Chapter-1

THE LIFE CYCLE OF ANIMALS

During summer, the land is parched and ponds dry up. There is very little sign of life anywhere. When the monsoons come, the ponds fill with rainwater and suddenly they are teeming with different kinds of plants and animals. There are algae, frogs, many kinds of insects and, sometimes, even fish! Have you ever wondered where all these living creatures suddenly appear from?

If you wander in the fields and gardens after the rain you will see lots of bright red velvety insects, millipedes and centipedes crawling around. A few days later they disappear as suddenly as they had appeared.

Some people think that these creatures are created or spontaneously generated from the water of these ponds, or the soil or the dung of different animals. Some people even think these creatures fall from the skies with the rain. Do you think these people are right? Do you think this is what happens?

Let's do a few experiments to find answers to this question. While performing these experiments we shall also study how animals develop from the egg stage to adulthood. Our observations will help us understand the lifecycles of various animals.

The best time to begin these experiments is during the rainy season. Since they will continue for many days, it would be a good idea to start more that one experiment at a time. But remember, you should note down your observations for each experiment very carefully every day.

EXPERIMENT 1

THE LIFE CYCLE OF A FLY

Take two tin cans. If you cannot find cans, use paper cups, coconut shells or earthen cups (*kulhad*).

Mark one can A and the other B.

Now look for some freshly excreted dung of a cow or buffalo. Put some of the dung in Can A. Take care not to splatter the remaining dung around.

You must also ensure that no flies sit on the dung in Can A. So cover the mouth of the can with a sheet of paper and tie the paper with a piece of string or a rubber-band. Pierce tiny holes in the paper with a pin or needle so that air can pass through. The holes should be small enough not to let flies or other insects pass through.

There will be a lot of flies buzzing around the remaining dung lying on the open ground. When you spot a fly sitting on the dung, observe its rear portion carefully. You should see whether it is laying eggs. The fly's eggs are long whitish stuff that come out of the rear.

Flies don't always lay eggs when they sit on dung, so don't get impatient. You could look for flies in several piles of dung in different places. While searching, remember that flies usually lay their eggs in cracks or craters formed in the dung.

Once you spot a fly laying eggs, take some of the dung containing eggs and place it carefully in Can B.

Figure 1 shows eggs lying on dung. The eggs of flies are about the size of the eggs you see in the picture.

Figure 1

Examine the eggs with a hand-lens and draw a picture of what you see. (1)

Cover Can B too with a sheet of paper like you did with Can A and make tiny holes in the paper for air to circulate.

This is the first day of your experiment. We shall call it Day 1. The days that follow will be called Day 2, Day 3, Day 4 and so on.

You will have to remove the covers of Cans A and B daily to make your observations. This experiment will continue for about 10 days.

PRECAUTIONS TO BE TAKEN

1. When you uncover the cans to examine the dung, ensure that no flies get into the cans.
2. Remember to cover the cans properly as soon as you finish making your observations.

Copy Table 1 in your exercise book and enter your daily observations in it. (2)

Table 1

No	Name of stage	Day on which first sighted	Colour	Lies in one place/ moves around/flies

On Day 2 of your experiment look for white eggs and the worm-like maggots that emerge from them on the surface of the dung in both cans.

These maggots will be just a little bigger than the eggs when they first appear.

If you do not find eggs or maggots on the surface of the dung, then scratch the surface a little and look for them inside the dung.

Did you find any maggots in Can A? (3)

You will definitely find some maggots in Can B on Day 2 or Day 3 of your experiment.

Note the day on which you find maggots in the table. (4)

Are these maggots moving around? (5)

Study one of them with your hand-lens and draw its picture. (6)

The **maggot** of a fly is its **larva** stage.

Can you guess what these maggots eat to survive and grow? (7)

Observe the changes taking place in the maggots every day. See what they do. Try and observe when the maggots become a little sluggish. When you find a maggot that is sluggish, observe it carefully from that day onwards.

Do you see a shell forming over its body or is the maggot already covered by a shell? (8)

Has the maggot stopped moving? (9)

This stage is known as the **pupa**.

Note the day you find the pupa in your table. (10)

Study the pupa with a hand lens and draw a picture of it. (11)

Observe the pupa daily.

DON'T LET YOUR FLY FLY AWAY

Be careful while you open your can every day to look at the pupa. Your fly should not fly away suddenly.

The day you find the fly, make a note in your exercise book. (12)

Does anything remain of the pupa after the fly is formed - is there just a shell or is there something more? (13)

Your experiment is complete when a fly emerges from the pupa.

The process of laying eggs, the maggot hatching from the egg and developing into a pupa and the fly emerging from the pupa is called the life cycle of a fly. The egg, maggot, pupa and adult fly are the different **stages** of this cycle.

Figure 2 shows the life cycle of a fly in **line diagrams**. One diagram shows the stages in pictures while the other gives the names of each stage. Only one stage - that of the fly - has been labelled in the second diagram.

Copy the line diagrams in your exercise book and fill in the blanks with the names of the appropriate stages. (14)

Such line diagrams are usually used to depict the life cycles of plants and animals.

Figure 2 FLY

CAN DUNG GIVE BIRTH TO A FLY?

Answer the following questions on the basis of your observations during your experiment with flies.

In which can did you see the various stages of the life cycle of a fly - Can A or B? (15)

You began the experiment by putting the same dung in both the cans at the same time. Yet the stages of the life cycle of the fly were seen only in one can. Why? (16)

Can dung give birth to flies? In other words can flies be generated spontaneously from dung? Give reasons for your answer. (17)

If a student leaves one of the cans open after making observations, what could go wrong with the experiment? (18)

Some people think flies are spontaneously generated from dung. In fact they even call fly maggots, dung maggots. After performing this experiment how would you explain to these people how flies are born? (19)

A CONTROL FOR COMPARISON

Why did you include the dung in Can A in your experiment? If this was not done, could you have answered Question 17? (20)

The dung in Can A was included so that you could compare it with the dung in Can B. If Can A was not included, you could never have been sure that flies are not spontaneously generated from dung. By including Can A, you have clearly shown that this cannot happen. The provision of a system to make a comparison is called a control.

Go through your Class 6 and 7 exercise books and make a list of all the experiments in which you made a provision for a control. (21)

EXPERIMENT 2

THE LIFE CYCLE OF A FROG

During the rainy season you may have seen a white frothy substance floating on the surface of ponds. This is frog spawn (eggs). It is usually found either at the edge of the pond or clinging to plants growing in it. The frog's eggs are held together by a sticky, slimy substance. Figure 3 shows a pond with frog spawn in it. The size of the frog eggs shown here are almost the same in real life.

Figure 3

Measure the size of the eggs shown in the picture and note it down in your exercise book. (22)

The best time to look for frog spawn is at the beginning of the monsoon when the ponds fill with water after the first couple of showers. Collect the mass of spawn in a glass tumbler or a wide-mouthed bottle. Be careful while you are doing so - don't let the spawn disintegrate. Also, collect some water and algae from the pond along with the spawn.

When you return to school, pour the pond water with the spawn and algae into a broad vessel. This vessel should be at least 15 cm deep. The broken lower half of an earthen pot (*matka*) would be ideal.

The whole class should do this experiment together. It is not necessary for each group (*toli*) to perform it separately. But each *toli* should make their own observations.

Examine the eggs carefully. The black core in the transparent sticky substance is the **embryo**.

Estimate the diameter of the frog embryo. (23)

This experiment is also a long duration one. If the water in the pot evaporates during the course of the experiment, add more water from the same pond. Don't add water from any other source.

As in your first experiment with flies, the day you brought the frog spawn to class is Day 1. Subsequent days are Day 2, Day 3 and so on.

You should observe the eggs daily and see the different stages they develop into.

On which day did the eggs hatch? (24)

Do the tiny creatures hatching out of the eggs look like frogs? (25)

The babies hatching out of frog's eggs are called **tadpoles**.

The tadpole is the **larva** stage of a frog.

A USEFUL TIP

If you can't find frog spawn in the ponds, don't get disheartened. You will certainly find tadpoles in them. You could start your experiments with tadpoles.

HOW TO OBSERVE TADPOLES

You will have to spend some time every day to observe the changes taking place in the tadpole. Note these changes in your exercise book and draw diagrams of them.

First examine the tadpole in the pot itself.

To observe the tadpole more closely pour some of the water from the pot into a glass tumbler or transparent plastic vessel. Use a dropper to suck the tadpole up, along with some water, and place it in this transparent vessel. You can now observe the tadpole from all angles.

Once the tadpoles become bigger it may not be possible to take them out with a dropper. You could scoop them out in your palm or with the lid of a bottle.

Examine the tadpoles carefully ever day. Whenever you notice a new organ or any change in the tadpoles, write the details in your exercise book and draw diagrams of what you observe. Mark the day you observed the change in your diagram.

On which day did you observe the tadpole's eyes? (26)

When the tadpoles are about 4 to 5 days old, look for their gills. They are located behind the eyes and look like fine threads or fibres.

On which day did you first observe the gills? (27)

Look for the following organs in the growing tadpoles and draw their diagrams in your exercise book. Mark the day on which you find each organ:

- **Heart**
- **Intestine**
- **Spine (vertebral column)**
- **The tube through which excreta is passed**
- **Hind legs**
- **Front legs (28)**

The day you see the hind legs of the tadpole, make a small island in your pot with the help of a few pebbles, like the one shown in Figure 4. At this stage the growing tadpole sometimes needs to get out of the water and sit on dry land. That is why it is important to build an island in your pot.

Figure 4 Pebbles Water

On which day did the gills disappear completely? (29)

When did the tail disappear completely? (30)

Now answer the following questions:

Why do frogs lay their eggs only in water? (31)

How many days did it take for an egg to grow into a baby frog? (32)

What different stages did you notice in the life cycle of the frog? Depict these stages in a line diagram. (33)

If someone tells you that frogs drop from the sky with the rain, what answer would you give him/her after what you have learned from your experiment? (34)

EXPERIMENT 3

THE LIFE CYCLE OF A MOSQUITO

After it rains, mosquitoes lay their eggs in water tanks, ponds, lakes and stagnant pools of water.

Figure 5a shows a puddle of water with mosquito larvae and pupae. The size of the larvae and pupae in the picture is almost the same as in real life.

Figure 5b shows the same larvae and pupae magnified by a hand-lens.

Figure 5a Figure 5b Larva Pupa

Take four glass bottles. Injection bottles will be suitable for this experiment. Now look for a pond or a puddle of stagnant water that contains mosquito larvae and pupae.

Collect some water from the puddle containing mosquito larvae in one bottle. Collect water containing mosquito pupae in the second bottle.

The third bottle should contain only water from the pond, without any larvae or pupae. Examine the water with a hand-lens. If you find any larvae or pupae in it, remove them.

Pour some fresh water from a tap or well into the fourth bottle.

Don’t fill the bottles to the brim. There should be some empty space above the surface of the water.

Cover the mouths of all four bottles with paper and tie the paper in place with rubber bands. Make tiny holes in the paper with a pin or needle.

Observe all four bottles daily and note down the changes that take place in your exercise book.

When your experiment is over, answer the following questions.

What changes occurred in the bottle containing larvae? (35)

What changes occurred in the bottle containing pupae? (36)

What remained in the water after a mosquito was formed? (37)

Did you see any larvae or pupae in the bottle containing only pond water? (38)

Were any larvae or pupae visible in the bottle of fresh water? (39)

If you found larvae and pupae in the bottle containing only pond water, can you explain where they came from? (40)

Why were there no larvae or pupae in the bottle containing fresh water? (41)

Draw a line diagram of the life cycle of a mosquito on the basis of your observations. (42)

METAMORPHOSIS

You saw the offspring of flies, frogs and mosquitoes hatching from eggs in the experiments you did. You saw that the offspring do not look like their parents. They undergo a slow process of change before the begin to look like the adults. Many new organs are formed during this process and some others disappear. This process of change in the body of animals during the various stages of their life cycle is known as **metamorphosis**.

A DIFFERENT KIND OF LIFE CYCLE

Are all life cycles similar to the life cycle of mosquitoes and flies? Let's try and find out.

Look at Figure 6. It shows the different stages in the life cycle of a grass-hopper, from an egg to the adult grass-hopper.

Now, answer the following questions:

Can you see the larva stage? (43)

Is there a pupa stage? (44)

What changes can you identify from the time the baby grass-hopper is hatched from an egg till the time it grows into an adult grass-hopper? (45)

What are the differences in the life cycle of a grass-hopper and a mosquito or fly? (46)

There are many insects whose life cycles are similar to that of the grass-hopper. Some examples are lice, bed bugs, cockroaches, the red beetles found on cotton or kausam trees etc

Figure 6

QUESTIONS FOR REVISION

1. You often see insects crawling in the wounds of cows and buffaloes. Many people think these insects are spontaneously generated from these wounds. What explanation would you give to these people after what you have learned in the experiments you performed?
2. Do all animals that lay eggs undergo metamorphosis?

NEW WORDS

adult larva pupa stage life cycle tadpole

control mechanism metamorphosis line diagram

Chapter-2

GRAPHS OF MOTION

Have you travelled in a bus, train or bullock cart? Try and recall a trip you made and answer the following questions:

Where did you begin your journey from and where did you go? (1)

What was the distance between these two places? (2)

How long did it take for you to make the trip? (3)

What was the average distance your vehicle (bus, train, bullock cart etc) travelled in one hour? (4)

The distance travelled by an object in a unit of time (hour, minute, second etc) is called the **average speed** of the object. The equation to calculate the average speed is simple:

$$\text{average speed} = \frac{\text{total distance travelled}}{\text{total time to cover the distance}}$$

If we measure the distance in kilometres and the time in hours, the unit of speed will be kilometres per hour or kph.

We can use other units of distance and time to measure the speed.

If the distance covered is measured in centimetres (cm) and the time in seconds, what will the unit of speed be? (5)

If the distance covered is measured in metres (m) and the time in minutes, then what will the unit of speed be? (6)

Bahadur travelled 15 km in 3 hours. Calculate his average speed and write your answer with the correct unit of speed. (7)

It is important to mention the unit when we measure anything, whether it is distance, time, speed, weight or any other amount. Otherwise the measurement becomes meaningless. So always remember to write the unit after the amount.

There are many different ways in which you can describe a journey. In this chapter we shall learn how to use graphs to describe and represent motion. We shall also see in what other ways such graphs of motion can be of use to us.

EXERCISE 1

Munnibai walked from her home to her school. The details of her journey are given in Table 1.

Table 1

Time (in minutes)	**Distance travelled (in metres)**
0-2 (first two minutes)	120
2-4 (second two minutes)	120
4-6 (third two minutes)	120

6-8 (fourth two minutes)	120
8-10 (fifth two minutes)	120
10-12 (sixth two minutes)	120

This data tells us the distance Munnibai walked in consecutive two-minute segments of her journey. But it doesn't tell us how far she walked at any given time of her journey, for example, say after 10 minutes. So, we cannot find the distance from her home to her school just by looking at the table. To get this information, we must present the data in the table in a different way. We must show the total elapsed time and the total distance covered, as in Table 2.

Table 2

Total elapsed time (in minutes)	**Total distance covered (in metres)**
2	120
4	240
6	360
8	480
10	600
12	720

Let us now use this data to make a graph of Munnibai's journey, showing the time taken and the distance covered.

You learned how to make graphs last year. For this graph, we shall show the time on the X-axis and the distance travelled on the Y-axis. Draw the X and Y axes on your graph paper and choose a scale for each axis. Record the scale in the upper right hand corner of your graph paper.

According to the data in Table 2, the first point of the graph will correspond to a time of 2 minutes on the X-axis and a distance of 120 metres on the Y-axis. In this way, plot the remaining five points of your graph. Connect these points in a straight line with the help of a ruler.

This is the graph of Munnibai's journey from her home to school.

A GRAPH IS NOT A MAP

You must remember one thing. The graph you have drawn and the other graphs you will draw in this chapter are graphs of time plotted against the distance travelled. They are not maps showing the route travelled. Never make the mistake of thinking that a graph shows the route of a journey.

Figure 1 is a map showing the road from Munnibai's house to the school. Munnibai walks to school down this road. To the left of the map is the graph of her journey.

Figure 1 **Graph 1**

Can you estimate how long Munnibai takes to reach her school by looking at the map? (8)

Can you guess how many turns there are along the road from Munnibai's home to her school, or where the road crosses the river, by looking at the graph? (9)

It is evident that the information you get from a route map cannot be obtained from a graph. Similarly, information about the speed at which Munnibai walked can be obtained only from the graph, not from the map.

Did Munnibai cover an equal distance in every 2-minute interval of her journey? (10)

If an object covers an equal distance in equal time intervals, it is said to be travelling with **uniform motion**.

How would the graph of time and distance look for an object travelling with uniform motion? (11)

If an object is travelling with uniform motion, the distance it covers in a unit of time is its speed.

What was Munnibai's speed for each 2-minute segment of her journey? (12)

Calculate the average speed of Munnibai's complete journey and write your answer in your exercise book. (13)

Is the speed for each two-minute segment the same as her average speed for the entire journey? (14)

The speed of an object travelling with uniform motion does not change. In such cases, the speed and average speed are the same.

EXERCISE 2

GRAPHS OF OBJECTS MOVING AT DIFFERENT UNIFORM SPEEDS

Lachu and Nandu raced from their home to school. Lachu ran at uniform speed. So did Nandu. But their uniform speeds were different. Graph 2 shows both their motions.

Can you tell who ran faster just by looking at the graph and without reading the figures? (15)

How long did Lachu take to run from home to school?

Calculate his average speed. (16)

What was Nandu's average speed? (17)

Compare your answers to Question 16 and 17. On the basis of this comparison, say whether your answer to Question 15 was right or wrong. (18)

Graph 2

RELATION BETWEEN SPEED AND THE SLOPE OF A GRAPH

If we have two graphs of uniform speed, we can tell just by looking at the two lines which speed is greater.

What we should look at is the angle the two graph lines make with the X-axis. We can estimate the slope of the graph lines from these angles. The greater the angle, the greater the slope of the graph line.

Take another look at Graph 2. Which graph line has the greater slope - Lachu's or Nandu's? (19)

Is his speed faster too? (20)

Any graph of uniform motion will be a straight line. The faster the speed of uniform motion, the greater will be the slope of the graph line (Graph 3). That is, the angle the graph line makes with the X-axis will be larger. But remember, you can make such visual comparisons only between graphs which have the same scale. You cannot compare graphs with different scales just by looking at them.

Graph 3

EXERCISE 3

GRAPHS OF STATIONARY OBJECTS

Karima went on a journey and the data of her trip is given in Table 3.

Can you say by looking at the table whether Karima rested somewhere during her journey? (21)

After walking how many minutes did Karima rest? For how many minutes did she rest? (22)

How would you show the duration of her rest in a graph?

To understand how this is done, let us draw a graph of Karima's journey.

But before we do this, we must rearrange the figures in Table 3 and write them in the way we did for Munnibai's graph.

Copy Table 4 in your exercise book and fill in the blanks. (23)

Use the data from Table 4 to draw a graph of Karima's journey. (24)

Look at the graph and estimate the distance Karima covered after eight minutes. (25)

How far did she reach after 12 minutes? (26)

From the 8th to 12th minute of her journey, the time increased but the total distance Karima covered remained the same. When any object stops at a place, the time continues to increase but the distance covered does not change. That is why the graph line remains parallel to the X-axis during the time that Karima rests.

Table 3

Time (in minutes)	**Distance covered (in metres)**
0-2	60
2-4	60
4-6	60
6-8	60
8-10	00
10-12	00
12-14	60
14-16	60

Table 4

Time (in minutes)	**Distance covered (in metres)**
2	60
4	120
6	
8	
10	
12	
14	
16	

EXERCISE 4

The graph of Jamuna's journey is given below (Graph 4). Look at the graph and answer the following questions:

What is the scale for the X-axis? (27)

What is the scale for the Y-axis? (28)

What was Jamuna's average speed for section AB of her journey? (29)

What was her average speed for section CD of her journey? (30)

Calculate Jamuna's average speed for the entire journey. (31)

After covering what distance did Jamuna rest, and for how long did she rest? (32)

Which section of the graph has a greater slope - AB or CD? (33)

Graph 4

EXERCISE 5

GRAPHS OF NON-UNIFORM MOTION

We have studied graphs of uniform motion in the exercises we have done so far. We shall now look at motions which are not uniform. You may have seen a train leaving or arriving at a station.

Is the motion of the train uniform as it leaves the station? (34)

What change occurs in the motion of the train while it comes to a halt at a station? (35)

Motion in which the speed increases or decreases is called **non-uniform motion**.

Rashid travelled by train from Hoshangabad to Powarkheda. He estimated the distance the train travelled in two-minute intervals by counting the telephone poles along the railway tracks. He noted his estimates in the form of a graph. Graph 5 shows the motion of the train from the time it left Powarkheda station until it stopped at Hoshangabad station.

Check the distance covered by the train in every two-minute interval in the graph and note these figures in Table 5. (36)

Table 5

Time (in minutes)	Distance covered (in metres)
0-2	100
2-4	400
4-6	
......	
......	
20-22	

Did the train travel equal distances in equal intervals of time? (37)

Which sections of the graph show the changing or non-uniform motion of the train? (38)

Which sections of the graph show the uniform motion of the train? (39)

In which section of the graph was the train stationery? (40)

Look at the sections of non-uniform and uniform motion in the graph.

What is the crucial difference you see between these two sections? (41)

A curved line in a graph of motion means the speed is changing continuously.

Examine section AB of the graph. It shows the gradual increase in the train's speed as it leaves Powarkheda station.

EXERCISE 6

You may have read the story of the flight of the turtle. Two swans held the two ends of a stick firmly in their beaks. The turtle gripped the middle of the stick with its teeth. The swans flew and carried the turtle along. As they were flying 180 metres above a lake, the turtle was overwhelmed by the beautiful scene below. He couldn't hold his excitement and exclaimed "Wow!" The remaining part of the story of the turtle's flight is given in Table 6.

Table 6

Time (in seconds)	Distance turtle fell (metres)
0	0
1	5
2	20
3	45
4	80
5	125
6	180

Draw a graph of motion of the turtle's fall. (42)

What does the graph look like? What is the shape of the graph line? (43)

Can you say, on the basis of this graph, whether the motion of the turtle was uniform or non-uniform? (44)

How long did the turtle take to fall into the lake from a height of 180 metres? (45)

What was the average speed of the turtle during its fall? (46)

EXERCISE 7

If you have ridden a bicycle, you may have noticed that you don't have any problem pedalling with uniform motion when the road is straight and level. But when you climb uphill, it gets difficult and your speed decreases. On the other hand, when you go downhill, your speed increases and the bicycle moves really fast.

Figure 6 shows the graph of a bicycle trip Kamala made.

Look at the graph and say which of the following statements are true:

1. Kamala cycled up a slope, then cycled down a slope, then stopped and rested for awhile and then cycled on a level road.

2. Kamala cycled uphill continuously.

3. Kamala first went downhill, then on a level road, then climbed uphill and finally rested.

4. Kamala first cycled uphill, then stopped and rested for some time because she was tired, then cycled on a level road and finally rode downhill. (47)

EXERCISE 8

SOME EXERCISES FOR REVISION

Ajay set out from his village, walking at a speed of 4 kph. After walking for two hours, he rested under the shade of a tree. An hour later, he again began walking at a speed of 3 kph. After walking for two hours, he met his friend Suresh. They sat under a tree talking for one-and-a-half hours. Then Suresh took Ajay doubles on his bicycle at a speed of 10 kph. They cycled for one-and-a-half hours before reaching the city.

Let us proceed step by step to draw a graph of Ajay's journey.

First we shall make a table of the distance he travelled in different time intervals. For example, in the first two hours he walked at a speed of 4 kph. That means he covered a distance of 2 x 4 = 8 km. In the same way, the distances he travelled in the remaining time intervals are as follows:

> Ajay rested under a tree for an hour. So the distance he travelled in this time was .... km.
>
> In the next two hours he walked at a speed of 3 kph. So the distance he travelled in these two hours was .... km.
>
> In the next one-and-a-half hours he sat and talked with his friend. So the distance he travelled in this time was .... km.
>
> Finally, in the next one-and-a-half hours he travelled on his friend's bicycle at a speed of 10 kph and reached the city. In this one-and-a-half hours he covered a distance of .... km.

Enter this data in a table.

Fill in the distances in the blanks in Table 7. (48)

Table 7

Time (in hours)	**Distance covered (in km)**
2	8
1	
2	
1.5 (One hour and 30 minutes)	
1.5 (One hour and 30 minutes)	

Make Table 8 on the basis of this table. It should contain the total elapsed time and the total distance covered. (49)

Table 8

Total elapsed time (in hours)	**Total distance covered (in km)**
0	
2	
3	
5	

6.5 (6 hours and 30 minutes)
8

Draw a graph of Ajay’s journey with this data. Answer the following questions on the basis of this graph:

After walking how many km did Ajay meet Suresh? (50)

How many hours did Ajay take to reach the city from his village? (51)

What was Ajay’s average speed for the first 5 hours? (52)

How far is the village from the city? (53)

Which section of the graph has the greatest slope? (54)

EXERCISE 9

Mona and Sona decided to visit Ramu Halwai’s sweetmeat shop after school. When they were about to leave school, the teacher called Sona. So Mona left alone. After a short while, Sona came running and caught up with Mona. They then went together to Ramu Halwai’s shop and ate sweetmeats there. The entire episode is shown below in the form of a graph (Graph 7). Their journeys are shown by separate graph lines marked with different symbols.

Look at the graph and answer the following questions:

What was Mona’s speed per minute? (55)

For how long was Sona detained by her teacher? (56)

For how long did Sona run before she caught up with Mona? (57)

What was Sona’s average speed per minute while she ran? (58)

At what distance from the school did Sona finally catch up with Mona? (59)

What distance did the two cover together? (60)

For how long did they walk together? (61)

Graph 7

A BRAIN TEASER

When school was over, Deepu and Hari left for their homes. Deepu’s house lay to the east of the school while Hari’s house lay to the west. The graph lines of their journey to their homes is shown in Graph 8. Look at the graph and answer the following questions:

Did Deepu walk with uniform motion throughout his journey? (62)

How far is Deepu’s home from the school? (63)

How far is Hari’s home from the school? (64)

How long did Deepu take to reach his home? (65)

How long did Hari take to reach his home? (66)

Did Hari stop on the way? For how long did he stop? (67)

Calculate Hari’s average speed during his journey. (68)

Did Deepu halt anywhere? How long did he stop? (69)

Calculate Deepu's average speed during his journey. (70)

Graph 8

THE GRAPH OF A STORY

This is a very old story. You may have heard it many times before. It is the story of the race between the hare and the tortoise. The two take a bet on who will win the race. The rabbit takes off swiftly while the tortoise begins at a slow and steady pace. The rabbit runs far ahead, then halts to rest under a tree for awhile. He falls asleep. The tortoise, meanwhile, continues to forge ahead steadily. When the rabbit awakes, he runs swiftly to the finishing post. But alas! When he reaches the finishing line he finds that the tortoise has already won the race.

Illustrate the race between the hare and the tortoise in the form of a graph. (71)

SOME QUESTIONS FOR REVISION

1. **Which section of Graph 9 has the greatest slope? What can you say about the speed in this section? What can you say about the speed in section CD of the graph?**

   Graph 9

2. **The river is 37 km from Jaya's house. There is a hillock on the way. Jaya left for the river one morning on her bicycle. She reached the hillock after 2 hours, pedalling at a speed of 5 kph. Since she couldn't cycle up the slope, Jaya continued on foot, pushing her bicycle along. She reached the peak of the hillock after 3 hours, walking at a speed of 3 kph. From there the road was all downhill. She rode her bicycle at a speed of 18 kph and reached the bottom of the hillock in half an hour. She then rested under a tree for half an hour. Refreshed after a rest, she cycled at a speed of 5 kph and reached the river in 2 hours.**

   Draw a graph of Jaya's journey from her home to the river.

3. **Sunita and her brother Bharat study in the same school. Sunita walks to the school while Bharat cycles to the school. So Sunita has to leave an hour before Bharat to reach the school on time. Graph 10 shows the graph lines of their journey from their home to the school. Look at the graph and answer the following questions:**

   a) Which graph line shows Sunita's journey?

   b) Whose graph line has a greater slope?

   c) Whose speed is greater?

   d) If Sunita wants to reach school in 3 hours, at what speed should she walk?

   Graph 10

4. **Graph 11 shows the journey of Ramesh and Hamid. Write a story about their journey on the basis of the graph.**

   Graph 11

NEW WORDS

motion speed uniform motion non-uniform motion

average speed slope

Chapter-3

REPRODUCTION IN ANIMALS

Which came first - the chicken or the egg? Have you ever thought about this question? Or has anyone ever asked you the question? Were you able to answer it? Most probably not, because it's a tricky question. Such questions are related to the subject of reproduction and reproduction is not always a straightforward matter. In this chapter we shall discuss some aspects of reproduction and why the process is sometimes complicated.

You have already studied the life cycles of some animals. You have also studied reproduction in plants. So it should not be difficult for you to answer the following questions on the basis of what you learned in those chapters:

Can there be houseflies if there were no eggs? (1)

If there were no houseflies, would there be eggs? (2)

Is it possible for tamarind trees to grow if there were no tamarind seeds? Is it possible to get tamarind seeds without tamarind trees? (3)

These questions are similar to the chicken-and-egg one. You can go round and round in circles trying to answer them. When a living organism (plant or animal) produces offspring like itself, the process is called reproduction. It seems to be a simple and straightforward matter, but it isn't! And the reason is variation. You know that there is a lot of variation in nature. There is a lot of variation in reproduction, as well. Let us look at some examples of such variation.

SEXUAL OR ASEXUAL

In the chapter 'Reproduction in Plants' in Class 7 you had seen that there are two types of reproduction - sexual and asexual. In sexual reproduction pollen grains reach the stigma of a flower, where they germinate. A long tube is formed that reaches directly to the ovary. The **male reproductive cell** of the pollen grain travels down this tube to the ovary where it fuses with the **female reproductive cell** in the ovule. So, sexual reproduction is basically the fusion of the male reproductive cell and the female reproductive cell. This process is called **fertilisation**. In animals, the female reproductive cell is called the **ovum** and the male reproductive cell is called the **sperm**. So fertilisation is the fusion of the ovum and sperm. Fusion does not take place in asexual reproduction.

Do you know of any animal that reproduces asexually? (4)

Perhaps, you may have seen such an animal. Or, maybe, you saw it but did not know whether it reproduces sexually or asexually. There are very few animals that reproduce asexually, but they do exist.

REPRODUCTION IN THE HYDRA

The hydra is one such animal. You can see what a hydra looks like in Figure 1. It reproduces both sexually and asexually and its reproduction process is very interesting. First, a swelling appears on its body. This swelling grows slowly till it assumes the shape of a baby hydra. The young one then separates to form a new hydra.

Figure 1 Hydra Small swelling Developing hydra New hydra

The honeybee is another interesting example.

REPRODUCTION IN THE HONEYBEE

Honeybees also reproduce sexually as well as asexually. Each beehive contains many females and a few males or drones (Figure 2). Only one female is capable of reproduction. She is called the queen bee. The other females are called worker bees. They cannot reproduce. The queen bee mates with a drone of the hive and stores several hundred thousand of his sperms in her body. She uses these throughout her life for fertilising her eggs. You will be surprised to know that one queen bee lays three to four thousand eggs every day. She lays a total of about 500,000 eggs in her lifetime. Most of the eggs are fertilised, but she also lays some unfertilised eggs.

The interesting part is that even unfertilised eggs develop fully into young bees.

Can this be called asexual reproduction? (5)

Another interesting fact is that fertilised eggs develop into females while unfertilised eggs develop into males.

Generally, however, most animals reproduce sexually. As we have seen, this is possible only when there is fusion between the male reproductive cell or sperm and the female reproductive cell or ovum. In plants, the process is straightforward. It is always the pollen grain that reaches the stigma for fertilisation. In animals, the process is not always so straightforward. There is a lot of diversity in the way fertilisation takes place. We shall study these differences in more detail later on.

Figure 2 Worker bee Drone Queen bee

Can you identify the queen bee, drones and worker bees in this beehive?

UNISEXUAL OR BISEXUAL

We had seen that some plants are unisexual while others are bisexual. Is this the general case with animals as well? (6)

Have you ever heard of a bisexual animal? Perhaps, you may have seen such an animal without realising that it is bisexual. Let’s study one such bisexual animal you see fairly often.

THE EARTHWORM : A BISEXUAL ANIMAL

You had studied earthworms in detail in Class 7 but did not pay much attention to the way they reproduce. Earthworms have both male as well as female reproductive organs. So they produce sperm and ova. But an earthworm cannot fertilise its ova with its own sperm. The ova can be fertilised only with the sperm of another earthworm while its sperm can fertilise the ova of other earthworms (Figure 3).

There are many other examples of bisexual animals, such as leeches, hydra, snails etc.

FERTILISATION - INSIDE OR OUTSIDE THE BODY?

You know it is necesary for the sperm and ovum to come together for fertilisation. In some animals fertilisation takes place inside the body of the female while in others it takes place outside her body.

Do you know any example of fertilisation taking place outside the ovary in plants? (7)

Table 1 contains information about whether fertilisation takes place inside or outside the body of the following animals.

Table 1 : Fertilisation in animals

Name of animal	**Fertlisation internal or external**
Cow	Internal
Frog	External
Housefly	Internal
Dog	Internal
Cat	Internal
Mosquito	Internal
Fish	External in some, internal in others
Pigeon	Internal
Snake	Internal
Whale	Internal
Earthworm	Internal
Butterfly	Internal
Crocodile	Internal

Answer the following questions on the basis of the table :

Does fertilisation take place in the body of all animals that live on land? (8)

What about animals that live in water? Is fertilisation internal or external? (9)

Can you formulate a general rule on the basis of this table? If you can, then write this rule in your own words. (10)

Can you think of a reason for this difference between animals that live in water and those that live on land?

THE PROBLEM OF EXTERNAL FERTILISATION

We shall first discuss the case of terrestrial animals (those that live on land). What would external fertilisation mean in the case of such animals? It would mean that the male and female leave their sperm and ova in the open. If this is done, the sperm and ova would dry up and be destroyed.

This is not the case with aquatic animals (those living in water). When they leave their sperm and ova in the water, there is no danger of their drying up. But there are other problems. The sperm and ova can be carried away by water currents, in which case they may not be able to come together for fertilisation.

So is it just a matter of chance that the sperm and ova come together for fertilisation to take place?

One way of increasing the probability of sperm an ova coming together is to produce them in very large quantities. They are then more likely to come in contact with each other. This is what actually happens in the case of animals where fertilisation takes place outside the body.

But even when eggs and sperm are produced in large quantities there is still the danger that fusion may not take place. Many animals have devised ways to ensure that fertilisation is not left entirely to chance. For example, male frogs deposit their sperm on top of the eggs laid by the female. Similarly, in the case of a fish called stickleback, the male builds a tunnel-like nest and the female lays her eggs in it. The male then leaves his sperm in the same nest. In some animals, the ova releases substances that attract sperm, thus increasing the chance of fusion.

FERTILISATION INSIDE THE BODY

For fertilisation to take place inside the body of a female, it is necessary for the sperm to reach inside her body. Animals in which fertilisation is internal have some arrangement for ensuring that the sperm enters the body of the female. This type of fertilisation occurs in insects, snakes, lizards and mammals.

DEVELOPMENT OF THE EMBRYO

The embryo is formed as a result of fertilisation. It then develops into a new animal. In some animals the embryo develops inside the body of the female while in others it develops outside. If fertilisation is external, it is obvious that the embryo develops outside the body.

