Part 4: Changing state: a physical change

PART 4

Activity 4.1 Observing changes in water

Activity type

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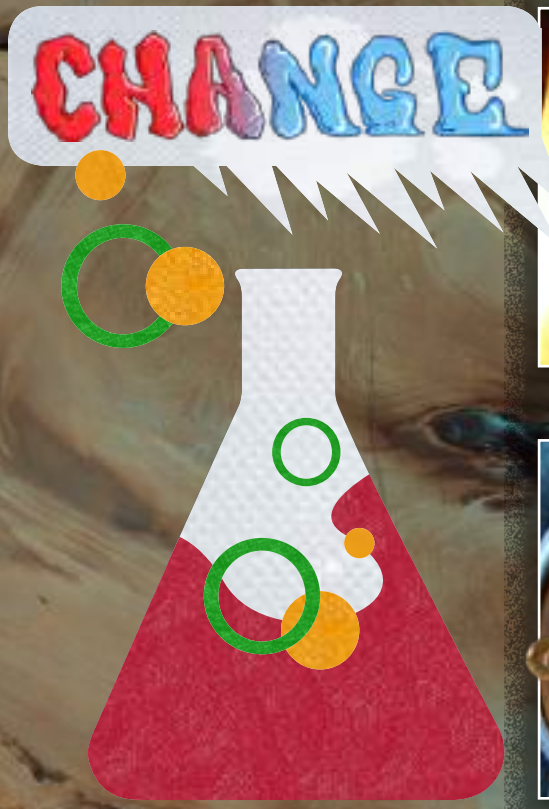


OUR WORLD IS FULL OF CHANGES, AND MANY OF THEM ARE VERY COMPLEX.

Many of these changes involve chemical reactions.

Many changes involve heat.

How many changes have you noticed today?

Changing states

In this activity you will observe the changes that take place when water changes state.

TAKE CARE WITH HANDLING THERMOMETERS AND GLASS WARE. ALERT YOUR TEACHER IMMEDIATELY IF A BREAKAGE OCCURS.

What to use:

Each GROUP will require:

- 250 mL beaker half filled with crushed ice
- thermometer (-10 - +110 °C)
- retort stand and clamp
- stirring rod
- Bunsen burner
- tripod
- gauze mat
- safety mat
- stopwatch

Each STUDENT will require:

- *Science by Doing* ***Notebook***
- safety glasses
- graph paper.

What to do:

Step 1
Copy the results table into your ***Notebook***.

Step 2
Set up the equipment as shown.

Step 3
Half fill the beaker with crushed ice.

Step 4
Measure the temperature of the ice.

Step 5
Record the temperature of the ice in your results table for time zero.

Step 6
Light the Bunsen burner and start timing.

Step 7
Measure the temperature every minute stirring gently before each reading.

Step 8
Record the temperature in your results table.

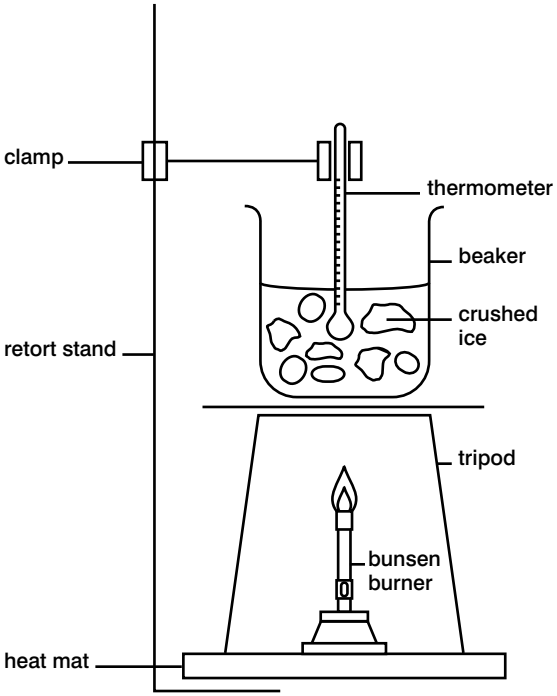
Step 9
Continue to measure the temperature every minute until the water has been boiling for three minutes.

Step 10
Graph your results.

Time (min)	Temperature (˚C)	Time (min)	Temperature (˚C)
0		16	
1		17	
2		18	
3		19	
4		20	
5		21	
6		22	
7		23	
8		24	
9		25	
10		26	
11		27	
12		28	
13		29	
14		30	
15			

Discussion:

- At what temperature did the water start to melt?
- At what temperature did the water start to boil?
- On your graph label when the water was a solid, liquid and gas.



