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EQUILIBRIUM CONSTANT K_c

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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

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

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

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

$5^0 = 1$

$\frac{1}{a^3} = a^{-3}$

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

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

Equilibrium constant K_c & units

$$A + B \rightleftharpoons C + 2D$$

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

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

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

Equilibrium constant K_c & units

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

$$\mathbf{K_c = \frac{[NH_3]^2}{[N_2]\,[H_2]^3}}$$

$$\frac{(\text{mol dm}^{-3})^2}{(\text{mol dm}^{-3})\,(\text{mol dm}^{-3})^3}$$

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

Equilibrium constant K_c & units

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

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\qquad K_c = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$

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	⇌	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	⇌	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	⇌	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 dm^3	A	+	2 B	⇌	C
moles at equilibrium	2.4		0.5		3.0

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

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

K_c Calculations

volume = 5.0 dm^3

$$2\,D \rightleftharpoons E + 2\,F$$

	2 D	E	2 F
moles at start	1.0	0	0
change	–0.8	+0.4	+0.8
at equilibrium	0.2	0.4	0.8

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

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