Can we say that in most aquatic animals the embryo develops outside the body? (11)

We shall now see what variations can occur in animals in which fertilisation takes place inside the body.

Once fertilisation takes place inside the body of the female, two things can happen. The embryo can continue to develop inside her body , or it can be expelled from the body in a partially developed form to undergo further development outside. Let us discuss both these possibilities.

EGGS OR YOUNG

You may have observed that some animals lay eggs while others give birth to young ones.

Write the names of ten animals that lay eggs and ten animals that give birth to young ones. (12)

Would it be correct to say that fertilisation is internal in those animals that give birth to young ones? (13)

Similarly, can we say that fertilisation is external in all animals that lay eggs? (14)

METAMORPHOSIS

There is still more variation. There are two types of egg-laying animals. You studied both types in the chapter ‘Life cycle of animals’. The young of some animals resemble their parents as soon as they hatch from the egg.

Name five such animals. (15)

You learned that in some animals the young do not resemble their parents when they emerge from the eggs. They undergo a process of metamorphosis over the next few days and only then do they begin to resemble their parents.

How many such animals do you know about? (16)

THE REPRODUCTIVE SEASON

Animals can be divided into two types on the basis of the period or season of reproduction. Some animals can reproduce anytime during the year. Others reproduce only during a particular season of the year. This season is called the reproductive period.

Some animals have been listed in the table below. Complete the table on the basis of what you already know. (17)

Name of animal	Reproduction throughout the year or during a particular season	When does it reproduce during the year?
Frog		
Mosquito		
Dog		
Man		
Sparrow		
Fowl		
Rat		
Butterfly		
Fish		
Cow		

Which animals reproduce throughout the year? (18)

Do all the animals that reproduce in a particular season reproduce in roughly the same season? Which is that season? What is the basis of your assumption? (19)

Discuss in the class the probable reasons for such seasonal reproduction. (20)

TAKING CARE OF THE EGGS

When fertilisation and embryonic development take place inside the body, the question of taking care of the eggs does not arise. But we have seen that in some animals fertilisation takes place outside the body while in others the eggs are expelled after internal fertilisation. Do such animals take care of their eggs or do they just discard them after laying them? Here, too, we come across variation.

Name some animals that take care of their eggs? (21)

Two such examples are given below.

CARING FOR THE EGGS:

MIDWIFE TOADS AND CRABS

The female midwife toad has a novel way of protecting her eggs. She lays her fertilised eggs on the back of the male. The male carries the eggs around until the tadpoles emerge from them.

Crabs have a different system of protecting their eggs. A cavity is formed below the abdomen of the female when she bends forward. Fertilised eggs undergo development in this cavity.

Study at least two other animals and find out what they do to protect their eggs after laying them. (22)

CARING FOR THE YOUNG

Animals that give birth to young ones are also of two kinds. Some take care of their young while some others do not.

Name five animals of each type. (23)

What would happen if those animals that take care of their young fail to do so? In other words, what do the young need that they cannot get for themselves? (24)

In this chapter, we discussed variations in the reproduction of animals. We did not, however, discuss many other aspects of their reproduction, such as the changes that occur in eggs after they are fertilised, the organ of the body in which the internal development of the egg takes place, how it is decided whether an offspring is male or female, how twins are born, whether test-tube babies are actually born in test tubes, what cloning is etc. These questions are all connected with reproduction. However, we need to have more information before we can begin answering these questions.

NEW WORDS

female reproductive cell   male reproductive cell   ovum

sperm   aquatic terrestrial

Chapter-4

MACHINES

Can you imagine a world without machines and tools? What would life be like in such a world? There would be no computers, no television, no planes, no trains. There would be no bullock carts, not even a screwdriver or a shovel. No clothes on your body, no shoes on your feet. Because even clothes and shoes are made with machines.

Could you list some other things we would have to live without in such a world? Could you paint a picture of such a world?

Such a world did exist many, many years ago. In prehistoric times, people did live without machines and tools. They could not cultivate crops the way we do today. They could not even kill animals for food or to protect themselves.

But slowly, our ancestors learned to make tools to help them in their daily work and chores. They built new tools and machines to perform tasks which they could not have dreamed of doing earlier.

Let us take a ride back in time and look at some of these tools and machines which our ancestors developed and see how these tools and machines changed the way they lived and worked.

Figure 1

USING A HAMMER

Try and insert a nail into a piece of wood with your thumb.

Were you able to do so? (1)

Now try and drive the nail into the wood with the help of a stone. First use a small stone, then a larger one.

Which stone made the job easier? (2)

Take a small stone, tie it to one end of a wooden stick and use this stone with a handle to pound the nail into the wood.

Did this stone hammer make the job of driving the nail into the wood even easier? (3)

There is a problem with using a stone hammer, however. If you use it repeatedly to hammer things, the stone may break into pieces.

Could you think of an alternative to stone to make the hammer stronger and longer lasting?

THE STORY OF METALS

In the beginning, our ancestors made tools of stone and wood. Later, they began using the bones of animals they hunted and killed.

Once they discovered metals, however, their progress in making tools was rapid. They were able to make much better and long-lasting tools.

Tools made of copper and iron are much stronger than tools made of stone and wood. Metals have one more advantage. They can be heated in a fire and moulded or cast into different shapes.

So it became possible to make a wider range of tools with such metals. Even hammers were made with metal heads.

Metal tools made work and life much easier for our ancestors. Shovels were produced to dig the ground and knives fashioned to skin animals. Thus activities like agriculture and hunting became much easier than before.

SEWING WITHOUT NEEDLES

Can you sew two pieces of cloth together with thread using only your fingers? Or, perhaps, you could try using a babool thorn instead of your fingers.

What problems would you face in trying to sew cloth in this way? (4)

How could you modify the babool thorn to make it easier to sew with? (5)

How does a sewing needle overcome these problems? (6)

How does a cobbler use his awl for stitching shoes? (7)

LIFTING WEIGHTS THE EASY WAY - LEVERS

Is there a large object lying somewhere near your school? Maybe a fallen tree or a rock? Try and lift it, or at least move it a bit, with your bare hands. Now take a long, strong pole. Push one end of the pole under the object. Then prop a small rock or brick under the pole, near the object, as shown in Figure 2.

Push down the other end of the pole and try lifting the object.

Were you able to lift the object easily in this manner? (8)

Repeat this experiment by shifting the prop (or fulcrum) under the pole further away from the object. That is, change the distance between the fulcrum and the object. Experiment with different distances.

What difference does it make when you change the distance of the fulcrum from the object? (9)

How far down does your hand go in pressing the pole in comparison to how high the object is lifted? (10)

Is there any way you can make it even easier to lift the object in this experiment? (11)

Lifting a rock with a pole, rowing a boat with an oar, the barrier at a check point or a hand pump - these are all examples of levers.

Figure 2

LET'S MAKE A PULLEY

The pulleys we'll make are like the ones used to draw water from wells or fitted into modern cranes that lift heavy weights. There are several ways of making pulleys, but the method we shall use is both simple and cheap.

You will need two cheap round plastic buttons, a candle, a needle and thread, two paper clips, a longer needle and a small piece of cycle valve tube (Figure 5-a).

Hold the two buttons back to back and sew them together with the needle and thread. Be careful not to use cross stitches while sewing because the thread should not cover the centre of the buttons.

Heat the tip of the longer needle and pierce the heated tip through the centre of the buttons to make a narrow hole through them. This is your pulley.

Remember: Use only those types of plastic buttons that don't crack when pierced with a heated needle.

To hang your pulley from a point, take the paper clip, open it to an S shape, then open one arm of the S as shown in Figure 5-b. That arm is the axle of your pulley. Slide the pulley onto this axle. To ensure that your pulley does not slip off the axle, fix the valve tube piece onto the end of the axle like a stopper.

Get more materials and make three such lightwieght, inexpensive and smoothly rotating pulleys.

Hang one of your pulleys from a nail, as shown in Figure 6. Slip a thread around the pulley. Tie an opened paper clip to one end of the thread to form a hook which can be used to lift a weight. If you don't have a paper clip, fashion a hook from a piece of wire.

For your weight, take a full matchbox and wrap a rubber band around it. Hook the rubber band onto the paper clip.

Now pull the free end of the thread downwards. Which way does the matchbox on the other side of the pulley go?

When you let go of the thread you are holding, which way does the matchbox go? (12)

Fix a paper clip hook to the free end of the thread you were holding and hook a filled matchbox to this end as well.

What happens now? (13)

Pull one of the matchboxes down and observe how far up the other matchbox goes. (14)

GETTING MORE FOR LESS

Fix two pulleys in the manner shown in Figure 7 and hang two filled matchboxes from the two hooks.

Do both matchboxes remain stable? (15)

If they do not, which matchbox goes downwards? (16)

Now add another filled matchbox to the hook on the left side, as shown in Figure 7.

Give the single matchbox on the right side a slight upward push and see whether the two coupled matchboxes on the other side go down to a similar extent or not. (17)

Which weight shifts more in this experiment - the heavier one or the lighter one? (18)

Answer the following questions by comparing the one-pulley and two-pulley experiments.

a) In which situation does a lighter weight lift a heavier weight?

b) If the lighter weight is pulled 1 cm downwards, how far up does the heavier weight go - the same distance, less or more? (19)

Another arrangement for hanging two pulleys is shown in Figure 8. In this experiment, replace the matchboxes with a large pebble on one hook and the pan of a weighing balance on the other. Pour sand into the pan until the pan and the pebble are suspended at the same height.

In your estimation, which weighs more - the pebble or the pan filled with sand? (20)

Does this arrangement also permit you to lift a greater weight with less force? (21)

TRY THIS AT HOME

Figure 9 illustrates two ways of using a three-pulley arrangement to lift weights.

Is it possible to lift heavier weights with this three-pulley set-up than with the two-pulley system?

MACHINES TO TAKE YOU FROM HERE TO THERE

The machines we have talked about till now are those we use for lifting weights. Let's now take a look at machines that transport us from one place to another.

Stack some books on the floor or table and try pushing this stack forward. Now take four round pencils, place them parallel to each other on the floor. If you cannot get round pencils, use four round stalks. Pick up the books and place them on the row of pencils. Push the stack forward once again.

Was it easier to push the stack forward this time? (22)

What would you do if you wished to push the stack of books from one end of the table to the other using only these four pencils? (23)

In ancient times, people moved heavy weights from one place to another in this way. They used tree trunks or logs as rollers. They laid the logs on the ground, placed the object on them and pushed it forward. In this way, they were able to bring huge stones for constructing buildings from the quarries in the mountains to their settlements.

In the earlier experiment, you picked up the pencils from the rear and placed them in front to move your load across the table. That is why moving the load forward was a slow and laborious process.

People invented the wheel to overcome this problem and speed up the process of moving things forward. It's impossible to guess who invented the wheel, or when. Perhaps, some clever ancestor devised a way of moving the log along with the load, without shifting the log from the rear to the front as the load moved forward. Once this was achieved, the idea of a wheel must have followed.

Suppose the wheel hadn't been invented. What effect would this have on life in your village and in the country? Discuss the matter with your friends and write a summary of your discussions in your exercise book. (24)

MAKE A MATCHBOX VEHICLE AT HOME

The materials you need are shown in Figure 11 a.

Heat the point of a pin and pierce the heated point through the centre of a plastic button. Now heat the head of the pin, place the head on the floor and push the button down onto it as shown in Figure 11 c. The heated pin head will get fused into the centre of the button and you will get something like a drawing pin.

Cut a 1.5 cm piece from an empty ballpoint pen refill and slide this refill piece onto the drawing pin.

Heat the tip of the drawing pin and stick another button onto it.

The two buttons are your wheels and the pin between them is the axle.

The refill piece is a rotating bearing.

Make another pair of wheels in this manner.

Stand a matchbox on its narrow side on the refill bearings, with one set of wheels in front and one at the rear, like in a motor car. Fix the wheels in place by winding a rubber band over them and the matchbox.

This is your matchbox cart.

Place another matchbox on its narrow (striking surface) edge on the table. Try pushing it forward. Note how much effort you had to use.

Now roll your matchbox cart.

Which matchbox takes more effort to move? And why? (25)

Make several such matchbox carts and join them together in a train.

MAKING A BEARING AT HOME

Stack some books like you did in the previous experiment. Spread seven or eight marbles on a table and place your stack of books on them. Try pushing the stack in different directions.

Do you experience any difference in pushing the stack of books on pencils and on marbles? Explain the difference in your own words. (26)

Collect two lids of tin containers. The lids of dalda tins would be ideal. Place one of them on the floor and arrange the marbles along the inside edge of its periphery. Place the other lid upside down over the marbles. Place a brick on the upturned lid and try to spin the brick. Now place the brick on the floor and try to spin it.

Do you feel any difference in spinning the brick in the two situations? (27)

You had to use a little more effort in rotating the brick when it was placed directly on the floor than when it was on the lids with marbles. The reason is because the brick scrapes against the floor. This scraping or rubbing between two surfaces is called friction. When the brick is rotated on the lids with marbles, there is less friction because of the rolling marbles between the two lids. That is why it is easier to rotate the brick on the lids.

Get an old ball bearing from a bicycle repair shop.

Examine the bearing and try to explain why tiny metal balls (*charra*) are placed between the axle and wheel of a vehicle. (28)

MOVING ONE PULLEY WITH ANOTHER

The blades of a windmill or a watermill are rotated by air or water. How can we use this motion to run another machine? Let's do a few simple experiments to understand how this is possible.

Fix two pulleys made from large pant buttons on the surface of a matchbox with the help of two pins, as shown in Figure 13 a. Wind a rubber band around the two pulleys to function like a belt. The rubber band should not be too large, otherwise it will hang loosely around the pulleys. Now rotate one of the pulleys.

What happens? (29)

Do both pulleys rotate in the same direction? (30)

Do the pulleys rotate at the same speed? (31)

Replace one of the pulleys on the matchbox with a piece of a ballpoint pen refill, as shown in Figure 13 b. The refill piece is also a pulley.

When you turn the large button pulley a full round, how many turns does the smaller pulley make? (32)

When one pulley is rotated, does the other pulley rotate in the same direction or in the opposite direction? (33)

Give some examples where one pulley is used to rotate another pulley. (34)

LEARN HOW TO MAKE GEARS

Collect some caps of cold drink bottles. Take two of them and make a hole in their middle with a nail. Arrange these upturned caps on a wooden board in such a manner that their teeth interlock. Nail the caps to the board in this position. Ensure that the caps are not nailed too tight and can rotate freely.

Rotate one cap and observe the direction in which the other cap turns. (35)

Compare your answer to the answers to questions (33) and (35) and explain how the direction of rotation changes when we turn a pulley with a pulley and a gear with a gear. (36)

Add a third bottle cap to the two on the wooden board and observe the direction in which each of the gears rotate. (37)

SOME QUESTIONS ABOUT BICYCLES

Carefully examine a bicycle. Locate its levers, bearings, pulleys and gears.

Make a list of these items. (38)

Which parts of the bicycle are oiled and why? (39)

Turn the bicycles pedal once and count the number of rotations the rear wheel makes. (40)

Is it easier to push a bicycle forward when its brakes are applied or when the brakes are released? Give reasons for your answer. (41)

Why is it difficult to pedal a bicycle when its tyres contain less air? (42)

VARIOUS KINDS OF MACHINES

Look around you and make a list of the machines you see. Divide them into the following groups:

a) hand or feet powered machines

b) animal drawn machines

c) machines which run on electricity or petrol, and

d) machines driven by air or water. (43)

Examine the machines in your list carefully. They all have pulleys or ball bearings or gears or levers fitted in somewhere. Try and spot where these various things are located in the different machines.

NEW WORDS

lever bearing barrier pulley friction crane

axle gear cross stitch

Chapter-5

GROWTH AND DEVELOPMENT

You may have noticed that plants grow slowly after they sprout. Their height and girth (thickness of the stem) increase, new branches and leaves appear, the length and width of their leaves increase, flowers bloom and fruit develop from flowers.

You may have seen similar changes occurring in animals. For example, a calf grows bigger after birth and, as it grows, many other changes occur in its body.

You have studied the life cycles of various insects and animals. You may have observed similar changes taking place in them as well.

We shall study these changes in this chapter. You will have to perform some experiments to understand these changes. These experiments will continue for many days. Most of them will be done with plants because it is easier to perform experiments with plants. We shall also discuss our observations. So, let's begin.

DEVELOPMENT IN ANIMALS

You performed several experiments in the chapter 'Life cycles of animals'. You studied the different stages in the life cycles of frogs, houseflies, mosquitoes, grasshoppers and butterflies.

The changes occurring in an animal from the embryo stage to the adult-like stage are called **development**.

In the chapter 'Reproduction in animals' you saw that the embryo develops inside the body of the female in some animals while it develops outside the body in others.

You also saw that the young ones that emerge from the eggs usually resemble their parents. They develop fully inside the egg itself. However, there are some animals whose young do not resemble their parents - they are in the form of larva. They go through a stage called metamorphosis before they begin to look like the adult. During this period, new organs are formed and some old organs disappear.

Only when an adult-like animal is formed from an embryo can we say that its development is complete.

DEVELOPMENT IN PLANTS

Plants, too, go through a similar process. Their embryo lies inside the seed. But there is one important quality in a seed which is not found in an animal embryo. In most animals, development begins the moment the embryo is formed. Seeds, on the other hand, can remain dormant for a long time. They develop only when they find favourable conditions. So development in a plant is the process of formation of the plant from its seed.

You studied the developmental stages of animals in the chapter 'Life cycles of animals'. In this chapter we shall study the growth and development of plants.

EXPERIMENT 1

We cannot study the growth and development of plants in a day. That's obvious. We need to conduct some long-duration experiments.

Fill soil from a field or garden in four earthen cups (*kulhads)* or small tins. Sow five healthy bean or cow pea (*chawla*) seeds in each earthen cup. Take care to leave some space between the seeds when you plant them. Sprinkle water on the soil and keep the earthen cups in a safe place. Ensure that the soil doesn't become dry during the experiment, which will continue for about ten days.

The day you sow the seeds is Day 0. Note the date in your exercise book. The days that follow will be called Day 1, Day 2 and so on.

Over the next ten days, you will have to uproot one seed every day and examine it. While uprooting the seed, take care not to damage the sprout or cotyledons. Wash the soil sticking to the seed. Repeat this process every day.

Note the changes you observe in the seed, cotyledons and sprout in Table 1. (1)

Table 1 : From seed to plant

Date of sowing the seeds:

Day	Changes observed	Diagram
1		
2		
3		
4		
...		
...		
10		

On the basis of your observations, say which part of the plant emerged first. (2)

Which part of the plant emerged last? (3)

Make a list of the parts which did not develop during the experiment. (4)

What changes did you observe in the cotyledons during the formation of the plant from the seed? (5)

EXPERIMENT 2

MEASURING GROWTH

This experiment will continue for about 20 days. So you must ensure that no one disturbs it during this time, and that the plant does not wither and dry.

It is best to perform this experiment at home during the monsoon season.

Table 2

Date of sowing the seeds:
Date of germination:

Day of growth	Height (cm)
1	
2	
3	
...	

....
10
11
....
20

Fill soil in an earthen cup or small tin. Sow one seed each of Bengal gram (*chana),* beans (*sem*) and green gram (*moong*) in it. Moisten the soil well and keep the earthen cup in a safe place. You should examine the seeds daily during the course of the experiment. Note your observations in Table 2.

Note the day when each seed sprouts. This is Day 1.

Measure the height of the plant daily from this day onwards and note the figure in the table. (6)

If the plant grows straight up, you can measure its height with a scale . If does not grow straight, use a thread to measure its height.

Plot a graph of the days of growth and height of plant. (7)

On the basis of your graph, identify the days when the growth of the plant was the slowest. (8)

Which were the days when its growth was the fastest? (9)

Did the plant grow at a constant rate during the first 20 days after sprouting, or did its rate of growth change on different days? (10)

It has been observed that the rate of growth in most plants, animals and humans is slow immediately after sprouting or birth, after which it is fast for some time before again slowing down or stopping altogether.

Does your data also match this observation? (11)

If you continue the experiment, what would happen to the plant? Explain in detail. (12)

You used gram and bean seeds for your experiment. Suppose you had used mango or tamarind (*imli*) seeds instead. Do you think your graph would have the same shape? If not, in what way would it be different? (13)

One thing you should remember is that plants like gram, bean, wheat etc are **annual plants**, whereas mango, tamarind etc are **perennial plants**.

TWO KINDS OF GROWTH

Let's discuss the example of a perennial plant like mango in greater detail.

Does the tree keep growing bigger? (14)

Does the size of its leaves also increase as it grows? (15)

You may have noticed that many trees shed their leaves every year. New leaves appear after the old leaves fall off.

Can we say that the growth of the trunk of these trees is unlimited, while the growth of their leaves is limited? That is, the trunk continues to grow bigger while the leaves stop getting larger after a stage? (16)

If the fruit remain on the trees, would they keep growing or would their growth also stop after a certain limit? (17)

In Experiment 2, we had measured the height of the plant to study its growth. But growth can be measured in other ways too. For example, we can measure the weight of the plant, or the increase in girth of its stem, or the growth and spread of its branches.

Do you think that plants continue to grow? Does the growth of animals stop after a certain limit? Discuss these questions in class and write your conclusions in your exercise book, giving examples and reasons. (18)

RATIO OF GROWTH

Have your ever compared the small and large leaves of the same plant?

Usually, they look alike. But have you ever wondered how a small leaf grow into a large leaf? Does it only increase in length or does its breadth also increase? Let us investigate.

EXPERIMENT 3

Bring five leaves each of a dicot and monocot plant to class. Ensure that the leaves are of different sizes - some should be small, some of medium size and some large. You could collect leaves of *besharam* (Ipomea) or *chandni* and some grass. Remember to get leaves of different sizes of *besharam/chandni* and grass.

Draw Table 3 in your exercise book. Make a separate table for the grass leaves.

Table 3

Name of the plant :

Leaf No.	Length of leaf	Breadth of leaf	Ratio of length and breadth
1 (smallest)			
2			
3			
4			
5 (largest)			

Now measure the length and breadth of each leaf and note your measurements in the table. (19)

(Measure the length from the upper end of the stalk to the tip of the leaf and the breadth at its widest part.)

Calculate the ratio by dividing the length of the leaf by its breadth. Note your result in the table. (20)

On the basis of the data in your table, can you tell whether the length-breadth ratio of a dicot (*besharam/chandni)* leaf changes as it grows, or whether it remains more or less the same. (21)

What is the situation of the length-breadth ratio of the monocot (grass) leaf as it grows? (22)

Have you ever thought how this ratio of growth works in the case of human beings? For example, when a child is growing does her/his height and girth increase in the same ratio? Let us consider a simple example.

The height of a child is about 30 cm. The length of his ear is about 4 cm. The average height of an adult is around 170 cm. This means that the height of an adult is about five-and-a-half times the height of a child.

If the length of the child's ears was to increase in the same ratio, how long would the ears be when he becomes an adult? (23)

Similarly, consider the size of the eyes. The adjoining figure shows what a child would look like as an adult if all his organs grow in the same ratio.

Figure

a) If the organs of a child increase in the same ratio, he would look like this when he grows up.

b) This is what a 12-year-old boy actually looks like.

Examine the figures carefully and say whether all the organs of human beings grow in the same ratio. (24)

Can you say whether the height of a tree increases more rapidly than its girth? (25)

WHERE GROWTH TAKES PLACE

All living things grow. But does growth take place throughout the body or only in some parts? For example, when a stem grows, does it grow at the top or the bottom? Or when a root grows, in which part does growth occur?

Let's investigate this problem by performing an experiment. In this experiment, we shall find out the parts of the root where the maximum growth takes place after a plant sprouts.

EXPERIMENT 4

Sprout some *moong* (green gram) seeds. You will first have to soak them in water and wrap them in a wet cloth. It is not necessary to sprout only *moong* seeds for this experiment. You could take gram, bean, pea or any other type of seeds.

The next stage of the experiment begins when the sprouts are about 1 cm long. We have to find the part of the root where the maximum growth takes place. For this we need a way of marking the root. Tie a thread about 3 mm from the tip of the root. Then tie another thread on the root 3 mm from the previous one. Keep the knot loose while tying the thread so that the root is not damaged. The threads divide the root into three segments

Now wrap the seeds in the cloth. Examine the sprouts the next day. Try and see which segment of the root has grown the most.

On the basis of your observations, state which part of the sprout (root) grows most rapidly. (26)

Which part of the stem grows the fastest? Design an experiment to find out and write the details in your exercise book. If possible, perform the experiment and note your conclusions. (27)

We performed several experiments in this chapter to study the growth and development of living things. But there is much more to learn on the subject. For example, what are the factors that affect growth? What is the relationship between the rate of growth and crop yields - can the graph of growth tell us when to manure and irrigate a crop? Can we assess the health of children by comparing the increase in their height and weight, and so on.

Similarly, we shall discuss many aspects of development in the higher classes. For example, where does the tail of a tadpole disappear during the development of a frog, what are the differences between a larva and an adult fly, why is the larva stage found only in certain animals etc.

NEW WORDS

Development

Chapter-6

FORCE IS EVERYWHERE

Chajju had the ball but the goal was still quite far off. Nevertheless, he took a chance and kicked the ball hard. It flew like a bullet and landed straight between the goalposts. The crowd was stunned. The people just could not believe their eyes. How could a puny little fellow like Chajju kick the ball with such force over such a distance?

Force, strength - you probably use these words everyday. At play, while fighting or wrestling, while doing hard physical labour ... these words are quite commonly used.

But the word 'Force' is used in a different way in science. For example, if you are asked to lift a book, you would probably exclaim, "Arre, it's so light. You don't require much strength to lift it." But the scientist would retort, "No sir. Let alone a book, you have to apply a force to lift even a pencil." Or suppose you are leaning lazily against a wall, just relaxing and doing no work - a force would still be acting on you. Strange, isn't it. You'd probably say, "No way. I'm standing here totally at rest. Where does the question of any force arise?"

So that's the question before us: Where does the scientist see a force in such situations? Or what exactly does a scientist consider force to be? We shall discuss this question in this chapter. Let's begin by taking some examples from our daily lives. Let's see if we can recognise or identify force in these commonplace situations.

Answer the following questions on the basis of your understanding.

Look carefully at the pictures given below. Can you say whether or not any force is being applied to the various objects shown? (1)

1. A handcart rolling down a slope
2. A handcart that moves forward slowly after being given a shove.
3. A ball falling to the ground.
4. A laden handcart that does not budge an inch even after being given a shove.
5. A bouncing ball hit with a stick.

So have you figured out the answers? Write them down in your exercise book.

We shall now try to identify the forces that act upon objects in the following experiments and study their effects on these objects. You can then reassess the answers you have written on the basis of the new things you learn about force.

If you push an empty handcart - that is, if you apply a force to it - it begins to move. It moves in the direction in which you apply the force. The arrow in the diagram shows the direction of the force. If you wish to stop the handcart rolling down a slope, you will have to apply a force in the direction opposite to which the handcart is moving.

If two people push a handcart from opposite sides with equal force, the handcart does not move. It remains stationary.

Before we begin our discussions on force, let's perform an interesting experiment.

EXPERIMENT 1

Take a plank of wood and place it on a *duree* or a *tatpatti* in your classroom. Place a stack of books under one end of the plank so that it slopes down to the *duree*. Make a mark on the plank near its raised end. Place a marble at that spot and release it.

How far did the marble roll? (2)

Now remove the *duree* from under the plank. Place the marble at the same spot on the plank as you did earlier. Let the marble roll down the plank onto the floor this time.

How far did the marble roll this time? (3)

Repeat the experiment a third time, but this time place the plank on a large sheet of glass.

What did you see? (4)

Why did the marble roll further when you changed the surface on which it rolls? (5)

Can you imagine a surface on which the marble will continue to roll forever, without stopping? It was questions like these that kept troubling a scientist called Galileo Galilei.

GALILEO'S THOUGHT EXPERIMENT

The story of force is quite old. In fact, it is among the oldest subjects in physics that people have been thinking about and trying to understand for thousands of years. How does an arrow fly through the air to its target? Why does a rolling stone come to a halt? Why do fruits on a tree fall to the ground when they ripen? Why does smoke always rise upwards? Why can't we fly? People do think about such everday questions but they seldom arrive at a clear or precise answer about why these things happen.

These were the questions Galileo grappled with. He conducted several experiments in his search for answers. During these experiments he observed that a marble rolling down a slope comes to a halt after rolling some distance. He wondered what he would have to do if he wanted the marble to roll to a greater distance.

He found that if the surface of the floor was uneven or rough, the marble did not roll far. So Galileo smoothened the surface of the floor a bit and found that the marble did, indeed, roll a little bit further.

From this observation, Galileo reached the conclusion that it was the roughness of the surface that was proving to be an obstacle to the rolling marble. He wondered if there could be some imaginary surface that was so smooth that it would not interfere at all in the rolling of the marble. Such a surface can only be an imaginary one, he felt, because how smooth can you make an actual surface?

But Galileo was not dismayed by the fact that he could not obtain an ideally smooth surface. He performed an experiment in his mind - a thought experiment - and solved one of the difficult riddles of physics. Let's see what conclusions he reached from his thought experiment.

Galileo said that if there is no outside influence on the marble, either from the surface of the ground or the air, the marble will continue to roll, without stopping. A very remarkable conclusion, indeed. Even in those days people must have found the conclusion a bit strange, like we do today. After all, has anyone ever seen something that keeps on moving forever, without stopping?

Another scientist, Isaac Newton, took up this point. He said the rolling marble stops because a force you cannot see is stopping it. This force occurs when the marble scrapes against the floor and it acts in the opposite direction to which the marble rolls. As the marble rolls forward on the surface, this 'scraping' force acts like a hidden hand to hold back the marble. This force is called **friction**. It eventually stops the rolling marble. But if there is no force to stop an object which is moving, that object will continue to move without coming to a halt.

It is truly a bit difficult to digest this fact. That's because we have never seen such a thing happening. If we perform a special experiment for the purpose, then maybe we would be able to see it happen. But we would not see it in our everyday life because there are many forces that act secretly and silently to stop objects from moving. We generally conclude that the object came to a halt on its own.

Let's now try and identify and recognise these hidden forces.

FIND THESE HIDDEN FORCES

If we keep pushing a handcart it will keep moving. Gradually, it will even pick up speed. If we stop pushing - stop applying a force - the handcart will slow down and come to a halt after some distance.

We may have stopped applying a force to the handcart. But there is an opposing force acting on it even now. That is the friction of the surface, which halts its motion. We may not see this force, but we can see its effect. This friction force was there even when we pushed the cart. But it could not match the force we applied to the cart. The friction force was weaker than the force we applied, that's why the cart moved forward.

ANOTHER HIDDEN FORCE

A moving handcart crashes against the wall and comes to a halt.

Who applied the force that brought the handcart to a halt? (6)

You guessed correctly. It was the wall that applied the force. That may sound a bit strange, but it's true. If the wall did not apply the force, the handcart would have continued to move forward. Suppose the wall was made of paper. The force such a paper wall applies would be negligible and the handcart would just brush it aside and move forward.

Whenever a moving object stops, or when its motion slows, we must look for and identify the force that is acting on it.

EXPERIMENT 2

FIND THE FORCE

Hold a ball at a height. Drop it gently to the ground. Do not apply any force while doing so. The ball falls to the ground.

What could be the force that pulls the ball downwards? (7)

Can you recognise this hidden force? (8)

You did not apply any force to the ball. Then who did? (9)

Did you notice any change in the motion of the ball as it fell to the ground? (10)

If you couldn't notice a change because the ball fell in the blink of an eyelid, then drop it from a greater height.

What happens? Does the speed of the falling ball decrease or increase as it falls? (11)

If you still aren't able to notice a change in motion, then roll the ball down a slope and check carefully to see whether its speed decreases or increases.

Now throw the ball upwards. You applied a force to throw the ball in the air. The force was applied while the ball was in your palm. The moment it left your hand the ball was freed of that force. The force of your hand was no longer acting on it. Carefully study the ball's motion while it is in the air.

Does the ball continue to rise upwards? (12)

Does its speed increase or decrease after it leaves your hand? (13)

What is the force that changes the motion of the ball? (14)

As it reaches the peak of its upward motion, the ball halts for a moment and then begins to fall to the ground. The force acting on it during its upward motion is the same as the force acting on it when it descends to the ground.

Do you recognise this force now? (15)

Our earth applies a force on everything. It pulls every object towards itself. The effect of this force can be felt far away from the earth. Even the moon cannot escape its effect. That's why the moon rotates around the earth. You have probably heard the name of this force. It is called **gravity**. Let us try and identify the effects of this gravitational force.

Show the direction of the force applied to the ball when it is rising upwards.

Does that question put you in a fix? Are you wondering why the force acts in some other direction while the ball is going upwards? Why does the force not act upwards?

So go over the sequence carefully again. You first threw the ball up, didn't you? You were exerting a force on the ball while it was in your hand. This force was exerted upwards. The moment the ball left your hand it was freed of the force you were exerting upwards. The ball rose upwards in the air but there was no force acting on it in this direction. There was only one force acting on it at this point - the earth's attraction or the gravitational force. And the direction of that force is downwards, towards the earth.

The situation is similar to the moment you let go of the handcart in the earlier experiment. When you let go of the handcart you were pushing, it continued to move forward. But a hidden force, the friction of the surface of the ground, was acting in the opposite direction.

These hidden forces do create some problems for us. But we should not get confused. We should remember that when the motion of an object slows down, it is because a force is acting on it in a direction opposite to the motion. Or if the object is speeding up, then the force is pulling or pushing it in the same direction as its motion.

If you remember these two important factors, you can easily identify the hidden forces acting on an object.

SOLVE THIS RIDDLE

A boatman rows a boat on a river. If he stops rowing, what effect would it have on the motion of the moving boat? (16)

Explain the reason for this difference in motion of the boat. What is the hidden force acting on the boat and in which direction is it acting? (17)

IF THE EARTH DID NOT ATTRACT THINGS

We saw that the earth attracts objects. Whether it is a ball or a stone, a tree or a book, cow, buffalo, rat, frog ... the force of the earth's attraction acts on all of them. That's why we are able to stand on the surface of the earth. Otherwise we would be floating somewhere far off in outer space. Isn't that an exciting thought?

So try and imagine what would happen if the earth did not attract objects towards itself. This is not an imaginary situation any more. Many people have actually experienced it. They are astronauts who travel far from the earth in space vehicles. The gravitational pull of the earth is very weak at such a distance. Strange things begin to happen. No object remains in its place. They don't stay on the surface you place them on. Utensils don't remain on racks. Books and pens don't remain on the table. As if that isn't enough, even people cannot remain seated in chairs. The chairs float in one direction while they float in another.

It even becomes difficult to pour water from a glass, because the water does not flow downwards but in any direction. The more you let your imagination run, the stranger will be the picture that comes to your mind. Life literally becomes topsy turvy. When Rakesh Sharma flew in a space vehicle, his pictures were shown on television. The film showed scenes such as these inside the space vehicle. Do you remember seeing these pictures?

Can you take this imaginary situation a step further. Think and write of something new and unusual that might happen on the earth if there is no gravitational force. (18)

In space there isn't even any air. Space vehicles have special arrangements to keep air inside. If our earth stopped attracting air, all the air would drift away into space and would not remain near the earth's surface. If that happened it would mean the end of the story of human beings on earth.

EXPERIMENT 3

WHAT IS WEIGHT?

Spread you arm horizontally with the palm facing upwards. Ask a friend to place three books on your palm. Do you feel a force acting on your palm? In which direction is this force acting?

