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VCE Chemistry ½

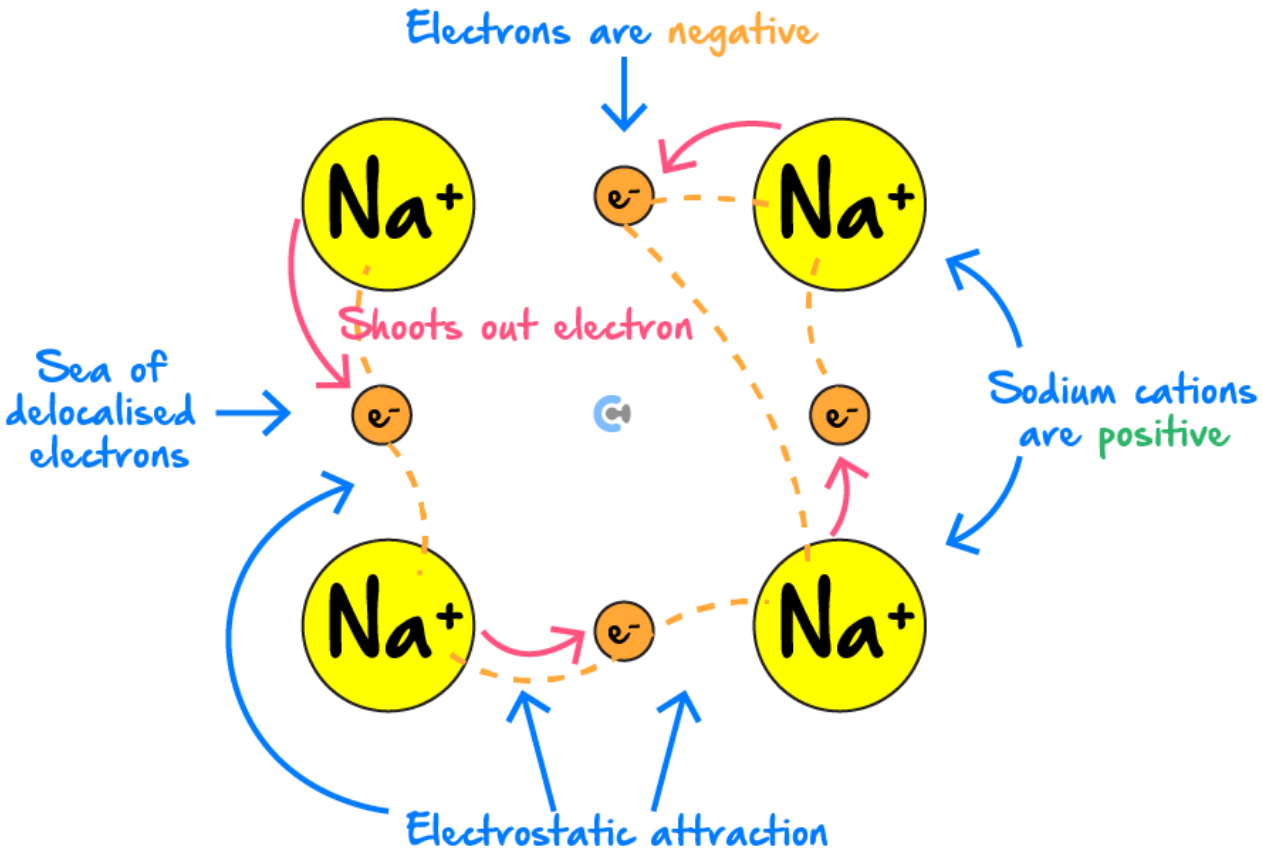
Metals & Covalent Lattice [0.2]

Workshop

Section A: Recap

Learning Objective: [1.3.1] – Explain the metallic bonding model

- Metallic bonding is caused by _____ between metal cations and the electrons lost.



- The lost electrons group together in a '_____ electrons'.
- The metal cations are arranged within a _____.

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Learning Objective: [1.3.2] – Identify properties of metals (High MP/BP, electrical & thermal conductivity, malleability & ductility, lustre)

- Metals are **[good] / [bad]** conductors of electricity and heat due to the presence of _____.
- Metals are malleable and ductile when struck, the lattice structure of a metal _____, but _____ due to electrostatic attraction between the cations and delocalised electrons.
- As delocalised electrons can reflect light, metals are _____.
- Metallic bonding is **strong, hard, and dense** due to the strong _____ between metal cations and the sea of delocalised electrons.
- A **[higher] / [lower]** charge of metal results in stronger metallic bonding.
- Within the same group, metals with smaller atomic radii will have **[greater] / [weaker]** electrostatic attraction and, therefore, **[stronger] / [weaker]** metallic bonding.
- Melting point → Intermolecular bonds are _____.
- Boiling point → Intermolecular bonds are _____.

