# OCR (A) Chemistry GCSE

## Topic 5 - Monitoring and Controlling Chemical Reactions

Flashcards

# What does the term concentration mean?

(Chemistry only) (Higher only)

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(Chemistry only) (Higher only)

Concentration refers to the amount or mass of a substance in a given volume of solution.

# What are the units of concentration?

(Chemistry only) (Higher only)

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(Chemistry only) (Higher only)

$mol/dm^3$

$g/dm^3$

# How can concentration be calculated?

## (Chemistry only) (Higher only)

# How can concentration be calculated?

(Chemistry only) (Higher only)

$$\text{Concentration (mol/dm}^3\text{)} = \text{moles} \div \text{volume (dm}^3\text{)}$$

or

$$\text{Concentration (g/dm}^3\text{)} = \text{mass (g)} \div \text{volume (dm}^3\text{)}$$

How could you increase the concentration of a solution of hydrochloric acid?

(Chemistry only) (Higher only)

How could you increase the concentration of a solution of hydrochloric acid? (Chemistry only) (Higher only)

Either:

- Increase the number of moles of hydrochloric acid
- Decrease the volume of the solution

# What equipment is required for a standard titration?

(Chemistry only)

What equipment is required for a standard titration? (Chemistry only)

- Burette
- Conical flask
- Pipette and pipette filler
- White tile
- Funnel
- Clamp and stand

# Describe how to carry out a standard acid/alkali titration to find the concentration of the alkali (Chemistry only)

# Describe how to carry out a standard acid/alkali titration to find the concentration of the alkali (Chemistry only)

- Add acid to burette. Use pipette to add 25 $cm^3$ of alkali to a conical flask.
- Add a few drops of indicator to the conical flask.
- Record initial burette reading. Slowly add the acid to the conical flask, swirling the flask constantly.
- When the solution in the conical flask changes colour, stop adding the acid and record the final volume in the burette.
- Calculate the total volume of acid added from the burette.

# Why must the conical flask be swirled during a titration?

(Chemistry only)

Why must the conical flask be swirled during a titration? (Chemistry only)

To ensure all the particles react.

# Why is a white tile used when carrying out a titration?

(Chemistry only)

Why is a white tile used when carrying out a titration? (Chemistry only)

The white tile is placed under the conical flask so that the colour change of the indicator is easier to see.

After an acid/alkali titration, how can you calculate the concentration of the alkali if you know the concentration of the acid? (Chemistry only) (Higher only)

# After an acid/alkali titration how can you calculate the concentration of the alkali if you know the concentration of the acid? (Chemistry only) (Higher only)

- Multiply the concentration of acid by the volume from the burette to calculate the number of moles of acid.
- Use the balanced equation to work out the molar ratio of acid:alkali then calculate the number of moles of alkali that reacted using this ratio.
- Calculate the concentration of alkali by dividing the number of moles of alkali by the initial volume of alkali in the conical flask.

What is 32 $cm^3$ in $dm^3$?

(Chemistry only)

What is 32 $cm^3$ in $dm^3$? (Chemistry only)

32 ÷ 1000

= 0.032 $dm^3$

# Define the molar volume of a gas (Chemistry only) (Higher only)

# Define the molar volume of a gas (Chemistry only) (Higher only)

The volume occupied by one mole of any gas at room temperature and pressure.

What is the molar volume of gas at room temperature and pressure?

(Chemistry only) (Higher only)

What is the molar volume of gas at room temperature and pressure?
(Chemistry only) (Higher only)

24 $dm^3$ or 24000 $cm^3$

# What is RTP?

## (Chemistry only) (Higher only)

# What is RTP? (Chemistry only) (Higher only)

Room temperature and pressure

- 20°C
- 1 atmosphere

# How can the volume of gas be calculated at RTP?

(Chemistry only) (Higher only)

How can the volume of gas be calculated at RTP? (Chemistry only) (Higher only)

Volume at RTP ($dm^3$) = moles x 24

How many moles of oxygen are there in 72 $dm^3$ of oxygen at RTP?

(Chemistry only) (Higher only)

How many moles of oxygen are there in 72 $dm^3$ of oxygen at RTP? (Chemistry only) (Higher only)

Moles = volume ÷ 24

= 72 ÷ 24

= 3 moles

Why can the theoretical mass of a product be calculated if you know the masses of all the other reactants and products?

