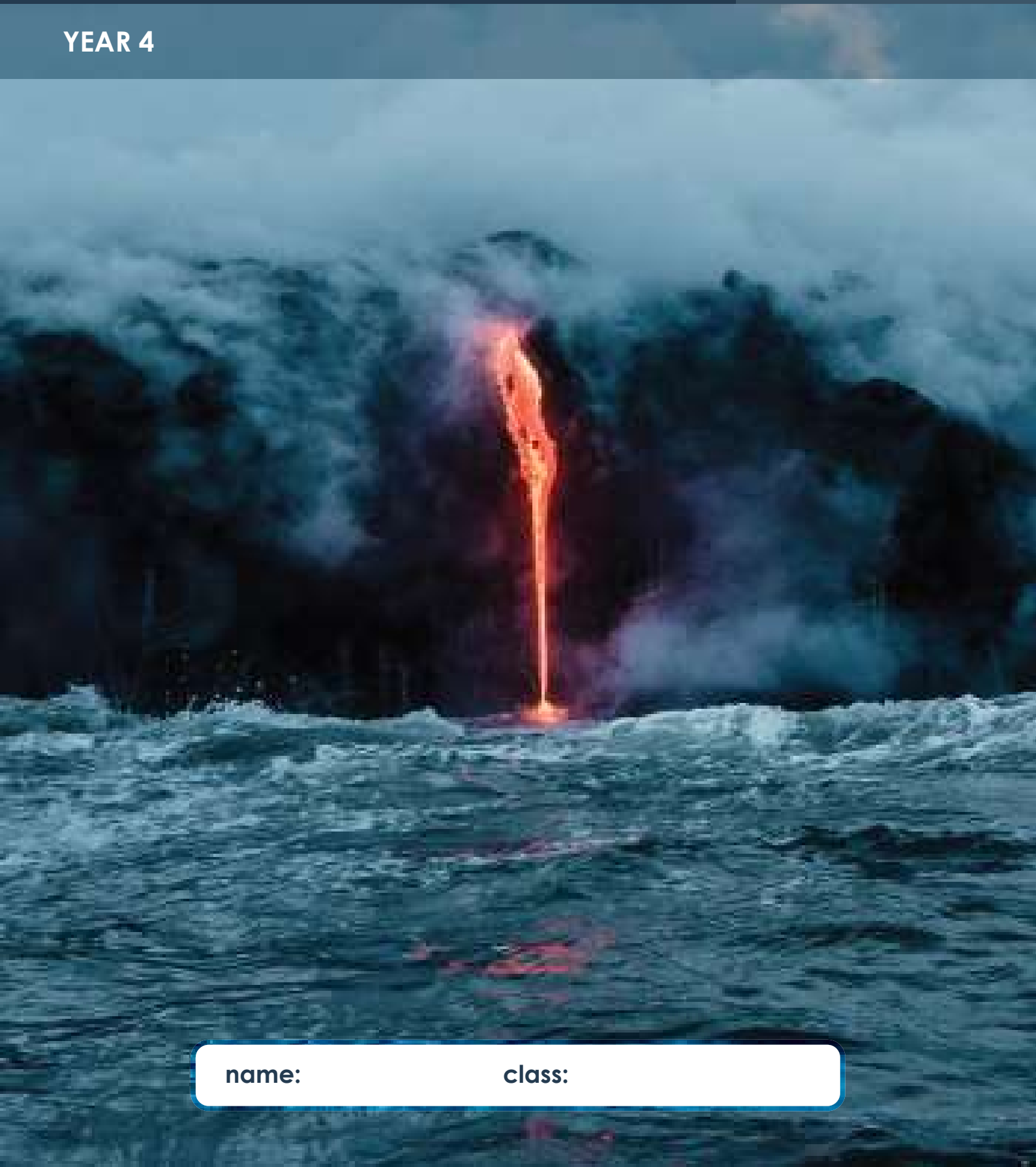
PHASES OF MATTER

REACH OUT

YEAR 4



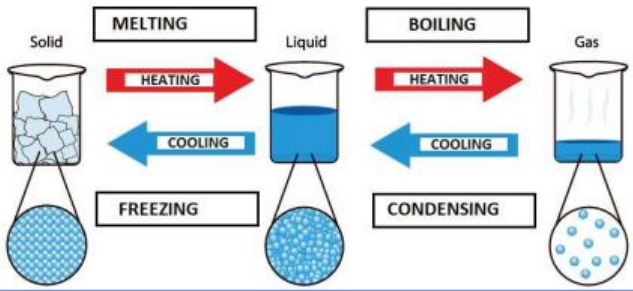
name: class:

Knowledge Organiser • Phase of Matter • Year 4

There are 3 states of matter (the different forms that we find stuff around us):

State of Matter	Is it compressible?	Can it flow?	What happens to its shape in a container?
Solid	✗	✗	It keeps a fixed shape
Liquid	✗	✓	It takes the shape of the bottom of the container it is in
Gas	✓	✓	It takes up the whole container it is in

State of matter	Examples
Solid	Iron poles, Wood, Ice,
Liquid	Water, Oil, Milk, Washing up liquid
Gas	Oxygen, Carbon Dioxide, Steam,
Difficult to categorise	Oobleck, Sand, Jelly, Custard

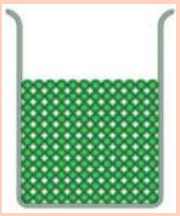


- Temperature is a measure of how hot a substance or a place is.
- Melting point is the temperature a substance changes from a solid to a liquid.
- Boiling point is the temperature a substance changes from a liquid to a gas.

Water's melting point = 0 °C.

