

Chapter 5 : Structure and Properties

No.

Date

Elements, Compounds & Mixtures

- Elements

- An element is a pure substance that cannot be broken down into two or more simpler substances by chemical means.
- Consists of only one element
- mostly natural occurring
- Fixed melting and boiling points

- Compounds

- A compound is a pure substance containing two or more elements chemically combined in a fixed ratio
- Compounds can be separated by:
 - Thermal decomposition
 - Electrolysis
- Formed from a chemical reaction
- Has different properties from its constituent elements
- Fixed melting and boiling points

- Mixtures

- Do not have substances in fixed ratios
- Can consist of elements and/or compounds
- Are physically combined
- Can be separated using:
 - Filtration
 - Chromatography
 - Distillation
- Formed through physical mixing
- No fixed ratio
- Have similar properties to its constituent substances
- Melt and boil over a range of temperatures

Giant ionic lattice structure

- An ionic compound has a giant ionic crystal lattice structure.
- A giant ionic crystal lattice structure consists of large number of positively-charged ions and negatively-charged ions held together by strong

electrostatic forces of attraction

- Physical properties:

- ★ → High melting and boiling points
- ♥ → Hard but brittle
- ⊛ → Soluble in water, insoluble in organic solvent
- ↑ → Conduct electricity in molten or aqueous state, but not in solid state

- Explanation for '★':

- It has a giant ionic crystal lattice structure
- Large amounts of energy is required to overcome the strong electrostatic forces of attraction between the oppositely charged ions

- The greater the charges of the ions, the higher the melting and boiling point.

- The shorter the distance between ions, the stronger the ionic bond

- Explanation for '♥':

- The strong electrostatic forces of attraction cause the ions to resist motion
- However, there are cases when the ionic lattice is deformed when a strong force is applied

- Explanation for '⊛':

- Many ionic compounds are soluble in water and insoluble in organic solvents like ethanol, turpentine and petrol
- Dissolved in water = Aqueous state

- Explanation for '↑':

- In the molten and aqueous states, mobile ions are free to move to carry charges to conduct electricity.
- In solid state, there are no mobile ions as all the ions are held in fixed positions in a giant ionic lattice structure

Simple covalent substances

- The atoms in simple covalent molecules are held by strong covalent bonds
- The molecules are held by weak intermolecular forces of attraction
- Strong covalent bonds exist within each molecule
- Weak intermolecular forces of attraction exist between the molecules.

- Physical properties :

→ Low melting and boiling points

- Simple covalent structure

- Little energy is required to overcome the weak intermolecular forces of attraction between molecules.

→ Insoluble in water but soluble in organic solvents

→ Most do not conduct electricity

- Absence of mobile ions and electrons to conduct electricity

- Exceptions :

- ♥ Hydrogen chloride

- ♥ Sulfur dioxide

- ♥ Ammonia

→ Volatile : evaporates easily

Grant Covalent Structures

- The atoms are connected to one another by strong covalent bonds

- Diamond and Graphite are allotropes of carbon

- Allotropes are different forms of the same element with different structures and atomical arrangement.

- Diamond

→ Each carbon atom forms covalent bonds with four other carbon atoms

→ Diamond has a tetrahedral arrangement

- Graphite

→ Forms covalent bonds with three other carbon atoms

→ has a layered structure of hexagonal rings

→ Weak intermolecular forces of attraction between the layers of hexagonal rings

- Silicon Dioxide

→ Silicon and oxygen atoms linked by strong covalent bonds

→ Ratio of silicon atoms to oxygen is 1:2

- Physical properties :

→ Hardness

- Diamond is the hardest material on earth

- Graphite is soft and slippery

→ Melting and boiling point

- Have high melting and boiling points
- Large amounts of energy is needed to break the strong covalent bonds

→ Solubility

- Insoluble in water and in organic solvents

→ Electrical conductivity

- Graphite can conduct electricity
- There is 1 electron that is mobile and not used in bonding, thus able to conduct electricity.

Giant metallic structure

- The mutual electrostatic attraction between positively charged metal ions and the "sea of delocalised electrons"

- An alloy is a mixture of a metal with one or more elements

- Examples:

→ Mild Steel

→ Low carbon steel

→ High carbon steel

- Metals vs Alloys:

→ Pure metals

- Have atoms of same size arranged in regular structure
- Layers of atoms can slide over one another easily
- Malleable
- Ductile

→ Alloys

- Atoms of different sizes
- Regular arrangement is disrupted, layers of atoms cannot slide over one another
- A larger force is needed to make the layers slide over one another
- Less malleable
- Less ductile
- Harder and stronger than pure metals.

- Properties:

→ Generally high melting & boiling points

- Giant metallic structure

- Large amounts of heat energy is needed to overcome the strong metallic bonds

→ Good heat conductor

→ Good electrical conductors