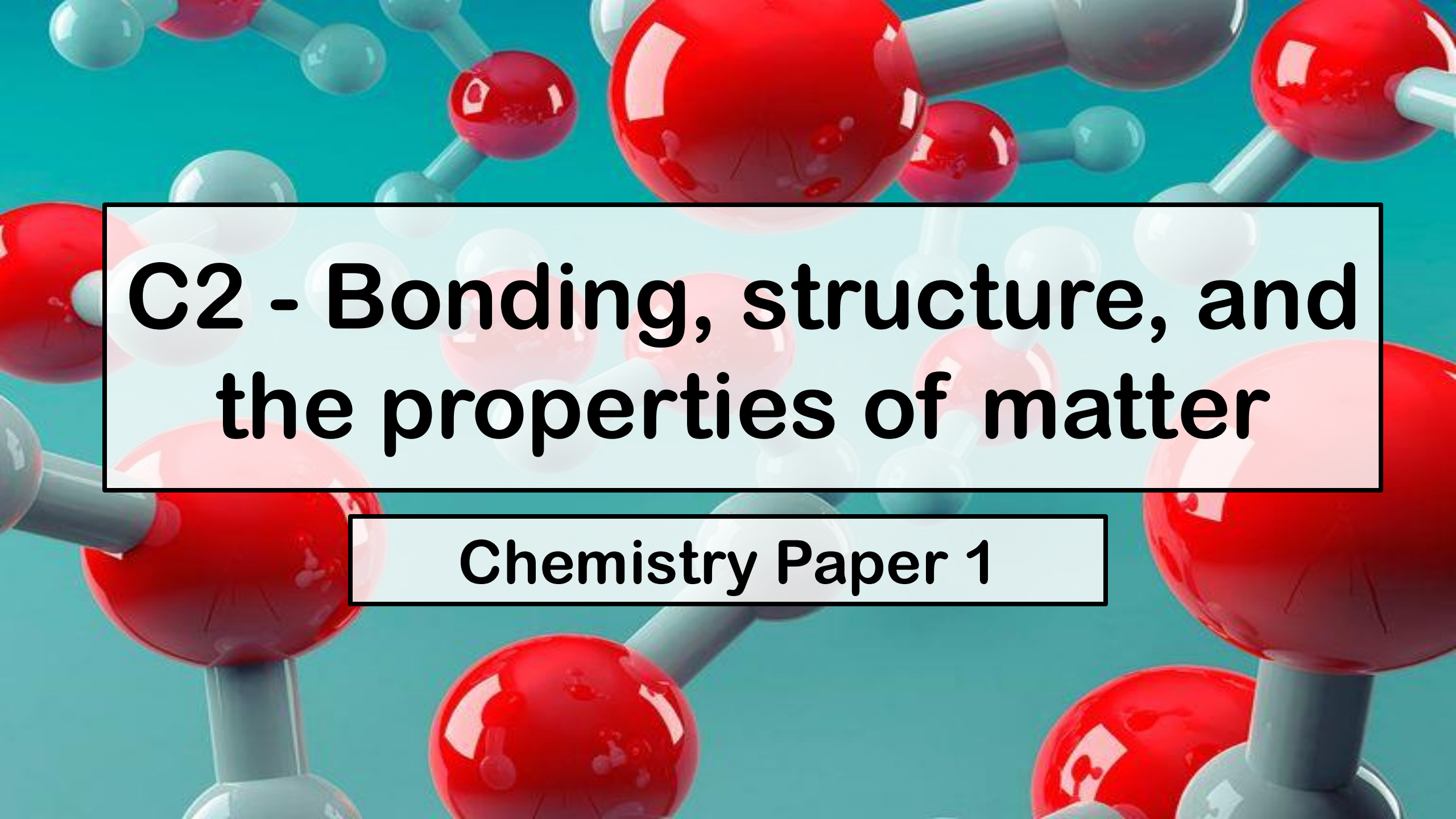

C2 - Bonding, structure, and the properties of matter

Chemistry Paper 1

C2 - Bonding, structure, and the properties of matter

Chemistry Paper 1

Lesson	Content
C2.1	The Particle Model and States of Matter
C2.2	Ionic Bonding
C2.3	Covalent Bonding
C2.4	Metallic Bonding
C2.5	Giant Covalent Structures
C2.6	Nanoparticles *(TRIPLE ONLY)*

Chemists use theories of structure and bonding to explain the physical and chemical properties of materials. Analysis of structures shows that atoms can be arranged in a variety of ways, some of which are molecular while others are giant structures. Theories of bonding explain how atoms are held together in these structures. Scientists use this knowledge of structure and bonding to engineer new materials with desirable properties. The properties of these materials may offer new applications in a range of different technologies.

Chemistry Paper 1

C2.1 –The Particle Model and States of Matter

We are learning this because it helps us to visualise the behaviour of particles

Learning Intention: To be able to explain the particle model and discuss the changes in state

Key words:
Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds

Particle Model

Fill in the blank boxes for the particle model

Solid **Liquid** **Gas**

A state of matter is a distinct form that matter can take on

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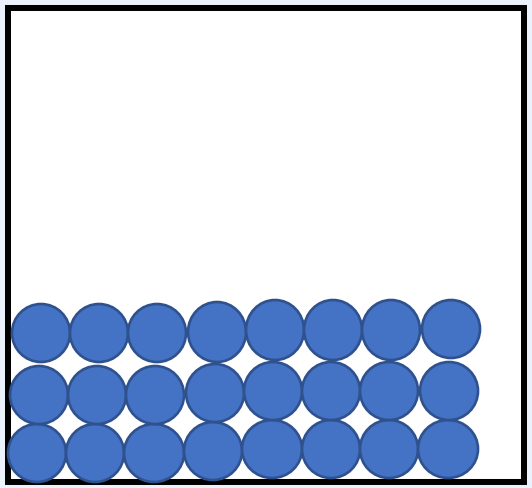
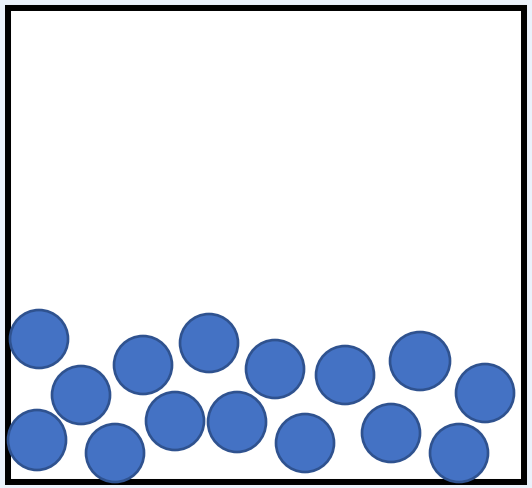
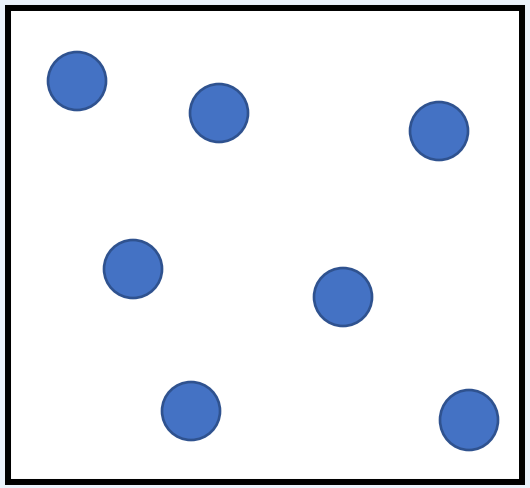
Particle Model Recap



