

Equilibrium

What is a *Reversible Reaction*?
Give 2 examples.

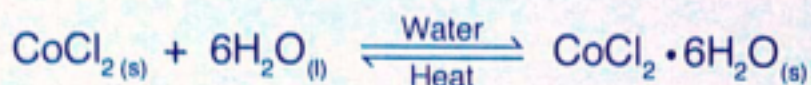
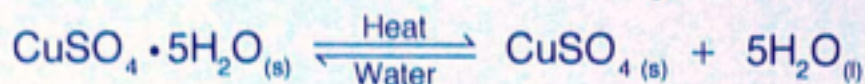
Explain what is meant by *Equilibrium*.

Explain how the equilibrium position is affected by changes in *Concentration*, *Temperature* and *Pressure*.

How is yield related to equilibrium position?

Reversible Reaction:

A reaction that can take place in both directions, e.g.



Equilibrium:

- The **forward** and **backward** reactions take place at the **same rate**
- There is no overall change in the concentration of reactants and products

Effect of Change in Concentration:

The equilibrium position moves to the **products** side if:

- the reactant concentration increases (e.g. more reactant is added)
- the product concentration decreases (e.g. product is removed)

Effect of Temperature Change:

Temperature **increase**: equilibrium position moves in the **endothermic** direction

Temperature **decrease**: equilibrium position moves in the **exothermic** direction

Effect of Pressure Change:

Pressure **increase**: equilibrium position moves to side with **fewer gas molecules**

Pressure **decrease**: equilibrium position moves to side with **most gas molecules**

Yield & Equilibrium Position:

The yield will be higher if the equilibrium position is further towards the products side

Sulfur

Name 3 natural sources of sulfur.

What is produced in the *Contact Process*?

List the raw materials.

State the 4 steps in the Contact Process, with equations.

Describe the properties of both *Dilute Sulfuric Acid*
& *Concentrated Sulfuric Acid*.

Give uses of *Sulfuric Acid* & *Sulfur Dioxide*.

Sources:

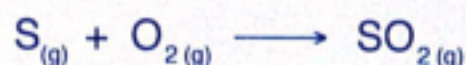
- As the element (underground and near volcanoes)
 - As a compound in metal ores, e.g. galena (lead(II) sulfide, PbS)
 - In fossil fuels, e.g. coal, crude oil & natural gas
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Contact Process:

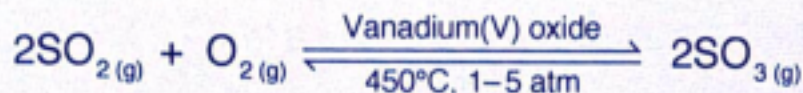
Product: Sulfuric acid (H_2SO_4)

Raw materials: Sulfur (or sulfur dioxide), air, water

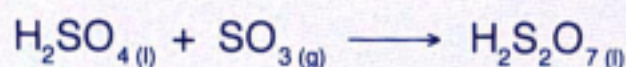
Step 1: Sulfur is burned in air to make sulfur dioxide:



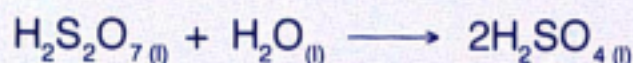
Step 2: SO_2 is mixed with more air and passed over a vanadium(V) oxide catalyst at 450°C , 1–5 atmospheres pressure to make sulfur trioxide:



Step 3: SO_3 is dissolved in concentrated sulfuric acid to make oleum:



Step 4: Oleum is mixed with water to produce concentrated sulfuric acid:



Properties of Sulfuric Acid:

- Dilute sulfuric acid shows the usual reactions of acids, e.g. it reacts with metals, metal oxides, hydroxides and carbonates forming salts called sulfates.
 - Concentrated sulfuric acid is a dehydrating/drying agent – it removes water.
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Uses of Sulfuric Acid:

- Fertilisers, e.g. ammonium sulphate
 - Soaps, detergents
 - Paints, pigments, dyes
 - Car batteries
 - Fibres, plastics
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Uses of Sulfur Dioxide:

- As a bleach in the manufacture of wood pulp for paper
- As a food preservative (it kills bacteria)

Haber Process & Fertilisers

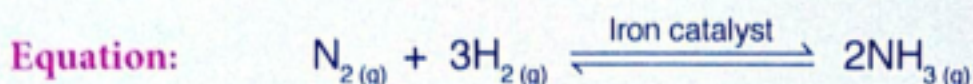
What is the *Haber Process*? Give an equation.
Where are the *Raw Materials* obtained from?
What *Temperature, Pressure & Catalyst* are required?
How can the equilibrium be forced to make
more ammonia?

Give uses of ammonia.

Why are fertilisers necessary? Give 4 examples of
fertilisers, including formulae.

Haber Process:

An industrial process for the production of ammonia (NH₃) from nitrogen and hydrogen



Raw Materials:

- Nitrogen – extracted from the air (by fractional distillation – see card **Pink 16**)
- Hydrogen – from reacting methane with steam or from cracking alkanes

Temperature: 450°C

Pressure: 200 atmospheres

Catalyst: Iron

Increasing the yield:

The ammonia is cooled, so that it condenses into a liquid and can be removed
This makes the equilibrium move to the products side, increasing the yield

Uses of Ammonia:

- Fertilisers
 - Explosives
 - Cleaning products
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Fertilisers:

Fertilisers make crops grow bigger and faster

e.g. Ammonium nitrate, NH₄NO₃

Ammonium sulfate, (NH₄)₂SO₄

Ammonium phosphate, (NH₄)₃PO₄

Potassium sulfate, K₂SO₄

*Fertilisers contain **N** (Nitrogen), **P** (Phosphorus) and **K** (Potassium) which are essential for healthy plant growth*