Chapter 3: Chemical Equilibrium

Part I: Multiple Choice Questions

1- Which of the following statements best describes a system at chemical equilibrium?

a) The concentrations of the reactants and products are exactly equal.
b) The rate of the forward reaction is equal to the rate of the backward reaction.
c) The chemical reaction has stopped completely.
d) All reactants have been entirely converted into products.

2- In the irreversible reaction between silver nitrate and sodium chloride solutions, the reaction proceeds to completion primarily because:

a) A gas is evolved which escapes the reaction vessel.
b) A solid precipitate of AgCl is formed, removing ions from the solution.
c) Both reactants are weak electrolytes.
d) The reaction requires a very high activation energy.

3- According to the Law of Mass Action (Guldberg and Waage), the rate of a chemical reaction at a constant temperature is directly proportional to:

a) The volume of the reaction container.
b) The product of the active masses (concentrations) of the reacting substances.
c) The total pressure of the gaseous mixture.
d) The amount of catalyst added to the system.

4- For the gaseous equilibrium reaction: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + Heat$. Which of the following conditions will increase the yield of ammonia (NH_3)?

a) Decreasing the pressure of the system.
b) Increasing the temperature of the system.
c) Increasing the pressure of the system.
d) Adding an inert gas at constant volume.

5- The numerical value of the equilibrium constant (K_c) for a specific reversible reaction changes only when there is a change in:

a) The initial concentrations of the reactants.
b) The atmospheric pressure.
c) The temperature of the reaction mixture.
d) The presence or absence of a catalyst.

6- Ostwald's dilution law applies to weak electrolytes and states that at a constant temperature, the degree of ionization (α):

a) Decreases as the dilution of the solution increases.
b) Increases as the dilution of the solution increases.
c) Remains completely constant regardless of dilution.
d) Is inversely proportional to the volume of the solution.

7- The ionic product of water (K_w) at 25°C is a constant value equal to:

a) 1.0×10^{-7}
b) 1.0×10^{14}
c) 1.0×10^{-14}
d) 1.0×10^{7}

8- An aqueous solution of ammonium chloride (NH_4Cl) turns blue litmus paper red (acidic) because:

a) It is a salt derived from a strong acid and a strong base.
b) It is a salt derived from a weak acid and a weak base.
c) It is a salt derived from a strong acid (HCl) and a weak base (NH_4OH).
d) It is a salt derived from a weak acid and a strong base.

9- The pH of a 0.001 M solution of the strong base sodium hydroxide (NaOH) at 25°C is approximately:

a) 3
b) 11
c) 10^{-11}
d) 14

10- In the solubility product (K_{sp}) expression for slightly soluble calcium fluoride (CaF_2), the concentration of the fluoride ions [F^-] must be raised to the power of:

a) 1
b) 2
c) 3
d) 1/2

Part II: True or False

11- Chemical equilibrium is a dynamic process at the microscopic level, meaning that reactions continue to occur in both directions at equal rates.

a) True
b) False

12- According to Le Chatelier's Principle, adding a catalyst to a reversible reaction shifts the equilibrium position predominantly towards the products.

a) True
b) False

13- When writing the equilibrium constant (K_c) expression, the active masses of pure solids and liquid solvents are omitted because their concentrations remain virtually constant.

a) True
b) False

14- For an endothermic reaction at equilibrium, decreasing the temperature of the system shifts the equilibrium in the forward direction.

a) True
b) False

15- An aqueous solution that has a pOH equal to 4 is considered to be an acidic solution.

a) True
b) False

16- The addition of a common ion to a solution of a sparingly soluble salt generally decreases the solubility of that salt (Common Ion Effect).

a) True
b) False

17- The numerical value of the pressure equilibrium constant (K_p) is always identical to the concentration equilibrium constant (K_c) for any gaseous reaction, regardless of the number of moles.

a) True
b) False

18- The process of salt hydrolysis in water is considered the chemical reverse of the neutralization process between an acid and a base.

a) True
b) False

19- Exposure to light has absolutely no effect on the rate of any chemical reaction.

a) True
b) False

20- When a stress is applied to a system at equilibrium, the system reacts in a way to counteract or relieve that stress, according to Le Chatelier's Principle.

a) True
b) False

Answer Key

1- b	**2- b**	**3- b**	**4- c**	**5- c**
6- b	**7- c**	**8- c**	**9- b**	**10- b**
11- a	**12- b**	**13- a**	**14- b**	**15- b**
16- a	**17- b**	**18- a**	**19- b**	**20- a**