Topic 9 – Kinetics and Equilibrium

Lesson 4 – Equilibrium

Terms to Know

Equilibrium –

Physical Equilibrium –

Phase Equilibrium –

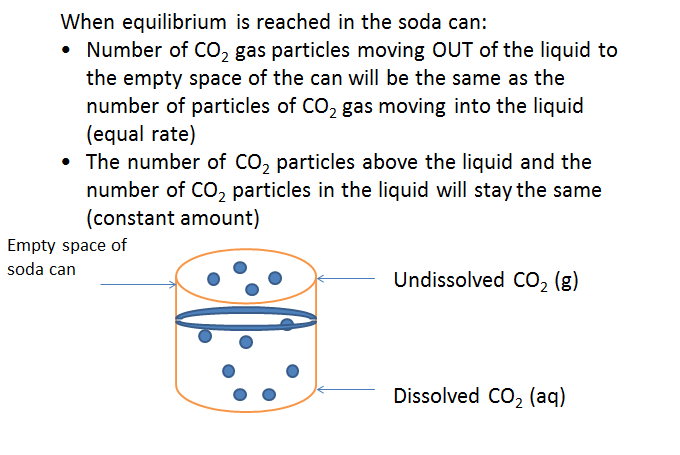
Solution Equilibrium –

Chemical Equilibrium –

Stress –

LeChatelier’s Principle –

Common Ion Effect –



**LeChatelier’s Principle states that when a stress is introduced into a reaction at equilibrium, the reaction will change by speeding up in one direction and slowing down in the other direction to bring the reaction back to equilibrium**

**STRESS 1: Increasing concentration**

**When a substance is added to a reaction to increase its concentration**

1. **Rate increases toward opposite side of the change**
2. **Rate decreases toward the same side of the substance**
3. **Concentration of other substances on the same side of the change decreases**
4. **Concentration of all substances on the opposite side of the change increases**
5. **Reaction will shift (speeds up) toward the opposite side of the change**

**FORWARD**

**N2 + 3H2 < ------- > 2NH3**

**Add stress: Increase concentration of N2**

**RESULT**

1. **Rate of forward increases**
2. **Rate of reverse decreases**
3. **Concentration of H2 decreases**
4. **Concentration of NH3 increases**
5. **Shift of reaction is to the RIGHT**

**STRESS 2: Decreasing concentration**

1. **Rate increases toward the side of the change**
2. **Rate decreases toward the opposite side of the change**
3. **Concentration of other substances on the side of the change increases**
4. **Concentration of all substances on the opposite side of the change decreases**
5. **Reaction will shift (speeds up) toward the side of the change**

**X + WY < -------- > XY + W**

**REVERSE**

**Add stress: Decrease concentration of WY**

**RESULT of decreasing concentration of WY**

1. **Rate of forward reaction decreases**
2. **Rate of reverse reaction increases**
3. **Concentration of XY and W decreases**
4. **Concentrations of X increases**
5. **Shift in reaction is to the LEFT**

**STRESS 1: Increasing temperature (adding heat)**

* **Favors endothermic reaction**

1. **Rate increases toward the side without the heat (endothermic reaction increases)**
2. **Rate decreases toward the side with the heat(exothermic reaction decreases)**
3. **Concentration of substances on the side with the heat decreases**
4. **Concentration of all substances on the side without heat increases**
5. **Reaction will shift (speeds up) toward side without heat**

**HI + heat < ------------ > H2 + I2**

**Add stress: Increase heat (temperature)**

**RESULT of increasing heat**

1. **Rate of forward reaction increases**
2. **Rate of reverse reaction decreases**
3. **Concentration of HI decreases**
4. **Concentration of H2 and I2  increases**
5. **Shift of reaction to the RIGHT**

**STRESS 2: Decreasing Temperature (Removing heat)**

* **Favors exothermic reaction (removing heat causes the exothermic reaction to increase)**

1. **Rate increases toward the side with the heat (exothermic reaction increases)**
2. **Rate decreases toward the side without the heat (endothermic reaction increases)**
3. **Concentration of substances n the side with the Heat increases**
4. **Concentration of all substances on the side without Heat decreases**
5. **Reaction will shift (speeds up) toward the side with heat**

**H2 + I2 < -------- > HI + heat**

**Add stress: Removing heat**

**RESULT of removing heat:**

1. **Rate of forward reaction increases**
2. **Rate of reverse reaction decreases**
3. **Concentration of HI increases**
4. **Concentration of H2 and I2 decreases**
5. **Shift of reaction toward the RIGHT**

**Stress 1: Increasing pressure (decreasing volume in gaseous reaction)**

1. **Rate increases toward the side of the smaller number of moles**
2. **Rate decreases toward the side of the greater number of moles**
3. **Concentration of substances on the side of smaller number of moles increases**
4. **Concentration of substances on the side of greater number of moles decreases**
5. **Reaction will shift (speeds up) in the direction of the smaller number of moles**
6. **None of the above will change if the number of moles on both sides are equal**

**CH4 + H2O < ----------- > 3H2 + CO**

**Add stress: Increase in pressure**

**RESULT of increasing pressure**

1. **Rate of reverse reaction increases (favors production of substances on side with lesser number of moles**
2. **Rate of forward reaction decreases**
3. **Concentration of CH4 and H2O increases**
4. **Concentration of H2 and CO decreases**
5. **Shift of reaction to the LEFT**

**Stress 1: Increasing concentration by common ion effect**

1. **Rate increases toward the opposite side of added ion (toward the solid)**
2. **Rate decrease toward the same side as the added ion (toward aq)**
3. **Concentration of other substances n the side of the added ion decreases**
4. **Concentration of substances on the opposite side of the added ion increases**
5. **Reaction will shift toward the opposite side of the added ion (toward the solid)**

**KNO3 (s) < ------- > K+ (aq) + NO3- (aq)**

**Add stress: Adding KCl (s): Will dissolve to give more K+**

**K+ concentration will increase**

**Result of adding KCl**

1. **Rate of reverse reaction increases**
2. **Rate of forward reaction decreases**
3. **Concentration of NO3- decreases**
4. **Concentration of KNO3 (s) increases**
5. **Shift of the reaction is to the left**