Chapter 5: Physical and Chemical Changes

Physical properties are characteristics that can be determined without changing the composition of the substance.

Examples: colour, mass, volume, density, hardness, solubility, electrical conductivity and melting and boiling point – e.g. the freezing point of water can be determined without changing the composition of water (liquid or frozen, it remains H_2O).

Chemical properties are characteristics related to the chemical reactivity of a substance – they can be determined only by changing a substance's chemical composition.

Examples: flammability, likelihood to corrode and the ability to be oxidised or reduced.

A physical change is a change to the physical properties of a substance – no new substance is formed.

A physical change alters the physical properties of a substance (e.g. ice melting), whereas a chemical change alters the chemical properties of a substance (e.g. a firework exploding).

A chemical change is a change to the chemical properties of a substance – i.e. there is a change in the chemical composition – one or more new substances are formed).

When hydrochloric acid reacts with sodium hydroxide, two new substances – salt and water – are formed ($HCl + NaOH \rightarrow NaCl + H_2O$). The reactants have chemically changed into new substances called the products. Bonds have been broken, new bonds have been made, and atoms have been rearranged. This is a chemical change (or chemical reaction).

Physical changes	Chemical changes
Change in physical properties only	Change in chemical properties
No change in chemical composition – i.e. no new substance formed	Change in chemical composition – i.e. new substance formed
No bonds broken or made – atoms not rearranged	Bonds are broken and bonds are made – atoms rearranged
Easily reversible	Difficult to reverse
Usually no change in colour, pH, etc.	Among other changes there can be changes in colour and pH. A precipitate or gas may be formed (fizzing may be observed).

The law of conservation of mass states that the total mass of the products of a chemical reaction is equal to the total mass of the reactants.

Experiment 1: Verify, using primary data, the law of conservation of mass

Essentially you must be able to describe an experiment where you measured the mass of the reactants before a chemical reaction, carried out a chemical reaction, and then measured the mass of the products.

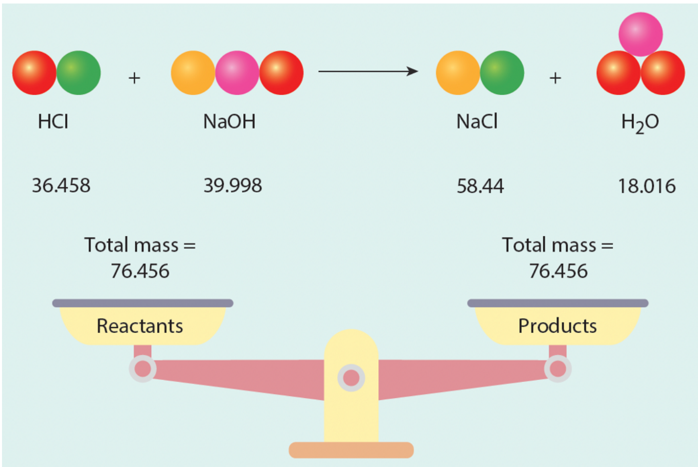
Example: Measure the mass of chunks of calcium carbonate and some hydrochloric acid, react them in a sealed conical flask, measure the mass after the reaction has occurred.

Modelling the law of conservation of mass

We can use the particle model to help explain why the law of conservation of mass is true.

If we look at the neutralisation reaction between hydrochloric acid and sodium hydroxide, **$HCl + NaOH \rightarrow NaCl + H_2O$**, and visualise this reaction in terms of particles, we can see that there are two hydrogen atoms, one chlorine atom, one sodium atom and one oxygen atom in the reactants, and the same number of each type of atom in the products - **i.e. the reactants and products contain equal numbers of each type of atom.**

If we then use the periodic table to find the mass of each atom (mass numbers: H = 1.008, O = 16.00, Na = 22.99, Cl = 35.45), and calculate the mass of each reactant and product, we can see that mass is conserved.



Chemical reactions also obey the law of conservation of energy.

The law of conservation of energy states that energy is neither created nor destroyed, but simply changes from one form to another.

This idea of conservation is also true in terms of energy – the law of conservation states that as any physical or chemical change occurs, energy is neither created nor destroyed.