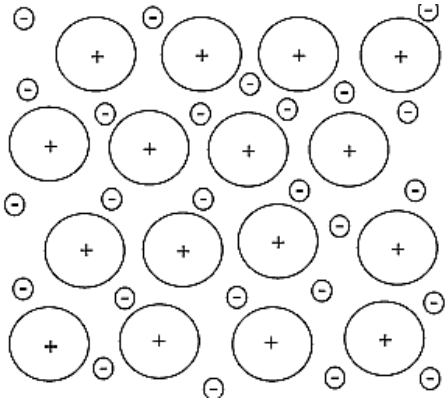
Topic 8 – Giant Metallic Structure

8.1 Structure and Bonding of Metals (7.3)

Metallic bond

strong electrostatic forces of attraction between positive metal ions and the sea of delocalised electrons



Structure of metal: **positive metal ions** in a **'sea' of delocalised electrons**

- Metal atoms lose outer electrons → cations (+)
- Negative electrons lost by metal atoms → delocalised (free to move between positive metal ions) → sea of electrons

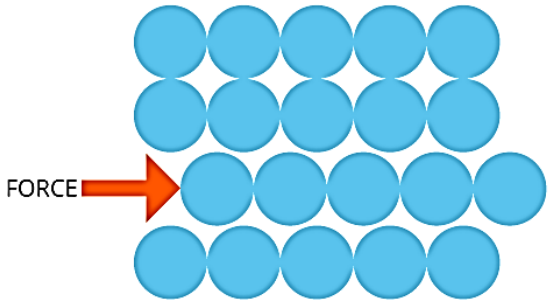
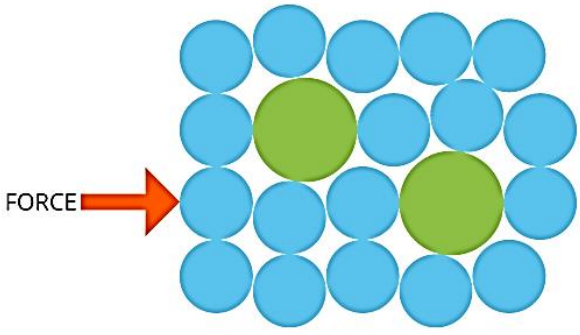
8.2 Physical Properties of Metals (7.3)

Physical properties

Property	Explanation	
1. **Melting** & **boiling** point: high (except Hg)	Large amount of energy is required to overcome the strong metallic bonds between the positive metal ions and 'sea' of delocalised electrons during the changing of states	
2. Good conductor of **electricity** 1) solid 2) molten	Outer electrons move freely within the metal lattice → negative to positive terminal	
3. Good conductor of **heat**	Movement of mobile electrons within the metal lattice → heat energy transferred easily by mobile electrons	
4. **Malleable**	Regular arrangement of layers of metal ions	Layers slide easily over each other → larger & thinner layer (metal hammered / pressed)
5. **Ductile**	Regular arrangement of layers of metal ions	Layers slide easily over each other → longer & narrower layer
6. (pure metals) Soft & weak	Orderly arrangement of layers of metal ions	Layers slide easily over each other

8.3 Alloy (14.1)

Alloy: mixture of metal + other elements
→ main metal + alloying agents

Pure metal	Alloy
	

Common alloys

Alloy	Composition	Usages
1. **Brass**	1) Copper (65 ~ 90%) 2) Zinc (10 ~ 35%)	1) Door locks and bolts 2) Brass musical instruments
2. **Steel** (low carbon)	1) Iron (80 ~ 98%) 2) Carbon (< 0.25%) 3) Other metals (a) chromium (b) manganese (c) vanadium	1) Metal structures 2) Car and airplane parts
3. Steel (high carbon)	1) Iron (80 ~ 98%) 2) Carbon (0.5 ~ 0.95%) 3) Other metals	1) Drill-bits 2) Cutting tools
4. Steel (stainless)	1) Iron (> 50%) 2) Chromium (10 ~ 30%) 3) Small amounts of: (a) carbon (b) nickel (c) manganese (d) molybdenum (e) other metals	1) Jewellery 2) Medical tools 3) Tableware
5. **Solder**	1) Tin 2) Lead	Low melting point – join metals 1) Join metal pipes
6. **Pewter**	1) Tin 2) Antimony 3) Copper	Bright and shiny 1) Decorative ornaments

Pure metals: not widely used in industry

Property	Explanation
1. **Soft**	• Atoms are packed regularly in layers • Layers of atoms can slide over one another easily when a force is applied
2. **Wear away & corrode easily**	React with air and water

Why metals often used as alloys

Property	Example	
1. **Harder and stronger**	Brass (Cu + Zn)	Harder and stronger than pure Cu, Zn
2. **Improve appearance**	Pewter (Cu + Sn + Sb)	Make ornaments (more beautiful)
3. **Lower melting point**	Solder (Sn + Pb)	Join electronic parts to circuit boards
4. **More resistant to corrosion**	Cupronickel (Cu + Ni)	Coins (does not corrode easily)

Stronger and harder

- Atoms of different elements have different sizes
- The regular arrangement of atoms in the pure metal is disrupted
- Atoms of different sizes cannot slide over each other easily when a force is applied
- As a result, an alloy is stronger and harder than pure metal

Properties of mixture VS compounds

Mixture	Compound
1) Elements are not chemically combined, not in a fixed composition	1) Elements are chemically combined, in a fixed composition / ratio
2) Melt & boil over a range of temperatures	2) Fixed melting & boiling points (pure substance)
3) Has same properties of the elements it is made up of	3) Has different properties from the elements it is made up of
4) Can be separated by physical means	4) Cannot be separated by physical means