7 Dynamic equilibrium and the equilibrium constant – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	**Write it 3 times** (English)		
reversible reaction			
Chemical equilibrium			
equilibrium constant			

Recall

You have met reversible reactions before:

- Some reactions can go both forwards and backwards (shown with $\rightleftharpoons$).
- At **equilibrium**, the amounts stop changing even though the reaction has not stopped.
- The Haber process for ammonia is a famous reversible reaction.

This sheet makes equilibrium exact. Each idea has a worked example.

New ideas

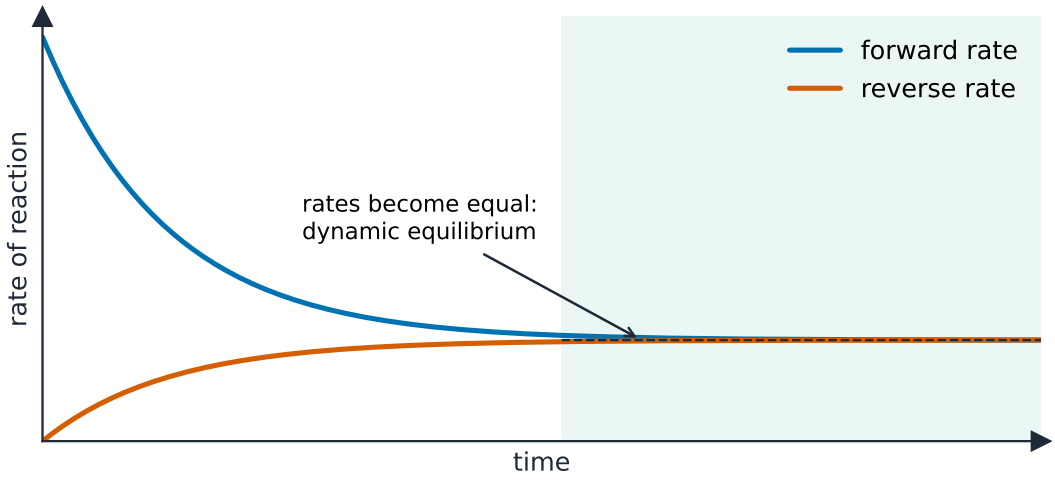
1 Reversible reactions

A **reversible reaction** can run both ways at once. Reactants make products, and products remake reactants.

2 Dynamic equilibrium

Chemical equilibrium is reached when the forward and reverse reactions go at the **same rate**, so the concentrations stop changing. It is **dynamic** – both reactions keep going, they just balance out.

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at equilibrium: $\text{rate}_f = \text{rate}_r \cdot K_c = \frac{[\text{products}]}{[\text{reactants}]}$

3 The equilibrium constant

The **equilibrium constant** K compares products to reactants at equilibrium:

$$K = \frac{[\text{products}]}{[\text{reactants}]},$$

each concentration raised to its coefficient.

Worked example. For $N_2O_4 \rightleftharpoons 2NO_2$ with $[N_2O_4] = 0.20$ M and $[NO_2] = 0.10$ M: $K = \dfrac{[NO_2]^2}{[N_2O_4]} = \dfrac{(0.10)^2}{0.20} = 0.050.$

4 What K tells you

- K much greater than 1: products are favoured (reaction nearly complete).
- K much less than 1: reactants are favoured (little reaction).

Watch out: at equilibrium the forward and reverse **rates** are equal, but the **amounts** of reactant and product are usually **not** equal – they are just no longer changing.

Practice

Try these in order. The methods are all above.

2.1 State what "dynamic equilibrium" means. [2]

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2.2 For $A \rightleftharpoons B$ with $[A] = 0.40$ M and $[B] = 0.80$ M, find $K = \dfrac{[B]}{[A]}$. [2]

2.3 A reaction has $K = 1 \times 10^{6}$. State whether products or reactants are favoured. [1]

2.4 For $H_2 + I_2 \rightleftharpoons 2HI$ with $[H_2] = [I_2] = 0.10$ M and $[HI] = 0.50$ M, find $K = \dfrac{[HI]^2}{[H_2][I_2]}$. [3]

2.5 State whether the amounts of reactant and product must be equal at equilibrium. [1]