## Chapter 9 - Lecture Worksheet 5

**1.** Consider the following system at equilibrium where  $\Delta H^{\circ} = -111$  kJ, and K<sub>c</sub> = 0.159, at 723 K:

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

If the **volume** of the equilibrium system is suddenly decreased at constant temperature:

A. The value of Kc 1. Increases 2. Decreases 3. Remains the same. Only Temperature changes K.

**B.** The value of Q 1. Is greater than K 2. Is equal to K 3. Is less than K

C. The reaction must:

- 1. Run in the forward direction to restablish equilibrium. Runs to reduce pressure, fewer moles of gas.
- 2. Run in the reverse direction to restablish equilibrium.
- 3. Remain the same. Already at equilibrium.
- **D.** The number of moles of H<sub>2</sub> will: 1. Increase 2. Decrease 3. Remain the same.

2. K<sub>p</sub> for the following reaction is 0.16 at 25<sup>o</sup>C. The enthalpy change for the reaction at standard conditions is 16.1 kJ. Predict the effect of the following changes on the direction the reaction must move in order to reestablish equilibrium: PRS Answers: 1. Left 2. Right 3. No change 2 NOBr(g) <----> 2 NO(g) + Br<sub>2</sub>(g)

**A.** Add more  $Br_2(g)$  Add product. <---- Left

B. Remove some NOBr(g) Remove reactant. <----- Left

C. Decrease the temperature Endothermic. K drops. Q now larger than K. <----- Left

**D.** Increase the volume of the container.  $\Delta n_{gas} > 0$  P drops, move to make more moles of gas. ----> Right

3. Consider the following system at equilibrium where  $\Delta H^{\circ} = -111$  kJ, and K<sub>c</sub> = 0.159, at 723 K: N<sub>2</sub>(g) + 3 H<sub>2</sub>(g) <----> 2 NH<sub>3</sub> (g)

If the TEMPERATURE of the equilibrium system is suddenly decreased:

A. The value of Kc 1. Increases 2. Decreases 3. Remains the same Exothermic rxn. Decrease T, ln K increases (see graph above) and therefore K increases. A second way to look at this: Energy is a product. Decrease T similar to removing product. Rxn runs forward to reestablish a new equilibrium position with larger K.

**B.** The value of Q 1. Is greater than K 2. Is equal to K 3. Is less than K K got larger. Q now less than K

## C. The reaction must:

- 1. Run in the forward direction to restablish equilibrium.
- 2. Run in the reverse direction to restablish equilibrium.
- 3. Remain the same. Already at equilibrium.
- **D.** The concentration of  $H_2$  will: 1. Increase 2. Decrease 3. Remain the same

4. If you want to MAXIMIZE the production of ammonia you should:			
1. Run at high temperature	3. Run at high pressure	5. Add $H_2$ and $N_2$	7. Add $NH_3$
2. Run at low temperature	4. Run at low pressure	6. Remove $H_2$ and $N_2$	8. Remove NH <sub>3</sub>
K larger	$\Delta n_{gas} < 0$	Drive rxn forward	Pull rxn forward