



## States of Matter Changing States Teaching Ideas

**Learning Objective:** To understand how matter can change from one state to another.

- Success Criteria:**
- To list the different changes of state.
  - To identify which change of state is happening.
  - To describe what happens as matter changes between states.

**Context:** This is the third lesson of the topic of 'States of Matter' in key stage 3 Chemistry.

### Starter

As students enter the classroom and settle, on slide 3 are three pictures, one of an ice cream melting, one of frost melting on a twig and finally one of cheese melted on nachos. There is a question asking, 'What connects these pictures?' This allows students to identify one of the keywords for today's lesson (melting) and allows the teacher to clarify any misconceptions.

### Main Activities

#### States of Matter Recap

Slides 4-5: Recap the three states of matter key points from previous lesson on slide 4 and introduce students to the concept of particles changing states on slide 5.

#### Identifying Changes Activity

Slides 6-11: Students follow the instructions on slide 6 and work in pairs to identify keywords they may already know to match to the picture showing. Answers are shown on slide 7. Two new keywords 'sublimation' and 'deposition' are introduced and an example of each are given on slide 9. An explanation of, 'How does this happen?' For freezing, melting condensing and evaporating happen are given slides 10 and 11.

#### Melting and Boiling Points

Slides 12-15: Show students the information about melting and boiling points, using tungsten (the element with the highest melting point) and helium (the element with the lowest melting point) as case studies. Pictorial explanations are given on slides 13 and 15 as to how each element changes state.

#### Definitions

Slides 16-18: Students are given a gap fill to complete on slide 16 and more prompts are given on slide 17 to note down the keywords covered so far in today's lesson. An extension question is also given on slide 17 to remember the two new keywords sublimation and deposition and the definitions of each. The answers are shown on slide 18.

## Investigating Freezing Points Practical Worksheet

Slides 19-20: Give students a brief introduction to the stearic acid practical. Stearic acid should be set up at the beginning of the lesson in boiling tubes, with a thermometer inside each and placed in a water bath (approx. 70°C). Students then follow the worksheet to understand the background, variables. A pre drawn results table is given, although this could be drawn independently by more able students. Students record the temperature of the stearic acid every minute and also note what state of matter it currently is. General science laboratory rules are given on slide 20. There is also a teacher feedback sheet on practical skills which provides an opportunity to record and feedback on how students performed during this practical.

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## Plenary

Students complete the five quick questions on the Investigating [Freezing Points Practical Worksheet](#). Remind the students of today's success criteria on slide 22 of the PowerPoint.

## Suggested Home Learning:

Students could complete [Particle Model Quick Assessment Sheet](#) or could plot their data as a graph using the prompts on the worksheet [Investigating Freezing Points Practical Worksheet](#).

# Changing State Quick Assessment

## 1. Identify the change of state happening:

a. Chocolate being left in a warm room:

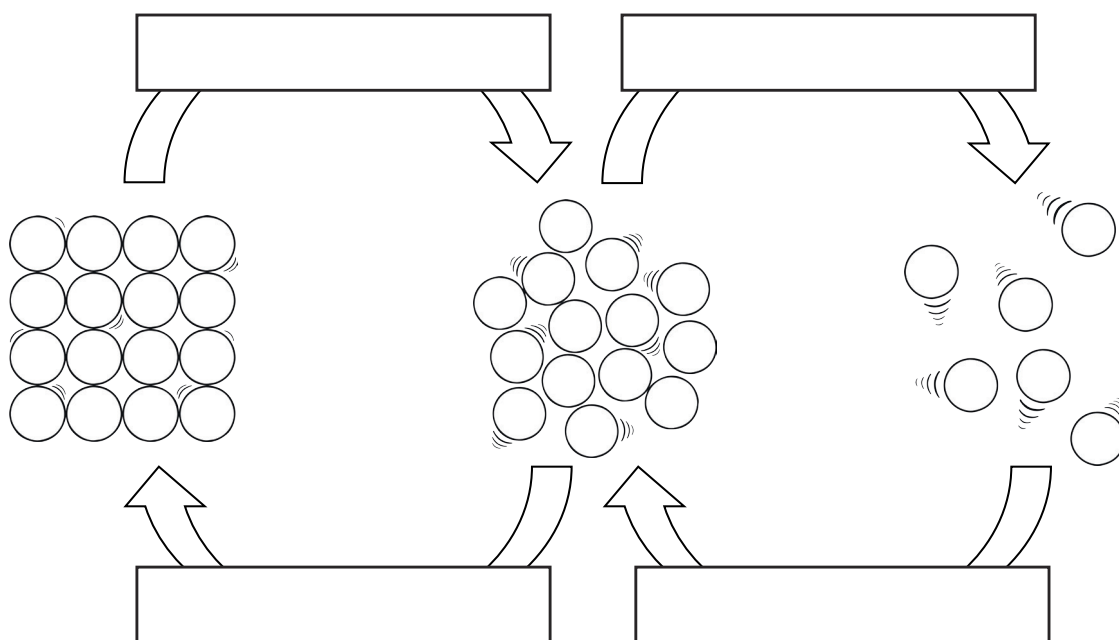
b. Water being placed in the freezer:

c. A puddle disappearing:

d. Water droplets on the outside of a cold drinks can:

e. A hairdryer being used on wet hair:

## 2. In each box, write the change of state that is taking place:



**Challenge:** Can you add your own extra arrows to show the changes of state called:

- Sublimation?
- Deposition?

3. Rahul takes a shower, makes a cup of tea and then hangs his washing outside to dry. For each scenario **identify** the change(s) of state happening and **describe** what is happening to the water molecules:

a. Turning the shower on and the mirror 'misting' over:

Change(s) of state:

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Description of what is happening to the water molecules:

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b. Turning the kettle on and steam appearing out of the spout:

Change(s) of state:

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Description of what is happening to the water molecules:

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c. Hanging wet washing outside to dry on a sunny day:

Change(s) of state:

---

Description of what is happening to the water molecules:

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**Learning Objectives:**

- I can identify everyday changes of state.
- I can identify which change of state is happening.
- I can describe what happens as matter changes between states.

# Changing State Quick Assessment Answers

1. Identify the change of state happening:

a. Chocolate being left in a warm room: **melting**

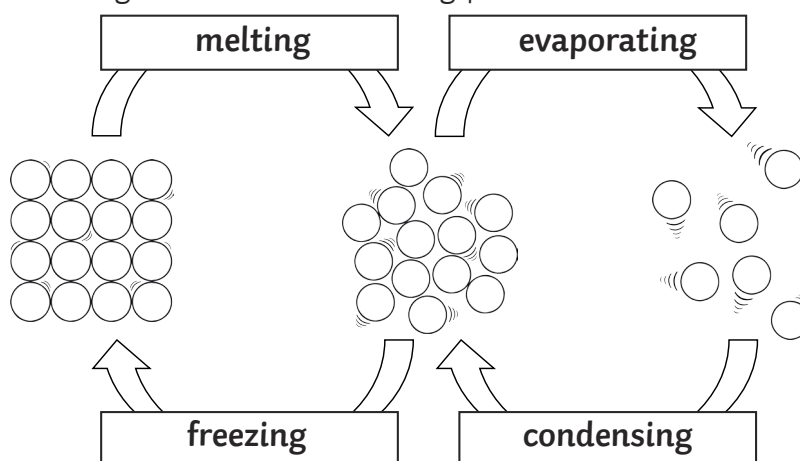
b. Water being placed in the freezer: **freezing**

c. A puddle disappearing: **evaporating/evaporation**

d. Water droplets on the outside of a cold drinks can: **condensing/condensation**

e. A hairdryer being used on wet hair: **evaporating/evaporation**. This evaporation process would happen naturally, but hairdryers accelerate it. However, when there is high humidity and water already in the air, this happens at a low rate, if at all.

2. In each box, write the change of state that is taking place:



**Challenge:**

For sublimation an arrow should be drawn from solid to gas, bypassing liquids.

For deposition an arrow should be drawn from gas to solid, bypassing liquids.

3. a. Turning the shower on and the mirror 'misting' over:

Change(s) of state: **Evaporation from the hot water and then condensation**

Description of what is happening to the water molecules: **The water molecules gain kinetic energy and move apart, some gain enough energy to change from a liquid to gas state. When they collide with a cold mirror, they lose this energy and collect as liquid water droplets.**

b. Turning the kettle on and steam appearing out of the spout:

Change(s) of state: **Evaporation**

Description of what is happening to the water molecules: **The water molecules gain kinetic energy and move apart, some gain enough to change from a liquid to a gas state.**

c. Hanging wet washing outside to dry on a sunny day:

Change(s) of state: **Evaporation**

Description of what is happening to the water molecules: **The water molecules on the clothes gain kinetic energy and move apart, most gain enough to change from a liquid to a gas state and thus move off the clothes. Similar to the hairdryer scenario, if there is high humidity and water already in the air, this happens at a low rate, if at all.**

# Changing State Quick Assessment **Teacher Feedback**

Effort: 1 2 3 4 5

You can identify some everyday changes of state.	You can identify most everyday changes of state.	You can identify all everyday changes of state.
You can use some keywords to define simple changes of state.	You can use most keywords to define the most common changes of state.	You can use all keywords to define all changes of state including sublimation and deposition.
You can describe how particles are arranged differently in each state of matter.	You can describe how the arrangement of particles changes from one state to another.	You can describe and explain how the arrangement of particles changes from one state to another.

