Knox Academy

Science Department

S1 Science

Our Material World

Part 1

1. Earth and the Solar System

What do we Know About the Solar System?

Hubble Telescope

Much of what we know about our Solar System has come from telescopes on the Earth's surface (sometimes based on tops of mountains) but in recent years high quality pictures have been obtained from telescopes in space. In particular the Hubble telescope, named after Edwin Hubble a famous astronomer.

Edwin Hubble

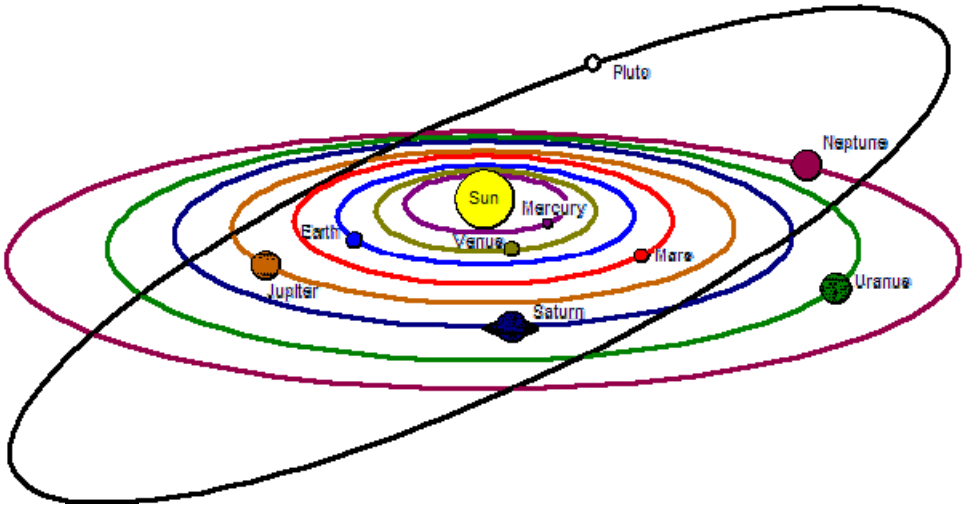
Activity: Watch the DVD 'Eyewitness Planets' and complete the worksheet worksheet 1.

Notes: Stick the completed sheet into your notebook under the heading 'Our Solar System'.

2. How Big is the Solar System?

Solar System

Activity: Look at the website www.nineplanets.org/



Collect: Starting Science Book 2

Notes: Using the information on page 10 of Starting Science book 2 make up a table with the following headings:- Planet, Diameter in km, Distance from the Sun in km, Length of Day, Surface Type.

Notes: Use this table to answer the following questions:-

1. How many planets are rocky?
2. How many planets are gas covered (gas giants)?
3. Which planet is roughly 5 times the distance from the sun that Earth is?
4. Looking at the diagram of the solar system can you suggest why Pluto may have lost its classification as a planet?

Model of the Solar System

Your teacher will direct you to a group and which planet models to make.

Collect: Premarked ball of string
Precut, marked lengths of wire with hooks at end.
Pieces of blank paper

Activity: 1. Use the lengths of wire to make circles to represent the planets you have been asked to do.

2. For all the planets except Jupiter and Saturn draw this circular shape onto a piece of blank paper. Look at the photographs of the planet or the website given on the previous page to get the correct colouring for your Planet.

3. Colour the circle in to represent the planets, cut out and use sticky tape to attach to the wire circles.

4. For Jupiter and Saturn, simply write their names on 2 rectangular pieces of paper, colour in suitable colours and attach to the wire circles.

5. When your teacher decides the class is ready, go into the corridor or playing field (your teacher will direct you) and attach the correct planet to the correct distance along the premarked string.

Notes: Write down two important facts you have learned by doing this activity.

3. Planet Earth: Rocks

The Surface of the Earth

Many thousands of rock types exist on Earth. Some examples can be seen here. All of the different rocks can be sorted into three main types:

1. **Igneous**
2. **Sedimentary**
3. **Metamorphic**

Granite

Porphyry


Kimberlite


Basalt

The names come from how the rock was made.
Your teacher will show you different rock types and point out the significant features of each type of rock.

Igneous Rocks

Igneous means made by fire. The Earths crust began as a very hot liquid or molten rock. As a result all the first rocks to form were igneous. Nowadays, new igneous rock is formed by volcanic eruption on land or under the sea. Liquid rock called magma appears either on the surface
or between layers under the crust.

