuit (IC) *which is an electronic device* that registers when the button has been pressed. The IC triggers a digitally recorded song or message. Electronic bells are becoming very popular nowadays.

Electric motor

You have learnt that when a current is passed through a wire, it produces a magnetic field. So, when a current-carrying conductor is placed in a magnetic field, it experiences a force and moves. This is the principle behind an electric motor. It converts electrical energy to mechanical energy. Motors are used in mixers, fans, and other electrical appliances.

So far, we have studied that a piece of soft iron behaves like a magnet if the wire coiled over it carries current. Is the reverse of this condition also true? That is, with the help of a magnet, can an electric current be generated in a closed loop of wire? Yes! this forms the basis of *electromagnetic induction*.

Michael Faraday (1791–1867)

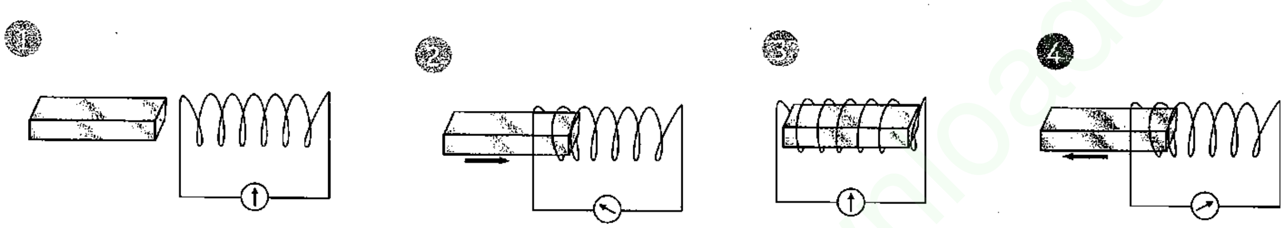
Michael Faraday was an English chemist and physicist who contributed significantly to the fields of electromagnetism and electrochemistry. He carried out experiments to prove that a magnetic field can be used to produce a current, which laid the foundation of electromagnetic induction.

ELECTROMAGNETIC INDUCTION

Michael Faraday and Joseph Henry in 1831 discovered that a change in the magnetic field within a closed conducting wire can induce electricity in the wire.

Thus, *the process of inducing current in a conducting coil due to the relative motion of the magnet in and out of the coil is called electromagnetic induction*. The current so obtained is called *induced current*. Electromagnetic induction is all around us. We use it in an ATM card, when its magnetic strips are moved in a scanner. We hear its effect every time we play a tape recorder as magnetized ferrite powder is used to coat tapes of cassettes for storing data.

The important steps in electromagnetic induction are summarized below:



1. If a bar magnet is kept close to a wire and no movement of the magnet or the wire is made, the current does not flow in the wire and the galvanometer shows no deflection.

2. When the magnet is slowly moved inside the coiled wire, current is produced in the wire and the galvanometer's needle deflects in one direction.

3. When the magnet is fully inside the coiled wire and no further movement of the magnet occurs, the galvanometer's needle shows no deflection, and no current flows through the wire.

4. When the magnet is again moved out of the coiled wire, the movement causes current to flow in the wire and the galvanometer's needle shows a deflection but this time in the opposite direction.

Can you tell why is the deflection of the galvanometer's needle in the 4^{th} step opposite to that in the 2^{nd} step? Because when a magnet is continually moved in and out of the solenoid, an induced electric current flows in one direction and then in the reverse direction. The same results can be obtained if you keep the magnet stationary and move the coil.

ACTIVITY

Aim: To show that a moving magnet near a closed loop of wire can produce an electric current.

Materials required: A thick copper wire, a bar magnet, a galvanometer to detect current.

Procedure: 1. Make a coil with copper wire. Make a few loops.

2. Connect the two ends of the copper wire to the two terminals of a galvanometer.

3. Move the bar magnet in and out of the loops of the copper wire. Observe the needle of the meter closely as you do this. What do you notice?

