

## Unit 1 – Building Blocks

### **a) Substances**

#### **(i) Elements**

- Everything in the world is made from about 100 elements.
- Each element has a name and a symbol.
- Elements are classified in different ways, including naturally-occurring/made by
  - scientists, solid/liquid/gas, metal/non-metal.
- Chemists have classified elements by arranging them in the Periodic Table.
- A group is a column of elements in the Periodic Table.
- A period is a row of elements in the Periodic Table.
- The groups include the halogens, the alkali metals and the noble gases.
- Elements in any one group of the Periodic Table show similar chemical properties.
- The noble gases are a family of very unreactive elements.
- The alkali metals are a family of very reactive metals.
- The halogens are a family of very reactive non-metals.
- The transition metals are found between Groups 2 and 3 in the Periodic Table.

#### **(ii) Compounds and mixtures**

- Most compounds with a name ending in '-ide' contain the two elements indicated; the ending '-ite' or '-ate' indicates the additional element oxygen.
- Compounds are formed when elements react together.
- All chemical reactions involve the formation of one or more new substances.
- Chemical reactions can be identified by changes in appearance of substance, including colour change, gas evolved, precipitate formed.
- Chemical reactions can be identified by energy changes.
- Exothermic reactions release energy to the surroundings and the products have less chemical energy than the reactants.
- Endothermic reactions take in energy from the surroundings and the products have more chemical energy than the reactants.
- Mixtures occur when two or more substances come together without reacting.
- Air is a mixture of gases.

- The test for oxygen is that it relights a glowing splint.
- There is not enough oxygen in the air for the test to be positive.
- A solution is a mixture formed when a solute dissolves in a solvent.
- A substance which dissolves in a liquid is soluble; a substance which does not dissolve is insoluble.
- A saturated solution is one in which no more substance can be dissolved.
- A dilute solution has a lower concentration of dissolved substance than a concentrated solution.
- A solution is diluted by adding more solvent.
- State symbols are used to show the state of species.

### ***b) Reaction rates***

#### **Following the course of a reaction**

- Reactions can be followed by measuring changes in concentration, mass and volume of reactants and products.
- The average rate of a reaction, or stage in a reaction, can be calculated from initial and final quantities and the time interval.
- The rate of a reaction, or stage in a reaction, is proportional to the reciprocal of the time taken, ie if the rate is high the time taken will be small, and vice versa.

#### **Factors affecting rate**

- The rates of reactions are affected by changes in concentration, particle size and temperature.
- The collision theory can be used to explain the effects of concentration and surface area on reaction rates.

### **(iii) Catalysts**

- Catalysts are substances which speed up some reactions and are not used up by the reactions.
- Catalysts can be classified as either heterogeneous or homogeneous.
- There are many everyday examples of uses of catalysts.
- Catalysts are used in many industrial processes.
- Heterogeneous catalysts work by the adsorption of reactant molecules.
- The surface activity of a catalyst can be reduced by poisoning.
- Impurities in the reactants result in industrial catalysts having to be regenerated or renewed.

- Catalytic converters are fitted to cars to catalyse the conversion of poisonous carbon monoxide and oxides of nitrogen to carbon dioxide and nitrogen.
- Cars with catalytic converters only use 'lead-free' petrol to prevent poisoning of the catalyst.
- Enzymes catalyse the chemical reactions which take place in the living cells of plants and animals.
- There are many everyday examples of uses of enzymes.
- Enzymes are used in many industrial processes.

### ***c) The structure of the atom***

#### **(i) Sub-atomic particles**

- Every element is made up of very small particles called atoms.
- The atom has a nucleus, which contains protons and neutrons, with electrons moving around outside the nucleus.
- Protons have a charge of one-positive, neutrons are neutral and electrons have a charge of one-negative.
- An atom is neutral because the numbers of protons and electrons are equal.
- Protons and neutrons have an approximate mass of one atomic mass unit and electrons, in comparison, have virtually no mass.

#### **(ii) Important numbers**

- Atoms of different elements have a different number of protons, called the atomic number.
- The electrons in an atom are arranged in energy levels.
- The elements of the Periodic Table are arranged in terms of their atomic number and chemical properties.
- Elements with the same number of outer electrons have similar chemical properties.
- An atom has a mass number which equals the number of protons plus neutrons.
- The number of protons, neutrons and electrons can be found from the atomic number and mass number, and vice versa.
- Atoms can be represented by nuclide notation, eg  ${}_{17}^{37}\text{Cl}$



#### **(iii) Isotopes**

- Isotopes are atoms with the same atomic number but different mass numbers.
- Most elements exist as a mixture of isotopes.
- The relative atomic mass of an element is rarely a whole number.