Collect: Starting Science book 1

Notes: Read about igneous rocks in Starting science book 1, page 17 and answer questions 1 to 4.

Collect: a sample of igneous rock.

Activity: Choose one of the samples and do a drawing of the rock in your jotter. Name it and label with any significant features.

e.g. **Granite**
Rough
Contains crystals
Very hard
Blue and pink

Use words from the list below:-

Word List:

Like glass, powdery, layers, empty spaces, grains, contains fossils, contains crystals, colour, smooth, rough, bands, jumbled pieces.

Sedimentary Rocks

Early in Earth's history jagged volcanic rocks rose from steaming oceans, only to be battered down by wind and water. This process is called erosion. Small pieces of rock were washed into streams, rivers, lakes and sea bottoms. Eventually layers of broken down igneous rock built up and were themselves turned into different types of rock, called **sedimentary** rocks.
For the last 3 billion years living organisms have also added to the sediments and so **fossils** have been formed where the shape of the organism is preserved in the rock.

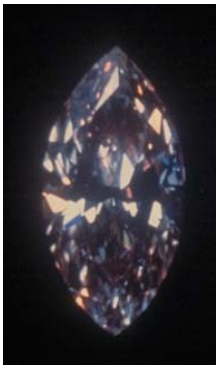
Notes: Read about sedimentary rock in Starting Science book 1 page 20 and answer questions 1 to 4.

Collect: a sample of **sedimentary** rock.

Activity: Draw the rock you have chosen, name it and label the drawing using words from the word list above.

Metamorphic Rocks

When any type of rock experiences high temperatures and/or pressures the rock can change from one type into another. When this happens the new rock is called **metamorphic**. Typical examples are graphite, which can turn into diamond, limestone which can change into marble and shale which can change into slate.



Diamond

Notes: Read about metamorphic rock in Starting Science Book 1 and answer the questions 1 to 4

Collect: a sample of **metamorphic** rock.

Activity: Draw the rock you have chosen, name it and label the drawing using words from the word list below.

Word List:

Like glass, powdery, layers, empty spaces, grains, contains fossils, contains crystals, colour, smooth, rough, bands, jumbled pieces.

4. The States of Matter

Everything around us is either a solid, a liquid or a gas. Solids, liquids and gases are the three **states of matter**. In this lesson you are going to be thinking about which of the three states of matter different substances are in.

Discussion: How many different examples of solids, liquids and gases can you think of which could be found in:

- the classroom
- your home
- the outside world

Notes: 1. Design a table which could be used to group substances as "solids", "liquids" or "gases". Leave space for <u>six</u> examples of each.

2. Add **three examples** of **each** from your discussion to your table.

Collect: A set labelled "states of matter".

Activity: 1. Examine each of the substances in the set you have collected.

2. Arrange them into groups on your desk according to which are solids, liquids or gases.

Notes: Add three of each of the substances from your set to the table in your jotter, under the correct heading.

Discussion: Imagine a scientist discovers a new substance on a planet and brings it back to Earth.

You have not seen the substance but you are asked to decide whether the substance is a solid, liquid or gas based on what you have been told about it.

Which of the following pieces of information would you need to decide if the substance was a solid, a liquid or a gas, and why?

- Its colour
- If you can see through it
- If you can squeeze it
- If it is heavy
- It is hard
- It is runny
- If it floats on water
- If it can change shape when poured
- If you can put your hand into it or through it

Would you want any other information?

Notes: Write a short note to cover:

1. What we mean by "the three states of matter".
2. How <u>you</u> are able to decide if a substance is a:
   - solid
   - liquid
   - gas

5. The Behaviour of Matter

We can tell which state of matter something is in by the way that it behaves. In science, a behaviour is often called a **property**. In this lesson you are going to be thinking about the different properties of solids, liquids and gases.

Discussion: What does the word "compress" mean?

Do you think the following sentences are <u>true</u> or <u>false</u>, and why?

- You can compress solids.
- Solids change shape when you pour them.
- You can compress liquids.
- Liquids change shape when you pour them.
- You can compress gases.
- Gases change shape when you pour them.

You are going to carry out two experiments to find out more about the properties of solids, liquids and gases. The two properties you will be studying will be "compression" and "shape when poured".

Notes: Copy the following table into your jotter. You will use this to record the results of some experiments.