Conclusion: You will notice that the needle deflects from one side to the other as you move the magnet in and out of the conducting wire loop. This shows that the movement of the magnet within the conducting wire loop induces a current in the wire.

The electric current which reverses its direction after fixed intervals of time is called *alternating current* or *a.c.* The electricity supplied to our homes and industries is an example of alternating current. On the other hand, the electric current which always flows in the same direction is called *direct current* or *d.c.* The current obtained from a battery or a cell is direct current.

Fig. 7.11 *A dynamo*

Le us discuss some devices, in brief, that work on the principle of electromagnetic induction.

***Dynamo (generator)*:** is a device that works on the principle of electromagnetic induction. It generates electric current by rotating a coil within a stationary magnetic field and converts mechanical energy to electrical energy (Fig. 7.11).

***Transformer*:** is a device used for transferring electric power from one coil of wire to another by means of electromagnetic induction. AC voltages can be increased or decreased using a transformer. Step-up transformers are used to increase voltage, whereas step-down transformers are used to decrease voltage. The big power houses in your locality use a step-down transformer to change the high voltage to 220 V for domestic consumption. Radio, televisions, and many other gadgets have inbuilt step-down transformers so that less than 220 V is available for their working.

KEYWORDS

Magnetic field Space around a magnet where its influence is felt

Magnetic lines of force Continuous curves by which forces in a magnetic field are represented

Electromagnet Current-carrying wire wound around a soft iron bar because of which the iron behaves like a magnet

Electromagnetic induction Process of inducing current in a conducting coil due to the changing magnetic field in a coil

Dynamo A device that converts mechanical energy to electrical energy

Electric motor A device which converts electrical energy to mechanical energy

Transformer A device to step up or step down a.c. voltage

SUMMARY

- The properties of magnets are (a) directive property; (b) attractive property; (c) like poles repel and unlike poles attract; (d) repulsion the surest test of magnetism; (e) magnetic poles do not exist separately; and (f) the magnetic strength is maximum at the poles of a bar magnet.
- The space around a magnet where the influence of the magnet can be felt is called the magnetic field.
- The magnetic lines of force tell you the direction of the magnetic field at that point.
- The earth is considered to be a huge magnet with its magnetic south pole near the geographic north pole and magnetic north pole near the geographic south pole.
- A current-carrying conductor acts as a magnet and has a magnetic field associated with it.
- The magnetic field due to a current-carrying conductor can be found out by using Maxwell's right-hand thumb rule. It says that if you hold a current-carrying conductor in such a way that the thumb points in the direction of the current, the direction of your fingers will give you the direction of the magnetic field.
- An electromagnet and an electric bell work on the principle that when current passes through a coil of wire, it gets magnetized.
- The process of inducing current in a conducting coil due to the relative motion of the magnet within the coil is called electromagnetic induction.
- The principle behind a generator is electromagnetic induction. It converts mechanical energy to electrical energy.
- Transformers are used to step up or step down a.c. voltage. If it is used to step up the voltage, it is called step-up transformer and the transformer which steps down the voltage is called step-down transformer.
- An electric motor is a device which converts electrical energy to mechanical energy. It is based on the mechanical effect of a current-carrying conductor in a magnetic field.

EXERCISES

I. Review questions

A. Choose the correct answer

1. The magnetic lines of force .... intersect with each other.
   (a) can (b) never (c) sometimes (d) most of the time
2. .... magnets are used in cranes picking up iron and steel items.
   (a) Permanent (b) Bar (c) Electro (d) U-shaped

3. .... converts electrical energy to mechanical energy.
   (a) An electric motor (b) A generator
   (c) A dynamo (d) A transformer
4. The magnetic lines of force near the poles of a bar magnet are ....
   (a) zero (b) parallel
   (c) crowded (d) spaced out
5. In a generator, ... energy is converted to .... energy.
   (a) electrical, mechanical (b) mechanical, electrical
   (c) electrical, chemical (d) chemical, electrical