Solid



Liquid



Gas

A state of matter is a distinct form that matter can take on

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Key words:
Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds

States of Matter

Sort the following boxes as into properties of SOLIDS, LIQUIDS or GASES

Particles are joined, packed side-by-side in fixed positions

Particles are far apart

Particles have some attraction to each other

Fixed shape & volume

Can be squashed

Particles close together but not in fixed positions

Cannot be squashed

No fixed shape, but do have fixed volume

Cannot be squashed

Particles strongly attracted to each other

Quick, lots of movement in particles

No fixed shape nor volume

Particles don't interact with each other

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States of Matter

SOLID
LIQUID
GAS

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Limitations of the particle model

- We draw solids liquids and gases using the particle model

- However the way this is shown does not necessarily give us the full picture

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Limitations of Particle Model

Higher

Limitations of the particle model

This simple particle model assumes that particles are made up of solid spheres with no forces operating between them. This is useful when comparing the properties of solids, liquids, and gases. However, the particles that make up substances are atoms, molecules, or ions. They can vary in size from the small He atoms in helium gas to the polymer molecules in plastics, which can contain many thousands of atoms and are not spherical. The interactions between neighouring atoms, molecules, and ions can also distort their shapes. Atoms are mostly empty space, so real particles are not solid at all.

Read the paragraph and make 3 summary bullet points

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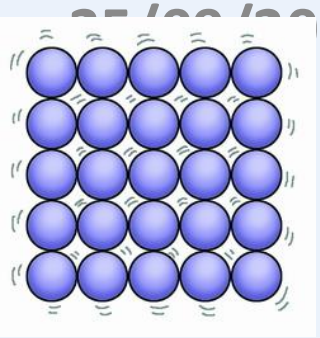
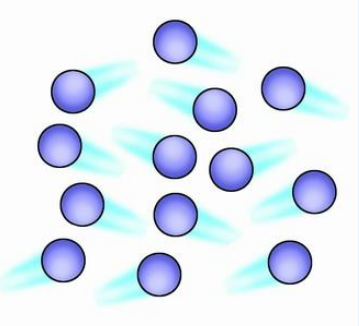
Problems with the Particle Model

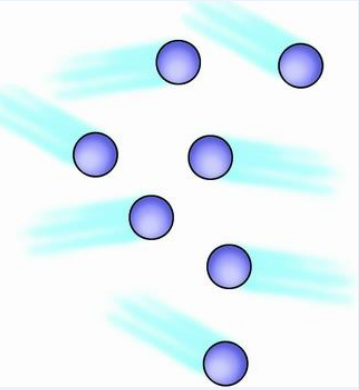


×There are no forces shown between the spheres



×All particles are represented as spheres

×The spheres are solid (we know atoms are not!)



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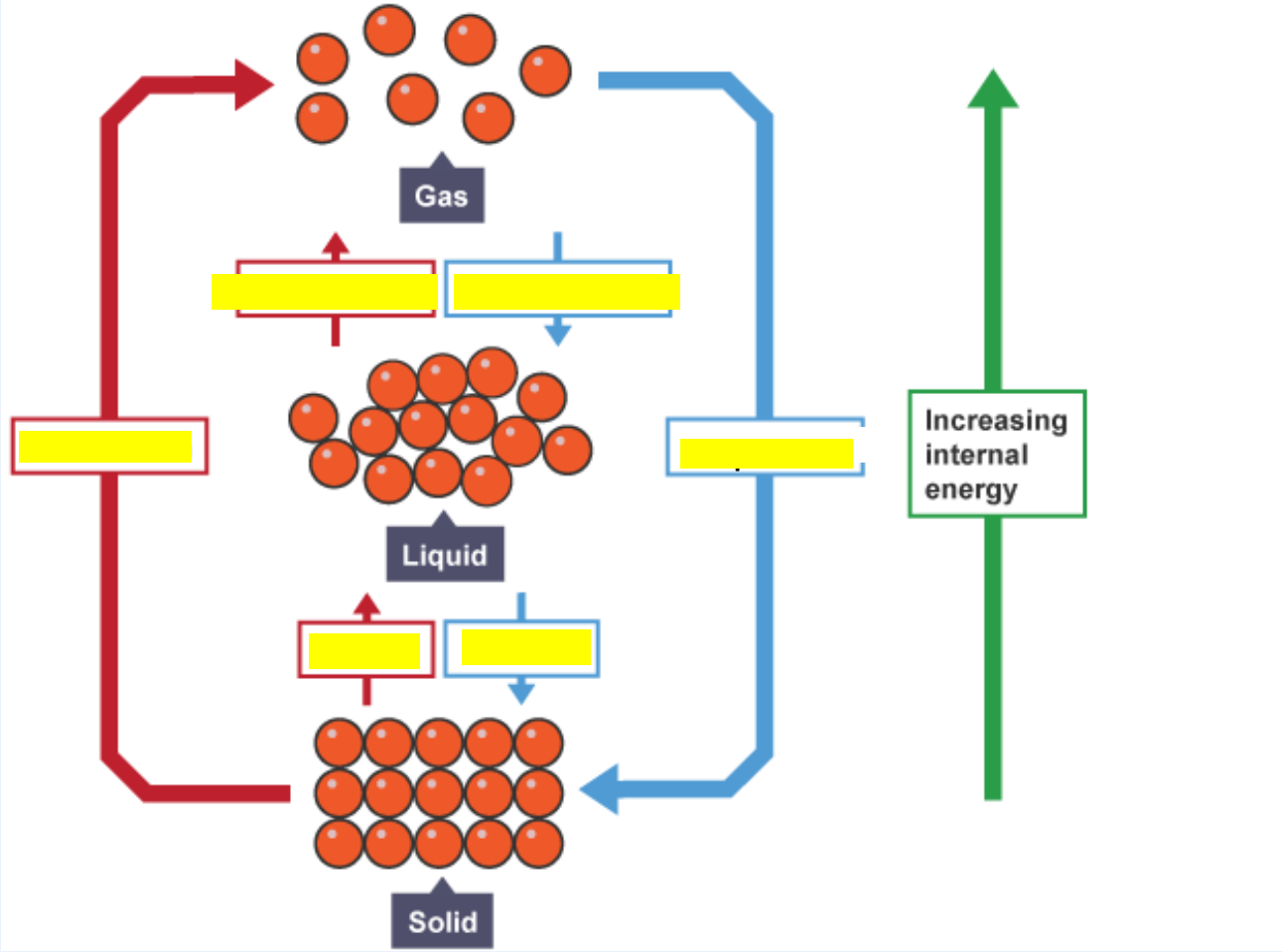
Changes in State



