Solutions

Each answer shows the steps, then the **result**.

2.1

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

2.2

- Haber process catalyst: **iron**

2.3

- the reaction is **reversible**

2.4

- about 20 000 kPa (200 atmospheres)

3.1 C

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

3.2

(a)

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

(b)

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

3.3

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

3.4

(a)

- vanadium(V) oxide, V_2O_5

(b)

- the amount of sulfur trioxide **decreases**
- increasing the temperature favours the endothermic (backward) reaction, so the equilibrium moves to the left

3.5

- nitrogen: from the air
- hydrogen: from methane (natural gas)