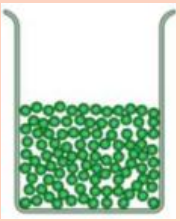
and boiling point = 100 °C

Properties of the particles in the three states of matter



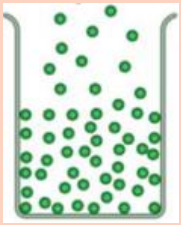
Solid:

- Particles are very close together
- In a regular pattern
- Particles cannot move but can vibrate



Liquid:

- Particles are close together
- In a random arrangement
- Particles can slide past each other



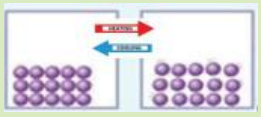
Gas:

- Particles are far apart from each other
- In a random arrangement
- Moving constantly in all directions

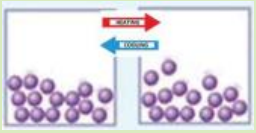
Effect of heat on particles

- Heating particles makes them move more.
- In solids, they vibrate more in their fixed position.
- In liquids and gases, they move more quickly.
- As a result, substances expand when they are heated and contract when they are cooled.

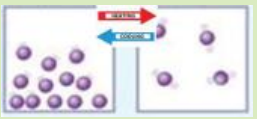
Solids:



Liquids:



Gases:



Lesson Question	You will learn	Learning Review
What are the properties of solids, liquids and gases?	• Describe what is meant by the property of a substance • Name the properties of solids, liquids and gases • Explain which state of matter a substance is in based on its properties	
How do particles behave inside of solids, liquids and gases?	• Describe what a particle is • Describe how particles are arranged in solids, liquids and gases • Explain how we know particles in liquids and gases are moving	
What happens when you heat or cool each state of matter?	• Describe what happens to particles when a substance is heated or cooled • Predict what happens to a solid, liquid or gas when it is heated or cooled • Give the evidence to show that each state expands when heated and contracts when cooled	
What are changes of state and why do they take place?	• Describe what happens to the arrangement of particles when a substance changes state • Name each of the changes of state • Give an example of each change in state	
How can we measure the melting points and boiling points of a substance?	• Describe what is meant by melting point and boiling point • Describe how it is possible to measure the melting point and boiling point of a substance • Suggest which state of a matter a substance will be in given its temperature	
Which substances do not fit into one state of matter?	• Give examples of substances that do not show typical properties of any state of matter • Explain how some not show typical properties of one state of matter • Describe what a non-Newtonian fluid is	

Lesson
01 What are the properties of solids, liquids and gases?

Retrieval practice from last year

1. What is an ecosystem?

   A community of a _____, p_____ and m_____ together with their h_____ is called an ecosystem.

2. Match the key word to the correct definition:

• Material • Raw material • Synthetic material	• Made from a raw material that has been changed • Any substance that has a name • A material that is found in nature and has not been changed by humans

3. Draw a line to match the part of a plant to its function:

• Leaves • Stem • Roots • Flowers	• Produces seeds which form new plants • Make food for the plant • Hold the plant upright and move water and minerals to other parts of the plant • Hold the plant in place and absorb water and minerals from the soil

1. Read the following passage about solids, liquids and gases

All matter can come in three states: solids, liquids and gases. We call these three states the three states of matter.

2. What are the three states of matter?

a. _____

b. _____

c. _____

Each of these three states of matter have particular properties. These properties can help us tell which state of matter a particular material is in. Examples of these properties are the following:

- Compressibility – whether a substance can be squashed into a smaller volume or whether it has a set volume.
- Ability to flow – can the substance smoothly slide from one container into another?
- Fixed or changing shape – substances may have a fixed shape, change their shape to fit the bottom of a container or always fill up the whole container.

Volume – this word means 'how much space something takes up'

3. Fill in the gaps below to complete the definitions of each property:

• volume	• set	• shape	• squashed
• smoothly	• bottom	• container	• container

Compressibility – whether a substance can be _____ into a smaller _____ or whether it has a _____ volume.

Ability to flow – can the substance _____ slide from one _____ into another?

Fixed or changing shape – substances may have a fixed _____, may _____ their shape to fit in the bottom of a _____ or always fill up the _____ container .

4. Watch the demonstration of the properties of solids, liquids and gases completed by your teacher.

Fill in the table below:

State of Matter	Is it compressible?	Can it flow?	What happens to its shape in a container?
Solid			
Liquid			
Gas			

5. Write down whether the teacher is thinking of a solid, liquid or a gas:

I am not compressible but I can flow. What am I? _____

I am compressible and I can flow. What am I? _____

I am not compressible and I have a fixed shape. What am I? _____

I take the shape of the bottom of the container I am in. What am I? _____

I completely fill whatever container I am in. What am I? _____

6. Write down if each of the following examples is a solid, liquid or gas and say why:

Example	Solid, liquid or gas?	Why?
 Water		
 Air into a balloon		
 A piece of wood		

7. Observe the range of substances in the classroom. Say whether each substance is a solid, liquid or gas and say why:

Substance	Solid, liquid or gas?	Why?

8. What are the properties of a solid, liquid and a gas?

Lesson
02

How do particles behave inside of solids, liquids and gases?

Retrieval practice

1. Fill in the gaps below to complete the definitions of each property:

   Compressibility – this property is whether a substance can be _____ into a smaller _____ or whether it has a volume.

   Ability to flow – can the substance _____ slide from one _____ into another.

   Fixed or changing shape – substances may have a fixed _____, may _____ their shape to fit in the bottom of a _____ or always fill up the _____ container.

2. Say whether each of the following are solid, liquid or gas?

   a. can be compressed and I fill whichever container I am in. What am I?

   b. I am not compressible and I have a fixed shape. What am I?

   c. I take the shape of the bottom of the container I am in. What am I?

