5.2 - Bonding, Structure and Properties of Matter

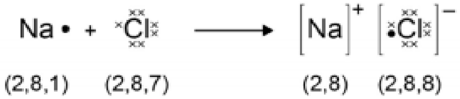
Section 1 – Key Definitions

1. Ionic bond – the electrostatic force of attraction between positively and negatively charged ions.
2. Dot and cross diagram – a drawing to show only the arrangement of the outer shell electrons of the atoms or ions in a substance.
3. Covalent bond – the bond between two atoms that share one or more pairs of electrons.
4. Metallic bond –
5. Alloy – a mixture of two or more elements, at least one of which is a metal.
6. Delocalised electrons – bonding electron that is no longer associated with any one particular atom.
7. Fullerene – form of the elements carbon that can exist as large cage-like structures, based on hexagonal rings of carbon atoms.
8. Giant covalent structure – a huge 3D network of covalently bonded atoms.
9. Giant structure/lattice – a huge 3D network of atoms or ions.
10. Polymer – a substance made from very large molecules made up of many repeating units.

Section 2 - Ionic

2A - Ionic Bonding

1. Bonds between metal positive ions and non-metal negative ions.
2. The outer-shell electron of the metal ion transfers to the non-metal ion.
3. Can be represented with dot and cross diagrams.



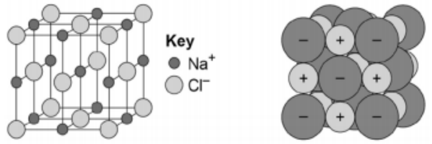
2B - Ionic Compounds

1. Ionic compounds are held together by strong forces of attraction between their oppositely charged ions.
2. These forces act in all directions in the compound.
3. Giant regular structure of ions.
4. They have high melting and boiling points, due to large amounts of energy being needed to break the strong bonds.
5. When melted or dissolved in water, ionic compounds conduct electricity due to free moving ions.

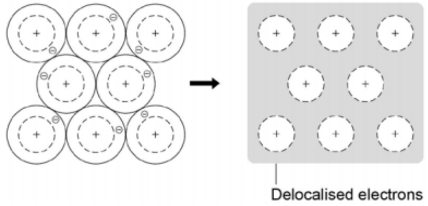
Section 3 – Metals and Alloys

3A - Metallic Bonding

1. Giant structures of atoms arranged in a regular pattern.
2. Delocalised outer shell electrons are free to move through the whole structure.
3. Sharing of delocalised electrons gives rise to strong metallic bonds.



Sodium chloride lattice structure



Metal bonding with delocalised electrons

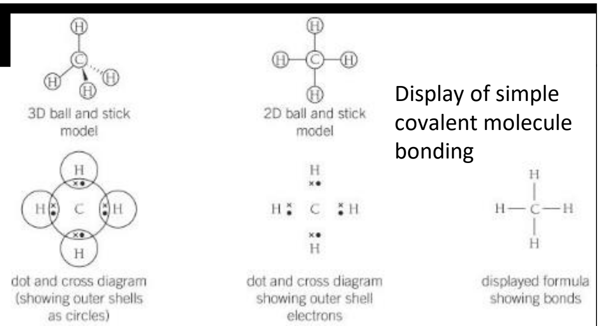
3B - Metal Properties

1. High melting and boiling points.
2. Atoms are arranged in layers which allows metals to be bent and shaped.
3. Pure metals are too soft for many uses. They are mixed with other metals to make alloys which are harder.
4. Metals conduct electricity because of the delocalised electrons carrying charge through the metal.
5. Good thermal energy conductors because energy is transferred by delocalised electrons.

Section 4 - Covalent

4A - Covalent Bonding

1. Between non-metal atoms.
2. Atoms share pairs of electrons.



Display of simple covalent molecule bonding

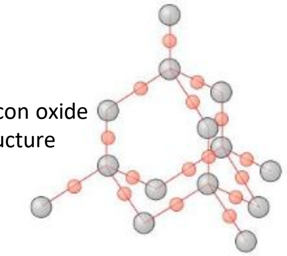
4B - Small Covalent Molecules

1. Gases or liquids with low melting and boiling points.
2. Weak intermolecular forces that break when the substance melts or boils.
3. Intermolecular forces increase with the size of the molecules.
4. Do not conduct electricity.
5. Examples – water, ammonia, carbon dioxide

4C - Giant covalent structures

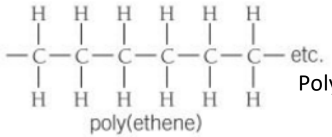
1. Solids with high melting points.
2. All atoms linked to other atoms by strong covalent bonds.
3. Examples – diamond, silicon dioxide

Silicon oxide structure



4D - Polymers

1. Very large molecules.
2. Atoms in the polymer are linked by strong covalent bonds.
3. Strong intermolecular forces.
4. Solid at room temperature.

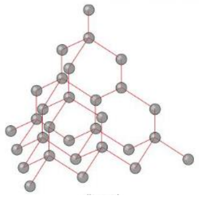


Polymer structure

Section 5 – Carbon Compounds

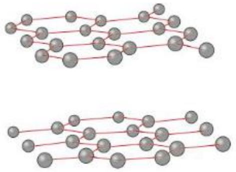
5A - Diamond

1. Carbon atoms form four covalent bonds with other carbon atoms in a giant covalent structure.
2. Very hard
3. Very high melting point.
4. Does not conduct electricity.



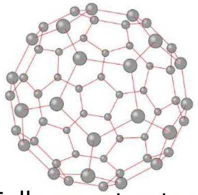
5b - Graphite

1. Carbon atoms form three covalent bonds with three other carbon atoms; forming layers of hexagonal rings.
2. No covalent bonds between layers.
3. One electron from each carbon atom is delocalised which behave like delocalised electrons in metals.

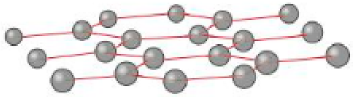


5C - Graphene and Fullerenes

1. Graphene is a single layer of graphite and has properties that make it useful in electronics and composites.
2. Fullerenes are molecules of carbon atoms with hollow shapes.
3. The structure of fullerenes is based on hexagonal rings of carbon atoms but they may also contain rings of five or seven carbon atoms.
4. The first fullerene to be discovered was Buckminsterfullerene (C60) which has a spherical shape.
5. Carbon nanotubes are cylindrical fullerenes with very high length to diameter ratios.
6. Nanotubes are useful for nanotechnology, electronics and materials.



Fullerene structure



Graphene structure

Section 6 – States of Matter

1. Solid to liquid state change is melting. Liquid to solid state change is freezing. Happens at the melting point.
2. Liquid to gas state change is boiling. Gas to liquid state change is condensing. Happens at the boiling point.
3. The amount of energy needed to change state from solid to liquid and liquid to gas depends on the strength of the forces between the particles of the substance.
4. The nature of the particles involved depends on the type of bonding and the structure of the substance.
5. The stronger the forces between the particles the higher the melting point and boiling point of the substance.
6. Particle model limited by the fact there are no forces, all particles are represented as spheres and that the spheres are solid.
7. States are represented by state symbols in chemical equations, (s), (l) and (g). (aq) for aqueous solutions.