B. Fill in the blanks

1. The magnetic strength is maximum at the .... (centre/poles) of a magnet.
2. The space around the magnet where its influence can be detected is called .... (magnetic poles/magnetic field).
3. Magnetic south pole of our earth is near the geographic .... (south/north) pole of earth.
4. The strength of an electromagnet can be increased by .... (decreasing/increasing) the strength of current.
5. .... (Electromagnet/Permanent magnet) is used in an electric bell.
6. Magnetic field due to a current-carrying conductor can be found by Maxwell's .... (right/left) hand thumb rule.
7. When you look at the coil of wire end on and if the current flows in the anticlockwise direction, then that end of the coil is the .... (north/south) pole.
8. The phenomenon of inducing electric current by changing the magnetic field in a coil of wire is called .... (electromagnetic induction/electromagnetism).
9. The magnetic lines of force outside a magnet always point from the .... (north pole to the south pole/south pole to the north pole).
10. Alternating voltage can be stepped up or stepped down with the help of a .... (transistor/transformer).

C. Match the following

1. Electromagnet	(a) Step down or step up a.c. voltage
2. Dynamo	(b) Electrical energy to mechanical energy
3. Transformer	(c) Crane
4. Permanent magnet	(d) Made of steel
5. Electric motor	(e) Mechanical energy to electrical energy

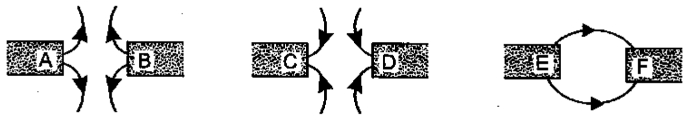
D. Answer the following questions

1. Write any four properties of magnets.
2. Define magnetic field.
3. Define magnetic lines of force and write any three properties of magnetic lines of force.
4. State two different ways in which the strength of an electromagnet can be increased.
5. State Maxwell's right-hand thumb rule.
6. Draw the field pattern due to a circular coil.
7. What are the different ways in which a magnetic field produced in a solenoid can be increased?
8. Draw the diagram of an electric bell and name its parts. Explain its working briefly.
9. What do you mean by electromagnetic induction?
10. State the principle on which a motor works.
11. State the principle on which a dynamo works.
12. What is the use of a transformer?

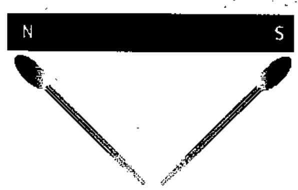
II. Skill-based questions

E. Answer the following by studying the figure given

The lines of force between the poles of three pairs of magnets are shown in the figure. Name the poles A,B,C,D,E and F.



F. Explain why needles hung from the two ends of a bar magnet held horizontally incline towards one another



III. Fun time

Use the clues given to find the words that fit in the following blanks.

1. The device that uses magnets to find directions.

   — — — — — ○ — ○   ○ — — — — — —

2. Branch of physics dealing with the magnetic effects of current.

   — — — — — — ○ — — — — ○ — — — —

3. A long wire with many number of turns.

   ○ — — — — — — ○

4. A device converting mechanical energy to electric energy using electromagnetic induction.

   — ○ — — ○ — ○ — —

Now unjumble the words in the circles to get the name of a scientists who discovered the magnetic field around a wire carrying current.

H — — —   — — — — — — — —

PROJECT IDEAS

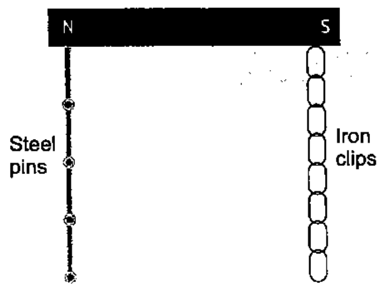
- **Aim:** To see how magnetic induction varies with the nature of the magnetic material and the distance between the magnet and the magnetic material.