#### *d) Bonding, structure and properties*

##### **Bonding**

- Atoms can be held together by bonds.
- In forming bonds, atoms can achieve a stable electron arrangement.
- In a covalent bond atoms share pairs of electrons.
- The covalent bond is a result of two positive nuclei being held together by their common attraction for the shared pair of electrons.
- Covalent bonds are strong forces of attraction.
- Polar covalent bonds are formed when the attraction of the atoms for the bonded electrons is different.
- The covalent bonds in water are highly polar.
- Ionic compounds are usually formed when metals combine with non-metals.
- Positive ions are formed by metal atoms losing electrons and negative ions are formed by non-metal atoms gaining electrons.
- Ionic bonding is the electrostatic force of attraction between oppositely charged ions.
- Metallic bonding is the electrostatic force of attraction between positively charged ions and delocalised electrons.
  
- **Structure**
- A molecule is a group of atoms held together by covalent bonds.
- A diatomic molecule is made up of two atoms.
- Hydrogen, nitrogen, oxygen, the halogens and carbon monoxide exist as diatomic molecules.
- Diagrams can be drawn to show how the outer electrons are shared to form the covalent bond(s) in a molecule.
- Diagrams can be drawn to show the shape of simple two-element molecules.
- Covalent substances can consist of discrete molecules.
- The bonds between the molecules are weaker than the covalent bonds within molecules.
- The formula for a discrete covalent substance gives the actual number of atoms in each molecule.
- Formulae can be written from models or given molecular pictures.
- A covalent network structure consists of a giant lattice of covalently bonded atoms.
- The formula for a covalent network substance gives the simplest ratio of atoms of each element.

- An ionic structure consists of a giant lattice of oppositely charged ions.
- The formula for an ionic compound gives the simplest ratio of positive ions to negative ions.
- A metallic structure consists of a giant lattice of positively charged ions and delocalised outer electrons.

### **(iii) Properties**

- Metal elements (solids, liquids) and carbon (graphite) are conductors of electricity because they contain free electrons.
- Covalent substances (solids, liquids, solutions) do not conduct electricity since they are made up of molecules which are uncharged.
- Ionic compounds do not conduct electricity in the solid state since the ions are not free to move, but these compounds do conduct electricity when dissolved in water or when molten as the ions are now free to move.
- Metals, ionic compounds and covalent network substances have high melting and boiling points.
- Discrete covalent substances have low melting and boiling points.
- Ionic compounds are usually soluble in water.
- Covalent substances which are insoluble in water may dissolve in other solvents.

### **(iv) Electrolysis**

- An electric current is a flow of charged particles.
- Electrolysis is the flow of ions through solutions and molten compounds (electrolytes).
- Electrolysis chemically changes the electrolyte and may lead to the break up of the compound.
- A dc supply must be used if the products of electrolysis are to be identified.
- Positive metal ions gain electrons at the negative electrode and negative non-metal ions lose electrons at the positive electrode.
- The results of electrolysis experiments can be illustrated by the migration of coloured ions.

### ***e) Chemical symbolism***

#### **Formulae: two-element compounds and group ions**

- Formulae can be written for names using prefixes, including mono-, di-, tri-, tetra-.
- Formulae for two-element compounds are written using the data booklet.
- Formulae can be written for compounds involving group ions but not requiring brackets, eg  $\text{Na}_2\text{SO}_4$ .

#### **Formulae: using Roman numerals and brackets**

- Formulae can be written for compounds using Roman Numerals, eg for iron(III) chloride.
- Formulae can be written for compounds requiring brackets, eg  $\text{Mg}(\text{OH})_2$ .

#### **Balanced equations**

- Formulae equations can be balanced to show the relative number of moles of reactant(s) and product(s).

### ***f) The mole***

#### **Number of moles**

- The relative formula mass of a substance can be calculated from the relative atomic masses.
- The gram formula mass of any substance is known as one mole.
- The number of moles can be calculated from the mass of a substance and vice versa.

#### **Using balanced equations**

- The mass of a reactant or product can be calculated using a balanced equation.