Multiple Choice (54 pts total, 3 pts each) Give the best answer for each of the following questions. Mark the correct answer in the space provided next to each question. Choose only ONE answer for each question and write clearly.

1. Which of the following solutions would be more acidic?
   a. A solution with a pH of 5.66
   b. A solution with [H+] = 9.45 x 10^-8
   c. A solution with pH of 7.31
   d. A solution with [H+] = 7.76 x 10^-4

2. Considering the reaction below, which species is considered the conjugate base?

   \[
   \text{CH}_3\text{COOH}(aq) + \text{CH}_3\text{NH}_2(aq) \rightarrow \text{CH}_3\text{COO}^- (aq) + \text{CH}_3\text{NH}_3^+(aq)
   \]
   a. CH_3COOH
   b. CH_3NH_2
   c. CH_3COO^-
   d. CH_3NH_3^+

3. Which of the following transformations described below take place with the absorption of heat?
   a. vaporization
   b. fusion
   c. the transition from a gas to a liquid
   d. the transition from a liquid to a solid

4. Water has quite a few unusual properties. Which of the following is not one of the properties of water?
   a. Water is a liquid at room temperature, unlike most compounds with similar molecular weights.
   b. The density of solid water is greater than the density of liquid water
   c. Water has a high heat capacity or specific heat
   d. Water is a universal solvent, capable of dissolving many different compounds

5. You are given a solution to inject into a patent which has a 0.99 % (mass/volume) NaCl solution. What is this solution considered and what will be the effect on the cells of the patient?
   a. isotonic, the cells will remain the same
   b. hypertonic, the cells will shrivel
   c. hypotonic, the cells will swell
   d. neotonic, the cells will shrivel
6. Which of the following compounds would you expect to be insoluble in water?
   a. KNO₃
   b. NH₃
   c. C₂H₆
   d. CO₂

7. Which of the statements about a solution of a gas dissolved in water is true?
   a. Increasing the temperature of the solution will not change the solubility of the gas
   b. Increasing the temperature of the solution will increase the solubility of the gas
   c. Decreasing the temperature of the solution will decrease the solubility of the gas
   d. Increasing the temperature of the solution will decrease the solubility of the gas

8. A certain compound is known to have a melting point of 38°C and a boiling point of 273°C. What state will a sample of the compound be in if the compound is at room temperature (25°C)?
   a. Solid
   b. Liquid
   c. Gas
   d. Louisiana

9. What is the most fundamental acid/base reaction?
   a. catalysis
   b. oxidation
   c. dispersion
   d. neutralization

10. Which of the following is a basic anhydride?
    a. HCl
    b. HPO₃
    c. LiO
    d. NH₃

11. The value of Kw is:
    a. 1.0 x 10⁻⁷
    b. 1.0 x 10⁻¹⁴
    c. 1.0 x 10⁺¹⁴
    d. 1.0 x 10⁻⁷

12. For the equilibrium below, a small value (below 1.00) for the equilibrium constant (K) indicates:
    \[ \text{HCN} \rightleftharpoons H^+ + \text{CN}^- \]
    a. More CN⁻ is present at equilibrium
    b. More HCN is present at equilibrium
    c. The products and the reactants are present in equal concentrations
    d. HCN is a strong acid
13. The salt RbNO₃ is a(n):
   a. basic salt
   b. acidic salt
   c. neutral salt
d. table salt

14. What purpose do buffers serve in your bloodstream?
   a. To keep your blood a liquid
   b. To prevent temperature changes in your blood
c. To maintain the acidity of your blood
d. To prevent changes in the pH of your blood

15. What intermolecular forces act on a sample of IF?
   a. Ionic interaction
   b. Dipole interactions
c. Hydrogen bonding
d. Choices b and c

16. Carbonic acid quickly degrades once synthesized. Which of the following is NOT one of the conjugate bases of carbonic acid available for purchase?
   a. K₂CO₄
   b. NaHCO₃
c. Na₂CO₃
d. baking soda

17. This question involves the following apparatus:

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0.5 M NH₄Cl (aq)             NH₄Cl (aq) 0.2 M
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If the separation between the two solutions is a semipermeable membrane, which of the following statements will be true?

   a. Water will pass through the membrane, flowing to the right side of the apparatus
   b. Water will pass through the membrane, flowing to the left side of the apparatus
c. NH₄Cl will pass through the membrane, flowing to the right side of the apparatus
d. NH₄Cl will pass through the membrane, flowing to the left side of the apparatus

18. Knowing the freezing point of pure water to be 0°C, what would you anticipate the freezing point of a solution of KCl dissolved in water to be?
   a. 100°C
   b. 110°C
c. -10°C
d. 0°C
Short Answer: (45 total points) Give the correct answer for each of the following questions. Partial credit will be given to those questions in which a valid attempt has been made to answer the question correctly. Reading instructions is a highly valuable skill. Be sure you completely read each question before answering. Answer each question with the correct number of significant figures.

1. A 12.011 mL solution of HBr has an unknown concentration. The solution is titrated with KOH, and it is found that 23.4 mL of a 0.1112 M KOH solution is required to reach the equivalence point. What was the concentration of the original HBr solution? (5 pts.)

2. I want to dilute a 15.0 mL sample of a 2.00 M solution of NaNO₃ so that the new solution has a molarity of 0.00200 mol/L of NaNO₃. What must be the volume of this new solution? (4 pts)
3. An aqueous solution of KOH is found to have a pH of 8.53. From this, what must be the concentration of OH⁻ ions ([OH⁻]) in this solution? (5 pts)

4. Set up the equilibrium constant expression for the following equilibrium: (3 pts)

   \[ \text{N}_2 \ (g) \ + \ 3\text{H}_2 \ (g) \ \rightleftharpoons \ 2\text{NH}_3 \ (g) \]

5. For the following pairs, circle the atom or molecule which will have the higher melting/boiling point: (3 pts each)
   a. Cl₂ or HCl
   b. KNO₃ or H₂O
   c. CF₄ or NH₃

6. The bicarbonate ion/carbonic acid buffer is very important to your body chemistry. Answer the following questions about this buffer system. (3 pts each)
   a. Write out the word “right” or “left” to indicate which direction you expect the equilibrium as it is written below to shift if a base is introduced into the blood stream.

   \[ \text{H}_2\text{CO}_3 \ (aq) \ \rightleftharpoons \ \text{H}^+ \ (aq) \ + \ \text{HCO}_3^- \ (aq) \]

   b. Write out the word “right” or “left” to indicate which direction you expect the equilibrium as it is written below to shift if an acid is introduced into the blood stream.

   \[ \text{H}_2\text{CO}_3 \ (aq) \ \rightleftharpoons \ \text{H}^+ \ (aq) \ + \ \text{HCO}_3^- \ (aq) \]
7. For the ionization reactions below, draw in the correct reaction arrows to indicate if the ionizations are reversible or irreversible (2 pts each)

a. KOH
   \[ K^+ + OH^- \]

b. CH₃COOH
   \[ H^+ + CH₃COO^- \]

8. Give two examples of colloids you may see in everyday life (2 pts)

9. List the three solutions below in order of increasing concentration (least concentrated to most concentrated). (4 pts.)

Solution A  | Solution B  | Solution C
-------------|-------------|-------------
1.2 mol KOH in 100 mL of solution | 6.2 x 10⁻¹ mol KOH in 10 L of solution | 5 M KOH

10. Using your own words, describe the difference between osmosis and dialysis (3 pts)