State	Can you compress it?	Can you change the shape when poured?
Solid		
Liquid		
Gas		

Activity: Your teacher will demonstrate a series of experiments to investigate the above properties.

Discussion Are the following statements true or false?

- Solids can be compressed
- Liquids can change their volume
- Liquids cannot change their shape when poured
- Water can change its shape when poured
- Water can change its volume
- Gases cannot be compressed
- Gases can change their volume

Think about the following descriptions of different substances, and decide whether they are describing a solid, liquid or gas:

- A substance which can be compressed and changes shape when poured.
- A substance which does not change shape when poured and cannot be compressed.

Notes: Copy and complete the following sentences. Into each space, insert "can" or "cannot" to make the sentences correct.

Solids _____ be compressed and
_____ change their shape when poured.
Their volume _____ be changed.

Liquids _____ be compressed and
_____ change their shape when poured.
Their volume _____ be changed.

Gases _____ be compressed and
_____ change their shape when poured.
Their volume _____ be changed.

Discussion: Are there any solids that you can think of that you can compress?
If so, why is it that you able to compress them?

6. The Idea of Particles

Scientists are interested in how everything in the world works. They come up with ideas to explain something they have seen, or they carry out experiments to test an idea that they already have. What a scientist thinks will happen in an experiment is called their "hypothesis".

In the last lesson you made some observations about the behaviour of solids, liquids and gases. In this lesson you will learn about how these observations have led to an idea called the "Particulate Nature of Matter."

Notes: Copy the following table into your jotter:

Substance 1		Substance 2		Total volume 1 + 2	
Name	Volume (cm^3)	Name	Volume (cm^3)	Hypothesis (cm^3)	Actual (cm^3)
Peas		Sand			
Water		Water			
Water		Alcohol			
Water		Salt			

Collect: Containers of sand and peas
2 x 100ml measuring cylinders with rubber stoppers

Activity: 1. Using separate measuring cylinders, measure out 40cm^3 of peas and 40 cm^3 of sand. Record these volumes in your table.

2. Think carefully about what you think their <u>total</u> volume will be when they are mixed. Record your hypothesis in your table.

3. Pour the sand into the measuring cylinder of peas, stopper the cylinder, and carefully shake the mixture.

4. Read the new volume from the measuring cylinder and record the results in your table under "actual".

5. Repeat for the following combinations:

- 40cm^3 water with 40cm^3 water
- 40cm^3 water with 40cm^3 alcohol
- 40cm^3 water with 1cm^3 salt

Discussion: Were the results what you were expecting? Can you explain what happened?

Activity: Read "The Heinemann Science Scheme" book 1, p80-81

Notes: 1. Make sketches in your jotter to show how particles are arranged in solids, liquids and gases.

2. Label each sketch to indicate what you are showing.

7. Particles in Motion

Particles are not stationary – they are moving all of the time. In this lesson you are going to learn about the differences in the way particles are moving in solids, liquids and gases and why this is.

Particles Moving in Solids

Collect: 2 test tubes of gel
2 rubber stoppers
Test tube rack
Spatula
Jar of blue crystals

Activity: 1. Add one spatula of the blue crystals to the gel in each test tube.

2. Put a rubber stopper in the top of each tube.

3. Put one of the tubes the correct way up in the test tube rack, and the other tube upside down.

4. Leave for half an hour.

Discussion: What do you think will happen in each test tube? Why?

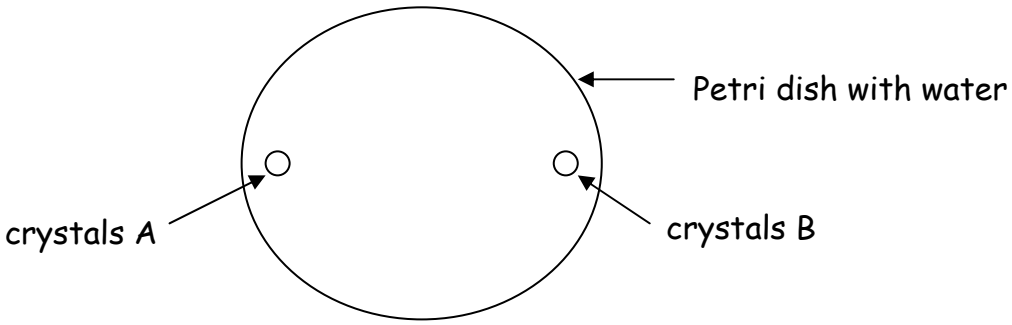
Notes: 1. Draw a labelled diagram of each of the test tubes you have set up.

