WORKBOOK

Online Chem Tuition

Bonding, Structure, and the Properties of Matter

TOPIC TWO

3RD APRIL

HELLO!

Welcome to your AQA GCSE Chemistry revision session. This workbook is designed to be straightforward and directly aligned with what I'll cover in the live lesson, it offers a practical way to apply your knowledge as you learn.

What's in the Workbook:

- **Questions**: These are selected to match the lesson topic, providing you with a chance to practice and solidify your understanding.
- **Symbols Guide**:
  HT - Indicates advanced content aimed at **Higher Tier** students.

  - Signifies material for **GCSE Chemistry** students only.

Using the Workbook During Lesson:

- **Stay Engaged**: Be ready to participate and use the workbook alongside the lesson. You can use the chat to ask questions or get help.
- **Peer Learning**: Take advantage of the group setting. Your classmates' questions can provide additional insights.

Zoom Lesson:

Make sure you have your workbook and a pen ready and join us here.

See you on Zoom!

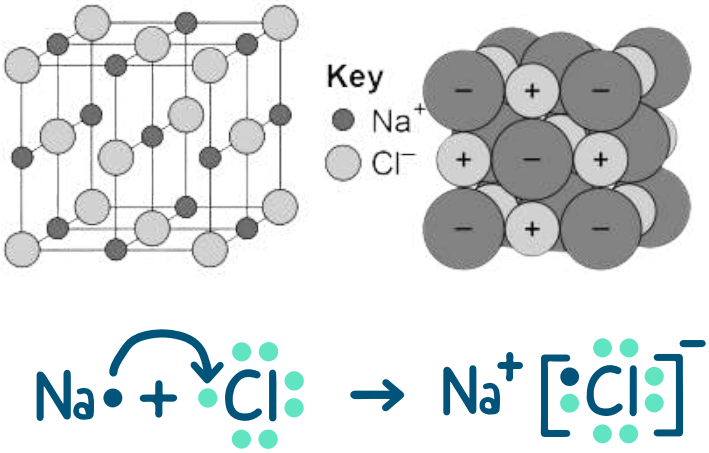
ALISON GREEN

Online Chem Tuition

CHEMICAL BONDING

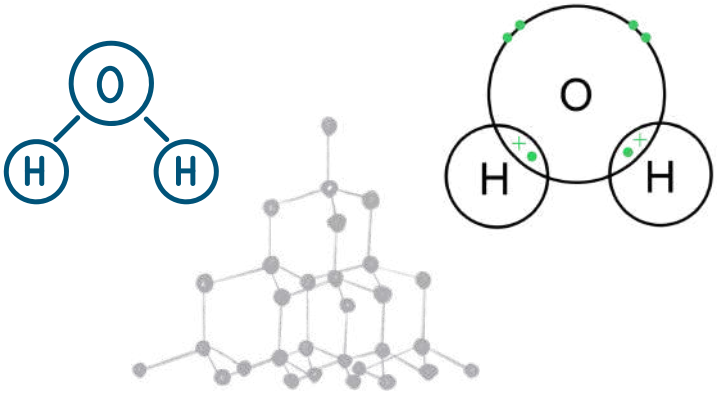
IONIC BONDING

Occurs between **metals and non-metal**s, involving the **transfer of electrons** from metal atoms to non-metal atoms, forming oppositely charged ions. An ionic compound is a **giant** structure of **ions** forming a **lattice**. Ionic compounds are held together by **strong electrostatic forces of attraction between oppositely charged ions**. These forces act in all directions in the lattice. Ionic compounds typically have high melting and boiling points due to strong electrostatic forces between ions.



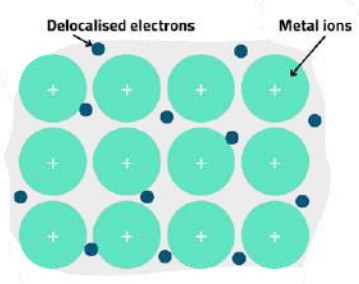
COVALENT BONDING

Involves the **sharing** of pairs of **electrons** between **non-metal atoms**. This type of bonding can form either **simple molecular** structures with low melting and boiling points due to weak intermolecular forces, or **giant covalent structures** like diamond and silicon dioxide, which have very high melting points.