## Next Steps:

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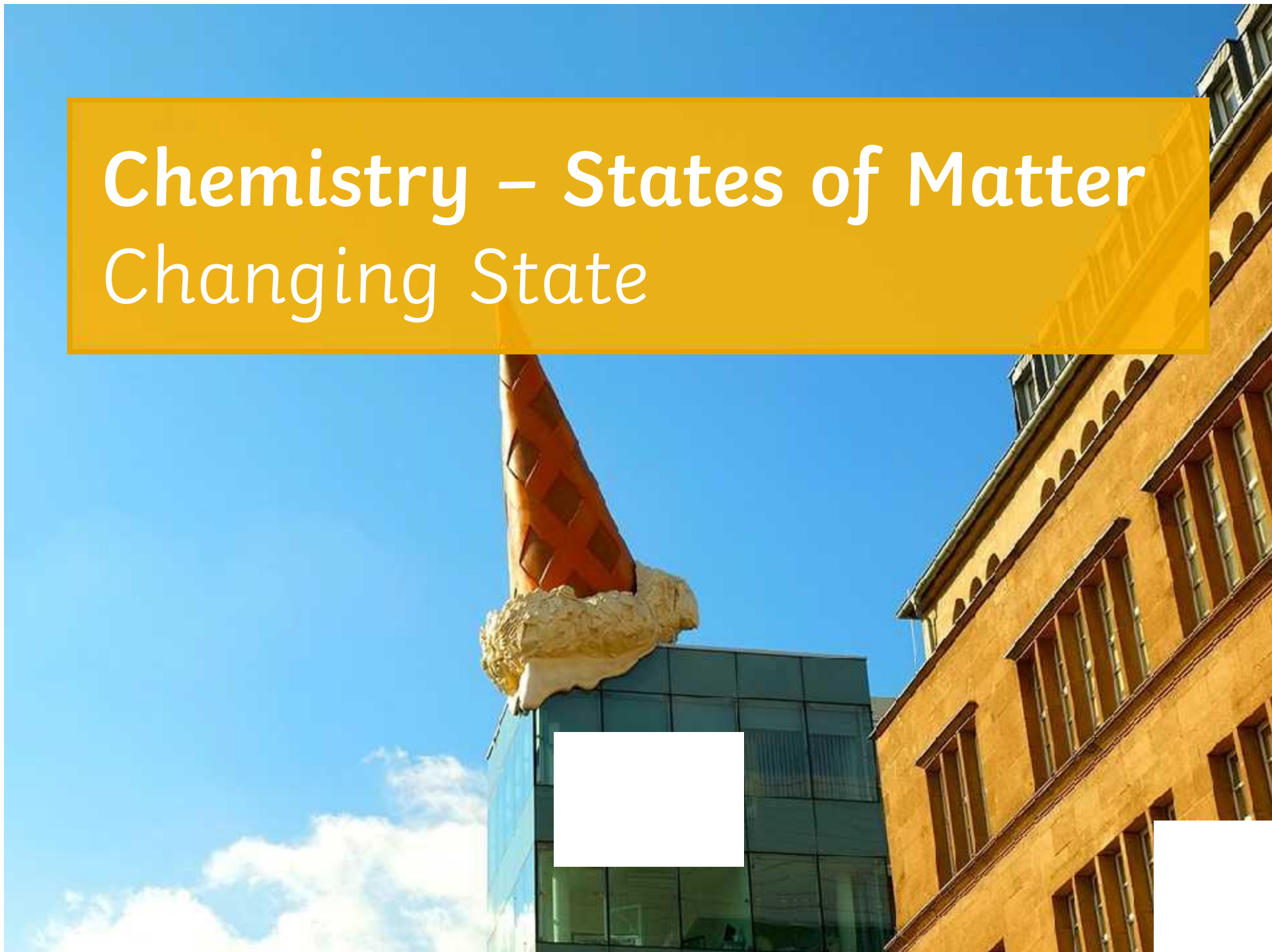
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# Chemistry – States of Matter

## Changing State



## Learning Objective

- To understand how matter can change from one state to another.

## Success Criteria

- To list the different changes of state.
- To identify which change of state is happening.
- To describe what happens as matter changes between states.



# Starter

What connects these pictures?



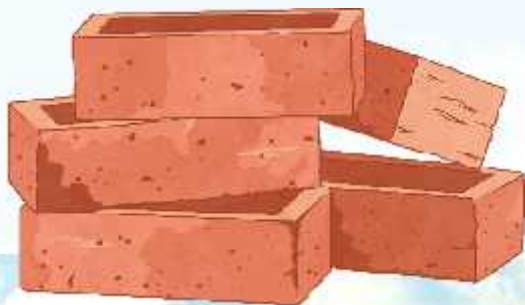
**Challenge:** What is the opposite of your word?

# States of Matter Recap

There are **three** states of matter:



**solids**



**liquids**




**gases**




# Changing State

Matter can change from one state to another.



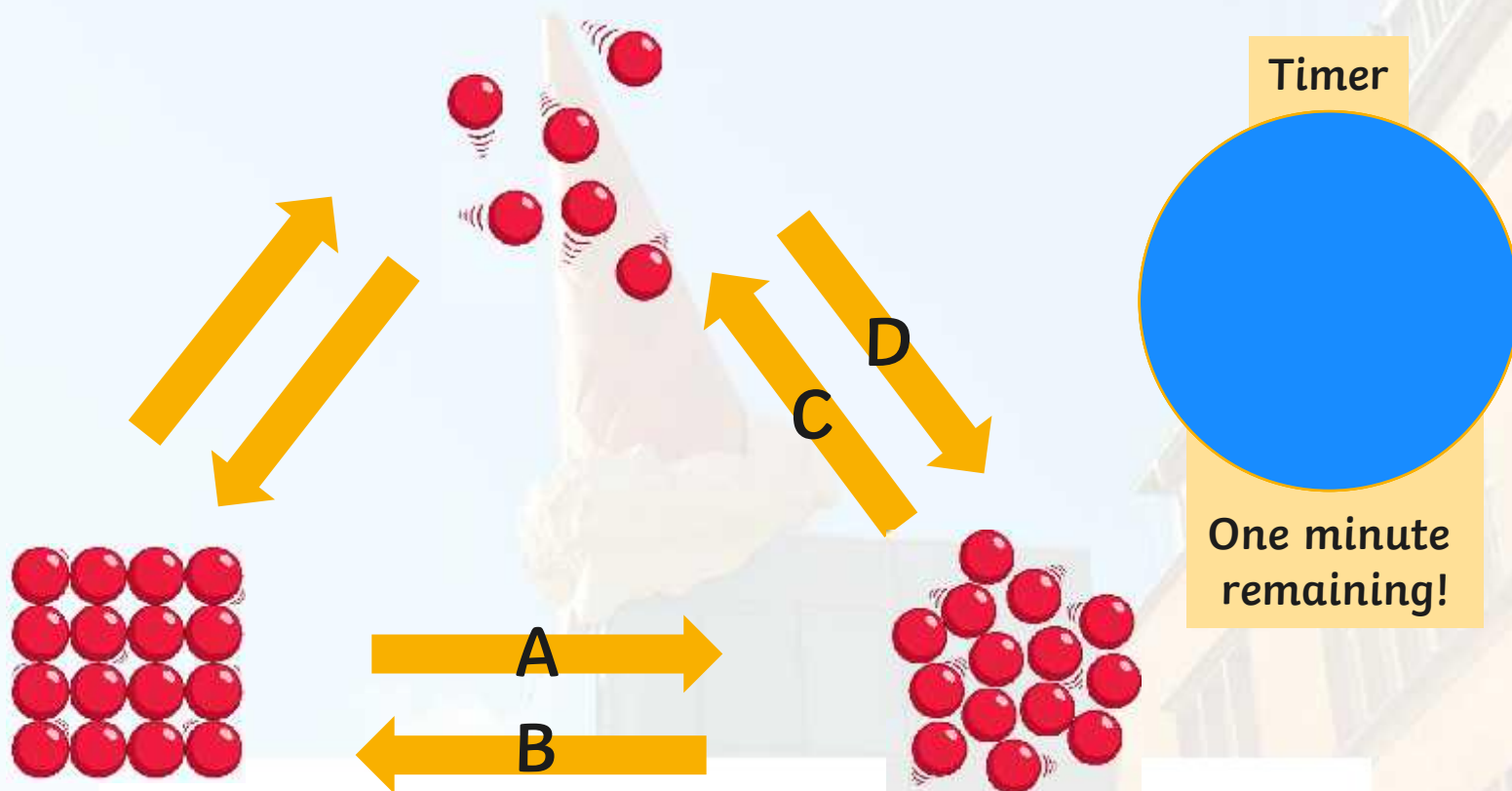
This means the particles will be arranged differently and so the properties of the substance will change.



