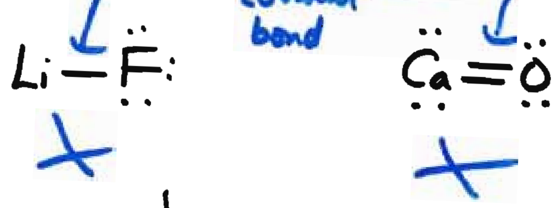
$Li^+F^-$ / $Ca^{2+}O^{2-}$

Metal + Non-metal    Metal + non-metal.

Ionic

Lewis:

covalent bond





$\rightarrow Li^+ \cdots :\ddot{F}:^-$

[He] $2s^1$    [He] $2s^2 2p^5$    [He]    [Ne]

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$\cdot Ca \cdot \quad \cdot\ddot{O}\cdot \longrightarrow Ca^{2+} \cdots :\ddot{O}:^{2-}$

[Ar] $4s^2$    [He] $2s^2 2p^4$    [Ar]    [Ne]

$$F \propto \frac{q_+ \cdot q_-}{r^2}$$

$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

$$K_c = \frac{[NO_2]^2}{[N_2O_4]}$$

$$K_p = \frac{P_{NO_2}^2}{P_{N_2O_4}}$$

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How do we convert $K_p \leftrightarrow K_c$ ?

– gases: $[A] = \frac{\#mol}{\#L} = \frac{n_A}{V}$

$$P_A V = n_A RT \Rightarrow \frac{P_A}{RT} = \frac{n_A}{V} = [A]$$

– $[B] = \frac{n_B}{V} = \frac{P_B}{RT}$

OR $P_A = [A] \cdot RT$ // $P_B = [B] \cdot RT$

let's look @ $aA(g) \rightleftharpoons bB(g)$

$$K_p = \frac{P_B^{\,b}}{P_A^{\,a}} = \frac{([B]\cdot RT)^b}{([A]\cdot RT)^a}$$

$$= \frac{[B]^b\,(RT)^b}{[A]^a\,(RT)^a}$$

$$\Rightarrow K_p = K_c \cdot \frac{(RT)^b}{(RT)^a}$$

$$= K_c\,(RT)^{b-a}$$

$$\boxed{K_p = K_c\,(RT)^{\Delta n_g}}$$

$\Delta n_g$ = Change in # mol gas

= # mol gas PRODS $\ominus$ # mol gas REACTS.

for rxn: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

$K_c = 4.63 \times 10^{-3}$ @ 25°C

or 298K.

$K_p$? $\Delta n_g = 2 - 1 = +1$

$$K_p = 4.63 \times 10^{-3} \left(0.08206 \frac{\text{atm}\cdot L}{\text{mol}\cdot K} \times 298K\right)^{+1}$$

$= 0.113$

Comments

Units?!

- We are required to measure P in atmospheres, + use the raw, unitless # in our expression for $K_p$.
- We're required to use molar concs ($M$, $\frac{\text{mol}}{L}$) is raw, unitless #'s in expressions for $K_c$.

ex: if $[NO_2]_{eq} = 0.0204M$
$[N_2O_4]_{eq} = 0.0898M$

for rxn: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} = \frac{0.0204^2}{0.0898}$$

$$= 4.63 \times 10^{-3}$$

(unitless)

In reality...

$$K_c = \frac{\left(\frac{[NO_2]}{c^\circ}\right)^2}{\left(\frac{[N_2O_4]}{c^\circ}\right)}$$

$c^\circ$ = STD/ref conc
= 1 M
↑
convention

$$K_p = \frac{(P_{NO_2}/p^\circ)^2}{(P_{N_2O_4}/p^\circ)}$$

$p^\circ$ = STD pressure
= 1atm.

Other things to note...

solids / liquids ⟶ effective conc/pressure = 1
↑ pure liqs / solvents (almost pure)

for example:

$$CaCO_3(s) \rightleftharpoons \underset{\text{"Lime"}}{CaO(s)} + CO_2(g)$$

$$K_p = \frac{\cancel{P_{CaO}}^{=1} \cdot P_{CO_2}}{\cancel{P_{CaCO_3}}^{=1}} = P_{CO_2}$$

ex: $2H_2O(l) + H_3PO_4(aq) \rightleftharpoons 2H_3O^+(aq) + HPO_4^{2-}(aq)$

$$K_c = \frac{[H_3O^+]^2[HPO_4^{2-}]}{\underbrace{\cancel{[H_2O]^2}}_{=1}[H_3PO_4]}$$

$$K_c = \frac{[H_3O^+]^2[HPO_4^{2-}]}{[H_3PO_4]}$$

ex: $H_3O^+(aq) + OH^-(aq) \rightleftharpoons 2H_2O(l)$

$$K_c = \frac{[H_2O]^2}{[H_3O^+][OH^-]} = \frac{1}{[H_3O^+][OH^-]}$$

The way we write chem. eq$^{\underline{m}}$ affects the value of K!

ex: $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

$$K_c = \frac{[NO_2]^2}{[N_2O_4]}$$

reverse chem eq:

$2NO_2(g) \rightleftharpoons N_2O_4(g)$

$$K_c' = \frac{[N_2O_4]}{[NO_2]^2} = \frac{1}{K_c}$$

inverted K.