CONTOUR EDUCATION

Website: contoureducation.com.au | **Phone:** 1800 888 300
Email: hello@contoureducation.com.au

VCE Chemistry ½
Metals & Covalent Lattices [1.3]
Homework Solutions

Homework Outline:

Compulsory	Pg 2 – Pg 9
Supplementary	Pg 10 – Pg 18

Section A: Compulsory (47 Marks)

Sub-Section: Explain the Metallic Bonding Model

Question 1 (4 marks)

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

a. Calcium. (1 mark)

+2

b. Rubidium. (1 mark)

+1

c. Francium. (1 mark)

+1

d. Beryllium. (1 mark)

+2

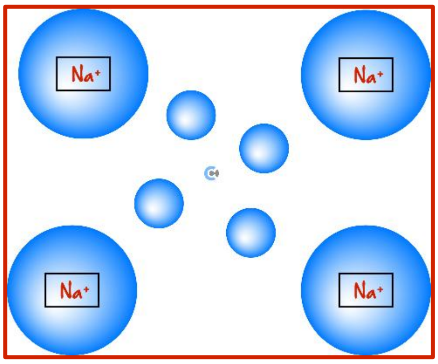
Question 2 (4 marks)

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

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

Na^+ Cation

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



Question 3 (5 marks)

Magnesium is a highly common metal found on Earth and is important in several industries.

a. State magnesium's ion form. (1 mark)

Mg^{2+}

b. State the key aspect of the metallic bonding model that allows it to stay together even though magnesium ions are positive and should repel each other. (1 mark)

Sea of delocalised electrons allowing metal cations to be attracted to it.

c. Explain how these magnesium atoms would form metallic bonds. (3 marks)

Once the metals are next to each other, they will ionise and eject their valence electrons, these ejected electrons then form a sea of delocalised electrons that have a net negative charge. Since the metal cations are positively charged, they will be attracted to the sea of delocalised electrons. This forms electrostatic attraction, causing magnesium to be arranged in a metal lattice.

Space for Personal Notes

Sub-Section: Identify Properties of Metals (High MP/BP, Electrical & Thermal Conductivity, Malleability & Ductility, Lustre)

Question 4 (3 marks)

a. State what defines if a substance can conduct electricity. (1 mark)

It has moving charges which defines carrying current and hence electricity.

b. Explain how metals can conduct electricity very easily, with reference to metallic bonding and lattices. (2 marks)

Metals can conduct electricity very easily due to the presence of delocalised electrons being able to carry charges and hence conduct electricity.

Question 5 (3 marks)

Between the metals Lithium and Beryllium, explain which would more likely have a higher melting point.

Beryllium ejects 2 electrons per atom whereas lithium only ejects 1 electron. Hence, the sea of delocalised electrons for beryllium would contain more charges than lithium, given the same amount of atoms. Hence, since there is a larger amount of charge associated with beryllium the metallic bonding that exists in its lattice would be stronger than lithium.

Space for Personal Notes

Question 6 (5 marks)

Consider an ingot of Calcium metal.

a. Pencil lead tends to break quite easily when excessive force is applied, but we see that the ingot of calcium metal will tend to just bend but not break. Explain this phenomenon with reference to calcium's properties. (3 marks)

Carbon is a non-metal which means it is brittle, resulting in it breaking very easily because once the structure of carbon is disrupted the bonds will not be aligned correctly, unravelling the entire structure.
Metals on the other hand are malleable, which means striking it with a force will only bends its shape, but it won't break because the lattice remains intact due to metal cations always being attracted to the sea of delocalised electrons even when altered.

b. Calcium metal in its pure form is also known for being quite shiny. Explain the chemical phenomena behind this observation. (2 marks)

The metal lattice of calcium contains electrons that constantly vibrate which allows it to reflect incoming light back out into the environment, hence providing it with the property of being lustrous.

Space for Personal Notes

Sub-Section: Explain the Covalent Lattice Structures Bonding & Properties of Diamond and Graphite

Question 7 (2 marks)

Explain the main difference between the covalent lattices of diamond and graphite.

In the covalent lattice of diamond, each carbon atom is bonded to 4 carbons whereas in graphite, it is bonded to 3 carbons.

