Chapter 8

A Journey through States of Water

“நெடுங்கடலும் தன்நீர்மை குன்றும் தடிந்தெழிலி
தான்நல்கா தாகி விடின்

(திருக்குறள்)

If it does not rain well, even the mighty ocean will be drained.

(Thirukkural)”

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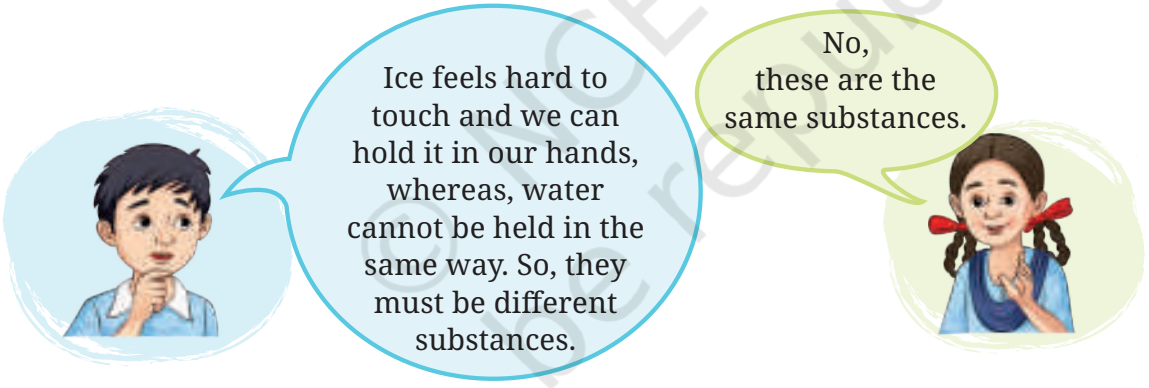
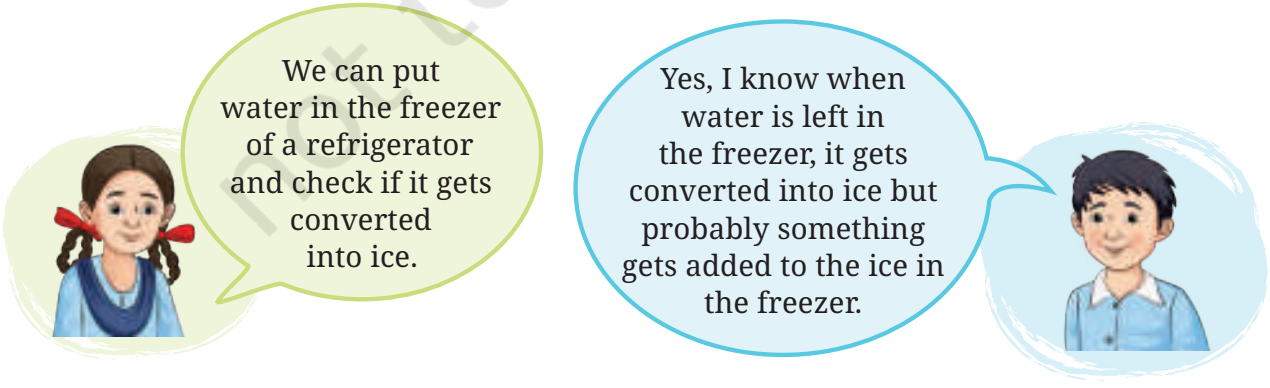
On a bright summer afternoon, Aavi and Thirav enjoy their *shikanji* (lemonade). After looking at the ice in the lemonade, Thirav wonders about the nature of ice and water.



Aavi has a counterview to Thirav. What do you think? Why?



Do you think Thirav is right? How can you find out?

Activity 8.1: Let us observe

- Put an ice cube in a cup, leave it on the table and observe.

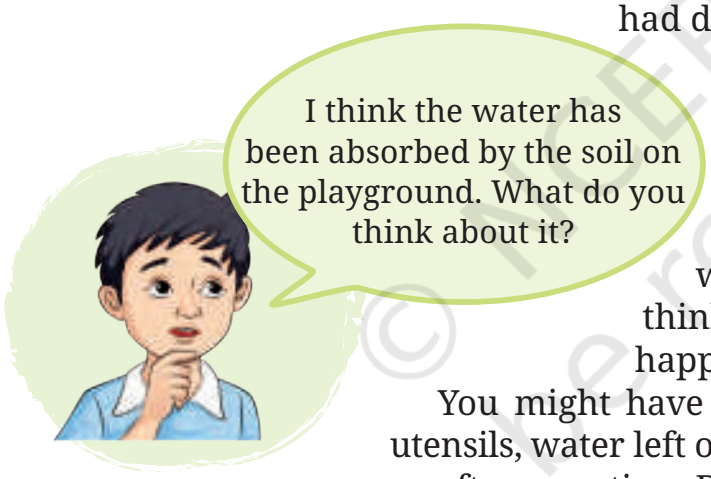
Ice gets converted into water.