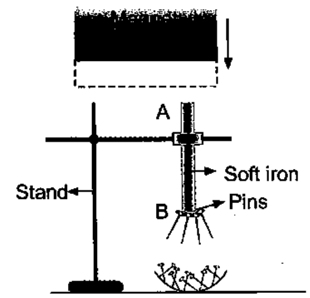
  Materials required: Iron paper clips, steel pins, a bar magnet, a soft iron bar, and wooden stand.

  Procedure: 1. Get some iron paper clips and steel pins and hang them from a magnet.

  2. Each clip or pin magnetizes the one below it by magnetic induction and the unlike poles so formed attract each other.

3. Now pull the iron clips' chain away from the magnet. What do you find? You will find that the chain collapses showing that magnetism induced in iron is temporary.
4. If the same procedure is repeated with the steel pins' chain, it does not collapse showing that the magnetism induced in steel is permanent (retained for a long time).
5. Now take a soft iron bar and fix it vertically on a wooden stand.
6. Keep a bowl of pins under the iron bar; bring a magnet closer to the iron bar and vary the distance between the magnet and the soft iron.
7. You will see that when the magnet is closer to the soft iron, induced magnetism is more and hence, the soft iron bar attracts lots of pins.





- **Make a solenoid** and see how the direction of the current affects the polarity of the solenoid. Wrap a long piece of wire in the form of a solenoid and connect the ends of the wire to a battery. Bring a compass needle near one end and notice the deflection. Now interchange the polarity of the battery and observe the deflection of the needle again. Which rule do you use to determine the poles of the solenoid?

TEACHER'S NOTES

- The concept of electromagnets could be explained by making one in the classroom.
- The principle behind a generator could be explained with the help of a cycle dynamo and the working of a motor with the help of one from a toy.
- The teachers could explain, with the help of magnetic induction, why steel is used to make a permanent magnet, while soft iron is used to make a temparory magnet (electromagnet).

Website references

http://theory.uwinnipeg.ca/mod_tech/node97.html (accessed 04 May 07)
http://library.thinkquest.org/11924/emagnet.html (accessed 04 May 07)
http://www.edumedia-sciences.com/m198_l2-magnetism.html [animation] (accessed 31 May 07)

PRACTICE SHEET I

1 Fill in the blanks

(a) A light year measures the .... (velocity of light/distance) in space.

(b) If the speed of light in a medium is less than that in vacuum, the refractive index of that medium is .... (high/low).

(c) The cause of refraction is that the speed of light .... (remains constant/changes) in different mediums.

(d) The swimming pool remains cool even in peak summer because the .... (latent heat/ specific heat capacity) of water is high.

(e) The property of a liquid to contract its surface area due to the intermolecular force of attractions is called .... (cohesion/surface tension).

(f) The deep-sea divers have to wear specially designed suits to protect them from the .... (huge/very low) pressure of the water underneath.

(g) A capillary tube immersed in mercury experiences capillary .... (rise/depression).

(h) .... (Compressed Natural Gas/Compressed kerosene gas) is a substitute for petrol and diesel fuel used in automobiles.

(i) The process of charging an object by touching it to an electrically-charged object is called charging by .... (induction/conduction).

(j) When a wire is wound around a soft iron bar, and electric current is passed through the wire, the soft iron bar becomes a .... (permanent magnet/electromagnet).

2 Match the following

1. Light year	(a) J/kg
2. Refractive index	(b) m
3. Speed of light	(c) J/°C
4. Specific latent heat	(d) J/kg °C
5. Heat capacity	(e) m/s
	(f) No unit

3 Correct the statements that are false

(a) A comet's tail is always directed towards the sun.

(b) The focal length of the objective lens of a telescope is less than the focal length of the eyepiece lens.

(c) The specific heat capacity of metals is very high.

(d) Liquids and gases can flow in any direction.

(e) When white light is passed through a prism, different colours deviate through different angles.

4 Answer the following questions

(a) Why is Pluto called a dwarf planet?

(b) Draw a convex lens and mark its optical centre, focus, radius of curvature, and principal axis.

(c) A person's leg appears shorter when he stands in a pool of water. Give reason.

