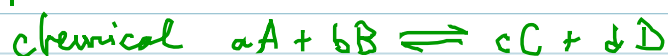
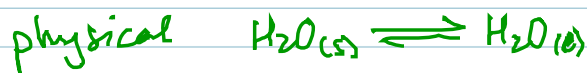


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CHAPTER 14 CHEMICAL EQUILIBRIUM

reversible reaction $\text{Rate}_{\text{FWD}} = \text{Rate}_{\text{REV}}$



EQ. constant $K_c = \frac{[\text{C}]^c [\text{D}]^d}{[\text{A}]^a [\text{B}]^b}$ "Law of mass-action"

DEPENDS ON T

$\uparrow K$, $\uparrow [\text{PRODUCTS}] @ \text{EQ}$

$\downarrow K$, $\downarrow [\text{PRODUCTS}] @ \text{EQ}$

HOMOGENEOUS EQ - all the reacting chemicals are in the same phase



$$K_c = \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2}$$

$$P = \left(\frac{n}{V}\right)RT \rightarrow M \quad P \propto M$$

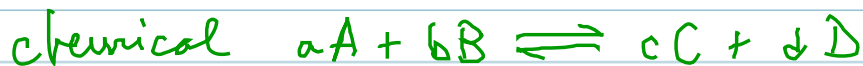
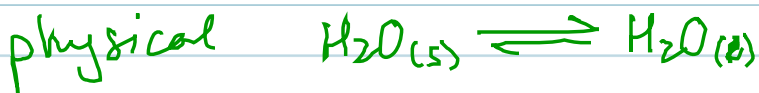
$$K_p = \frac{P_{\text{N}_2\text{O}_4}}{P_{\text{NO}_2}^2} \rightarrow \text{partial pressures}$$

$K_c \neq K_p$
usually

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CHAPTER 14 CHEMICAL EQUILIBRIUMreversible
reaction

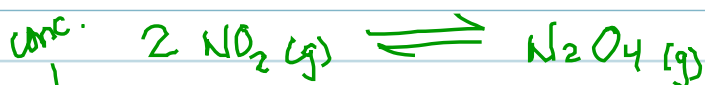
$$\text{Rate}_{\text{FWD}} = \text{Rate}_{\text{REV}}$$



EQ. Constant $K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}$ "Law of mass action"

DEPENDS ON (T) $\uparrow K$, \uparrow [PRODUCTS] @ EQ $\downarrow K$, \downarrow [PRODUCTS] @ EQ

HOMOGENEOUS EQ - all the reacting chemicals are in the same phase



$$K_c = \frac{[\text{N}_2\text{O}_4]}{[\text{NO}_2]^2}$$

$$P = \left(\frac{n}{V}\right) RT \rightarrow M \quad P \propto M$$

$$K_p = \frac{P_{\text{N}_2\text{O}_4}}{P_{\text{NO}_2}^2} \quad \left. \vphantom{K_p} \right\} \text{Partial pressures}$$

$K_c \neq K_p$
usually

$$a A_{(g)} \rightleftharpoons b B_{(g)}$$

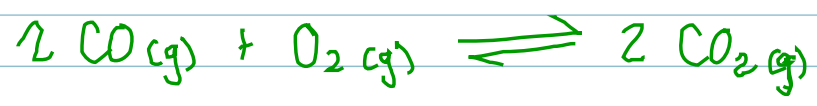
$$K_c = \frac{[B]^b}{[A]^a} \quad \left| \quad K_p = \frac{P_B^b}{P_A^a}$$

$P_B = \frac{n_B RT}{V}$
 $P_A = \frac{n_A RT}{V}$

$$K_p = \frac{\left(\frac{n_B}{V}\right)^b}{\left(\frac{n_A}{V}\right)^a} (RT)^{b-a} \Rightarrow \boxed{K_p = K_c (RT)^{\Delta n}}$$

$\Delta n = \text{moles of gas products} - \text{moles of gas reactants}$

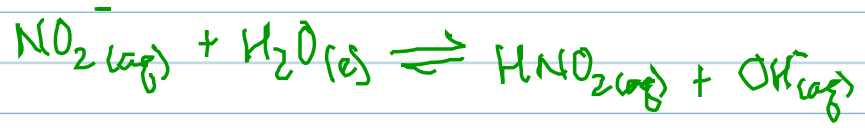
(if $\Delta n = 0$, $K_c = K_p$)



$$K_c = \frac{[CO_2]^2}{[CO]^2 [O_2]} \quad K_p = \frac{P_{CO_2}^2}{P_{CO}^2 \cdot P_{O_2}} = K_c (RT)^{-1}$$

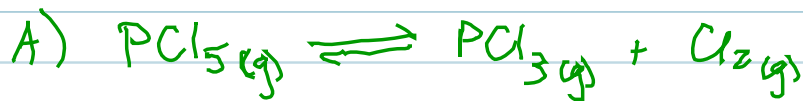
AQUEOUS SYSTEM

$[H_2O] = 55.5 M$
 treat as a constant (omit)



$$K_c = \frac{[HNO_2][OH^-]}{[NO_2^-]} \quad (K_b!)$$

Example



$$K_c @ 191^\circ\text{C} = 0.00326 \quad K_p = ?$$

$$K_p = K_c (RT)^{\Delta n} = (0.00326) \left(0.0821 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}} \right) (464\text{K})^1$$

$$K_p = 0.124$$

$$B) \text{ If, at EQ, } P_{\text{PCl}_5} = 3.50 \text{ atm}$$

$$P_{\text{PCl}_3} = ?$$

$$P_T = ?$$

$$X = ?$$

$$P_A = X_A P_T$$

$$X_A = \frac{P_A}{P_T}$$

$$K_p = \frac{P_{\text{PCl}_3} \cdot P_{\text{Cl}_2}}{P_{\text{PCl}_5}}$$

$$K_p \cdot P_{\text{PCl}_5} = P_{\text{PCl}_3} \cdot P_{\text{Cl}_2}$$
$$(0.124)(3.50 \text{ atm}) = x^2$$

$$x = P_{\text{PCl}_3} = P_{\text{Cl}_2} = 0.659 \text{ atm}$$

$$P_T = 3.50 \text{ atm} + 0.659 \text{ atm} + 0.659 \text{ atm} = 4.82 \text{ atm}$$

$$X_{\text{PCl}_5} = \frac{3.50 \text{ atm}}{4.82 \text{ atm}} = 0.726$$

$$X_{\text{PCl}_3} = \frac{0.659 \text{ atm}}{4.82 \text{ atm}} = 0.137 = X_{\text{Cl}_2}$$