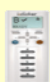
Equilibrium Constants – Meaning of the Magnitude of K

The equilibrium constant, Kc, for the following reaction is 1.29×10^{-6} at 600 K.

$$COCl_2(g) \Leftrightarrow CO(g) + Cl_2(g)$$

Assuming that you start with only $COCl_2$, describe the relative abundance of each species present at equilibrium.

 $[COCl_2(g)]$ a. Higher ✓ b. Lower c. Can't tell

 $[CO(g)]$ a. Higher b. Lower ✓ c. Can't tell

$K = 1.29 \times 10^{-6}$ @ 600K

→ Reactant-favored reaction.

15.2 The Equilibrium Constant, K

Writing Equilibrium Constant Expressions

$$aA + bB \rightleftharpoons cC + dD$$

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

However: a) Pure solids do not appear in the expression.

b) Pure liquids and solvents do not appear in the expression.

a) $C(s) + H_2O(g) \rightleftharpoons H_2(g) + CO(g)$ $K = \frac{[H_2][CO]}{[H_2O]}$

b) $CH_3CO_2H(aq) + H_2O(l) \rightleftharpoons CH_3CO_2^- + H_3O^+$ $K = \frac{[CH_3CO_2^-][H_3O^+]}{[CH_3CO_2H]}$

15.2 The Equilibrium Constant, K

The Relationship between K_p and K_c

$$2\ NOBr(g) \rightleftharpoons 2\ NO(g) + Br_2(g)$$

$$K_c = \frac{[NO]^2[Br_2]}{[NOBr]^2} \quad ; \quad K_p = \frac{P_{NO}^2\ P_{Br_2}}{P_{NOBr}^2}$$

How are K_c and K_p related ?

$$PV = nRT$$
$$P = (n/V)RT$$

$(n/V) \rightarrow mol.\ell^{-1}$ $= [\ ]RT$

$$K_p = \frac{P_{NO}^2\ P_{Br_2}}{P^2_{NOBr}}$$

$$= \frac{[NO]^2(RT)^2[Br_2](RT)}{[NOBr]^2(RT)^2}$$

$$= \frac{[NO]^2[Br_2]}{[NOBr]^2} \times \frac{(RT)^3}{(RT)^2}$$

$$K_p = K_c(RT)^3(RT)^{-2}$$
$$= K_c(RT)^{3-2}$$

3 - 2 = mol gas products - mol gas reactants
$2\ NO(g)$ & $Br_2(g)$ — $2\ NOBr$
3 - 2

$$K_p = K_c(RT)^{\Delta n}$$

Δn = mol of gas products - mol of gas reactants

15.2 The Equilibrium Constant, K

The Relationship between K_p and K_c

The equilibrium constant, **Kc**, for the following reaction is **2.90×10^{-2} at 1260 K**.
Calculate Kp for this reaction at this temperature.

$$2\ SO_3(g) \Leftrightarrow 2\ SO_2(g) + O_2(g)$$

Kp = ?.00

a) 1
b) 2
c) 3 ✓
d) 4
e) 3

R = 0.0821 L.atm.mol^{-1}.K^{-1}

$$K_p = K_c (RT)^{\Delta n}$$

$$\Delta n = 2 + 1 - 2 = 1$$

$$K_p = 2.90 \times 10^{-2} \times (0.0821 \times 1260)$$
$$= 2.99$$