What can you conclude from the observations?

Does this mean that ice and water are the same substance? Yes, ice and water are the two forms of the same substance. These forms are also called states. These different states of water show many differences in their behaviour. Water flows but ice does not. Water splashes but ice does not.

8.1 Investigating Water's Disappearing Act

It is a rainy morning. While going to school, Aavi and Thirav observe that there are a lot of water puddles in the playground. That evening, when they go to play, they are surprised to observe that some of the water in the puddles had disappeared.



Have you ever noticed water in the puddles disappearing? Where does it go? Discuss with your friends.

Where else have you seen water disappearing? Can you think of a possible **reason** why this happens?

You might have observed that after washing the utensils, water left on the surface of the utensils, dries up after some time. Does the reason you thought earlier to explain water disappearance apply in this case also?

Aavi wonders if water has seeped through the surface of the utensils.

Thirav thinks that water does not seep through the surface of the utensils. Design an activity to **investigate** whose idea is correct.

Activity 8.2: Let us investigate

- Take a tablespoon of water on a steel plate as shown in Fig. 8.1.

- Observe whether water seeps through to the other side of the plate or not.
- Keep observing this at regular intervals until the water completely disappears.

What do you infer? Is this activity enough to come to the conclusion that water does not seep through a steel plate?

If water does not seep through the steel plate. Then, where has the water gone?

This water gets converted into gaseous state called **water vapour**. The water vapour is another state of water. Let us think of another observation where you notice the water disappearing.

Fig. 8.1: Steel plate with a tablespoon of water

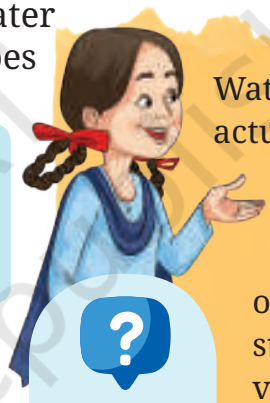
While making dosa, we sprinkle some water on the hot pan and it disappears. Where does it go?

Let us draw

Draw a detailed sketch (with labels and caption) about what happens to the water.

The water which is sprinkled on the hot pan gets converted into steam. Steam is actually water vapour, some part of which converts into water droplets.

The process of conversion of water into its vapour state is called **evaporation**.



Do you know?

Water vapour is actually invisible but the presence of tiny droplets of water in the steam makes it visible.

The process of evaporation takes place continuously, even at room temperature. Can you think of other examples of evaporation?

Drying of wet clothes, mopped floor, and sweat on our body are some examples of it.

Now what do you think is the reason for the disappearance of water from the puddles? Is it due to (i) seeping of water into the ground or (ii) evaporation of water or (iii) both of these?

Hand sanitiser disappears as you rub it on your hands. What happens to it?

8.2 Another Mystery

Next day, Aavi, Thirav and their friends decide to make lemonade. During the preparation, they take cold water in a glass tumbler and add ice cubes into it. After a few minutes, they notice something exciting about the outer surface of the glass tumbler.

Let us find out by conducting a similar activity ourselves.

Activity 8.3: Let us experiment

- Take cold water in a glass tumbler.
- Add a few ice cubes into it as shown in Fig. 8.2.

Fig. 8.2: A glass tumbler containing cold water and ice cubes

- Leave it undisturbed for five minutes and observe it.
- **Record** your observations and the questions that arise in your mind in Table 8.1. You can also touch the outer surface of the glass tumbler to feel if there is any change.

You may have many observations and questions here.

Table 8.1: Record the observations and questions

I observe	I wonder

One observation that arises in Aavi's mind is, "There are some water droplets (tiny drops) appearing on the outer surface of the glass tumbler." Initially, water droplets are deposited and these droplets combine together to form bigger drops. You can also try the above process with a metal container. You may be curious about where the water droplets come from.

Suggest possible reasons explaining the appearance of water droplets on the outer surface of the glass tumbler.

Discuss with your friends. Write down the possible reasons in Fig. 8.3.

Fig. 8.3: Provide your possible reasons explaining the appearance of water droplets on the outer surface of the glass tumbler

You may have various possible reasons. You may agree or disagree with the reasons of others. Aavi and Thirav argued with a chain of reasons. What do you think about the possible reasons mentioned in Fig. 8.4?

