SUBJECT: Science

UNIT: C6 Rate and Extent of Chemical Change

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Calculating Rates of Reaction

Reactions happen at varying rates. The rate of a chemical reaction tells us how fast a product is formed or how quickly a reactant is used up.

$$mean\ rate\ of\ reaction = \frac{quantity\ of\ reactant\ used\ OR\ product\ formed}{time\ taken}$$

Ambitious Vocabulary

Catalyst
Collisions
Equilibrium
Reversible

Factors Affecting the Rate of Reaction

Concentration, pressure, catalysts, surface area, and temperature are all factors affecting the rate of reaction. The rate of reaction will increase if there are more frequency **successful** collisions between reactants.

Concentration and Pressure

If the number of reactant particles in a given space is doubled then there will be more frequency successful collisions increasing the rate of reaction.

Surface Area

Larger lumps of a solid have a small surface area to volume ratio and breaking this up will increase the surface area and will increase the amount of successful collisions and therefore rate of reaction.

Temperature

As a substance is heated the particles gain kinetic energy causing them to move faster. This causes more frequency successful collisions and increases the rate of reaction.

Measuring the Volume of a Product

The changing volume of a reaction mixture can be measured during a reaction. This is used when gases are released in reactions. There are two main ways to measure this:

1. Attach a gas syringe to the reaction using a bung and measure the volume of gas produced.
2. Place a full measuring cylinder top down in a tray of water. Place a bung in the top of the reaction and use a delivery tube to connect this to the measuring cylinder.

Calculating a gradient

To find the rate of reaction from a straight-line graph:

$$gradient = \frac{y}{x}$$

The steeper the graph the higher the rate of reaction.

Required Practical: Concentration

React together different concentrations of hydrochloric acid and measure the volume of carbon dioxide gas produced.

Independent Variable: concentration of hydrochloric acid.

Dependent Variable: volume of carbon dioxide gas produced.

Control Variables: mass of calcium carbonate, time for reaction.

Required Practical: Colour Change

React together different temperatures/ concentrations of sodium thiosulphate with hydrochloric acid and time how long it takes for a precipitate to be made to obscure vision of a cross underneath the conical flask.

Independent Variable: temperature of sodium thiosulphate.

Dependent Variable: time for precipitate to obscure cross below conical flask.

Control Variables: volume and concentration of hydrochloric acid.

Catalysts

A catalyst is a substance that speeds up a chemical reaction without being used up during the reaction. Catalysts offer an alternative pathway at a lower activation energy. Enzymes are biological catalysts.

Dynamic Equilibrium

In a closed system a reversible reaction can reach dynamic equilibrium. This is where the forward and reverse reactions are occurring at the same rate and the concentrations of all substances remain constant.

Reversible Reactions

A reversible reaction is one which the reactants form products. The products are then able to react together to reform the products. For example:

$$A + B \rightleftharpoons C + D$$

The forward reaction goes to the left and the backwards reaction goes to the right. For example, if the forward reaction is exothermic then the backwards reaction is endothermic. The amount of energy transferred in both directions is the same.

Reversible Reactions

Le Chatelier's Principle is that the position of equilibrium can be altered by changing the conditions of the reaction such as pressure, concentration, or temperature. The position of the equilibrium will shift to counteract any changes. For example, increasing the temperature of a reaction in the forward direction (exothermic) will result in equilibrium being shifted in favour of the reverse direction to reduce the temperature.