From last year:

3. Match up the words below with the right definition:

Independent variable …	… the thing you observe to see how it is affected
Dependent variable …	… the things you have to keep the same to make sure it is a fair test.
Control variables …	… the thing that you change

1. Watch the video and fill in the gaps below:

- Matter is anything that has w_____ and takes up s_____
- All matter is made out of very, very s_____ things called p_____
- Particles in a s_____ are packed so tightly that they don't move
- Particles in a l_____ have some s_____ between them
- There is a lot of s_____ between particles in a g_____

2. Watch the video and discuss with a partner what happened to the particles in solids, liquids and gases

3. Read the following passage about particles:

The discovery that all matter is made from particles first came from scientists observing sand. Sand is made from very small grains of solid and it appears to act as a liquid. Sand seems to be able to flow and takes up the shape of the bottom of any container it is in.

This helped scientists to understand that all liquids must be made of tiny parts called 'particles' which we think of as tiny balls. If liquids can become solid or gas then all matter must be made from particles.

To make the properties we observed in lesson 1, then particles must be arranged in the following ways in each state of matter:

Solid

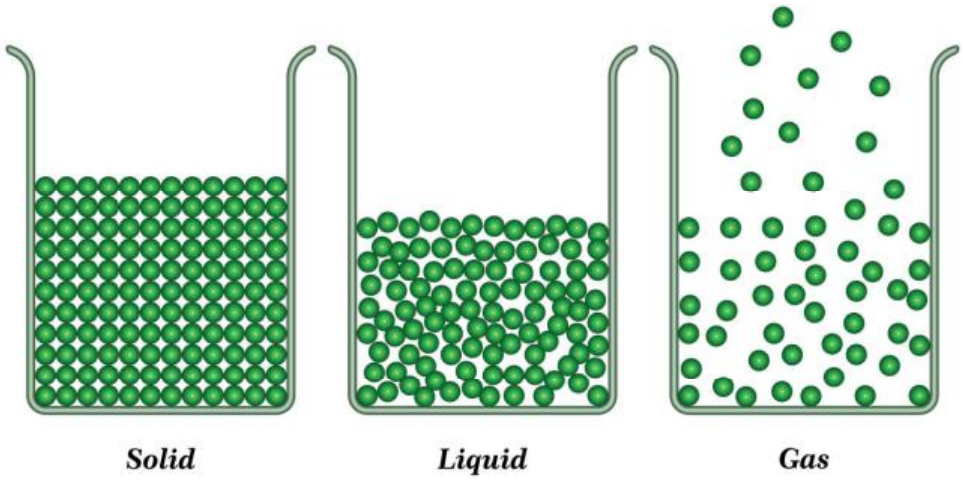
- Particles are very close together
- In a regular pattern
- Particles cannot move but can vibrate

Liquid

- Particles are close together
- In a random arrangement
- Particles can slide past each other

Gas

- Particles are far apart from each other
- In a random arrangement
- Moving constantly in all direction



Solid *Liquid* *Gas*

4. Find answers to the questions below in the passage above

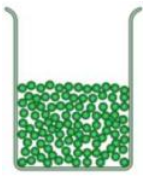
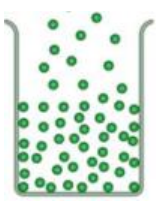
1. Which substance helped scientists understand that all substances must be made from particles?
2. Draw lines to match the description to the correct state of matter.

Solid	Particles are very close together
Liquid	Particles are far apart from each other
Gas	Particles are close together

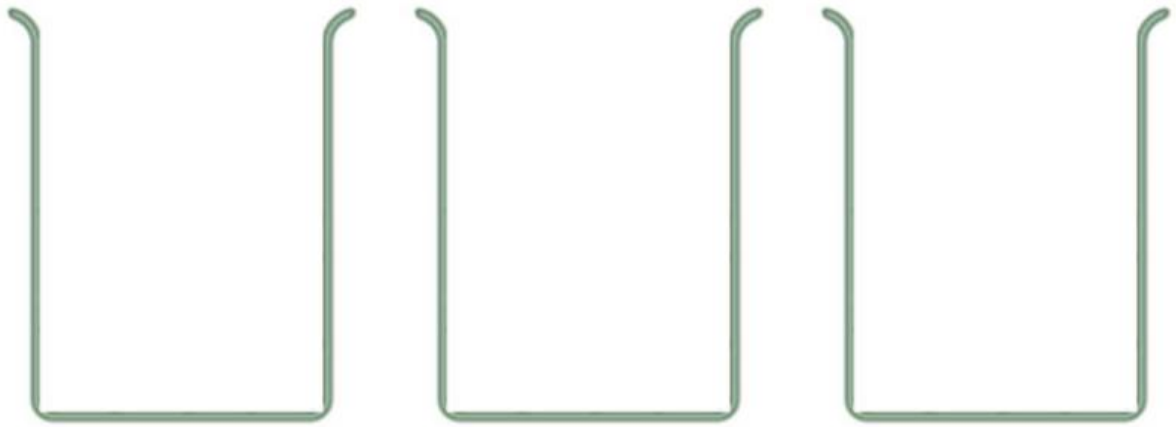
Solid	Particles can slide past each other
Liquid	Particles are moving constantly in all directions
Gas	Particles cannot move but can vibrate

5. Watch the video and discuss with partner – how can you tell that particles in gases and liquids are moving all the time?