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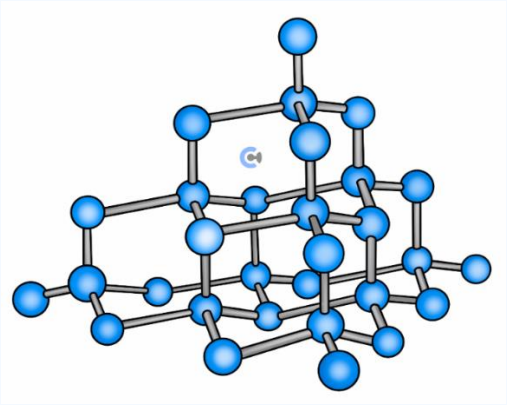
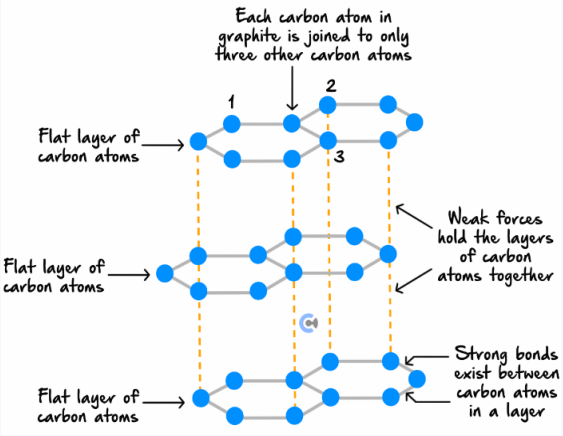
Learning Objective: [1.3.3] – Explain the covalent lattice structures bonding & properties of diamond and graphite

- Diamond and graphite are both _____ of carbon.

Diamonds	Graphite
	
Strength: **[High] / [Low]**	**Strength:** Vertical Strength: **[High] / [Low]** as it bonds via _____. Horizontal Strength: **[High] / [Low]** as it bonds via _____.
Melting Point: **[High] / [Low]**	Melting Point: **[High] / [Low]**
Conductivity of Electricity: **[High] / [Low]**	Conductivity of Electricity: **[High] / [Low]**
Conductivity of Heat: **[High] / [Low]**	Conductivity of Heat: **[High] / [Low]**

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Section B: Warm Up (17 Marks)

INSTRUCTION: 17 Marks. 11 Minutes Writing.

Question 1 (2 marks)

Write each of the following metals in their metal ion form:

a. Sodium. (0.5 marks)

b. Aluminium. (0.5 marks)

c. Potassium. (0.5 marks)

d. Magnesium. (0.5 marks)

Question 2 (4 marks)

Suppose there exists 4 Beryllium atoms that exist next to each other in space.

a. Write a beryllium atom's ion form, classifying the ion type. (1 mark)

_____

b. Draw the metallic lattice of these beryllium atoms, including all the aspects of metallic bonding. (3 marks)

Question 3 (1 mark)

What is the metallic bonding model best described as?

A. An electrostatic attraction between metal atoms and delocalised electrons.

B. The tendency of metal atoms to lose electrons when bonding with other elements.

C. The electrostatic attraction between layers of positive metal ions and negative metal ions.

D. Layers of metal cations held electrostatically by surrounding delocalised electrons.

Question 4 (1 mark)

Which one of the following will not undergo metallic bonding?

A. Pb

B. Hg

C. Si

D. W

Question 5 (3 marks)

a. Draw the metallic bonding structure of potassium metal, showing at least six potassium atoms and the appropriate number of electrons. (2 marks)

b. Label one instance of the attraction that holds the metallic structure together on the diagram above. (1 mark)

Question 6 (6 marks)

Consider the atom of Magnesium.

a. Draw the Lewis Structure of Magnesium. (2 marks)

b. State what Mg needs to do in order to become stable. (1 mark)

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c. Do you expect Mg to have stronger or weaker metallic bonding than Li? Justify your answer. (3 marks)

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Section C: Ramping Up (13 Marks)

INSTRUCTION: 13 Marks. 10 Minutes Writing.

Question 7 (2 marks)

Draw the metallic lattice structure of calcium metal, ensuring that the diagram has exactly 10 electrons.

Question 8 (8 marks)

In the medical field, it is known that the tip of surgeon knives most often utilise small amounts of diamonds.

a. Explain why diamond is used in these applications rather than graphite in terms of choosing between the allotropes of carbon. (3 marks)

b. Is it possible to make liquid diamonds? Justify your answer. (2 marks)

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c. Compare the hardness of a diamond lattice compared to a lattice of iron. (3 marks)

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Question 9 (3 marks)

You are given the following clues about four unknown metals A, B, C, and D.