METALLIC BONDING

Metals consist of giant structures of **atoms** arranged in a **regular pattern**. The **electrons** in the outer shell of metal atoms are **delocalised** and so are **free to move through the whole structure**. The sharing of delocalised electrons gives rise to strong metallic bonds. This bonding explains metals' high melting and boiling points, electrical conductivity, and malleability.



BONDING

Q1. Name the type of bonding in compounds formed between metals and non-metals.

[1 mark]

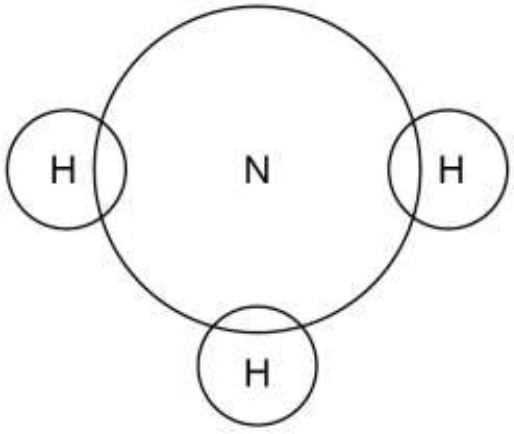
AQA June 22 H Q1.6

Q2. Calcium nitrate contains the ions Ca^{2+} and NO_3^- Give the formula of calcium nitrate.

[1 mark]

AQA June 18 H Q1.2

Q3.a) Complete the dot and cross diagram for the ammonia molecule shown below. Show only the electrons in the outer shell of each atom.



[2 marks]

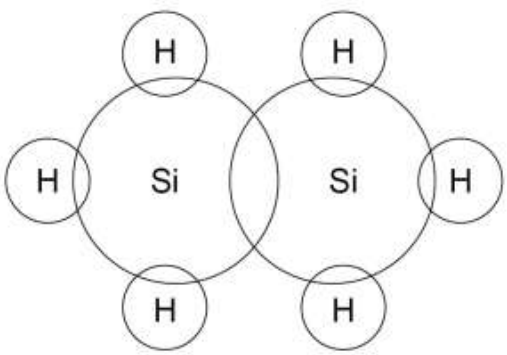
AQA June 19 H Q5.1

Q3.b) Give **one** limitation of using a dot and cross diagram to represent an ammonia molecule.

[1 mark]

AQA June 19 H Q5.2

Q4. Si_2H_6 is a covalent compound of silicon and hydrogen. Complete diagram below to show the outer shell electrons in a molecule of Si_2H_6



[1 mark]

AQA June 22 H Q7.5

Q5. Magnesium oxide is a compound formed from the metal magnesium and the non-metal oxygen. Describe what happens when a magnesium atom reacts with an oxygen atom. You should refer to electrons in your answer

[4 marks]

AQA June 22 H Q1.7

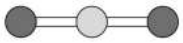
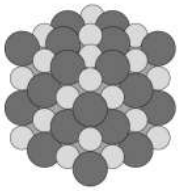
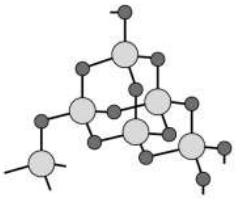
Q6. Draw a dot and cross diagram to show what happens when atoms of sodium and oxygen react to produce sodium oxide.
Sodium is a Group 1 element and oxygen is a Group 6 element.