6. You are going to act out particles in a solid, liquid and a gas in groups. How could you show each of the following in a group of 4-5 students:

State of matter	How can you show how the particles behave?
 Solid	• • •
 Liquid	• • •
 Gas	• • •

7. The way that particles are arranged explains the properties of each state of matter. Draw the particles in each container to match their state:



Solid Liquid Gas

8. How are the particles arranged in a glass of water? How are they arranged in snow?

Lesson
03 What happens when you heat or cool each state of matter?

Retrieval practice

1. Fill in the gaps below:

   In solids: particles are very _____ together in a _____ pattern. Particles cannot _____ but can _____.

   In liquids: particles are _____ together and in a _____ arrangement. The particles can _____ past each other.

   In gases: particles are _____ _____ from each other and in a _____ arrangement. They are _____ constantly in all directions.

2. Say whether each of the following is 'true' or 'false:

   a. Liquids are incompressible _____

   b. Solids fill the container that they are in _____

   c. Gases are compressible _____

   d. Solids have a fixed shape _____

   e. Liquids take the shape of the bottom of the container they are in _____

   f. Gases stay in a fixed shape no matter which container they are in _____

From last year:

3. Add the arrows to this food chain to show the transfer of energy between organisms.

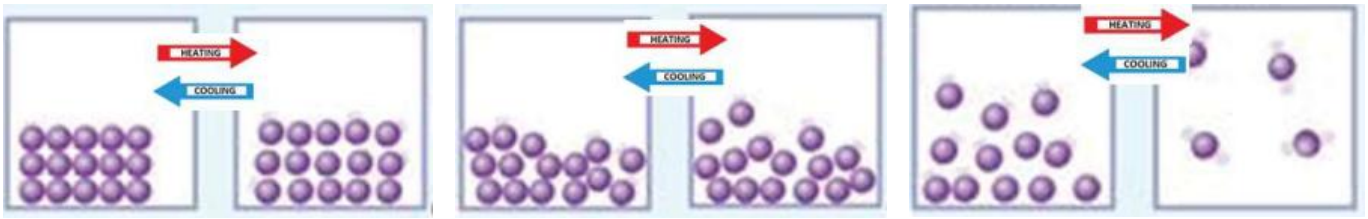



1. Read the following passage about heat and particles

When heat is given to a substance, the particles in the substance begin to move more quickly. In a solid, this means that the particles will vibrate more. In a liquid and a gas, this means that particles will move with a faster speed.

When particles move more quickly, they push the particles around them more forcefully. This makes the particles spread out a bit more which means the substance they are in expands. This means the volume (the space taken up by the substance) increases.

When a substance cools down, it loses some of its heat. This means the particles move less quickly. In a solid, this means that the particles will vibrate less and in a liquid and a gas this means that particles will move more slowly. As a result, the particles take up less room and the substance contracts (takes up less space).



2. Find answers to questions below in the passage above

1. What to the particles in a substance if it is heated?

   If a substance is heated, the particles begin to _____.

2. What happens to the movement of particles in solids, liquids and gases when they are heated?

   In a solid, the particles will _____ more. In liquids and gases, the particles will move with a _____ .

3. What happens to a substance overall when it is heated and why?

   When a substance is heated it e_____ (this means the volume i_____). This happens because the particles push each other more _____ which makes the particles s_____ o_____.

4. What happens to a substance overall when cools down and why?

   When a substance cools, it c_____ (this means the volume d_____). This happens because the particles take up less s_____.

3. Act out 'cold' particles and 'hot' particles in solids, liquids and gases

4. Label of the diagrams below to show with one of the following:

- Cold solid
- hot solid
- cold liquid
- hot liquid
- cold gas
- hot gas

_____

_____

_____

_____

_____

_____

5. Discuss with a partner - how we might we be able to tell if a substance has expanded or contracted?

6. Watch the demonstration of solids, liquids and gases being heated. Write down what you observe below

Demonstration	Observation
Solid – ball and ring experiment	When the solid ball was heated, I observed that _____ _____
Liquid – potassium permanganate and capillary tube	When the purple liquid was heated, I observed that _____ _____
Gas – heated air creating bubbles	When the gas in the flask was heated, I observed that _____ _____

7. Watch the video of balloons being put into liquid nitrogen. What do you observe? Why does this happen?

8. How can heating and cooling be helpful in the following examples:

Putting a jar under the hot tap to help get the lid off	Heating the lid could be helpful because _____ _____
Using liquid in a thermometer to tell temperature	Heating the liquid in a thermometer when you place it in something hot is helpful because _____ _____
Cooling oxygen and hydrogen to put them into tanks	When storing gases like oxygen and hydrogen, cooling them is helpful because _____ _____

9. Why might it be dangerous to heat a gas when it is trapped in a metal can?

Lesson
04

What are changes of state and why do they take place?

Retrieval practice

1. What do the particles in a substance if it is heated?

   If a substance is heated, the particles begin to _____.

2. What happens to the movement of particles in solids, liquids and gases when they are heated?

   In a solid, the particles will _____ more. In liquids and gases, the particles will move with a _____ .

3. Label of the diagrams below to say if they show a hot or cold solid/liquid/gas

_____

_____

_____

_____

_____

_____

From last year

4. Fill in the gaps below in the definitions:

   The independent variable is the thing you _____ .

   The dependent variable is the thing you _____.

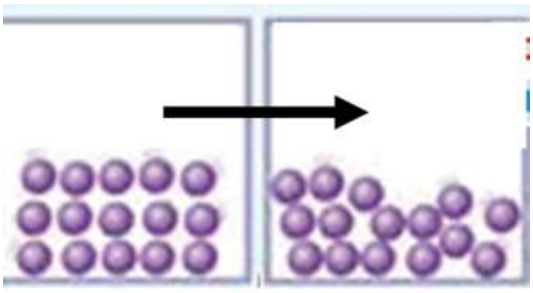
5. What are sounds?