KEEP GOING

SUMMARY

What is the name given to what is happening when water changes from

a) a solid to a liquid?

b) a liquid to a gas?

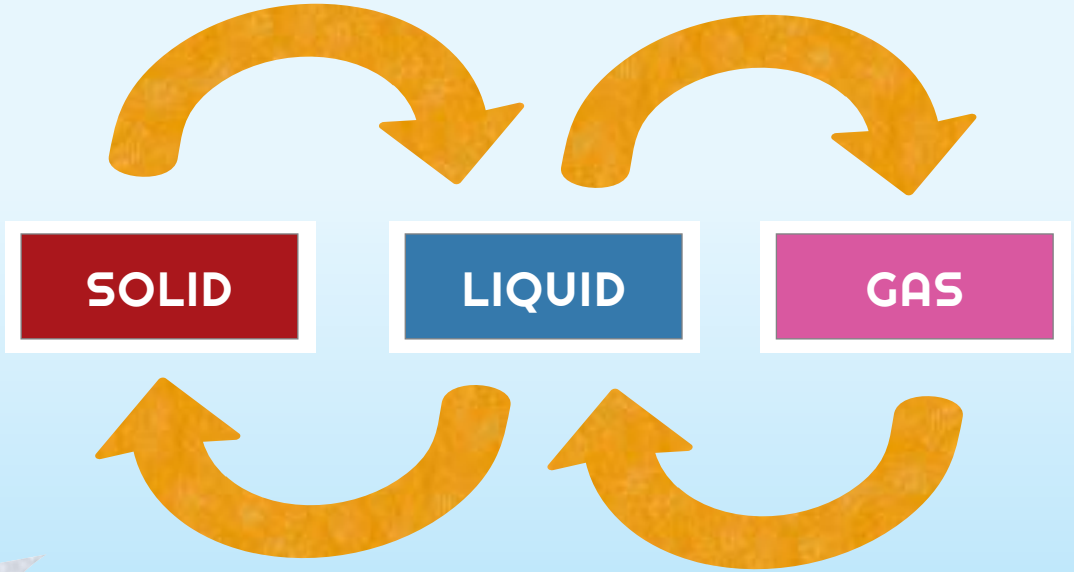
What is the name given to what is happening when water changes from

a) a gas to a liquid?

b) a liquid to a solid?

What to do:

Copy and complete the diagram below adding the name of the phase change on the arrows.



Think of another example to illustrate the following:

a) a solid changes to a liquid

b) a liquid changes to a gas

c) a gas changes to a liquid

d) a liquid changes to a solid.

KEEP GOING

The process of changing from one state of matter to another is often referred to as a **PHYSICAL CHANGE**.

The water molecules are the same whether they are in a gas (water vapour), liquid or a solid (ice).

Its formula is still H_2O.

It is relatively easy to change between different states by heating and cooling.

The empty gap between the kettle spout and the visible steam is actually where the water vapour is.
Water vapour is invisible.

The steam cloud that is visible consists of tiny droplets of liquid water that have condensed as they come into contact with the cool air.

Did you know that water vapour is an invisible gas?

So what do you see coming from the spout of a boiling kettle?

Clouds also consist of tiny droplets of liquid water, or even ice particles. They have condensed, or frozen, in the cold air at high altitudes.

Click here to explore the behaviour of water at the molecular level.

Activity 4.2 Ice play

Activity type

DOWNLOAD e-NOTEBOOK

Ice cream in a bag

How did people make ice cream before the invention of freezers?

What to use:

Each GROUP will require:

- 1 cup milk (or ½ cup of cream and ½ cup milk)
- 2 tablespoons sugar
- 1/4 teaspoon vanilla
- 6 cups of ice cubes (crushed)
- 1/2 cup table salt
- 1 small ziplock bag
- 1 large ziplock bag
- clean spoon for each student.

What to do:

Step 1
Add the milk, sugar, and vanilla to the small bag and zip it closed.

Step 2
Place the ice and salt in the larger bag.

Step 3
Now place the closed small bag inside the larger bag.

Step 4
Shake and knead both bags until the ice cream begins to solidify in the small bag. Now enjoy.

Discussion:

1. Explain why the ice cream froze in this recipe.
2. Why was the salt important?

Extension:

Design an experiment to test the effect of adding salt to icy water on its temperature.

Carry out your experiment to determine how low the melting point of ice can driven by adding salt.

