

Exercise walk-through

6.3

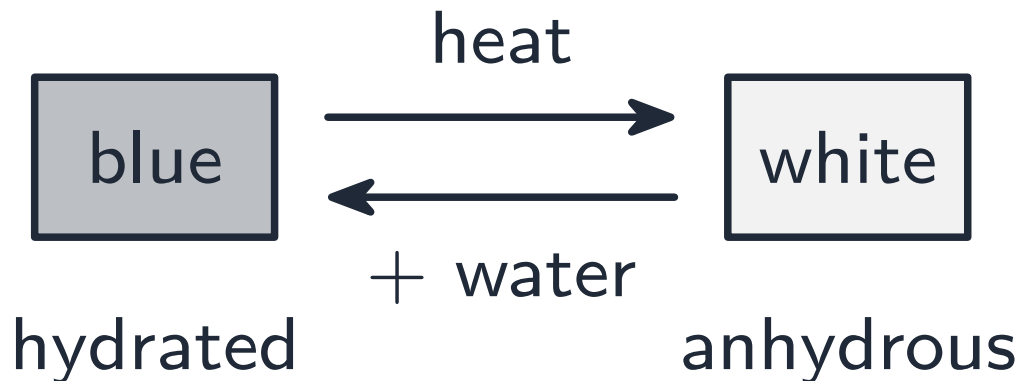
Reversible reactions and equilibrium

IGCSE Chemistry

Reversible reactions

A **reversible reaction** ($\rightleftharpoons$) can go both ways.

Blue **hydrated** $\text{CuSO}_4 \rightleftharpoons$ white **anhydrous** $\text{CuSO}_4 + \text{water}$. Adding water turns it blue – a test for water.



A reaction that runs both ways

Reverse reaction

In a reversible reaction the products re-form the reactants – the **reverse reaction** – and both run at once.

Equilibrium

At equilibrium the two rates are *equal*, so the amounts stop changing. Nothing has stopped happening.

A classic test

Hydrated copper(II) sulfate turns white when heated and blue again with water – reversible, and visible.

Redox in one line

A **redox reaction** is any reaction where electrons transfer: one species is oxidised as another is reduced.

Equilibrium is dynamic. Marks are lost by writing that the reaction “stops”.

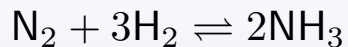
Equilibrium

At **equilibrium** (closed system): rate forward = rate reverse
concentrations stop changing (but the reaction is still going)

To shift the position: **heat** → endothermic side; **pressure** → fewer-molecules side; **add a substance** → the other side. A **catalyst** does not shift it.

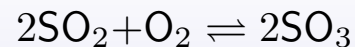
Industry: Haber and Contact

Haber – ammonia



450°C, ~200 atm, iron catalyst

Contact – SO₃



450°C, ~2 atm, V₂O₅ catalyst

Conditions are a **compromise** : medium pressure (safe), fairly high temperature (good rate).

Why these conditions are chosen

- A higher pressure would give more product, but very high pressure is dangerous and expensive, so a medium pressure is used.
- A lower temperature would give more product (both forward reactions are exothermic), but the reaction would be too slow, so a fairly high temperature is used to keep a good rate.
- The catalyst speeds up the reaction without changing the position of equilibrium, which lowers cost.

Exercises 2.1·2.2

2.1 State the two conditions for a reaction at equilibrium. [2]

2.2 Give the catalyst used in the Haber process. [1]

Exercises 2.1·2.2

2.1 State the two conditions for a reaction at equilibrium. [2]

2.1

- forward and reverse reactions occur at the **same rate**
 - concentrations of reactants and products **stay constant**
-

2.2 Give the catalyst used in the Haber process. [1]

2.2

- Haber process catalyst: **iron**

Exercise 3.1

3.1 Adding a catalyst to a reaction at equilibrium:

[1]

☐

A moves the equilibrium to the products

B moves it to the reactants

C does not move the position, but reaches equilibrium faster

D stops the reaction

Exercise 3.1

3.1 Adding a catalyst to a reaction at equilibrium:

[1]

☐

A moves the equilibrium to the products

B moves it to the reactants

C does not move the position, but reaches equilibrium faster

D stops the reaction

3.1 C

- a catalyst **does not move the position**; it only reaches equilibrium **faster**
- A and B would change yield; D is false

Exercise 3.2 (a)

3.2 In the Haber process $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$.

(a) State the effect of increasing the pressure on the amount of ammonia.

[2]

Exercise 3.2 (a)

3.2 In the Haber process $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$.

(a) State the effect of increasing the pressure on the amount of ammonia.

[2]

(a)

- the amount of ammonia **increases**
- equilibrium moves to the side with **fewer gas molecules** (2 vs 4)

Exercise 3.2 (b)

3.2 In the Haber process $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$.

(b) Explain why a temperature of about 450°C is used, even though a lower temperature would give more ammonia. [2]

Exercise 3.2 (b)

3.2 In the Haber process $\text{N}_2(g) + 3\text{H}_2(g) \rightleftharpoons 2\text{NH}_3(g)$.

(b) Explain why a temperature of about 450°C is used, even though a lower temperature would give more ammonia. [2]

(b)

- a lower temperature gives more ammonia but the reaction is **too slow**
- 450°C is a **compromise** that keeps a good rate

Exercise 3.3

3.3 Anhydrous copper(II) sulfate is white; adding water turns it blue. State what this is used to test for, and why this is a reversible reaction. [2]

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3.3

- it tests for **water**
- the reaction can go **both ways** – lose water on heating, gain it again