   Sounds are _____ that spread through the air.

1. Watch the video and look at what happens to the particles when they change from solid to liquid to gas

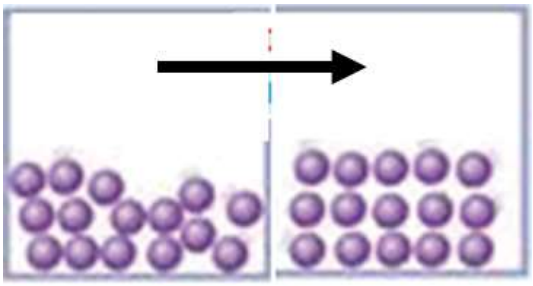
2. Read the following passage about changes of state

We know that particles can be arranged to make solids, liquids or gases but how do move from one state to another?



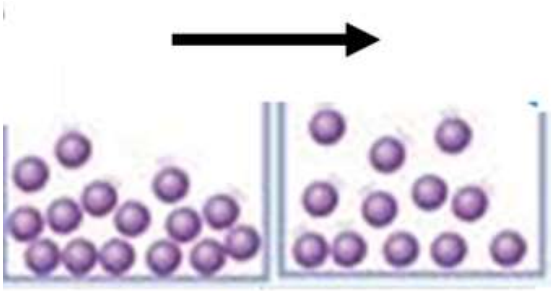
Melting

When the particles in solids vibrate more and more as they are heated, some of their bonds start to break. This means the particles can begin to slide over each other which means they now form a liquid. This process is called melting.



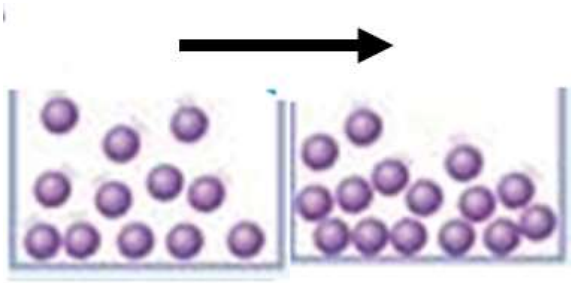
Freezing

When these particles cool and move less, they become strongly bonded again and stuck in a fixed position – they have become a solid. We call this process freezing.



Boiling

When the particles in liquids move faster and faster as they are heated, the last bonds that were left start to break. This means the particles can begin to move freely and become far apart from each other. This means they now form a gas. This process is called boiling.



Condensing

When these particles cool and move less, they become bonded to each other again and are stuck together but can still move – they have become a liquid. We call this process condensation.

3. Find answers to questions below in the passage above

1. What happens to the particles in a solid when they are heated strongly?

   The bonds between some of the particles b_____ which means they can now s_____ o_____ each other. It has become a l_____ .

2. What happens to the particles in a liquid when they cool down a lot?

   The particles move more s_____ and become strongly b_____ together again. They are now in a f_____ p_____ and have become a s_____.

3. What happens to the particles in a liquid when they are heated strongly?

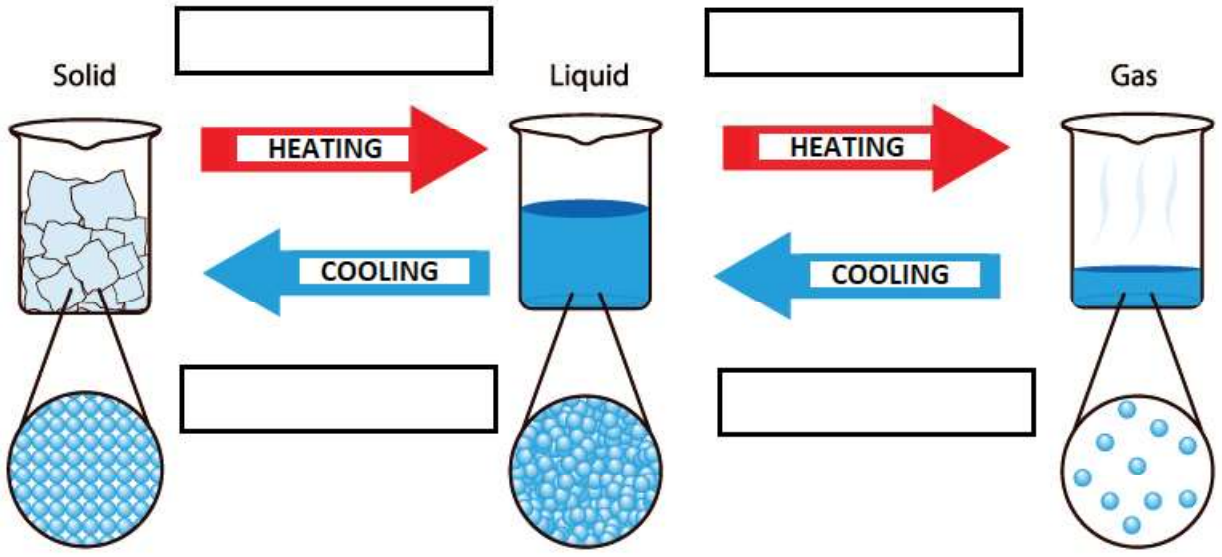
   Any bonds that are left over between particles now b_____ which means they can now move f_____ a_____ from each other. It has become a g_____.

4. What happens to the particles in a gas when they cool down a lot?

   As the particles move more s_____, the become b_____ together again. The are stuck together but can still s_____ p_____ each other and move so they have become a l_____.