- Metal A has two valence electrons.
- Metal B has a larger atomic radius than A.
- Metal C has fewer delocalised electrons than all of the other metals.
- Metal D has the strongest metallic bonding of all four metals.

Given that the metals are either Potassium, Calcium, Magnesium, or Aluminium, state the identities of each of the metals.

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Section D: Getting Trickier I (10 Marks)

INSTRUCTION: 10 Marks. 8 Minutes Writing.

Question 10 (1 mark)

Which one of the following properties is typical of most metals?

A. Brittle.

B. Dull.

C. High Boiling Point.

D. Low electrical conductivity in solid state.

Question 11 (9 marks)

Historically, lead styluses were used in place of pencils to write text on paper. However, due to the toxicity of lead, it was quickly replaced with graphite.

a. Draw a diagram that reflects the structure of graphite. Ensure that you refer to the number of bonds formed by each carbon and the forces present. (2 marks)

b. Explain why graphite can work well for use in a pencil. (2 marks)

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c. Some scientists think that they may be able to use graphite and other carbon allotropes in order to make diamonds. What is the structure of diamond, and in what ways does it differ from that of graphite? (3 marks)

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d. Are diamond and graphite both electrically conductive? Why or why not? (2 marks)

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Let's take a BREAK!

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Section E: VCAA-Level Questions I (12 Marks)

INSTRUCTION: 12 Marks. 30 Seconds Reading. 11 Minutes Writing.

Question 12 (12 marks)

Grace is investigating silver, an expensive metal that has been used in a wire to conduct electricity.

Silver wire

a. Complete the metal lattice structure in the diagram above. (1 mark)

b. Explain why the metal can conduct electricity. (1 mark)

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_____

c. The wire has been stretched out horizontally and thinned out like so:

Silver wire

i. On the diagram above, draw how the metallic bonding will look like now, given that the wire has exactly doubled in length and halved in width. (2 marks)

ii. Explain what this property is and why the metal is capable of doing this. (2 marks)

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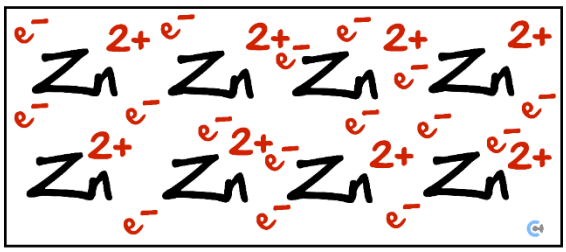
The silver wire is restored to its original form, but now a large amount of negative charge is placed near its right side.

Silver wire

d. Draw the electrons and their positioning throughout the silver wire now on the diagram above. (1 mark)

The properties of this silver wire are then compared to a zinc wire, which is a typical metal used in wires.



Zinc wire

e. Compare the electric conductivity of zinc and silver. Justify your reasoning. (3 marks)

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f. Explain why zinc metal appears lustrous. (2 marks)

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Section F: Multiple Choice Questions (8 Marks)

INSTRUCTION: 8 Marks. 8 Minutes Writing.

Question 13 (1 mark)

Select the option that best explains why graphite is commonly used as pencil lead.

A. The forces within a layer of graphite are strong.

B. The forces within a layer of graphite are weak.

C. The forces between layers of graphite are weak.

D. The forces between layers of graphite are strong.

Question 14 (1 mark)

What is the correct explanation of malleability?

A. When the metal has been hit, the lattice structure is broken but then reformed, thus causing a change in shape.

B. Although the metal has been hit, the lattice structure stays intact as the electrons are holding the metal cations together. Therefore, it will only change its shape.

C. The metal, when hit, will absorb the force by vibrating the electrons and reflecting it back, and as such, it will not change shape.

D. When the metal has been hit, the lattice structure stays intact because the cations are held too tightly to even move in the metal lattice.

Space for Personal Notes

Question 15 (1 mark)

Why are metals considered to have relatively high densities compared to other types of elements?

A. Metal lattices have a lot of metal ions packed tightly together compared to other elements with the same volume.

B. Metal lattices need to have a lot of metal atoms involved.

C. All metals have a high molar mass value.

D. Metals are typically solid at room temperature, so they automatically have high densities.

Question 16 (1 mark)

Consider the following statements about metals and select the option which is true.

I. The explanation for why metals are malleable and ductile are similar.

II. Metals being conductors do not relate to their lattice structure.

III. Metals being lustrous is directly affected by the lattice structure.

A. I, II, III

B. I, II

C. II, III

D. I, III

Question 17 (1 mark)

Mercury (Hg), is one of the only metals in the periodic table that is liquid at room temperature. What is one of the properties of mercury that may be responsible for this?

