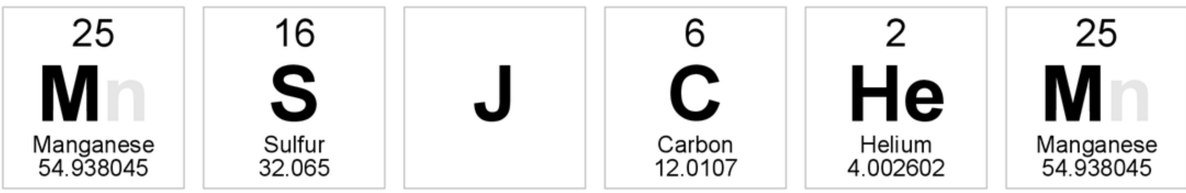
Structure 2.3
SL/HL

IB CHEMISTRY SL/HL



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:

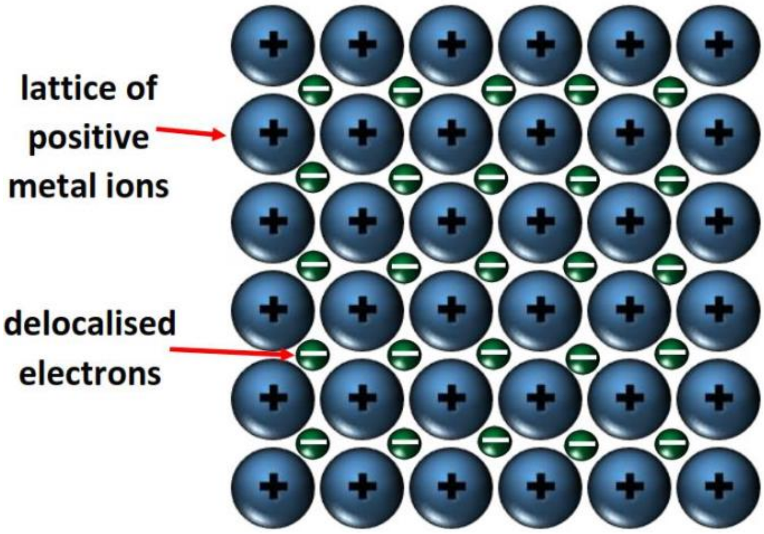
- Relate characteristic properties of metals to their uses (2.3.1).
- A simple treatment in terms of charge of cations and electron density is required (2.3.2).

Linking questions:

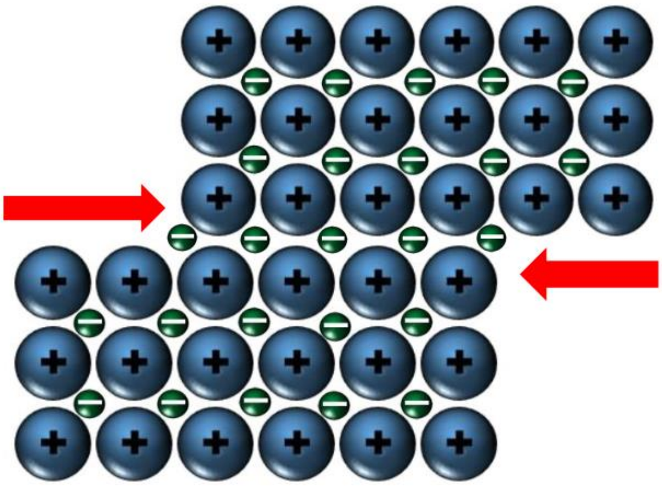
- Structure 3.1 What experimental data demonstrate the physical properties of metals, and trends in these properties, in the periodic table?
- Reactivity 3.2 What trends in reactivity of metals can be predicted from the periodic table?
- Structure 2.4 What are the features of metallic bonding that make 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 (× 10^{-12} m)**	**Melting point (°C)**
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. Outline the metallic structure and the formation of the metallic bond.

2. Explain the following properties of metals:

a. Metals are good conductors of heat and electricity.

b. Metals are malleable and ductile.

3. Explain why aluminium has a higher melting point than sodium.

4. Explain why the melting point of the group 1 metals decreases down the group.

Structure 2.3.3 HL

Understandings:

- Transition elements have delocalized d-electrons.

Learning outcomes:

- Explain the high melting point and electrical conductivity of transition elements.

Additional notes:

- Chemical properties of transition elements are covered in Reactivity 3.4.

Linking questions:

- Structure 3.1—Why is the trend in melting points of metals across a period less evident across the d- block?

Properties of transition elements

- Transition elements in the d-block of the periodic table have higher melting points compared to metals in the s-block and p-block of the periodic table.
- This is because transition elements have delocalised d-electrons which results in an increase in the number of delocalised electrons in the metallic bond.
- The delocalised d-electrons increase the strength of the metallic bond and result in a higher melting point.
- Transition elements also have good electrical conductivity which is also a result of the extra delocalised d-electrons.