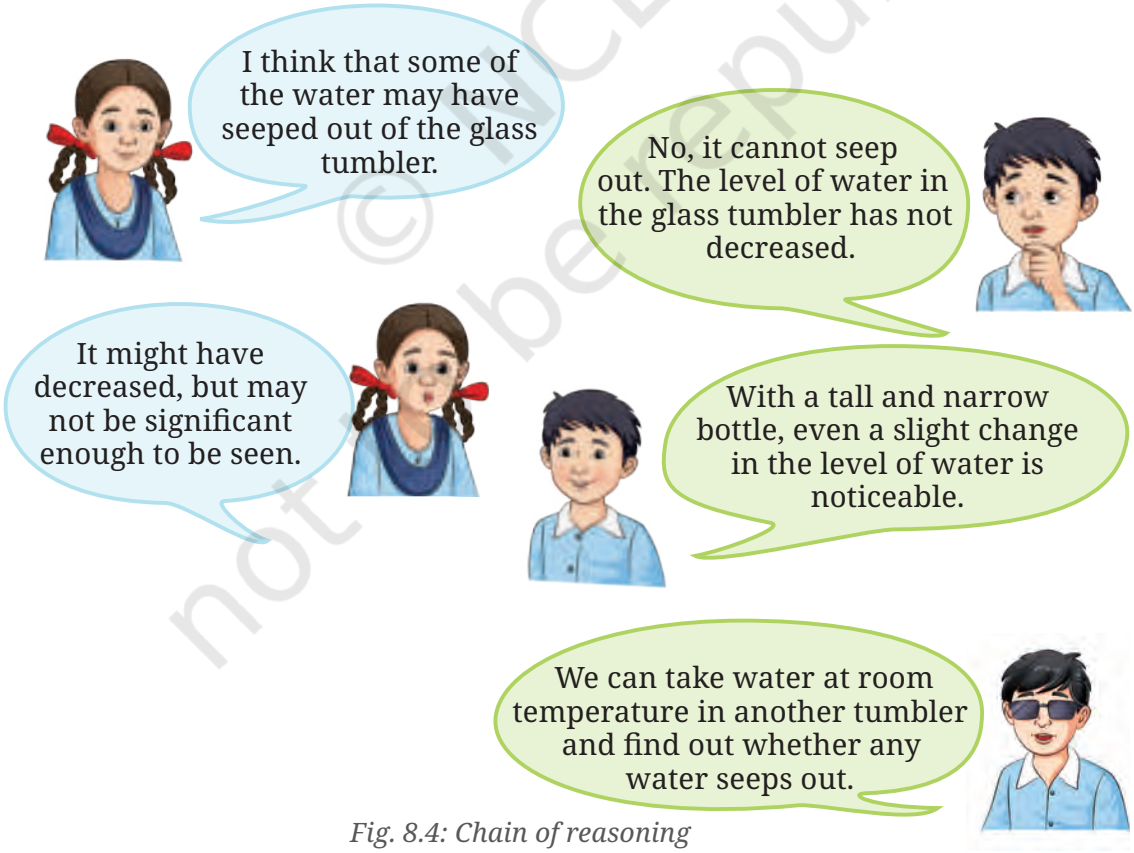


Fig. 8.4: Chain of reasoning

Continue the discussion on the given reasons or conduct activities to find evidence for the reasons given to help in this discussion. Where else have you seen water droplets like this?

Dew drops on plants

You might have seen dew drops on plants. Why do we see dew drops more in the morning? When we boil the water in a half-filled utensil and cover it with a steel plate, some water drops accumulate on the inner side of the steel plate. Where do these water drops come from? What do you think?

When the water vapour present in the air comes in contact with a cold surface, it forms water droplets. The process of conversion of water vapour into its liquid state is called **condensation**.

After understanding the concept of condensation of water, let us go back to Activity 8.3. Could the water appearing on the outer surface of the glass tumbler in Activity 8.3 also be due to condensation of water vapour present in the air? Let us investigate it.

Activity 8.4: Let us measure

Aavi and Thirav conduct an activity to find evidence for their reasons. You can also conduct the activity by following the steps given below. Record your data in Table 8.2.

- Take a glass tumbler half-filled with water containing a few ice cubes. Cover it with a small steel plate. Weigh it on a digital weighing balance.
- Observe the reading on the balance and record the weight after every five minutes.
- Continue observing for 30 minutes. Record your observations in Table 8.2.

Predict what will happen to the mass of cold water kept on the digital weighing balance. Will it increase or decrease or remain the same?

Table 8.2: Measurement of mass in condensation experiment using a digital weighing balance

Time	Mass of water
0 min	
5 min	
10 min	
15 min	
20 min	
25 min	
30 min	

Do your findings match with your predictions? Explain your observations.

