Structure 2.3 Answers

IB CHEMISTRY SL

25	16		6	2	25
Mn	**S**	**J**	**C**	**He**	**Mn**
Manganese	Sulfur		Carbon	Helium	Manganese
54.938045	32.065		12.0107	4.002602	54.938045

Structure 2.3.1 and 2.3.2

Understandings:

- A metallic bond is the electrostatic attraction between a lattice of cations and delocalized electrons (2.3.1).
- The strength of a metallic bond depends on the charge of the ions and the radius of the metal ion (2.3.2).

Learning outcomes:

- Explain the electrical conductivity, thermal conductivity and malleability of metals (2.3.1).
- Explain trends in melting points of s and p block metals (2.3.2).

Additional notes:

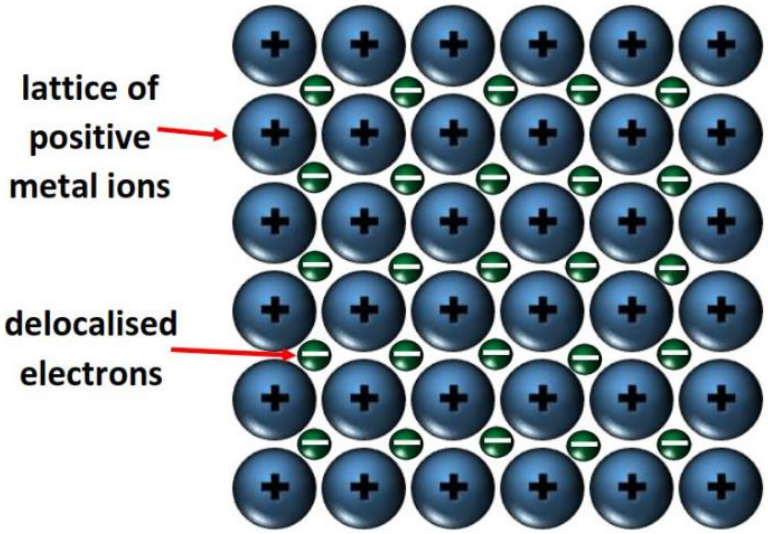
- Relate characteristic properties of metals to their uses (2.3.1).
- A simple treatment in terms of charge of cations and electron density is required (2.3.2).

Linking questions:

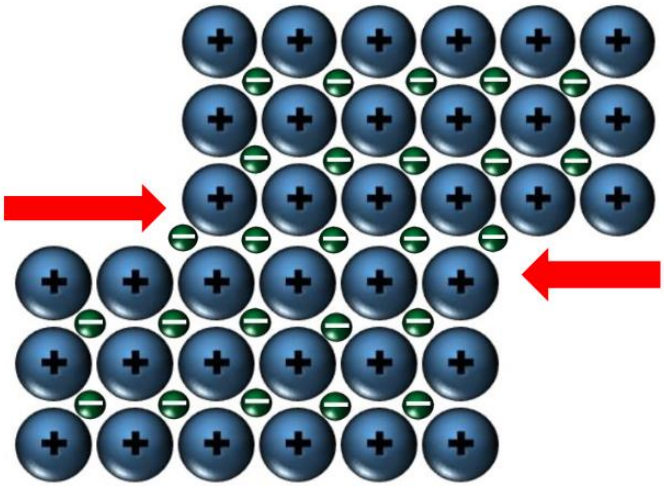
- Structure 3.1 What experimental data demonstrate the physical properties of metals, and trends in these properties, in the periodic table?
- Reactivity 3.2 What trends in reactivity of metals can be predicted from the periodic table?
- Structure 2.4 What are the features of metallic bonding that make it possible for metals to form alloys?

Metallic bonding

- The metallic bond is the electrostatic attraction between a lattice of positively charged metal ions and delocalised electrons.
- Metallic bonding is non-directional because the force of attraction between the ions and delocalised electrons occurs in all directions.



- Metals are good conductors of electricity because of the presence of delocalised (mobile) electrons that move when a voltage is applied.
- Metals are malleable (can be bent into shape) and ductile (can be drawn into wires) because the metallic bond remains intact even if the structure is distorted.
- The layers can slide over each other when metals are bent, hammered, or stretched, without breaking the metallic bond.



Strength of the metallic bond

- The strength of the metallic bond is determined by the charge on the metal ion and the ionic radius of the metal ion.
- Ions with a higher charge density have a stronger metallic bond and a higher melting point.

Ion	Charge on ion	Ionic radius ($\times 10^{-12}$ m)	Melting point (ºC)
Na^+	1+	102	98
Mg^{2+}	2+	72	650

- Mg has a higher melting point than Na due to its greater ionic charge and smaller ionic radius.
- The higher the charge on the ion, the more delocalised electrons that exist in the metallic structure.
- This results in a stronger electrostatic attraction between the lattice of positive metal ions and the delocalised electrons, and a stronger metallic bond.
- The strength of the metallic bond decreases down a group as the size of the metal cation increases.

Exercises:

1. Describe the metallic bond.
The metallic bond is the electrostatic attraction between a lattice of positive metal ions and a sea of delocalised electrons.

2. Explain the following properties of metals.

a. Metals are good conductors of electricity
The delocalised (mobile) electrons move when a voltage is applied.

b. Metals are malleable and ductile
The layers of positive ions in the lattice can slide over each other without breaking the metallic bond.

3. Explain why aluminium has a higher melting point than sodium.
The aluminium ion has a higher charge and smaller ionic radius than the sodium ion. This results in a higher charge density, a stronger metallic bond and a higher melting point.

4. Explain why the melting point of the group 1 metals decreases down the group.
The strength of the metallic bond depends on the ionic radius of the ions. The ionic radius increases down the group, therefore, the metallic bond gets weaker which results in a decreasing melting point.