[4 marks]

AQA June 21 H Q4.4

Q7. Table below shows the structures of three compounds

Diagrams not to scale

Compound	Structure
Carbon dioxide	 Key: O, C
Magnesium oxide	 Key: O^{2-}, Mg^{2+}
Silicon dioxide	 Key: O, Si

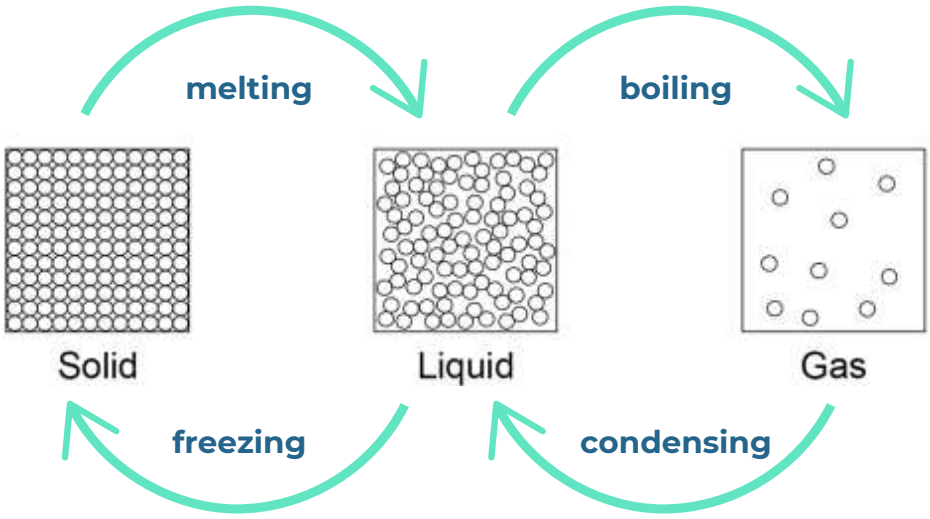
Compare the structure and bonding of the three compounds:
• carbon dioxide • magnesium oxide • silicon dioxide

[6 marks]

AQA June 2020 H Q1.2

PROPERTIES

The three states of matter can be represented by a simple model. In this model, particles are represented by small solid spheres.



HT Limitations of the simple model above include that in the model there are no forces, that all particles are represented as spheres and that the spheres are solid.

Determining structure and bonding from physical properties

DOES IT CONDUCT ELECTRICITY WHEN SOLID?

YES → **GIANT METALLIC**

Metals are ductile, malleable, good conductors of heat and electricity due to the **delocalised electrons** moving **through the structure**. **Alloys**, mixtures of a metal with other metals or non-metals, are **harder** than pure metals due to the **disruption** of the metal lattice structure.

NO ↓

DOES IT CONDUCT ELECTRICITY WHEN MOLTEN / DISSOLVED?

YES → **GIANT IONIC**

Generally soluble in water, **conduct electricity** when **molten or in solution** due to the **ions** being able to **move**. **Cannot conduct** when **solid** as the **ions** are fixed in the lattice and **cannot move**.

NO ↓

DOES IT HAVE A LOW MELTING / BOILING POINT?

YES → **SIMPLE MOLECULAR**

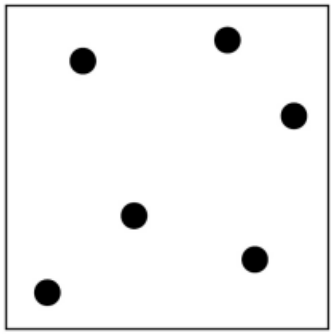
Molecules held together by **weak intermolecular forces**, leading to **low melting and boiling points** (only a small amount of energy needed to overcome) and **non-conductivity of electricity** (no electrons free to move).

NO ↓

GIANT COVALENT

High melting points as lots of energy is needed to overcome the **strong covalent bonds**. Diamond, a form of carbon, is an excellent electrical insulator, while graphite, another form of carbon, conducts electricity.

Q8. The three states of matter can be represented by a simple particle model. Below is a simple particle model for hydrogen gas



HT

Give two limitations of this simple particle model for hydrogen gas.

[2 marks]

AQA June 20 H Q7.4

Q9. The table below shows information about four substances.

