

## GENERAL CHEMISTRY: CHM 131

### TUTORIAL 7a

#### CHEMICAL EQUILIBRIUM

1. Write the equilibrium constant expression,  $K_c$ , for each of the following reactions:
- $2\text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$
  - The decomposition of solid potassium chlorate to solid potassium chloride and oxygen gas.
  - $4\text{HCl}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{H}_2\text{O}(\text{g}) + 2\text{Cl}_2(\text{g})$
  - $2\text{NO}_2(\text{g}) + 7\text{H}_2(\text{g}) \rightleftharpoons 4\text{H}_2\text{O}(\text{l}) + 2\text{NH}_3(\text{g})$
  - $\text{H}_2\text{O}(\text{g}) + \text{C}(\text{s}) \rightleftharpoons \text{CO}(\text{g}) + \text{H}_2(\text{g})$
  - The reduction of solid copper (II) oxide with hydrogen gas to produce copper metal and water at  $500^\circ\text{C}$ .

#### Answer

$$\text{a) } K_c = \frac{[\text{NO}_2]^2}{[\text{NO}]^2[\text{O}_2]}$$

$$\text{b) } K_c = [\text{O}_2]$$

$$\text{c) } K_c = \frac{[\text{H}_2\text{O}][\text{Cl}_2]^2}{[\text{HCl}]^4[\text{O}_2]}$$

$$\text{d) } K_c = \frac{[\text{NH}_3]^2}{[\text{NO}_2]^2[\text{H}_2]^7}$$

$$\text{e) } K_c = \frac{[\text{CO}][\text{H}_2]}{[\text{H}_2\text{O}]}$$

$$\text{f) } K_c = \frac{[\text{H}_2\text{O}]}{[\text{H}_2]}$$

2. The equilibrium constant  $K_c$  for the reaction:  $2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{CO}_2(\text{g})$  is  $2.24 \times 10^{22}$  at  $1273^\circ\text{C}$ . Calculate the  $K_p$  for the reaction at the same temperature.

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

$$= (2.24 \times 10^{22})[(0.0821)(1546.15)]^{-1}$$

$$= 1.76 \times 10^{22} \text{ atm}$$

4.  $K_c$  and  $K_c'$  are the equilibrium constants for reactions I and II respectively.



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