Question 8 (6 marks)

Explain the following properties of diamond.

a. Is it able to conduct electricity? (2 marks)

Diamond does not conduct electricity because there is no moving charge.

b. Is it able to conduct heat? (2 marks)

Diamond does conduct thermal energy due to vibration of the carbon in its covalent lattice.

c. What is the relative durability or toughness of it? (2 marks)

Each carbon is bonded to 4 other carbons, the strength of the lattice is very high due to highly interconnected covalent bonds in the lattice.

Question 9 (4 marks)

List and explain two differences in property between the two main allotropes of carbon.

a. Property 1. (2 marks)

Graphite is able to conduct electricity due to there being free moving charges due to the free electrons leftover from the carbon bonding to 3 other carbons.

b. Property 2. (2 marks)

Diamond is very durable whereas graphite would be hard in one direction but soft in another direction due to its layer lattice structure.

Space for Personal Notes

Sub-Section: Final Boss

Question 10 (11 marks)

Consider the element of potassium.

a. What is potassium's ion form? (1 mark)

K^+

b. Potassium is a commonly used element, but is also similar to another element, calcium. Compare their melting points to each other. (3 marks)

Calcium has a +2 ion charge whereas potassium has +1 charge, and as such in their metal lattice form, the calcium will have a higher/stronger charge overall and its electrostatic attraction between itself will be much greater than that of potassium. Hence, calcium will have a higher melting point.

c. Hence, from the above, which one would you choose to be melted into a liquid form with energy efficiency in mind? (1 mark)

Melt faster → Lower melting point → Potassium.

d. The lattices of metals such as potassium are often compared to the covalent lattices of carbon allotropes. Compare the lattices of potassium with graphite and explain how that affects their properties. (4 marks)

Each potassium atom contributes 1 electron to its delocalised sea of electrons which is similar to carbon in graphite as one valence electron is ejected. However, in the potassium metal lattice, the cations are attracted towards the electrons, which forms the electrostatic attraction that holds the entire lattice together. For graphite, the carbons are all covalently bonded to each other, with each carbon bonded to 3 other carbons, with the delocalised electrons existing in the space between. This means that graphite forms a covalent layer lattice, less so a lattice-like potassium. (Graphite is also not shiny because of the lack of charges that are able to 'reflect' light.)

e. For electronic device purposes, we may choose to use graphite over potassium for circuitry requirements. Suggest a reason why this may be the case. (2 marks)

Graphite because potassium will be quite reactive and a low melting point whereas graphite is held together by covalent bonds which suggests better stability with similar amounts of electrical conductivity.

Space for Personal Notes

Section B: Supplementary (48 Marks)

Sub-Section: Explain the Metallic Bonding Model

Question 11 (3 marks)

The metallic bonding has several key features that define it.

a. What type of force exists between multiple metal atoms? (1 mark)

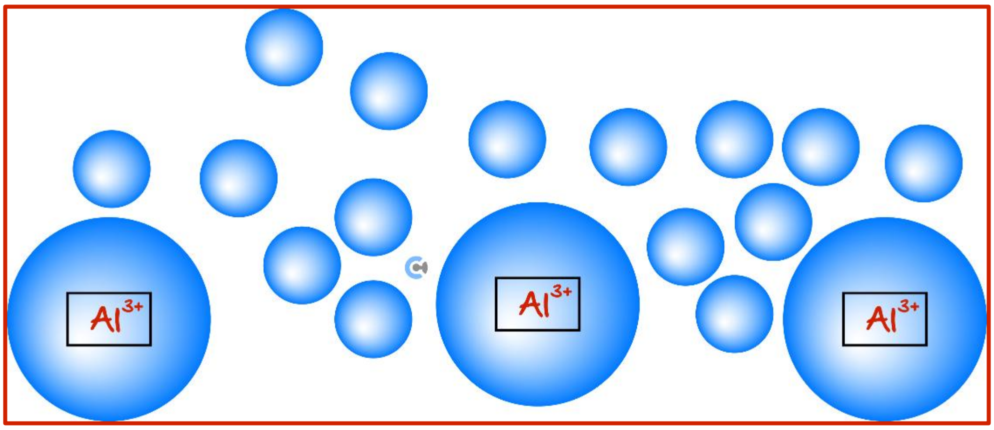
Electrostatic attraction / Covalent bonds.

b. Explain what a 'metallic character' is. (2 marks)

Metallic character is the tendency for the atom to lose electrons.

