Chemistry – C1

Atomic Structure

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Atoms, Elements, and Compounds

All substances are made of small particles called atoms. These atoms can combine in different ways to make different substances. A small number of substances are made from all of the same type of atom. These are called **elements**. Elements can have many different properties; they may be shiny or dull, metallic or not, light or dense.

Atoms – The smallest part of a substance. (e.g., an iron atom)

Elements – A substance made up of all the same type of atoms. (e.g., a block of iron)

Compounds – A mixture of different types of atoms which are chemically combined (e.g., Co2)

Mixtures – A mixture of different types of atoms which are not chemically combined and can be physically separated.

Chemical Equations

Chemical Equations show the reactants (starting materials) and products (materials produced) in a chemical reaction. In any chemical reaction, ***the mass of the products is equal to the mass of the reactants***(or in other words, the starting weight will be equal to the ending weight, provided that nothing escapes, eg a gas). This is called ***the law of conservation of mass.***

State Symbols and Balancing Equations

Equations can also be written in symbol form, which means that you can see the amount of each substance involved in a chemical reaction. Balanced equations have the same number of each type of atom on both sides of the equation.

We can also use state symbols, which show the state (solid, liquid, gas, aqueous) of each substance in the reaction. In a chemical equation, (s) means solid, (l) means liquid, (g) means gas, and (aq) means aqueous – or substances dissolved in water.

Filtration and Crystallisation

Filtration is used to separate substances that are soluble from substances that are not, for example separating sand from sea water.

Crystallisation

To obtain pure salt from sea water, we need to separate the salt (filtrate) from the water (solvent). This can be done by evaporating the water, leaving the salt behind. The best way of doing this is to heat the solution in an evaporating basin, either on top of a water bath, or directly on a tripod. The solutions should be heated until small crystals form on the edge of the basin. The rest of the water is then left to evaporate on a windowsill.

Distillation

Crystallisation {link here} separates a solid (salt) from a solvent (water). However, sometimes you want to keep the solvent as well. To do this you can use distillation. In Simple Distillation, a substance is heated and boiled to evaporate the solvent. However instead of escaping into the air, the vapour passes through a condenser, which cools down the gas, turning back into a liquid, where it is caught in a separate container.

Diagram

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Fractional Distillation

Fractional Distillation is similar to Simple Distillation {link}. However, the main problem with simple distillation is that it cannot separate pure substances with similar boiling points (eg ethanol and water). This is because the substance with the higher boiling point will not boil, but it will still give off vapour.

To ensure a pure end product, we can use fractional distillation, which solves this problem. To aid separation, you can put a fractionating column between the flask and the condenser. A fractionating column is a thin tube filled with glass beads. As both liquids are heated and give of vapour, the liquid with the higher boiling point condenses more readily onto the glass beads, and drips back into the flask.

Paper Chromatography

One technique that can be used to separate and identify substances in mixtures that are dissolved in solution in paper chromatography. It works because some substances dissolve more than others in a chosen solvent.

A spot of each solution is placed on a pencil line near the bottom of the chromatography paper. The paper is then placed into a solvent in a beaker, with the pencil line at the bottom. The solvent soaks up the paper, passing the spots of the substances. The solubility of each substances determines how far each substance will travel up the paper. The more soluble a substance is, the further it will travel up the paper.

Diagram

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The History of the Atom

The history of the atom can be split into five main parts:

* Early ideas about atoms
* Evidence for electrons
* Evidence for the nucleus
* Evidence for electron shells
* Evidence for neutrons in the nucleus

Early ideas about Atoms:

In the early 1800s John Dalton suggested that atoms were like tiny solid spheres, and that each chemical element had it’s own atoms. He believed that atoms were the building blocks of nature, and could not be split any further.

Evidence for Electrons:

However, by the end of the 1800s Dalton’s work was disproven by a scientist called JJ Thomson, after he discovered the electron whilst he was experimenting on applying voltages to gases at low pressures. He found very small, negatively charged particles which he called electrons. He knew that atoms had no overall charge, so decided that atoms were many negatively charged electrons held in a cloud of positive charge.

Evidence for the Nucleus

The next big step in the development of the atom happened around 10 years after the discovery of the electron, when some students were experimenting with radioactive particles. They were firing dense positively charged (alpha) particles at a thin sheet of gold foil. They expected all of the particles to pass straight through the foil, however some were reflected back in the opposite direction. They determined that the positive charge was located in one point of the atom, and that the alpha particles were being repelled by it.

Rutherford proposed that the current atom diagram was wrong, and said that the positive charge in an atom was not a wide cloud, but a concentrated charge in one part of the atom.

Evidence for Electron Shells

The next development for the atom happened in 1914, when Niels Bohr revised the atomic model. He noticed that the light given off when the atoms were heated had a specific amount of energy. He suggested that the electrons must be orbiting the nucleus at fixed energy levels, or “shells”. The energy and light given off when the atoms are heated must be the electrons falling from a high energy level to a lower energy level.

Evidence for Neutrons in the Nucleus

Scientists speculated that there were two types of sub-atomic particles in the nucleus. They already knew about protons, but speculated that there was another particle, which would explain the missing mass that had been noticed in atoms. These new particles must have no charge, and the same mass as a proton. Because they had no charge, it was very difficult to detect neutrons. They were finally proven in 1932 by James Chadwick.

Structure of the Atom

Atoms contain 3 sub-atomic structures,

* Protons – carry a positive charge
* Neutrons – carry no charge
* Electrons – carry a negative charge

Ions

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Isotopes

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