Fill in the blank yellow boxes of the changes of state processes

We are learning this because it helps us to visualise the behaviour of particles

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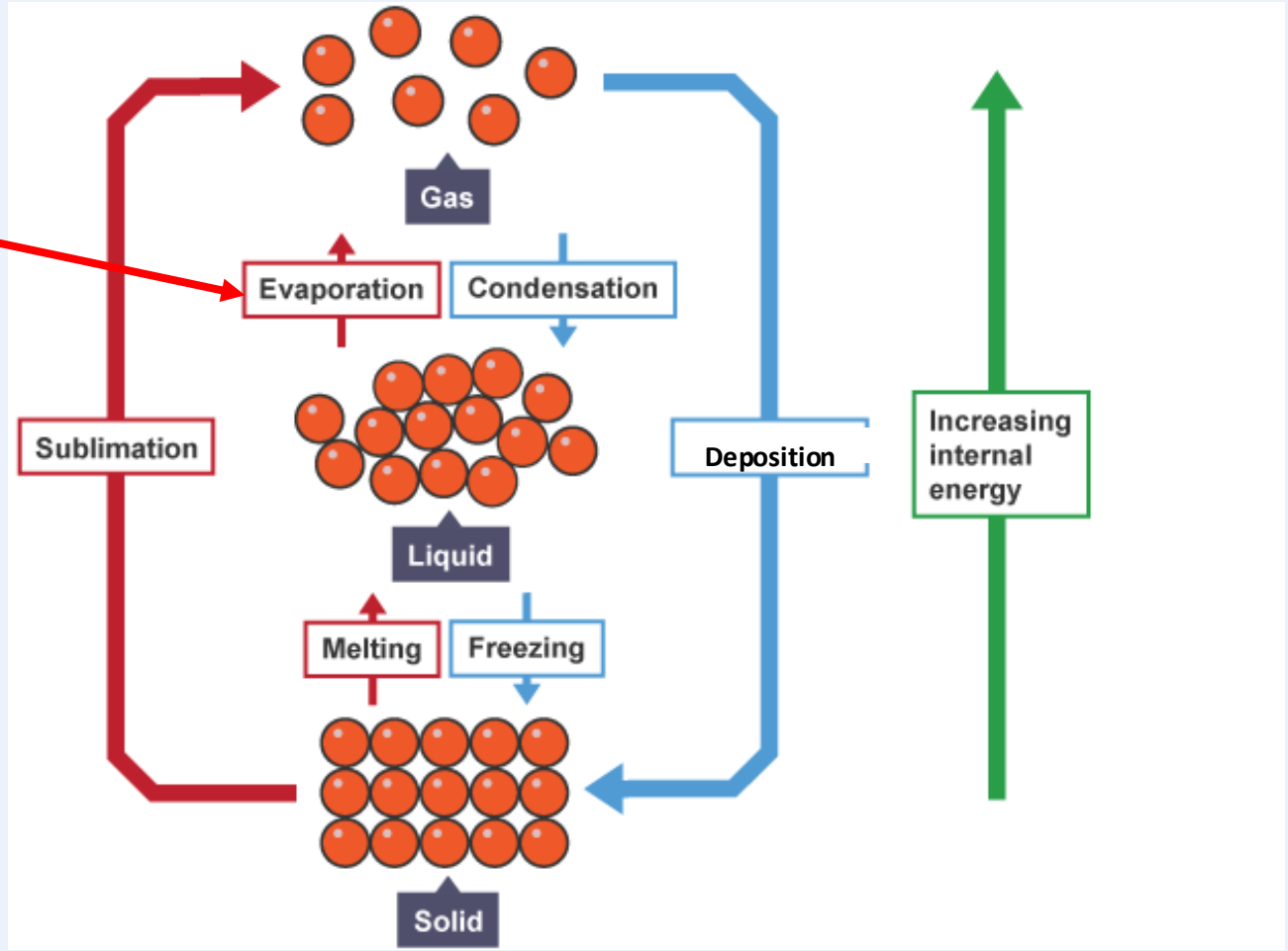
Key words:
Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds

Changes in State

Evaporation can be referred to as VAPORISATION



This is a recap from Year 7, make sure you remember these!

We are learning this because it helps us to visualise the behaviour of particles

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Key words:
Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds

What temperatures do you think the following pictures are at?

25/09/2025

0 °C

Melting Point

100 °C

Boiling Point

We are learning this because it helps us to visualise the behaviour of particles

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Changing State

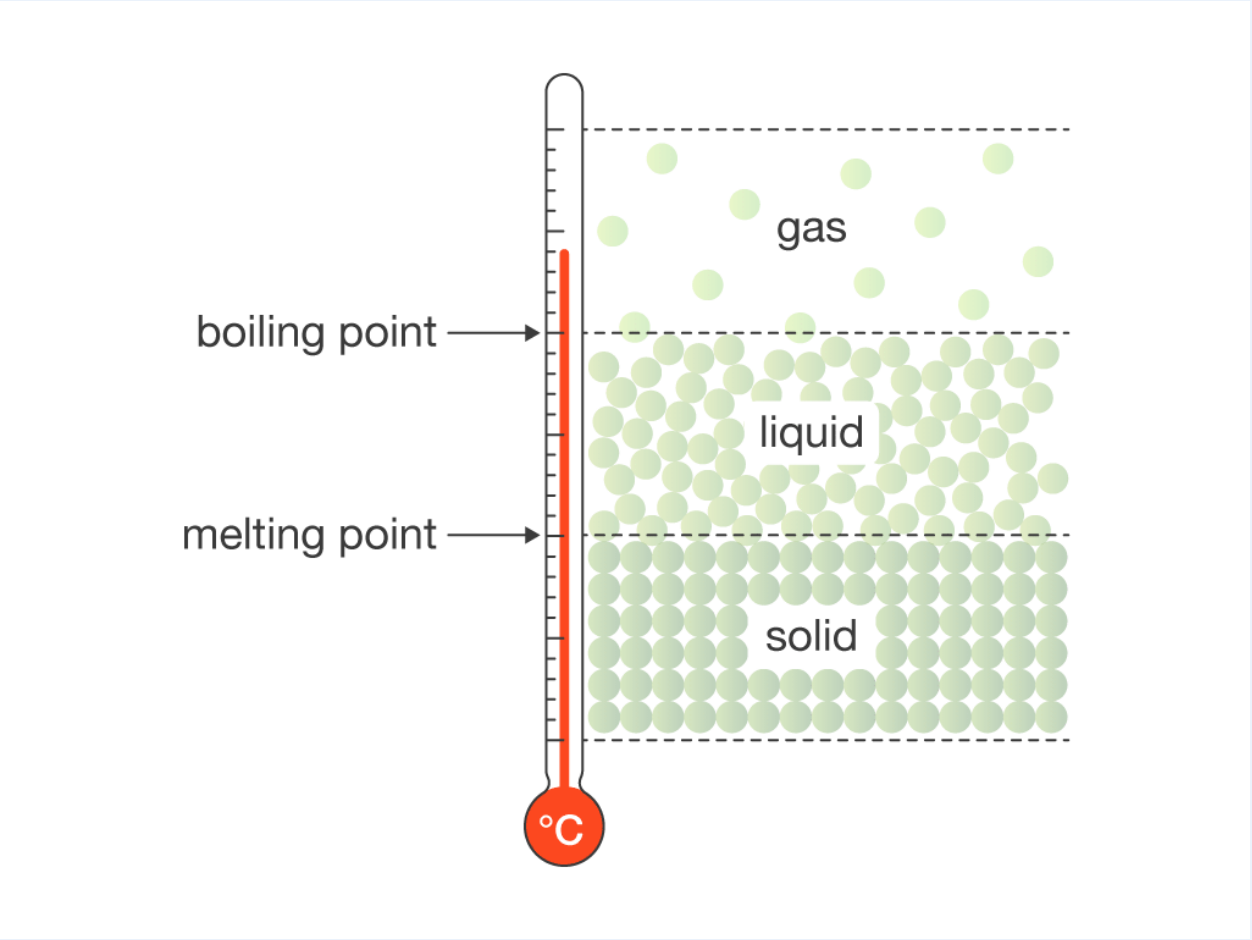
Melting point and boiling point… What changes occur at these points?