2. Which of the three states of matter do the blue crystals have to move through?

3. Write down your hypothesis for each experiment.

Particles Moving in Liquids and Gases

Collect: a petri dish
spatula
crystals A
crystals B



Activity: 1. Put enough water into the petri dish to cover the bottom.

2. Add $\frac{1}{4}$ spatula of crystals A at one side of the dish (the less you use the better this experiment will work).

3. Add $\frac{1}{4}$ spatula of crystals B to the other side of the dish.

4. Leave the dish for a few minutes and watch carefully what happens. Do not move the dish.

Notes: 1. Make drawings to show the contents of the petri dish at the start of the experiment and then again at the end of the experiment.
2. Label crystals A and B and indicate their colour.
3. Indicate the colours in the petri dish at the end of the experiment.

Activity: Your teacher will demonstrate an experiment to show particles moving through a gas.

Activity: Read p56 and p57 of Starting Science book 1.

Activity: Look at the two test tubes you set up earlier with the blue crystals and the gel. You can leave these until the next lesson and view them again.

Notes: 1. What word is used to describe particles moving through another substance?
2. Are particles able to move fastest through a solid, liquid or gas?

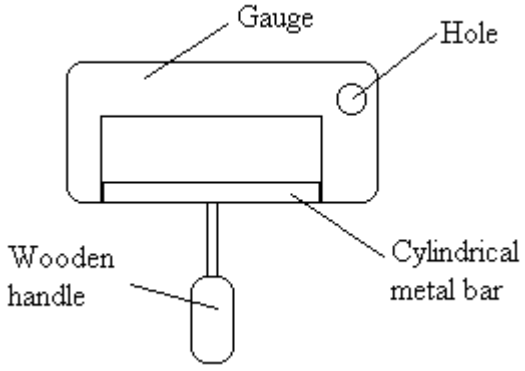
8. Expansion and Contraction

In the previous lesson you learned that particles are moving, but there are differences in the way they are moving in solids, liquids and gases. Is it possible for us to change the way the particles are moving? Can we speed them up or slow them down? Can we cause them to spread out more and take up more space, or come closer together and take up less space? This is what you will be learning about in this lesson.

Heating Solids

Collect: A metal bar with wooden handle
Gauge
Bunsen burner and heat-proof mat

Activity: Check to see if the metal bar fits into the gauge and the hole in the gauge.



Discussion: What do the words "expand" and "contract" mean?

If you heat the metal bar, other than just getting hot, do you think anything will happen to it?

Activity: 1. Heat the metal bar using a blue Bunsen flame for 1-3 minutes.

2. Holding on to the wooden handle (REMEMBER THE METAL WILL BE VERY HOT), see if the bar is still able to fit into the gauge and through the hole.

Discussion: What happened to the size of the bar?

In terms of particles and the spaces between particles, why do you think this happened?

Notes: 1. Make a drawing to show what you did and what happened in your experiment.

2. What happened to the size of the metal bar when it was heated?

3. What scientific word is used to describe this?

4. What is the opposite of this word?

Activity: Now that the bar has had time to cool down, check to see if it can fit into the gauge and through the hole.

Heating Liquids

Discussion: If you heat a liquid, do you think it will expand or contract?
How will this compare to heating a solid?
How will this compare to heating a gas?

Collect: A test-tube of coloured water with a capillary tube
250 cm^3 beaker

Activity: 1. Mark the level of the coloured water in the capillary tubing using an attached rubber hoop

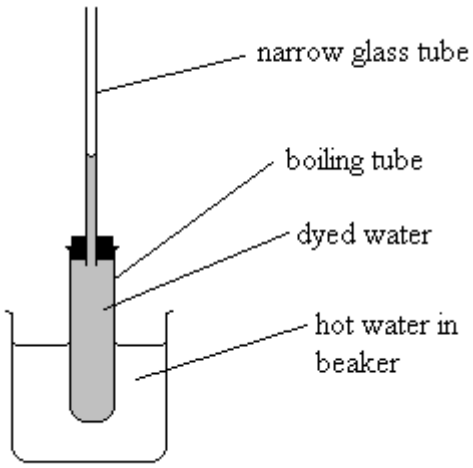
2. Half-fill the beaker with boiling water from the kettle.