Ask your friend to place one more book on your palm.

Can you estimate how many books you can carry in your palm in this manner without bending your elbow? (19)

The force exerted by the books on the palm of your hand has a familiar name. Can you say what it is? Yes, that force is called the weight of the books. Yes, the same weight you are familiar with. The gravitational force that acts on the books is the same as the weight of the books. And that is the force you feel on your palm. In other words, the weight of any object is the gravitational force of the earth acting on the object.

When you say the weight of a sack of wheat is 20 kg, that means the value of the gravitational force acting on the sack of wheat is 20 kg. Actually, the unit for weight should be kg weight but people generally refer to it in its shorter form - kg. There is another unit of force called the Newton which has been named after the famous scientist.

YOUR WEIGHT ON THE MOON

Don’t worry, we aren’t sending you to the moon to check your weight. Just imagining what your weight would be if you somehow reached the moon.

We saw that the earth attracts every object. But the earth isn’t the only body to possess this quality. All objects exert their gravitational force on one another. The more massive the object, the greater is its gravitational force. The moon is also a huge object. So it exerts its gravitational force on all objects near it. But the moon is smaller than the earth. So the earth attracts objects with greater force than the moon. The gravitational force of the moon is six times less than the earth’s.

Suppose your weight on earth is 36 kg wt. If you go to the moon what would happen to your weight? (20)

On the moon your weight would be six times less. You will look the same - as tall and as broad - but your weight would be only 36/6 = 6 kg wt. You will thus become very light on the moon. That could be fun. Each step you take would carry you a long way. And since everything is lighter there, you would be able to easily lift even heavy looking objects.

Now suppose we take you to Jupiter. This planet is even bigger than the earth. So the gravitational force there would be five times more than earth’s. Your weight there would also be five times more - 36 x 5 = 180 kg wt. You’d be so heavy you may feel like you are made of iron.

Let’s return to earth from our imaginary trip to the planets and talk of less weighty matters than gravitational force.

THE BATTLE OF FORCES - TOTAL FORCE EXERTED ON A BODY

You’ve probably often engaged in a battle of *panja* (arm wrestling) with your friends. As long as both opponents exert the same force, their palms remain locked at midpoint. In such a situation, both forces cancel each other out and the palms remain stationary. But the moment one opponent applies greater force, the palms tilt in the direction of that force.

We had seen a similar situation of equal and opposite forces exerted on the handcart. Even with two forces acting on the handcart it could not move, it had no motion. Since both forces are equal and acting in opposite directions, scientists say the total force acting on the handcart is zero.

Let’s take an example. A child is seated on a stool.

Is there any force acting on this seated child? (21)

You know one such force - the earth’s gravitational attraction. But is it the only force in action?

If that was the only force, the child would have been rapidly pulled towards the earth. But this does not happen. Why? (22)

Because the stool supports him. It exerts a force upwards on the child. This force is equal to the weight of the child but in a direction opposite to it. That’s why both forces cancel each other out or neutralise each other. The stool exerts the same force upwards as the weight acting on it.

But if the force pushing down on it is excessive, it may not be able to exert an equal and opposite force upwards. The outcome of this situation is illustrated in the picture.

Let’s now take another example in which two forces battle to a draw. That is, the outcome is zero force.

A boat floats on water. It does not move in any direction. It is stationary.

Is there a force exerted on the boat, pulling it downwards? (23)

The boat is stationary. It is not sinking. So, obviously there is another opposite force acting upwards which is supporting it on the surface of the water.

What is the force on the boat which acts upwards? (24)

From these examples we can see that there are many situations in which it doesn’t appear that any forces are acting, but in reality a battle of forces is under way in which the forces fight to a draw. That is, they cancel each other out. An object may appear to be in a position of rest, or reclining. But there are two or more hidden forces acting upon it.

There is no situation on this earth that is free of such forces. When we stand on the ground, there are two forces acting on us - the gravitational pull of the earth and the force that supports us on the ground. Since both forces cancel each other out, we do not feel anything. The total force acting on us is zero. That’s why we are sometimes under the illusion that no force is acting on us.

One final example, in which we exert tremendous pressure but we do not see any effect of the force. There is a fully laden handcart. You push it with all your might but it does not budge.

What is the force that is cancelling the tremendous effort you put in to move the handcart? Could you identify it? (25)

Yes, it’s the gravitational force. Because the handcart is heavy, the friction of the surface acting on it is also high. If you have to overcome this friction, you must exert even greater force to push the handcart. If you can’t do it alone, get help from a friend. This time the handcart does move. That means the combined force exerted by you and your friend is greater than the friction that is keeping the handcart rooted to the spot.

If you wish to show these forces with arrows in the diagrams below, you could do it

this way or this way.

In the latter diagram, the two forces pushing the handcart forward have been combined and depicted by a longer arrow. Because the friction force in the opposite direction is less, it is depicted by a shorter arrow.

SOME EXERCISES FOR REVISION

1. **Are there any forces acting on the objects shown below? If yes, in which directions are they acting? Mark them with arrows.**
    a) **A ball that is kicked.**
    b) **A ball rolling down a slope.**
    c) **A bird sitting on a stone.**
    d) **A fruit falling from a tree.**
    e) **A child swimming on her back.**
2. **There are some incomplete sentences below. You have to complete them.**
    a) **The force on the ball that is thrown upwards acts in the .... direction.**

b) **The gravitational force exerted by the earth on every object is called the.................. of the object.**
c) **The friction of the surface acting on a rolling ball .... the motion of the ball.**
d) **When you stop pedalling a cycle it comes to a halt because a .... force is acting on it.**

3. **Say which of the following sentences are true or false:**

a) **There is no force acting on us when we sleep on a cot.**
b) **A handcart slows down as it rolls down a slope.**
c) **If no force is exerted on a moving object, it continues to move forever, without stopping.**
d) **If we go to the moon we will not experience any gravitational force.**
e) **The gravitational force of the earth also acts on birds flying in the sky.**
f) **There is only one force acting on an arrow flying through the air that pulls it down to the earth.**

4. **You are standing on the earth. The earth pulls you towards itself. But you do not experience the gravitational force of the earth. Why?**

5. **You did the experiment of rolling a marble on a *duree.* You saw that the marble rolled to some distance and then came to a halt. If the same experiment is repeated on a smooth floor, will the rolling marble come to a halt after covering a shorter or longer distance? Why does this difference in distance occur?**

NEW WORDS

gravity kilogram weight space space vehicle

Chapter-7

THE MUTUAL RELATIONSHIP OF ACIDS AND BASES

In the chapter 'Identification of acids and bases' in Class 6, you learned to identify acids, bases and neutral substances with the help of litmus paper. In the chapter 'Gases' in Class 7 you learned to use another indicator - phenolpthelein - to identify acids and bases.

On the basis of your observations in these chapters fill in the blanks in the following sentences.

1. **Acidic substances turn .... litmus ....**
2. **The substances that change the colour of .... litmus to .... are bases.**
3. **.................... substances turn the pink indicator solution phenopthalein colourless while .... substances turn the colourless indicator solution pink.**
4. **Those substances that show no effect on blue or red litmus paper are called .... substances. (1)**

You have seen that neutral solutions have no effect on the indicator solutions. You have also seen that acids and bases have opposite effects on the indicator solutions. So is it possible to get a neutral solution by mixing an acid with a base? Let's find out if this is possible.

EXPERIMENT 1

PREPARING A NEUTRAL SOLUTION

Take two clean test-tubes. Label one caustic soda and the other hydrochloric acid.

Ask your teacher to fill the first test tube half full with caustic soda and the second half full with hydrochloric acid.

Take another clean test tube. Use a dropper to pour 10 drops of hydrochloric acid into it. Count the drops while pouring. Add two drops of colourless indicator solution to this test tube.

What is the colour of the solution?

Take some caustic soda solution in another dropper. Add this solution drop by drop to the third test tube, counting the drops as you pour them. Shake the test tube well after adding each drop to see if the colour of the solution changes or not. Keep adding drops of caustic soda solution till the solution in the test tube begins to turn pink.

What is the nature of the solution in this test tube? Is it acidic or basic? (3)

Now add a drop of hydrochloric acid to this test tube and see whether the solution changes back to its original colourless form. If it has not changed, add another drop of hydrochloric acid solution. Keep adding drops until the solution in the test tube turns colourless.

What is the nature of the solution now? Is it acidic or basic? (4)

If you are given an acidic solution, can you change it into a basic solution on the basis of what your learned in this experiment? (5)

If you are given a basic solution, how would you change it into an acidic one? (6)

We saw in this experiment that a stage comes when the acidic solution turns basic if one additional drop of caustic soda is added to it. If a drop of acid is then added to this basic solution, it again turns acidic.

Think it over and suggest a way in which you can prepare a neutral solution in this experiment. Discuss your method with your teacher and then write it down in your own words. (7)

A neutral solution is obtained by mixing fixed quantities of an acid and a base. We can say in the above experiment that the point where a neutral solution forms lies somewhere between the point where the acidic solution turns basic when a drop of basic solution is added to it and the basic solution, in turn, becomes acidic when a drop of acid solution is added to it. This process is called neutralisation.

How many drops of caustic soda were required to neutralise 10 drops of the acidic solution? (8)

EXPERIMENT 2

AN EXERCISE IN NEUTRALISATION

Pour 25 drops of the hydrochloric acid given to you in Experiment 1 in a clean test tube. Add two drops of colourless indicator solution to this test tube.

On the basis of your answer to Question 8, estimate how many drops of caustic soda solution would be required to neutralise 25 drops of hydrochloric acid solution. (9)

Now, add caustic soda solution drop by drop to the test tube to neutralise the solution it contains.

Did you add more or less drops of caustic soda than you estimated to neutralise the solution? (10)

EXPERIMENT 3

Your teacher will prepare a fresh solution of hydrochloric acid for this experiment. To do this he will take 25 ml of the hydrochloric acid solution used in Experiment 2 and add enough water to it to make its volume 50 ml.

Pour 25 drops of this new solution in a clean test tube.

If you have to neutralise this solution with the caustic soda solution you used in Experiment 2, how many drops of caustic soda would you require? Note your estimate in your exercise book. (11)

Now add caustic soda solution drop by drop to neutralise the solution in the test tube. Count the number of drops required for neutralisation.

How many drops of caustic soda solution were required to neutralise 25 drops of this new acidic solution? (12)

Were the number of drops of caustic soda solution required for neutralisation in this experiment more or less than the number of drops required in Experiment 2? Why was there a difference? (13)

Based on your observations in Experiment 2 and 3 say whether the quantity of acid in the hydrochloric acid solutions used in the two experiments was the same or was more or less. (14)

If we take 1ml each of the acidic solutions used in Experiment 2 and 3, which solution would have a greater quantity of acid? How much more acid would it contain than the other? (15)

EXPERIMENT 4

Wash the test tubes, droppers and other apparatus used in the previous experiments. Take two test tubes and label them sulphuric acid and sodium carbonate respectively. Ask your teacher to pour 10ml each of sulphuric acid and sodium carbonate solution in the respective test tubes.

Pour 20 drops of sulphuric acid in another clean test tube. Add two drops of pink phenopthalein indicator solution to the test tube. Now neutralise the solution in this test tube by adding sodium carbonate solution drop by drop, counting the number of drops as you add them.

How many drops of sodium carbonate solution did you require to neutralise 20 drops of sulphuric acid? (16)

A PUZZLE

Ramesh poured 10 drops of sulphuric acid in a test tube. He added 10 drops of water to it. How many drops of sodium carbonate solution would he require to neutralise this solution? (17)

Carry out the experiment and check whether your guess was correct.

Was your guess correct? If not, discuss the matter in your class to find the reason for the difference. (17)

SALTS

You have carried out the process of neutralisation several times till now. You have seen that acids and bases lose their properties during the process. When acids and bases are mixed together, a chemical reaction takes place. A salt is formed as a result of this chemical reaction.

For example, when a solution of hydrochloric acid is neutralised by a solution of caustic soda, common salt (sodium chloride) is formed.

Other examples of salts formed in this manner include: sodium carbonate (washing soda), calcium chloride, calcium sulphate, calcium carbonate, magnesium sulphate, ammonium chloride, copper sulphate (blue vitriol) etc. You have used some of these salts in the chapter ‘Water - hard and soft’.

But it is important to remember one thing. All neutral solutions are not salt solutions. For example, sugar or starch solutions are neutral but sugar and starch are not salts. So you should make the mistake of labelling all neutral solutions you come across as salt solutions.

Similarly, some salts solutions are not neutral, but acidic or basic. For example sodium carbonate is a salt that is basic in nature and reacts with an acid.

QUESTIONS FOR REVISION

1. **Twenty drops of hydrochloric acid are poured in a test tube. It takes 20 drops of a solution of sodium hydroxide to neutralise this acidic solution. If 20 drops of the sodium hydroxide solution are poured in a clean test tube, how many drops of acid would be required to neutralise it?**
2. **A teacher prepared one litre each of acidic and basic solutions in her class. Ten drops of the acidic solution can be neutralised by 10 drops of the basic soluton. A student accidentally added water to one of the two solutions.**

   When neutralisation was again carried out, 15 drops of basic solution were required to neutralise 10 drops of acidic solution.

   Can you say which solution was diluted with water?

   Can you also say how much water was added to the solution?
3. **Anita neutralised 10 drops of sulphuric acid with sodium hydroxide (caustic soda) solution. She needed seven drops of caustic soda solution for the purpose.**

   She then added 10 ml of water to 20 ml of the caustic soda solution to get 30ml of diluted solution.

   How many drops of this new caustic soda solution would she requireto neutralise 10 drops of sulphuric acid?
4. **Ten drops of a base were required to neutralise 10 drops of a certain acid ‘A’.**

   Twenty drops of the same base were required to neutralise 10 drops of another acid ‘B’.

   Fatima poured 5 ml of acid ‘A’ in a test tube and added 10ml of acid ‘B’ to it. She then neutralised this new solution with the same base used above. How many drops of the base did she require?
5. **It takes 20 ml of an acid to neutralise 30 ml of a base. If we take 20 ml of the base, how much acid would be required to neutralise it?**

NEW WORDS

salt neutralisation

Chapters-8

PRINCIPLE OF THE BALANCE

Why do things fall to the ground when we hold them up and drop them? (1)

The force that pulls a body downwards is called its weight. You performed some experiments on this subject in the chapter 'Where there is no force'. You also learned that this force acts on a body because of the earth's attraction.

In the marketplace, things like gold, silver, grain, pulses, sugar, vegetables, salt, oil etc are bought and sold by weight.

When you buy or sell these things, what unit does the tradesman use to weigh them? (2)

Weight is measured in grams, kilograms and quintals. A kilogram contains 1,000 grams and a quintal contains 100 kilograms.

How many grams are there in a quintal? (3)

Milli means a thousandth part. If a gram is divided into 1,000 equal parts, each part is a milligram.

How many milligrams are there in a gram? (4)

How many milligrams are there in a kilogram? (5)

1 quintal	=	100 kilograms
1 kilogram	=	1,000 grams
1 gram	=	1,000 milligrams

In earlier times, gold was measured in units called *tola, masha, ratti* etc. But today, things are measured in milligrams, grams, kilograms and quintals.

Do you know of any other unit for measuring weight? List these units. (6)

How many grams are there in a *tola*? (7)

How many grams are there in a *masha*? If you do not know, find out from someone who does. (8)

Also, find out how many grams there are in other units of weight. (9)

Based on your answers to Questions 3 to 9, which units do you think are more convenient for measuring weights, and why? (10)

BALANCES OF DIFFERENT KINDS

You may have come across different kinds of balances or scales for measuring weights - in shops, the grain market, the post office, the railway station, the goldsmith's.

DO A LITTLE EXPLORING

Go to these places and examine these balances used to measure weights. See how they work. Sketch them in your exercise book. (11)

THE BALANCE IN YOUR KIT

Your kit contains a balance that can weigh 1 to 200 grams. Examine this balance and each of its weights carefully. It has two identical pans which weigh the same. Each pan has three equally spaced holes. Attached to these holes are chains of equal length. The chains of each pan are attached to a hook. The hooks, in turn, are attached to the two ends of the beam of the balance. The weight of these hooks are also equal.

Does your balance have a rider? (12)

Why do you think a balance needs a rider? (13)

We shall discuss the importance of the rider later. For the moment, look carefully at the beam of the balance. It is fixed to a metal pivot at its middle, just below the needle of the balance. The beam moves freely on this pivot.

If the beam cannot move freely on the pivot how would this affect the balance? (14)

The needle at the centre of the beam indicates whether the pans are balanced or not.

If you hold up the empty balance by its handle and find that

- **the beam leans to one side, or**
- **the pans of the balance are not level, or**
- **the needle of the balance does not point to the centre,**

then would you call it a proper balance? (15)

If not, then what is a proper balance? (16)

What would be the position of the beam if two objects of equal weight are placed in the two pans of a proper balance? (17)

The scales are said to be **balanced** in this position.

In which position should the needle be when a shopkeeper says his scales are balanced? (18)

When the scales are balanced, we can exchange the contents of the two pans - shift the contents of the left pan to the right and the right pan to the left - and the scales will remain balanced.

Empty the pans of the balance in your kit and hold it up by its handle.

Is it balanced? (19)

Place a 1 gm weight in one of its pans.

What happened to the balance? (20)

Can you weigh a 1 gm weight with this balance? (21)

The writing on the beam says ‘To weigh 200 grams’. This means you cannot weigh more than 200 gm with this balance.

If you weigh objects heavier than 200 gm, your balance will be ruined.

If the balance is ruined, can you still weigh a 1 gm object? (22)

To answer this question, study your answer to Question 14.

Look carefully at the ends of the beam. There are holes with sharp inner edges at the ends. The pans are attached to hooks hung from these holes.

The pans hang from two specific points in the holes at the ends of the beam.

Take a scale and thread and measure the distance between these points and the pivot in the middle of the beam. (23)

What did you find? (24)

You have just observed two essential characteristics of a two-pan balance.

THE WEIGHTS OF YOUR BALANCE

You may have observed shopkeepers weighing goods with their balances. They use weights of different measures. Your kit contains weights of 200 gm, 100 gm, 50 gm, 20 gm, 10 gm, 5 gm, 2 gm and 1 gm. Can you weigh anything from 1 gm to 200 gm with your balance using these weights? Since there is only one balance and set of weights in the kit for the whole class, you will have to make your own balance and weights to perform the following experiments.

A NOTE FOR THE TEACHER

> There is only one balance and one set of weights in the kit. So get each group to make its own balance and set of weights. To help them do this, each group should be allowed to use the balance and weights in the kit during its free time.

MAKE YOUR OWN WEIGHTS

You can make your own weights using the balance and weights in the kit. Some ways of making weights are given below. You can choose the way that suits you best.

1. Every coin has a fixed weight. Weigh different coins to find out their weights. Use combinations of these coins to obtain a desired weight. You could tie each lot of coins in a polythene bag and put a tage with the weight in grams. As far as possible, try to use new coins.

2. You could make weights from broken tiles, bricks or wood. The tiles or bricks can be scraped and the wood shaved down to the desired weight.

3. You could put heavy things like nails, pebbles, sand, ball bearings, nuts and bolts in a polythene bag to get a desired weight.

4. You could collect smooth pebbles of different sizes from the river bed and use them as weights.

You could think of several other ways of making your own weights.

Each group will need a set of weights for the following experiments. In addition to 1 gm and 200 gm weights, they will need two weights each of 20 gm, 30 gm, 40 gm, 50 gm, 60 gm and 100 gm. Each group must have this entire set of 14 weights.

MAKE YOUR OWN BALANCE

Have you ever tried to make a balance before? Now that you know the important features of a balance, you can make one that weighs things accurately. It will certainly be more accurate than any balance you made earlier.

You could use bowls, the lids of tin containers or the caps of plastic bottles for your pans. But make sure both pans are identical.

What would you use for the beam? Perhaps, you could ask the ironsmith or a mechanic to fashion an iron rod for the purpose. Or you could ask a carpenter to make you a wooden beam. Or else you could yourself trim a piece of bamboo and make holes or grooves in it. You could even make the pivot yourself. The more effort you put in, the better will your balance be.

Use materials that will permit you to weigh as little as 1 gm and as much as 200 gm with your balance. If you find it difficult to make a single balance to weigh this wide range of weights, make two separate balances - one for measuring small weights and one for heavier weights.

Now answer this question: Why did we suggest that you make two separate balances for light and heavy weights?

A goldsmith would not use a grain merchant’s balance to weigh gold. Nor would you weigh the grain you buy on a jeweller’s scales.

Can you explain why this can’t be done? (25)

What special features must a balance to weigh light items possess? (26)

What special features must a balance to weigh heavy items possess? (27)

If you did make two separate balances, what differences were there in the materials you used in each balance? List these differences in a table. (28)

You will now perform several experiments using your weights and balances. So make sure your balances are sturdy. Perhaps these pictures of balances made by other students can provide some guidance to you (see Figure 1-b).

HOW GOOD IS YOUR BALANCE?

Hold your balance by its handle and examine it. Push one end of the beam down with your finger, then let it go.

Did the beam return to its original position? (29)

The beam should swing freely and easily on the pivot at its midpoint. It should not stick. Each time you push the beam down, it should return to its original position. If this does not happen, check what the problem is and rectify it.

EXPERIMENT 1

FIXING THE RIDER

Hold up your balance again.

Is it balanced? (30)

If it is not balanced, then fix a rider to one side of the beam to balance it.

Which problem in your balance did you solve by using a rider? (31)

Figure 1-a : The weighing balance in your kit

EXPERIMENT 2

A SURE WAY TO TEST YOUR BALANCE

Place a 100 gm weight on each pan of your balance. Is it balanced?

If it is, it means your balance is properly constructed.

> Putting equal weights on each pan of your balance is a sure way of testing whether your balance is correct or not. Use this test whenever you need to check your balance in the following experiments.

Even if your balance is properly constructed, you would still have to perform the following experiments to understand the principles of a balance. If you study some of the faulty balances made by your classmates you will get a clearer idea of these principles.

If your balance is faulty, there could be three possible reasons for the imbalance:

- there could be some problem with your weights.
- there could be something wrong with your balance.
- your weights and balance could both be faulty.

Figure 1-b : Weighing balances built by students. Check the materials used to make the pans. You could use such materials to construct your own balance.

Check the weights you have made with the help of the balance and weights in the kit.

If your weights are faulty, rectify them. Test your balance once again by putting weights in both pans.

If your balance is still imbalanced, the fault is not with the weights. The problem must lie in the balance itself. This is a problem that cannot be solved by using a rider.

So what could be the cause of the problem?

To understand the cause, you need to understand the principle of a balance. For this you will need to perform a few experiments.

EXPERIMENT 3

Take a half-metre scale. Tie a thick string around its middle. The scale should be balanced when it is held up by the string. That is, it should not lean to one side but should hang parallel to the ground.

In this position, the point at which the string is tied is called the **balancing point**. Mark the balancing point on the scale and note its centimetre reading. Ensure that the string does not slip when you mark the balancing point.

Figure 2

Take your 20 gm, 30 gm, 40 gm and 50 gm weights. Tie a thread around each weight to form a loop, as shown in Figure 3. You can hang these weights from the scale by these loops.

Figure 3

First hang the 20 gm weight exactly 10 cm to the left of the balancing point of your scale. The loop should hang exactly from the 10 cm mark. The correct way to hang the weight is shown in Figure 4.

Figure 4

Hang the other 20 gm weight on the other side of the balancing point. Its distance from the balancing point should be such that the scale is balanced when you lift it by its string handle.

How far from the balancing point did you hang the second 20 gm weight? (32)

Shift the left hand weight 15 cm from the balancing point. Then slide the right hand weight until the scale is balanced.

How far from the balancing point did you have to hang the right hand weight this time? (33)

What conclusion can you draw about balancing the scale and the distance at which the weights are hung from the balancing point? (34)

Repeat the experiment with the 30 gm, 40 gm and 50 gm weights, hanging them at different distances from the balancing point and confirm whether your conclusion is correct. (35)

SOLVE THIS RIDDLE

A balance has pans of the same weight and equal weights are placed in them. Yet the beam of the balance is not horizontal.

Based on your observations in Experiment 3, what do you think could be the problem with this balance? (35)

RECTIFYING THE BALANCING ERROR

Measure the distance of the two pans from the balancing point. Are these two distances the same? If they are not, make them equal. Is your balance correct now? Hold it up to find out.

EXPERIMENT 4

Slide the string handle 1 cm to the left or right of the balancing point. Hang 20 gm weights at a distance of 20 cm on either side of this new point.

Is your scale balanced? (36)

Why do you think this happened? (37)

At the end of Experiment 3 you had measured the distance of the pans on either side of the balancing point and equalised these distances.

If your balance was still incorrect after this adjustment, then explain on the basis of your observations in Experiment 4 what could be the possible problem. (38)

CHECKING THE BALANCING POINT

Remove the pans of your balance. Lift the beam by the handle.

Is it balanced?

If it isn't, correct the balancing point of the beam. Hang the pans at equal distances from this point.

Now check your balance again.

If the balance is still faulty, the only remaining possibility of error could be the rider. It may not be in the correct position. Your balance will be accurate if you shift the position of the rider.

DON'T LOSE HEART

If, after doing all this your balance still poses problems, it could be that you erred in fixing the balancing point, or in hanging the pans at equal distances on either side, or in fixing the rider. Recheck each step and try to find out where you may have erred. Rectify your error and fix your balance.

HOW USEFUL IS YOUR BALANCE?

What is the smallest weight you can weigh with your balance? Experiment and find out. (39)

In your estimation, what is the heaviest weight you can weigh on your balance? (40)

EXPERIMENT 5

Your balance is ready. Let us now weigh some things with it. There are three aluminium blocks of different sizes in your kit.

Weigh these blocks on your balance and record their weights in your exercise book. (41)

A WARNING

Your balance and weights are only to be used in your experiments. Do not use them for buying and selling things in the marketplace. It is a legal offence to use a balance and weights that do not carry the stamp of the Inspector of Weights and Measures.

EXPERIMENT 6

A CLOSER LOOK AT THE PRINCIPLE OF A BALANCE

In Experiment 3 you used equal weights on the two sides of your balance. We shall now repeat this experiment but with different weights.

Balance your scale by sliding the string handle back to the balancing point.

Hang a 20 gm weight 16 cm to the left of the balancing point. Hang a 40 gm weight on the right side. Now balance your scale.

How far from the balancing point did you have to slide the 40 gm weight? (42)

Now hang the 20 gm weight 24 cm to the left of the balancing point.

How far did you have to hang the 40 gm weight to balance your scale this time? (43)

Hang the 40 gm weight 7 cm to the right of the balancing point. Estimate the distance at which you will have to hang the 20 gm weight in order to balance your scale. (44)

Check your answer by actually performing the experiment.

If you hang the 40 gm weight 11 cm to the left of the balancing point, how far to the right would you have to hang the 20 gm weight to balance your scale? (45)

Repeat the experiment with a 30 gm weight on one side and a 60 gm weight on the other.

E**xplain the conclusion you have drawn from this experiment. (46)**

EXPERIMENT 7

THE PRODUCT OF BALANCING

If we combine the conclusions of Experiment 3 and Experiment 6, we arrive at the principle on which a balance works. Let us perform this experiment in even finer detail to understand this principle more thoroughly.

Copy the table on Page 74 in your exercise book and fill the data from Experiment 3 and Experiment 6 in the table. (47)

Hang a 20 gm weight 10 cm to the right of the balancing point. Hang a 10 gm weight on the left side and balance your scale. Now balance your scale using 30 gm, 40 gm, 50 gm and 60 gm weights, one by one.

Record your results in the table. (48)

Hang a 20 gm weight 20 cm to the right of the balancing point. Now balance your scale using, one by one, 30 gm, 40 gm, 50 gm and 60 gm weights. Record your results in the table.

Hang a 50 gm weight 7 cm to the left of the balancing point. On the right side, hang, one by one, a 20 gm, 30 gm and 40 gm weight and balance your scale. Record your results in the table.

Make the calculations to fill in the ‘product’ column of your table. Some products have been given as examples so you should be able to fill in the rest of the column.

Compare the products on the left side of the table to those on the right side.

Table

What did you learn in each experiment? (49)

Do you understand the principle which emerges from these three experiments? Discuss the principle with your teacher and explain it in writing. (50)

THE EQUATION OF THE BALANCE

You have solved many equations in your mathematics class. We use the equal sign (=) to depict equality of both sides of an equation.

The product on the left side in these experiments was:

(weight on the left side) x (distance of weight from balancing point)

The product on the right side was:

(weight on the right side) x (distance of weight from the balancing point)

Write your principle in the form of an equation (51)

This equation is the formula for the principle of the balance.

EXPERIMENT 8

USING THE FORMULA TO WEIGH A HEAVY OBJECT WITH SMALLER WEIGHTS

Study the conclusions you reached in Experiment 7. You have a half-metre scale with a string handle at its balancing point.

If you are given a 40 gm weight, can you find the weight of the largest aluminium block in your kit? How would you weigh the aluminium block? (52)

Hang the aluminium block 4 cm to the left of the balancing point. Then hang the 40 gm weight on the right side of the balancing point and balance your scale.

Note the distance of the weight from the balancing point. (53)

What is the product of the right side of your scale? (54)

This product will equal the product of the left side of your scale on which is hung the aluminium block whose weight you do not know.

Now using the formula of the principle of the balance, calculate the weight of the aluminium block. (55)

NEW WORDS

rider horizontal balance

imbalance balancing point

Chapter-9

RELATIVE DENSITY

You know that some things float in water and some things sink in it. But have you ever taken one of those things that float in water and tried to see if it floats in kerosene?

HAVE A LITTLE FUN

Take a boiling tube and fill it about halfway with water. Add 15 to 20 ml of kerosene to the water. Drop in, one by one, 2 to 3 plastic buttons, 1 to 2 pins, pieces of a matchstick, small pebbles, tiny paper balls, some sand, bits of wax etc and see what happens. Close the mouth of the boiling tube and shake it well. Wait for some time and again observe what happens.

Did kerosene float above the water or did water float above the kerosene? (1)

Which objects floated in kerosene? (2)

Why didn't they sink in kerosene? (3)

Which objects sank in kerosene but floated in water? (4)

Why were they stuck in between? (5)

Which objects sank in water? Why did they sink? (6)

Draw a diagram of the boiling tube, showing the results of your experiment. (7)

Why did different objects behave differently? Which objects floated in which liquid and sank in which liquid? We shall try to find answers to these questions in this chapter.

SOME QUESTIONS, SOME ANSWERS

You know that a glass marble sinks in water while a matchstick floats in it.

Can you tell why this happens? (8)

You would probably say that the marble sank because it is heavy while the matchstick floated because it is light.

Is this what you think? (9)

Perform the following experiment and again think about the problem.

Take a glass marble and a wooden block.

Which is heavier? (10)

Float each separately in water.

What happened? Based on the results of this experiment, will you still say a light object floats while a heavy object sinks? (11)

WHAT IS HEAVY, WHAT IS LIGHT?

To understand the results of the experiment we just did, we must understand the meaning of the term heavy. We use this word in our everday life in two ways: We say "Two quintals of wood are heavier than one quintal of iron". But we also say "Iron is heavier than wood".

Can you explain the difference in meaning of the word 'heavier' in both these sentences? 12)

Scientists try to ensure that each word they use has only one meaning for everyone. So let's see in what way these two sentences differ.

The first sentence says if we keep two quintals of wood in one pan of a balance and one quintal of iron in the other, the beam of balance will tilt towards the pan with wood in it.

What is the meaning of the second sentence?

When we say iron is heavier than wood, it means if we take a piece of iron and a piece of wood of the same size and weigh them, the iron will be heavier than the wood. In the language of science, we say "Iron is more dense than wood".

To understand this better, consider the two examples below.

Example 1

Neeraj took some wheat to the mill to grind. He filled a tin box to the brim with wheat. After the wheat was ground, Neeraj found that the box was not big enough to carry all the ground wheat.

Can you explain why this happened? (13)

Example 2

A bottle in the school laboratory holds one kg of water when filled to the brim. The teacher gave this bottle to Shama and asked her to get one kg of oil. The shopkeeper filled the bottle up to the brim with oil, but there was still some oil left over.

Why did this happen? (14)

Which is more dense - water or oil? (15)

Suppose we take two test-tubes of the same size and fill one to the brim with water and the other with oil.

On the basis of your answer to question 15, explain which will weigh more and why? (16)

WHICH IS MORE DENSE - RELATIVE DENSITY

Your science kit contains two equal sized blocks made of wood and rubber.

Which of these two blocks is heavier? (17)

Can you tell which one is more dense? (18)

SOLVE THIS PROBLEM

You have two blocks. You do not know what material they are made of. The volume of one block is 30 cubic cm while the other is 60 cubic cm. The second block is heavier than the first.

Based on this information, can you tell which of the two blocks is more dense? (19)

When the volume of two objects is different, it is difficult to tell which object is more dense solely on the basis of its weight. One way in which we can compare the denseness of objects is to take equal volumes of the two objects and compare their weights. But this is not always possible.

There is another simple method. Let's perform an experiment and learn this method.

But first, check your weighing balance. We shall have to weigh objects several times to find how dense they are so your balance should function properly. The way to check your balance is explained in the chapter on principles of the balance.

We shall use a simple method of comparing the denseness of each object with water. In the following experiment we shall find out how many times each solid object is more dense than water. This is the relative density of that object. Relative density means how many times an object is more dense than water.

To find the relative density of an object, we must first weigh the object and then weigh an equal volume of water. The two weights are then compared. Let us perform an experiment to understand how this is done.

EXPERIMENT 1

Take an overflow vessel and a 50 ml measuring cylinder from your kit. You already have a weighing balance and weights.

Copy Table 1 in your exercise book and record the results of your experiment in it. First we shall find out the relative density of rubber.

Table 1

Weight of measuring cylinder .... gm

S. No.	Name of object	Weight of object	Weight of displaced water and cylinder	Weight of displaced water by object	Relative density of object
(1)	(2)	(3)	(4)	(5)	(6)

Weigh the empty 50 ml measuring cylinder. Remember that you will have to use the same measuring cylinder throughout the experiment. Otherwise your results may not be correct.

Note the weight of the cylinder in the table. (20)

Weigh the rubber block.

Record this in column 3 of the table. (21)

We need to find the weight of water equal to the volume of the rubber block. Only then can we find out how dense the block is compared to water. That is, the relative density of the block. We require the overflow vessel for the purpose.

Pour water in the overflow vessel until it starts dripping from its beak. When water stops dripping from the beak, place the 50 ml measuring cylinder under it. Slip the rubber block gently into the water, ensuring that water does not splash out. Once the block is in the overflow vessel, water flows out of the beak and collects in the cylinder. Wait till the flow stops.

Weigh the cylinder with the water that overflowed and record the weight in column 4. (22)

If we subtract the weight of the measuring cylinder from this weight, we get the weight of water.

This is the weight of water displaced by the rubber block. Record it in column 5 of the table. (23)

Based on what you learned in the chapter ‘Volume’ in Class 7, say whether the volume of water is equal to the volume of the rubber block. (24)

We can find the relative density of the block by taking the weight of the block and dividing it by the weight of an equal volume of water. This tells us how many times the block is denser than water.

$$\text{Relative density} = \frac{\text{weight of the object}}{\text{weight of water equal to the volume of the object}}$$

Find the relative density of the block and record it in column 6 of the table. (25)

Repeat the experiment with other objects made of rubber or iron like nails, weights etc.