Make a note of your results in your *Notebook*.

KEEP GOING

When salt is dissolved in water a **PHYSICAL CHANGE** is formed.

Common salt is a compound of sodium and chlorine. It's formula is NaCl.

As the salt crystals dissolve the sodium (Na) and chlorine (Cl) atoms are pulled apart by the water molecules.

In some countries with cold winters salt is put on icy roads. This melts the ice at a lower temperature than normal making it less slippery.

But salt will make cars rust so this treatment is not used so much today.

Rather than salty iced water you can make ice cream using liquid nitrogen. Some fancy ice-cream shops use this method.

Activity 4.3 Can matter skip states?

Activity type

Placing dry ice in water actually adds heat, causing the dry ice to sublimate.

What is unique about dry ice? What is it made of?

Your teacher will provide a sample of dry ice.

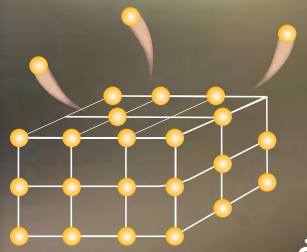
What happens when it is placed on the desk top?

What happens when it is added to water?

Why do you need to wear gloves when handling dry ice?

The dense white fog mostly comes from the water as it evaporates and mixes with the cold CO_2 gas, and is sometimes used to create special fog effects in theatre productions.

Iodine is another substance which, when heated, goes from a solid to a gas. At what temperature does this take place? How could we turn iodine gas back to pure iodine crystals?



sublimation depicted at submicroscopic level

Phase changes of matter

What to do:

Draw the phase changes of matter in your ***Notebooks***.

Click here to learn more about changes of state and sublimation.

Activity 4.4 Detecting an invisible gas

Activity type

DOWNLOAD e-NOTEBOOK

The invisible gas

How do we know that an invisible, odourless gas is really there?

What to use:

Each GROUP will require:

- 1 large beaker
- 1 small beaker
- Sodium bicarbonate
- Hydrochloric acid (0.1 M)
- Tea light candle
- Spatula.

What to do:

Step 1
Place the tea light candle in the bottom of the small beaker and light it.

Step 2
Add 1 spatula of sodium bicarbonate to the bottom of the large beaker, and add 50 mL of the hydrochloric acid. The mixture will start to fizz. Allow this to stand for at least 30 seconds.

Step 3
Carefully tip the large beaker over the smaller beaker, making sure that none of the liquid spills out, as shown in the image.

Step 4
Observe the behaviour of the candle.

Discussion:

1. What happened to the candle?
2. Referring to the chemical equation shown at right, explain why the candle behaved in this way.
3. Based on your observation do you think carbon dioxide is lighter or heavier than air?

Here is the equation that describes the reaction that occurred in the large beaker.

Sodium bicarbonate + Hydrochloric acid → Sodium chloride + Water + Carbon dioxide

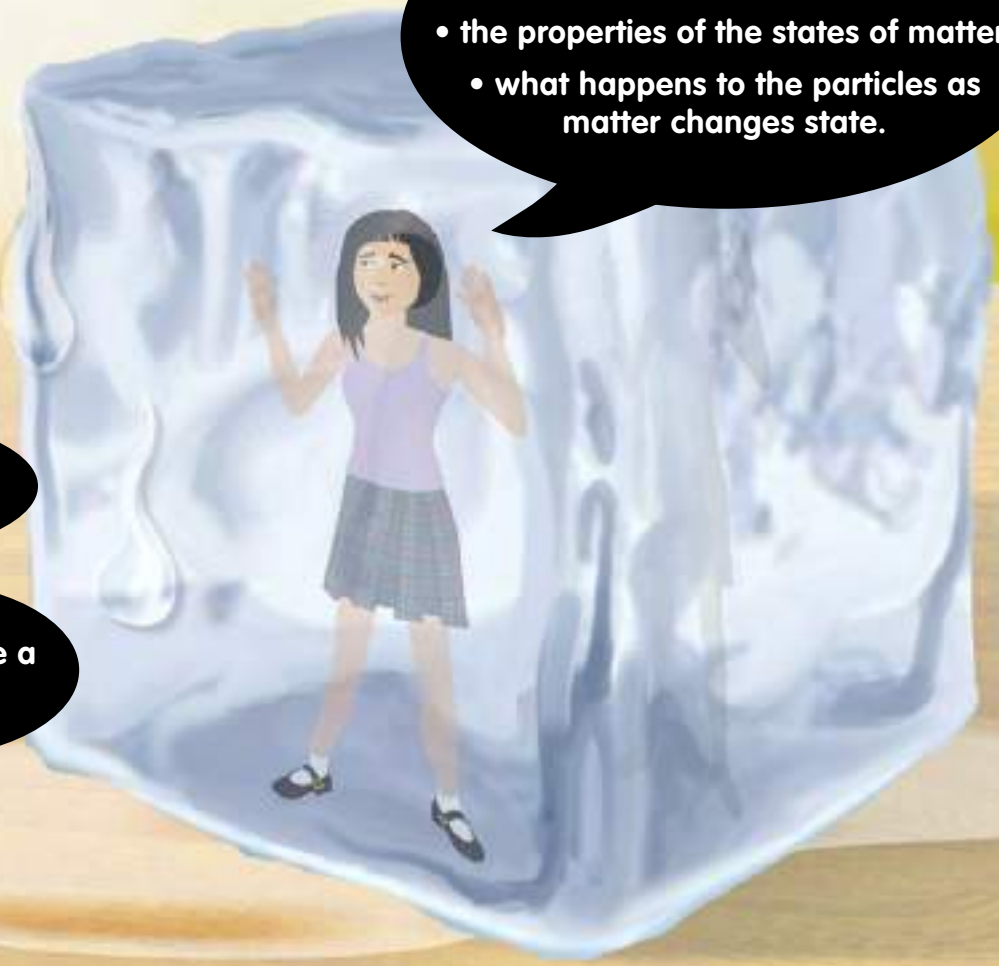
Click here to learn about gases we come across in our everyday lives and their properties.