Discussion: If you put the test-tube of coloured water into the beaker of hot water, what do you think will happen?

Why?

Activity: 1. Put the test-tube of coloured water into the beaker of hot water and leave it for up to 5 minutes.

2. Look to see if the level of water in the capillary tube has changed.



Notes: 1. Draw labelled diagrams to show the level of coloured water in the capillary tubing at the start and end of the experiment.

2. When it was heated, did the liquid expand or contract?

3. Copy and complete:
When substances are heated, their particles move _____ and spread out more. The substance expands.

When substances are cooled, their particles move _____ and move closer together. The substance contracts.

Activity: Your teacher will show you a video clip of a balloon of gas being cooled down.

Discussion: Decide whether or not you think the following statements are <u>true</u> or <u>false</u>?

1. Gases can expand roughly 3000 times more than solids.

2. The Forth railway bridge is 2.5 km long in the winter time, but in the summer time it is half a meter longer.

3. It would be a sensible idea to have power cables hanging tightly just before the start of winter months.

9. Pressure

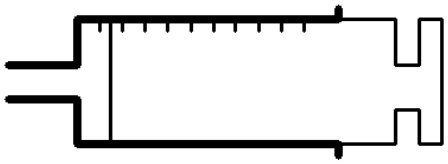
Pressure is caused by particles moving. By hitting the sides of the container they are in, particles cause pressure. Solids and liquids do not cause significant pressure because their particles do not move much compared to gases. However, the particles in a gas are moving freely and do affect the pressure inside a container. In this lesson you will learn about how you can increase or decrease pressure.

Temperature and Pressure

Notes: Copy the following table into your jotter

	At start	In tap water	In hot water	In cold water
Volume of air (cm^3)				

Collect: a plastic syringe Ice
3 beakers
Blue tac



← Lower half→

Activity: 1. Pull back the plunger on the syringe to 5 cm^3. Record this volume in your table under "at start".
2. Seal the open end of the syringe with blue tac.
3. Submerge the lower half of the syringe in tap water for 1 – 2 minutes.
4. Take the syringe out of the water, make a note of the volume of gas inside it, and record the result in your table.
5. Repeat steps 3 and 4 for hot water from a kettle, and then for water with ice cubes in it.

Discussion: What was in the syringe at the start of the experiment, when you had a volume of 5 cm^3?

What happened to the volume of gas in the syringe in each experiment?

Why do you think this happened?

Notes: 1. Make a labelled diagram of <u>one</u> of your experiments.

2. Describe what you saw happening in <u>each</u> experiment.

3. Some of the statements below are true and some of them are false. Use the statements which you think are true to try to write an explanation for what happened in your experiments.

For any false statements, you should be able to change one or two of the words to make them true.

- The syringe contained a gas
- When the gas was heated, it took up less space
- Heating a substance makes the particles move faster
- Heating a substance makes the particles get bigger
- Heating a substance makes the particles spread out more
- Heating a substance means that the spaces between the particles get smaller

Activity: Your teacher will demonstrate an experiment involving a plastic bottle and hot water.

Other ways to Change Pressure

Discussion: You should now have learned that by changing the temperature of a container of gas, you can change the pressure inside it. Can you think of two other ways to change the pressure inside a container?

Notes: What are the two other ways that you can increase the pressure inside a container of gas?

10. Density

Why is it that a ship made of iron metal will float on water, and yet a nail made of exactly the same metal will sink? Why is it that a helium filled balloon will float off into the sky but a balloon you blow up yourself will slowly fall to the ground? These are the sorts of question you should be able to answer by the end of this lesson.

Activity: Concept Cartoon – "balloon"

Discussion: Are the following statements <u>true</u> or <u>false</u>?

- Air does not weigh anything.
- 1 cm^3 of water weighs 1g.
- 1 cm^3 of any liquid weighs 1g.

Float or Sink?

Notes: Copy the following table into your jotter:

Object	Hypothesis (float or sink)	Result (float or sink?)

Collect: A tub of "float/sink" objects
A plastic tub

The **density** of a substance determines if it floats or sinks. If something is more dense than water, it will sink. If it is less dense than water, it will float in water.

Activity: 1. Half-fill the plastic tub with water.

2. Add each of the objects you have collected to the water and observe whether they float or sink.

3. Record your results in your table.

Activity: Your teacher will demonstrate an experiment with three blocks which are all the same size and shape but made of different types of material.

