Student Name: _____ Date: _____

40S Chemistry

Chemical Equilibrium

Le Châtelier's Principle Questions

Use Le Châtelier's Principle to explain the effect of the given changes upon the equilibrium systems shown.

Use the scheme:
1. Tell what the stress is
2. Tell what the system tries to do to reduce the stress
3. Tell what concentrations increase, decrease.
4. Tell whether the equilibrium shifts left, right or no change.

1. Effect of adding more hydrogen (H_2) to the system:

$$2NO_2\,(g) + 7H_2\,(g) \quad \leftarrow \quad \rightarrow \quad 2NH_3\,(g) + 4\,H_20(g)$$

- **An increase in the [ ] of the reactant H_2**
- **The system produces more product to use up the additional reactant. The forward reaction is favoured.**
- **[NO_2] and [H_2] decrease and the [NH_3] and [H_20] increase**
- **Equilibrium shifts to the right**

2. Effect of raising the temperature (adding more heat) to the system:

$$N_2O_4\,(g) + 58.5\ KJ \quad \leftarrow \quad \rightarrow \quad 2NO_2$$

- **An increase in temperature when heat is a reactant (endothermic reaction)**
- **The system adjusts to reduce the amount of heat by producing more product. The forward reaction is favoured.**
- **[N_2O_4] decrease and the [NO_2] increases**
- **Equilibrium shifts to the right**

3. Effect of removing some I_2 (g) (i.e. decreasing I_2 concentration).

$$H_2\,(g) + I_2\,(g) \quad \leftarrow \quad \rightarrow \quad 2HI\,(g) + 12.5\ KJ$$

- **A decrease in the [ ] of the reactant, I_2**
- **The system produces more reactant to replace the missing I_2. The reverse reaction is favoured.**
- **[HI] decreases and the [H_2] and [I_2] increases**
- **Equilibrium shifts to the left**

4. Effect of increasing the pressure on the system by decreasing the volume of the container:

$$2NO\,(g) + O_2\,(g) \quad \leftarrow \quad \rightarrow \quad 2NO_2\,(g)$$

- **Decrease in volume when the number of reactant particles > number of product particles**
- **The system reduces the pressure by favouring the forward reaction to reduce the number of particles.**
- **[NO] and [O_2] decrease and the [NO_2] increases**
- **Equilibrium shifts to the right**

5. Effect of adding more ammonia, NH_3, to the system:

$$2NO_2\,(g) + 7H_2 \quad \leftarrow \quad \rightarrow \quad 2NH_3\,(g) + 4H_2O\,(g)$$

- **Increase in the [ ] of the product, NH_3**
- **The system reduces the amount of NH_3 by favouring the reverse reaction and producing more reactant.**
- **[NH_3] and [H_2O] decrease and the [NO_2] and [H_2] increase**
- **Equilibrium shifts to the left**

6. Effect of reducing the temperature (removing heat) on this system:

$$2C\,(s) + O_2\,(g) \quad \leftarrow \quad \rightarrow \quad 2CO + 222\ KJ$$

- **Decrease in temperature when heat is a product (exothermic reaction)**
- **The system increases the amount of heat by favouring the forward reaction.**
- **[C] and [O_2] decrease and the [CO] increases**
- **Equilibrium shifts to the right**

7. Effect of removal of some Nitrogen Dioxide, NO_2, from the system:

$$2NO_2\ (g) + 7H_2\ (g) \quad \leftarrow \quad \rightarrow \quad 2NH_3\ (g) + 4H_2O\ (g)$$

- **Decrease in the [ ] of the reactant, NO_2**
- **The system replaces the missing NO_2 by favouring the reverse reaction.**
- **[NH_3] and [H_2O] decrease and the [NO_2] and [H_2] increase**
- **Equilibrium shifts to the left**

8. Effect of decreasing the volume on the system:

$$N_2\ (g) + O_2\ (g) \quad \leftarrow \quad \rightarrow \quad 2NO\ (g)$$

- **An increase in pressure when the number of particles of reactant = the number of particles of product.**
- **There is no shift in equilibrium.**

9. What is the effect of reducing the concentration of Zn^{+2} on the following reaction:

$$Zn\ (s) + Cu^{+2}\ (aq) \quad \leftarrow \quad \rightarrow \quad Cu\ (s) + Zn^{+2}\ (aq)$$

- **Decrease in the [ ] of the product, Zn^{+2}**
- **The system produces more product to replace the missing Zn^{+2}. The products are favoured.**
- **[Zn] and [Cu^{+2}] decrease and the [Cu] and [Zn^{+2}] increase**
- **Equilibrium shifts to the right.**

10. Explain the effect of compressing this system to a smaller volume:

$$N_2O_4\ (g) \quad \leftarrow \quad \rightarrow \quad 2NO_2\ (g)$$

- **Increase in the pressure of the system when the number of particles of product > than the number of particles of reactant.**
- **The system decreases the pressure by producing fewer particles. The reverse reaction is favoured.**
- **[N_2O_4] increases and the [NO_2] decreases.**
- **Equilibrium shifts to the left.**