Substance	Melting point in °C	Boiling point in °C	Does it conduct electricity in the solid state?	Does it conduct electricity in the liquid state?
A	–117	79	No	No
B	801	1413	No	Yes
C	1535	2750	Yes	Yes
D	1610	2230	No	No

Which substance could be a metal?

[1 mark]

AQA June 21 H Q6.1

This question is about the halogens. Table below shows the melting points and boiling points of some halogens.

Element	Melting point in °C	Boiling point in °C
Fluorine	–220	–188
Chlorine	–101	–35
Bromine	–7	59

Q10.a) What is the state of bromine at 0 °C and at 100 °C?

[1 mark]

AQA June 20 H Q8.1

Q10.b) Explain the trend in boiling points of the halogens shown in the table.

[4 marks]

AQA June 20 H Q8.2

Q11. Chlorine reacts with hydrogen to form hydrogen chloride. Explain why hydrogen chloride is a gas at room temperature. Answer in terms of structure and bonding.

[3 mark]

AQA June 18 H Q7.3

Q12. Titanium chloride is a liquid at room temperature. Explain why you would **not** expect titanium chloride to be a liquid at room temperature.

[3 marks]

AQA June 18 H Q8.4

Q13. Explain why ammonia has a low boiling point. You should refer to structure and bonding in your answer

[3 marks]

AQA June 19 H Q5.3

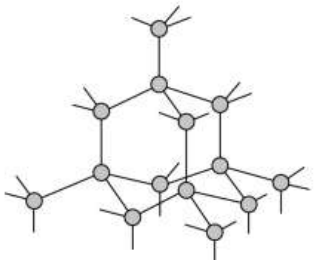
Q14. Explain why alloys are harder than pure metals.

[3 marks]

AQA June 21 H Q6.2

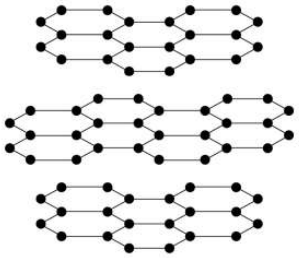
STRUCTURE AND BONDING OF CARBON

DIAMOND



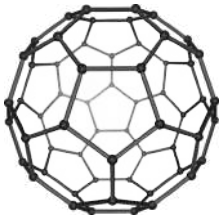
Each carbon atom forms **four strong covalent bonds** with other carbon atoms, creating a rigid **three-dimensional lattice**. This structure makes diamond extremely **hard** and gives it a very **high melting point** as l**ots of energy needed to overcome the strong covalent bonds.** Diamond does not conduct electricity as there are no free electrons.

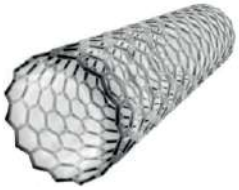
GRAPHITE



Consists of **layers of carbon atoms** arranged in a hexagonal lattice. Each **carbon atom is bonded to three others** in the plane, with **one delocalised electron per carbon atom.** This structure allows graphite to **conduct electricity** along the planes. The **layers are weakly bonded** to each other and **can slide over one another**, making graphite a good lubricant.

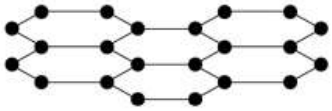
FULLERENES AND NANOTUBES





Molecules of carbon that can form closed cages. The most famous fullerene is **Buckminsterfullerene** (C_{60}), which has a **spherical** structure. **Carbon nanotubes are cylindrical fullerenes** with remarkable electrical and mechanical properties. They are **strong, can conduct electricity and heat**, and have potential applications in various fields, including electronics and materials science.

GRAPHENE



A **single layer of graphite**, graphene is a sheet of carbon atoms arranged in a hexagonal lattice. It is **incredibly strong, lightweight, and an excellent conductor of electricity and heat**. Graphene's unique properties make it of interest for a wide range of applications, from electronics to composite materials.

NANOPARTICLES

Nanoparticles range from **1 to 100 nanometres (nm)** in size.