(d) The specific heat capacity of an object is 385 J/kg °C. What does this sentence mean?

(e) Why does the temperature remain constant when there is a change in state?

(f) Name any three hydroelectric projects in India.

(g) Why do droplets of water assume a spherical shape?

(h) Why can you not drink fruit juice with a straw in space?

(i) What is the principle behind an electric motor?

(j) Write three differences between charging an object by conduction and by induction.

PRACTICE SHEET II

1 Fill in the blanks

(a) A total of .... (66/88) constellations have been known so far.
(b) The image formed by a .... (concave/convex) lens is always erect and diminished.
(c) When white light is passed through a prism, ... (red/violet) colour deviates the most when it emerges from the other side.
(d) .... (Ice/Dry ice) has high specific latent heat of fusion.
(e) The meniscus of mercury is .... (concave/convex) shaped.
(f) When a glass rod rubbed with silk is brought near another glass rod rubbed with silk, they .... (attract/repel) each other.
(g) When a charged body is earthed, ... (electrons/protons) flow from the body or towards the body depending on the excess charge on the body.
(h) .... (Electronic/Conventional) current flows from a higher potential to a lower potential.
(i) When the distance between the magnet and the magnetic substance increases, the force of attraction .... (increases/decreases).
(j) The strength of the magnetic field in a solenoid depends on the .... (length of the wire/ number of turns) in the solenoid.

2 Match the following

1. m	(a) Heat capacity
2. Ampere	(b) Pressure
3. N/m^2	(c) Speed of light in vacuum
4. m/s	(d) Electric current
5. J/°C	(e) Focal length
	(f) Voltage

3 Correct the statements that are false

(a) The distance between the centre of curvature and the principal focus of the lens is called the focal length.
(b) Water can store large amount of heat energy for a small change in temperature.
(c) A nuclear power plant uses the principle of nuclear fusion.
(d) The magnetic and geographic poles coincide.
(e) A transformer transfers electric power from one coil of wire to another by electromagnetic induction.

4 Answer the following questions

(a) How are tides formed?
(b) Why does the light bend as it passes from one medium to the other?
(c) The specific heat capacity of two objects is 385 J/kg °C and 500 J/kg °C. If equal masses of these objects are heated from 20 °C, which one will reach 39 °C faster and why?
(d) Define the specific latent heat of vaporization of steam.
(e) Why should a person handling radioactive sources wear lead apron?
(f) Explain why hot water is preferred over cold water to clean clothes.
(g) Define the law of flotation.
(h) A positively-charged body is brought near an insulated metal sphere. Draw and explain in steps, what kind of charge is developed by the metal after earthing it?
(i) How is conventional current different from electric current?
(j) What is the principle behind a dynamo?

PRACTICE SHEET III

1 Fill in the blanks

(a) The third brightest object in the sky is .... (the moon/Venus).

(b) A ray of light travelling parallel to the principal axis, after refraction, passes through the .... (centre of curvature/focus).

(c) During a change of state, the .... (heat energy/temperature) remains constant .

(d) A .... (solar cooker/solar panel) is used to power satellites and spacecrafts.

(e) If the weight of a floating body is 5 N, then the weight of the liquid displaced will be .... (5 N/less than 5 N).

(f) A capillary tube kept in a trough of water experiences capillary .... (rise/depression).

(g) Fossil fuels contain a large amount of .... (nitrogen/sulphur) which produces a poisonous gas on burning.

(h) Acid rain occurs due to .... (nitric acid/sulphuric acid) falling along with rain.

(i) An electroscope with its leaves diverged is brought near a charged body. If the leaves diverge more, it means that the electroscope and the charged body have .... (different/same) charge.

(j) The process of inducing current in a conducting coil due to the relative motion of the magnet in and out of the coil is called .... (electromagnetism/electromagnetic induction).

(k) Magnetic lines of force outside the magnet always start from the .... pole to the .... (south/north) pole.