Record your observations in the table. Also, calculate the relative density of each item and note it in the table. (26)

Check the relative density of iron and other objects in the table and say whether the relative density of iron increases , decreases or remains the same with the increase or decrease in volume of the items. (27)

Is iron more or less dense than water ? (28)

Find the average relative density of iron from the figures in your table.

One interesting aspect of relative density is that it has no units. Whenever we measure something we have a unit of that measurement. For example the unit for volume is cubic cm, for speed cm per sec etc. We shall discuss later why there is no unit for relative density.

EXPERIMENT 2

Find the relative density of other objects, using the same method. For example, wooden block, rubber block, glass slide, plastic cubes etc. You can even use glass marbles, stones, cork etc. But remember, whatever object you take, its volume should be more than 20 ml. For example, one glass slide will be insufficient. You will have to take 10 slides for the experiment.

Find the relative density of various objects and record the results in Table 1. (29)

Based on the table, answer the following questions:

Do objects that have a relative density less than 1 sink or float in water? (30)

Do the objects that sink in water have a relative density less than 1 or more than 1? (31)

Explain in your own words the relationship between relative density and floating-sinking of objects? (32)

We have discussed the relative density of solid objects. We can also find the relative density of liquids. For this, we need to find the weight of a fixed volume of the liquid and the weight of an equal volume of water. The formula for finding the relative density of a liquid is:

$$\text{Relative density} = \frac{\text{weight of the liquid}}{\text{weight of the same volume of water}}$$

EXPERIMENT 3

In this experiment we shall find the relative density of milk, groundnut oil and kerosene. Take a small bottle in which you can fill about 50 ml of liquid.The bottle should weigh not less than 10 gm.

Draw Table 2 in your exercise book.

Table 2

Weight of the empty bottle = ... gm

S.No.	Name of liquid	Weight of bottle filled with liquid (gm)	Weight of liquid (gm)	Relative density
1.	Water			
2.	Milk			
3.	Groundnut oil			
4.	Kerosene			

Record your observations in T able 2. (34)

The volume of the liquids in the bottle were the same. We can, thus, find their relative density using the above equation.

Calculate the relative densities and note the figures in the table. (35)

Answer the following questions by comparing Table 1 and Table 2.

If groundnut oil is poured over water, which liquid will float on top? (36)

If we put a wooden block in kerosene, will it float or sink? Give reasons for your answer. (37)

A SIMPLE QUESTION

A piece of wax floats in water but the same piece sinks in liquid A.

Based on this observation, will the relative density of liquid A be less than 1 or greater than 1? (37)

WATERY MILK OR MILKY WATER?

Can we use relative density to find out whether water is added to milk? Let's try and find out.

If we mix some water in milk, will the relative density of the mixture be less than or more than the relative density of milk? Refer to Table 2 to find the answer. (38)

If we take two bottles of equal volume and pour pure milk in one and milk mixed with water in the other, which one will be heavier? (39)

We can use a simple instrument to find out. It is called a lactometer.

EXPERIMENT 4

MAKE A LACTOMETER

This is a simple instrument that you can easily make yourself.

Take an empty ball point refill. It should have a metal point. Take a boiling tube and fill it with water. Put the refill in with the metallic point inside the water.

Did the refill sink completely or is some part above the water surface? (41)

Use a pen to mark the point on the refill that is at the water surface (as shown in the figure). Pour out the water from the boiling tube and fill it with milk. Float the refill in the milk.

Did the refill sink to the same mark as in water ? If not, did it sink more or less in milk than in water? Why did this happen? (42)

Put a second mark at the point where the refill is at the surface of the milk.

Now pour a mixture of milk and water in the boiling tube.

If we put the refill in this mixture, to which point it will sink? Take a guess. (43)

Test if your guess is correct by actually dipping the refill in the milk-water mixture.

TEST OF ADULTERATION: THE STORY OF ARCHIMEDES

In Experiment 4 we used a lactometer to find out whether milk was adulterated with water. How can we check adulteration in a solid object? Archimedes faced a similar problem many, many years ago. His king had a crown made of gold. It was a beautiful crown and the king liked it immensely. But he had doubts about whether the crown was made of pure gold. He called Archimedes and asked him to find out. But he placed one condition - Archimedes should not break or destroy the crown.

Archimedes thought hard and long. How could he solve the problem?

The questions below give you hints on how to solve the problem. Discuss these questions in class and solve the king's problem.

How much water does an object displace when it is completely immersed in water?

If we take the crown and an equal weight of gold and measure the amount of water they displace, will the amounts of water be equal?

Will the crown and gold displace different volumes of water? Discuss among yourselves.

Were you able to think of a method of solving the king's problem? If you were, explain your method. (44)

How did Archimedes solve the problem? The story goes that he decided to take a bath one day. The bathtub was full to the brim. When Archimedes got into his bathtub, he noticed that some water overflowed. This gave him the idea to solve the problem of the king's crown. He was so excited that he got out of his bathtub and, forgetting to put on his clothes, ran naked to the king's palace shouting 'Eureka, Eureka'. 'Eureka' means 'I found it' in Greek.

EXERCISES FOR REVISION

1. Given below are the relative densities of two objects.

A = 1.5 B = 1.7

If the weights of the two objects are equal, which one will displace more water? Give reasons for your answer.

2. Some figures are given below. Calculate which of the objects listed in the table will float in water and which will sink.

Name of object	Weight of object	Weight of displaced water	Sinks or floats
Iron block	100 gm	8 gm	
Piece of ice	500 gm	55 gm	
Plastic block	30 gm	25 gm	

3. You are given a 1kg weight of iron. You are also given a ball. The weight of the ball is 1 kg. How will you explain whether the ball is made of pure iron or whether it is adulterated?

4. You are given two test tubes. One contains water and the other sugar solution. You do not know which test tube has which liquid. One way to check is to taste both liquids. But if you are not allowed to taste, how will you identify them?

There are two possible methods. Can you explain the two methods?

UNIT FOR RELATIVE DENSITY

While discussing area, volume etc it was stressed that every measure must have a proper unit. What is the unit for relative density. Let us see how one finds out about the unit of measurement. On the same basis we shall find the unit for relative density.

We know that speed of an object is the distance covered by an object in a unit of time. That means:

$$\text{Average speed} = \frac{\text{distance covered}}{\text{time taken to cover that distance}}$$

Let us write units for each quantity in the formula.

$$\text{Average speed} = \frac{\text{cm}}{\text{second}} = \text{cm per sec}$$

What can be the unit for relative density?

First we shall write the formula for relative density.

$$\text{Relative density} = \frac{\text{Weight of the object}}{\text{Weight of an equal volume of water}}$$

The next step is to write the units for each quantity.The unit for weight is gm.Hence, wherever the word weight comes we shall write gm

$$\text{Relative density} = \frac{\text{gm}}{\text{gm}}$$

When you divide gram by gram, what do you get? Can you now reflect and say why there is no unit for relative density?

Chapter-10

WHAT SINKS, WHAT FLOATS?

You had performed some experiments and learned about relative density in an earlier chapter. Let's recall a few of the main points of that chapter. To help you remember what you learned, fill in the blanks in the following sentences.

To find the relative density of a substance, we need to know the weight of the substance and the weight of an .... of water. (1)

The unit to measure relative density is .... (2)

If we take equal volumes of two substances, the weight of the substance with a higher relative density will be .... (3)

The relative density of substances that float in water is .... (4)

If two substances have the same weight, the volume of the substance with a higher relative density will be .... (5)

Now a question about substances that sink.

Explain on the basis of relative density why a block of iron sinks in water. (6)

In this chapter we shall try and see how substances with a relative density greater than 1 can be made to float on water.

EXPERIMENT 1
MAKING IRON FLOAT

You saw what happens when you put a block of iron in water. Now take an iron vessel or container and try to float it on water.

Does the iron container float on water? (7)

Iron has a relative density greater than 1. So how does the iron container float on water? Before looking for an answer to that question, let's perform another interesting experiment.

EXPERIMENT 2
A BOWL MADE OF WHEAT FLOUR

Knead a little wheat flour and mould it into the shape of a bowl.

Does the bowl float on water? (8)

Now squash the wheat flour bowl into a ball and try to float this ball on water.

Does the ball of wheat flour float on water? (9)

Are the relative densities of the wheat flour bowl and the ball of wheat flour different? Then why does the bowl float and the ball sink?

We saw in the earlier chapter that substances with a relative density greater than 1 sink in water. But in Experiments 1 and 2, we saw that substances with a relative density greater than 1 can sometimes float on water. So it seems we cannot judge whether a substance will sink or float only on the basis of its relative density. There is definitely some other factor we need to take into account. Let’s investigate what this special property is that a substance that floats has but a substance that sinks doesn’t have?

In the earlier chapter we had compared the weight of the substance with the weight of the water it displaces to find its relative density. In that experiment, we immersed the substance fully in water and collected the water it displaced. We shall now do the same experiment, but with a slight difference. The substance will again be put in water. But this time, if it sinks we’ll let it sink and if it floats, we’ll let it float. We’ll collect the water displaced in both cases - whether the substance sinks or floats. We’ll then compare the weight of water displaced with the weight of the substance. So let’s begin the next experiment.

EXPERIMENT 3

Before beginning the experiment, copy Table 1 in your exercise book. Note down your observations in this table.

Place a beaker on the pan of a weighing balance. (If a beaker is not available, a small bowl or container will do.) Pour enough sand or any other substance in the other pan to balance the two pans. Let the sand remain in the pan.

Fill water in an overflow jar. Wait until the water stops dripping from the outlet of the overflow jar. Then take the beaker from the weighing balance and place it below the outlet of the overflow jar. Take a wooden block, moisten it with water and then drop it gently into the overflow jar. Don’t forcefully submerge the wooden block in the water. Also, ensure that it does not block the outlet of the overflow jar. Water will flow out of the overflow jar and collect in the beaker.

Do you think the weight of the water displaced by the wooden block will be less than or equal to or more than the weight of the wooden block? Take a guess. (10)

Place the beaker containing the displaced water on the empty pan of the weighing balance. Take the wooden block, wipe it clean of water and place it on the pan that contains the sand.

Do the two pans balance? (11)

Is the weight of the water displaced by the wooden block less than, equal to or more than the weight of the wooden block? Note your observation in the table. (12)

Repeat this experiment with several other substances that float or sink. Things that float could include a small bowl, a ball, a steel container and your wheat flour bowl. In each case, check whether the weight of the water displaced is less than, equal to or more than the weight of the substance.

Note your observations in the table. (13)

Table 1

S No	Name of substance	Weight of displaced water
1.	Wooden block	
2.	Rubber ball	
3.	Bowl	
4.	A fruit that floats	
5.	A fruit that sinks	

6. Wheat flour bowl

--

Your class teacher will now draw a collective table on the board. The results of all the groups should be entered in this table. If any group has a result that is very different from the other groups, that group should repeat the experiment.

On the basis of the collective table, explain the relationship between the weight of the substances that float and the weight of the water they displace. (14)

Can you express this special property of substances that float in the form of a theory? (15)

The special property of floating substances that you identified in this experiment was first discovered by a Greek scientist called Archimedes.

Test your theory by experimenting with several different substances that float.

THINK IT OVER

You had earlier performed an experiment with a wheat flour bowl. The bowl floated on water.

On the basis of Experiment 3, estimate how much water this wheat flour bowl will displace. (16)

If the same wheat flour is rolled into a ball, it will sink in water.

Will its relative density be less or greater than 1? (17)

The relative density of iron is also greater than 1. Can you think of a way to make iron float on water? (18)

Perhaps, the following experiment will give you some ideas about how you can float iron on water.

EXPERIMENT 4

Take a small sheet of aluminium foil. Fold it four or five times, pressing the foil tight after each fold. You already know the relative density of aluminium from an earlier experiment.

Given the relative density of aluminium, do you think the foil will float or sink in water? (19)

Drop the folded aluminium foil in the water and test whether your guess is correct or not.

Now unfold the aluminium foil and make it into a small bowl. Place this bowl in the water and see whether it floats or sinks.

How much water did the aluminium foil bowl displace? Explain on the basis of your theory of floating substances. (20)

Can you now explain why large ships made of iron and steel float on water while a small block of iron sinks in water? (21)

A QUESTION ABOUT HOT AIR

You may have seen puris being fried in oil. When the raw puri is put into the pan of oil, it first sinks. But after some time, it rises to the surface of the oil and floats.

Why does this happen? Can you explain in your own words? (22)

A COLDER QUESTION

Have you ever seen ice floating on water? You know that ice is formed from water. So how does it float on water?

If ice floats on water, what is the relationship between its weight and the weight of water it displaces? (23)

If we take a kilogram of water and a kilogram of ice, which would have the larger volume? (24)

A RIDDLE

Imagine a mug floating in a bucket of water. The water level is marked on the inner rim of the bucket.

Now suppose we immerse the mug in water in such a way that it first fills with water before it sinks.

Can you guess what effect the sunken mug will have on the water level in the bucket?

- **Will the water level remain the same?**
- **Will the water level rise?**
- **Will the water level fall?**

Give reasons for your answer. (25)

Test whether your guess was correct by actually doing the experiment. Write the results of your experiment in your own words. (26)

ANOTHER RIDDLE

Imagine a mug floating on water in a bucket. The mug contains a little water. The water level has been marked in the bucket.

We empty the mug and again float it on the water.

What effect would this have on the water level in the bucket? (27)

Do the experiment and see whether your guess was correct. Explain, with reasons, why the water level in the bucket was affected. (28)

Chapter-11

You have done experiments to produce gases like carbon dioxide and oxygen. How quickly was the gas produced in these experiments? Did it take some time for the gas to form?

What can we do to produce gas more quickly? (1)

In this chapter we shall learn how to measure the speed of chemical reactions and also see what affects this rate. There are different **causative factors** that affect the rate of chemical reactions.

WHO IS FAST, WHO IS SLOW

So the rate at which a gas is produced depends on the speed of the chemical reaction. If the reaction occurs fast, the gas is produced quickly. In fact, we can tell the rate of a chemical reaction by the rate at which the gas is produced. It is easy to measure the rate at which a gas is produced. For example, when you collect gas through water, you can count the number of gas bubbles that form in a minute to find out the rate of gas production. The faster the reaction, the more gas bubbles you get in a minute.

We shall produce carbon dioxide and hydrogen gases in the following experiments. The method for producing carbon dioxide is the same as that you used before. The only difference is that this time we shall change each factor one at a time while producing the gas to see how they affect gas production. You have not produced hydrogen gas before. You will learn the method of producing hydrogen in this chapter. So let's proceed.

CARBON DIOXIDE

You have performed this experiment before. Carbon dioxide gas is formed when we pour hydrochloric gas over marble chips.

Take an injection bottle with a rubber lid. Make a hole in the lid and push a piece of an empty ballpoint pen refill through it, with only a small portion of the refill being inside the bottle. Fit a long cycle valve tube to the upper portion of the refill.

Fill a testtube with water. Now take a tray or the lid of a tin and fill it with water. You are now ready to do the experiment. We shall do some experiments with carbon dioxide.

In Experiment 1-a we shall see how the concentration of the acid affects gas production.

In Experiment 1-b we shall study the effect of temperature.

In Experiment 1-c, we shall see whether there is any change in the rate of gas production if we use bigger or smaller marble chips.

EXPERIMENT 1-A
THE EFFECT OF ACID CONCENTRATION

In this experiment we shall see what difference there is in the rate of chemical reaction when we use concentrated or dilute hydrochloric acid. For this, we require two solutions of hydrochloric acid.

Take two test tubes and label them 1 and 2. Fill both testtubes with an equal quantity of hydrochloric acid. We shall not add any water to the acid in Testtube 1. In Testtube 2, we shall add as much water as the amount of acid in the testtube.

In this way, the acid in Testtube 1 is concentrated and the acid in Testtube 2 is dilute.

We shall now test both these acid solutions.

You should set up the apparatus for the experiment in the way shown in Figure 1. Before beginning the experiment, choose one person from your group to keep note of the time with the help of a watch. (S)he should note the time the moment the experiment begins and then count the number of gas bubbles that form. It would be better to begin counting the gas bubbles a little after the gas begins to form.

Figure 1

Stand the water-filled testtube upside down in the water in the tray. Ensure that no water spills out of the testtube while you turn it upside down. Put 4 to 5 marble pieces in the injection bottle. Then pour some concentrated hydrochloric acid from Testtube 1 over the marble chips. When some gas begins to come out of the valve tube, insert its free end into the testtube standing in the tray of water. The gas bubbles will pass through the water and collect in the testtube.

Count the number of gas bubbles with the help of the watch and then calculate how many gas bubbles were formed in a minute.

Note your observations in Table 1. (2)

Table 1

S.No.	Acid	Number of gas bubbles per minute
1	Concentrated	
2.	Dilute	

Now empty the acid from the injection bottle. Then repeat the experiment by adding the dilute acid from Testtube 2.

After the experiment, note down the number of gas bubbles formed in a minute in the table. (3)

How was the rate of gas production affected when the acid was diluted? (4)

Are the results of all the groups similar or different? (5)

In the next experiment, we shall try and examine the effect of temperature on the chemical reaction rate. We had not heated or cooled the acid we used in Experiment 1-a. Its temperature was the same as the temperature of other things around it. We call this temperature the room temperature. In the following experiment, we shall warm the acid a little and see what happens in the chemical reaction.

EXPERIMENT 1-B
THE EFFECT OF TEMPERATURE

Pour 5 ml of hydrochloric acid in a testtube and add 15 ml of water to it. Divide this acid into two equal lots in two testtubes. Put 4 to 5 marble chips in the injection bottle. Pour the acid from one testtube over the marble chips and collect the gas formed. Count the number of gas bubbles formed per minute.

Note this figure in Table 2 (6)

Table 2

S. No	Temperature of acid	Number of gas bubbles per minute
1	At room temperature	
2.	Warm	

Now empty the acid from the injection bottle. Don't throw away the marble chips. Warm the acid in the other testtube a little over a candle flame. When the acid is slightly warm, pour it over the marble chips in the injection bottle. Count the number of gas bubbles formed.

Note the figure in the table. (7)

How was the rate of the chemical reaction affected when the temperature was increased? (8)

If we used acid of different concentrations in this experiment, what problems would we face in reaching any conclusion about the effect of temperature on the rate of the chemical reaction? (9)

You saw the effect of acid concentration and temperature on the rate of chemical reactions in Experiments 1-a and 1-b. Can any other thing influence the rate of the chemical reaction? For example, would the rate change if we changed the size of the marble chips?

EXPERIMENT 1-c
BIG AND SMALL MARBLE CHIPS

Take a large marble chip. Pour 5 ml of hydrochloric acid in a testtube and add 15 ml of water to it. Divide the acid in two equal lots in two testtubes. Put the large marble chip in the injection bottle and pour acid from one testtube over it. Measure the rate of the chemical reaction.

Note your observations in Table 3 (10)

Table 3

S. No	Size of marble chip	Number of gas bubbles per minute
1.	Large	
2.	Fine particles (powdered)	

Now empty the acid from the injection bottle. Take the large marble chip from the bottle and crush it into a fine powder. Put this powder in the injection bottle and add the acid in the second testtube to it. Now count the number of gas bubbles to find out the rate of gas production.

Note your figures in Table 3 (11)

How was the rate of gas production affected by changing the size of the marble chips? (12)

The concentration of acid in both testtubes was the same. The temperature of the acid in both testtubes was the same. And the amount of marble chips in the injection bottle was the same.

Then why did the rate of gas formation change? Discuss the matter in class and write your answer in your own words. (13)

THE RATE OF HYDROGEN PRODUCTION

Hydrogen is also a gas like carbon dioxide and oxygen. It is easy to produce. Hydrogen is produced when sodium hydrochloride (caustic soda) reacts with aluminium. The question is, will there be similar effects on the production of hydrogen like we saw in the production of carbon dioxide?

Let's find out.

Put some aluminium foil in an injection bottle. You could also use the shiny seal of an injection bottle. Pour a solution of caustic soda over it and collect the gas produced in the way shown in the figure.

Just like we did in the case of carbon dioxide, we shall measure the rate of production of hydrogen gas under different conditions.

In Experiment 2-a, we shall see the effect of concentrated and diluted acid on gas production.

In Experiment 2-b, we shall change the temperature of the same solution of sodium hydrochloride and see the effect on the reaction rate.

In Experiment 2-c, we shall tear the aluminium foil into small and large pieces and see the effect on the reaction rate.

To measure the rate, we shall count the number of gas bubbles formed in a minute.\

These experiments should be done in exactly the same way as you did Experiments 1-a. 1-b and 1-c.

EXPERIMENT 2-a

Make two solutions of caustic soda according to the instructions contained in Table 4. Use these two solutions one by one in the experiment.

Table 4

S. No	**Concentration of solution**	**Number of bubbles per minute**
1.	2 gm of caustic soda in 15 ml water	
2.	2 gm of caustic soda in 30 ml water	

Note your figures in Table 4 (14)

EXPERIMENT 2-b

For this experiment, make a solution similar to the second solution of the previous experiment, with 2 gm of caustic soda in 30 ml of water. Divide this solution into two equal lots. Now do the experiment with one lot at room temperature and the second lot slightly warmed.

Note your results in Table 5 (15)

Table 5

S. No	**Temperature of solution**	**Number of bubbles per minute**
1.	At room temperature	
2.	Slightly warmed	

EXPERIMENT 2-c

Take two equal sized pieces of aluminium foil. Tear one of the aluminium foils into smaller pieces and let the other one remain intact.

Perform the experiments separately with the intact foil and the torn pieces of foil. But remember, use the same caustic soda solution in both cases.

Note your results in Table 6 (16)

Table 6

S. No	**Size of aluminium foil**	**Gas bubbles formed per minute**
1.	Large intact piece	
2.	Small pieces	

What was the effect of the different causative factors on the rate of production of hydrogen? Explain with reasons. (17)

Fill in the blanks in the following sentences:

1) **When the temperature was increased, the rate of the chemical reaction ....**
2) **If powdered marble is used instead of a single large marble chip, the gas is produced ....**
3) **If water mixes with the acid while we are producing carbon dioxide, ... gas will be formed. (18)**

NEW WORDS

Causative factors

Chapter-12

INTERNAL ORGANS OF THE BODY AND THEIR FUNCTIONS (II)

In 'Internal organs of the body and their functions (I)' you studied those organs that provide support to parts of the body and help them to move. In this chapter you will learn about the body's other internal organs. You will also learn about organs that coordinate and control various organs and systems of the body.

TWO DISSECTED RATS

Your kit contains two dissected rats 'A' and 'B'. Both are dissected from the underside of the body - the side where the abdomen is. The rat is laid on its back and the skin of its underside is cut lengthwise down the middle and separated from the muscles underneath. The muscles and ribs below the skin are also cut and removed. Once this is done, the organs below the muscles and ribs become visible in their natural position. Rat 'A' displays these organs (Figure 1). But the organs that lie below these organs, or towards the back, are not visible. Rat 'B' shows those organs lying towards the back. In order to expose these organs, some of the organs in front are cut and removed while others are tied to one side. Figure 2 shows a male rat 'B' and Figure 3 a female rat 'B'.

GETTING TO KNOW THE INTERNAL ORGANS

Observe rats 'A' and 'B' carefully. Identify their organs with the help of Figures 1, 2 and 3. Is your 'B' rat male or female ?

Figure 1 : Rat 'A' in your kit

In this figure, the skin has been dissected from above the testes and the testes are visible. The testes may not be visible in the rat in your kit because the skin may not have been cut open in this manner. Or else, the rat could be a female.

Figure 2 : Rat 'B' in your kit (male)

In Figures 2 and 3 the stomach, small intestine and large intestine have been pushed aside to the left. The tissue that holds these organs together has also been torn off. The pancreas is attached to this tissue so it is not seen. In this figure, the liver, diaphragm, lungs and respiratory tract have also been removed to reveal the oesophagus.

Figure 3 : Rat 'B' in your kit (female)

In this figure the left uterus is shown as a straight tube while the right uterus has four swellings or raised structures on it. Each swelling has an embryo within. Usually, embryos can be seen in both uteruses.

ORGANS OF DIGESTION

In Class 6, you learned in the chapter titled 'Our food' that digestion of starch begins in the mouth with the help of saliva.

Identify the following organs in rat 'B' with the help of Figure 2 :

mouth, oesophagus, stomach, small intestine, caecum and large intestine. The anus is situated at the end of the large intestine.

All these organs are part of the same tube in which food is digested. This tube is called the alimentary canal.

Cut out the diagram of the digestive system of a human being from your kit copy and paste it in your exercise book. Compare this diagram with Figures 1 and 2 which show the digestive system of the rat. Identify those organs that appear similar in the digestive systems of human beings and rats.

What do the arrows in the figure of the digestive system of the human being given in your kit copy indicate?

In rat ‘B’, observe the tube that carries food from the mouth to the stomach.

GLANDS OF THE DIGESTIVE SYSTEM

You learned in Class 6 that saliva is produced in the mouth. Saliva is produced in the salivary glands situated at the rear of the mouth. Identify these glands in Figure 4. Saliva helps to digest a part of the starch in the mouth itself.

Look at the liver of rat ‘A’. It is a large gland which is dark red in colour. The liver secretes bile which helps in the digestion of fat.

You can also see the pancreas in rat ‘A’. This is a small, spread out gland. Its juices help to digest starch, protein and fat present in food.

THE PROCESS OF DIGESTION

Food collects in the stomach. Hydrochloric acid and digestive juices are produced in the stomach. The food is mixed and churned thoroughly with these juices. The acid makes the food acidic and helps to kill any bacteria present in it. The food is churned by the contraction and expansion of muscles on the wall of the stomach. It becomes a semi-liquid mass. Muscles play an important role at every step of digestion. Their contraction and expansion causes food to move forward in the alimentary canal.

The digestive juices in the stomach mix with the food and help to digest protein.

The food now moves to the small intestine. Juices from the liver and pancreas pour into the small intestine. The food becomes alkaline and turns into a thin liquid. The process of digestion is completed in the small intestine.

The major portion of the food digested in the stomach and intestine, along with water and salts, is absorbed in the intestine. Once water is absorbed, the remaining undigested food is expelled through the anus in the form of faeces.

Digested food is used in the body in two ways. The body gets energy from food. In addition, food helps the body to grow and helps to maintain and repair it.

The digestion of food, the absorption of digested food, water and salts and the formation of faeces are part of the process of digestion. The organs which help in this process are called digestive organs. The digestive organs - alimentary canal and its related glands - together form the digestive system.

DIARRHOEA: A DISEASE OF THE DIGESTIVE SYSTEM

In our country, thousands of children die every year of diarrhoea. Because of constant loose motions, the body of a victim loses a lot of water and becomes dehydrated. The tongue becomes dry. If the skin is pinched, it takes a long time to return to its normal shape.

Pinch your skin. Does it return to its normal shape soon?

Treatment of diarrhoea: Add a pinch of salt and a teaspoon of sugar to a glass of water and make the patient drink this solution at frequent intervals. This is a life-saving solution or *jeevan-rakshak ghol.*

The patient should continue to eat normal food and should be taken to the hospital as soon as possible.

CIRCULATORY SYSTEM:

THE FLOW OF BLOOD IN THE BODY

Food is digested in the alimentary canal. How is the digested food sent to every part of the body?

The digested food is absorbed in the intestine and goes into the blood, which carries it to various parts of the body.

Have you ever thought about how blood reaches every part of your body?

Identify the heart of rat 'A'. The heart is the organ which acts like a pump. It contracts and expands continuously. When it contracts, blood is pumped all over the body through pipes or blood vessels. When it expands, blood is brought back to the heart from various parts of the body through another set of blood vessels. The heart and these two sets of blood vessels form the circulatory system.

Put your ear to the left side of the chest of your friend.

Do you hear a sound?

This is the sound of the heart beating.

Can you feel the beating of the heart with your hand?

When a doctor examines a patient, (s)he uses a stethoscope to listen to the sound of a patient's breathing as well as the beating of the heart.

It is possible to see or feel some blood vessels below the surface of our skin. We shall perform some experiments for the purpose.

EXPERIMENT 1

IDENTIFY YOUR VEINS

Hold your right arm tightly with your left arm, just above the elbow, as shown in Figure 5.

Close your right fist and shake it up and down 4 or 5 times. Look carefully at your right forearm.

Do you see any swollen blood vessels on it? (1)

Now release the arm.

Does it come back to normal?

The swollen vessels you saw carry blood from the hand to the heart. The vessels which carry blood from the organs to the heart are called veins.

Why do the veins swell when the upper arm is gripped tightly? (2)

You may have seen a doctor or *vaidya f*eeling the pulse of a patient. Let us try to feel the pulse ourselves.

EXPERIMENT 2

THE BEATING OF THE PULSE

Hold the wrist of one hand with the fingers of your other hand as shown in Figure 6. Press the wrist slightly with your fingers.

Could you feel a beat?

With the help of a watch, find out how many beats occur in a minute. Note this figure in your exercise book. (3)

The vessels which take blood from the heart to different parts of the body are called arteries.

When the heart pumps blood into the arteries, the arteries beat simultaneously with the heart. This beat is called the pulse.

Feel the beating of your heart and the beating of your pulse simultaneously. Do they beat at the same time?

Locate other parts of the body where you can feel the pulse. Make a list of these organs. (4)

Arteries and veins are spread over the body like a net. The network of major arteries and veins of the human body is shown in Figure 7.

Digested food reaches different parts of the body through the blood. There the food combines with oxygen and energy is released. This energy is used by the body. This process is called oxidation.

Can you think how oxygen gets into the blood? (5)

RESPIRATORY SYSTEM

In Class 7 you performed experiments on respiration. During respiration, oxygen is absorbed from the air we breathe in and carbon dioxide is released.

The respiratory organs of a human being are shown in Figure 8. Examine them and answer the following questions:

When the ribs expand and the diaphragm is pulled downwards, what effect could this have upon the lungs? (6)

When the ribs contract and the diaphragm is lifted upwards, what effect could this have on the lungs? (7)

EXPERIMENT 3

Let us do an experiment to find out where the lungs are situated in our body and how they are affected when we breathe in and out.

Take a measuring tape or a piece of string. Measure the chest of your friend. To do this, take one end of the tape/thread around the back and bring it to the front of the chest. Hold both ends of the tape or string lightly and ask your friend to slowly breathe in and out.

How does the measurement of the chest change when air is inhaled and exhaled? (8)

TUBERCULOSIS (TB): A DISEASE OF THE RESPIRATORY SYSTEM

Tuberculosis affects the lungs of the patient.

Which function of the body would be affected if something went wrong with the lungs? (9)

A TB patient gets a fever every evening and perspires at night. (S)he coughs constantly, becomes weak and loses appetite. (S)he begins to lose weight and spits blood. A person with these symptoms should be taken to the hospital immediately for examination by a doctor.

TREATMENT OF TB

There are medicines available today that can cure TB. But they need to be taken daily for many months under the guidance of a doctor.

SMOKING AND THE RESPIRATORY SYSTEM

Cigarette or *bidi* smoke contains many harmful substances. The lungs of heavy smokers are damaged by this smoke and they suffer from shortness of breath. They cough constantly and their lungs and trachea face the risk of contracting a dangerous disease called cancer.

THE RELATIONSHIP BETWEEN THE RESPIRATORY AND CIRCULATORY SYSTEMS

All organs of the body need a continuous supply of oxygen for respiration. In the process of respiration, carbon dioxide is continuously formed in these organs. Carbon dioxide is harmful for the body and it is necessary to expel it. The blood brings oxygen to the organs of the body and takes carbon dioxide away from them.

The veins bring blood from all over the body to the heart. Look at the veins in Figure 7. The blood in the veins contains less oxygen and more carbon dioxide as compared to the blood in the arteries. This blood goes from the heart to the lungs.

The lungs contain the air we breathe in. The blood absorbs the oxygen from this air and discharges carbon dioxide into it. The air with carbon dioxide is breathed out.

The blood which has absorbed the oxygen now goes to the heart. The arteries take this oxygenated blood from the heart to the organs.

Complete the following sentences and write them in your exercise books:

a) The air we breathe into our lungs contains more ________ and less ________ . (10)

b) The air we breathe out of our lungs contains more ________ and less ________. (11)

c) The blood containing carbon dioxide comes to the heart from different organs of the body through through the _______ . (12)

d) The blood containing oxygen goes from the heart to different organs through the ___________. (13)

URINARY SYSTEM:

ORGANS THAT EXPEL HARMFUL SUBSTANCES FROM THE BODY

If urine collects in a place, it has a strong smell. This smell comes from a gas - ammonia.

Many chemical reactions take place in the body. During some reactions, ammonia gas is formed. This gas is harmful for the body. So it is necessary to expel it.

This gas is converted into urea in the liver. The urea dissolves in the blood and is carried to the heart from where it circulates to the entire body through the arteries. When it reaches the kidneys, the urea is filtered from the blood and expelled from the body in the form of urine.

The figure of the urinary system of human beings (male) is given in the kit copy. Cut it out and paste it in your exercise book. Compare it with the urinary system of rat 'B' as shown in Figure 2.

On the basis of this comparison, label the different organs of the human urinary system. (14)

Observe the arrows in the figure of the urinary system in the kit copy. Try and understand - with the help of these arrows - how the kidneys function.

Now complete the following sentences and write them in your exercise book:

a) Urine is mainly a solution of _________ in water. (15)

b) Blood containing urea reaches the heart from the liver through the __________. (16)

c) Blood containing urea reaches the kidneys from the heart through the __________. (17)

d) In the kidneys __________ is separated from the blood. (18)

e) Urine reaches the __________ from the kidneys through the ___________ and is then expelled from the body. (19)

REPRODUCTIVE SYSTEM

Try to identify the human reproductive organs with the help of the figure of rat 'B'.

Cut out the figures of the male and female reproductive systems from the kit copy and paste them in your exercise book. Compare the human reproductive system with the reproductive system of rat 'B'.

What difference do you see between the female reproductive organs of humans and rats? (20)

Sperms are formed in the testes. Similarly, ova are formed in the ovaries. The embryo is formed only after the sperm and the ovum fuse with each other. The embryo develops in the uterus.

Look at the figure of the human male reproductive organs and identify the tube (vas deferens) which takes sperms from the testes to the seminal vesicles.

What would happen if the vasa deferentia were tied up and closed? (21)

Look at the ovary and oviduct in the figure of the female reproductive system.

What would happen if ova from the ovaries were not allowed to reach the uterus? (22)

The procedure of closing the vas deferens and oviduct is called sterilisation.

CONTROLLING AND COORDINATING THE ORGAN SYSTEMS

We saw that the digestive, circulatory, respiratory and excretory systems are closely connected with each other.

Suppose there was no coordination between these systems. What would happen to the body? Would digested food be absorbed by the blood? If the blood did not carry oxygen, would it be possible to oxidise digested food in the cells of the body? If oxidation did not take place in the cells, how would they get energy to do their work?

In the chapter 'Internal organs of the body (1)' in Class 7 you learned that just as the different parts of a truck, tractor, car, motorcycle or bicycle work in a coordinated way, it is necessary for the internal organs of the body to work in coordination. There are two systems in the body that help to coordinate the functions of the internal organs. One is the nervous system and the other is the endocrine system.

NERVOUS SYSTEM:

A NETWORK OF FIBRES TO CARRY MESSAGES

You had performed some experiments on senstitivity in Class 6. You saw that we become aware of a sensation the moment something touches our palm. If we touch a hot object, we move our hand away. These reactions occur immediately, as quickly as an electric bulb lights up when the switch is pressed.

When a thorn pricks your foot, you remove it.

Which organs do you use to perform this task? List them. (23)

How did the hand come to know that it should remove a thorn from the foot? Is there some wire connecting the hand and the foot, like telephone wires?