Collect: Starting Science book 1.

Activity: Read p60 of Starting Science book 1

Notes: Answer the following questions:

1. Describe what you understand by the word "density".

2. If an object is less dense than water, does it float or sink?

3. Which of the objects you tested were less dense than water?

Density and Liquids

Collect: a bottle of coloured water
a bottle of paraffin
a glass measuring cylinder with rubber bung

Activity: 1. Slowly pour 30 ml of coloured water into the measuring cylinder

2. Slowly pour 30 ml of paraffin into the same measuring cylinder and observe what happens

Discussion: Which liquid is the more dense?
What would happen if you had poured the paraffin in first and then added the water?

Activity: Put the rubber bung in the top of the measuring cylinder and invert the cylinder several times. Observe what happens.

Notes: 1. Draw a labelled diagram of the measuring cylinder containing the two liquids

2. What did the experiment tell you about the density of the two liquids?

Discussion: Re-read the introduction to this lesson. In a small group, discuss answers to the questions that were being asked.

11. Changing State: Between Solid and Liquid (part 1)

You have been learning a lot about solids, liquids and gases. However, just because a substance is in a particular state when you are looking at it, does not mean that the substance will always be in that state. In this lesson you will be thinking about what causes a substance to change state. Using water as an example.

Discussion: Can water be found as a solid?

If so, what name is used to describe water in this state?

How could you turn liquid water into a solid?

Collect: 100 cm^3 beaker Ice cubes
A thermometer

Activity: 1. Look carefully at the thermometer and take its reading. This is the temperature of the air in the room at the moment (room temperature).
2. Put the thermometer into a beaker of ice and watch the reading on the thermometer carefully.

Notes: 1. Draw a labelled diagram of your experiment.

2. What was the room temperature of your lab?

3. What was the lowest temperature that the thermometer recorded in the ice?

Ice is solid water. When it changes into liquid water this is called **melting**. Ice starts to melt at 0 °C but it will melt at any temperature above this. 0 °C is the **melting point** of ice.

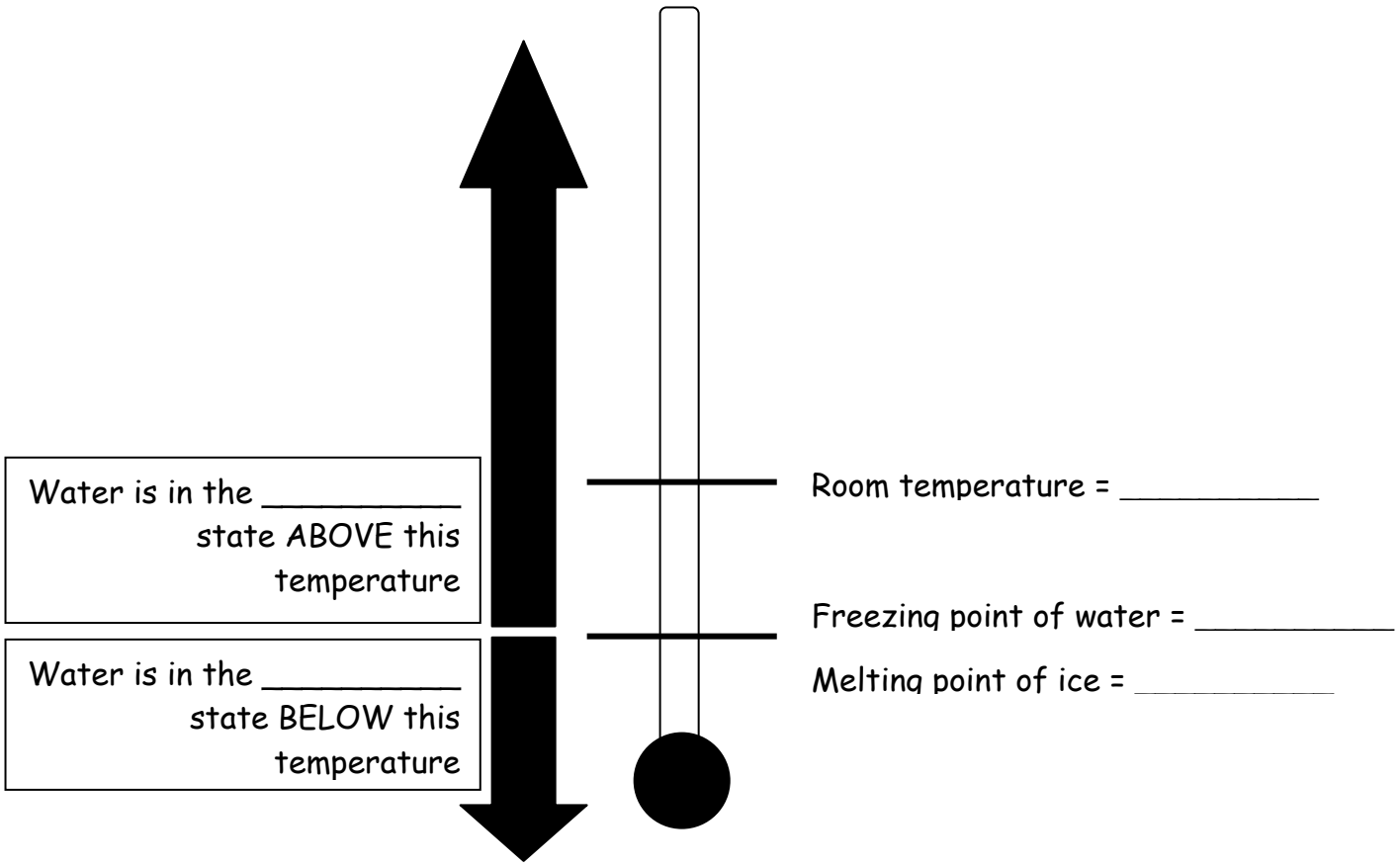
Discussion: What temperature is the inside of a fridge?