2 Match the following

1. Short sightedness	(a) Galaxy
2. Force of cohesion	(b) Constellation
3. Concave meniscus	(c) Surface tension
4. Permanent magnet	(d) Water
5. Ursa Minor	(e) Steel
	(f) Concave lens

3 Correct the statements that are false

(a) The image formed by a lens is due to the reflection of light.

(b) The pressure exerted by a liquid decreases with an increase in its area of contact.

(c) Sea water gives more upthrust than fresh water.

(d) The direction of conventional current is opposite to the direction of electric current.

(e) The nucleus consists of protons and electrons.

4 Answer the following questions

(a) Draw the diagram of a solar eclipse, and explain how it occurs.

(b) Draw a diagram to show how a pencil appears to be bent when put in a trough of water.

(c) The angle of refraction in a medium is less than the angle of incidence. What can you say about the speed of light in that medium and its refractive index?

(d) If 5 kg of water is heated from 20 °C to 80 °C, and it absorbs 1.26×10^6 J of heat energy, calculate its specific heat capacity. (4,200 J/kg °C).

(e) Steam is used in cold countries to heat up rooms than boiling water. Why?

(f) Differentiate between nuclear fission and nuclear fusion.

(g) What are the factors on which the buoyant force depends?

(h) Why we do not feel the tremendous atmospheric pressure on our body?

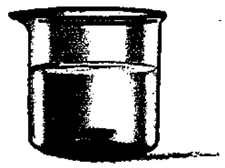
(i) Why is water not used as a barometric liquid?

(j) Draw an electroscope, label its parts, and explain how it can be used to identify the charge on a charged object?

Appendix

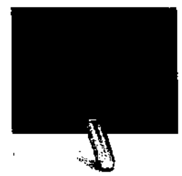
Materials required for performing activities given in the book:

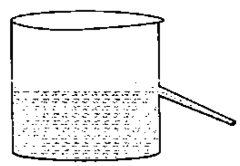
Diary and a pencil
Beaker and water
Coin
Glass slab
Thick sheet of paper
Thumb pins and cellotape
Cardboard tube
Two convex lenses of different focal lengths
Frying pan
Ice cubes
Thermometer
Polystyrene cup with a lid
Ammonium nitrate
Empty dry can with an airtight stopper
Metre-long glass tube
Mercury
Scale
Clamp stand
Three tins/plastic bottles of different diameters and sizes
Stone
Spring balance
Eureka can
Plastic tube
Wooden board
Funnel
Balloon membrane
Four balloons and four equal-length strings
Piece of wool
Glass bottle with a wide mouth
Copper wire
Small metallic plate
Aluminium foil
Hook
Ebonite/glass rod
Bar magnet
Compass needle
Galvanometer
Iron paper clips and steel pins
Soft iron bar
Wooden stand
Battery

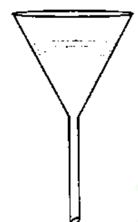

Beaker

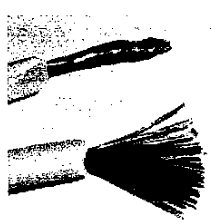

Glass slab


Convex lens


Mercury


Eureka can


Funnel


Copper wire


Aluminium foil


Thermometer

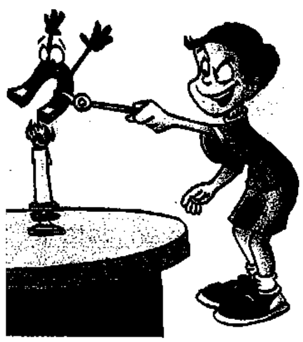
Bar magnet


Compass needle

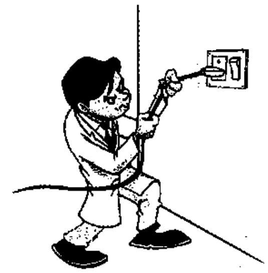
Safety in a science laboratory

- Always wear your coats/aprons and shoes in the lab, and use gloves and safety glasses as instructed by your teacher.
- Always tie long hair and secure loose clothing before beginning to work on any experiment in the laboratory.
- Follow all written and verbal instructions carefully. If you do not understand any direction or part of the procedure, ask your teacher before proceeding with the experiment.