- **Melting Point =**

  Melting and freezing

- **Boiling Point =**

  Boiling/evaporating and condensing



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Key words:
Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds

what state?

Fill in the column for the state at room temperature (20°C)

Element	Melting point (°C)	Boiling point (°C)	State at room temp?
Oxygen	- 218.79	-182.95	
Bromine	-7.20	58.80	
Potassium	63.38	759.00	
Iron	1538.00	2861.00	
Neon	-248.59	-246.08	

Extension:
What state would each element be at 100°C?

We are learning this because it helps us to visualise the behaviour of particles

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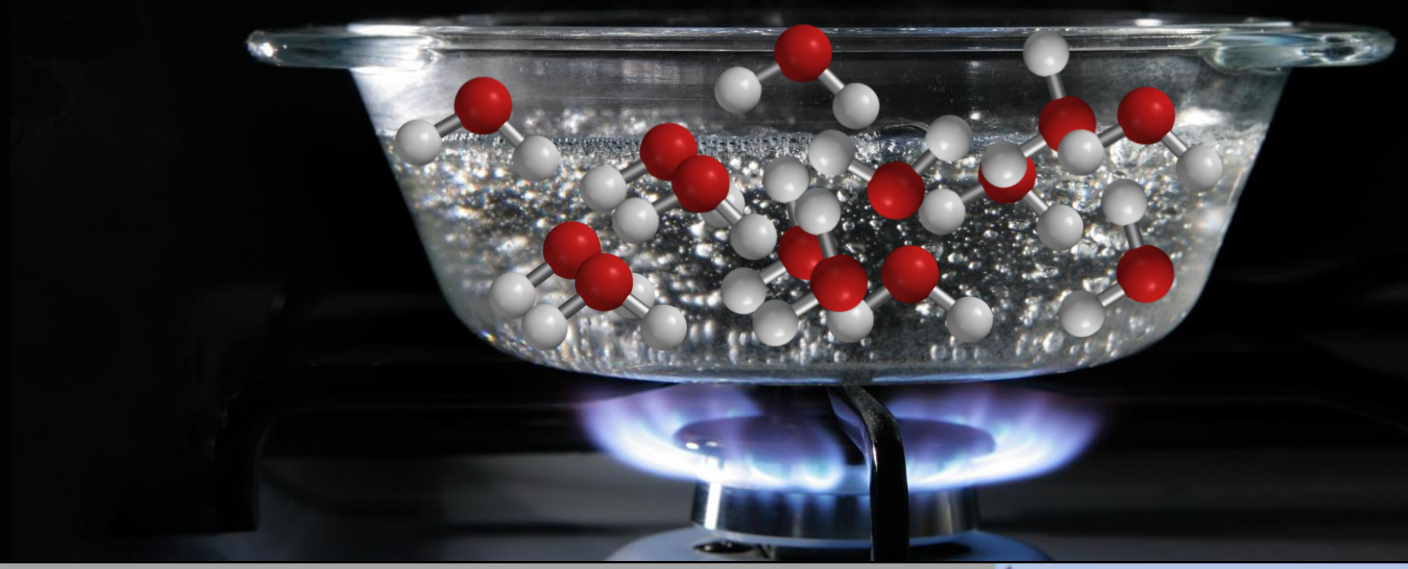
Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds

When water boils, why is steam produced and not hydrogen and oxygen gas?



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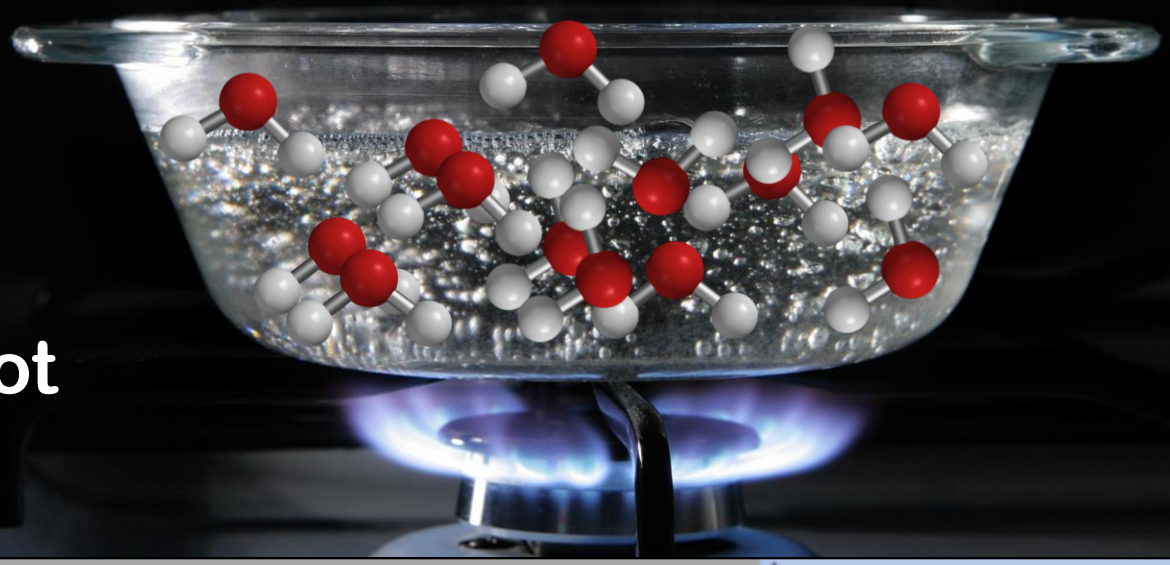
Boiling Point

- **Melting and boiling are both due to breaking of intermolecular bonds**
- **When water is boiled, it is bonds BETWEEN water molecules that break, not covalent bonds between hydrogen and oxygen**
- **Boiling water makes steam, not hydrogen gas and oxygen gas**

Intermolecular bonds are much weaker than intramolecular bonds (i.e. ionic/covalent/ metallic bonds)