Activity 4.5 What is happening to me?

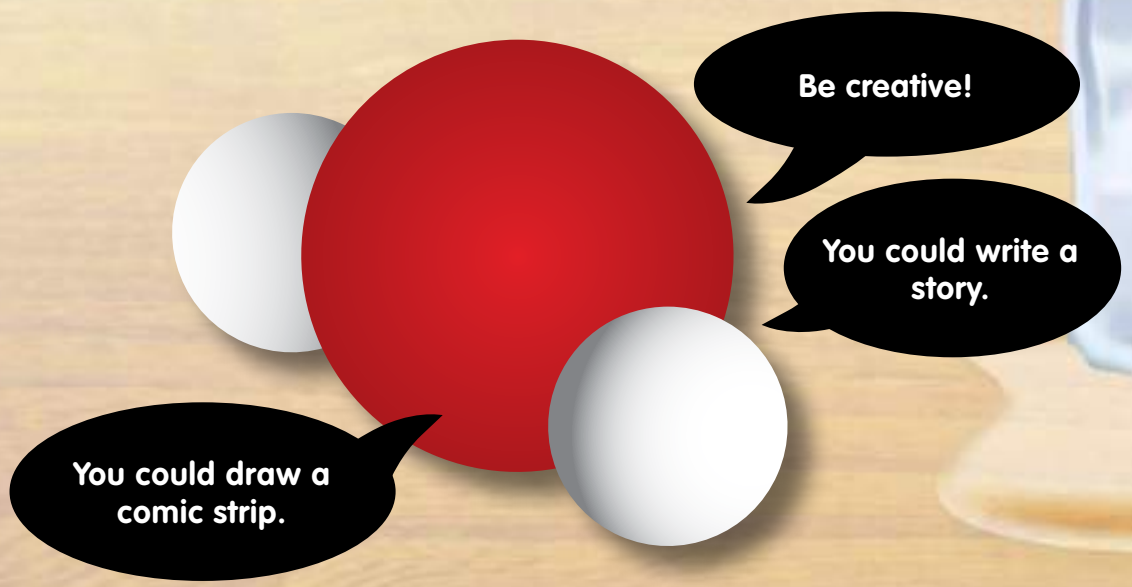
Activity type

Make sure you use what you have learned about

- the properties of the states of matter;
- what happens to the particles as matter changes state.



Imagine you are a molecule of water in an iceblock. Describe what would happen if you were left in the sun.



Summary

PART 4

Changes from one state of matter to another are examples of **physical change**. These particular changes occur easily either by adding or removing heat.

A change of state can be explained using the kinetic (or particle) model.

Usually substances move between the solid and liquid state, or between the liquid and gas state, but some substances under some conditions can move directly between the solid and gas states. **Sublimation** is the process where a substance moves directly from a solid to a gas.

Most gases are colourless and odourless in their pure form. This makes them hard to detect and potentially hazardous.

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