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EQUILIBRIUM CONSTANT K_c

Indices rules

$$a^b \times a^c = a^{b+c}$$

$$a^b \div a^c = a^{b-c}$$

$$(a^b)^c = a^{bc}$$

$$a^0 = 1$$

$$\frac{1}{a^b} = a^{-b}$$

Examples

$$a^2 \times a^3 = a^5$$

$$a^2 \div a^3 = a^{-1}$$

$$(a^2)^3 = a^6$$

$$5^0 = 1 \quad \frac{1}{a^3} = a^{-3}$$

$$(\text{mol dm}^{-3})^2 = \text{mol}^2 \text{ dm}^{-6}$$

$$(\text{mol dm}^{-3})^{-3} = \text{mol}^{-3} \text{ dm}^9$$

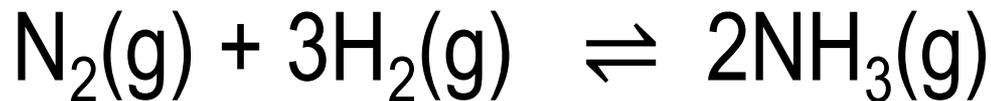
Equilibrium constant K_c & units



$$K_c = \frac{[C][D]^2}{[A][B]}$$

$$\begin{aligned} & \frac{(\text{mol dm}^{-3}) (\text{mol dm}^{-3})^2}{(\text{mol dm}^{-3}) (\text{mol dm}^{-3})} \\ &= \frac{(\text{mol dm}^{-3})^3}{(\text{mol dm}^{-3})^2} = (\text{mol dm}^{-3})^1 = \mathbf{\text{mol dm}^{-3}} \end{aligned}$$

Equilibrium constant K_c & units

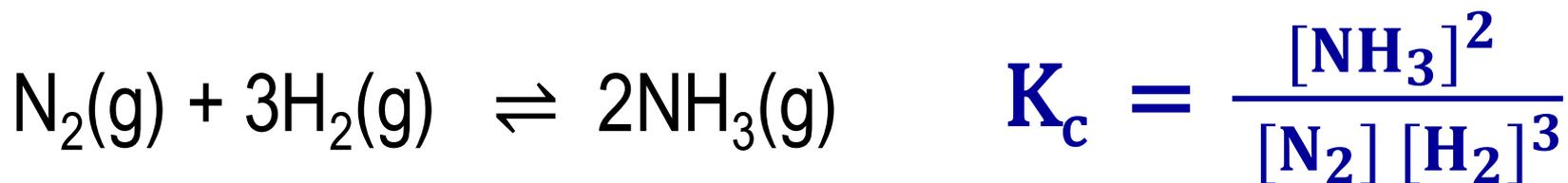


$$K_c = \frac{[\text{NH}_3]^2}{[\text{N}_2] [\text{H}_2]^3}$$

$$\begin{aligned} & \frac{(\text{mol dm}^{-3})^2}{(\text{mol dm}^{-3}) (\text{mol dm}^{-3})^3} \\ &= \frac{(\text{mol dm}^{-3})^2}{(\text{mol dm}^{-3})^4} = (\text{mol dm}^{-3})^{-2} = \mathbf{\text{mol}^{-2} \text{dm}^6} \end{aligned}$$

Equilibrium constant K_c & units

K_c for any equilibrium is **only** affected by changes in temperature



Change	Effect on position of equilibrium	Effect on K_c
increase P	shifts right to give more NH_3	no effect
add more N_2	shifts right to give more NH_3	no effect
decrease T	shifts right to give more NH_3	K_c increases

Moles at equilibrium

	A	+	B	\rightleftharpoons	C
moles at start	2.0		3.0		0
change	-0.8		-0.8		+0.8
at equilibrium	1.2		2.2		0.8

Moles at equilibrium

	D	+	2 E	\rightleftharpoons	F
moles at start	2.5		4.0		0
change	-1.1		-2.2		+1.1
at equilibrium	1.4		1.8		1.1

Moles at equilibrium

	G	+	3 H	\rightleftharpoons	2 J	+	K
moles at start	1.6		2.0		0		0
change	-0.4		-1.2		+0.8		+0.4
at equilibrium	1.2		0.8		0.8		0.4

K_c Calculations

volume = 2.0 dm³



moles at equilibrium 2.4 0.5 3.0

$$K_c = \frac{[\text{C}]}{[\text{A}][\text{B}]^2} = \frac{\frac{3.0}{2.0}}{\frac{2.4}{2.0} \times \left(\frac{0.5}{2.0}\right)^2} = 20$$

$$= \frac{\text{mol dm}^{-3}}{(\text{mol dm}^{-3})^3} = (\text{mol dm}^{-3})^{-2} = \mathbf{\text{mol}^{-2}\text{dm}^6}$$

K_c Calculations

volume = 5.0 dm³



moles at start

1.0 0 0

change

-0.8 +0.4 +0.8

at equilibrium

0.2 0.4 0.8

$$K_c = \frac{[E][F]^2}{[D]^2} = \frac{\frac{0.4}{5.0} \times \left(\frac{0.8}{5.0}\right)^2}{\left(\frac{0.2}{5.0}\right)^2} = 1.28$$

$$= \frac{(\text{mol dm}^{-3})^3}{(\text{mol dm}^{-3})^2} = (\text{mol dm}^{-3})^1 = \mathbf{\text{mol dm}^{-3}}$$