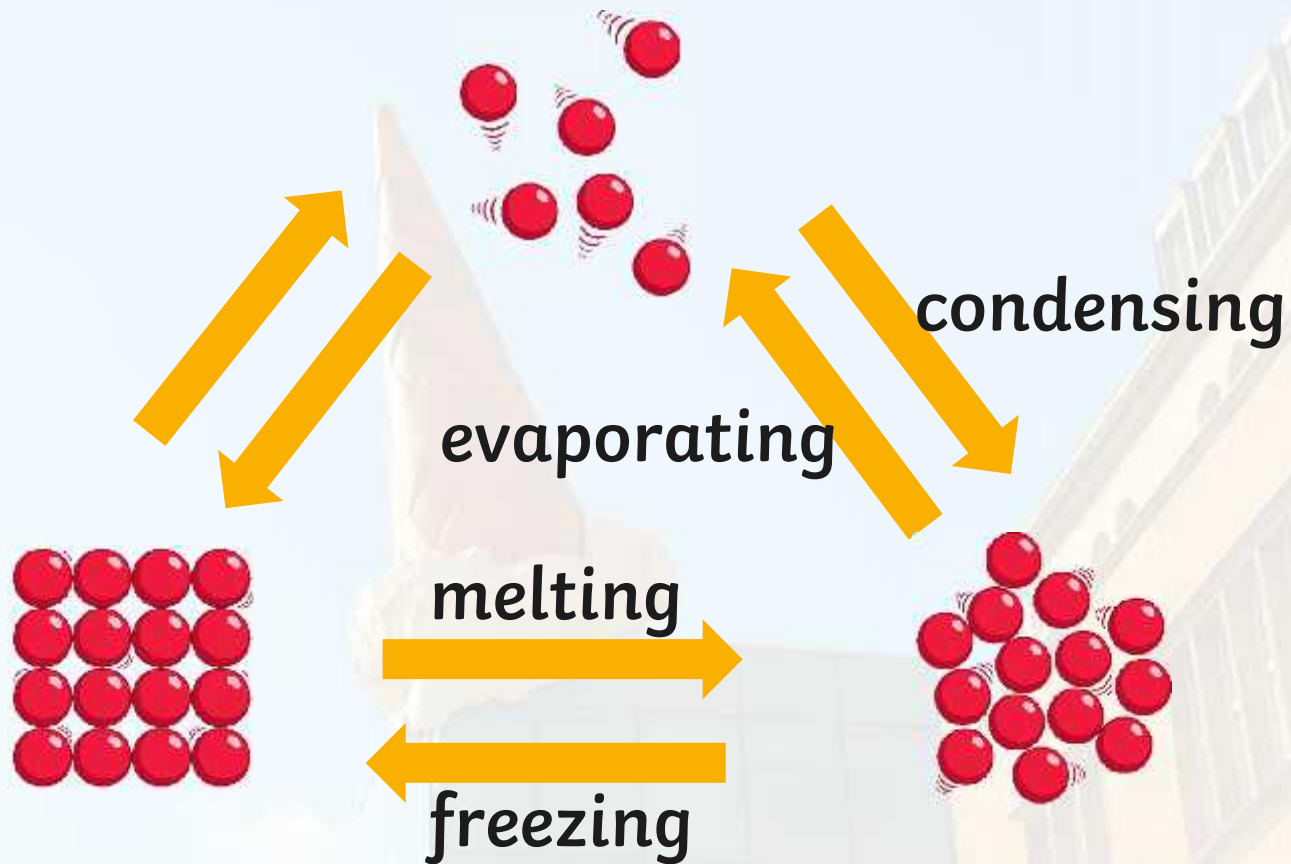
# Identifying Changes Activity



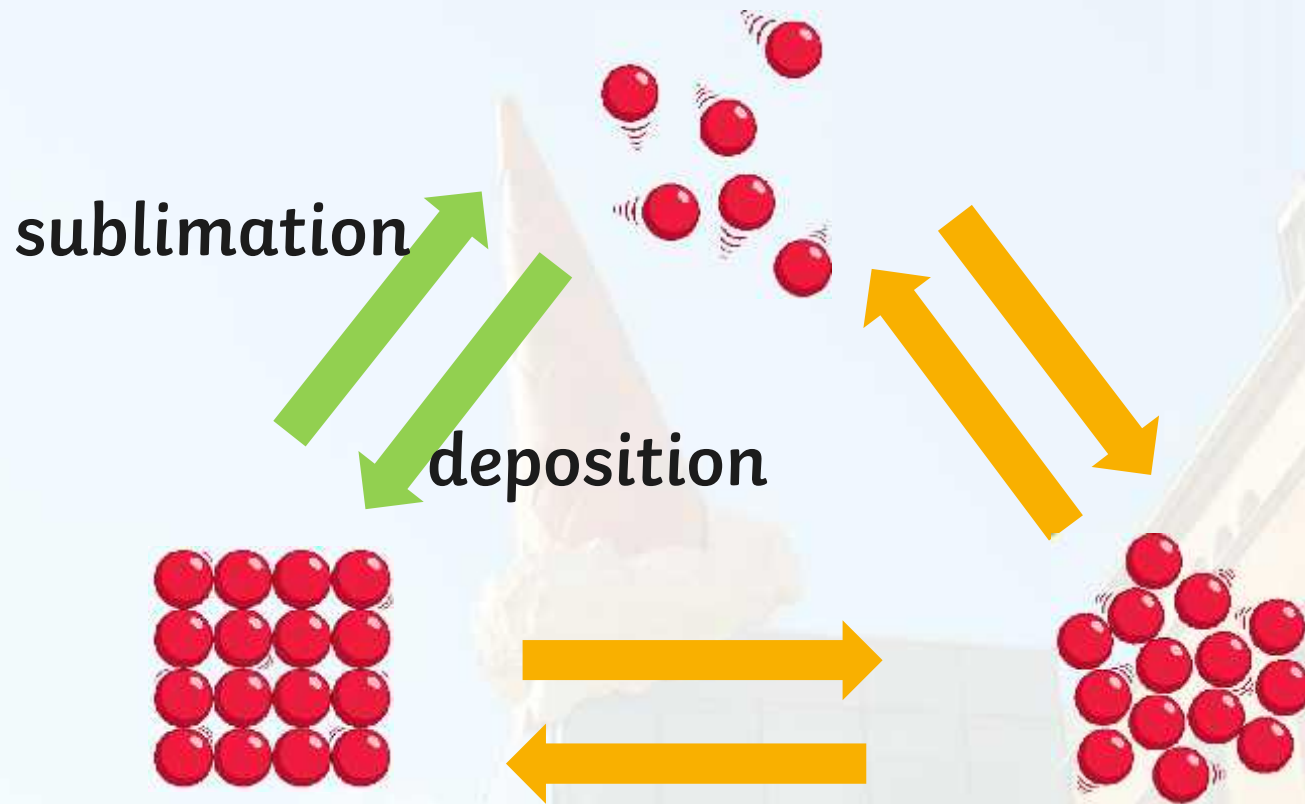
In pairs you have two minutes to define the keywords for each change of state from letters A to D!



# Answers



# New Keywords



# New Keywords



By Christopher from Salem, via Wikimedia Commons

## sublimation

Dry ice happens because solid carbon dioxide sublimates at room temperature and turns straight into a gas!