Would liquid water turn into solid water if you put it in a fridge?

At what temperature do you think liquid water starts to turn into solid water?

Ice forms when liquid water turns into a solid. This is called **freezing**. Liquid water starts to freeze at 0 °C but it will freeze at any temperature under this. 0 °C is the **freezing point** of water.

Notes: Collect a cut-out sheet of the following diagram (see next page) and complete it to summarise information about water changing state:



Notes: Draw a diagram to show what happens to the particles in water when it changes:

(a) from ice into water

(b) from water into ice.

12. Changing State: Between Solid and Liquid (part 2)

In the last lesson you learned that water freezes at 0 °C and ice melts at 0 °C. Do all substances freeze and melt at this temperature? This is what you will be thinking about in this lesson.

Solid to Liquid

Collect: A test tube of white powder
Bunsen burner
Tripod stand and heat-proof mat
Clamp-stand
250 cm^3 beaker
Thermometer

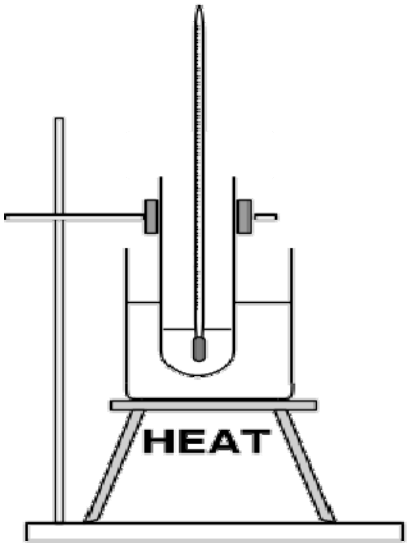
Discussion: What state is the white powder in?

What does this tell you about its melting point compared to ice?

You are going to carry out an experiment to measure the melting point of the white solid.

Activity: 1. Half fill a beaker with water from the tap.

2. Set up your apparatus so that you can heat the beaker of water as shown:



3. Place the test-tube of white powder in the beaker of water, held in place by the clamp-stand.

4. Put the thermometer in the test tube and note the temperature reading.

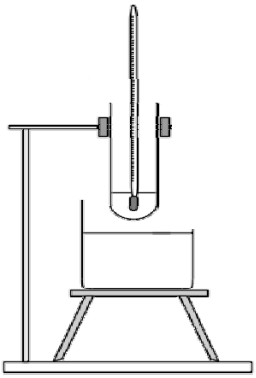
5. Slowly heat the water with the air hole of the Bunsen burner half-open. Watch the white powder carefully. As soon as you see it start to melt, take a reading fr e thermometer.

Notes: 1. Draw a labelled diagram of the experiment.