4. Write the words into the correct empty box in the diagram

• Freezing • Melting • Boiling • Condensing



5. You are going to act out particles changing from a solid to a liquid and from a liquid to a gas and back again.

Can you act out:

1. A cold solid to a hot solid?
2. A cold liquid to a hot liquid?
3. Show particles in a solid become a liquid and then changing from liquid back to solid?
4. Show particles in a liquid become a gas and then changing from gas back to liquid?
5. Show particles in a solid change to liquid, then gas and back to liquid and back to a solid?
6. Show the change in state your teacher calls out.

6. Write down the change of state that is present in each example below and explain your choice

Example	Which change of state?	Why?
 When water forms on a mirror that you breath on		
 The steam produced from a kettle		
 Rain turns into snow		
 When a puddle turns to ice in cold weather		

7. Write down extra examples of each change of state below:

Melting	• •
Freezing	• •
Boiling	• •
Condensing	• •

8. What happens to the particles in chocolate if you hold on to it for too long?

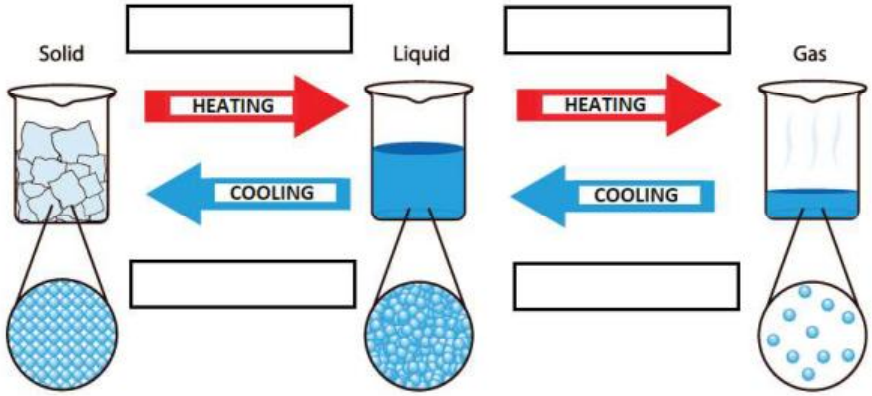
Lesson
05 How can we measure melting points and boiling points?

Retrieval practice

1. What happens to a substance overall when it is heated and why?

   When a substance is heated it e_____ (this means the volume i_____). This happens because the particles push each other more _____ which makes the particles s_____ o_____.

2. Write in the correct words to describe each change of state in the 4 boxes below:



From last year:

3. Match up each synthetic material with the raw material that it is made from:

Plastic	Sand
Paper	Clay
Glass	Wood
Brick	Oil, natural gas or coal

4. Match the key word to the correct definition

Organism	Natural home of an organism.
Habitat	A commuity of plants, animals and microorganisms together with their habitat.
Microorganism	Anything that is alive.
Ecosystem	An organism that is too small to be seen by the human eye.

1. Read the following passage about melting points and boiling points

Temperature is a measure of how cold or how hot a substance or a place is. In the UK, we usually measure temperatures using a scale called 'degrees Celsius' which is written as '°C'. The UK used to use a scale called Fahrenheit which is rarely used anymore. We can find the temperature of a substance using a thermometer.

The Celsius temperature scale was named after a Sweden scientist called Anders Celsius who lived between 1701 and 1741. It was made so that 0°C matched up with the temperature that ice melted to water and so that 100°C matched up with the temperature that water boiled to become steam.

Using the Celsius temperature scale we can find the 'melting point' and the 'boiling point' of different substances. The melting point is the temperature that the solid version of the substance melts to become a liquid. The boiling point is the temperature that the liquid version of a substance boils to become a gas.

2. Find answers to questions below in the passage above

1. What is temperature?

   Temperature is a measure of _____.

2. What scale do we normally use to measure temperature?

   We normally use a scale called _____ which is written as _____ .

3. How did scientists decide what 0 and 100 should mean in this scale?

   0°C is the temperature that _____

   100°C is the temperature that _____

4. What do 'melting point' and 'boiling point' mean?

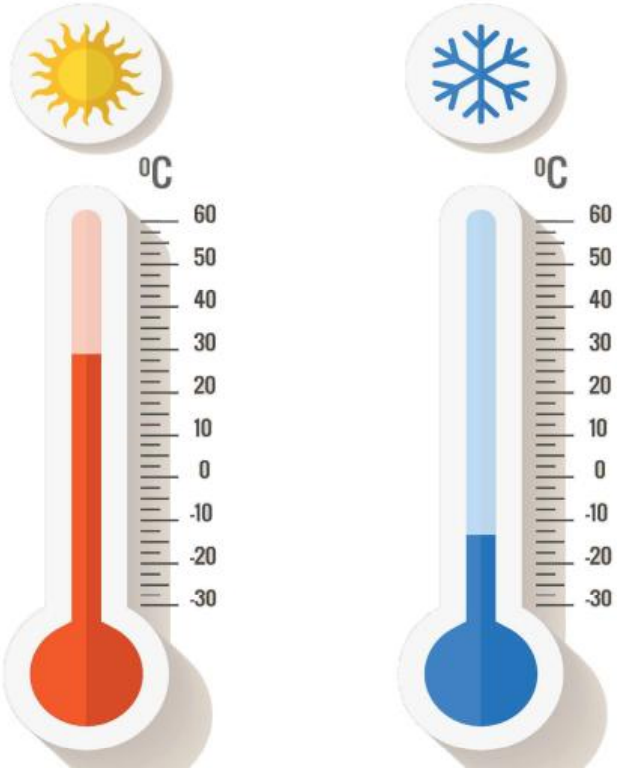
   Melting point is the _____.