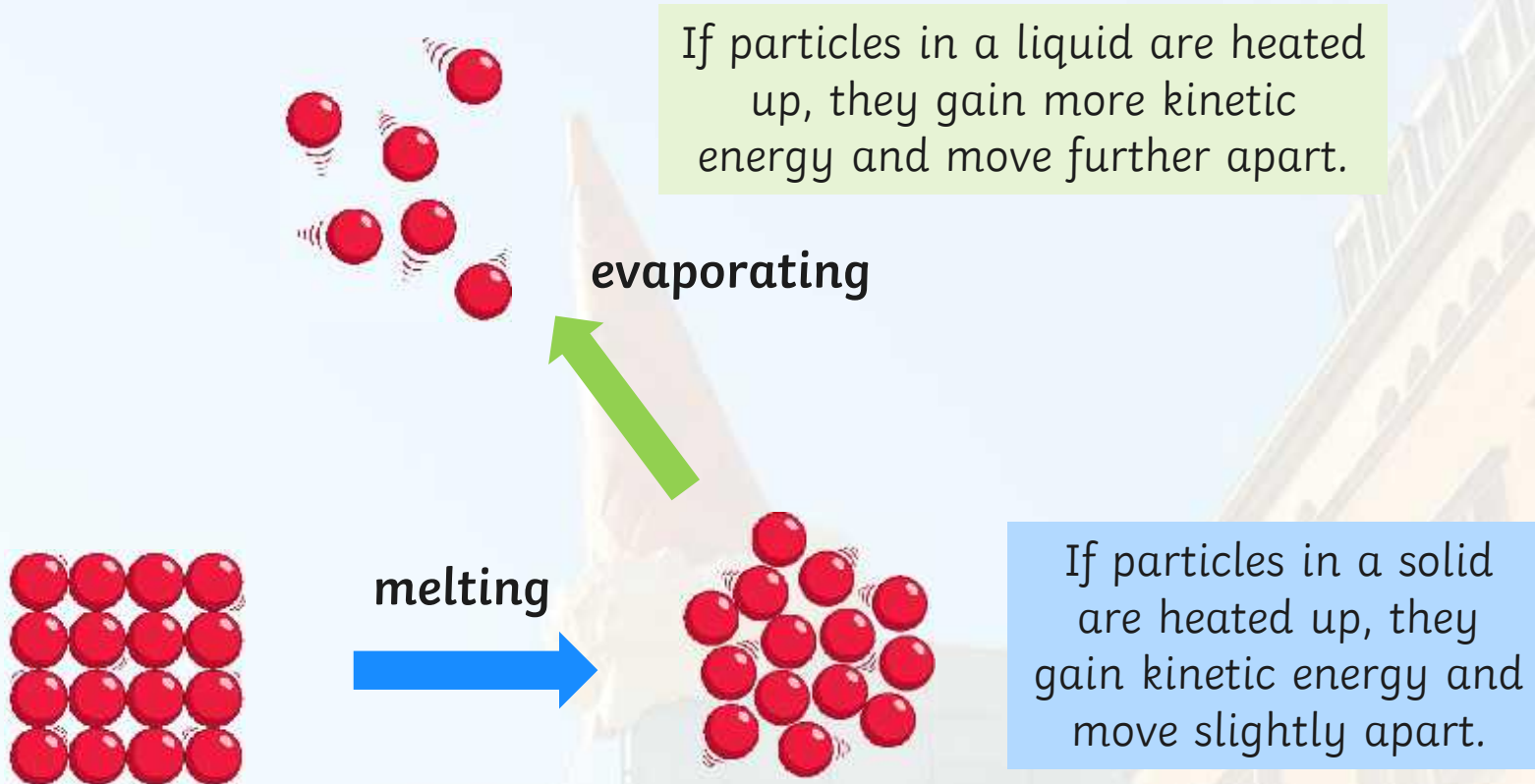


Photo courtesy of james\_mann, via Flickr.com

## deposition

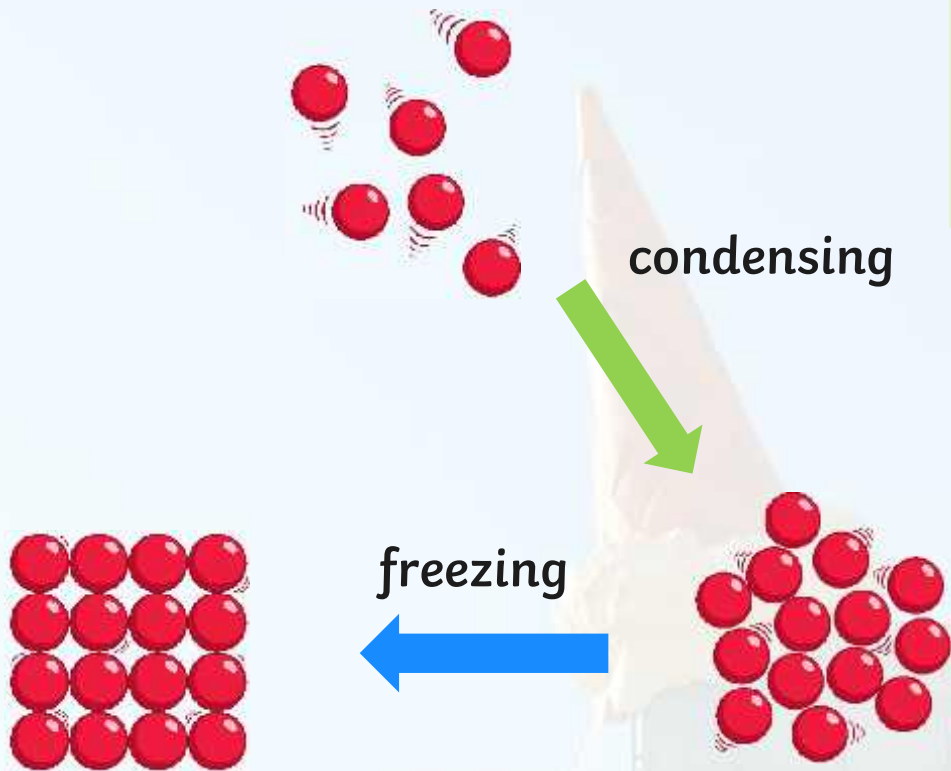
Snow happens because gaseous water vapour deposits in clouds and turns straight into a solid!

# How Does This Happen?





# How Does This Happen?



If particles in a gas are cooled, they have less kinetic energy and move closer together.

If particles in a liquid are cooled, they have less kinetic energy and move even closer together.

# Melting and Boiling Points

- The element with the highest melting point is tungsten.
- It has the symbol 'W' from the word 'wolfram' from the mineral it was discovered in.
- Tungsten comes from Swedish for 'heavy stone'.



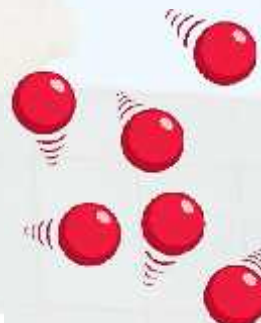
## Pause for Thought

Tungsten is often used as the filament inside of lightbulbs - why do you think this is?

# Melting and Boiling Points

To overcome **some** of the forces between the particles and make tungsten **melt** from a solid into a liquid, you must heat it to  $3422^{\circ}\text{C}$ !

To overcome **all** of the forces between the particles and make tungsten **boil** from a liquid into a gas, you must heat it to  $5555^{\circ}\text{C}$ !



# Melting and Boiling Points

The element with the **lowest** melting point is **helium**.

It has the symbol 'He' from the Greek God 'Helios' who was thought to drive his chariot of the sun across the sky every day.

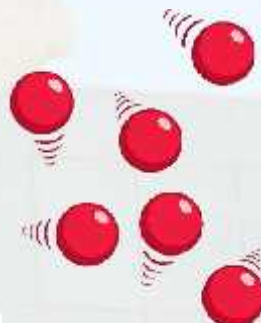


Helium exists as a gas at room temperature and is often used in balloons as it is **less dense** than air.

# Melting and Boiling Points

To turn helium from a gas into a liquid you must cool it to below  $-268^{\circ}\text{C}$ !

To turn helium into a solid you must cool it even further to below  $-272^{\circ}\text{C}$ !



# Definitions

- **Melting:** a s\_\_\_\_\_ changing into a l\_\_\_\_\_.
- **Evaporating:** a \_\_\_\_\_ changing into a \_\_\_\_\_.
- **Condensing:** a \_\_\_\_\_ changing into a \_\_\_\_\_.
- **Freezing:** a \_\_\_\_\_ changing into a \_\_\_\_\_.

**Words to use:** solid, liquid and gas.



## Key Terms

Check your spelling as you write each term down.



# Definitions

- **Melting:** a s\_\_\_\_\_ changing into a l\_\_\_\_\_.
- **Evaporating:** a l\_\_\_\_\_ changing into a g\_\_\_\_\_.
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- **Freezing:** a l\_\_\_\_\_ changing into a s\_\_\_\_\_.

**Challenge:** Can you remember the two new keywords?



## Key Terms

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# Definitions

- **Melting:** a solid changing into a liquid.
- **Evaporating:** a liquid changing into a gas.
- **Condensing:** a gas changing into a liquid.
- **Freezing:** a liquid changing into a solid.

## Challenge:

**Sublimation:** a solid changing directly into a gas.

**Deposition:** a gas changing directly into a solid.





# Investigating Freezing Points Practical

Stearic acid is a white waxy solid at room temperature.

You will be given stearic acid as a **hot** liquid and will record when it becomes a solid (**solidifies**).



# Lab Safety Rules

**Aim:** Follow the worksheet to safely complete the practical.

## **Remember:**

- Stand up at all times.
- Wear safety goggles at all times.
- Tie long hair up.
- Report any accidents to the teacher or the TA asap.
- Do not take your eyes off your equipment.
- Work well as a team and ask how to pack away.
- Most of all stay focused and enjoy!



# Plenary

Complete the five quick questions on your practical sheet.

## Investigating Freezing Points Stearic Acid Practical

**Background Information:** Circle the correct word.

Stearic acid is a white waxy solid / liquid at room temperature. The particles would be arranged in regular lines / small clusters and would / would not be able to move freely and solid / could not be compressed.

**Method:**

**Team roles:** Temperature recorder and stopwatch monitor.

1. Put on safety goggles and tie hair back. Ensure working area is clear and the floor is clear of obstructions.
2. Place a test tube rack in the middle of your desk.
3. Collect a stopwatch and a thermometer.
4. Using metal tongs, carefully remove a boiling tube of stearic acid from the hot water bath and place it into the test tube rack on your desk.
5. Using the thermometer, record the start temperature in degrees Celsius ( $^{\circ}$ C) on the results table (on the back of the sheet) at 0 minutes and press start on the stopwatch.
6. Then every minute, record the temperature of the stearic acid and note what state of matter it is on the results table.
7. Once the investigation is over, ask your teacher how to pack away safely and then answer the questions on the back of the sheet.