Question 12 (2 marks)

Draw the metallic lattice when you have 3 atoms of Aluminium.



Space for Personal Notes

Question 13 (5 marks)

Copper is a versatile metal extensively used in electrical wiring and other applications.

a. What type of metal is copper considered, and what is the usual charge of this metal? (1 mark)

Transition metal, Cu^{2+}

b. Identify a key feature of the metallic bonding model that enables copper to conduct electricity efficiently. (1 mark)

Delocalised sea of electrons and metal cations → moving charges.

c. Describe how copper atoms would interact to form metallic bonds. (3 marks)

Copper atoms would first eject their valence electrons to ionise and become Cu^{2+}, these delocalised electrons would form a 'sea of delocalised electrons', which the copper cations will be attracted towards. This electrostatic attraction will arrange the copper atoms into a metal lattice.

Question 14 (7 marks)

Metals are important for human development, as they have unique properties from metallic bonding. Consider the structure and bonding of metals such as lithium and beryllium.

a. Define 'delocalised electrons' and explain their role in metallic bonding. (2 marks)

A sea of ejected valence electrons that provides electrostatic attraction to the metal cations and holds the metal lattice structure intact.

b. How does the metallic character change across the period? (2 marks)

Metallic character decreases as their effective nuclear charge/no. of valence electrons increase.

c. Iron is commonly used in construction and manufacturing. Write its most likely ion form. (1 mark)

Fe^{2+}

d. How is a metal like iron different to another metal like potassium? (2 marks)

Iron is a transition metal meaning it has slightly different properties and has multiple valencies where as potassium is a group 1 metal, meaning it is highly reactive and has a single type of ion.

Space for Personal Notes

Sub-Section: Identify Properties of Metals (High MP/BP, Electrical & Thermal Conductivity, Malleability & Ductility, Lustre)

Question 15 (1 mark)

Define the property of malleability.

Malleability refers to the property of metals being able to bend and alter its physical shape without breaking.

Question 16 (3 marks)

Between metals of potassium and sodium, explain which one would have a higher melting point and explain why.

As sodium has a smaller atomic radius than potassium, the electrons are closer to the nucleus and its attractive strength is stronger than potassium despite them both having the same ion charge of $+1$. Hence, sodium will have a higher melting point.

Question 17 (4 marks)

Most metals that you can think of often have a shiny 'metallic' look to them.

a. Explain this phenomenon. (2 marks)

Lustre due to the metallic lattice reflecting light back due to the moving charges.

b. Suppose that Alex is preparing to have a BBQ on his metal grill on a sunny day. If it had been sitting out in the sun for a few hours, what would happen if Alex touched the hood of the BBQ grill? (2 marks)

Alex would likely feel the high temperature as metals are good conductors of heat to the particles in the metallic lattice vibrating and transferring heat.

Question 18 (7 marks)

You are given the following clues about four unknown metals X, Y, Z, and W:

- Metal X has two valence electrons.
- Metal Y has a larger atomic radius than X.
- Metal Z has more delocalised electrons than the other three metals.
- Metal W has the weakest metallic bonding of all four metals.

a. Given that the metals are either Radium, Calcium, Magnesium, or Aluminium, state the identities of the metals. (3 marks)

X – Mg, Y- Ca, Z- Al, W – Ra

b. Can the strongest metal that you have stated in **part a.**, be turned into a wire? In your answer, include the name of this property. (2 marks)

Yes, because metals are inherently ductile due to their flexibility because the metal cations are going to remain attracted to the sea of delocalised electrons no matter what specific shape the lattice takes shape in, meaning they can be drawn into a wire.

c. Why would you consider metallic bonding to be stronger than dipole-dipole interactions? (2 marks)

Yes, because metallic bonding involves electrostatic attraction between full $(+1)$ or even stronger charges whereas dipole-dipole interactions involve electrostatic attraction between partial charges.

Space for Personal Notes

Sub-Section: Explain the Covalent Lattice Structures Bonding & Properties of Diamond and Graphite

Question 19 (1 mark)

Define what an allotrope is and give an example.

An allotrope is a way in which an element can exist by itself. e.g. graphite/diamond for carbon. Oxygen gas or Ozone gas for oxygen.

Question 20 (3 marks)

Explain what a sublimation point is and relate it to a carbon allotrope.