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Key words:
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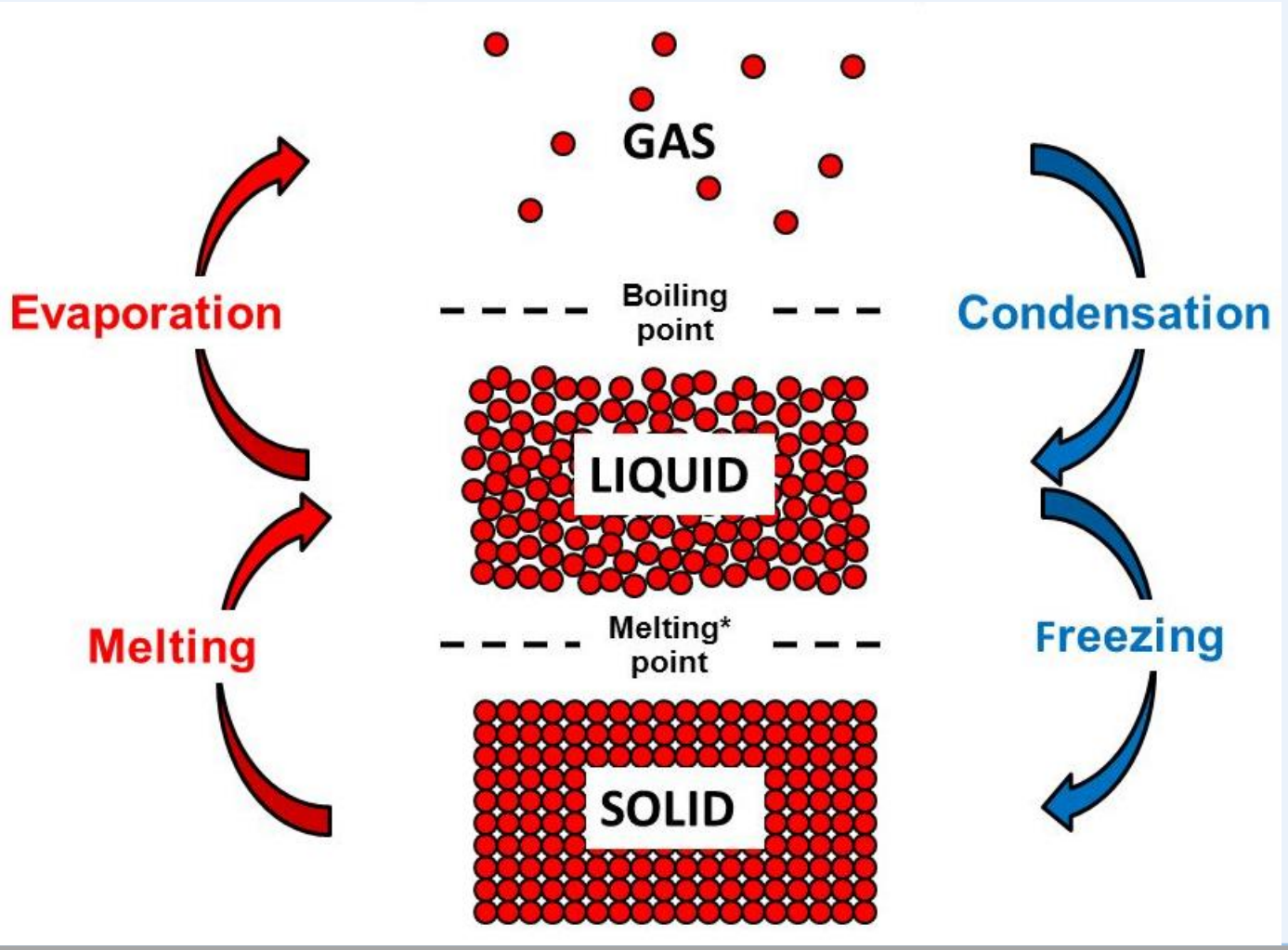
SOLID
STATES
OF
MATTER
LIQUID
GAS

Changing State



- The amount of energy needed to change state from **solid to liquid** and from **liquid to gas** depends on the strength of the forces between the particles of the substance (intermolecular forces/bonds)
- The *stronger* the intermolecular forces, the more energy is required to break them, the higher the melting point and boiling point of the substance

We are learning this because it helps us to visualise the behaviour of particles

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Key words:
Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds

- **Write down an explanation of why a substance melts when it is heated above its melting point**

- **Your explanation must include the terms: Kinetic energy, vibration, forces of attraction**

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Key words:
Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds

Extension States of Matter: Post-GCSE!

- There's a 4th state of matter (not needed to know at GCSE)
- Called Plasma
- Plasma is hot, ionised gas consisting of approx equal numbers of positively charged ions and negatively charged electrons
- Characteristics of plasma = very, very different from those of ordinary neutral gases
- Eg plasmas are made up from charged particles, so they are very strongly influenced by magnetic and electrical fields – ordinary neutral gases aren't
- This is why we class Plasma as a 4th state of matter

You do not need to know this for GCSE, but its cool right?!
(Or should we say HOT?!)

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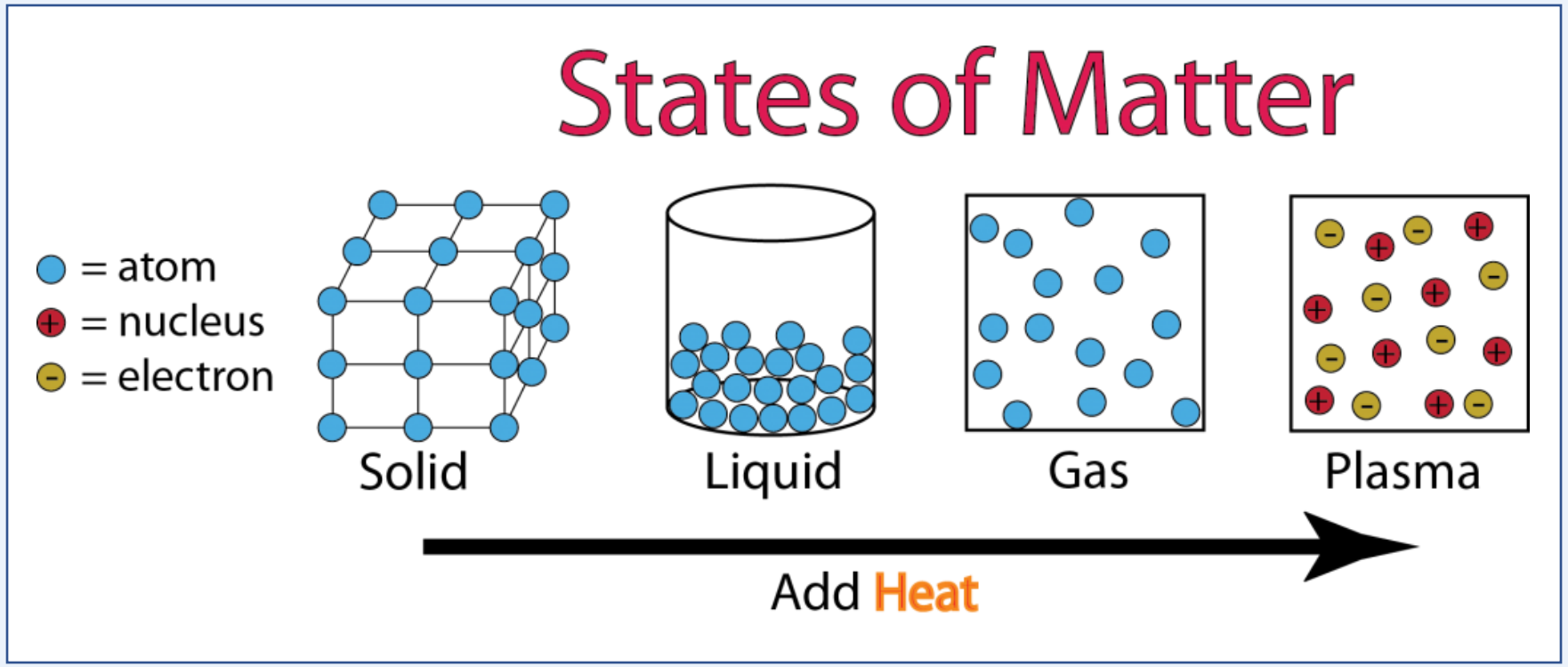
Extension States of Matter: Post-GCSE!