You may observe some water droplets on the glass tumbler. Water vapour from the air comes in contact with the cold surface of the glass tumbler and gets converted into water droplets on the glass tumbler through condensation. There is an increase in the reading on the digital weighing balance. Can we conclude that water is not seeping through the wall of the tumbler? Can we also conclude that the water collected outside the tumbler is only due to condensation? No, we cannot say that conclusively from Activity 8.4. What more can you do to show that water is not seeping from the glass tumbler? How would you modify Activity 8.4 to find the answer?

Repeat Activity 8.4 with the following modifications—

- Mark the water level on the glass tumbler with a permanent marker or a visible tape.

What do you observe? Water level in the glass tumbler does not go down but the extra water gets collected on the outer surface of the glass tumbler. What can you conclude

More to do!

The amount of water vapour in the air is also known as humidity. The daily humidity data for your area is reported in the newspapers and other sources. Compile the data for the year and study any patterns, if present.

from this? This activity shows that water is not seeping from the glass tumbler and the extra water is getting collected because of condensation.

8.3 What are the Different States of Water?

Water is a substance that can be observed in three different states in our daily life. In the solid state, it exists as ice. On heating, the ice melts and gets converted into its liquid state. On further heating, water gets converted into its gaseous state. Let us perform Activity 8.5 to identify the properties of different states of water.

Activity 8.5: Let us identify

- Put an ice cube in one container and transfer it to another container of different shape. What changes do you notice in the shape of the ice cube? Record your observations in Table 8.3.
- Pour water from one container to another container of a different shape. Observe how water behaves compared to the ice cube and make a record. Did you notice how water flows from one container to the other? What happens to its shape?
- Pour water on a clean surface and observe how it spreads.
- When water gets converted into water vapour, how does this water vapour spread? Compare this with the spreading behaviour of water.

Table 8.3: Compare different states of water

Property	Ice (Solid state)	Water (Liquid state)	Water vapour (Gaseous state)
Shape			
Ability to flow			
Ability to spread			

What are the differences in the properties of water in solid, liquid and gaseous states?

Ice (solid state) retains its shape irrespective of the container in which it is placed while water takes the shape of the container. Ice does not flow or spread.

Water (liquid state) flows and changes its shape. Water does not have a fixed shape. It takes up the shape of the container in which it is kept, but the volume of water remains constant. Does water also possess the property to spread? Yes, water also has the property to spread while keeping the volume constant.

Water vapour (gaseous state) exhibits a property of spreading out in the entire available space. Gases do not possess a fixed shape. Water vapour exists even at room temperature; though it is invisible to us. It is present in the air around us. The water that evaporates during processes like drying of clothes or mopping of floors contribute to the water vapour in the air around us.

You are now familiar with the three states of water. Some other substances also exhibit these states. For example, wax, oil and ghee. Let us look at some more examples of solids, liquids and gases.

Look around and find some examples of solid substances. Some examples could be stones, wood and glass.

What are the other examples of liquids you can think of? Here are two examples—milk and oil. Think of five more examples.

Have you ever noticed that you can smell the food being cooked even without entering the kitchen? How does this smell reach us?

It is because the smell of yummy food from cooking spreads through the air and reaches our nostrils, even if we are not in the kitchen.

What are the other examples of gases you can think of? What about oxygen and carbon dioxide?

8.4 How can We Change the States of Water?

So far we have learnt that water can exist in solid, liquid and gaseous states. How can you change the state of water?

More to know!

Atmospheric Water Generator (AWG) machines collect water from humid air to produce drinkable water. This is done through condensation of water vapour by cooling the air. This process is similar to the formation of drops of water outside the glass tumbler filled with ice cold water.

How can you quickly change ice to its liquid state, water?

If we have to change ice into water, and water into water vapour, we have to supply heat to it. If we want to change water into ice, what should be done?

It can be done by placing water in a cold environment, such as a freezer. Water freezes and is converted into ice. If we take the ice out of the freezer, it melts and is converted into water.

Can you think of any other example, besides water, that can change from solid to liquid?

A candle, which is made of wax, is one such example.

How can we turn candle wax into liquid state? How can we change the liquid wax back into solid state? We should cool the liquid wax to change it into a solid. What are the other liquids you have seen which get converted into a solid? Have you ever seen coconut oil getting converted into its solid state during the winter season?

Hence, we can see that water and other substances change their states on heating or cooling. The process of conversion of a solid into liquid state is called **melting**. The process of conversion of liquid into solid state is called **freezing**.

Let us check the connection between different states of water through Activity 8.6.

Activity 8.6: Let us complete the diagram

Fill up the blank boxes in Fig. 8.5 marked as A, B, C and 1, 2, 3, 4 for conversion of different states of water using the words given in the box. Two words have been filled for you.