Figure 10 shows the nervous system of human beings. The brain lies in the skull and the spinal cord lies in the vertebral column. Thread-like nerves come out of both these organs and spread all over the body like a net. In this figure, only the major nerves of the human body have been shown.

We know that our skin tells us whenever an object touches our body. We also know whether the object is hot or cold, hard or soft, or whether it is a gas, liquid or solid.

This is possible because our skin covers our entire body and has hundreds of thousands of sensory cells that collect information. These groups of sensory cells send the information to the brain and spinal cord through the nerves. The brain or spinal cord then orders the organ to act.

For example, when the hand touches a hot object, the sensory cells in the skin send a meassage to the spinal cord through the nerves. The spinal cord orders the muscles of the arm, through another set of nerves, to move the hand away from the hot object.

What would happen if the body did not have a nervous system? (24)

Apart from the skin, there are other organs in the body that collect information (sensation) from outside and convey it to the brain.

Can you identify some of these organs? Make a list of them. (25)

The organs that collect information from outside are called sense organs. The skin is a sense organ.

You saw that the brain and spinal cord control and coordinate actions like removing a thorn from the foot. This process of control and coordination goes on all the time in our body. We may not be aware of it most of the time. For example, when we exercise, the body needs more energy. To produce more energy, it is necessary that oxidation of the digested food takes place at a faster pace. For more oxidation, more oxygen is needed. So the rate of respiration should increase. The brain gives the message to speed up respiration because it controls all these processes.

LEPROSY

Have you seen a person afflicted by leprosy? This disease is caused by germs that attack and destroy the nerves of the hands and feet. The skin of the hands and feet loose their sensitivity. So a person suffering from leprosy won’t know that his fingers are getting burned if he picks up a glowing ember with his eyes closed. Nor would he feel any sensation if rats gnaw his fingers.

If anyone has a patch on her/his skin that does not hurt even after pricking it with a needle, (s)he should immediately consult a doctor. There is a cure available for this disease.

ENDOCRINE SYSTEM:

GLANDS WITHOUT TUBES

The endocrine system has many glands. These glands do not have tubes (ducts) to carry substances they produce to different parts of the body. These substances are released in the blood and circulate throughout the body. But they effect only those organs for which they are made. These glands are called endocrine glands and the substances produced in them are called hormones.

The thyroid gland is an example of an endocrine gland. Look at the thyroid gland in Figure 11.

The hormone produced in the thyroid gland controls digestion, respiration, circulation etc.

GOITRE

You may have seen persons with a big swelling on their throats that bloats their necks. This swelling is caused when a gland called the thyroid gland gets enlarged and this disease is called goitre. It is caused when there is not enough iodine in our food.

If the thyroid gland of a child does not produce enough hormone, the child's brain is affected. It does not develop properly and the child becomes dull. The child's skin becomes dry and the hair starts falling.

Let's now play a game of building a model of the internal organs

There is an outline of the human body in your kit copy. It contains many short lines marked with the alphabets a, b ... etc. Cut slits along these short dark lines with a razor blade.

Carefully cut out the figures of the organs given in the kit copy. Each organ outline has a square tag with an alphabet printed on it. Insert these tags into the slits with the corresponding alphabet in the body outline. You can look at Figure 12 for guidance.

The order in which to fix the alphabetically numbered organs:

a-b	Kidneys
c1-d1	Mouth and upper half of the food tube (oesophagus)
c2-d2	Mouth and upper part of respiratory tube (trachea)
e-f	Lungs
g-h	Stomach
i-j	Heart
k-l	Ureter
m-n	Small intestine
o-p	Large intestine
q-r	Spleen
s-t	Liver
u-v	Urinary bladder
w-x	Brain

Your model of the internal organs of the body is ready. When you fix the organs in this order you will see that some organs and systems lie on top of other organs and systems. This is the way in which the organs and organ systems are arranged in our body. Compare your model with Figure 12.

Which are the important organs that you have cut out and fixed in the model that are not visible in Figure 12? Explain why these organs are not visible. (26)

NEW WORDS

dissected	liver	vein
digestive system	pancreas	artery
oesophagus	diarrhoea	stomach
nervous system	small intestine	life-saving solution
large intestine	respiratory system	spinal cord
anus	diaphragm	alimentary canal
trachea	sense organ	gland
blood circulatory system	urinary system	kidney
ureter	urinary bladder	abdomen
caecum	nile	faeces
dehydration	pulse	oxidation
sputum	cancer	oxygenated blood
reproductive system	vas deferens	sterilisation
seminal vesicle	sperm	ovum
leprosy	endocrine system	endocrine gland
duct	hormone	thyroid gland

Chapter-13

LOOKING AT THE SKIES

Elderly people seem to know a lot of things. They can look at the shadow cast by a tree or building and say what time of the day it is, whether it is noon or evening. There must be an elderly relative in your own home who looks at the night sky and says that winter (or summer or the rainy season) is near. How does (s)he make such a guess?

The answer to this question lies in the motion of the sun and stars. We should learn to recognise these stars and constellations and observe their motion across the sky throughout the year.

Telling the time of the day, or the day of the year, by looking at the sun, moon and stars is not something new. People have been doing so for centuries. For example, in the 18th century, Raja Jaisingh, the Maharaja of Jaipur, built several instruments to trace the movement of these heavenly bodies. He built observatories in Delhi, Jaipur, Ujjain, Mathura and Varanasi which are famous the world over. They are known as *jantar mantars.*

One thing must be made very clear when we talk of the movement of the sun, moon and stars across the skies. These are motions observed from the earth and not from some other point in the skies.

One more thing. Before proceeding further, quickly review what you learned in your geography lesson about the sun and earth and their mutual relationship.

Now answer the following questions:

What causes day and night? (1)

Why does the weather change during the course of the year? (2)

Where exactly is the sun situated in the sky at noon? (3)

Where is the sun situated in the sky in the morning and, again, in the evening? (4)

How does the shadow of a tree change from morning to evening? (5)

We shall now perform some experiments which will help us understand these questions more thoroughly.

EXPERIMENT 1

A STICK IN THE GROUND - DOES IT TICK?

This experiment should be performed on a day when the sky is clear, preferably between nine in the morning and four in the evening.

Pick a spot in the open where you can be sure you will have sunshine throughout the day. It should be a spot where people won’t come and meddle with your experiment.

Take a stick which is a little over a metre long and plant it vertically in the ground. Ensure that exactly one metre of the stick remains above the surface. You could even build a fence around your stick to keep people away from it. To build a fence, drive four pegs in the ground around the stick to form the corners of a square and join the pegs with a string, as shown in the figure.

You should take one more precaution. You should choose a spot which is as flat as possible. Also there should not be any trees or buildings nearby which can cast a shadow on the stick during the day. That would spoil your experiment.

Make your first observation at nine in the morning. Check where the tip of the shadow of the stick is on the ground and make a mark at that point with a nail or peg. Measure the length of the shadow. Then, make similar observations every half an hour throughout the day till four in the evening. Use your watch to fix the time for making your observations. Enter the measurements of the length of the shadow and the time you made the measurement in a table.

Use the data in your table to draw a graph. Before making your graph, discuss among yourselves what you would like to plot on the 'x' axis - the time or the length of the shadow. On what basis would you make this decision?

Since you will be making observations over the next two weeks at least, you should ensure that the pegs and stick are not disturbed.

Is your graph a straight line or some other shape? (6)

Look at your graph and see at which time of the day the shadow was the shortest. (7)

Now recall the methods you learned for finding directions.

In which direction does the shortest shadow fall? (8)

When was the shadow the longest in your experiment? (9)

Why does the length of the shadow change with time? Illustrate your answer with the help of a diagram. (10)

If you continue your experiment from sunrise to sunset, at what times do you think the shadow would be the longest? (11)

A USEFUL TIP

The shortest shadow cast by a vertical object on the ground always falls in the north-south direction. You can use this fact to locate directions.

A RIDDLE

Look at the nails or pegs you have fixed to the ground to keep track of the shadow of the stick throughout the day. From their position, can you tell how the position of the sun changes in the sky from sunrise to sunset?

If you can answer that question, then solve the riddle posed in Figure 1. The figure shows the position of the sun in the sky at three different times during the day. The positions of the shadows cast by the stick are also shown in the figure.

Copy this figure in your exercise book. Try and guess the time of day corresponding to each position of the sun shown in the figure. (12)

WHAT HAPPENS NEXT?

The day after doing Experiment 1, observe whether the shadow of the stick falls at the same spots at the same times throughout the day. (13)

Can you use your stick as a clock (sun dial) to tell the time? If your answer is 'Yes', explain how this is possible. (14)

Two weeks later, once again check to see whether the stick's shadow falls at the same spots at the same times during the day. (15)

If the shadow does not fall on the same spot, what could be the possible reason? Illustrate your answer with the help of a diagram. (16)

A SUGGESTION

You observed in Experiment 1 that the position of the sun in the sky changes during the day. If you continue your experiment for a full year, you will find that the position of the sun changes from day to day as well. That is, the position of the sun at 10.00 am today will be different from its position one month later at the same time. If you choose a particular time every week and mark the position of the sun with a peg at that time, you can build a calendar for the full year. You could use this calendar the following year to figure out dates.

A POINT TO PONDER OVER

The sun feels hotter during some parts of the day. At which position in the sky is the sun when it feels the hottest? Is the heat of the rising or setting sun greater or less than the noon-day sun? (17)

You had made a second set of observations in Experiment 1 after a gap of two weeks.

Did the length of the shadows change during this time? If they did change, did they become longer or shorter? (18)

Can you guess whether summer or winter is coming by gauging the length of the shadows? (19)

AN EXPERIMENT YOU CAN DO ON YOUR OWN

Pick a spot near your home from where you can observe the sunrise. You may have to climb to the terrace or roof of a nearby house or go to an open field for the purpose. Choose a tree, electricity pole or some other stationery object as a reference point. Over the next 10 to 15 days, note the spot at which the sun rises daily, keeping in mind your reference point. Make a daily sketch of the rising sun as well as your reference point in your exercise book during this period. If possible, try and do this experiment either during March-April or September-October. That is the best time of the year to make these observations.

Does the spot where the sun rises change? If it does, in which direction does it seem to move? (20)

When the sun is in the southern part of the sky, it is called the winter solstice (*dakshinayana*). When it is in the northern part of the sky it is called the summer solstice (*uttarayana*).

Was the sun in the winter or summer solstice during the time you made your observations? (21)

EXPERIMENT 2

MAKE YOUR OWN SUN-DIAL

First of all, you will need to cut a right-angled triangle ABC from a sheet of cardboard. Angle C of the triangle should equal the latitude of your city or town and Angle A should be 90 degrees. (Figure 2)

A list of latitudes is given below:

Table 1

No	District	Latitude
1	Betul, Chhindwara and Khandwa	22 degrees
2	Hoshangabad, Narsinghpur, Dhar, Dewas Ujjain, Indore, Jhabua, Ratlam and Shajapur	23 degrees

3	Mandsaur	24 degrees

Fix your cardboard triangle vertically in the middle of a rectangular wooden board. Glue strips of paper along both edges of BC and the wooden board to make the triangle stand erect.

Place your board with the triangle on level ground in an open space which gets sunlight throughout the day. Base BC of the triangle should be placed in the north-south direction, with B pointing to the north.

At nine in the morning, draw a line along the shadow of side AC on the wooden board. Mark the time alongside the line. Draw lines of the shadow of side AC at one-hour intervals (use a watch to check the time) through the day till sunset and mark the time for each line. Your sun-dial is ready.

You can tell the time by looking at the shadow on the sun-dial. But remember that base BC of the triangle in the sun-dial must always be in the north-south direction if you wish to read the time correctly

EXPERIMENT 3

THE MOVEMENT OF THE MOON

(A home assignment)

Amavasya is the night of the new moon. Note the date of the day after *amavasya*, when the moon first appears in the sky. Also note the time at night when the moon sets.

Record your observations in a table in your exercise book. Draw a picture of the moon as you see it in your table. (22)

Continue making observations for as many nights as possible. Then, observe the moon from a few days before until a few days after the full moon (*purnima*) and note the date and time at which the moon rises in your table. Also, draw pictures of the shape of the moon when you make each

observation.

From your observations, can you calculate the number of hours between one moon rise and the next or the number of hours between one moon setting and the next? (23)

How many hours separate one sunrise from the next, or one sunset from the next? (24)

Which takes longer to completely circle the sky - the sun or the moon? (25)

You saw that the shape of the moon changes night after night. These changes in appearance are called the phases of the moon. Can you guess why the shape of the moon changes? Let us perform two experiments to find out.

EXPERIMENT 4

(A home assignment)

Choose a day one week after the new moon when the moon is visible in the sky during the day. Take a yellow lemon or a whitewashed ball of earth and hold it up towards the moon. Ensure that you are standing in the sunshine when you do this experiment.

Observe the shape formed by the sunlight on the surface of the lemon or ball of earth.

Is there some similarity between the shape formed and the shape of the moon? (26)

EXPERIMENT 5

(Do this experiment at around 4.00 pm)

Wrap a ball tightly with a white handkerchief or piece of cloth. Assume this is the moon. Hold this ball in front of your eyes in bright sunshine and turn around slowly. Observe how the shape of the illuminated part of the ball changes.

Does sunlight fall on half the ball at all times while you turn around? (27)

Does the shape of the illuminated part appear different in different positions in spite of this? (28)

Why does this happen? To understand the reason better, look carefully at Figure 3. The large circle in the middle of Figure 3 b is the earth and the smaller circles around it are the moon in different positions. The sun's rays falling on the moon illuminate half its surface in all the positions. However, we cannot see the entire illuminated surface from the earth in all the positions. In some cases we see the entire illuminated surface while in others we see only part of it. In one particular position, we cannot see the illuminated surface at all.

The shape of the moon we see is the shape of the illuminated portion visible to us.

In Figure 3 a, the day of the new moon is called Day 0. The picture of the moon on Day O is shown in Figure 3 b as position 1. In this position, the illuminated surface is not visible from earth, so the moon cannot be seen from earth.

Four days later (Day-4), the moon is in position 2. A small part of its illuminated surface is visible from earth. On Day-7, the moon is in postion 3, so more of it is visible from earth. Fourteen days later (Day-14), the entire illuminated surface of the moon is visible from earth. This is the day of the full moon. Subsequently, the moon grows smaller with each day as it passes through positions 6, 7 and 8. After 28 days, the moon is once again in position 1.

So, although half the surface of the moon is illuminated on new moon day, we cannot see the moon. Try and duplicate this position with your ball. For this, you will have to hold the ball towards the sun.

In this position, which half of the ball is illuminated? (29)

On a full moon day, the situation is reversed. The illuminated half of the moon faces us so we see a full moon.

In the phases in between, we see different shapes of the moon.

Hold your ball in different positions and draw pictures of the shapes of the visible illuminated portion in each case. (30)

The different shapes of the moon in its different phases, as seen from the earth, are shown in Figure 3 a.

Compare the drawings you have made with those in Figure 3 a. (31)

From the above explanation, you may have understood that the sun and moon must be on the same side of the earth on a new moon day and on opposite sides of the earth on a full moon day.

Can you now state in which direction the moon will rise on a full moon day? (32)

WHY DO ECLIPSES OCCUR?

You read about solar and lunar eclipses in the chapter on 'Light' in Class 7. Why do eclipses occur? The myth of *Rahu* and *Ketu* is very popular in our country. But we now know that a solar eclipse occurs when the shadow of the moon falls on the earth and a lunar eclipse occurs when the shadow of the earth falls on the moon. You performed some experiments on forming shadows in this same chapter in Class 7.

Describe the situation during a lunar eclipse on the basis of Figure 3. (33)

Why does a lunar eclipse only occur on a full moon day? (34)

According to Figure 3, in which position will the shadow of the moon fall on the earth? (35)

Can this position occur only on one particular day? (36)

Can you now explain why a solar eclipse occurs only on a new moon day? (37)

However, why is it that a solar eclipse does not occur on every new moon day and a lunar eclipse does not occur on every full moon day? Let us try and understand why.

A solar eclipse occurred on the afternoon of February 16, 1980. Because the sun was covered during the eclipse, the earth was clothed in darkness during the day. Figure 4 contains a photograph of this eclipse. It is a time exposure photograph. That means the exposures of the different stages of the eclipse were made at 10-minute intervals on the same frame. The photograph shows the moon slowly covering the sun and then moving away. The covered portion of the sun appears black in the photograph and the uncovered portion white.

You can easily guess the position of the moon at each stage of the eclipse. Can you draw lines tracing the paths of the sun and moon in the photograph?

A larger diagram based on the photograph is given in your kit copy. That should help make your job easier. This diagram has two round discs at the bottom - one black and one white - with their centres marked. The white disc is your sun and the black disc your moon. Cut out these discs neatly with a blade.

We shall assume that the white portions of the other discs in the diagram are the sun and the black portions the moon. Each of these discs depicts the position of the sun and moon at various stages of the eclipse.

We shall now find the centres of the sun and moon at each stage. To do this, take the white disc you have cut out and place it exactly atop the white portion of any of the stages in the diagram. Pierce a hole through the centre of your disc with a pin to mark the spot at the centre of the sun's outline at that stage in the diagram. Remove the white disc and mark the spot with a pencil.

In this way, mark the sun's centre at every stage of the eclipse in your diagram. Join these spots with a line. This line depicts the path of the sun.

To find the moon's path, repeat the exercise. But this time use the black disc and mark the centres of the black portions at each stage of the eclipse. Join these spots with a line and you will get the path of the moon during the eclipse.

Do the sun and moon follow parallel paths or do their paths cross each other during the course of the eclipse? (38)

What would be the difference in the position of the sun and moon on new moon days when no eclipse takes place and when there is an eclipse? Use the diagram to try and figure out your answer. (39)

There is another aspect to note in the diagram. The sun and moon reached the point of intersection of their paths at exactly the same time during the eclipse on February 16, 1980.

If this had not happened, would a total solar eclipse still have occurred? (40)

Can you now tell why a total solar eclipse does not occur on every new moon day? (41)

EXPERIMENT 6

THE MOTION OF CONSTELLATIONS

(To be done at home at night)

When you look at the night sky, do the stars appear to be moving? If you wish to study the movement of stars across the sky and trace their paths, you must observe the Pole Star, the seven stars of the Great Bear (*Saptarishi*) constellation and the six stars of the Casseopia (*Kashyapi*) constellation. Seek guidance from any knowledgeable elder in your village to locate these stars.

You can easily recognise the Great Bear with its rectangular head in the northern sky (Figure 5 a). In winter, this constellation rises a few hours before sunrise. In this season, you can also see Casseopia in the same part of the sky, its six stars forming the letter 'W' (Figure 5 b).

You can locate the Pole Star with the help of these two constellations. If you are able to spot only the Great Bear, look at the two stars that form the outer side of its rectangular head. Extend an imaginary line from these two stars. The Pole Star will be located on that extended line (Figure 5 a).

If only Casseopia is visible, the Pole Star will be located on a line extended from the middle star of the 'W' (Figure 5 b).

Once you have located the Great Bear, Casseopia and Pole Star in the night sky, do the following experiment.

Take a 20cm x 20cm square sheet of paper and make a 1 cm diameter hole in its centre. Mark a cross on one side of the sheet of paper as shown in Figure 6.

Hold the sheet in front of your eyes with the X mark at the bottom and look for the Pole Star through the hole. Once you have located the Pole Star, check in which direction the Great Bear and Casseopia lie.

Draw an arrow on the paper in the direction in which you see each of the constellations. Mark the time at which you made your observation in both cases. (42)

Choose a nearby tree or house as a reference point. Draw a picture of your reference point on the paper, clearly indicating its location. (43)

Repeat your observations at one-hour intervals. Ensure that you are standing on the same spot each time you look at the stars.

Draw arrows in the direction of the position of the Great Bear and Casseopia during each observation and note the time of the observation nest to the arrows. (44)

Using the tree or house you have chosen as your reference point, check whether the position of the Pole Star has changed or not. If it has changed, note the changed position. (45)

Repeat this activity as many times as possible, the minimum being four times. But ensure that the X mark on your sheet of paper remains at the bottom during all your observations.

You could also use other known stars or constellations close to the Pole Star to perform this experiment.

Study the picture you have drawn and answer the following questions.

Do the positions of the stars change over time? (46)

Does the position of the Pole Star also change with time? (47)

Does the shape of the Great Bear and Casseopia change with time or does the position of the entire constellation in the sky change? (48)

What kind of path do these constellations trace in the sky? (49)

From your observations, you would have realised that the stars do not remain in the same spot in the sky but revolve around the Pole Star. The Pole Star, however, remains fixed at one place. It takes the stars 24 hours to complete a revolution around the Pole Star. We can observe only half this revolution during the course of a night.

NEW WORDS

constellation	winter solstice	summer solstice
latitude	phases	

Chapter-14

OUR SOIL

Air and water are so much part of our lives that we don't really pay much attention to them. We just keep using them every day. It's the same case with soil.

Make a list of the uses of soil (1)

If you combine the lists of all the groups in the class, you can see that soil has many different uses.

But can different types of soil be used for any and every purpose? For example, can you make pots (*matkas* or *surahis*) from any soil or do you require a particular type of soil? Or can you grow different kinds of crops in any type of soil? Or does each crop grow better in a particular type of soil?.

Can you think of other examples where a particular type of soil is required for a particular purpose? (2)

The use to which a particular type of soil can be put depends on the qualities of the soil. We shall study and analyse various soils in this chapter to understand their qualities and the differences between them.

MAKE YOUR PREPARATIONS

For our study, we require soils collected from different places. Examples of some of these locations are given below:

fields	lakeside	open meadows	river banks
gardens	forests roadside	fallow land	

You can change the list, adding or subtracting names, to suit your convenience. But you should make sure that you get different types of soil from different places. It would be even better if the soils are of different colours.

Collect the soil samples while you are on your way to school from home. But, first, let your teacher distribute the work of collecting different soil samples among the different groups in the class. The class can decide which group should visit which location and bring back which type of soil samples to school. This work distribution should be done a day before the chapter is begun in the class.

Leave home a little early on that day, go to the location allotted to you, collect about 250 gm of soil for your sample, and bring it to school. You can carry the soil in a polythene bag. But remember, collect the soil the day you begin the experiments in class. Don't forget to put a label on your soil sample, stating where your got it from and the date on which you collected it.

GOING ON A FIELD TRIP

During the time this chapter is being done in class, try and go to places that have been recently dug up to a depth of about four feet - for example, for laying a road, or constructing a bridge, or digging a well, or laying the foundation of a house. If you live near a river or stream, there may also be places where the water has cut into or eroded the banks and exposed several layers of the soil.

These places will give you a good picture of the different layers of soil. Each layer has a distinct texture and is different from the other.

Make a diagram of a section of the dug up or eroded soil. Note the thickness of each layer, the shape and size of the particles of soil in each layer, their colour etc. (3)

FOR THE TEACHER

The arrangements for doing experiments and going on the field trips are slightly different for this chapter. You should finalise the list of locations and distribute them among the groups a day before the field trip. That way, you can plan in advance what observations should be made and what the students should look for. The groups will thus know exactly where to go to get their samples. Each group should bring at least two soil samples from two different locations.

You require at least five different soil samples before you can begin any of the experiments in class. The students should be told to weigh 100 gm of each sample when they reach school. They should then spread out each sample separately on a sheet of newpaper and let the soil dry properly.

After the discussions in the class, you should make a comprehensive list of as many properties of soil from the collective table of all the groups, .

First, copy Table 1 in your exercise book. Note all your observations in this table. (4)

Table 1

Group No ....   Location from where sample was collected ....

S No	Experiment No	Properties	Observations
1	1	Shape of particles	
2	1	Colour	
3	1	How it feels	
4	1	Smell	
5	1	How it looks under a microscope	
6	1	Organisms present	
7	1	Remains of organisms	
8	3	Type of soil	
9	5	Moisture content (%)	
10	6	Water retention (ml)	
		Percolation rate (ml per minute)	
11	7	Acidic/alkaline	

EXPERIMENT 1
EXAMINING THE SOIL AFTER RETURNING TO SCHOOL

Have you ever studied the properties of soils? Examine the different soil samples brought to class and see whether you can identify various properties of soil. Make a list of these properties. Some points to look for are given below.

1. How does the soil look? Is it a fine powder or granular?
2. What is its colour? Is it black, brown or some other colour?
3. How does it feel when you touch or press it? Hard, soft, elastic, dry, sticky etc?
4. How does it smell? Is it aromatic, foul smelling or without a scent?
5. Can you see anything new when you examine the soil under a microscope?
6. Can you see any living creatures or plants in the soil?
7. Can you see any remains of dead creatures or plants?

To observe properties No 6 and 7, you will have to grind the soil to a fine powder, spread it out and examine the particles through a hand lens.

Check the soil for the properties listed in the table and fill the details in the table. (5)

Did you find any organisms in the soil? What do they look like? Describe them in your own words. (6)

Do you think rotting vegetation and animal remains are important for the soil? In what way? (7)

Are all the particles in the same sample of soil similar? (8)

If you have a problem in answering this question, do the following experiment and then try to answer it.

EXPERIMENT 2

Take a little soil. Grind the larger particles into a fine powder. Fill a test tube three-fourths with water and add half the amount of powdered soil to it. Use a twig to stir the soil in the water. Now examine the soil solution and answer the following questions.

Do you see layers of different sized particles in the solution? (9)

Make a diagram of these layers and estimate the approximate thickness of each layer. Write down your estimates in the diagram. (10)

Compare the layers of soil in your test tube with the layers of soil in the test tubes of other groups. Make a list of the differences or similarities you observe. (11)

Now try and answer Question 8.

You had made a diagram of the layers of soil you saw during your field trip. Compare your first diagram with the diagram of soil layers in the test tube. (12)

This experiment shows that soil is made up of different sized particles. The proportion of these different sized particles would differ in soils from different locations. We classify soils on the basis of the proportion of different sized particles they contain.

If the proportion of larger sized particles is more, we call the soil **sandy**. If the proportion of fine particles is more, the soil is **clay.** If large and fine particles are present in equal proportions, the soil is called **loam**.

We can do a simple experiment to find out which soil is of what type.

EXPERIMENT 3
TYPES OF SOIL

Take 20 gm to 25 gm of soil from your soil sample. Remove the pebbles, grass and other organic matter from it. Add water to the soil, drop by drop, kneading the soil while doing so. Pour enough water so you can make small balls of soil, without the soil sticking to your palms. Make a 2.5 cm diameter ball of soil. Put this ball on a flat surface and try and roll it into a 15-cm-long rod. If you can bend the rod without breaking it, then bend it into a ring.

You can identify a soil type by the extent to which you can mould it.

Identify the different types of soils in the line diagram given below.

Did the ball of soil form easily?

No — The soil is sandy

Yes — The soil could be sandy loam, light loam, heavy loam, light clay or heavy clay

Try and roll the ball of soil into a rod
Could you roll it into a rod?

No — The soil is sandy loam

Yes, but the length of the rod is small — The soil is light loam

Yes (if the length of the rod is 15 cm) — The soil is heavy loam, light clay or heavy clay

Bend the rod into a ring

It cannot be bent — The soil is loam

Only forms a semicircle — The soil is heavy loam

There are cracks in the rod when a ring is formed — The soil is light clay

A full ring is formed — The soil is heavy clay

Note your conclusions in the table. (13)

What type of soil would be ideal for making clay vessels, toys or models? (14)

EXPERIMENT 4
MOISTURE IN SOIL

Put two teaspoonsful of soil in a boiling tube. Heat the boiling tube over a flame.

What happens when you heat the soil? (15)

Do you see any moisture anywhere? If you do, how did you recognise that it is water? (16)

Remove the soil from the boiling tube after you heat it. Compare the soil with a sample of soil that has not been heated.

Do you notice any differences between the two soil samples? If you do, what are these differences? Explain in your own words. (17)

For the next two experiments (No 5 and No 6), don’t collect soil samples immediately after it rains or after a field is irrigated. Your observations about the soil will be incorrect. Wait at least 48 hours after it stops raining or the irrigation is completed before collecting the soil samples for these experiments.

EXPERIMENT 5
THE MOISTURE CONTENT OF SOIL

There are many ways of finding out the moisture content of different soils. We shall use a simple method. Grind the soil you wish to find the moisture content of into a fine powder. Weigh 100 gm of soil from this pile. Spread it on a newspaper and dry it for about two hours in the sun. While drying the soil, the sky must be clear and the heat of the sun intense. That is essential. So the best time to dry the soil is in the afternoon. Keep turning the soil over while you are drying it. But be careful that the soil does not spill out of the newspaper. That would affect the results of your experiment.

Weigh the soil again after it has completely dried. The difference in the two weights will tell you how much water 100 gm of the soil contained. This quantity is known as the **percent moisture content** of the soil.

Let all the groups do the experiment with different soil samples.

Write the percent moisture content of the soil samples in the table. (18)

Are the figures of the percent moisture content of all the soil samples the same? Compare your findings with those of the other groups. (19)

EXPERIMENT 6
TWO PROPERTIES OF SOIL

We shall study two properties of soil together. The two properties are:

1) The amount of moisture absorbed by soil.
2) The percolation rate of the soil.

You require a 5 ml or 10 ml syringe, a measuring cylinder and a weighing balance. Also, get a watch to keep track of the time.

Weigh 5 gm of soil with the weighing balance. Put this soil on a sheet of paper and grind it to a fine powder. Pour the powdered soil into the syringe and level the soil. Stand the syringe upright inside a boiling tube or test tube. Now measure 5 ml of water with the measuring cylinder. Pour the water slowly over the soil in the syringe. Note the time when you begin pouring the water.

After the water on the surface has completely percolated into the soil in the syringe, note the time again.

Some water will seep through the soil and drip into the test tube. When water stops dripping into the test tube, measure the quantity of water collected in the test tube.

Do this experiment with different soil samples and note your observations in a table.

You had noted the time you began pouring 5 ml of water on the soil. Now calculate the percolation rate (ml per minute) of the soil. Note your results in the table. (20)

We call this the **percolation rate** of the soil.

Find the percolation rates of different soils and list them in the table. (21)

To find the amount of water absorbed by the soil, you will have to deduct the amount of water collected in the test-tube from the original amount (5 ml) of water taken.

Calculate how much water different types of soil absorb. Note your results in the table. (22)

EXPERIMENT 7
SOLUBLE SUBSTANCES IN SOIL

Fill a beaker half full with soil. Pour some rainwater or distilled water over the soil. You should pour enough water to fill the beaker three-fourths. Stir the soil and water with a twig. Then let the solution stand for some time. Once the soil settles down, drain out the water carefully. Fill a boiling tube half full with this drained water. Heat the boiling tube over a candle flame. Continue heating till only a fourth of the water remains. Then answer the questions given below.

What is the colour of the water? (23)

Use blue and red litmus to test whether the water is acidic or basic. Note the result in the table. (24)

Make a collective table on the blackboard and enter the results of all the groups in this table. Copy the table and results in your exercise book. (25)

Collective table

S No.	Location from which soil was obtained	Type of soil	Percent moisture content	Percolation rate (ml/minute)	How much water absorbed by 5 gm of soil	Acidic or basic
1.						
2.						
3.						
-						
-						

COLLECTIVE TABLE

Answer the following questions on the basis of the collective table. But first discuss the table in the class before answering.

Which type of soil has the highest percolation rate? (26)

Which type of soil has the lowest percolation rate? (27)

You may have noticed that the water level in a well rises about 8 to 10 days after it rains.

Through what type of soil would water percolate into the well faster and in larger quantities? (28)

In which type of soil would most of the rain water drain off the surface itself? (29)

What difference would there be if you planted a crop in two different soils, one with a high percolation rate and the other with a low percolation rate? If you cannot think of any differences, talk to a farmer and find out. Write your findings in your own words in your exercise book. (30)

A paddy crop grows best in a field that remains filled with water for a long time. Is paddy grown in your area?

Can you explain which type of soil is best for growing paddy - a soil with a high or a low percolation rate? (31)

What type of soil absorbs the most water and which absorbs the least? (32)

Is the percolation rate of soil that absorbs more water higher or lower than other types of soil? (33)

Explain in your own words what you have understood about the relationship between the percolation rate and the amount of water aborbed. (34)

If water is not available for a few days, in which soil would crops wither faster - those that absorb more water or those that absorb less water? (35)

You have now studied many properties of soil, including type, colour, smell, organic matter content, percolation rate, water absorption capacity, acidic/basic etc. The crops commonly grown in any area depend on many factors. One major factor is the kind of soil available in that area and its properties.

SOME QUESTIONS FOR DISCUSSION

You may have heard about the Tawa dam in Hoshangabad district. It is a major irrigation project. The dam has helped to increase agricultural production. But it has also caused some problems. For example, in some villages, the land around the canals has become waterlogged and marshy. In some places, the soil has eroded. In some fields the excess water does not drain out.

You may have heard that many more such dams like the Tawa are being built in Madhya Pradesh. One is the Indira Sagar dam. Some people believe these dams will also cause problems like those seen in the Tawa irrigation area.

The things you learned about soil in this chapter will help you understand these problems in a more scientific manner.

Now discuss the experiments you have done in this chapter with your classmates and try to identify those experiments that help you to understand these problems in a more scientific manner. Write in your own words, what you understand about the relationship between these problems and the properties of soil. (36)

NEW WORDS

percolation rate project loam

Chapter-15

OUR CROPS (PART II) : SOME QUESTIONS, SOME ANSWERS

You saw in the chapter ‘Our food’ in Class 6 that we require different kinds of food. They include various kinds of seeds like wheat, rice and dal, different types of leaves like spinach and methi and many other things. In addition, non-vegetarians eat meat, fish and eggs. While discussing food chains in the chapter ‘Nutrition in plants’ we also learned that the diet of non-vegetarians is eventually linked to plants.

Can you estimate how much grain your family consumes in a month? (1)

Can you also guess how much land is required to grow this amount of grain? (2)

Apart from human beings, other living creatures also need food to survive. Many of these animals have been domesticated and live with us. So we need to provide them with fodder, grain etc.

In this chapter, we shall discuss what methods are used to increase the production of the crops we grow for food. There is one thing that needs to be stressed when we talk about increasing production. It can be explained more easily through an example. Suppose we plant a crop of wheat. Suppose the plants grow nice and healthy but they do not produce any grain. Would you call this a good wheat crop? So when we talk about increasing production, what we mean is increasing that part of the crop that is useful for us.

Let’s now begin our discussion on increasing production.

The production of a crop does not increase because of any one factor alone. Only when there is a proper combination of several factors can the production increase. Some of these factors include the kind of seed planted, the properties of the soil, the availability and proper application of irrigation and fertilisers, the weather, controlling insect attacks and the growth of weeds and so on.

Experiments done with corn have shown the impact of some of these factors on crop production. Some results of these experiments are given in Table 1.

Table 1

Method	**Production (kg/ha)**	**Gain (kg/ha)**
Time of planting		
A month after the onset of rains	3,400	
Immediately after the onset of rains	5,830	2,430
Density of planting		
19,800 plants per hectare	4,100	
39,600 plants per hectare	5,130	
Weeding		
Once	4,040	
Twice	5,200	
Nutrient application		
Without phosphorus	4,570	
56 kg of phosphorus	4,660	

Without nitrogen	4,320
78 kg of nitrogen	4,900

The table shows us the gains achieved in production by using different methods. For example, planting the seed at the correct time resulted in a production gain of 5,830 - 3,400 = 2,430 kg per hectare.

Calculate the exact gain from each method mentioned in the table and note the results in the table. (3)

You now have some idea about some of the factors that affect the production of various crops.