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State Symbols

- We have developed standardised shorthand method for describing chemical reactions, using state symbols
- State symbols are used to indicate states of reactants and products of chemical reactions

( ) = solid

( ) = liquid

( ) = gas

( ) = aqueous, *(solution – something dissolved in water)*

Fill in the blank yellow boxes for the state symbol

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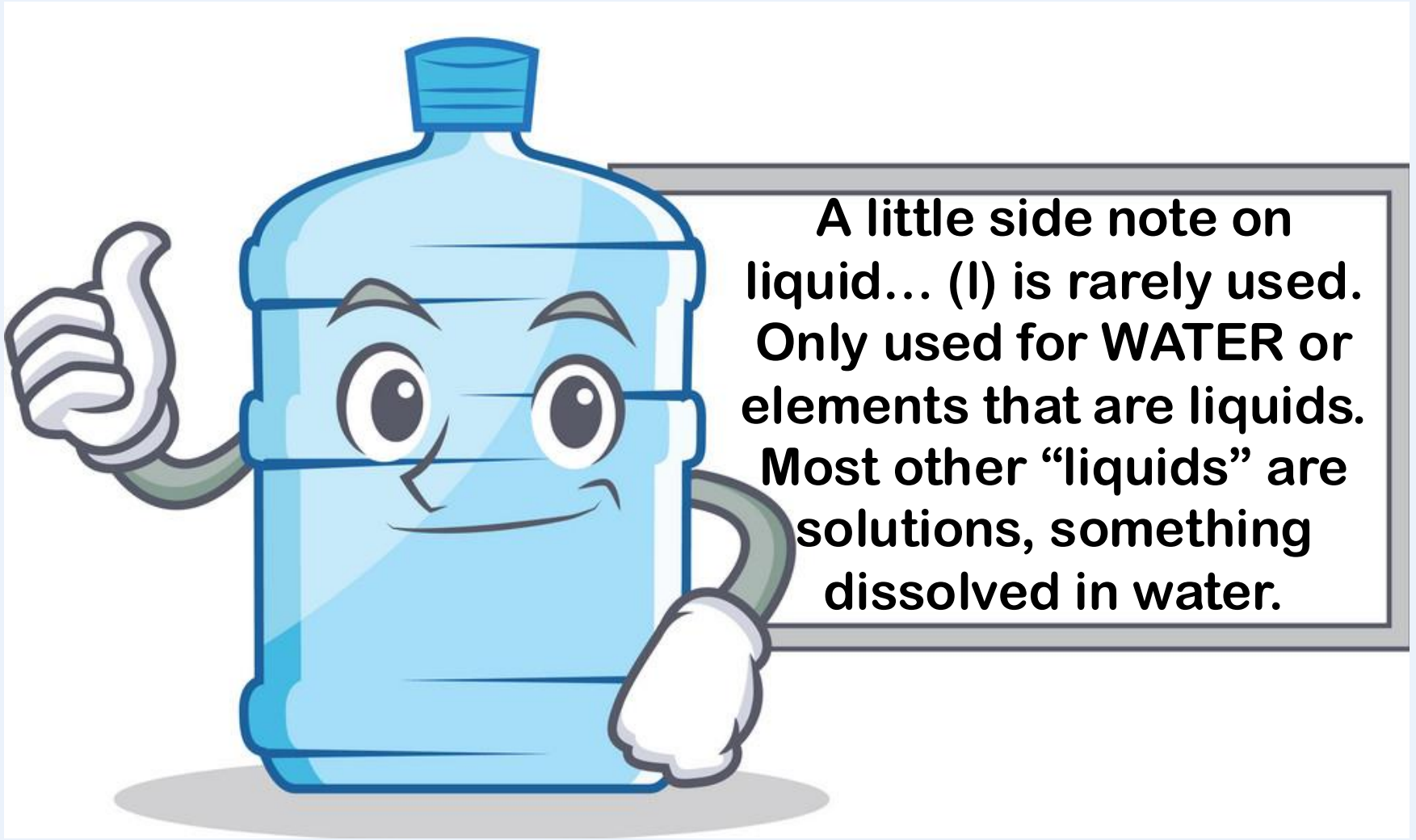

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State Symbols – Example

Magnesium burns in oxygen, forming magnesium oxide

$$2Mg_{(s)} + O_{2\ (g)} \rightarrow 2MgO_{(s)}$$

We can tell that magnesium was a solid, that reacted with oxygen gas (in the air) and made a solid product, magnesium oxide

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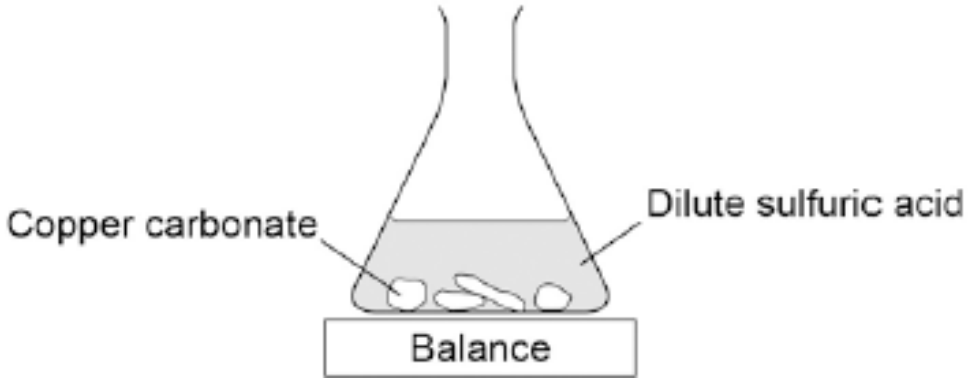
State Symbols – your turn!

A student investigated the reaction of copper carbonate with dilute sulfuric acid

The student used the apparatus shown in the figure below.



Fill in the gaps!

