C3: Structure and Bonding: Knowledge Organiser: Chemistry Specification

States of Matter

The three states of matter are solids, liquids and gases. The symbols are (s), (l), (g) and (aq) for aqueous solutions. The boiling point of a substance is the temperature at which boiling and condensing happen. The melting point of a substance is the temperature at which freezing and melting happen. Different substances have different melting and boiling points due to the strength of the forces between the particles of the substance. The stronger the force the higher the melting and boiling point of the substance.

Chemical Bonds

There are three types of chemical bonds. Ionic bonds occur in compounds formed from metals combined with non-metals. Covalent bonds are found in in non metal elements and compounds that are made of non metals. Metallic bonding occurs in metallic elements and alloys.

Metallic Bonds

Metals are giant structures of atoms arranged in a lattice. The electrons in the outermost shell of the metal atoms are delocalised are are free to move through the whole structure. This is why metals can conduct electricity. Strong electrostatic attractions between the negative electrons and the positive metal ions bond the metal ions together.

Properties of Metals

The bonds in metals are very strong and so metals have high melting and boiling points. In pure metals the atoms are arranged in layers which means metals can be bent and shaped. Metals can conduct electricity due to the delocalised electrons. They are also good conductors of thermal energy because energy can be transferred by the delocalised electrons. To make metals harder they can be mixed with other metals. This forms an alloy.

Ionic Bonding

When a metal reacts with a non metal electrons from the metal ion are transferred to the non metal ion. The metal atom loses electrons to become a positive ion while the non metal atom gains electrons to become a negative ion. Atoms in group 1 lose 1 electron from their outermost shell and form +1 ions while atoms in group 2 lose 2 electrons from their outermost shell and form +2 ions. Atoms in group 7 gain 1 electron and form -1 ions while atoms in group 6 gain 2 electrons and form -2 ions.

Ionic Compounds

An ionic compound is a giant structure of ions that are held together by strong electrostatic forces of attraction that act in all directions between oppositely charged ions. Ionic compounds have giant ionic lattices which means they have a regular structure. They have high melting and boiling points due to the strong bonds between the ions. When solid ionic compounds cant conduct electricity because the ions are not able to move. When molten or dissolved ionic compounds can conduct because the ions are able to move freely.

Graphene and Fullerenes

Graphene is a single layer of graphite. It is useful in electronics and composites. It has a very low density and for its mass is very strong. Fullerenes are molecules of carbon with hollow shapes. They also have hexagonal rings or carbon, but can also have rings made up of 5 or 7 carbon atoms also. The first to be discovered with Buckminsterfullerene which was a sphere. Carbon nanotubes are cylindrical fullerenes with high length to diameter ratios. They are useful in electronics. They all have delocalised electrons and so can conduct electricity. They also have high tensile strength.

Polymers

Polymers are very large molecules. The atoms in the polymer molecules are linked to other atoms by covalent bonds which are very strong. The intermolecular forces between the polymer molecules are strong and so the substances are solids at room temperature.

Covalent Bonding

When atoms share pairs of electrons they form covalent bonds. These bonds are very strong. Covalent bonds are found in small molecules such as oxygen, water, carbon dioxide and ammonia and are also found in very large molecules such as diamond, graphite and silicon dioxide.

Small Covalent Molecules

Small molecules are usually gases or liquids with low melting and boiling points. This is because there are weak forces between the molecules. These are known as intermolecular forces. As the molecule increases in size the intermolecular forces increase and so they have higher melting and boiling points. Small molecules do not conduct because the molecules do not have an overall electric charge.

Giant Covalent Structures

Giant covalent structures are solids with high melting and boiling points. This is because all of the atoms are bonded together with strong covalent bonds. In diamond each carbon atom is covalently bonded to 4 others so it is very hard. It does not have delocalised electrons so cant conduct electricity. In graphite each carbon atom is covalently bonded to 3 others forming layers of hexagonal rings with no covalent bonds between the layers, this means the layers can slide over each other. In graphite, for each covalent atom, there is one delocalised electron so it can conduct electricity.

Nanoscience

Nanoscience is the science of structures that are between 1-100nm in size. Nanoparticles are used in medicine, electronics, sunscreen, cosmetics, as deodorants and as catalysts. Nanoparticles have properties different from those for the same material in bulk due to their high surface area to volume ratio. This means that smaller quantities are needed to be effective also. Nanoparticles are smaller than fine particles which have diameters between 100-2500nm. Coarse particles, also known as dust, have diameters between $1x10^{-5}$m and $2.5x10^{-6}$m.