Can you explain from what you learned in the chapter 'Nutrition in plants' how a crop like wheat or corn can produce so much of grain. (4)

Let's now discuss the various factors that affect the production of crops in more detail.

IRRIGATION

An experiment was conducted to find out how irrigation affected the production of a crop. In the experiment, crops were grown in two fields. One field was irrigated while the other wasn't. The same amount of nutrients, like nitrogen, was applied to both fields. However, the amount of nitrogen was increased by the same quantity for successive crops in both the irrigated and unirrigated fields. The results of the experiment are illustrated in Graph 1.

On the basis of Graph 1, explain the importance of irrigation in increasing crop production. (5)

What difference is there in crop production when the same quantity of nitrogen is applied to both the irrigated and unirrigated field? (6)

WHAT DOES A PLANT DO WITH WATER?

We learned in the chapter 'Nutrition in plants' in Class 7 that a plant absorbs water from the soil. What does it do with this water? We saw that the plant combines water and carbon dioxide with the help of sunlight to produce carbohydrates. Starch is one such carbohydrate. Different types of sugar and cellulose are also carbohydrates. A chemical analysis will show that 100 grams of water react with 260 grams of carbon dioxide to form 180 grams of carbohydrate. But the plant does not use all the water it absorbs through its roots to produce carbohydrates. Actually, most of this water evaporates in the air.

If you tie a plastic bag over a leaf, you will be able to see how much water a plant releases in the air. It is estimated that a plant uses only 0.1 percent of the water it absorbs to form carbohydrate. That means, if a plant absorbs one litre of water, only one millilitre will be used to produce carbohydrate. The remaining 999 millilitres evaporate from the leaf.

THE RELATIONSHIP BETWEEN WATER AND CROP YIELDS

You may have wondered what difference it would make if water is scarce when only 0.1 percent is used to produce carbohydrate. Let's investigate the matter a little more in depth. Graph 2 tells us how much water evaporates from plants in different seasons.

Find out from the graph the months in which the most water evaporates from plants. (7)

Are these the same months as the monsoon season when the rainfall is heavy? (8)

So what effect does the availability of more water have on the plant? (9)

Let's now look at an interesting fact. Most of the water released by plants evaporates from the leaves. The leaves have tiny, microscopic holes called **stomata**. Water evaporates through these stomata. We know that more water evaporates when the weather is hot. In such a situation, the stomata begin to close. This lessens the amount of water that evaporates from the leaves.

We learned in the chapter 'Nutrition in plants' that plants absorb carbon dioxide. The carbon dioxide also reaches the leaves through the stomata.

When the weather is hot and the stomata close, what effect would this have on the absorption of carbon dioxide by the plant? (10)

What effect would a change in the amount of carbon dioxide absorbed have on the growth of the plant? (11)

If the plant does not get water at this time, what effect would this have on its growth? Explain with reasons. (12)

PLANT NUTRIENTS

Just as we need different kinds of nutritious food, plants also require different kinds of nutrients. You know that a plant absorbs carbon dioxide from the air and water from the soil and produces carbohydrates with the help of sunlight.

Plants also absorb different kinds of mineral salts from the soil, in addition to water. Among these are salts that plants require in larger quantities. There are other salts that are important for plants but are required in smaller quantities. For example, plants need nitrogen, phosphorus and potassium salts in larger quantities. These salts are obtained from the soil. When we grow a crop, the plants absorb some salts from the soil. Table 2 shows the amounts of nitrogen, phosphorus and potassium salts absorbed from the soil by different crops. Plants also soak up other salts from the soil, but the table does not give details of these salts.

Table 2: Absorption of salts by different crops

Crop	Yield per hectare	Nitrogen	Phosphorus	Potassium
Rice	2,240	34	22	67
Wheat	1,568	56	22	67
Millet	1,792	56	15	146
Corn	2,016	36	20	39
Sugarcane	67,200	90	17	202
Groundnut	1,904	78	22	45

Every time any of these crops are sown in a field, they absorb these amounts of nutrients.

If a field is farmed for many years, what would happen to the nutrient content of the soil? (13)

So, the question is, how does the soil get back or replenish these nutrients? Let's examine this question in more detail.

SOIL NUTRIENTS

We began by talking about our food, then went on to talk about nutrition in plants and now we are faced with the question of soil nutrition. That cycle is actually similar to the food cycle.

Soil nutrients are replenished or returned to the soil in many different ways. For example, by rotating crops, adding organic manure or chemical fertilisers etc.

CROP ROTATION

Usually, farmers don't grow only one crop in a field. Different crops are grown in different seasons. It has been seen that cereal crops take a lot of nutrient elements from the soil. Legumes are different. While they do take nutrients from the soil, they also give the soil some nutrients. Growing leguminous crops results in an increase in the quantity of nitrogenous salts in the soil.

Can you name some leguminous crops? (14)

Leguminous crops usually have many small nodules on their roots. Several different kinds of bacteria live in these nodules. These bacteria absorb nitrogen from the air and convert it into a form that can be used by the plant.

You could uproot a soyabean plant, or a Bengal gram plant, to see the nodules on their roots.

The microorganisms in the nodules use some of the nitrogen for their own purpose. Some nitrogen is used by the leguminous plant itself. But after the crop is harvested, the roots remain in the soil. So the soil gets some nitrogen in this way. Experiments have shown that a leguminous crop gives about 50 kg to 150 kg of nitrogen per hectare. The crop grown after the leguminous crop can take advantage of the availability of more nitrogen in the soil.

Nowadays a bacterial culture is also available. This is mixed with the seeds. When the seeds are sown, the plants are able to produce more nodules on their roots.

Apart from this, there are various kinds of blue-green algae that add nitrogen to the soil. Blue-green algae culture is also available. It is applied in rice fields.

So if a leguminous crop is rotated with a cereal crop, the leguminous crop replenishes, to some extent, the nitrogen taken from the soil by the cereal crop. But potassium, phosphorus and other nutrient elements cannot be replenished in this way.

ORGANIC MANURE

By organic manure we normally mean the plant residues in the field, such as stalks and roots, cow-dung, urine etc. The percentage of various nutrient elements in one tonne of organic manure is given in Table 3.

Table 3: Percentage of nutrient elements in organic manure (kg/tonne)

Manure	Nitrogen	Phosphorus	Potassium
Goat manure	5-7	4-7	3-4

Dry compost	5-10	4-8	6-12
Dry organic manure	4-15	3-9	3-10

(Dry organic manure is made by mixing cow-dung, hay, urine etc)

Suppose a paddy crop is grown in a field and five tonnes of rice are harvested.

Calculate from Table 2 how much nutrient elements this crop must have taken from the soil. (15)

To replenish this quantity of nutrient elements in the soil, how much of dry compost needs to be added? (16)

GREEN MANURE CROPS

Do you know that some crops are grown so that they can be ploughed back into the soil? Some examples are berseem, kulthi, sanhemp, lobia, green gram etc. Details of these crops and the nitrogen they provide per hectare are given in Table 4.

Table 4: Percentage of nitrogen in different green manure crops

Name of crop	**Nitrogen (kg/tonne)**
Lobia, beans	7.1
Dhaincha	6.2
Kulthi	3.3
Green gram	7.2
Sanhemp	7.5
Horsegram	8.5

If the total weight of the green manure crop in a field is 8 to 25 tonnes per hectare, the amount of nitrogen it provides on being ploughed back into the soil is 70 kg to 90 kg per hectare.

Find out whether all the green manure crops mentioned in Table 4 are leguminous crops. (17)

On the basis of Table 4, explain the reason for growing green manure crops. (18)

CHEMICAL FERTILISERS

You may have heard names like urea, NPK and superphosphate. These are chemical nutrients. They are either manufactured in factories or dug from under the earth in mines.

We have already seen that plants get many of their nutrients from the soil. The quantity of nutrients in the soil decreases if plants continue to absorb them. We have also seen some ways in which soils replenish their nutrient content. There is one other way in which soils can receive nutrients - by adding chemical fertilisers.

The percentage of nutrients differs in various chemical fertilisers. So a farmer who uses a chemical fertiliser first checks how much of which nutrient he gets from that fertiliser before applying it in his fields.

Table 5: Percentage of nutrients in different chemical fertilisers

Name of fertiliser	**Nitrogen**	**Phosphorus**	**Potassium**

	(%)	(%)	(%)
Urea	46	0	0
Superphosphate	0	8-9	0
Ammonium sulphate	21	0	0
Potassium nitrate	13	0	44

If we use 50 kg of urea, then according to Table 5, 23 kg of nitrogen (46 percent) will be added to the soil.

To get the same quantity of nitrogen, how much ammonium sulphate should we add? (19)

If 50 kg of superphosphate is added to the soil, how much phosphorus would the soil get? (20)

But whether we use organic manure or compost or chemical fertilisers, it is not enough to know the percentage of nutrient elements they contain. It is important to know how much of this nutrient is finally available to the plant. It is also necessary to know which is the best time to provide the nutrients so that the plant can make the fullest use of them. We must also examine which is the best way to add the nutrients to the soil. For example, would it be better to sprinkle them in the field or to dissolve them in the irrigation water or to place them under the soil.

THE METHOD DETERMINES THE EFFECT

It is not necessary that the production of all crops increases equally if an equal amount of nutrients is applied. The type of crop determines the effect of the nutrients. For example, the effect of applying nitrogen fertilisers on an indigenous rice variety (Peta) and a hybrid rice variety (IR-8) is shown in Graph 3.

What is the difference in effect of nitrogen fertiliser on Peta and IR-8? (21)

Normally, a farmer uses chemical fertiliser to increase the crop production from his fields. The question is, how much fertiliser should he add?

Graph 4 shows the resultant increase in crop production for different quantities of chemical fertilisers.

Look at the graph and say whether crop production will continue to increase as we add more and more quantities of nitrogenous fertilisers? (22)

Suppose 120 kg of nitrogen per hectare are added to a crop of Sonora-64 wheat. A total of 5.3 tonnes of wheat will be produced.

On the basis of Table 2, calculate how much of phosphorus and potassium will be absorbed from the field by this wheat crop. (23)

Is it advisable to add only nitrogenous fertiliser to increase production? What effect will this have on other nutrients in the soil? Explain with reasons. (24)

Now let’s consider the last factor relating to crop production.

CROP PROTECTION

Suppose we take the best variety of seeds, sow them at the correct time, apply fertiliser properly and at the proper intervals and irrigate the crop well. Will there be any obstacle to getting a good crop?

There are many other factors that affect crop production. Let’s look at some of them.

WEEDS

Often, other plants grow in a field along with the crop. These plants are called **weeds**.

What effect do weeds have on a crop? Before trying to answer this question, discuss the following points in class:

1. How would weeds affect the supply of nutrients to the crop?
2. How would they affect the sunshine available to the crop?
3. What effect will there be on the water available for the crop?

Will these factors affect crop production? (25)

Look at the crop figures relating to weeding in Table 1 and explain what effect there would be on crop production if a field is not weeded. (26)

What do you think should be done to rid a field of weeds? (27)

A PROJECT

Make a list of the major weeds in your area. Find out which weeds grow with which crops. If possible, collect these weeds and make your own weed display. Also, try and find out what farmers do to get rid of these weeds.

INSECTS AND PLANT DISEASES

Apart from weeds, plants are affected by insect attacks. Some insects eat the stems of plants, some nibble at the leaves, while others destroy the roots. But there are also insects that are useful for plants. For example, many insects help in the pollination of plants.

There are several microorganisms that destroy plants. We cannot see them, but we can see the destruction they cause in plants. These include shrivelling and discolouration of leaves, rusting of the stem and leaves, fungal growths etc. There are, however, some useful microorganisms that make nitrogen available for plants, as we saw earlier.

The diseases caused by insects and microorganisms affect crop production. The question is, how should we deal with this problem? Nowadays, farmers use insecticides, fungicides and other chemicals. However, there are other ways to solve the problem. For example, weeding could rid a field of weeds. Or insects can be captured and removed from the fields.

Insecticides are actually chemicals. They poison the insects. You read the story of the mosquito in the chapter ‘Diversity in the animal kingdom’ in Class 6.

On the basis of this story, can you explain whether insects can develop immunity to the insecticides used to destroy them? Immunity means the insecticide no longer has any effect on the insect it targets. (28)

There is another problem when we use insecticides to kill pests or weedicides/herbicides to destroy weeds. A large percentage of these chemicals remains in the soil. From the soil, these chemicals find their way into water sources. Do you think that a chemical used to kill insects will have no effect on humans?

People who spray these chemicals in the fields are exposed to them and some of the chemicals enter their body. What effect do you think these chemicals will have on their health?

Another problem is that these chemicals destroy all insects. We have seen earlier that some of these insects are useful and helpful to plants.

If insects that pollinate crops are killed, what effect will this have on crop production? (29)

Some people ask the question: If we don't use these chemicals, how can we get a good crop, how can we increase production? Is there an answer to this question? What could it be?

Some people say we can use some methods that don't give rise to these problems. For example, they say we can make use of the natural food chains. Remember, we had discussed food chains in the chapter 'Nutrition of plants'? There are many insects that eat other insects. They are called **predatory insects**. We can make use of these insects. There are also birds that eat insects. We can use these birds to get rid of insects.

Similarly, people say we can capture harmful insects and kill them. The problem is that this method is both slow and time consuming. However, supporters of this method say the process can be speeded up. For example, if a lighted bulb is placed in a field, insects would cluster around it.

What are your thoughts on this subject? Discuss them and share them in class.

NEW WORDS

weeds insecticides fertilisers fungicides

irrigated farming unirrigated farming predatory insects

bacteria immunity stomata carbohydrate

bacterial culture

Chapter-16

ELECTRICITY AND ITS DIFFERENT EFFECTS

You performed experiments with electricity in Class 6 and 7 and learned quite a few interesting facts. For example, you saw that a bulb lights up when electricity flows through it. The light of the bulb is one of the effects of electricity. There are several other important effects of electricity. We shall study some of these effects in this chapter.

PART 1: THE CHEMICAL EFFECTS OF ELECTRICITY

EXPERIMENT 1

COPPER PLATING

Take a beaker, fill it half full with water and prepare a copper sulphate solution. The colour of the solution should be a deep blue. Remove the carbon rod from a spent dry cell (battery) and wind a length of wire around its upper end. Ensure that the wire is properly cleaned. Take another length of thick copper wire, clean it well and flatten one end with a hammer. Immerse the carbon rod and the flattened end of the copper wire in the copper sulphate solution. Take them out after two minutes and examine them.

Has anything happened to the carbon rod or copper wire? (1)

Now connect the rod and flattened wire to two cells as shown in Figure 1. Ensure that the rod is connected to the negative terminal of the cells and the flattened wire to the positive terminal. Again immerse the rod and wire in the copper sulphate solution. But this time, ensure that they do not touch each other and that the wire wrapped around the upper end of the carbon rod remains above the surface of the solution. Take the rod and copper wire out after two minutes.

Has anything happened to them this time? (2)

Now reverse the cells in the circuit so that the carbon rod is connected to the positive terminal and the flattened wire to the negative terminal. Place the rod and wire in the solution in the same way as you did earlier. Take them out after two minutes and examine them.

What change do you see in them now? (3)

Before doing this experiment, had you heard about the process which you just saw? If not, consider what possible uses it can be put to.

Let’s now observe a chemical effect of electricity.

EXPERIMENT 2

IODINE RELEASED FROM POTASSIUM IODIDE

Take three test tubes. Put a pinch of wheat flour in test tube A, fill it three fourths with water, and prepare a wheat flour solution. To dissolve the flour, warm the test tube a little over a low flame. Put 3 to 4 pinches of potassium iodide into test tube B, fill it three fourths with water and prepare a potassium iodide solution. Pour approximately half the solutions from both test tubes A and B into test tube C and mix them well.

Did the colour change when you mixed these two solutions? (4)

Clean two lengths of copper wire and immerse them in the solution in test tube C in such a way that they do not touch each other. Complete the circuit shown in Figure 2.

What happens in the test tube? Did the colour of the solution change? What could be the possible reason for the change? (5)

You could refer to the experiment for testing starch in the Class 6 chapter “Our Food” to answer this question.

Observe carefully on which wire some fresh activity is taking place.

Is this wire connected to the positive or negative terminal of the cell? (6)

You could perform a magic trick with the help of this chemical process.

EXPERIMENT 3

AN ELECTRIC PEN

Mix the remaining solution from test tubes A and B in a clean test tube. Dip a strip of filter paper in this new solution. Spread the wet filter paper on the upper surface of an aluminium block. If you do not have an aluminium block you could wrap aluminium foil around a wooden block and use it for the experiment.

Place the block on one end of a copper wire as shown in Figure 3. Connect the other end of the wire to the negative terminal of a cell. Take another length of copper wire, connect one end to the positive terminal of the cell and coil the other end around a thicker copper wire. Use this thick copper wire to write what you wish on the strip of wet filter paper. You do not require a pen or pencil for the purpose.

How is the ink of the electric pen formed? (7)

PART II : HEAT FROM ELECTRICITY

EXPERIMENT 4

Cut a narrow pointed strip in the shape of an arrow from the aluminium foil of a cigarette packet. Ensure that the arrow head is a fine point.

Take one more precaution. Ensure that the aluminium foil does not have a paper backing. If it does, remove the paper first before cutting out your arrow.

Place your arrow-shaped strip of foil on a wooden board. Connect two lengths of wire to the two terminals of a cell as shown in Figure 4. Attach pins to the free ends of these wires. Now press one pin onto the pointed tip of the arrow-shaped foil. Press the other pin into the foil at a distance of about 1 to 2 mm from the first pin.

What happens to the aluminium foil? Can you state the reason for the change you saw occurring in the foil? (8)

What would happen if you increase the number of cells in the circuit? (9)

You may have seen the fuse that is connected to the electrical circuit in your school or home. This fuse blows up if there is a sudden increase in the electric current to your home. Once it blows up, the flow of electricity is stopped.

Can the aluminium foil used in the experiment be considered as a fuse? Give reasons for your answer. (10)

If there is no fuse in the electrical connection to your home or school, what danger could there be? (11)

PART III : THE MAGNETIC EFFECTS OF ELECTRICITY

Let’s study the magnetic effects of electricity. It was a Danish scientist named Hans Christian Oersted who first discovered that electricity produced a magnetic field. That was over 180 years ago in 1819. Let us perform the very same experiment he did to discover this effect. But before doing the experiment, we need to understand one fact. When we connect wires to the terminals of a cell to complete a circuit, an electric current flows in the circuit in a particular direction.

THE DIRECTION OF AN ELECTRIC CURRENT IN A CIRCUIT

You saw in your copper plating experiment that copper was deposited on the carbon rod when the copper wire was connected to the positive terminal of the cell and the carbon rod was connected to the negative terminal. When the connections were reversed - the copper wire was connected to the negative terminal and the carbon rod to the positive terminal - the copper was redeposited on the copper wire. We can, therefore, state that in such a circuit copper always flows from the positive terminal to the negative terminal. Scientists have accepted the direction in which the copper flows as the direction of the electric current. Thus it is accepted that in every circuit, the electric current flows from the positive terminal of the cell to the negative terminal. The direction of the electric current is shown by the arrows in Figure 5.

Copy the following circuit diagrams in your exercise book and draw arrows to show the direction of the electric current in each circuit. (12)

We shall now perform the experiment Oersted did.

EXPERIMENT 5

OERSTED'S EXPERIMENT

Place a compass on a flat surface. The compass should be placed in such a way that the north-south direction in which its needle points should be exactly in line with the north-south direction marked on the compass. Now prepare the circuit shown in Figure 6. Use a two-metre length of enamelled copper wire for the purpose. Place the section XY of the copper wire over the compass in the north-south direction. Ensure that this section is placed in the middle of the compass. Press the switch and complete the circuit.

What is the direction of the electric current in wire XY - north to south or south to north? (13)

Was the compass needle affected? If the needle was deflected, state in which direction its north pole turned. (14)

While noting your observations remember that the direction of an electric current in a circuit is from the positive terminal of the cell to the negative terminal.

Reverse the cell in the above circuit and repeat the experiment.

State the direction of the electric current this time. If the compass needle is deflected, in which direction did its north pole turn? (15)

Make a table like the one shown below in your exercise book and list your observations in it.

Table 1

Direction of electric current in wire XY	Is wire XY above or below the compass	Direction of rotation of compass needle's north pole
North to south	Above	
South to north	Above	
North to south	Below	
South to north	Below	

Now place the compass over section XY of the wire.

Find the direction in which its north pole turns when the electric current is

a) flowing in the north-south direction,

b) flowing in the south-north direction. (16)

Until now, you had observed that a compass needle is deflected when a magnet is brought near it. In this experiment, you saw that a wire in which an electric current flows has the same effect on the needle.

Does the wire behave like a magnet when an electric current flows through it? (17)

THE RIGHT HAND RULE

It is now clear that an electric current has a magnetic effect. In Experiment 5, we saw how a compass needle was deflected by an electric current. We can identify the direction in which the needle will be deflected in any situation with the help of our right hand.

Figure 7

To do this, place your right hand as shown in Figure 7, such that:

a) your fingers point in the direction of the flow of electric current and

b) the palm of your hand faces the compass and the wire is between the compass and your palm.

When you place your right hand in this manner, your thumb indicates the direction in which the north pole of the compass is deflected.

Test this rule with your observations.

EXPERIMENT 6

Set up Experiment 5 again. Fold section XY of the wire in the middle to double it. Place the folded section north-south.

What is the effect of the electric current on the direction of the needle when:

a) the folded wire is directly over the compass (Figure 8 a).

b) the folded wire is directly below the compass (Figure 8 b)

c) the compass is placed between the folds of wire (Figure 8 c). (18)

Figure 8 a   Figure 8 b   Figure 8 c

Draw the three diagrams in your exercise book and mark the direction of the electric current in wire XY. (19)

Discuss the experiment with your teacher and explain your observations in your own words, giving reasons. Use the right hand rule you learned above. (20)

Look at the arrangement shown in Figure 8 c once more. The wire XY is wound around the compass once. If it is wound twice, and then three times, will the deflection be greater or less? Do the experiment and find out.

If we keep increasing the turns of wire around the compass, what would be the maximum deflection of the needle? (21)

First estimate your answer. Then actually do the experiment and see if your estimation is correct.

EXPERIMENT 7

MAKE AN ELECTROMAGNET

Cut out a sheet of paper 20 cm long and 7 cm to 8 cm wide and apply glue to one side. Keeping the glued end outwards, roll the paper over a pencil to get a 7 to 8 cm long tube. Remove the pencil carefully and stick the glued end. Let the glue dry. Take the two-metre enamelled copper wire you used in Experiments 4, 5 and 6. Leaving a length of 10 cm from one end, wrap the wire around your paper tube in the manner shown in Figure 9 a to form a coil.

The coil should have at least 100 turns of wire. Ensure that the turns are closely packed but do not overlap. Insert a long nail in the tube. Connect this coil to the circuit shown in Figure 9 b. Spread some pins around the coil, then press the switch to complete the circuit.

Are the pins attracted to the ends of the coil? (22)

What happens when the switch is released? (23)

You had studied the magnetic field of a bar magnet in Class 6. If the electric coil produces a magnetic effect, it must have a magnetic field as well. To study the magnetic field, place the coil with its nail in a north-south direction. Hold a card sheet over the coil and sprinkle some iron filings on it. Complete the circuit and tap the card sheet a couple of times. For comparison, repeat this experiment with a bar magnet in the north-south direction.

Compare the magnetic fields of the electromagnet and the bar magnet and illustrate your observations with diagrams. (24)

Discuss the results of all the experiments you have done with your teacher and find out the similarities between an electromagnet and a bar magnet. Write your answer in your own words. (25)

MAKE AN ELECTRIC MOTOR

An electric motor uses the effect of the magnetic fields of two fixed magnets on an electromagnet. When an electric current flows through the coils of the electromagnet, it begins to rotate. As simple as that. But if we look at the uses to which an electric motor is put, it would count among the greatest inventions of the world. So let’s make a simple electric motor.

You will have to collect the following materials for constructing your motor: copper wire, bar magnet, one large cell, two stove pins (which have a hole at one end).

Take a 1.5 metre length of copper wire from your kit. Wind it around the cell. Your coil should have at least 15 to 20 turns.

When your remove the coiled wire from the cell it should open like a spring.

To prevent the coil from spreading like a spring, wind the ends of the wire around the coiled part.

You will get a coil of wire with two ends sticking out.

The two ends of the wire should fall on the line passing through the centre of the coil. The coil should rotate freely and smoothly on this axis. To ensure this, see that the coil is equal and balanced on both sides of the axis. Scrape the two ends of the wire with a blade.

Why did you scrape the two ends of the wire with a blade?

Don’t remove all the enamel from the ends. Remove the enamel from only one side of each end.

Fix the stove pins on two sides of a cell with the help of broad rubber bands. The side with the hole should be on top. The holes on the two pins should face each other and be directly in line with each other.

Fix the coil in these two holes. The protruding wires of the coil should slip into these holes.

Place a magnet on the cell as shown in the figure. If you don’t have a bar magnet and only have disc magnets, don’t worry. You can still do the experiment. Your motor is ready. If the motor does not rotate, give the coil a slight spin and it will start rotating.

Chapter-17

HEAT AND TEMPERATURE

It is the month of May. The sun shines hot and fierce. But you are cool because you are sitting under a fan at home. Suddenly, the electricity supply shuts down. You begin to feel uncomfortable in the heat and the sweat pours down your face. In such heat, even dogs, cats and cattle seek out the nearest shady place. And if the heat spell continues for long and there is not enough water available, plants and trees begin to wilt and wither.

So the summer heat affects plants, animals and us, human beings. But does it affect the non-living things around you? Have you ever wondered about this? Let’s do a few experiments to find out how heat affects gases, liquids and solids.

EXPERIMENT 1
THE EFFECT OF HEAT ON AIR

Take an empty injection bottle (with the lid) and a 5-cm piece of an empty refill. Poke a hole in the middle of the bottle lid with a needle or nail. Make sure the hole is not wider than the diameter of the refill. Push the refill partly through the hole (Figure 1) and then put the lid on the bottle. Pour two drops of water into the upper end of the refill. If the water does not flow into the refill, then lift the lid off the bottle. Remember, the water should remain in the refill and not drain out. If you use coloured water, all the better, because you can easily see the water.

Now rub your palms together till they become a bit warm. Then hold the bottle in one palm.

Figure 1

What happens to the drops of water in the refill? Why did this happen? (1)

What effect did the heat from your palms have on the air in the bottle? (2)

If you want to repeat this experiment, first take the lid off the bottle, then rinse the bottle with some water.

You could do this experiment in another way. Invert the bottle and dip the exposed end of the refill in water. Now warm your palms by rubbing them together and clasp the bottle in one palm.

What did you observe this time? (3)

What effect did the heat from your palms have on the air in the bottle? (4)

You did Experiment 5 in the chapter ‘Games with air’ in Class 7. In case you have not done the experiment, do it now.

What happened in the experiment and why did it happen? (5)

EXPERIMENT 2

We saw what happens when we heat air. Would we see the same effect if we heat water? Let’s do an experiment to find out.

You will need a test tube, one-holed cork, glass tube and candle. Fill the test tube to the brim with water. Colour the water blue by mixing two drops of ink in it. That way, you can easily see the water level in the glass tube.

Push the glass tube into the one-holed cork and fit the cork into the mouth of the test tube (Figure 2). Some water from the test tube will rise into the glass tube. If necessary, seal the cork with candle wax to prevent water from leaking out of the test tube. Mark the water level in the glass tube with your pen.

Now hold the test tube upright over a candle flame and heat it continuously. Observe the water level in the glass tube carefully for five to ten minutes.

Figure 2

Did the water level in the glass tube rise continuously while you were heating the test tube? Why did this happen? (6)

What change occurred in the volume of water on heating? (7)

Mark the new water level in the glass tube with your pen. Blow off the candle. The water will cool gradually.

Watch the water level carefully for five to ten minutes during cooling.

What happened to the volume of water on cooling? (8)

EXPERIMENT 3
EFFECT OF HEAT ON SOLIDS

Why is the iron rim of a bullock cart wheel heated before it is fitted onto the wheel? Why is a small gap left between two lengths of railway lines? We can perform an interesting experiment to find an answer to these questions. All we need to do is heat a cycle spoke.

You will need a bulb, dry cell, candle, cycle spoke, coin (or broad-headed nail) and two wooden blocks. Place one end on the cycle spoke on a wooden block and connect an electric wire to it. Put a stone over the spoke to hold it firmly in place on the wooden block, as shown in Figure 3. The spoke should be parallel to the ground. Place the second wooden block near the free end of the spoke. Wrap some electric wire around the coin (or nail) and place it on the block. Put a stone over the coin to hold it in place.

Connect a bulb and the dry cell to the free ends of the wires from the coin and spoke and make the circuit shown in the figure. When the tip of the free end of the spoke touches the coin, the circuit is completed and the bulb lights up. If the bulb does not light up, it means the circuit is not complete, so check your connections properly.

Now slide a page of your exercise book between the coin and spoke and then slide it out. That way you would have a gap between the coin and spoke equal to the thickness of the sheet of paper.

Figure 3

Does the bulb light up? If it doesn't, what could be the reason? (9)

You saw that the bulb does not light up when the spoke does not touch the coin. Now light the candle and heat the spoke with it.

Did the bulb light up after the spoke was heated for some time? (10)

If it did, then explain how the spoke touched the coin after it was heated. (11)

Why does the bulb go off some time after the candle is taken away from the spoke? (12)

What happens to the length of the spoke when it is heated or cooled? (13)

Now explain why the iron rim of a cartwheel is heated before it is fitted onto the wooden wheel. (14)

In the three experiments done so far, you saw the effect of heat on gases, liquids and solids.

On the basis of these experiments, explain what effect heat has on the volume of these three substances. (15)

The word heat is used in many different ways. It means many different things. For example, you could get into a heated argument with your friend. But in science, heat has a specific meaning.

We saw one aspect of heat. Now let us look at another. Are various substances good or bad conductors of heat, just as they are good or bad conductors of electricity?

GOOD AND BAD CONDUCTORS OF HEAT

We have no problem in holding a cup or earthen vessel filled with boiling tea. But if the same tea is poured in a steel tumbler, it is difficult to hold the tumbler.

Why is this so? Explain in your own words. (16)

A substance that absorbs heat easily and allows the heat to spread easily within it is called a **good conductor** of heat. Steel is a good conductor of heat. A substance that does not absorb heat easily and does not allow heat to spread easily within it is called a **bad conductor** of heat. For example, wood is a bad conductor of heat. No matter how hot a frying pan gets, we can hold its wooden handle without any problem because the heat of the frying pan does not reach our hand through the wooden handle.

But our hands can be easily fooled by good or bad conductors of heat. For example, things lying out in the cold are more or less the same temperature as the outside air. But if we touch an iron pole it feels much colder than a wooden stick. The difference occurs because the iron pole easily absorbs heat from our palm, as a result of which our palm feels colder. On the other hand, the wooden stick does not easily absorb heat from our palms, that is why it does not feel as cold as the iron pole when we touch it.

Try and give some examples from your daily life in which you use good or bad conductors of heat. (17)

We use sweaters, coats, shawls, quilts, blankets etc to protect ourselves from the cold. We call them warm clothes. Are they really warm? If we touch warm clothes, they don’t feel warmer than other clothes.

So where does the warmth come from when we wear warm clothes? (18)

How do warm clothes protect us from the cold? (19)

In desert areas, the the heat of the sun is intense and the temperature is always very high. People there wear cotton clothes when the go out of their homes.

Discuss among yourselves and explain the advantage of wearing cotton clothes in very hot places. (20)

We usually cover an ice block with a gunny bag or sawdust to keep it from melting.

The gunny bag or sawdust stops the flow of heat. But in which direction is the flow of heat stopped? And how? Think well before answering. (21)

We have seen that some substances are good conductors of heat while some are bad conductors of heat. But, do all substances **conduct heat** in the same way? Let's do some experiments to understand how heat is conducted in gases, liquids and solids.

EXPERIMENT 4
HOW HEAT TRAVELS FROM ONE PART OF A SOLID TO ANOTHER

We can observe how a solid heats up with a simple experiment. In this experiment, pins are stuck with candle wax on a strip of iron and the iron strip is heated. We can then see how quickly heat moves from one end of the strip to the other.

Take a 15-cm long iron strip. Use a candle to put a drop of molten candle wax on the iron strip, 3 cm from one end. Stick the head of a pin in the wax. When the wax cools and solidifies the pin should stand upright on the iron strip (Figure 4-a). Now fix pins in this manner at one cm intervals from the first pin.

Turn the metal strip over and heat the end where you stuck the first pin, as shown in Figure 4-b.

Figure 4-a **Figure 4-b**

Which pin fell off the iron strip first. (22)

Did all the pins fall of together? (23)

Was there a particular order in which the pins fell off? (24)

Suppose we heat the iron strip from the middle, as shown in Figure 5.

Figure 5

Which pin would fall off first in this case? (25)

The way in which heat flows from one part of a metal - or any other solid substance - to another in called **conduction**.

EXPERIMENT 5

Hold a cycle spoke with one end slightly higher than the other, as shown in Figure 6. Heat the middle of the spoke over a candle flame.

Figure 6

Did you feel the upper and lower ends of the spoke becoming warmer after some time? (26)

Did the heat reach the lower end quicker than the upper end? (27)

EXPERIMENT 6
HEAT IS CONDUCTED IN LIQUIDS IN A DIFFERENT WAY

Fill a test tube two-thirds full with water. Hold it at a tilt over a candle flame and heat the portion on the test tube where the water level is (Figure 7). The water will begin to boil after a while.

Figure 7

Touch the bottom of the test tube and see whether it has become hot or not. (28)

Why did this happen? (29)

If all the water in the test tube is to be heated, which part of the test tube should we heat? (30)

When a metal is heated in the middle, the heat spreads in all directions.

In which direction does heat flow in a liquid? (31)

EXPERIMENT 7
CURRENTS IN WATER WHEN IT IS HEATED

Heat flows in all directions if any part of a solid is heated. But why does heat always flow upwards when a liquid is heated? Let’s do an experiment to find out.

a) Fill a test tube half full with water. When the water is still, drop a grain of potassium permanganate in it. Watch how the colour spreads for some time.

In which direction did the colour spread? (32)

b) Throw out the coloured water and again fill the test tube half full with water. Put a grain of potassium permanganate in the water. But this time, heat the test tube over a candle flame (Figure 8). Watch how the colour spreads for some time.

Figure 8

In which direction did the colour spread this time? (33)

What were the differences in the way the colour spread in experiments (a) and (b)? (34)

Try and observe the upward and downward water currents. You can see these currents more clearly in a glass beaker.

Make a diagram of these water currents. (35)

Will the water flowing upwards be cold or warm? (36)

Is the water flowing downwards cold or warm? (37)

In this experiment, the potassium permanganate was added only to colour the water. There could be many other currents in water when it is heated, which we don’t see. When liquids are heated the kind of processes that occur in it are called **convection**.

EXPERIMENT 8
IN WHICH DIRECTION DOES HEAT FLOW IN AIR?

Take a test tube or boiling tube with the bottom broken off. Hold the test tube at a tilt with the help of a test tube holder and heat it in the middle over a candle flame. After some time, put your finger in the open upper end of the test tube (Figure 9)

Figure 9

Is the air at this end of the test tube warm? (38)

Now put your finger in the open lower end of the test tube and feel how warm the air is.

Did you notice any difference in the temperature of the air in the upper and lower ends of the test tube? (39)

Compare this experiment with Experiment 6 and explain the similarities in the way heat flows from one part to the other in liquids and air. (40)

HOW DOES HEAT FLOW IF THERE IS NO AIR?