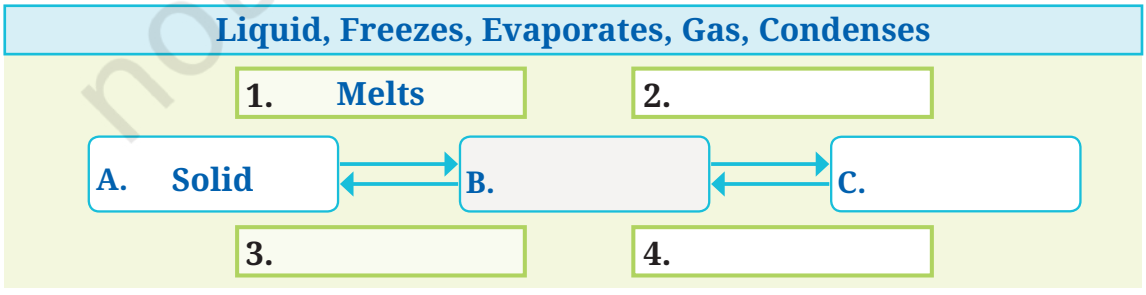


Fig. 8.5: Conversion of different states of water

8.5 How can Water be Evaporated Faster or Slower?

In section 8.1, we have learnt about evaporation. Let us explore it more!

Observe your surroundings. What are the conditions that affect how fast water evaporates? What differences do you see in evaporation on a cold day versus a hot day? Discuss with your friends. The following words may help in your discussion—fan, drying cloth, sweating, windy day, hot day, rainy day.

Let us perform Activity 8.7 to investigate conditions that will affect how fast water will evaporate.

Activity 8.7: Let us investigate

- Take water in a small cap of a bottle (you may use sanitiser in place of water).
- Take the same amount of water in a plate. The exposed area of water in the bottle cap and the plate are different.
- Keep both of them near each other.
- Record the time taken for the water to completely evaporate in each case in Table 8.4.

Let us investigate

Reflect on what you did really well in this activity. ?

Table 8.4: Findings of the investigation

Exposed area of water	Time taken for complete evaporation
Less (bottle cap)	
More (plate)	

What can you conclude from this investigation?

If you spread out water on a plate, its area exposed to air is larger. Therefore, evaporation is faster.

What would happen if milk is taken instead of water in the above activity?

Other conditions which affect how fast water evaporates

Design an activity similar to Activity 8.7 to find out what are the other conditions which can affect how fast water will evaporate. What would you change? What would you keep the same? Perform this activity, use Table 8.5 to record the data and discuss your observations.

Table 8.5: Record the data of an investigation where one condition is changed and other condition remains the same

Condition that is kept the same: _____

Condition that is changed	Time taken for complete evaporation

Other than the conditions you have explored to find how water can be made to evaporate faster or slower, you can also conduct Activity 8.8 to explore it further.

Activity 8.8: Let us explore

- Take identical caps of two bottles.
- Pour equal amount of water in each of the cap.
- Place one of the cap in sunlight and keep the other in shade as shown in Fig. 8.6.
- Observe the two caps of bottles after every 15 minutes.
- Record the time taken for the water to completely evaporate in each case.
- You can also repeat this activity on a windy or a rainy day, and record your observations.