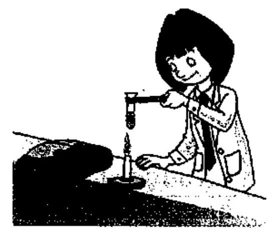
- Keep your working area and equipment clean while working and after you finish your experiment.
- Do not drop, heat, or hit a magnet; the magnet can lose its properties.
- Store the magnets (with magnetic keepers) properly in their boxes such that they do not lose their properties.



- When using simple circuits, do not touch the bare ends of wires from the cell or battery or an electric switch with your hands. You might get a shock. Always wear rubber gloves while handling electrical equipment.



- Use Bunsen burners or any other source of heat and fire with caution.
- Use clamps and wear gloves while handling hot glassware.
- Do not immerse hot glassware in cold water, the glassware might shatter.



- Use spatula, spoon, or tweezers to handle chemicals. Handling chemicals with bare hands could result in burns or allergies.
- Handle thermometers, glassware and other equipment with care. Never use broken or chipped glassware. Report any broken equipment to your teacher.
- Wash your hands with soap and water after working in the laboratory.

PHYSICS – CLASS 8

UNIT 1: THE UNIVERSE

1. The sun – some simple facts about it – the names of the nine planets, in correct order.
2. Natural satellites – the moon and its phases – tides.
3. Galaxy, constellations, comets, meteors, meteorites – in brief.
4. Eclipses of the sun and the moon (revision).
5. Artificial satellites and their uses.
   Caution: Explain to students that watching the sun directly, even through a darkened glass, can seriously damage their eyes. To observe a solar eclipse, it can be projected through a pinhole on a wall or a reflected image can be obtained using a mirror.
   - Observe and record the phases of the moon (E)
   - Project work – develop research and presentation skills – using encyclopaedia, internet and other sources

UNIT 2: LIGHT

1. Definitions/explanation of the terms: refraction, angles of incidence and refraction, refractive index (ratio of the speed of light in vacuum to the speed of light in the medium), concave and convex lenses, focus of a lens, real and virtual images.
2. Ray diagrams showing the passage of a ray of light through a parallel-sided glass block and a prism.
3. Dispersion of light by a prism.
4. Ray diagrams showing the formation of images by a convex lens for different positions of the object.
5. Brief, simple explanation of long sightedness and short sightedness and how they may be corrected.
6. Some optical instruments that use lenses – magnifying glass, simple camera, microscope and telescope – ray diagrams need not be drawn by students.
   - Observing the refraction of a narrow beam of light through a parallel-sided glass block (E)
   - Observing the formation of images by a convex lens for different positions of the object – no measurements required (E)

   (*Note:* A simple convex lens, as obtained in a dissection set, will suffice to set up this improvised experiment; a white card can serve as a screen. Ensure students understand the difference between real and virtual images.)

UNIT 3: HEAT

1. **(a)** Heat flows from a body at a higher temperature to one at a lower temperature.
   (b) Factors on which the quantity of heat required to raise the temperature of a body depends – its mass, the rise in temperature, the substance of which it is made.
   (c) Definition/explanation of the terms: calorie, kilocalorie, specific heat capacity, heat capacity.
2. Heat is a form of energy and can also be measured in joules (J).
   (*Note:* It is essential for students to know the correct units for these quantities, in the SI system.)
3. Using given data to solve simple numericals based on the formulae:
   (a) Quantity of heat = mass × specific heat × rise in temperature
   (b) Heat capacity = mass × specific heat capacity
4. Conductors and insulators (revision) – link with specific heat capacity of material.
5. Change of state occurs at a fixed temperature – melting point or boiling point – and it takes up heat. This heat does not cause a rise in temperature and is called latent heat (qualitative explanation only).