You saw in the previous experiment that when air is heated it carries the heat from bottom to top. But there is no air in outer space. So how does the heat of the sun reach the earth? In the chapter 'Light' you focused the rays of the sun with a hand lens and burned a hole in a sheet of paper. You could repeat this experiment now, if you wish. It is the sun's rays that carry heat to the earth. This method of conveying heat is called **radiation**.

TEMPERATURE

When a person has a fever, his body feels warm. If the body becomes hot, we begin to worry whether the fever isn't too high. We can estimate whether the fever is very high or not by touching the person's forehead with our palms. We can also use our fingers to find out whether the tea in a cup has cooled enough to drink or whether milk has been heated enough to set for making curds. But our palms and fingers can sometimes deceive us. Like they did in the experiment on hot, cold and warm water in the Class 6 chapter 'Sensitivity'.

In that experiment, warm water felt cool with one finger but hot with the other. So we can always be fooled if we try to judge temperature only by touch.

To know the temperature of the body, we need to measure the temperature. We use an instrument called the **thermometer** for this purpose (Figure 10). We shall use a thermometer in the next few experiments. But this one is slightly different from the thermometer used to measure the temperature of the body.

If there are not enough thermometers in the kit for each student, the teacher should make arrangements for all the students to get a chance to handle and read a thermometer. One way to ensure this is to make only as many groups as there are thermometers.

Figure 10

EXPERIMENT 9
MEASURING TEMPERATURE WITH A THERMOMETER

Examine the thermometer in the kit. You will see that it contains some shining mercury in the bulb at one end. The bulb is joined to a long narrow tube called the stem of the thermometer. When the mercury is heated, it rises in the stem.

Can you explain why the mercury rises in the stem when it is heated? (41)

Look at the stem of thermometer from all sides. It's outer surface has a scale that is marked in degrees Celsius. Celsius is the unit for measuring temperature. The temperature at which water freezes and becomes ice is 0 degrees Celsius. Now look at the scale on the thermometer.

What is the minimum reading of the scale? (42)

If you wish to find the temperature of a substance, you should place the bulb of the thermometer on it. You can see the silver thread of mercury rising in the stem of the thermometer. The point to which the thread rises on the scale is the temperature of that substance.

Clasp the bulb of the thermometer in your palm. Watch the mercury rise in the stem.

What is the temperature of your palm? (43)

Dip the thermometer in water and find the temperature of the water. (44)

What is the temperature of the outside air? Take a guess.

Now measure the temperature of the outside air, both in the shade and in open sunlight. (45)

EXPERIMENT 10
THE TEMPERATURE OF BOILING WATER

You have to arrange this experiment in such a way that you have water boiling on a stove and a thermometer dipped in the water to measure its temperature (Figure 11). The thermometer should not touch the vessel in which the water is being heated. All the students in the class should read the thermometer one by one. You will need the hot water for the next experiment, so don't throw it away.

Figure 11

Read the temperature of the boiling water and note the reading on the blackboard. What is the temperature of boiling water? (46)

Once all the students have written down their readings, study the readings and say whether the temperature of the boiling water continued to rise after it was heated for some time. (47)

When boiling water is heated for some time, the water continues to receive more heat, but its temperature does not rise further. The point at which the temperature of water becomes stable and it begins to form steam is called the **boiling point** of water. Cooking oil begins to boil at 250 degrees Celsius. But cooking oil is a mixture, so its boiling point is not stable.

One day in 1922, the air temperature was measured at 59 degrees Celsius in the shade in Libya, Africa. In India, the maximum temperature reached in some places is approximately 48 degrees Celsius. The coldest temperature in the world was measured in the Antarctic continent. It was approximately minus 89 degrees Celsius. The minus sign (-) is used when the temperature falls below the freezing point of water, which is 0 degrees Celsius. If water becomes ice at 0 degrees Celsius, you can imagine how cold -89 degrees Celsius would be.

Our body feels cool if the air temperature is around 15 to 20 degrees Celsius.

Now estimate the night temperature in your village or city during winter. (48)

EXPERIMENT 11
WE CAN ADD WATER TO WATER, BUT DO TEMPERATURES ADD UP?

If we take some water at a temperature of 20 degrees Celsius and add some water at a temperature of 60 degrees Celsius to it, would the temperature of the mixture be 80 degrees Celsius? Let's do an experiment to find out.

Pour some water in a container. What is its temperature? (49)

Fill a beaker one-third with hot water. Note the temperature of the water. (50)

Pour the water from the container into the hot water in the beaker, filling the beaker to the brim. Stir the water in the beaker so that the plain water and hot water mix. Measure the temperature of the mixed water immediately. (51)

Suppose we filled the beaker half full with hot water, instead of one-third, would the temperature of the mixed water be more or less than in Experiment 11? Think carefully before making a guess. (52)

SOME USEFUL INFORMATION

We measured temperature in Celsius in this chapter. There is another unit for measuring temperature. It is called Fahrenheit. The 0 degrees on a Celsius thermometer equals 32 degrees Fahrenheit and 100 degrees Celsius equals 212 degrees Fahrenheit. In other words, if we read the temperature at which water freezes in Fahrenheit, it would be 32 degrees Fahrenheit, while the boiling point of water would be 212 degrees Fahrenheit.

If someone told you he has a temperature of 102 degrees, did he measure the temperature of his body in Celsius or Fahrenheit? (53)

The normal temperature of our body is 37 degrees Celsius and 98.6 degrees Fahrenheit.

NEW WORDS

thermometer	heat	convection	degrees Celsius
boiling point	conduction	radiation	degrees Fahrenheit

Chapter-18

THE TINY WORLD OF MICRO-ORGANISMS

In Class 6 and 7 you observed many things by magnifying them under a microscope. It is fun seeing things that we normally cannot see. Before the first microscope was invented about 300 to 350 years ago, people didn't even know that the world around us is filled with so many living and non-living things that are not visible to the naked eye.

It was a cloth trader living in Holland in the 17th century who invented the microscope. His name was Anton von Leeuwenhoek. Leeuwenhoek was fond of making different kinds of glass lenses and observing things through them. Once he made a lens that magnified things about a hundred times. A whole new world of tiny living organisms was thrown open to him. He started observing various minute living organisms, drawing their pictures and describing them. Soon, other scientists too started observing things through the microscope. This led to the discovery of thousands of different kinds of living organisms. It also generated new information about the structure of animals, plants and non-living things.

Before we proceed further it would be useful to learn the correct way of observing things through a microscope.

BOX 1
THOSE WHO SEEK SHALL FIND!

Magnifying tiny things, observing them and drawing their diagrams is an important activity in science. In this chapter you will learn to observe very small things and draw their diagrams. A microscope is essential for doing this. If you have not used a microscope, you may have some difficulty in the beginning. But with practice, you will be able to see very small things with ease. And when you do see them, it's so much fun!

All the experiments in this chapter have been performed many times before with the microscope you will use. Even with very large and powerful microscopes, scientists have to peer into the lenses for hours, adjusting them to be able to see something properly. But there is a saying that those who seek shall find. So you will be able to see things only if you keep looking for them. If you cannot see something in the microscope the first time, do not despair. Keep trying. Once you know how to look through the lens, you will find it hard to stop looking at new things through the microscope.

HOW TO OBSERVE THINGS THROUGH A MICROSCOPE

The parts of a microscope are shown in Figure 1. Study the diagram and try to familiarise yourself with all these parts.

Figure 1

1. Now, do the following tasks:
   a) Remove the lens cap of the microscope and take out the lens. Check whether it is clean. If it is not, wipe it clean with a soft cloth.
   b) Does the lens move up and down when you screw and unscrew the knob? If the screw is loose, change its valve-tube.

c) The mirror strip of the microscope should always be clean. Adjust it to an angle where you see bright light when you look through the lens.

2. Wash the glass slide with water and wipe it clean.

3. To be able to see anything through a microscope, you must move the lens up and down until it comes to a position where the object is clearly visible. This is known as focusing the lens. Sometimes, while focusing, the lens may touch the water drop in which the object floats. To prevent the lens from getting wet, you can cover it with a strip of polythene.

   You will need several such polythene cover slips for your observations. Cut them from a clean and transparent polythene bag. First cut a long strip of polythene two cm wide with a blade. Then cut this strip into small two square cm pieces. These pieces can serve as cover slips to shield the objects you wish to observe. Glass cover slips are also available in the market.

4. When you wish to observe an object, pour a drop of water on the glass slide. Pick the object up with a needle or tweezers and place it in the drop of water. Cover it with the cover slip. If the water leaks out from under the cover slip, use filter paper or blotting paper to soak it up so that the object and the cover slip remain stationery and do not float.

5. Place the glass slide on the microscope. The object you wish to observe should be directly under the lens. Move the lens up and down to focus on the object.

   Rotate the mirror strip to increase or decrease the amount of light while you observe the object.

EXPERIMENT 1
OBSERVING TINY THINGS: ALGAE

The water of any pond has strands of algae floating in it. Collect some algae along with some water and bring it to class. Use a needle or babool thorn to pick a bit of the algae and place it on the glass slide. Try to separate the strands and draw a picture of what you see.

Observe the algae through the microscope.

Draw a picture of what you see. (1)

Now collect some soft moss growing on walls or garden bricks.

Draw a picture of the moss plant. Now observe it through the microscope and draw a picture of whatever you see. (2)

CELLS

Figure 2: Robert Hooke made these drawings of the bark of a tree.

We said earlier that many scientists began observing different things through the microscope after its discovery by Leeuwenhoek. Among them was Robert Hooke of England. In 1660, Hooke observed a thin strip of tree bark through his microscope. He thought it was made up of very small cavities (Figure 2). He called these cavities cells. Later, scientists found that these cells are not empty spaces; they are filled with a kind of liquid. This liquid is called cytoplasm. It contains minute parts that help the cell to do its work.

Let us try to look at some cells under the microscope.

EXPERIMENT 2
ONION SKIN CELLS

Peel the top few layers of an onion and cut a squarish piece from the thick and juicy inside layer with a blade (Figure 3). Fold this piece into two till it splits. Gently tear away the two fleshy parts (Figure 4). You will get a thin transparent layer from the inner side of the two pieces. Cut a small piece from this onion skin film. Put 2 to 3 drops of water on a glass slide and spread the onion skin on the slide with the help of a needle or babool thorn (Figure 5).

Figure 3 **Figure 4** **Figure 5**

Examine it through the microscope. Adjust the glass slide so that you see all parts of the onion skin.

Can you see many rectangular structures stacked together in the onion skin? These structures are called cells. The partitions between the calls are called cell walls.

Draw a diagram of the onion skin cells. Label the cell walls in this diagram. (3)

EXPERIMENT 3
LEAF FILM CELLS

You can peel a similar transparent layer of skin from leaves if you fold them down the middle like you did with the onion layer. Thick fleshy leaves are good for this purpose. For example, you can easily get a skin film from a betel (paan) leaf or the leaf of a lily. Examine these skin films through the microscope, like you examined the onion skin.

Draw a picture of what you see. (4)

Are all the cells in this skin the same, like all the cells in the onion skin, or are they different from each other? (5)

A WORD OF CAUTION

In the following experiments you will have to cut sections of plants to examine their cells. If you wish to see the cells clearly, your sections must be as thin as possible. Use a new blade to cut thin sections. Don’t use this blade for cutting anything else. Keep it only to cut sections.

EXPERIMENT 4
SECTION OF A STEM

Take a thin and soft stem of a dicotyledonous plant. The stems of methi, bathua, panwar or chiroutha will be ideal for this experiment.

Cut a few thin transverse sections of the stem with the blade. Pour some water in a plate or small bowl. Place these sections in the water with the help of a needle or babool thorn (Figure 6). Cut more sections and place them in the water.

Figure 6

Examine these sections with a hand lens. Find the thinnest and most transparent section. Place it on the glass slide and observe it through the microscope.

Are the shapes of all the cells you see the same or are there some differences in them? Compare the section you have cut with the section shown in Figure 7. How many of the cells seen in Figure 7 can you identify in your section? Draw a picture of your stem section. (6)

Figure 7 : Diagram of the transverse section of the stem of a dicotyledonous plant.

FIND THE NUCLEUS OF THE CELL

You read that the cell is not empty or hollow. It is filled with cytoplasm which contains many microscopic parts. You can't see all these structures with your microscope. But there is one part that is clearly visible. It is called the nucleus.

Figure 8. The nucleus in the cells of an onion skin film.

Place an onion skin film on the glass slide like you did in Experiment 2. Pour on or two drops of red ink on the film and let it stand for about 10 minutes.

Pour water on the film with a dropper. Continue pouring water until all the red colour runs out of the film. Now place a cover slip over the film and examine it under the microscope.

Do you see red-coloured circular structures in most of the cells? These are the nuclei of the cells. There is a nucleus in every cell and it is an important part of the cell (Figure 8).

Draw a picture of the onion skin film showing the nucleus (7)

EXPERIMENT 6

STARCH IN CELLS

Take a large square or rounded piece of potato and cut several horizontal sections from it. Place a thin section on a glass slide and pour water on it with a dropper until the whitish substance stops flowing from it. Pour a drop of iodine on the section.

After a minute, wash the section by pouring water over it with a dropper. Put a cover slip over it and examine it under the microscope.

Draw a picture of whatever you see. (8)

The dark blue dots you see in the cell are starch.

THE BODY IS MADE UP OF CELLS

In the experiments done till now you have seen that the onion skin film, algae, leaves, stems of plants and potatoes are made of cells. You have also seen that cells are of different sizes and shapes. This is because their functions are different. Some cells in the plant stem transport water absorbed by roots to the upper parts of the plant. Other cells near the surface of the stem protect the plant. Some cells are factories where food is produced while some cells store the food that is produces.

All cells have cytoplasm in which the nucleus and other minute structures are located. The size and shape of a cell depends on the work it does.

Figure 9 shows some of the different kinds of cells found in plants and their functions.

Figure 9 Some plant cells and their functions

Just as the plant's body is made up of innumerable cells, similarly the bodies of animals are also made up of millions and billions of cells. It is not possible to see the cells found in the bodies of animal with the microscope in your kit. But Figure 10 shows some of these cells and their functions.

Figure 10 Some cells in the human body and their functions.

Although all cells are very small, there is great variation in the sizes of different cells. The onion skin cells are big enough to be seen with the help of your microscope. But they are still small enough for 3,000 to 4,000 of them to fit on a pin head. Animal sperm cells are much smaller than even these onion skin cells. About 40,000 to 50,000 of them would be required to cover the same pin head.

UNICELLULAR ORGANISMS

Some plants and animals have bodies made up of a single cell. Do you think these organisms can be seen without the help of a microscope? Figure 11 shows some of these organisms as seen through a microscope.

Figure 11

The line shown in this diagram is just as long as a 0.1 mm line would appear if seen through the same microscope.

Measure this line and calculate how many times it has been magnified by the microscope. (9)

Using this line as a scale find the actual length (a to b) and breadth (c to d) of the four organisms shown in the figure.

Copy the table given below in your exercise book and note your measurements in it. (10)

Table

Organism	**Dimensions**	
	a to b	**c to d**
Organism 1		
Organism 2		
Organism 3		
Organism 4		

SOME SPECIAL EXERCISES

1. Draw a picture of any fungus growing on pickle, roti or bread. Examine it through the microscope and again draw a picture of it.

2. Bring some stagnant water from a pond or lake. Put a drop of this water on a glass slide, cover it with a cover slip and examine it through the microscope.

Do you see any micro-organisms swimming in the water? If you can see them, draw their pictures. (11)

NEW WORDS

focusing cell nucleus cytoplasm cell wall

Chapter-19

CHANCE AND PROBABILITY

Bankhedi is a small station on the Itarsi-Allahabad railway line in the eastern part of Hoshangabad district. Every morning at around 10 o'clock, a train for Itarsi called the Bina Express stops at this station. This train is usually 15 to 20 minutes late. Sometimes it comes as much as two hours late. But sometimes, it comes exactly on time.

There is another train for Itarsi, the Allahabad-Itarsi passenger, that leaves Bankhedi at around 12.00 noon. That is the time you find written in the time table. In reality, the passenger comes two to four hours late on several days of the month. Sometimes it comes one to one-and-a-half hours late. But, once in a while, maybe once or twice a month, the passenger takes everyone by surprise by coming to Bankhedi on time.

A few questions about the arrival and departure of trains at Bankhedi are given below. Discuss these questions among yourselves before writing down your answers.

A businessman came one day at 11.00 am to Bankhedi station to catch the Bina Express. Can you state, with reasons, whether he caught the train or not that day? (1)

Another trader wanted to catch the Allahabad-Itarsi passenger the following day. Thinking the passenger would be late by at least an hour, as it usually is, he reached the station at 1.00 pm (approximately 45 minutes after its scheduled time of arrival). To his surprise, he found that the train had left on time that day.

He cursed his luck for having missed the train.

Is the passenger coming on time an unlikely or improbable event? Taking into account its history of latecoming, give reasons for your answer. (2)

A class has 50 children enrolled in it. On average, around 40 children are present every day. What would be the attendance on Monday? Can you guess the correct number. (3)

A GAME OF *COWRIES/CHIYE*

You may have played games with *cowries*, tamarind seeds (*chiye*), dice or coins.

Can you make the c*hiye, cowries,* dice or coins fall the way you want? (4)

Suppose you throw four *cowries* 20 times. Is it possible for the *cowries* to fall the same way on every throw? (5)

Let's perform a few experiments and play a few games to try and understand events like catching or missing a train, the attendance of children in a class on a particular day, or throwing a particular number with *cowries* or dice.

HEADS OR TAILS

Take a coin and flick it in the air so that it spins rapidly several times before falling to the ground (Figure 1). If it falls with the Ashoka Pillar facing up, call it heads and if it falls with the number facing up, call it tails.

EXPERIMENT 1

THE HEAD AND TAILS RACE

All the students in the class should play this game together. The minimum number of students required is 20. If your class does not have 20 students, get some students from

Class 6 or 7 to join in. But remember, you will have to explain the game to them and how they should fill in their individual charts.

To prepare for the game, draw 15 parallel lines on the ground in an open *maidan* or playground. The spacing between the lines should be one step and all the lines should be of equal length. The line should be long enough for all the students to stand together on it, with a small gap between adjacent students.

Label the middle line as Line 0. Label the lines on one side of Line 0 serially as Front 1, Front 2, Front 3 and so on till Front 7. Similarly, label the lines on the other side Back 1, Back 2, Back 3 and so on till Back 7.

Your teacher can be the referee.

HOW TO PLAY THE GAME

At the start of the game, all the students should stand on Line 0, facing line Front 1. Each student should have a coin. When the referee blows the whistle, all the students should flip their coins and check whether it falls heads or tails. Those who flip heads should move a step forward to line Front 1 while those who flip tails should move a step backwards to line Back 1. This is the first move of the game.

Every time the referee blows the whistle, the students should flip their coins together. Those who flip heads should move a line forward and those who flip tails should move a line backwards from the line on which they are standing.

The first student to reach either Front 7 or Back 7 is the winner. The race ends once a student reaches the winning line.

MAINTAINING YOUR GAME DIARY

Details of the moves in the game are kept in two ways.

1. **Individual charts**: Each student maintains a record of her/his moves in the Heads and Tails Race Chart in the kit copy. The example below explains how each move should be entered in the chart.

A student marked her position on the chart at the start of the game. She drew a large dot at the point where the horizontal Line 0 and the vertical line ‘At the Start’ intersected. Her first eight moves were heads, heads, tails, heads, tails, tails, tails, tails. After each move, she marked a dot on the intersection point of the (horizontal) line she had reached and the (vertical) line showing the move number (Figure 2).

When the game ended, she joined all the dots with straight lines.

You should also mark your moves in this manner. Keep your kit copy with you while you are playing the game and mark your moves in the chart with dots.

2. **Collective table**: The referee will maintain a collective chart of all the students. The way to make this collective record is outlined in Table 1. After each move in the game, the number of students on each line is marked in the table. Some figures have been entered in the table here to show how the record is kept. Obviously, the record of your game will have different numbers.

Before the game begins, the referee should draw the collective table on the blackboard. The starting position is shown by marking the number of students on Line 0 at the ‘Starting’ point. After each move, the referee counts the number of students on each line and marks the number at the appropriate point in the table. This record is maintained till the game ends.

A DISCUSSION ON THE GAME

Complete your individual chart when the game ends.

Who won the race? (6)

Copy the collective table on the blackboard in the graph paper in your kit copy. (7)

Look at your individual chart and see whether there is any particular order in your moves back and forth. (8)

Can you guess the order in which numbers will fall in a game of *cowries-chiye*? (9)

The students should pin their individual charts on the wall. Examine these charts.

Is there any particular order in the backward and forward movement of the students? (10)

What would you call this kind of movement? (11)

Use a coloured pencil or red ink to mark the following in your individual chart:

- if only heads fall every time the coin is flipped. How would your chart look? (12)

- if a heads is followed by a tails and a tails by a heads. How would your chart look now? (13)

It is possible that one or two students in your class may flip only heads, or only tails, or may have heads and tails falling in a particular order.

If that happens, on what basis would you draw any conclusions about the order of heads and tails? On the basis of the results of a couple of students? Or on the basis of the results of the majority of students? Give reasons for your answer. (14)

Examine the collective table.

On which line were all the students standing at the start of the game? (15)

As the game progressed, how were the students distributed on the lines after each move? (16)

Look at the number of students on different lines in the collective table when the game ended.

Were most students on the lines close to Line 0 or were most of them on the lines further away from Line 0? (17)

If the game doesn't finish after a student reaches Line 7 and if the moves continue, what would happen? Think carefully about the problem before you answer. (18)

Were you able to predict the winner at the beginning of the game? (19)

Why is it not possible to predict the winners and losers in a heads and tails race? Give reasons for your answer. (20)

Can all the students be joint winners in a heads and tails race? Give reasons for your answer. (21)

MORE HEADS OR TAILS?

The line a player reaches at the end of the game depends on whether (s)he gets more heads or tails. A player who ends the game on Line 0 would have got an equal number of heads and tails. A player who is on Front 3 must have got three heads more than tails, while a player on Back 3 must have got three tails more than heads. The more heads a player gets, the further in front (s)he would be from Line 0. Similarly, the more tails a player gets, the further back (s)he would be from Line 0.

Look at the collective table and find out which line had the most students on the final move. (22)

What was the difference in number of heads and tails of the students who had reached this line? (23)

TWO IMPORTANT QUESTIONS

The major questions you will have to answer after the game are:

Did a tails follow every heads and did a heads follow every tails? If not, were there an equal number of heads and tails? If this was also not the case, then what happened?

If the game is played a second time, would the student who won the first game win the second game as well? If you have time, play the game again and find out for yourself. (24)

You got some answers to many of these questions while playing the game. You can confirm your answers only if you repeat your heads and tails experiment several times.

We cannot tell whether a heads or tails will fall if we flip a coin once. But if we flip the coin a sufficient number of times, we can roughly guess how many times heads will fall and how many times tails will fall.

We shall do some experiments with a larger number of moves.

EXPERIMENT 2

All the students in the class must have a coin each for this experiment.

Each student will have to flip the coin 100 times and find out how many times heads falls and how many times tails falls.

Before the students start flipping coins, try and guess how many heads will fall in the next 100 moves. (25)

Cut a sheet of graph paper with at least 10 squares in the horizontal lines. Or else take the 10 x 10 square coin flipping chart from your kit copy. Each line is for ten flips of the coin. So ten lines will give you 100 flips.

If a heads falls in the first flip, put a tick (/) mark in the first square of the first line and if a tails falls put a cross (x) mark. In this manner, mark a tick for every heads and a cross for every tails that falls in subsequent flips.

When one line is completed, count the number of tick marks it contains. This number will tell you how many times heads fell in ten flips of the coin. Write the number to the right end of the line (Figure 3).

Your chart will be filled after 100 flips of the coin. Add the numbers written at the right hand side after every line to find out how many times heads fell in 100 flips.

We shall now total the figures of the entire class after the students have filled in their charts and got their totals for 100 flips.

You made a guess of the number of heads before the experiment began.

Was your guess more or less than the number of heads you got? How much more or less? (26)

On what basis did you make your guess? (27)

Every student flipped a coin 100 times. Calculate how many flips of the coin the entire class made. (28)

On the basis of question 28, estimate how many heads the entire class got. (29)

Note the figures of the entire class in a table.

What have you learned about the probability of heads or tails falling if you flip a coin many times?

On this basis can you tell whether a heads or tails will fall if you flip a coin once? (30)

We cannot predict whether a single event will occur or not. But we can predict the probability of the event occurring by performing a series of experiments. In other words, we can experimentally determine the probability of the event occurring.

Divide the total number of heads in Table 2 by the total flips of the coin. You will get the probability of a heads falling in a single flip.

That is:

$$\text{Probability of heads} = \frac{\text{Total number of heads}}{\text{Total flips of the coin}}$$

Similarly,

$$\text{Probability of tails} = \frac{\text{Total number of tails}}{\text{Total flips of the coin}}$$

Calculate these two figures from the collective data in Table 2.

What is the sum of the probability of heads and tails? (31)

You get either a heads or tails when you flip a coin.

Can you understand the answer to the previous question on this basis?

Any event (such as flipping a coin) can have several probable results (heads or tails). The probability of a particular result occurring can be obtained experimentally in the following way (equation):

$$\text{Probability of a particular result} = \frac{\text{Number of times the result occurred}}{\text{Number of times the event occurred}}$$

The minimum probability is zero and the maximum probability is equal to one. If an event will definitely occur, its probability is one. For example, the probability of night following day is one, because night (the result) definitely occurs after every day (the event).

Can you give an example of an event whose probability is one? (32)

Can you give an example of an event whose probability is zero? (33)

Is the probability of heads or tails falling, which you found out experimentally, approximately the same? (34)

The probability of all results need not be the same. We shall see in Experiment 4 that the probability of different results can be different.

PROBABILITY AND PREDICTION

On the basis of the probability you calculated, can you tell how many heads and tails will fall on flipping a coin ten times? (35)

Do the experiment and find out for yourself. Was your guess correct? (36)

Collect the figures (data) of ten flips made by all the students in the class and calculate how many heads and tails there are. (37)

Does the total number of flips make any difference? To get a clearer answer to this question, we shall do another experiment with the figures (data) of the whole class.

EXPERIMENT 3

In this experiment we shall arrange the figures we got in Experiment 2 in another way. We shall take the total of all the ten moves in each line as a single move. The number written to the right side of each line gives the number of heads in that move. This number will be between 0 and 10. For example, there were 6 heads in the first move and 3 in the second. When the experiment is completed, we can count the numbers and say how many times 6 heads fell in 10 moves.

We shall make a histogram with these numbers. The histogram will tell us at a glance how many times each total number of heads fell.

MAKING A HISTOGRAM

Take a sheet of graph paper from your kit copy. Draw a thick line with a pencil along one of its horizontal lines, as shown in Figure 3.

Mark the numbers 0, 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 on the graph paper as shown in the figure. These are the total number of heads that fall in every move. You will have to show on this graph paper how many times each total number of heads fell in 10 moves.

For example, if there were 3 heads in the first move, shade the square above the number 3 with a pencil. If the following move had 5 heads, shade the square above the number 5 (Figure 4). If the next move again had 5 heads, then shade the second square above 5. (Figure 5).

In this way, you should shade the squares according to the number of heads for each move. On looking at the completed histogram, we can tell from the height of the columns which number of heads occurred the most and which the least.

Using the method outlined above, make a histogram of ten moves. (38)

On the basis of your histogram, state whether the number of heads in all columns is more or less the same or different. (39)

Which number of heads occurred most frequently? (40)

The number of heads that occurs most frequently is called the **mode** of the histogram.

Now collect the figures of all the students in your group and make a group histogram. Figure 6 shows you how this is done. Two students from a group have marked their figures on the same sheet of paper in the figure. One has used a cross (x) mark and the other a zero (0) mark. The two other students of the group should also mark their figures in the same way.

Can you see any difference between your histogram and the histogram of your group? (41)

What is the mode of the group histogram of the number of heads? (42)

All the groups should paste their histograms on the wall.

When you paste your histogram on the wall, put glue only on the four corners of the paper. That way, it will be easier to remove the histogram when you want to and it will not be damaged. You will have to paste your histogram in your exercise book later on.

Carefully examine the histograms.

Do the histograms of all the groups look similar? (43)

On the basis of these histograms, can you tell, for each move, whether the probability of any particular number of heads occurring will be higher? (44)

The conclusions from these histograms are based on only 40 moves (or 400 flips of the coin).

Will you get a different result if more than 40 moves are made? Take a guess. (45)

To assess your estimate, we need to have more than 10 moves. Since all the groups performed this experiment, can we not use the figures from all the groups to find out?

So let's make a collective histogram with the data of all the groups.

Table 3

	How many times number of heads occurred										
	0	1	2	3	4	5	6	7	8	9	10
Group 1											
Group 2											
Group 3											
Group 4											
Total											

Copy Table 3 in your exercise book. Examine the histograms of the groups one by one.

Enter the figures of each group into the table and calculate their totals on the last line. Make a collective histogram based on the totals of the entire class. Remember, these figures will be fairly large. So you will have to choose a proper scale to draw your collective histogram.

Compare your individual histogram and the histograms of each group with the collective histogram of the class.

Is there some similarity between the collective histogram and your histogram? Explain your observations and write your answer in your exercise book. (46)

POINTS TO PONDER OVER

There were few students in a certain class. So there was insufficient data to make a collective histogram. "Don't worry," said the teacher. "I have last year's data with me. We can combine it with our data."

Will the experiment be changed in any way if we include last year's data? Why? (47)

Discuss this question among yourselves.

The probability of all events was equal in Experiment 2. But this is not always the case. Generally, the probability of different events is different. You will see this in the next experiment.

EXPERIMENT 4

A HORSE RACE

This experiment is a horse racing game. In this race, horses numbered 1 to 12 will compete to reach the winning line (Line 10). You won't need real horses for your race, just make-believe horses. You can mark your horses on a sheet of paper with a cross (x). This sheet of paper is also your race track.

So let's prepare for our race. Take a sheet of graph paper and write the numbers along its horizontal and vertical lines as shown in the figure. All the competing horses are on Line 0 at the start of the race and they have to reach Line 10. The horses move forward according to throws of two dice.

To make these dice, take two small wooden blocks from your science kit. Serially number their faces 1, 2, 3, 4, 5 and 6. You can do this by writing these numbers on small bits of paper and sticking these bits of paper on the faces of the dice. Put a special mark on one dice to distinguish it from the other.

A horse can move forward one line only if the total of the two dice thrown equals the number of the horse. For example, horse No 5 can move a line forward only if the dice show 4 and 1 or 2 and 3. Similarly, horse No 12 can move forward only if both dice show 6.

Try and guess which horse has the greatest probability of winning the race. (48)

Which horses have a low probability of winning the race? (49)

Is there any horse that may not be able to move forward in the race at all? (50)

Since this is a new game, your teacher will first demonstrate it to you. Then each group can play the game and see which horse wins. If you wish, you can change your guess about which horse will win at any time during the race.

When the race ends, enter your data in Table 5. (51)

Was your guess about the winning horse correct? (52)

Which horse won the race? (53)

Discuss among yourselves and explain why all the horses did not move forward at the same pace. (54)

We shall now look at the collective data of all the groups and see what result we get.

A collective table is given below. Make this table on the blackboard and enter the data of all the groups in it.

Table 5 : Results of the Groups

Horse No	No of lines advanced
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Table 6 : Collective Table

	Number of steps each horse moved forward											
	1	2	3	4	5	6	7	8	9	10	11	12
Group 1												
Group 2												
Group 3												
Group 4												
Total												

Look at the collective table and state which horse moved the most lines and which moved the least. (55)

Is there any group in which horse No 2 or horse No 12 won the race? (56)

Why is the probability of horses No 2 and 12 winning the race low? (57)

The results of this race can be illustrated in an interesting histogram. Assume each step of a horse equals 1 cm. Cut out 1 sq cm strips of paper for every step each horse in your group moved forward. Write the horse number on the strips of paper. Each group should stick its strips of paper on the wall one after another. First stick the strips of horse No 1 one atop another to form a long strip. Then stick the strips of horse No 2 next to it. Do the same with the strips of all the horses serially.

If, instead of adding the numbers shown by the two dice, we subtract them, what would happen?

Guess which horse will win this race. (58)

Play the subtraction game and see if your guess is correct or not. (59)

WHAT IS CHANCE?

You performed several experiments in this chapter in which you saw several examples of events that had two (or more) results. You could make predictions by calculating the probability of these results. For example, approximately how many times would heads fall if you flip a coin many times. Which horse would win more often in the horse racing game?

But you cannot predict the result of a single event.

If you flip a coin once, would you get a heads or a tails? If you toss a dice, which number would you get?

Which horse would win if you played the horse racing game once?

Any result is possible if an event occurs only once. The result that occurs is a matter of chance.

Changu flipped a coin thrice and he came up heads all three times. If he flips the coin a fourth time, what will he get?

Changu and Mangu got into an intense discussion about the outcome.

Changu: We got heads all three times so we will get heads again.

Mangu: We haven't got tails for a long time, so we'll definitely get tails this time.

What do you think? Who do you think is right? (60)

If the Bina Express is 10 minutes late today, what time will it arrive tomorrow? Can you predict the time? (61)

The captain of the Indian cricket team lost the toss four times in a row. Will he win the toss the next time? (62)

AN EXERCISE TO DO AT HOME

A farmer had paddy seeds which were several years old. He decided to test the seeds before sowing them. He did a total of five experiments, planting different numbers/quantities of seeds each time and checking the percentage of seeds that germinated. The results are given in Table 8.

Table 8

S. No	No/% of seeds planted	No/% of seeds germinated	Percentage of seeds germinated
1.	1	0	
2.	10	10	
3.	150	60	
4.	1,000	650	
5.	1/2 kg	About two-thirds	

Fill in the percentage of seeds that germinated in each experiment in the last column of the table. On this basis, which experiment should the farmer place greater faith in to find out the percentage of seeds that germinated? Give reasons for your answer. (63)

What can you say about the germination of seeds on the basis of the farmer's first and second experiments? (64)

Why is there such a vast difference in the results of Experiments 1 and 2 and the last two Experiments 4 and 5? On the basis of whatever you have studied in this chapter, can you give any reason for these differences? (65)

MAKE A SPECIAL EFFORT

You may have played a game of *changa* with tamarind seeds (*chiye*) or *cowries*.

Throw your *cowries* or *chiye* 1,000 times and find out how many times you got 1, 2, 3, 4 and 8. (66)

On the basis of your data, find out the chance of getting the numbers 1, 2, 3, 4 and 8. (67)

You may have understood by now why it is difficult to get a 4 or an 8 while playing a game of *changa*, and why you get 2 so often.

DIFFERENT EXPERIENCES, SOME OURS, SOME YOURS

Answer the following questions on the basis of what you have learned in this chapter.

Doctors test for tuberculosis (TB) by examining the sputum under a microscope. If they do not see any bacteria the first time, they collect sputum 3 to 4 times for further tests.

Why do they do this? (68)

Have you seen a gram sevak collecting soil from a field for testing? He goes to several spots in the field and takes samples of soil from each spot. He mixes these small amounts of soil together. He then takes a small portion from this mixture and sends it to the laboratory for testing.

Why is it not enough to collect soil from one spot in a field if we wish to test the soil quality of the field? (69)

NEW WORDS

chance laboratory probability

histogram tuberculosis (TB) collective table

Chapter-20

LIVING AND NON-LIVING

What is living, what is non-living?

We know that many things we find around us are living while many others are non-living. For example, we would say that a cow or a mango tree are living while a stone or water are non-living.

