

2. EQUILIBRIUM CONSTANTS

UNIT 3 – CHEMICAL EQUILIBRIUM

CH40S MR. WIEBE

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EQUILIBRIUM LAW

equilibrium law the mathematical description of a chemical system at equilibrium

equilibrium constant (K) a constant numerical value defining the equilibrium law for a given system; units are not included when giving the value of K

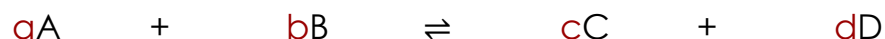


Figure 1 Cato Maximilian Guldberg (1836–1902) and Peter Waage (1833–1900) first proposed the equilibrium law in 1864.

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QUANTIFYING EQUILIBRIUM - K

An **equilibrium system**, at any given temperature, can be described by an **equilibrium expression** and its resulting **equilibrium constant**.



$$K = \frac{\text{Products}}{\text{Reactants}} \quad K = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

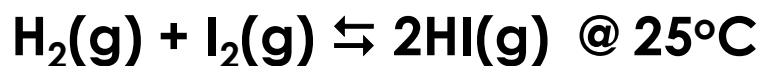
Equilibrium Constant = a number

Equilibrium Expression = equation

ONLY(aq) and (g) are included! (l) and (s) are **NOT**!

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USING THE EQUILIBRIUM EXPRESSION



Initial concentration (mol/L)		
[H ₂ (g)]	[I ₂ (g)]	[HI(g)]
2.00	2.00	0
Equilibrium concentration (mol/L)		
[H ₂ (g)]	[I ₂ (g)]	[HI(g)]
0.442	0.442	3.119

$$K = \frac{[\text{HI}(\text{g})]^2}{[\text{H}_2(\text{g})][\text{I}_2(\text{g})]}$$

$$K = \frac{(3.119)^2}{(0.442)(0.442)}$$

$$K = 49.8$$

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THE SIZE OF K HAS MEANING

Big K = [Reactants] < [Products] @ Eq'm

$$K = \frac{\text{products}}{\text{reactants}} = \text{BIG}$$

Eq'm is PRODUCT FAVOURED

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THE SIZE OF K HAS MEANING

Small K = [Reactants] > [Products] @ Eq'm

$$K = \frac{\text{products}}{\text{reactants}} = \text{SMALL}$$

Eq'm is REACTANT FAVOURED

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THE SIZE OF K HAS MEANING

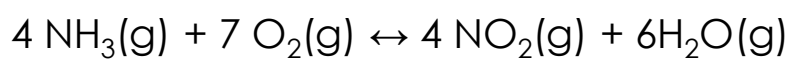
$K = 1 \dots [\text{Products}] = [\text{Reactants}] @ \text{Eq'm}$

$$K = \frac{\text{products}}{\text{reactants}} = 1$$

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EXAMPLE 1

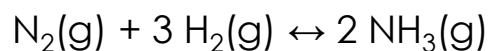
Write the equilibrium expression for the following reaction:



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EXAMPLE 2

The following reaction happens in a closed container at a constant temperature. At equilibrium, the concentrations of each chemical are 1.50×10^{-5} mol/L $\text{N}_2(\text{g})$, 3.45×10^{-1} mol/L $\text{H}_2(\text{g})$, and 2.00×10^{-4} mol/L $\text{NH}_3(\text{g})$. Calculate the equilibrium constant.



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PUTTING IT ALL TOGETHER...

When **0.800 moles** of SO_2 and **0.800 moles** of O_2 are placed in a **2.00 L** container and allowed to reach equilibrium, the equilibrium $[\text{SO}_3]$ is found to be **0.300 mol/L**. Calculate the **K** value for this reaction at this temperature.



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