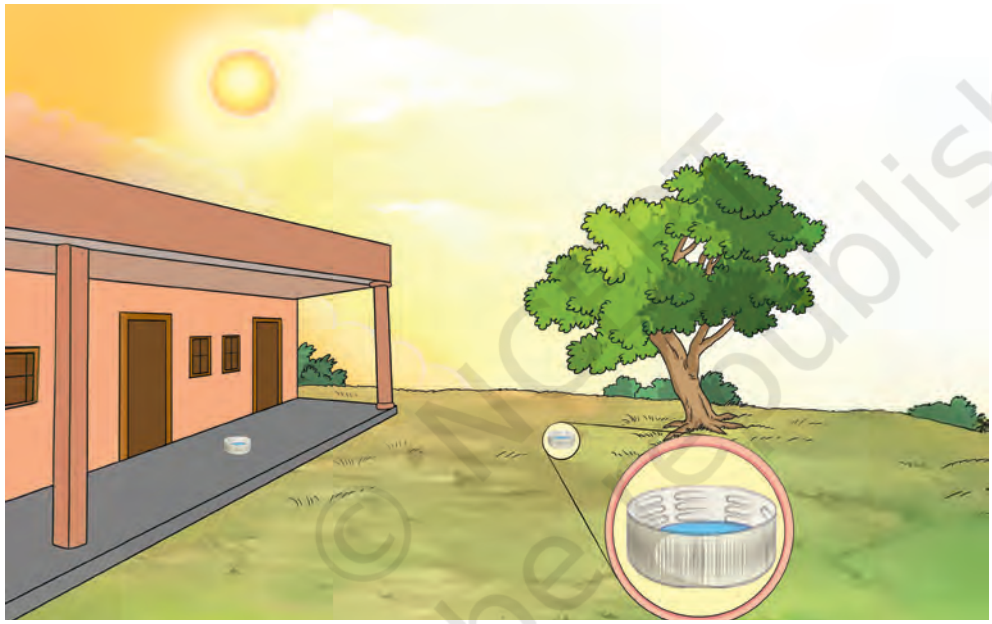


Fig. 8.6: Evaporation of water in sunlight and in shade

What conclusions can you draw from Activity 8.8 and other similar experiences?

- Water evaporates faster from the cap kept in sunlight compared to the cap kept in shade.
- It is a common observation that clothes dry faster on a hot sunny day. Do clothes dry faster or slower on a windy day? It is once again a common observation that clothes dry faster on a windy day. With the increase in the movement of air, water evaporates faster.

Do you know?

The amount of water vapour in the air is more on rainy days and hence rainy days are more humid.

- It is also a common observation that clothes dry slowly on a rainy day. On a rainy day, water evaporates slowly. If the amount of water in the air is already high (more **humidity**), water evaporates slowly.

If you want to dry your clothes on a rainy day, how can you make it faster?

8.6 Cooling Effect

Aavi's mother purchased a new *matka* (earthen pot) to replace the stainless steel pot for storing drinking water. Upon returning from school, Aavi notices the earthen pot and drinks water from it. Aavi expresses surprise and asks, "Why is the water in the earthen pot so cold? I never observed water getting cold in a stainless steel pot." What do you think is the reason?

Water seeps through the surface of the earthen pot and evaporates, which imparts a cooling effect on the water. What are the other examples of cooling effect? Sprinkling water on the floor or the roof during summer to cool it, is another example.

How do you feel when you rub sanitiser on your hands?

Let us perform Activity 8.9 to observe the cooling effect by making a simple and electricity-free model of pot-in-pot cooler.

Activity 8.9: Let us make a model

- Take two earthen pots of different sizes.
- Fill the bottom of the larger pot with a layer of sand.
- Place the smaller pot into the centre of the larger one as shown in Fig. 8.7.
- Fill the gap between the pots with more sand.
- Pour water in the sand area.

- Place a lid or wet jute sack to cover the top of the smaller pot.
- You can also make a drawing of the pot-in-pot cooler once it is ready.

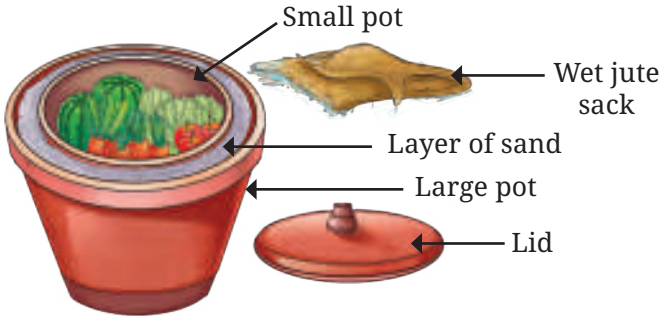


Fig. 8.7: A pot-in-pot cooler

Allow 4-5 hours for the mini pot-in-pot cooler to cool down. The time range can be influenced by many conditions. Observe and discuss how it creates a cooling effect inside the pots. Keep some vegetables and fruits in it and observe for a week on a daily basis to check for the freshness of the vegetables and fruits kept inside the cooler. You will have to add water regularly to keep the sand moist. For how many days can the vegetables and fruits be kept fresh in it? What are the conditions which can affect the number of these days? What else can be used in place of sand for better cooling?

You all may be familiar with this unique clay pot which is called *Surahi* (Fig. 8.8). In summers, *surahi* is used to keep the water cold.