(Chemistry only)

Why can the theoretical mass of a product be calculated if you know the masses of all the other reactants and products? (Chemistry only)

The law of conservation of mass means that the total mass of the reactants must equal the total mass of the products.

11 g of calcium carbonate is heated to produce 4.7 g of carbon dioxide. What mass of calcium oxide is theoretically produced?

(Chemistry only)

11 g of calcium carbonate is heated to produce 4.7 g of carbon dioxide. What mass of calcium oxide is theoretically produced? (Chemistry only)

Mass calcium carbonate = mass of carbon dioxide + mass of calcium oxide

Mass of calcium oxide = 11 - 4.7

= 6.3 g

How can the theoretical mass of a product be calculated using the mass of one reactant only?

(Chemistry only) (Higher only)

# How can the theoretical mass of a product be calculated using the mass of one reactant only? (Chemistry only) (Higher only)

- Divide the mass of the reactant by its molecular mass to find the the number of moles of this reactant.
- Work out the molar ratio of reactant to product and use this to find the number of moles of the product. (e.g. a 1:2 ratio means you would double the number moles of the reactant).
- Multiply the moles by molecular mass to find the theoretical mass of the product.

# How can percentage yield be calculated?
(Chemistry only)

# How can percentage yield be calculated? (Chemistry only)

Percentage yield =

(actual mass of product ÷ theoretical mass of product) x 100

Calcium carbonate decomposes, forming 3 g of calcium oxide. The theoretical yield was 5 g. Calculate the percentage yield.

(Chemistry only)

Calcium carbonate decomposes, forming 3 g of calcium oxide. The theoretical yield was 5 g. Calculate the percentage yield. (Chemistry only)

Percentage yield = (3 ÷ 5) x 100

= 60 %

# Why is percentage yield usually less than 100%?

(Chemistry only)

# Why is percentage yield usually less than 100%? (Chemistry only)

- Incomplete reaction.
- Some of the product may have escaped (if gaseous) or vaporised.
- Impurities in the starting material.

What is meant by the term atom economy?

(Chemistry only)

What is meant by the term atom economy? (Chemistry only)

The proportion of reactant atoms which form the desired product in a reaction.

# How can atom economy be calculated?
(Chemistry only)

How can atom economy be calculated? (Chemistry only)

Atom economy =

$$\frac{\text{molecular mass of desired product}}{\text{total molecular mass of reactants}} \times 100$$

The equation for the fermentation of glucose is shown below. What is the atom economy of this reaction when producing ethanol?

$$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$$

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The equation for the fermentation of glucose is shown below. What is the atom economy of this reaction when producing ethanol?

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$ (Chemistry only)

Molecular mass of ethanol = (12 x 2) + (6 x 1) + 16 = 46

Total molecular mass of ethanol in equation = 2 x 46 = 92

Molecular mass of reactants (glucose) = 180

Atom economy = (92 / 180) x 100 = 51.1%

Some products can be produced by different reaction pathways. What must be considered when choosing the most appropriate pathway?

(Chemistry only) (Higher only)

Some products can be produced by different reaction pathways. What must be considered when choosing the most appropriate pathway?
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- Percentage yield
- Atom economy
- Uses of by-products
- Rate of reaction
- Position of equilibrium
- Availability of reactants

# How can rate of reaction be calculated?

# How can rate of reaction be calculated?

Rate of reaction =

$$\frac{\text{Amount of product formed or reactant used}}{\text{Time (s)}}$$

# Suggest units that could be used for rate of reaction

Suggest units that could be used for rate of reaction

g/s

$cm^3/s$

mol/s (Higher only)

How can the rate of reaction be measured if a precipitate is produced?

# How can the rate of reaction be measured if a precipitate is produced?

- Place a conical flask over a black cross.
- Start the timer as soon as the reactants are combined in the conical flask.
- Time how long it takes for the black cross to disappear.

# Why is the disappearing cross rate of reaction experiment not very accurate?

Why is the disappearing cross rate of reaction experiment not very accurate?

It's very subjective, people might disagree about the exact point the black cross disappears.

How can the rate of reaction be measured if hydrogen is produced?