(a) Complete the state symbols in the equation

$$CuCO_{3\ (.....)} + H_2SO_{4\ (aq)} \rightarrow CuSO_{4\ (aq)} + H_2O_{(.....)} + CO_{2\ (.....)}$$

(2)

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Exam Question Practice

Have a go at the exam questions!

Q1.

The three states of matter are solid, liquid and gas.

(a) Lithium reacts with water to produce lithium hydroxide solution and hydrogen.

Use the correct state symbols from the box to complete the chemical equation.

aq	g	l	s

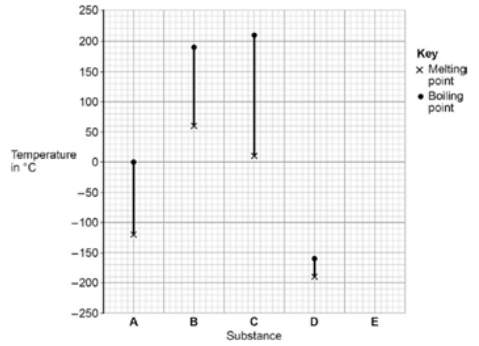
$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(\_\_\_\_) + H_2(\_\_\_\_)$

lithium + water → lithium hydroxide + hydrogen

(2)

(b) **Figure 1** shows the melting points and the boiling points of four substances, **A**, **B**, **C** and **D**.

Figure 1



Which substance is liquid over the greatest temperature range?

Tick **one** box.

A ☐

B ☐

C ☐

D ☐

(1)

(c) Which **two** substances are gases at 50 °C?

Tick **one** box.

A and **B** ☐

B and **C** ☐

C and **D** ☐

A and **D** ☐

(1)

(d) A different substance, **E**, has:

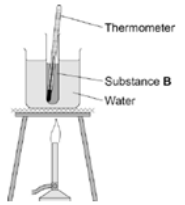
- a melting point of −50 °C
- a boiling point of +120 °C

Plot these two values on **Figure 1**.

(2)

(e) **Figure 2** shows the apparatus a student used to determine the melting point and the boiling point of substance **B** in **Figure 1**.

Figure 2



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Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds

Exam Question Practice – Mark Scheme

1.

(a) LiOH (aq)

this order **1**

H_2 (g) **1**

(b) C **1**

(c) A and D **1**

(d) point x at −10 °C **1**

point • at +150 °C **1**

(e) substance B will not reach its boiling point of 190 °C **1**

because the boiling point of water is only 100 °C **1**

(f) there is too much substance B to melt instantly.

allow answers based on thermal conductivity or temperature gradient from the wall of the test tube to the thermometer **1**

[9]

We are l

Learning Intenti
changes in state

y words:
id, liquid, gas,
raction, melt, boil,
porate, intermolecular
nds

Exam Question Practice – Mark Scheme

2. (a) balls are far apart from each other — 1

balls move randomly — 1

(b) solid — 1

gas — 1

[4]

We are learning this because it helps us to visualise the behaviour of particles

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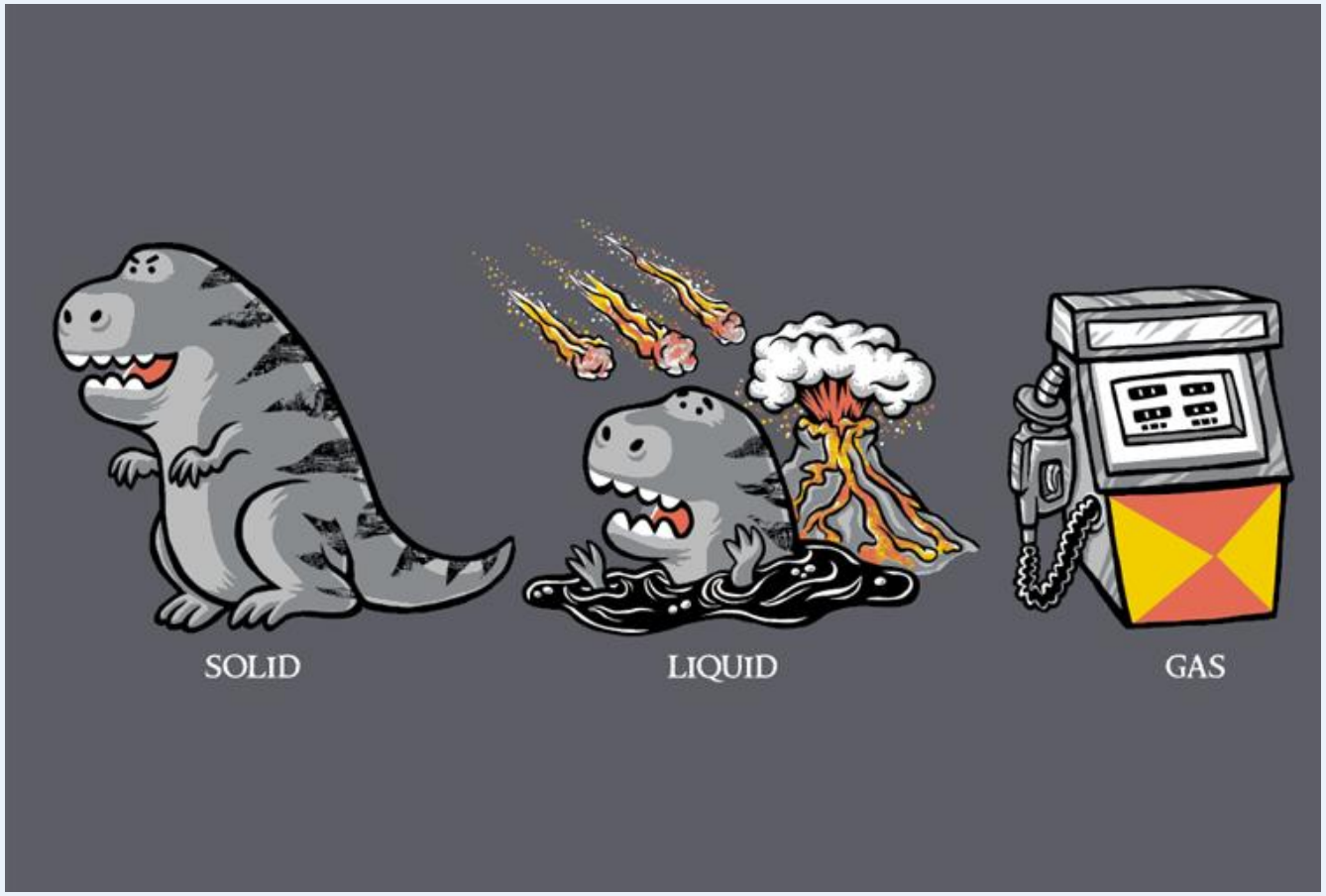
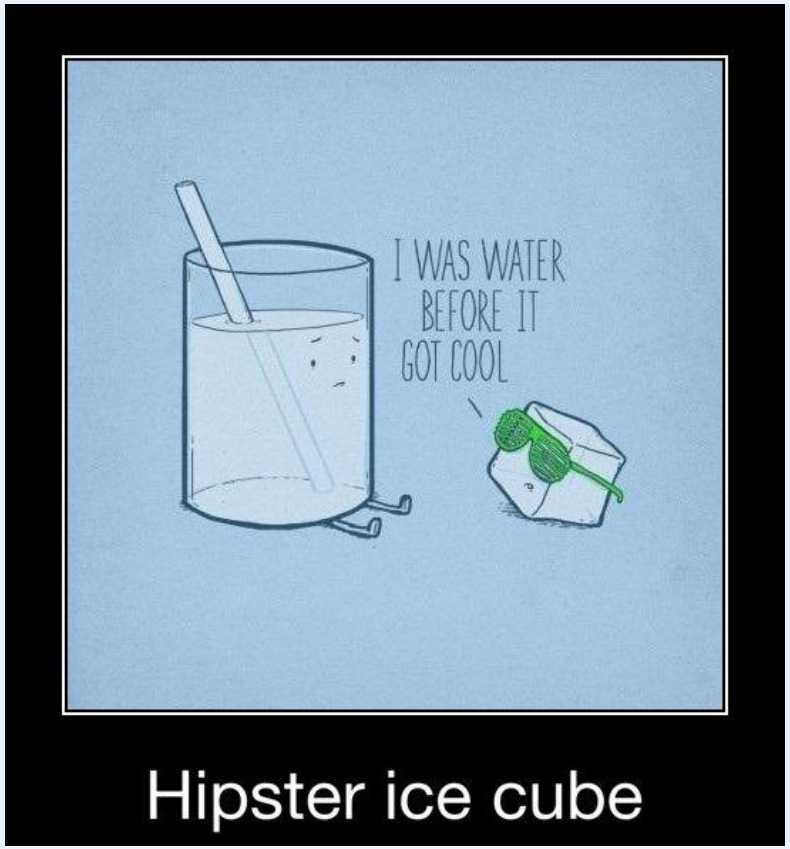
Explain the pictures!