### Variables:

- We are changing (the **independent** variable):

- We are measuring (the **dependent** variable):

- We will keep these the **same** (the control variables):



Investigating Freezing Points Stearic Acid Practical

Results Table:

Independent Variable	Dependent Variable	State of Matter Observed at (solid, liquid or gas?)
Units	Units	

### Quick Questions:

1. How many minutes did it take for the stearic acid to become a solid (solidify)?  
\_\_\_\_\_
2. What name is given to the change of state from liquid to solid?  
\_\_\_\_\_
3. At what temperature do you think liquid water becomes a solid?  
\_\_\_\_\_
4. How could you improve the accuracy of your data collection?  
\_\_\_\_\_  
\_\_\_\_\_
5. How could you improve the reliability of your data collection?  
\_\_\_\_\_  
\_\_\_\_\_

# What Did You Achieve Today?

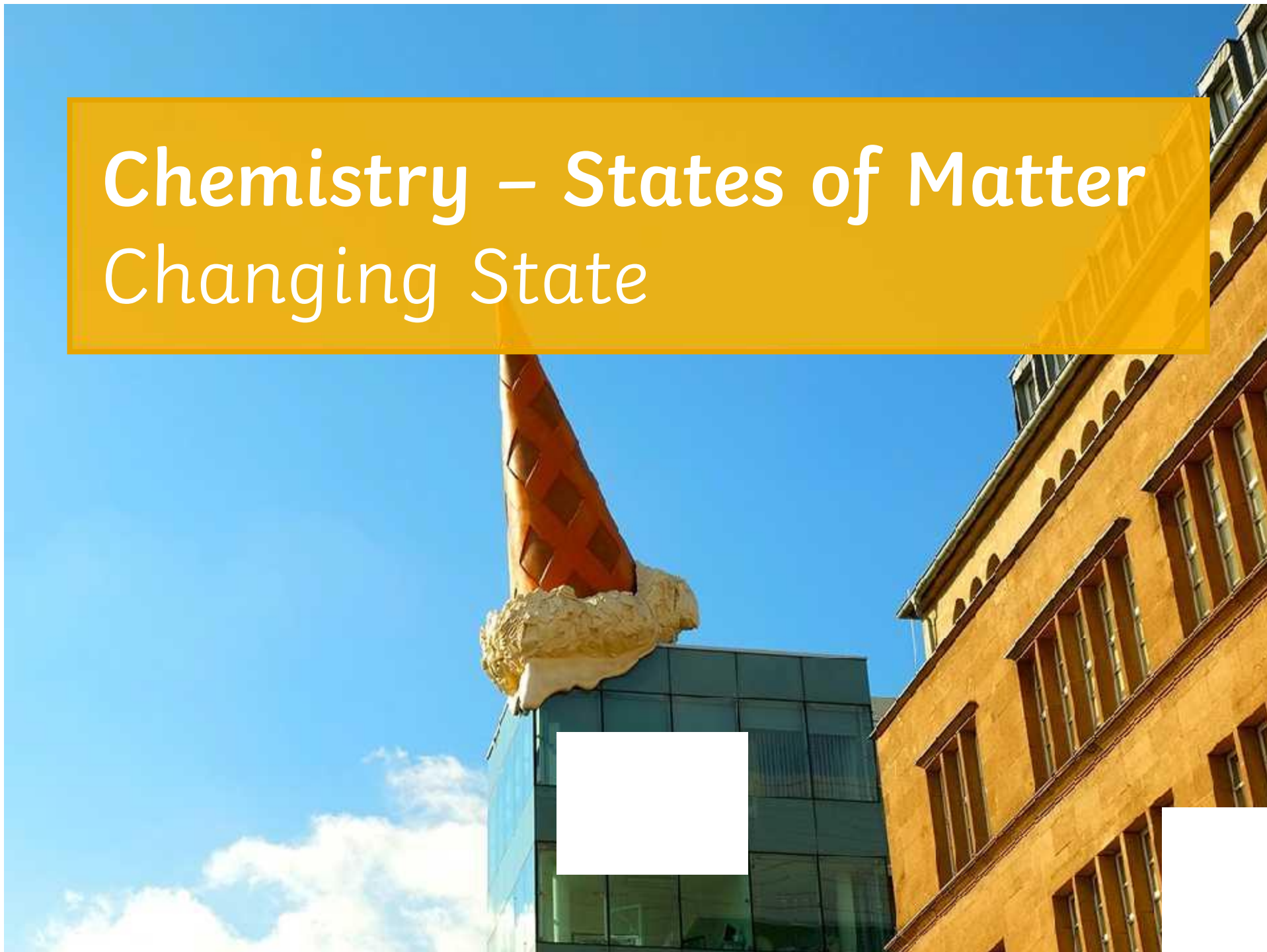
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# Chemistry – States of Matter

## Changing State



# Learning Objective

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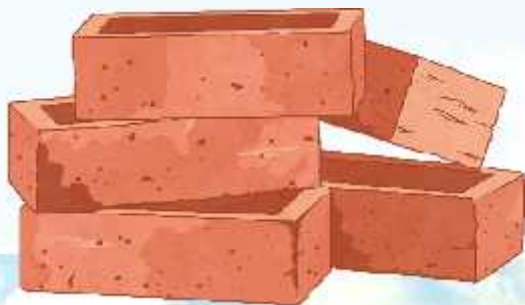


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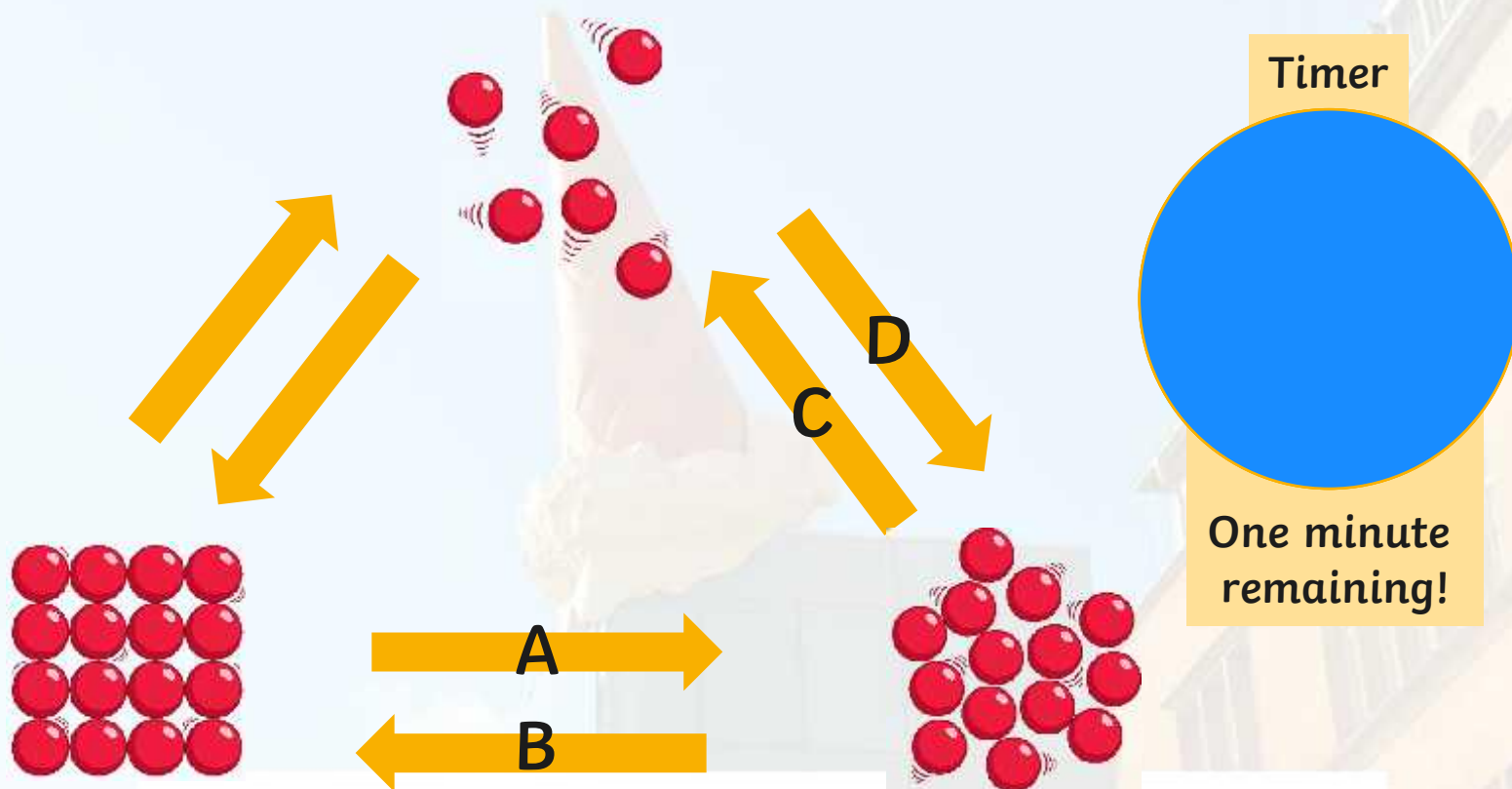