# How can the rate of reaction be measured if hydrogen is produced?

By collecting gas in a gas syringe or upturned measuring cylinder in a water trough:

- Reactants are placed in conical flask with a bung and delivery tube connected to a gas collection vessel.
- Start timer.
- Measure the volume of gas collected in 30 seconds.
- Calculate rate of reaction.

# When and how can the rate of reaction be measured using a digital mass balance?

# When and how can the rate of reaction be measured using a digital mass balance?

When a gas is produced as the gas will escape the reaction vessel causing mass to decrease.

- Record initial mass of reactants.
- Start timer when reactants are combined.
- Record the mass every 15 seconds for 2 minutes.
- Calculate the rate of reaction.

How could you investigate the effect of temperature on the rate of a reaction?

# How could you investigate the effect of temperature on the rate of a reaction?

Calculate the rate of reaction using either:

- Disappearing cross method
- Gas syringe method
- Digital mass balance method

Then repeat the same experiment, changing the temperature of the reactants to collect results for 10°C, 20°C, 30°C etc. Plot the results on the same graph to compare.

# How can the rate of reaction be calculated at a specific time in a reaction?

# How can the rate of reaction be calculated at a specific time in a reaction?

If the amount of product formed/reactant used has been recorded at regular intervals during the reaction, plot results on a graph:

- X axis - time (s).
- Y axis - amount of product formed / reactant used.
- Draw a tangent at the specific time. The rate of reaction at this time is equal to the gradient of the tangent (change in y ÷ change in x).

# How do the concentrations of reactants and products change during a reaction?

# How do the concentrations of reactants and products change during a reaction?

The concentrations of the products increase rapidly at the start then slows down before staying constant when the reaction is complete.

The concentrations of the reactants decrease as the reaction progresses. They decrease rapidly at the start then slow down before staying constant when one or all of the reactants have been used up.

# Describe and explain the gradient of the curve on a rate of reaction graph

# Describe and explain the gradient of the curve on a rate of reaction graph

Initially the gradient is very steep because the rate of reaction is fastest at the start (there are more reacting particles so more frequent successful collisions).

The gradient decreases over time as the reactants are used up.

The curve eventually levels off when the reaction is complete (one or all of the reactants have been completely used up).

What is proportional to the rate and gradient of a rate of reaction graph?

What is proportional to the rate and gradient of a rate of reaction graph?

1/t

# What does the term ‘activation energy’ mean?

What does the term ‘activation energy’ mean?

The minimum amount of energy required for a reaction to take place.

# What conditions can be changed to increase the rate of a reaction?

What conditions can be changed to increase the rate of a reaction?

- Increase temperature
- Increase pressure
- Increase surface area of reactants
- Increase concentration of reactants

# How does temperature affect the rate of reaction?

# How does temperature affect the rate of reaction?

Increasing temperature increases the rate of reaction because the reactants have more energy so more particles have energy above the activation energy so more collisions will produce successful reactions. Collisions also occur more frequently because the particles have more kinetic energy.

# How does surface area affect the rate of reaction?

# How does surface area affect the rate of reaction?

Increasing surface area increases the rate of reaction because more reacting particles are exposed so there are more frequent successful collisions.

# How does concentration affect the rate of reaction?

# How does concentration affect the rate of reaction?

Increasing concentration increases the rate of reaction because there are more reacting particles in the same volume. This means more frequent successful collisions occur.

# How does pressure affect the rate of a gaseous reaction?

# How does pressure affect the rate of a gaseous reaction?

Increasing the pressure of a gaseous reaction increases the rate of reaction because there are more reacting particles in the same volume of gas (or the same number of reacting particles in a smaller volume) so there are more frequent successful collisions.

Marble chips react with hydrochloric acid to produce calcium chloride, water and carbon dioxide. How could you calculate the rate of reaction?

Marble chips react with hydrochloric acid to produce calcium chloride, water and carbon dioxide. How could you calculate the rate of reaction?

Since gaseous carbon dioxide is released, the rate can be measured by using digital balance to measure the change in mass over a period of time or by using a gas syringe / measuring cylinder to collect the gas.

Marble chips react with hydrochloric acid to produce calcium chloride, water and carbon dioxide. How could you increase the rate of this reaction?

Marble chips react with hydrochloric acid to produce calcium chloride, water and carbon dioxide. How could you increase the rate of this reaction?