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Say what you see…

Chemical bonds, what are they?

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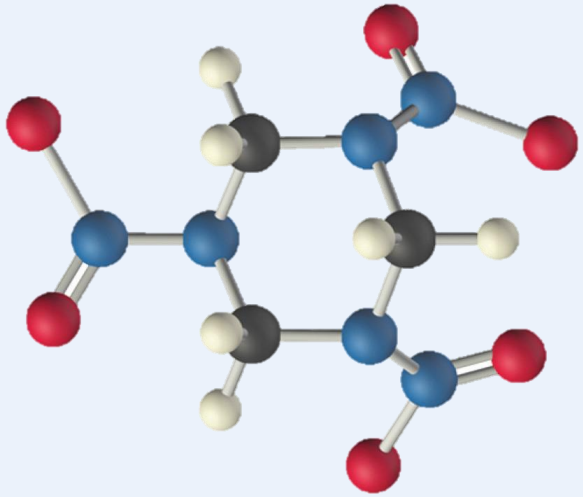
Chemical Bonds

A chemical bond is a lasting attraction between atoms that enable formation of chemical compounds, i.e it's how atoms are held together



There are 3 types of chemical bond… what are they?

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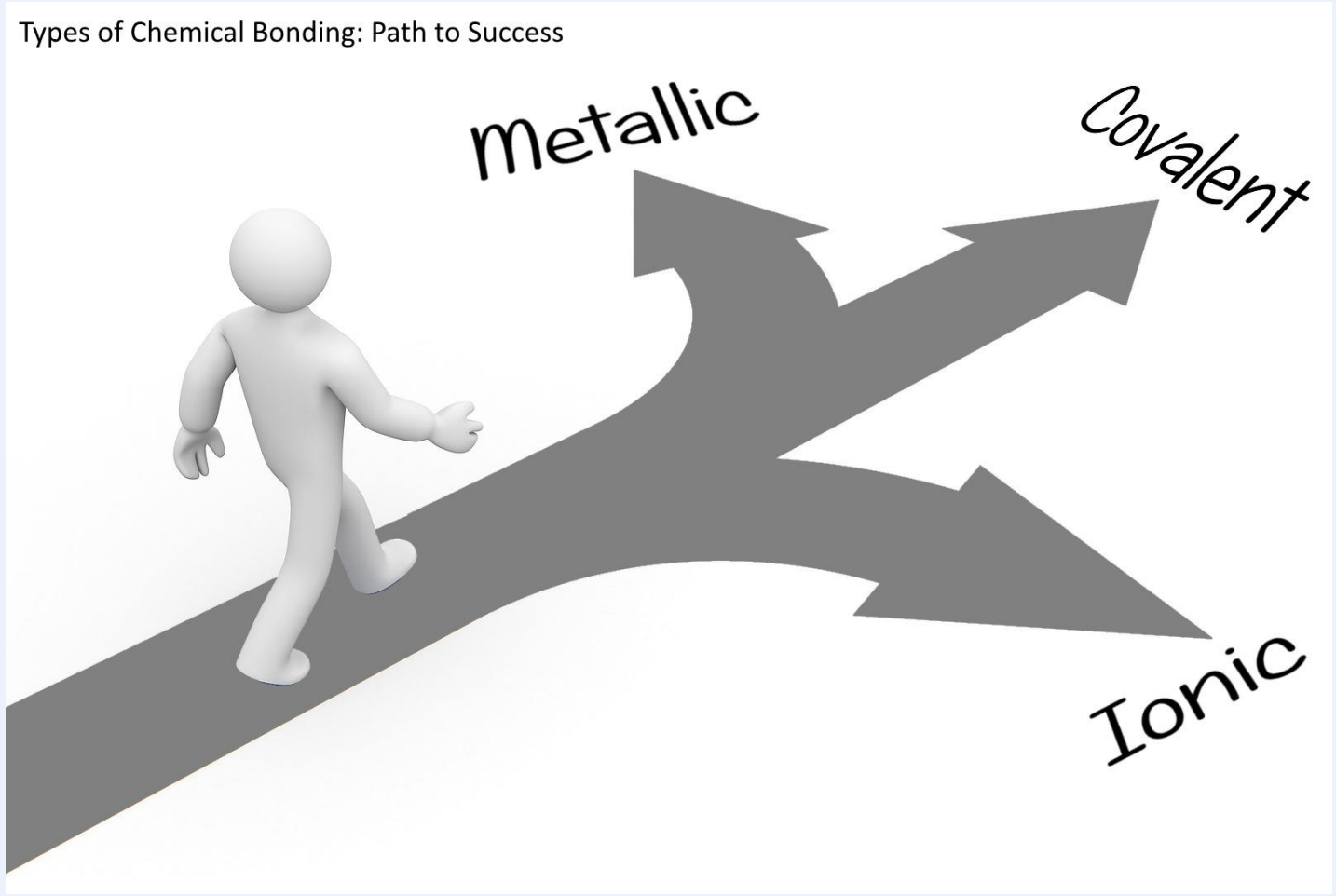
Solid, liquid, gas, attraction, melt, boil, evaporate, intermolecular bonds



We will be learning about all 3 types in this topic. It is important that you can describe and explain the differences between them

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