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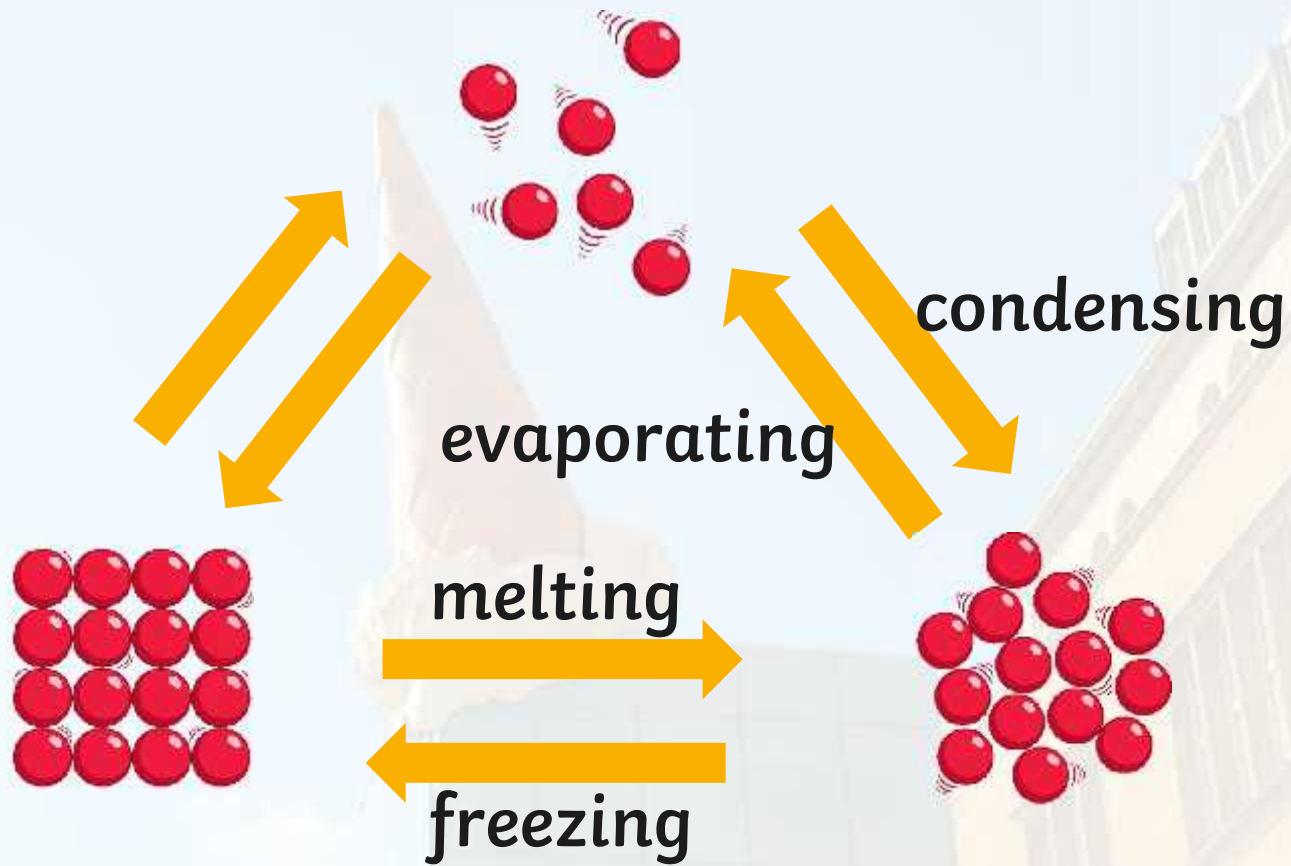
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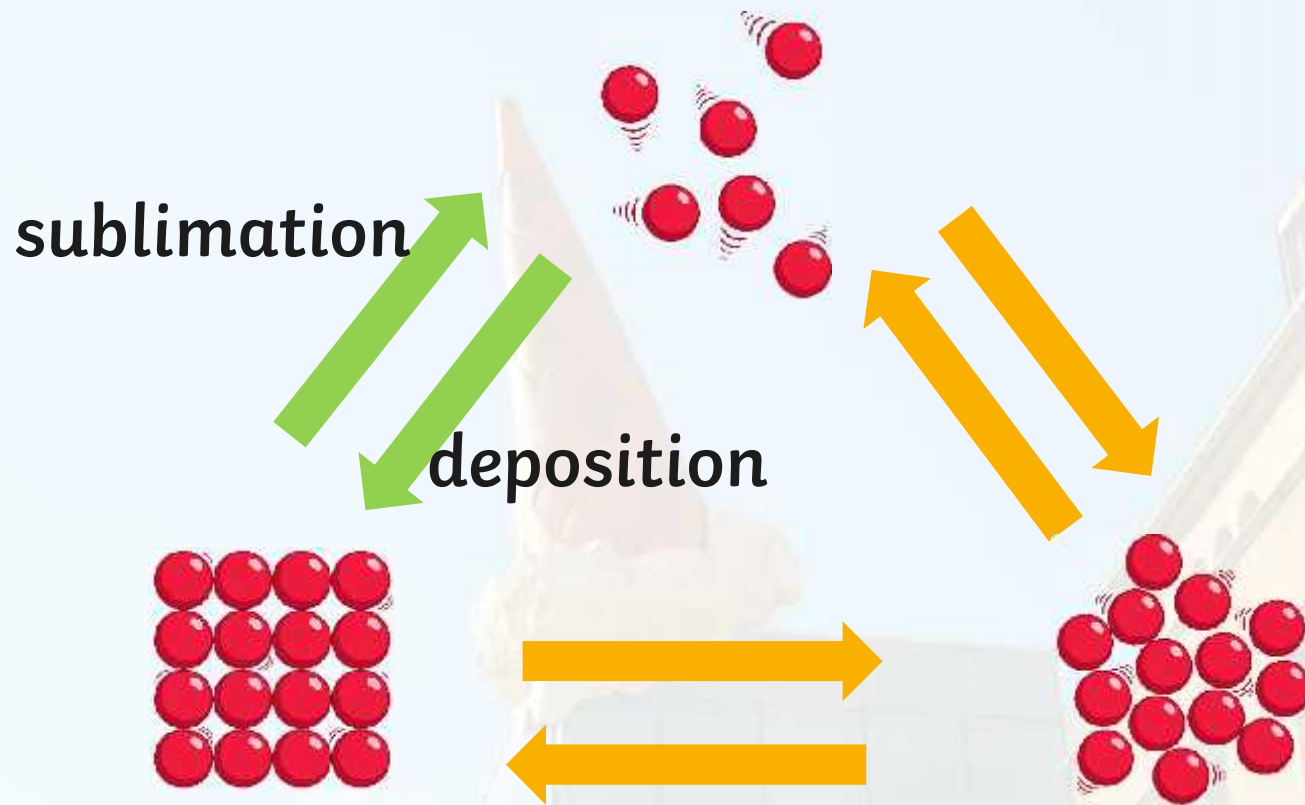
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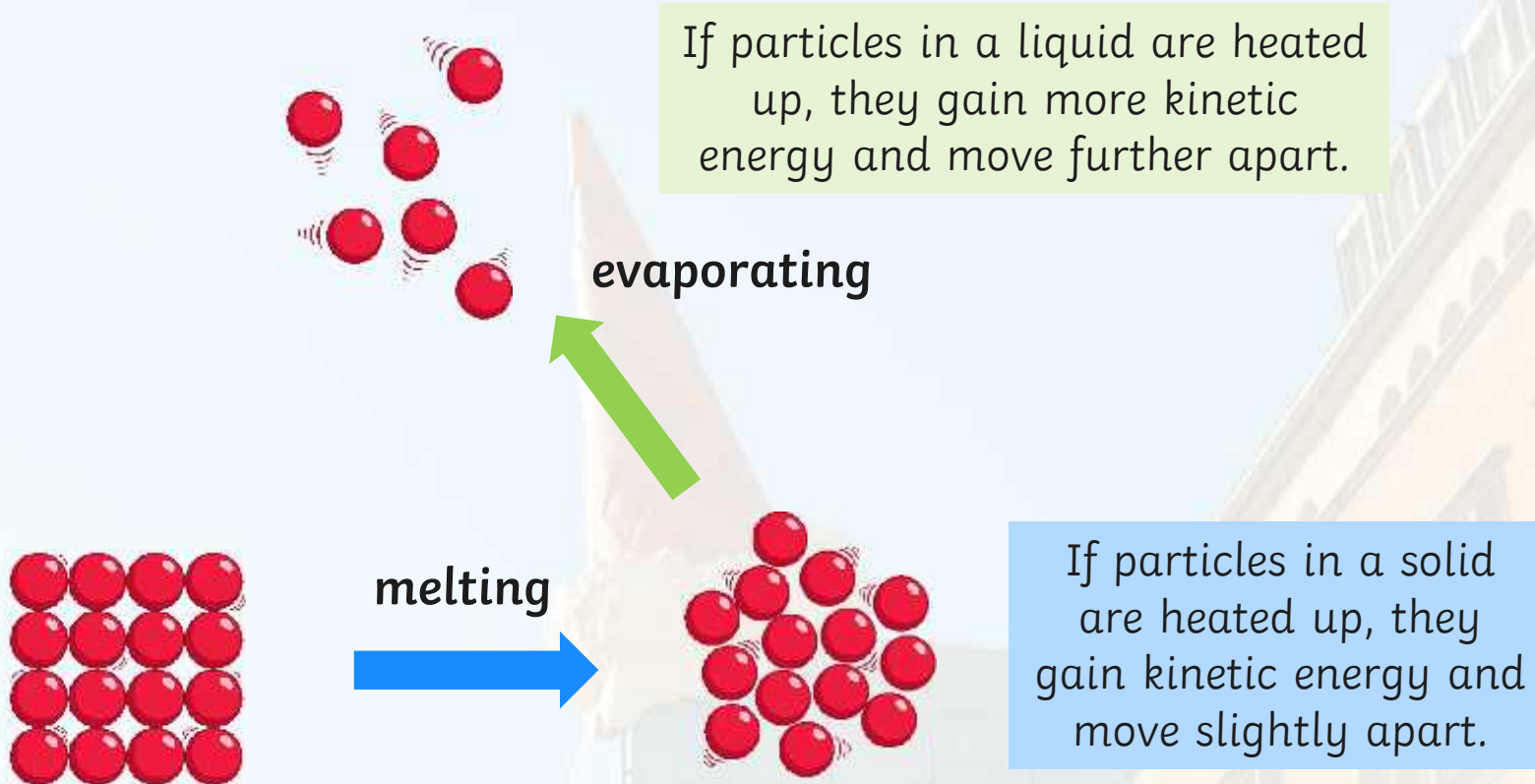