   Boiling point is the _____.

3. What are the two temperatures that are shown on the thermometers below?

Reading:

_____



Reading:

_____

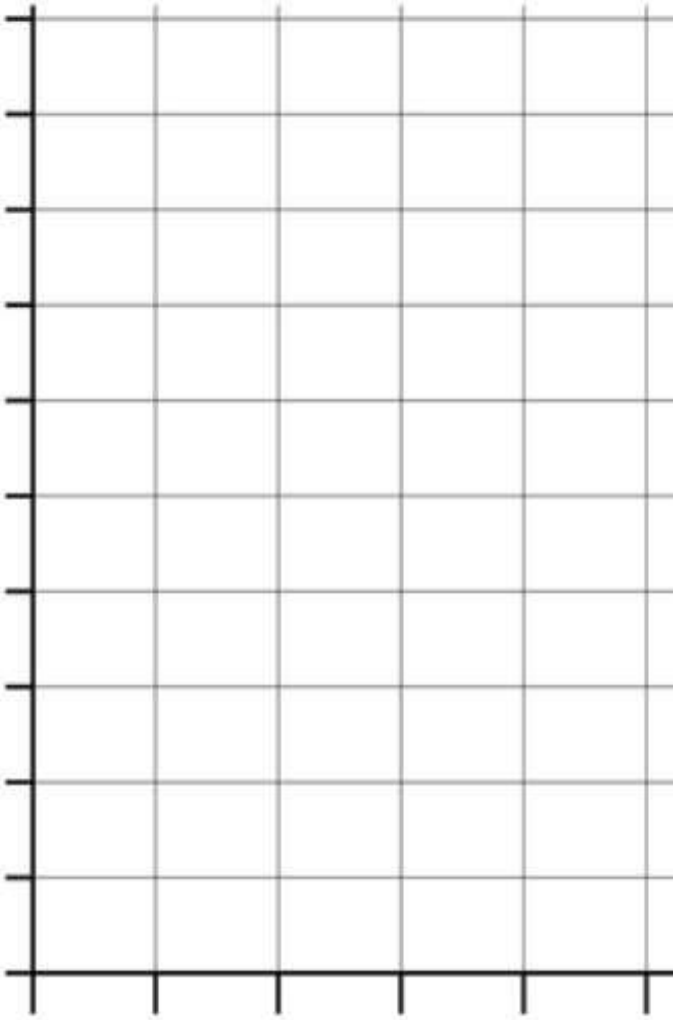
4. Watch the video and observe how the two scientists measure the boiling point and the melting point of water. Write down your observations below:

When they were measuring the boiling point of water, I observed that they have heated the water until it was _____. They then placed an electric _____ into the boiling water and they measured a temperature of _____.

When they were measuring the melting point of water, I observed that they mixed ice into the water until the ice would no longer _____ when it was placed in the water.. They then placed an electric _____ into the ice-cold water and they measured a temperature of _____.

5. Draw a bar chart on the grid of the melting points of the different substances in the table:

Substance	Melting point (°C)
Water	0
Chocolate	31
Road Tarmac	50
Butter	35
Coconut oil	24



6. Look at the table of melting points and boiling points below before answering the questions underneath:

Substance	Melting point (°C)	Boiling point (°C)
Water	0	100
Aluminium	660	2467
Chlorine	-101	-35
Iodine	114	184
Oxygen	-218	-164

1. Which substance melts at 114°C? _____
2. Which substance melts at -218°C? _____
3. Which substance boils at -35°C? _____
4. Which substance boils at 2467°C? _____

We can tell what the state of matter of each substance would be if we were in a classroom by thinking about 'room temperature' which we say is normally 25°C.

For example, at room temperature (25°C), Aluminium is a solid because this is lower than the melting point or the boiling point.

Which state of matter would each of the following be at room temperature (25°C)? Circle the correct answer:

a. Chlorine would be a solid/liquid/gas.

b. Iodine would be a solid/liquid/gas.

c. Oxygen would be a solid/liquid/gas.

7. What temperature would something be if it was 'hot' and what temperature would a cold object be at?

Lesson
06 Which substances do not fit into one state of matter?

Retrieval practice

1. What is temperature?
   Temperature is a measure of _____.

2. What scale do we normally use to measure temperature?
   We normally use a scale called _____ which is written as _____ .