A. High atomic number.

B. Low boiling point.

C. Large atomic radius.

D. Low melting point.

Question 18 (1 mark)

Non-metals and metals have several key differences that distinguish them apart. Which one of the following is false?

A. Metals tend to be lustrous, whereas non-metals are not.

B. Metals are going to act as cations in molecules, whereas a lot of non-metals tend to be anions.

C. Metals are generally solid at room temperature, whilst all non-metals are gases.

D. Metals usually have higher boiling points than non-metals.

Question 19 (1 mark)

Carbon is a unique element as it can form covalent lattices with itself. Which one of the following is a property of the carbon allotrope of diamond?

A. Diamond is the only allotrope of carbon to exist, as carbon is usually bonded in a molecule with other atoms.

B. The carbon atoms in the diamond allotrope do not eject any electrons, and instead, each carbon atom is bonded to four other carbon atoms.

C. The carbon atoms in the diamond allotrope are cations with a $+1$ charge as it has ejected an electron in order to form its covalent lattice.

D. The carbon atoms in the diamond allotrope are strong in one direction but weak in the other direction.

Question 20 (1 mark)

Which of the following cannot be explained by the metallic bonding model?

Property I: Magnetism.

Property II: Ductility.

Property III: Variations in melting temperatures.

A. All three properties can be explained by the metallic bonding model.

B. Property I only.

C. Properties I and III only.

D. All three properties cannot be explained by the metallic bonding model.

Section G: VCAA-Level Questions II (9 Marks)

INSTRUCTION: 9 Marks. 30 Seconds Reading. 8 Minutes Writing.

Question 21 (9 marks)

Computer chips are arguably one of the most important objects of the modern world. The function of these computer chips is enabled by the presence of various metals and metalloids, such as Si.

a. Give an explanation as to why we commonly find Gold (Au) used in computer chips. (2 marks)

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b. Manufacturers often tend to use gold rather than lithium, although technically, both can produce electricity. Suggest a reason why lithium isn't used. (3 marks)

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c. Under normal circumstances, silicon usually doesn't conduct electricity, but by adding energy into the silicon, it is able to conduct electricity. Thus, we refer to it as a 'semiconductor.' This is the basis of how transistors in modern technology work.

Give an explanation as to why adding energy into silicon will allow electricity to be conducted.
(Hint: Think about the definition of electrical conductivity). (4 marks)

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Section H: Extension Questions (28 Marks)

Question 22 (3 marks)

Why does chromium have a shinier surface than zinc? Consider the nature of their metallic bonds and electron density.

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Question 23 (9 marks)

Carbon exists in many different forms naturally.

a. What is the most common form in which carbon exists? Provide a brief overview of this form. (2 marks)

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b. For the following applications, state which allotrope of carbon is more desirable and justify your answer.

i. Surgeon knife. (2 marks)

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ii. Battery circuitry components. (2 marks)

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c. Explain how graphite pencil leads work in leaving a mark on paper. (3 marks)

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Space for Personal Notes

Question 24 (7 marks)

Harish, a designer for a big tech company – Pineapple, is designing a new charger for the new series of iPhones. To do this, Harish decides to use aluminium as the body for the charging block. However, after only a few weeks on the public market, Harish receives a range of complaints and is forced to explain these to the CEO, Cim Took.

a. The first complaint is that of electrocution when users touch the aluminium charging brick. With your knowledge of metallic bonding, explain why this is the case. (2 marks)

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b. The second complaint is that the charging brick gets extremely warm during operation. With your knowledge of metallic bonding, explain why this is the case. (2 marks)

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c. Why was this electrocution and overheating risk not an issue with previous, nonmetallic compounds? (1 mark)

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d. Luckily for Harish, the CEO is willing to look past his mistakes due to the beauty of the new charging block. Particularly, Cim Took is astonished by the shine of the chargers. Explain what this property is called and why aluminium expresses it. (2 marks)

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Space for Personal Notes

Question 25 (9 marks)

An avid local gym goer, Ishaan, is well known in the local gym for lifting barbells loaded with iron weight plates. However, over the years, Ishaan's constant use has resulted in some of these iron weights losing their original shape.

a. With reference to metallic bonding, explain why metals such as iron have a high hardness. (2 marks)

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b. What is the difference between malleability and ductility? Which one of these is being shown through the aforementioned example? (2 marks)

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c. Why is Ishaan able to change the shape of the iron weight plates through constant use? (2 marks)

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d. Following this experience, Ishaan is intrigued by the different strengths and melting points of different metals. Would potassium or francium be expected to have a higher melting point, and why? (3 marks)

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