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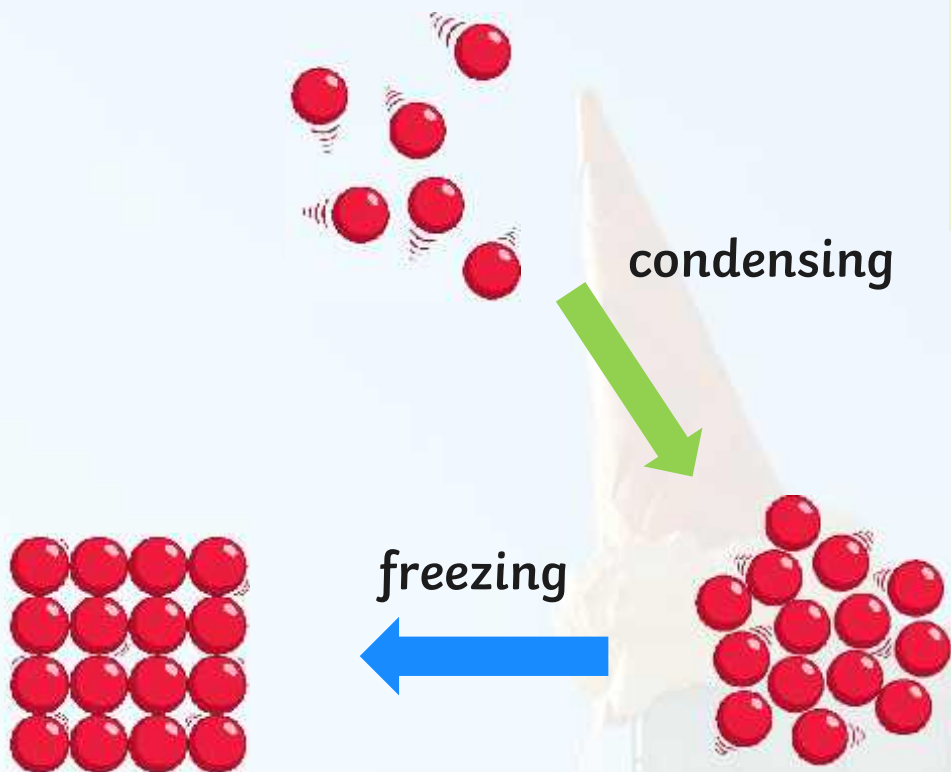
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# Melting and Boiling Points

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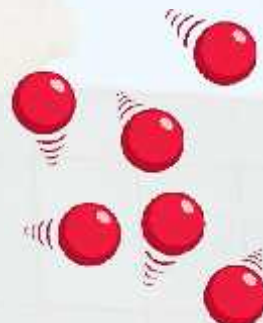
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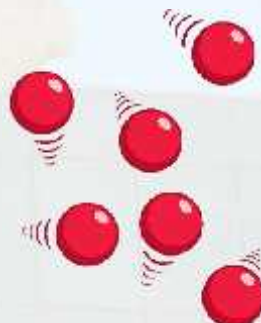


Helium exists as a gas at room temperature and is often used in balloons as it is **less dense** than air.

# Melting and Boiling Points

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# Definitions

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## Challenge:

**Sublimation:** a solid changing directly into a gas.

**Deposition:** a gas changing directly into a solid.



# Investigating Freezing Points Practical

Stearic acid is a white waxy solid at room temperature.

You will be given stearic acid as a **hot** liquid and will record when it becomes a solid (**solidifies**).





# Lab Safety Rules

**Aim:** Follow the worksheet to safely complete the practical.

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# What Did You Achieve Today?

- I can list the different changes of state.
- I can identify which change of state is happening.
- I can describe what happens as matter changes between states.





# Investigating Freezing Points Stearic Acid Practical

**Background Information:** Circle the correct word.

Stearic acid is a white waxy **solid / liquid** at room temperature. The particles would be arranged in **regular lines / small clusters** and **would / would not** be able to move freely and **could / could not** be compressed.

## Method:

Team roles: Temperature recorder and stopwatch monitor.

1. Put on safety goggles and tie hair back. Ensure working area is clear and the floor is clear of obstructions.
2. Place a test tube rack in the middle of your desk.
3. Collect a stopwatch and a thermometer.
4. Using metal tongs, carefully remove a boiling tube of stearic acid from the hot water bath and place it into the test tube rack on your desk.
5. Using the thermometer, record the start temperature in degrees Celsius ( $^{\circ}\text{C}$ ) on the results table (on the back of the sheet) at '0' minutes and press start on the stopwatch.
6. Then every minute, record the temperature of the stearic acid and note what state of matter it is on the results table.
7. Once the investigation is over ask your teacher how to pack away safely and then answer the questions on the back of the sheet.



## Variables:

- We are changing (the **independent** variable):

- We are measuring (the **dependent** variable):

- We will keep these the **same** (the control variables):

**Results Table:**

<b>Independent Variable=</b> <b>Units=</b>	<b>Dependent Variable=</b> <b>Units=</b>	<b>State of Matter Observed as</b> <b>(solid, liquid or gas?)</b>

**Quick Questions:**

1. How many minutes did it take for the stearic acid to become a solid (solidify)?

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2. What name is given to the change of state from liquid to solid?

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3. At what temperature do you think liquid water becomes a solid?

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4. How could you improve the accuracy of your data collection?

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5. How could you improve the reliability of your data collection?

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**Graph:**

**Temperature (°C)** (Dependent variable)



**Time (minutes)** (Independent variable)



**Helpful tips:**  
The independent variable is always on the x-axis.  
The dependent variable is always on the y-axis.



# Stearic Acid Practical Answers

## Variables:

The **independent** variable is time (minutes).

In this investigation, it is difficult for students to identify an independent variable, as you are not 'changing' time but observing it. However, as you are specifying the time intervals (every minute) it becomes the independent variable.

The **dependent** variable is temperature ( $^{\circ}\text{C}$ ).

The **control** variables: The start temperature of the stearic acid ( $^{\circ}\text{C}$ ) and the volume / amount of stearic acid used ( $\text{cm}^3$ ).

## Quick Questions:

1. Times may vary from student to student.
2. Freezing is the term given for when a liquid changes into a solid.
3. At  $0^{\circ}\text{C}$  fresh water will freeze, but saltwater is actually lower at  $-1.9^{\circ}\text{C}$ !
4. To improve the accuracy of your data collection you could use a digital thermometer or a data logger.
5. To improve the reliability of your data collection you could repeat the experiment, two or three times, exclude any anomalies before calculating a mean.

# Stearic Acid Practical Skills Teacher Feedback

Effort: 1 2 3 4 5

With teacher guidance, you can write down variables in this practical.	You can identify <b>some</b> variables in this practical.	You can identify <b>all</b> of the variables in this practical.
With teacher guidance, you can mostly follow a written method.	With teacher or peer guidance, you can follow a written method safely.	You can independently follow a written method safely.
With teacher guidance, you can collect results.	With teacher or peer guidance, you can collect accurate results.	You can independently collect accurate and valid results.
You can apply the keyword 'freezing' to this practical.	You can apply today's practical to an everyday situation of water freezing.	You can suggest ways of improving data collection in this practical.

## Next Steps:

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# Investigating Freezing Points Stearic Acid Practical

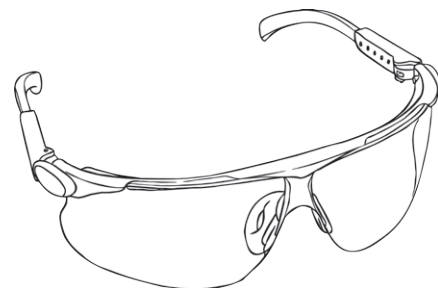
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- We will keep these the **same** (the control variables):

**Results Table:**

<b>Independent Variable=</b> <b>Units=</b>	<b>Dependent Variable=</b> <b>Units=</b>	<b>State of Matter Observed as</b> <b>(solid, liquid or gas?)</b>

**Quick Questions:**

1. How many minutes did it take for the stearic acid to become a solid (solidify)?

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2. What name is given to the change of state from liquid to solid?

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3. At what temperature do you think liquid water becomes a solid?

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4. How could you improve the accuracy of your data collection?

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5. How could you improve the reliability of your data collection?