The carbon allotrope of diamond has really strong bonding in its covalent lattice and so it requires a large amount of thermal energy to break all the carbon covalent bonds. As such, when heating it up, the diamond will either exist in a state where the whole lattice exists or the lattice structure breaks entirely. Hence, it will go straight from a solid to a gas, which is sublimation.

Question 21 (6 marks)

Carbon exists in different forms with distinct properties.

a. Explain why graphite conducts electricity, but diamond does not. (2 marks)

Graphite conducts electricity because the carbon only uses 3 bonds and the last valence electron is ejected, forming a sea of delocalised electrons, resulting in the presence of moving charges in its covalent lattice, allowing electricity to be conducted. Whereas diamond utilises all 4 bonds, leaving no moving charge.

b. Which allotrope of carbon would you select for the purpose of sharpness and durability? Explain your answer. (2 marks)

Diamond, due to its covalent lattice being highly interconnected and strong as one carbon atom is always bonded to 4 other carbon atoms, resulting in very strong covalent bonds.

c. Explain what amorphous forms of carbon are. (2 marks)

Amorphous carbon are irregular, random arrangements of carbon that is the most common form of carbon present in wood, coal, etc.

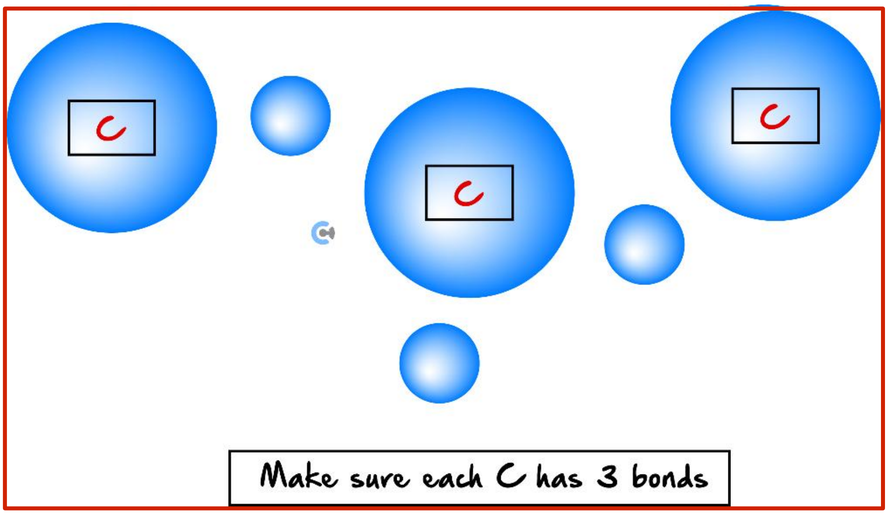
Question 22 (6 marks)

Consider the allotrope of graphite.

a. What is the main element comprising graphite? (1 mark)

Carbon

b. Draw a structure of graphite containing 3 carbons. (2 marks)



c. Explain why graphite is very hard in one direction but very soft and weak in another direction, with reference to its structure and bonding. (3 marks)

As graphite is a covalent layer lattice, it has covalent bonds within a layer of graphite which is very strong. However, the bonding in between layers is just intermolecular bonding (dispersion forces) as carbon is not electronegative. As covalent bonds are much stronger than dispersion forces, the intralayer bond strength is much higher than the interlayer bond strength. As such, graphite is very hard in one direction because of covalent bonds, but weak in another direction due to the dispersion forces.

Space for Personal Notes

CONTOUREDUCATION

Website: contoureducation.com.au | **Phone:** 1800 888 300 | **Email:** hello@contoureducation.com.au

VCE Chemistry ½

Free 1-on-1 Support

Be Sure to Make The Most of These (Free) Services!

- Experienced Contour tutors (45+ raw scores, 99+ ATARs).
- For fully enrolled Contour students with up-to-date fees.
- After school weekdays and all-day weekends.

1-on-1 Video Consults	Text-Based Support
Book via bit.ly/contour-chemistry-consult-2025 (or QR code below). One active booking at a time (must attend before booking the next).	Message +61 440 137 304 with questions. Save the contact as “Contour Chemistry”.

Booking Link for Consults

bit.ly/contour-chemistry-consult-2025

Number for Text-Based Support

+61 440 137 304