Fig. 8.8: A surahi

8.7 How Do Clouds Give Us Rain?

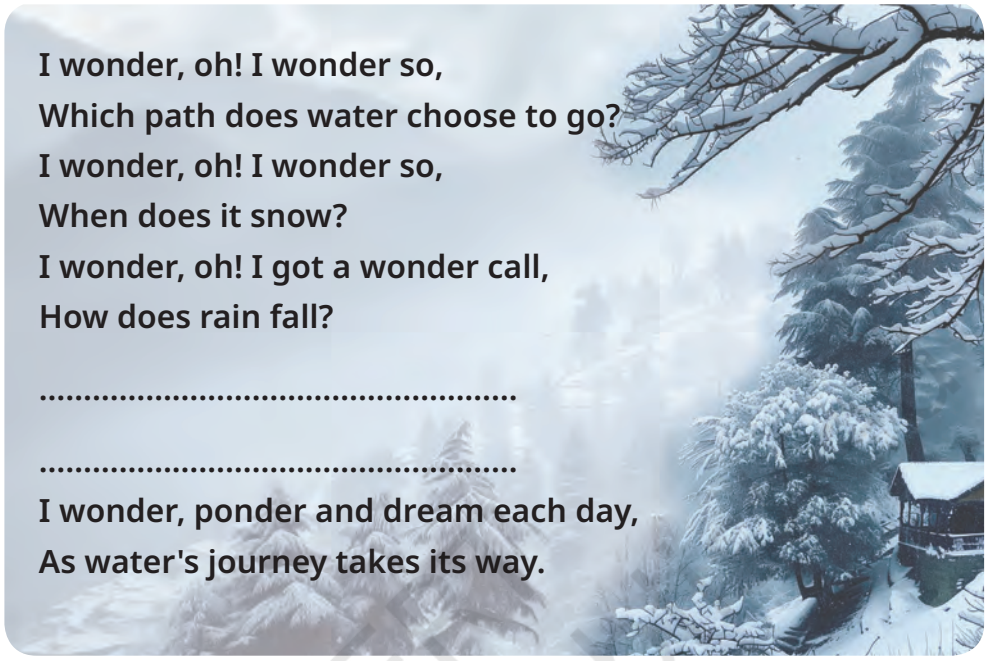
Condensation plays a significant role in the process of bringing evaporated water back to the Earth's surface. How does this happen? When air moves higher above the Earth's surface, it becomes cooler and cooler. At certain heights, the air gets so cool that the water vapour in it turns into droplets which are generally formed around dust particles. These small droplets float in the air and form clouds. Many droplets join together to form bigger drops of water. Some drops get so heavy that they start falling. These falling water drops are what we call rain.

Do you know?

Why does air containing water vapour go up in the atmosphere (thin layer of air that surrounds the Earth)?

As we know, gas balloons containing lighter gases go up in the air. Similarly, water vapour is lighter than air, causing it to rise.

Under special conditions, it might also fall as hail or snow. Aavi enjoys the rain and creates a poem. You can complete the poem and present it in your class.



I wonder, oh! I wonder so,
Which path does water choose to go?
I wonder, oh! I wonder so,
When does it snow?
I wonder, oh! I got a wonder call,
How does rain fall?

.....

.....

I wonder, ponder and dream each day,
As water's journey takes its way.

Activity 8.10 demonstrates the role of dust particles in the formation of clouds.

Caution
Handle burning paper carefully.

Activity 8.10: Let us engage in a group activity

- Take an empty discarded one litre plastic bottle. Pour about one cup of water into it.
- Close the lid tightly. Now quickly squeeze and release the bottle continuously for about 2–3 minutes. Observe the space above the water in the bottle.
- Repeat the same activity after adding a small burnt piece of newspaper into the water.
- What will you observe?
- In this case, you will observe some haziness (clouds) above the water in the bottle.
- The burnt newspaper provides very small invisible dust particles, around which water vapour condenses and forms clouds.

Let us perform Activity 8.11 to represent our understanding of how water changes its state and its movement.

Activity 8.11: Let us understand the process

Label Fig. 8.9 using arrows shown and the words given in the box to show where water is stored, how water changes its state and where it moves.