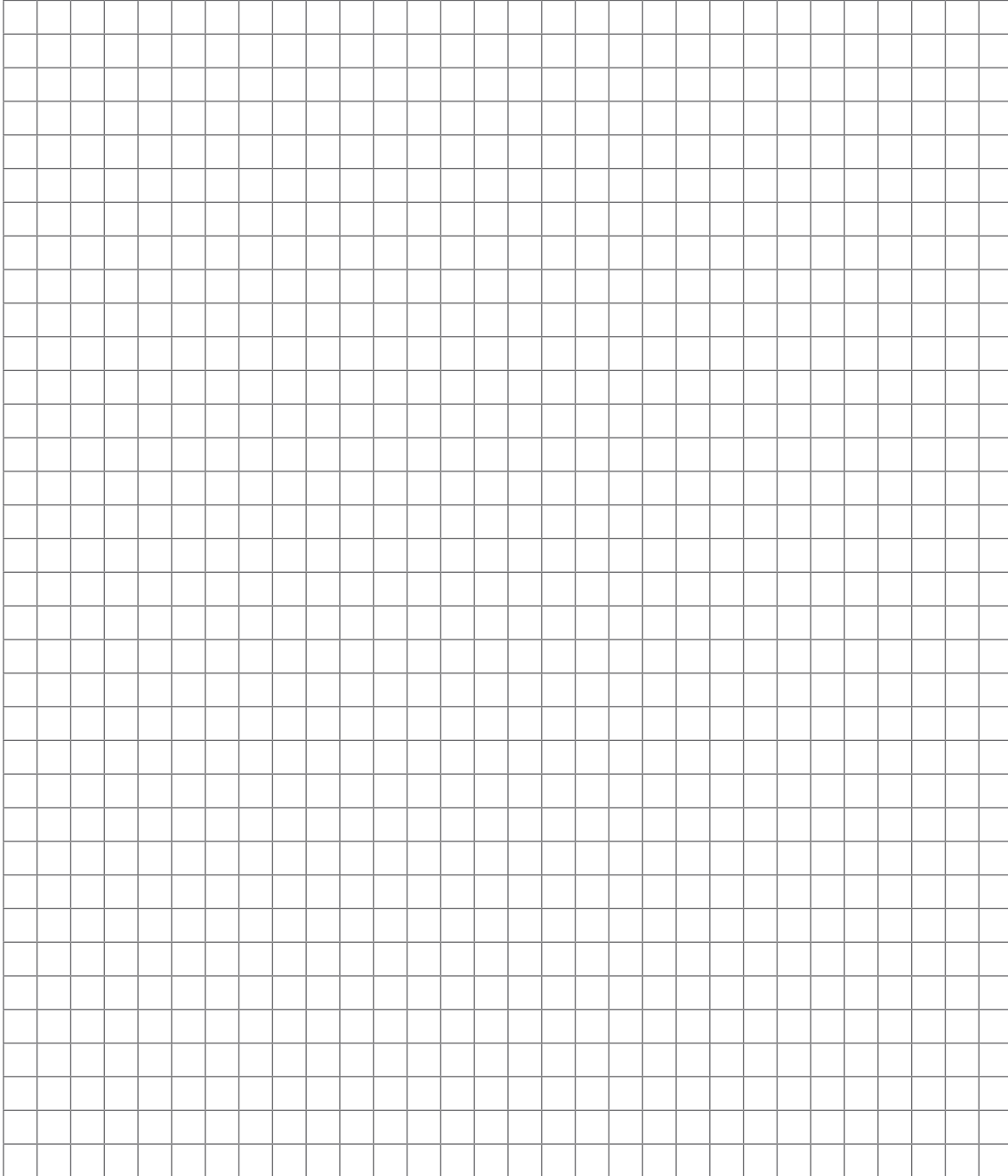
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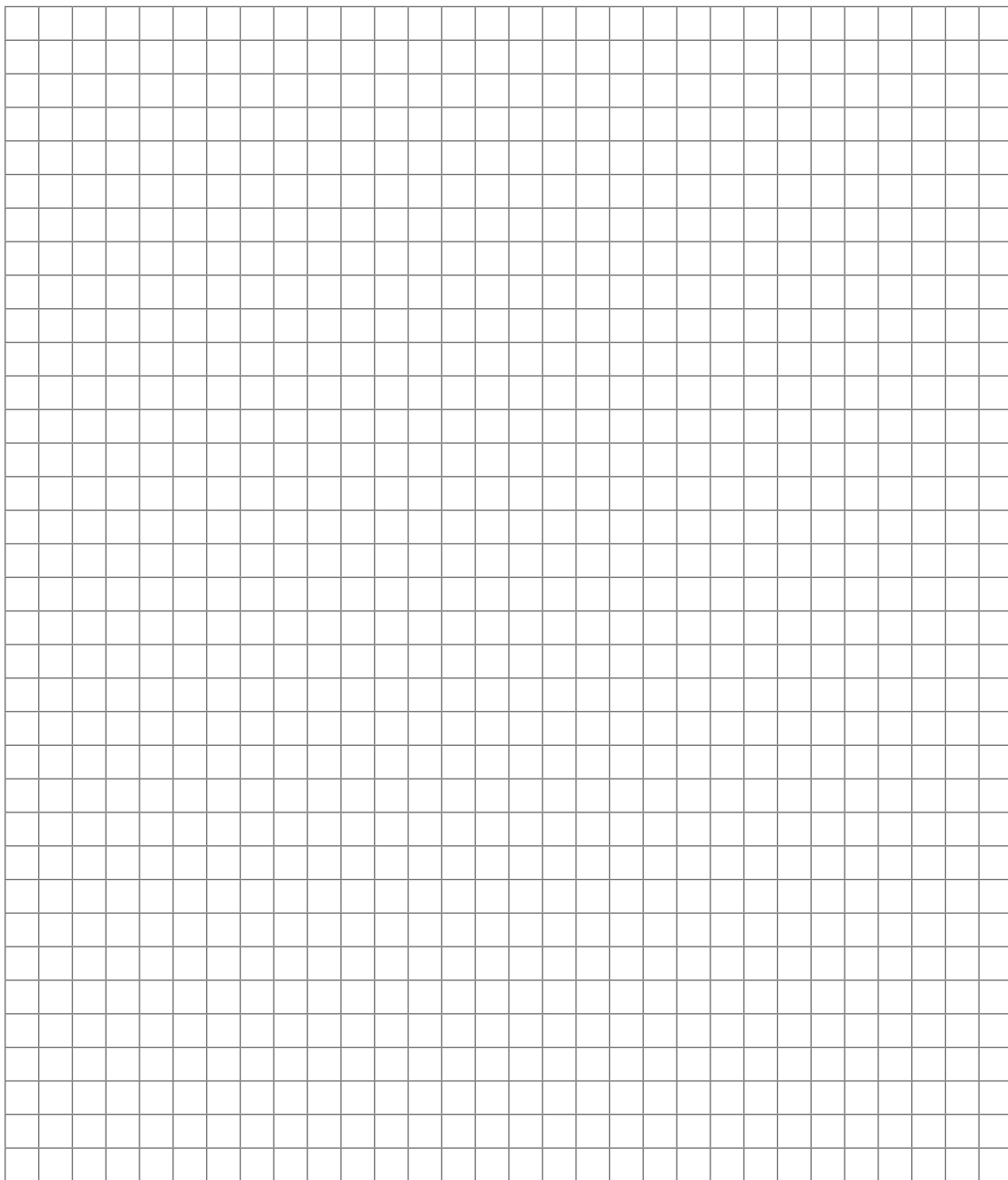
Graph:

Temperature (°C) (Dependent variable)



Time (minutes) (Independent variable)

**Graph:**



**Helpful tips:**  
The independent variable is always on the x-axis.  
The dependent variable is always on the y-axis.

# Stearic Acid Practical Answers

## Variables:

The **independent** variable is time (minutes).

In this investigation, it is difficult for students to identify an independent variable, as you are not 'changing' time but observing it. However, as you are specifying the time intervals (every minute) it becomes the independent variable.

The **dependent** variable is temperature ( $^{\circ}\text{C}$ ).

The **control** variables: The start temperature of the stearic acid ( $^{\circ}\text{C}$ ) and the volume / amount of stearic acid used ( $\text{cm}^3$ ).

## Quick Questions:

1. Times may vary from student to student.
2. Freezing is the term given for when a liquid changes into a solid.
3. At  $0^{\circ}\text{C}$  fresh water will freeze, but saltwater is actually lower at  $-1.9^{\circ}\text{C}$ !
4. To improve the accuracy of your data collection you could use a digital thermometer or a data logger.
5. To improve the reliability of your data collection you could repeat the experiment, two or three times, exclude any anomalies before calculating a mean.

# Stearic Acid Practical Skills Teacher Feedback

Effort: 1 2 3 4 5

With teacher guidance, you can write down variables in this practical.	You can identify <b>some</b> variables in this practical.	You can identify <b>all</b> of the variables in this practical.
With teacher guidance, you can mostly follow a written method.	With teacher or peer guidance, you can follow a written method safely.	You can independently follow a written method safely.
With teacher guidance, you can collect results.	With teacher or peer guidance, you can collect accurate results.	You can independently collect accurate and valid results.
You can apply the keyword 'freezing' to this practical.	You can apply today's practical to an everyday situation of water freezing.	You can suggest ways of improving data collection in this practical.

## Next Steps:

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