UNIT 4: MORE ABOUT SOLIDS, LIQUIDS AND GASES

1. Kinetic Theory of Matter: the three states of matter – intermolecular forces (cohesion) and the arrangement of molecules in each state – explaining the general properties of solids, liquids and gases (revision).
   Liquids: surface tension, formation of droplets and a meniscus.
   What happens when a substance is heated – conduction, convection.
   Gases and liquids exert pressure – what happens to the pressure when a gas is compressed or allowed to expand.

2. Facts about pressure in liquids.
3. Archimedes' Principle and the Law of Flotation.
4. Atmospheric pressure – the mercury barometer – the lift pump.
   - Exploring facts about pressure in liquids at the same and different levels (E)
   - Archimedes' Principle (D)
   - The Law of Flotation (D) – <u>why ice floats on water</u>?
   - Mercury/Fortin barometer (D)
   - The Lift Pump – model – if possible (D/E)

UNIT 5: MORE ABOUT ENERGY

1. Different forms of energy-interconvertibility – energy chains starting from the sun (brief revision).
2. Why coal and oil are called fossil fuels? (revision)
3. Electricity is the most widely used form of energy – simple ideas about generation in thermal and hydroelectric power stations – location of some major power projects in the country.
4. Renewable and non-renewable sources of energy – non-conventional or alternative sources of energy: solar energy, biomass, nuclear energy, wind energy, geothermal and tidal energy.
   Brief explanations of:
   (a) Direct use of solar energy for heating/cooking – use of solar photovoltaic cells – examples of their use in India, especially in their own state/their own lives.
   (b) Nuclear power stations – location in India – dangers associated with these, need for careful use and strict observance of precautions.
   (c) Biomass – produces both biogas (methane) and fertilizer.
   (d) Wind energy – wind farms.
   (e) Geothermal and tidal energy.
5. Air pollution caused by the use of fossil fuels in industry and transport. The use of CNG.
6. Personal steps in the conservation of all forms of energy and reduction in consumption of fuels and materials of all kinds (Energy is used in the preparation of all materials.) (Link with Biology, Class VIII, Unit 5).
   - Identifying local situations where energy is wasted and steps to be taken to reduce the same.
   - Practising small but significant changes in life style through participation in campaigns at school, home and outside. e.g. "Say 'No' to plastic", Save water, Switch off Something (to save electricity), setting up compost pits in gardens, collecting garbage, recycling materials, creating useful products from waste, etc.

UNIT 6: STATIC ELECTRICITY

1. Charged and uncharged bodies – types of charges – charging by friction – simple electrostatic phenomena observed in everyday life.
2. The particles found inside the atom – basic facts about them.
3. The Law of Electrostatic Attraction and Repulsion.
4. An electroscope – charging an electroscope by conduction and induction – determining the nature of its charge (positive/negative).
5. Lightning and lightning conductors.
6. Static electricity, the flow of electrons in a conductor, direction of conventional current.
   - Observing simple electrostatic phenomena (E)
   - Electrostatic attraction and repulsion (D/E)
   - Making an improvised electroscope (E) – charging it by conduction – testing its charge (E)

UNIT 7: MAGNETISM AND ELECTRICITY

1. Revision of properties of magnets.
2. Magnetic fields around a bar magnet – lines of force.
3. Brief and simple explanation of the magnetic field of the Earth – magnetic compass.
4. **(a)** Making electromagnets – their strength depends on the number of coils and the current in the circuit (increase in the number of cells).
   (b) Uses of electromagnets.
   (c) Structure and functioning of an electric bell.
5. **(a)** Magnetic field associated with a straight current carrying conductor.
   (b) The Right Hand Rule
   (c) Clockwise and anti-clockwise current – determining the polarity of a solenoid.
6. **(a)** Electromagnetic Induction
   (b) A brief, simple introduction to the meaning of an alternating current – how it differs from a direct current.
   (c) Devices that work on this principle – dynamo, transformer.
   (d) Electric motor
   (*Note:* Devices are not to be studied in detail.)