Cloud, Lake, Ocean, River, Groundwater, Evaporation, Condensation, Rain, Snow

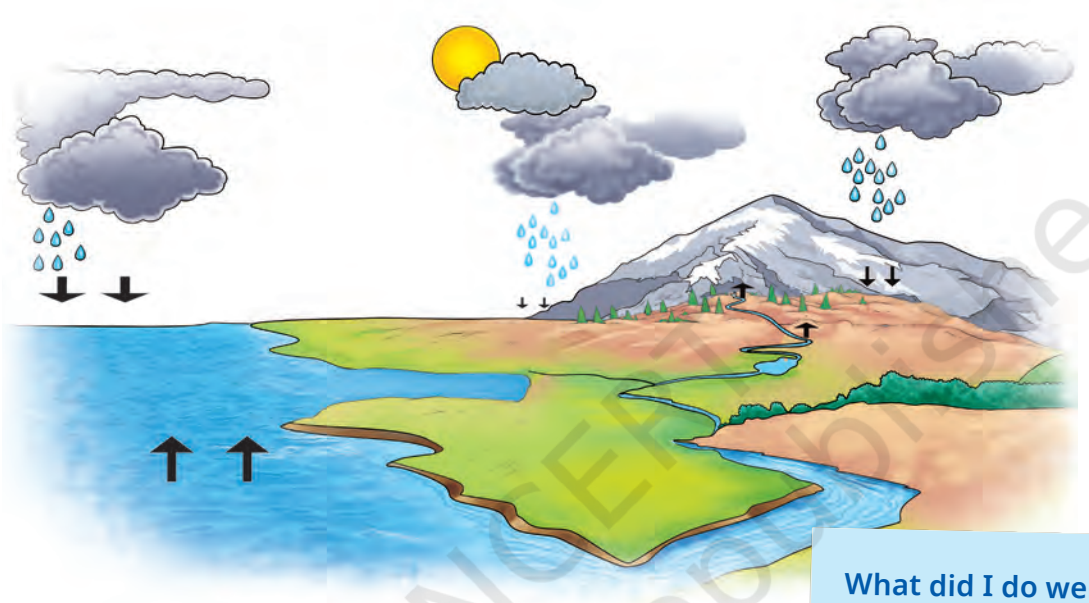


Fig. 8.9: Change of states and movement of water

The water from the ocean and the Earth's surface evaporates into the atmosphere as vapour and returns as rain, hail or snow, ultimately flowing back to the oceans. This circulation of water is known as the **water cycle**.

Only a small portion of water available on the Earth is fit for use by plants, animals and humans. Most of the water is in the oceans and it cannot be used directly. We use water for drinking and also for many other activities. The number of people using water is increasing with a rise in population. The increasing demand for water causes its shortage in many parts of the world. Hence, it is very important to use water wisely and avoid wasting it. Let us keep our water bodies free from pollution. You will learn more about water and its conservation in the chapter 'Nature's Treasures'.

What did I do well? Was I able to label all the parts of the water cycle? Which parts of the water cycle were unclear to me? ?

Keywords

Condensation	Experiment
Evaporation	Investigate
Freezing	Observe
Gas	Predict
Humidity	Question
Liquid	Reason
Melting	Record
Solid	
Water cycle	
Water vapour	

Summary

Key Points

- The process of conversion of water into its vapour state is called evaporation.
- The process of conversion of water vapour into its liquid state is called condensation.
- Water is found in different states—solid, liquid and gas.
- Water changes its state on heating or cooling.
- Conditions which make the evaporation faster or slower are exposed area, humidity, air movement, etc.
- Evaporation causes cooling effect.

- The water vapour in the air condenses to form tiny droplets of water, which appear as clouds. Many tiny water droplets come together and fall down as rain, hail or snow.
- The circulation of water between the Earth surface and atmosphere is known as the water cycle.
- We have used the process of observation, questioning, possible reason and experimenting to find out the concepts of evaporation and condensation.

Let us enhance our learning

1. Which of the following best describes condensation?
   (i) The conversion of water into its vapour state.
   (ii) The process of water changing from a liquid into gaseous state.
   (iii) The formation of clouds from tiny water droplets.
   (iv) The conversion of water vapour into its liquid state.
2. Identify in which of the given processes, evaporation is very important—
   (i) Colouring with
   (a) crayons (b) water colours
   (c) acrylic colours (d) pencil colours
   (ii) Writing on paper with
   (a) pencil (b) ink pen (c) ball point pen
3. We see green coloured plastic grass at many places these days. Space around natural grass feels cooler than space around the plastic grass. Can you find out why?
4. Give examples of liquids other than water, which evaporate.
5. Fans move air around, creating a cooling sensation. It might seem strange to use a fan to dry wet clothes since fans usually make things cooler, not warmer. Normally, when water evaporates, it requires heat, not cold air. What do you think about this?
6. Usually, when sludge is removed from drains, it is left in heaps next to the drain for 3–4 days. Afterward, it is transported to a garden or a field where it can be used as

manure. This approach reduces transportation cost of the sludge and enhances the safety of individuals handling it. Reflect upon it and explain how.

7. Observe the activities in your house for a day. Identify the activities that involve evaporation. How does understanding the process of evaporation help us in our daily activities?

8. How is water present in the solid state in nature?

9. Reflect on the statement "Water is our responsibility before it is our right." Share your thoughts.

10. The seat of a two-wheeler parked on a sunny day has become very hot. How can you cool it down?

Learning further

- Wet one hand with water and leave the other dry. Blow air across both hands and feel the cooling effect. Find out the reasons for it.
- Make a game to navigate through different states of water and water related concepts to reach the finish line. Challenge cards with questions related to water cycle, evaporation, condensation, etc., can be some game elements.
- Discuss with your teacher and act out the stages of the water cycle through a role-playing activity in your school assembly.