2. What was the melting point of the white powder?

Liquid to Solid

Activity: 1. Use the clamp-stand to take raise the test-tube out of the beaker of hot water:



2. Watch carefully for the liquid turning back into a solid and make a note of the temperature at which this starts to happen.

Notes: 1. At what temperature did the liquid start to turn back into a solid?

2. What is the freezing-point of the liquid?

Discussion: Do all substances melt at the same temperature?

Do all substances freeze at the same temperature?

Are the melting-point and the freezing-point of a substance always the same for that substance?

13. Changing State: Between Liquid and Gas (part 1)

In the last two lessons you were thinking about changing solids into liquids and liquids into solids. This was called melting and freezing. In this lesson you are going to be thinking about changing liquids into gases.

Discussion: After it has been raining, there will be puddles on the ground. Why do these puddles seem to disappear after a while?

Collect:
4 glass slides
Small beaker of water
Dropper
Card
Wooden splint
Stopwatch
Bottle of propanone

Notes: Copy the following table into your jotter:

Chemical	Conditions	Evaporation time (s)
Water	Cool, no air movement	
Propanone	Cool, no air movement	
Water	Warm, no air movement	
Propanone	Warm, no air movement	
Water	Cool, air movement	
Propanone	Cool, air movement	
Water	Warm, air movement	
Propanone	Warm, air movement	

Activity: You have eight different experiments to carry out, so you may wish to do more than one at the same time in a small group.
You will create the "conditions" mentioned in the table as follows:

Cool:	Place slide on the desk surface
Warm:	Hold slide on the flat palm of your hand
Air movement:	Fan the slide with a piece of card
No air movement:	Don't fan the slide

*If any of the drops have not evaporated after 10 minutes (600 seconds) then record this as ">600" in your table.

1. Put 1 drop of water on a glass slide and spread it out using a wooden splint.

2. Create the conditions as mentioned in the first line of your table, and time how long it takes until you can no longer see the liquid.

3. Repeat steps 1 and 2 for acetone. Make sure the drops are the same size.

4. Continue to use the same method to time how long it takes for the liquid to "disappear" for the rest of the combinations in the"Changing state" help sheet table.

Collect: Starting Science book 2

Activity: Read p80 of Starting Science book 2

Discussion: Based on the results of your experiment, decide if the following statements are true or false.

- When a liquid changes into a gas this is called evaporation.
- Liquids need to boil to evaporate.
- All liquids evaporate at the same speed.
- Warm conditions speed up evaporation.
- Blowing air over liquids speeds up evaporation.

Notes: Copy out the sentences above which are true.

14. Changing State: Between Liquid and Gas (part 2)

When liquids change into gases, this is called evaporation. Liquids do not need to boil to become a gas, boiling is simply a very fast form of evaporation. The temperature at which a liquid boils is called its **boiling point**. Different chemicals have different boiling points.

Boiling

Activity: Concept Cartoon – "boiling water"

Notes: Copy the following table into your jotter:

Volume of water (cm^3)	Time for water to boil (s)	Temperature of boiling water (°C)
$100cm^3$		
$200cm^3$		

Collect:
Bunsen burner
Tripod stand
Heat-proof mat
Stop watch
2 x 250 cm^3 beakers
Watch glass

Activity: 1. Set-up your apparatus so that you can heat a beaker of water.

2. Add 100 cm^3 of water to one beaker and 200 cm^3 of water to the other beaker.

3. Put a thermometer into the small beaker, start to heat it and start the stop-watch. Watch the water carefully, and keep checking the temperature.

4. Once the water in the beaker starts to boil, stop heating, stop the stop-watch and take a temperature reading. Record this information in your table.

5. Repeat steps 3 and 4 with the large beaker of water.

6. Once the large beaker of water is boiling, if you want to, carefully hover a watch glass about 30 cm above the top of the beaker and observe what happens to it.

Discussion: Are the following statements <u>true</u> or <u>false</u>?

- The volume of water is important in determining how quickly water boils.
- The volume of water is important in determining at what temperature water boils.
- If you continued to heat the water once it was boiling, it would continue getting hotter.

Changing Back to a Liquid

In the last experiment you did you should have held your hand above the beaker of hot water and felt your hand getting wet. This is because the water in the form of a gas (steam) hit your hand, cooled down, and turned back into liquid water. This is called **condensation**.

Collect: Cut-out sheet "changing the state".

Notes: Complete the diagram and stick the sheet into your jotter.