Applications of Nanoparticles: The unique properties of nanoparticles have led to their use in various applications, including medicine (drug delivery systems), electronics (conductors and semiconductors), cosmetics (sunscreens and creams), and catalysts.

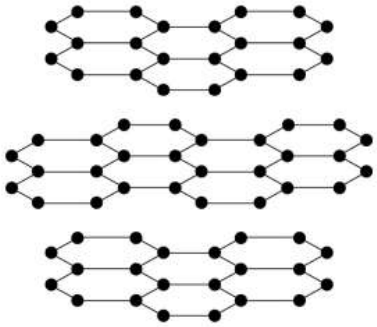
Nanoparticles may have properties different from those for the same materials in bulk because of their high surface area to volume ratio. It may also mean that smaller quantities are needed to be effective than for materials with normal particle sizes.

Q15. The diagram below represents the structure of graphite.

Explain why graphite is:

- a good electrical conductor
- soft and slippery.

You should answer in terms of structure and bonding.

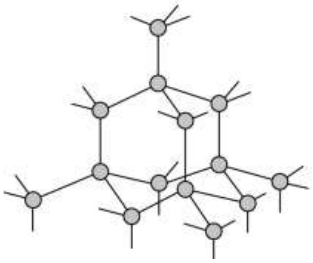


[6 marks]

AQA June 21 H Q1.6

Q16. Diagram below represents the structure of diamond.

Describe the structure and bonding of diamond.



[3 marks]

AQA June 22 H Q3.1

NANOPARTICLES

Q17.a) What shape is a Buckminsterfullerene molecule?

[1 mark]

AQA June 21 H Q1.1

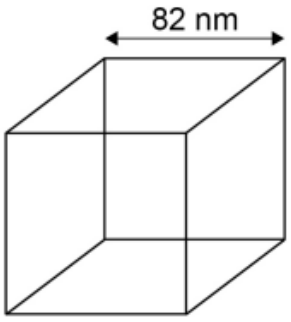
Q17.b) Give one use of a fullerene.

[1 mark]

AQA June 21 H Q1.1

Q18.a) A nanoparticle of zinc oxide is a cube of side 82 nm The diagram below represents a nanoparticle of zinc oxide.

Calculate the surface area of a nanoparticle of zinc oxide. Give your answer in standard form.



[3 marks]

AQA June 19 H Q3.3

Q18.b) Some suncreams contain zinc oxide as nanoparticles or as fine particles. Suggest **one** reason why it costs less to use nanoparticles rather than fine particles in suncreams.

[1 mark]

AQA June 19 H Q3.4

Q19. The structure and bonding in a carbon nanotube are similar to graphene. Carbon nanotubes are used in electronics because they conduct electricity. Explain why carbon nanotubes conduct electricity.

[2 marks]

AQA June 19 H Q3.1

ADDITIONAL RESOURCES

Congratulations on completing the workbook!

To further enhance your understanding and support your revision, I've curated a list of additional resources.

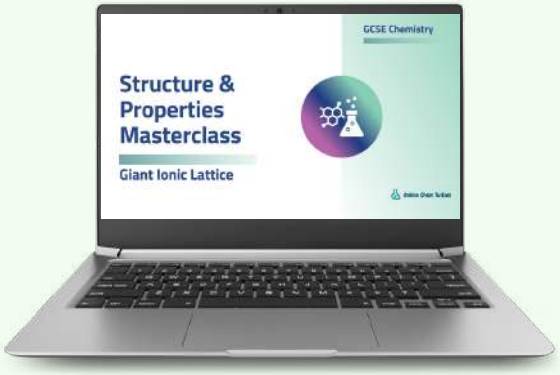
VIDEO

SIMPLE COVALENT

This video from my recorded masterclasses goes through simple molecules.

ACCESS NOW

WORKSHEET



VIDEO

IONIC LATTICES

This video from my recorded masterclasses goes through ionic lattices.

ACCESS NOW

WORKSHEET

Here are three videos from my recorded masterclasses.

METALLIC BONDING

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IONIC BONDING

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COVALENT BONDING

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