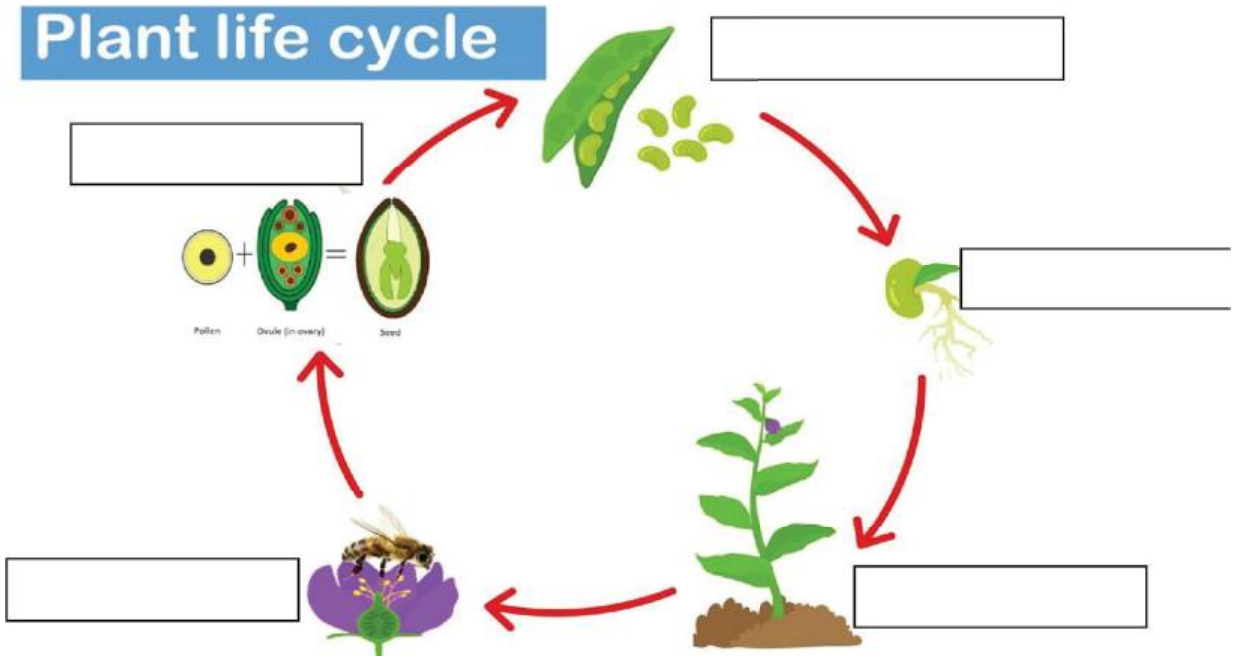
3. How did scientists decide what 0 and 100 should mean in this scale?
   0°C is the temperature that _____
   100°C is the temperature that _____

4. What do 'melting point' and 'boiling point' mean?
   Melting point is the _____.
   Boiling point is the _____.

From last cycle:

5. Label the life cycle of a plant:

• Seed dispersal • flowering • fertilisation • pollination • germination



1. Fill in the gaps below – how much can you remember about solids, liquids and gases?

1. Match each property to its definition:

Compressibility	Whether a substance can be squashed into a smaller volume or whether it has a set volume.
Ability to flow	Substances may have a fixed shape, change their shape to fit in the bottom of a container or always full up a whole container
Fixed or changing shape	Can the substance smoothly slide from one container into another

2. Fill in the table below:

State of Matter	Is it compressible?	Can it flow?	What happens to its shape in a container?
Solid			
Liquid			
Gas			

2. Some substances show properties of more than one state of matter. How do each of the following things show properties of more than one state of matter?

Jelly

Jelly is like a solid because it is not c_____ and because it does not take the shape of the container.

However, jelly could be seen as a liquid as it does not keep a f_____ s_____ if you were to wobble the container it is in.

Foam balls

Foam balls are like solids because a single ball does not take the s_____ of the c_____ it is in and it moves but does not f_____ (it cannot be poured).

However, foam balls are like a gas because they can be c_____. This is partly because they are a mixutre of s_____ and air bubbles which an example of a g_____.

Sand

Sand is like a solid because it is not c_____ and each grain of salt keeps a fixed shape.

However, it acts like liquid because it takes the s_____ of the bottom of the c_____ that it is in. It also f_____ when you pour it.

3. Watch the video and observe how custard can act as a solid and a liquid depending on how it is treated.

4. Read the following passage about Non-Newtonian fluids

Some substances do show all the properties of a solid, liquid or gas but instead show a mixture of properties. One example of those are some liquids that are called 'Non-Newton fluids'. These are liquids that change their behaviour when a force is applied to them.

One example of this is 'Oobleck' which is a mixture of cornflour and water (which are both ingredients in custard). When you squeeze it or try and pull something through it, it becomes more solid and will not allow its shape to be changed.

However, when it is not under pressure, it will flow and take the shape of the bottom of the container that is in – exactly as a liquid would do. In this way, Oobleck acts as both a solid and liquid depending on how it is treated.

5. Find answers to questions below in the passage above

1. What is a Non-Newtonian fluid?

   A Non-Newtonian fluid is a liquid that changes its _____ when a _____ is applied to them.

2. What happens when you try and squeeze Oobleck?

   When you try to squeeze it, it becomes more _____ and will not allow its _____ _____ .

3. How does Oobleck behave when it is not under pressure?

   When not under pressure, it will _____ and take the shape of the _____ that is in. Exactly as a _____ would do.

6. Follow the instructions below to first make and then investigate your own batch of Oobleck

Equipment:

- 1 cup of water
- 2 cups of cornflour
- (optional: food colouring)
- 1 bowl to mix ingredients in
- 1 spoon to mix and use to test the Oobleck

Method:

- Place the cornflour in the bowl
- Add the water (and food colouring if you are using some)
- Stir the flour together very slowly
- Your Oobleck should now be ready

Observations – do the following things and write down what you observe:	
Test	What do you observe?
Try to quickly grab some oobleck in the bowl	When I tried to grab the oobleck quickly, I found that _____ _____
Quick pick up some oobleck and hold your hand open over the bowl	When I released my hand, I found that _____ _____
Drag your fingers through the oobleck quickly and then slowly	When I tried to move my fingers through quickly, I found that _____ When I moved my hands through slowly, I found that _____ _____
Tip the bowl to the side quickly (not upside down)	If I tip the bowl quickly, I find that _____ _____
Gently tip bowl to the side (don't let it spil!)	If I tip the bowl slowly, I find that _____ _____
Try picking up oobleck and squashing it into a ball then leave it in your hand	If I squash it into a ball, I find that _____ _____ If I leave it in my hand, I find that _____ _____

7. Is sand solid or liquid? How do you know?

REACH OUT

The Reach Foundation, 53-55 High Street, Feltham TW13 4AB
Charity no. 1129683 | Company no. 06546261
reachacademyfeltham.com