- Increase the surface area of the marble chips by turning them into a powder.
- Increase concentration of acid.
- Increase temperature of the reaction.

What can be added to speed up the rate of a reaction?

What can be added to speed up the rate of a reaction?

Catalyst

# What is a catalyst?

What is a catalyst?

A substance which speeds up the rate of reaction without being chemically changed at the end.

# How does a catalyst affect the rate of reaction?

# How does a catalyst affect the rate of reaction?

A catalyst increases the rate of reaction because it provides an alternate reaction pathway with a lower activation energy. More particles have energy above the activation energy so more frequent successful collisions will occur.

# How can a catalyst be identified in a reaction?

How can a catalyst be identified in a reaction?

They are chemically unchanged so can be distinguished from the product. They are not involved in the reaction equation as they are not used up.

# What do the terms exothermic and endothermic mean?

What do the terms exothermic and endothermic mean?

Endothermic - a reaction that takes in energy from the surroundings.

Exothermic - a reaction that gives out energy to the surroundings.

Draw a reaction profile diagram for an exothermic reaction, labeling activation energy. How would this change if a catalyst was added?

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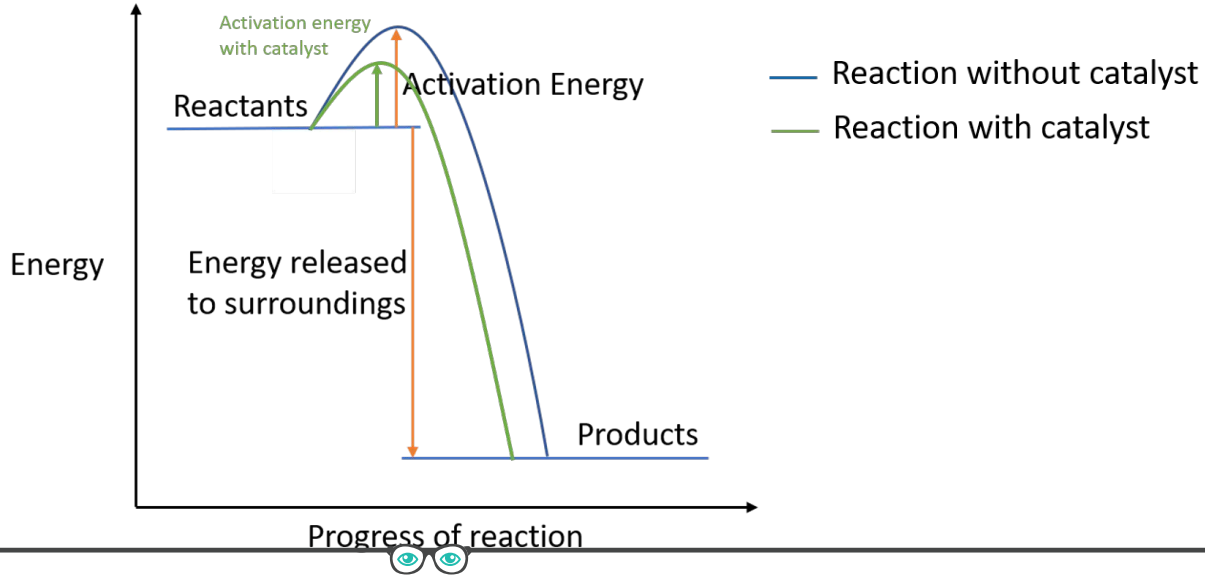