Make a list of animals, trees, plants and other things around you.

Divide these things into two groups of living and non-living. (1)

What are the things you have listed in the living category? On the basis of which properties of these things have you categorised them as living?

List these properties and tick () those that you have already studied till now. (2)

Is it essential for a living thing to have all of these properties or could a thing be considered living if it has some of these properties? Let's take a closer look at the problem.

Plants and trees cannot walk from one place to another.

If you still consider them to be living, state your reasons. (3)

You had studied different kinds of seeds in Class 6. You also know that if we sow a seed a new plant grows from it.

Study the list of properties of living things. Which of these properties do seeds possess:

a) **Do they need nutrition?**
b) **Do they grow?**
c) **Can they walk on their own?**
d) **Do they respire?**
e) **Do they reproduce? (4)**

If you faced a problem in answering Question 4d, do the following experiment.

EXPERIMENT 1
DO DRY SEEDS RESPIRE?

Choose any two of the following seeds – chick pea, corn, whole green gram or black gram. Pour some pink indicator solution (phenolphthalein) into three test tubes and cover the solution in each test tube with a swab of cotton as shown in Figure 1.

Precaution

1. The colour of the phenolphthalein solution should be light pink.
2. The layer of cotton must not be very thick.

Drop the seeds into test tubes 'a' and 'b'. There should be enough seeds to fill the test tubes to the brim. Fill test tube 'c' with beads of an abacus or tiny pieces of thermocol.

Cover the mouth of all three test tubes with pieces of polythene tied down with a piece of string or a rubber band. The mouths should be closed tightly enough to prevent air from entering the test tubes.

Check the indicator solution in all three test tubes after about 2 or 3 hours.

In which test tubes did the colour of the indicator solution change? (5)

Recall what you learned in the chapters on 'Gases' and 'Respiration' in Class 7 and explain in your own words what activity could have caused the indicator solution to change its colour. (6)

Can a similar reaction occur in boiled seeds? (7)

On the basis of a comparison between boiled and unboiled seeds, which would you consider to be living and which non-living? (8)

You know that a child grows taller for several years after birth.

Have your parents grown taller in the past three or four years?

How much taller have you grown in this same period?

People stop growing taller after a certain age.

Would it be wrong to categorise them as living after they stop growing taller? Give reasons with your answer. (9)

Frogs usually burrow into the earth during winter. They do not eat or move around. They emerge only in summer. When the weather becomes hot and the ponds dry up, frogs again bury themselves in the mud.

Would you categorise these frogs as living? Explain with reasons. (10)

You may have heard of hermits who go into a state of intense meditation. They bury themselves in a pit. This is called a *samaadhi*. During the period of *samaadhi*, they neither eat nor drink water, nor do they walk about.

Would you categorise a hermit in *samaadhi* as living? Explain with reasons. (11)

From the examples given above could we conclude that a thing can be considered living even if it does not have all the properties of living things?

Would it be correct to conclude that a thing is non-living by checking only one of the required properties? Answer with reasons. (12)

What happens to the body of an animal after it dies? If a dead rat or any other animal is buried, would its body remain in the same state after a few days? Due to a process of decay and decomposition, the bodies of dead animals slowly change into non-living substances. A similar process occurs with dead plants as well. Of the substances formed in this way, the solids and liquids mix with the soil while the gases escape into the air. Plants absorb some of these substances mixed in soil through their roots. These substances provide nutrition for plants. You also know that plants absorb carbon dioxide present in air. Thus, many non-living substances from the soil and air are ingested or absorbed into the bodies of living things.

Of the things listed below, which are living, which are dead and which are non-living? (13)

- **a) A fish out of water**
- **b) A leaf fallen from the tree**
- **c) A mango**
- **d) Dry wood**
- **e) A running horse**
- **f) Glass**
- **g) A green tree**
- **h) An iron nail**

Did you have any problem in answering this question? In the chapter 'Getting to know leaves' in Class 6 you read that when the leaves of the *ajooba* plant fall off, they grow into new plants on the ground. You may have also seen dry stems sometimes sprouting leaves and growing into new plants. This often happens with the *besharam* plant. So it is sometimes difficult to say when a living thing has died or when it became non-living after death. Respiration and photosynthesis continue for some time in leaves plucked from trees. These processes gradually slow down and finally stop when the leaf is dead.

Some people donate their eyes. When the person dies, the doctor immediately removes her/his eyes and transplants its outer transparent layer, the cornea, to the eyes of another person who cannot see. The blind person thus regains her/his lost sight. Such transplantation is possible because the cells of the cornea remain alive for some time after a person dies. Similarly, the kidneys of a person can be removed immediately after her/his death and transplanted in a person whose kidneys have stopped functioning.

LIVING FROM NON-LIVING

You already know that plants get nutrition from fertilisers. Similarly without nutrition living beings can neither grow nor can it have the energy to walk around or do any other work. You studied in the chapter on 'The internal organs of the body – 2' that the body gets its energy from the oxidization of digested food.

You saw in that that when food is digested it converts into substances that can be used by the body. With the help of these substances new cells develop in the body. Millions of cells keep getting destroyed in the body every day. To make up for this loss new cells are formed. New cells are also needed to heal an injury to the body. Development takes place in the body with the formation of new cells.

In this way non-living things like food and fertilizer help in building bodies of living things.

What all would happen if a plant or a living being does not get water for a long time? It is important that there is water in every cell of every living thing. If there is no water the activities that take place in a cell stop and that plant or living being does not live very long. In this way water in spite of being non-living, is an important part of the bodies of living things.

Can living things be formed on their own from non-living?

From the discussion we have had, hope you haven't concluded that something living can directly be formed from non-living substance. In ancient times people used to believe that scorpions are born on their own from dung, bed bugs are formed on their own in old clothes, or that maggots develop on their own in a rotting animal's body. However, in the seventeenth century, Francesco Ready, and Italian scientist after some very carefully conducted experiments proved that maggots could develop in a carcass only if a fly lays eggs in it. These experiments were similar to the kind you did to study the life cycle of a fly.

Then, in 1862, with a simple experiment, a French scientist, Luis Pasture showed that unless another living thing is already present a new living thing couldn't be formed on its own. Pasture took two glass jars and in which he placed a nutrient substance in which microorganisms could grow and develop well (picture 2). He let the tube of one jar remain straight and turned that of the other as shown in the picture. He then heated the nutrient substance in both the jars to such a high temperature that all existing organisms died. Then he let both the jars stand like that. Later when he tested the nutrient substance of both the jars he found that millions of organisms had entered the jar with the straight pipe but there were none at all in the jar with the bent pipe.

If it were possible for organisms to develop on their own in a nutrient substance they would have been present in both jars. But this did not happen. Organisms in the air could easily get into the jar with the straight pipe but in the other jar they got held in the moisture that collected in the twisted pipe and could not get to the nutrient substance.

If living things do not develop from non-living things on their own then what is the relationship between living and non-living? Come, let us try and understand this.

Read the sentences given below carefully:

a) Plants take water and fertilizer from the soil for their nutrition.

b) Plants take carbon dioxide from the air to make their food.

c) Herbivorous animals feed on plants and carnivorous animals feed on herbivorous animals.

Complete the table given below. (14)

Name of the substance	**how is it used**	**is it living or non-living**
Water	necessary for the body of plants and animals	
Fertilizer	develops the body of the plant	
Carbon dioxide	helps in making food for plants	
Digested food	becomes a part of the bodies of plants and animals	

In normal circumstances a non-living substance can become a part of the body of a living thing only when it has been taken in as food or water or from the air during photosynthesis.

New words

Organisms

Practice questions

1. Read the following sentences carefully and say with reasons whether each one is correct or wrong:

a) Living things can always move from one place to another on their own,

b) Wheat with insects is non-living.

c) Cooked rice is living.

d) Fungus that grows on pickles is non-living.

e) Fruit on a tree is not living.

2. All the parts of the body of a plant or an animal do not die at the same time. Write of three such examples in your own words.

Chapter-21

PENDULUMS AND TIME

You learned to make a sundial in the Chapter ‘Looking at the skies’. You learned that noon - or midday - is the time when the shadow of the vertical stick of the sundial is the shortest. The period between one midday and the next is called a solar day.

Your experiments with sundials also showed that the time when the shortest shadow forms changes a little from one day to the next. That means the period - or length - of the solar day also changes from day to day. If we average the lengths of the solar days over an entire year we get what is known as an average solar day.

This average solar day is divided into 24 equal periods of time. Each such section of time is called an hour. For smaller measures of time, this hour has been further divided into minutes and seconds.

You also learned how to tell time by looking at the position of the stars. Another tool to measure time is the phases of the moon. The regular pattern of full moon and no moon days tells us the number of days that have passed.

Similarly, changing seasons are indicators of the passage of time. The appearance of flowers on a mango tree tells us a year has passed since the last flowering.

There are a number of such processes in nature that occur repeatedly in a more or less a fixed interval of time. We can use such processes to measure time.

You may have observed many such processes occurring around you.

Make a list of these processes and say what period of time you can measure with each of them. (1)

What are the processes that are repeated in a wristwatch? At what intervals are these processes repeated? Look at a clock to find out. (2)

You may have seen different kinds of clocks - water clocks, sand clocks, candle clocks - at science fairs or museums.

Let us make a few clocks and see which of their processes we can use to measure time.

EXPERIMENT 1

MAKE YOUR OWN WATER CLOCK

In this experiment we shall learn an easy way to make a water clock. Take a tin can open at the top and make a fine hole with a nail in the centre of its base. Fill a bucket with clean water and float the can in it. Water will seep into the can through the hole. If this does not happen, make the hole a little bigger. The hole should be just big enough so that the can fills up and sink in about five minutes. Now empty the can and float it once more in the bucket. This time, use a watch to measure how much time it takes to sink.

Record the time the can took to sink in your exercise book. (3)

Repeat this activity at least five times. Ensure that the can is empty before each observation.

Does the can sink in about the same period of time each time? (4)

What is the average time the can takes to sink? (5)

Can you use this can to measure a time period equal to this average time? (6)

How will you use your water clock to measure time periods shorter than its average time? (7)

Why is it important to use clean water in the bucket? (8)

EXPERIMENT 2

ANOTHER CLOCK TO MAKE AT HOME

Take two empty injection bottles and their rubber caps.

Apply puncture solution on the flat sides of both the caps and seal them together.

Use a babool thorn or nail to pierce a hole through the centre of the caps.

Cut a half centimetre bit of an empty refill.

Use the tip of the refill to push this piece through the hole in the caps. The piece will go in smoothly if it is slightly wet.

You now have a neat hole in the centre of the caps. Fill one bottle with fine dry sand. Fix this bottle.and the other empty bottle onto the caps. Place the empty bottle standing upright on a table. The bottle with sand will be directly over it in an upside down position. The sand in the bottle on the top will flow through the refill hole into the empty bottle below. Let the sand flow for a whole minute by the clock. Remove the remaining sand from the bottle on the top. You have a one-minute sand clock.

We have suggested two simple ways of making clocks. Can you think of better ways of making other clocks. If so, make them and send your suggestions to Sawaliram.

It is not easy to measure small units of time with a water or sand clock. Let us perform an experiment in which small intervals of time can be easily and accurately measured.

EXPERIMENT 3

PENDULUM

Tie a stone to one end of a two-metre long string. Tie the other end of the string to the latch of a door. If the door does not have a latch, hammer a nail into the wooden frame and tie the string to it. You will need to alter the length of the string several times during the course of the experiment. So keep this in mind when you tie the knot of the string to the nail.

A weight hanging in this manner is your pendulum. Move the stone a little to one side and relese it. When you do this the stone should swing independently. The swinging is known as an oscillation. The movement of the pendulum from position ‘A’ to ‘B’ and back to ‘A’ is one complete oscillation. Do not push the pendulum to make it move. Just move it a little to on side and release it.

YOUR PULSE IS YOUR CLOCK

To conduct Experiment 3 each group must have a watch with a long seconds hand. If a watch is not available, the experiments with the pendulum in this chapter will have to done using your pulse rate.

Every person has a different pulse rate. The pulse rate varies in different circumstances. If a person is relaxed and sitting, his pulse rate remains fairly constant as long as he remains in that state. Because it is so regular, the pulse rate can be used as a clock.

Let one member of your group sit in a relaxed manner. Measure her/his pulse rate the way you did in the chapter ‘Internal organs of the body’. Another member of your group can hold the pendulum a little distance from its central point and wait for a signal from the student measuring her/his pulse rate. As soon as (s)he gets the signal (s)he should release the pendulum and start counting its oscillations. The student measuring the pulse rate should also simultaneously start counting the pulse beats mentally. Make sure to start counting from 0. As soon as the decided number of oscillations are over the student counting the pulse beats should stop. The period of oscillations should be recorded in pulses instead of seconds.

Now borrow a watch with a seconds hand and find out how many times your friend’s pulse beats in one minute. To find out the pulse rate, start counting the pulses when the seconds hand is on twelve and keep counting till it comes back to twelve again. Do this at least three times and calculate your friend’s average pulse rate per minute. On the basis of this information you can convert your earlier observations from pulses to seconds.

You can also use the sand clock for this purpose.

Find out how long your pendulum takes to make one oscillation. (9)

This time is known as the time period of the pendulum.

Did you have any problem in measuring the time period? If you did, what was the problem? (10)

Measure the time taken for ten oscillations.

How long did the pendulum take to complete ten oscillations? (11)

On the basis of this measurement, can you calculate how long one oscillation takes? (12)

Measure how long the pendulum takes to make 20, 30, 40 and 50 oscillations.

Enter your recordings in a table. (13)

Find out the average time period in each case and record these in the table. (14)

Was the average time period about the same in every case? (15)

What conclusions can you draw about the oscillations of a pendulum from this experiment?

In the 17th century, an Italian scientist named Galileo Galilei first observed this quality of the pendulum that you learned about in your experiment. For many years wall clocks were made on the basis of this property of the pendulum and such clocks are used in many places even today.

We saw in our experiment that the average time period of a single oscillation of the pendulum remains the same, regardless of the number of times we measured it. Does this time period of a pendulum depend on the length of the pendulum or on the weight of the stone tied to the string? We shall find answers to these questions by doing the following two experiments.

EXPERIMENT 4

EFFECT OF THE LENGTH OF A PENDULUM ON ITS TIME PERIOD

The distance between the point from which the pendulum is suspended and the stone is the length of the pendulum. Keep the length at 20 cm and measure the time taken for 50 oscillations. Repeat this activity thrice and find the average time taken for 50 oscillations. Divide this average by 50 and find the average time period. Now increase the length of the pendulum by 10 cm and repeat this activity. Keep adding 10 cm to the length of the pendulum and repeat this activity until the length reaches 100 cm.

Make a table like the one shown shown below in your exercise book and record the figures of the length of the pendulum and the time period in it. (17)

Students who record the time period in pulse counts should convert the figures of the last column of their table into seconds. The procedure for doing so is described in experiment 3.

No.	Length of thread (cm)	Time for 50 oscillations (seconds)	Average time period (seconds)
		1 2 3 average	

What effect does increasing the length of the pendulum have on its time period? (18)

What should be the length of a pendulum with a time period of 2 seconds? Make an estimate on the basis of your table. (19)

Time can easily be measured in seconds with this kind of pendulum.

It is called a seconds pendulum.

EXPERIMENT 5

RELATIONSHIP BETWEEN WEIGHT OF STONE AND TIME PERIOD

Would the average time period of a pendulum change if the weight of the stone is varied? We can perform an experiment to find out the answer to this question. Keep the length of the pendulum constant, but use stones of different weights and find out the average time period in each case.

Record the data from your experiment in a table. (20)

What effect does changing the weight of the stone have on the average time period of the pendulum? (21)

Why was the length of the pendulum kept constant in this experiment? (22)

AN EXERCISE FOR REVISION

Jagdish made a 50 cm-long pendulum and found its average time period. He repeated the experiment with a 100 cm-long pendulum and found its average time period.

Compared to the time period in the first case, would the time period in the second case

Increase
Decrease
Remain the same? (23)

Compared to the first case, would the time period of the longer pendulum be

Half
Double
More than double
Less than double? (24)

NEW WORDS

Solar day	time period	pendulum
Average time period		oscillation

Chapter-22

THE LANGUAGE OF SYMBOLS

You see and use many substances in your daily life. You have also performed experiments with different substances and seen chemical reactions taking place between them. Some of these substances were transformed during these reactions and new substances were formed. Perhaps, you also tested the properties of these new substances. For example, when you pour acid on marble chips, carbon dioxide is formed. Or when you heat potassium permanganate, oxygen is released. Or when iron is left exposed to air and moisture, it begins to rust. These are all examples of chemical reactions. In all these experiments, some new substance is formed.

Give five more examples of chemical reactions in experiments you did in Class 6, 7 and 8. (1)

Scientists who perform such experiments are called chemists and the branch of science dealing with chemical reactions is called **chemistry**. Over the years, chemists discovered hundreds and hundreds of different substances. They felt they needed a language to name and describe these chemical substances. One requirement was that such a language should be universal. That is, it should be understood by people from different parts of the world who speak different languages. In this chapter you will learn a few things about this language. It has its own letters, words and grammar. It follows its own strict rules. It is not possible to learn the entire language in one chapter, but we shall make a simple beginning.

In the chapter 'Our food' in Class 6, you tested various food items to see if they contained protein. When a solution of sodium hydroxide and copper sulphate is added to food items that contain protein, a purple colour is produced.

Have you ever wondered why a food item that does not contain protein does not produce this purple colour? (2)

Similarly, why does rust form on iron but not on aluminium?

The kind of chemical reaction a substance undergoes depends on its chemical properties. Substances can be grouped or classified on the basis of their chemical properties. For example, in Class 6 you learned to recognise and group acids and bases on the basis of their effect on the colour of litmus paper.

PURE SUBSTANCES

If you wish to study any substance, you must first get it in its pure form. This is essential. Scientists have discovered several ways of getting substances in their pure form. You have already used some of these methods for separating substances in the chapter 'Separation' in Class 6. For example, you separated a mixture of salt and sand.

When we say a substance is pure, it means it contains only that single substance. There is no other substance mixed in it. If a substance can be separated into two or more substances, we say it is impure, or a mixture of substances. In other words, if you cannot separate a substance into two or more substances after using all these different methods, the substance can be considered to be pure.

But there is a problem in defining a pure substance in this way. The problem is that you may have tried all the methods of separating a substance that you know about today.

Maybe, the substance cannot be separated by any of these methods. So you think the substance is pure. But it is possible that a scientist could discover some new method of separating substances in future. It is possible that the substance you thought was pure today could then be separated into different substances, using this new method.

So what you think is a pure substance may not actually be pure. For example, suppose you draw water from a well and filter it with a filter paper. Suppose all the water passes through the filter paper without leaving a deposit.

What would you conclude about this water? (3)

Now suppose you heat this water and some deposit is left behind after the water has evaporated.

Would you now consider this water to be pure? (4)

It has actually happened in this way before. A substance that was considered pure at one time was found to be a mixture at a later time. Take the example of the air we breathe. Once upon a time, air was considered to be a pure substance. But after newer methods of separating substances were discovered, people found that air was a mixture of different gases. It contains oxygen, nitrogen, carbon dioxide and other gases.

So it is sometimes very difficult to say whether a substance is pure or not.

Anyway, we know that substances can be divided into two types - pure substances and mixtures. We use many different kinds of mixtures every day. For example, wheat flour, dal, masalas, ghee, cooking oil etc are mixtures. You may be surprised to know that what we call ‘pure’ ghee is actually a mixture of many fats.

In our daily life, we use the word ‘pure’ in a slightly different way. When we say that a certain brand of ghee is pure what we mean is that there are no other substances mixed in it that should not be present in ghee.

Today, iodised salt is sold in the market. Would it be correct to call it pure salt? (5)

Milk is a mixture that is 95 percent water. Would it become impure if we mix a little more water in it? In what way have we used the word ‘pure’ and ‘impure’ when we talk about milk? (6)

Most of the substances we use in our daily life are mixtures.

Let’s now discuss pure substances in more detail.

TWO TYPES OF PURE SUBSTANCES

Copper sulphate (blue vitriol) is a pure substance. It cannot be separated further by any of the methods of separation we know today. Now recall an experiment you did in Class 7. In that experiment you dropped a piece of aluminium foil in a solution of copper sulphate. After some time you found that a layer of copper was deposited on the aluminium foil. You also saw that the blue vitriol solution became colourless. Why did this happen? Apparently, a chemical reaction took place during which the copper present in some form in the solution was separated from it when it came in contact with aluminium.

So can we say that the copper sulphate solution is a mixture?

No, we cannot. It is a different kind of substance. It contains more than one substance but these substances can be separated only by a chemical reaction. Such substances are called **compounds**. We can define compounds as pure substances that can be separated into two or more substances by means of a chemical reaction. Those substances that cannot be separated into two or more substances even with the help of a chemical reaction are called **elements**.

So we now have two types of pure substances - compounds and elements.

It is important to stress this aspect before we proceed further. If any substance can be separated into two or more constituent parts by a chemical reaction, that substance is definitely a compound.

If, despite all our attempts, we cannot divide a substance in this way, then this substance is probably an element. We say probably because we can never say with certainty that it is actually an element. Maybe, some time in the future some one could discover a method to divide this substance further. In that case, the substance that we thought was an element could actually turn out to be a compound. However, until that happens, we can accept it as an element.

To give an example, people once thought that water was an element. But later they discovered that water is a compound. There are many such examples we come across in the history of science.

To sum up, it is difficult to decide whether any substance is a mixture, compound or element. So it is better to consider any decision we make as a temporary decision.

But there is another way of identifying mixtures, compounds and elements and distinguishing between them. This method is based on the particles the substance is composed of.

THE PARTICLES OF A SUBSTANCE

All substances are made up of particles. There are countless substances in the world, yet each one has totally different properties from the other. Does this mean the particles of one substance are different from particles of other substances? Yes, that is correct. The particles of different substances are different from each other. The particles we are talking about here are very small in size, so small that we can’t even see them under the best microscope.

If we take a mixture, it would contain many different kinds of particles. The number of different kinds of particles in the mixture would equal the number of substances it contains. For example, if we take a sugar syrup, it would contain particles of water and particles of sugar.

Figure 1

Mixture **After separation**

We have already talked about pure substances. All the particles of a pure substance are identical. That is, they all weigh the same and have the same properties.

We saw that pure substances are of two kinds - elements and compounds. The special characteristic of a pure substance is that all its particles are identical, whether it is a compound or an element.

Figure 2: A pure substance

For example, we can produce distilled water in many different ways. We can obtain distilled water by condensing the vapour of water from the sea, a well or a river. However, it does not matter where we got the water from, all its particles will be identical. That is, the weight of all the particles will be equal. Similarly, the weight of all particles of iron will be the same, as will be the weight of all particles of ammonia., or all particles of copper.

Now take another example. All of us respire. You know that the air we exhale contains more carbon dioxide than the air we inhale.

Will the particles of carbon dioxide you exhale be identical to the particles of carbon dioxide your friend exhales? (7)

Yes, particles of the same substance are always identical. However, the weight of a particle of water will be different from the weight of a particle of iron. Particles of each substance have a definite weight and all the particles of that substance have the same weight.

We would again like to remind you here that we are talking about very small particles. These are not the kind of particles you get if you grind salt to a fine dust. The finely ground grains of salt will not weigh the same. The particles we are talking about are called **molecules** and **atoms**.

Let's get more familiar with these particles.

MOLECULES AND ATOMS

The particles of substances we are talking about are very small indeed. In fact, they are so small that we cannot get smaller particles of that substance. We cannot get a quantity of that substance that is smaller than the weight of the atom or molecule of that substance.

So we know that particles of different substances are of two kinds - atoms and molecules. Atoms are the most fundamental of all particles. They can be found existing alone in nature, or two or more atoms can combine. When atoms combine, they form molecules.

When the particles of a substance contain only one type of atom, that substance is called an **element**.

There are many elements whose smallest particle is an atom. That is, each of their smallest particles comprises only a single atom. Iron, copper, zinc, aluminium, silver, gold etc are examples of substances in which the smallest particle is a single atom. If we show each atom as a small circle, then the element iron can be shown like the diagram in Figure 3.

Figure 3

But it is not necessary that the particle of an element is only a single atom. The particles of many elements are a combination of two or more identical atoms. These particles are called molecules.

Oxygen and nitrogen are examples of substances in which the particles are a combination of two or more identical atoms. That is, the smallest particles of these substances are molecules. For example, a molecule of oxygen has two atoms. The atoms combined into molecules are depicted as small circles in Figure 4.

Such substances are also elements.

Figure 4

Is it then correct to say that elements can also have molecules? (8)

When the atoms of two or more elements join together to form a molecule, a **compound** is formed. For example, if atoms of hydrogen and oxygen join together in a molecule, they form water. Water is a compound.

Figure 5

What is the difference between the molecule of an element and the molecule of a compound? (8)

Can there be atoms of a compound? (9)

Can you tell by looking at Figure 5 how many atoms each of hydrogen and oxygen make a molecule of water? (10)

Actually, most of the substances we use are compounds. For example, water, sugar, caustic soda, baking soda, lime, plastic, salt etc are all compounds.

A molecule of water is formed by the combination of atoms of hydrogen and oxygen. All the molecules of water are identical. All the molecules of water have the same weight.

So is it possible for any number of atoms of hydrogen to combine with any number of atoms of oxygen to form a molecule of water? (11)

For all the molecules of water to be identical, it is essential that the atoms of hydrogen and oxygen are present in fixed numbers. If this number is not fixed, how could all the particles of water be identical? Each molecule of water contains two atoms of hydrogen and one atom of oxygen.

It is important to keep in mind that there are only a few types of atoms in nature. These atoms join together in different ways to form different molecules. In this way, innumerable types of molecules are formed. The chemical properties of a substance are determined by the types of atoms in its particles, their numbers and the way in which they are combined. We get this information from the symbols and formulas used to depict these substances.

We shall now discuss these symbols and formulas.

SYMBOLS

You may have observed that different substances have different names in different languages. For example, iron is called *loha* in Hindi while copper is called *tamba*. Water also has several names like *pani, jal, neer* etc.

Having so many names for substances could create problems in a field like chemistry where work is conducted throughout the world. How would scientists from different countries who speak different languages communicate with each other? There should be some way in which they can understand each other. To make this possible, we must have universally accepted names for different substances. That is, a scientist from any part of the world should be able to recognise the substance by its name.

Many elements like iron, gold, silver, mercury, copper and zinc have been known from ancient times. But many other elements were discovered in more recent times.

When a new element is discovered, the discoverer gives it a name. That becomes the name of the element. When modern chemistry was being developed, the language most commonly used among scientists was Latin, the language of Rome. Thus the names of many elements were based on Latin words. Take the example of hydrogen. One of the properties of this gas is that it combines with oxygen to form water. The Latin name for water is 'hydro'. So this gas was named hydrogen, which means 'gas that makes water'.

Another similar case is that of helium. This gas was first discovered in the sun, not on earth. The Greek name for sun is 'helios', so the gas was named helium.

Many elements were named after the places in which they were discovered. Some examples are scandinavium and californium. Some elements were named to honour well known scientists. One example is mendelium, named after Gregor Mendel.

The story of oxygen is very interesting. At one time people believed that any compound that contained oxygen would be acidic in nature. The Latin word for acid is 'oxy'. Hence the gas was called oxygen, meaning 'gas that forms acid'. It was later discovered that the acidic property was not related to oxygen. However, by then the name had come into common use so it was not changed. After all, what's there in a name!

The names of many elements are their English names as well. For example, the chemical names aluminium, carbon, oxygen, nitrogen and hydrogen are also the English names of these elements. However, this is not always the case. The chemical name ferrum is iron in English while cuprum is copper.

The next step in naming elements was to write them in an abbreviated form. Thus, carbon was given the symbol of a capital C. Generally, the first letter of the name of the element became the symbol of that element. For example, H for hydrogen, O for oxygen and N for nitrogen.

But this caused a problem. There are many elements whose names begin with the same alphabet. Examples include copper, carbon, calcium and chlorine, which all begin with the letter C.

Can you suggest a way in which this problem can be solved? Should the names of these elements be changed? (12)

No, the names of the elements were not changed. In these cases, instead of using only the first letter of the name, the second or any other letter were added on. So while carbon became C, cuprium became Cu, calcium became Ca and chlorine became Cl.

Here, too, it is necessary to remember one thing. When two letters are used to form the symbol of an element, the first letter is written in capitals while the next letter is in the lower case. So the symbol for calcium would have a capital 'C' and a lower case 'a' to form Ca.

There is one more variation. The symbols of some elements are not assigned according to their English names but according to their Latin names For example, the symbol for sodium is Na which is derived from its Latin name natrium. Similarly, K, the symbol for potassium, is derived from kalium, and Fe, the symbol for iron, is derived from ferrum.

The names and symbols of some elements are given in the following table:

Name of element	English name	Latin name	Symbol
Aluminium	Aluminium		Al
Calcium	Calcium		Ca
Carbon	Carbon		C
Chlorine	Chlorine		Cl
Chromium	Chromium		Cr
Silver	Silver	Argentum	Ag
Copper	CopperCuprium		Cu

Sodium	SodiumNatrium		Na
Gold	Gold	Argentum	Ag
Iodine	Iodine		I
Iron	Iron	Ferrum	Fe
Nitrogen	Nitrogen		N
Nickel	Nickel		Ni
Oxygen	Oxygen		O
Phosphorous	Phosphorus		P
Sulphur	Sulphur		S
Zinc	Zinc		Zn

You may have noticed that names of some common substances like wood, sugar, bronze, paper, plastic etc have not been included in the table. This is because these substances are not elements. You will, perhaps, be surprised to know that bronze is not an element but a mixture of copper and zinc.

Are you wondering whether these substance have symbols or not? Do they have abbreviated names or not? The answer is yes, they do. But before discussing these symbols, we need to look at one more aspect.

One advantage of using symbols is that we don’t have to write the full name of the substance everytime we refer to it. There is another advantage. When we use the full name of a substance, say iron, we do not know the quantity of the substance. But when we write its symbol Fe, we know there is only one atom of iron. This represents the equivalent of the atomic weight of iron. To show two atoms of iron we write 2 Fe.

How will you show three atoms each of carbon, silver and gold? (13)

ELEMENTS WITH MORE THAN ONE ATOM

We had said earlier that several elements have more than one atom in their smallest constituent particle. That means each particle contains two or more atoms which join together to form a molecule. Oxygen, hydrogen and nitrogen are examples of such elements.

For example, a molecule of oxygen has two atoms. We need a formula to represent such a molecule in a simple way. The formula for oxygen is O_2.

You may have noticed that we did not write 2O here. Writing a formula in the way we did means that the two atoms of oxygen are combined in a molecule. So, we first write the symbol for oxygen and then write 2 as a subscript after the letter O.

How would you depict two molecules of oxygen? (14)

If hydrogen, nitrogen and chlorine also have two atoms each in their molecules, how would you write their formulas? (15)

How would you show five molecules of nitrogen? (16)

You may have heard about ozone gas. This gas is found in large quantities in the upper layers of the earth’s atmosphere. It protects us by shielding the earth from some harmful rays of the sun. Every molecule of ozone has three atoms of oxygen.

What is the formula of ozone? (17)

Until now, we have discussed the symbols and formulas of elements. What about compounds?

FORMULA OF COMPOUNDS

There are a total of 109 elements that have been discovered till now. Some of these elements were produced in the laboratory by scientists. Ninety two elements exist in nature. These elements react with each other to form compounds.

Before proceeding further, we must understand one thing about the reaction of elements. Every element has a definite bonding capacity. They react with other elements according to this bonding capacity.

Let us look at this aspect in greater detail. When elements react with other elements, it is their atoms that react. The reaction could involve either one, two or more atoms. It is not possible for one-and-a-half or two-and-three-quarter or five-and-a-half atoms to react. This means the atoms of elements that constitute a compound will always be in whole numbers - 1, 2, 3 etc.

One more aspect needs to be emphasised. We have already seen that the particles of any substance (elements or compounds) are identical. This means that if an element in a compound has two atoms then all the molecules of that element will have two atoms of that element. Take the example of sugar. Sugar is a compound. Its molecule contains atoms of carbon, hydrogen and oxygen. One molecule of sugar contains 12 carbon, 22 hydrogen and 11 oxygen atoms. Sugar can be produced in many different ways - from sugarcane, sugar beet etc. However, whatever be the source or process by which sugar is produced, a molecule of sugar will always contain 12 carbon, 22 hydrogen and 11 oxygen atoms.

While writing the formula of a compound we must keep two things in mind. First, we must see what elements are present in a molecule of the compound. Second, we must see the number of atoms of each element present in the molecule. For example to write the formula of sugar, we must write the symbols of the elements present in it - C for carbon, H for hydrogen and O for oxygen. We must then write the number of atoms of each element present in the molecule. This number is written as a subscript after the symbols of the element.

So the formula of sugar will be C_{12} $H_{22}O_{11}$. This is the **formula of one molecule** of sugar**.**

If we have five molecules of sugar how would we show this in the formula? (18)

Let us now practice writing the formulas of different compounds.

Nitrogen and oxygen react differently with each other under different conditions. As a result, different compounds are formed in these different reactions. The table below gives details of some of these reactions.

No. of N atoms	**No. of O atoms**	**Name of compound**	**Formula**
2	1	Nitrous oxide	
1	1	Nitric oxide	
1	2	Nitrogen dioxide	
2	3	Nitrogen trioxide	
2	5	Nitrogen pentoxide	

On the basis of the information in the table, write the formula of the compounds formed in each reaction. (19)

You should keep in mind that the formula you write should give the symbol of elements as well as the number of atoms.

There is one more rule to be observed in writing formulas. If the molecule of a substance contains only one atom, we do not write the number 1. For example, a molecule of salt contains one atom of sodium and one atom of chlorine. It does not matter whether the salt came from sea water or if it is rock salt - its molecule will always have one sodium and one chlorine atom. So the formula for salt will have the symbols of these two elements - sodium (Na) and chlorine (Cl). Since there is only one atom each of these elements, we do not write the number 1 in the formula. So the formula of salt is NaCl, not Na_1Cl_1.

Now look at another example. A molecule of carbon dioxide contains one atom of carbon and two atoms of oxygen. Carbon and oxygen also react to form another gas called carbon monoxide. A molecule of carbon monoxide contains one atom of carbon and one atom of oxygen.

Write the formulas of carbon dioxide and carbon monoxide. (20)

The formula of some compounds you have used before are given below.

Baking soda (sodium bicarbonate)	$NaHCO_3$
Washing soda	Na_2CO_3
Copper sulphate	$CuSO_4$
Potassium iodide	KI
Calcium chloride	$CaCl_2$
Calcium sulphate	$CaSO_2$
Magnesium sulphate	$MgSO_4$
Water	H_2O
Iodine	I_2
Potassium permanganate	$KMnO_4$
Caustic soda	NaOH
Sulphuric acid	H_2SO_4
Hydrochloric acid	HCL

The formula of any substance tells us the names of the elements that constitute each molecule of that substance and the number of atoms of each constituent element.

EXERCISES FOR REVISION

1. **What are the elements and the number of atoms of each element in the compounds listed above?**
2. **What do you understand from the following formulas? Discuss with your group.**

Hydrogen peroxide	H_2O_2
Glucose	$C_6H_{12}O_6$
Calcium carbonate	$CaCO_3$

3. **Why are there no formulas for mixtures, like we have for compounds? Discuss the matter in class.**

NEW WORDS

chemistry	chemical property	compound	element
bonding capacity	molecule	atom	symbol
formula	Latin		