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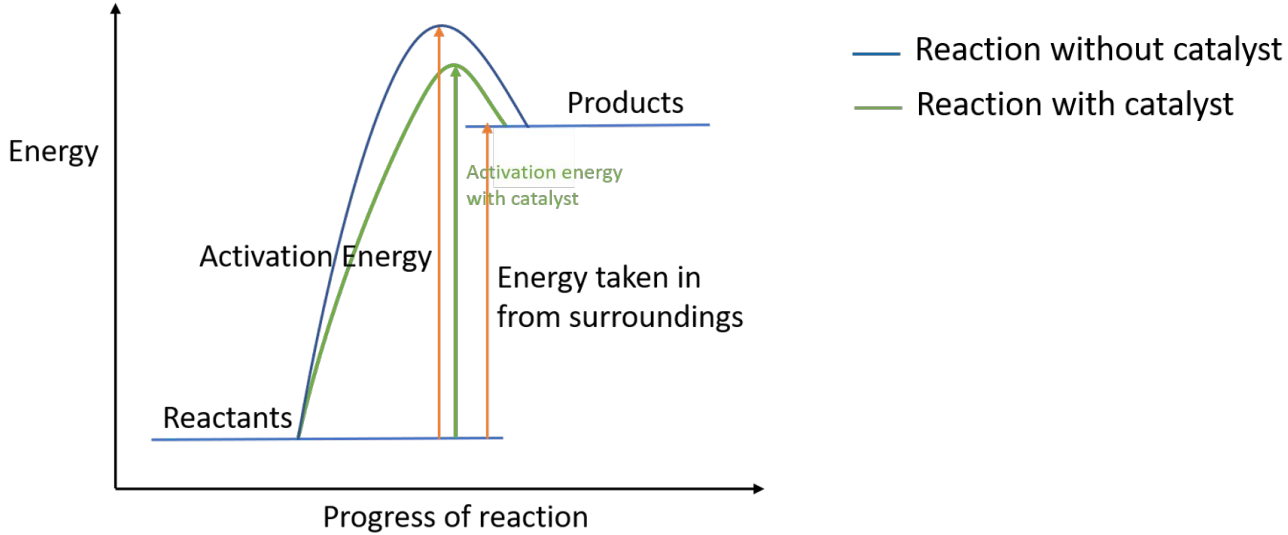

# What are enzymes?

# What are enzymes?

Biological catalysts that speed up the rate of reactions in living cells.

# What is a reversible reaction?

# What is a reversible reaction?

A reaction in which the products can react together to reform the original reactants.

# How can the direction of a reversible reaction be changed?

How can the direction of a reversible reaction be changed?

By changing the conditions.

# What is meant by the term dynamic equilibrium?

What is meant by the term dynamic equilibrium?

Dynamic equilibrium occurs in a closed system when the rates of the forward and backward reactions are equal. The concentration of reactants and products remain constant.

Write a balanced chemical equation for the reversible reaction between nitrogen and hydrogen to form ammonia

Write a balanced chemical equation for the reversible reaction between nitrogen and hydrogen to form ammonia

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

# What is Le Chatelier's principle?

(Higher only)

# What is Le Chatelier's principle?

(Higher only)

If a reaction at equilibrium is subjected to a change in temperature, concentration or pressure, the position of equilibrium will shift to oppose this change.

What happens to the position of equilibrium if the concentration of the reactants increases?

(Higher only)

What happens to the position of equilibrium if the concentration of the reactants increases?
(Higher only)

The position of equilibrium will shift right (towards the products) to reduce the concentration of reactants and form more products.

What happens to the position of equilibrium if the concentration of the products increases?

(Higher only)

What happens to the position of equilibrium if the concentration of the products increases?
(Higher only)

The position of equilibrium will shift left (towards the reactants) to decrease the concentration of products and form more reactants.

How does a change in pressure affect the position of equilibrium?

(Higher only)

How does a change in pressure affect the position of equilibrium? (Higher only)

Increasing the pressure causes the position of equilibrium to shift towards the side with the fewest gaseous moles in order to counteract the pressure change.

What will be the effect on equilibrium position and yield of ammonia if pressure is increased in the reaction below?

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(Higher only)

What will be the effect on equilibrium position and yield of ammonia if pressure is increased in the reaction below?

$N_2 + 3H_2 \rightleftharpoons 2NH_3$ (Higher only)

Equilibrium position will shift right as there are fewer molecules of gas in the products.

The yield of ammonia will increase.

What happens to the position of equilibrium if the temperature of a reaction is increased? (Higher only)

What happens to the position of equilibrium if the temperature of a reaction is increased? (Higher only)

The position of equilibrium shifts in the direction of the endothermic reaction to take in more heat energy from the surroundings.

For the production of ammonia the forward reaction is exothermic. What temperature should be used to produce as much product as possible?

(Higher only)

For the production of ammonia the forward reaction is exothermic. What temperature should be used to produce as much product as possible?
(Higher only)

A low temperature because the forward reaction is exothermic.