Chem 103 Exam #1

Multiple Choice

Identify the letter of the choice that best completes the statement or answers the question.

____ 1. Which of the following can act as a Bronsted-Lowry base, but not as a Bronsted-Lowry acid?
a. HPO_4^{2-}
b. H_2O
c. NH_4^+
d. PO_4^{3-}
e. HSO_4^-

____ 2. Methylamine, CH_3NH_2, acts as a weak base in water. The products of the reaction are _____ and _____.
a. OH^- and $CH_3NH_3^+$
b. H_3O^+ and $CH_3NH_3^+$
c. H_3O^+ and OH^-
d. OH^- and CH_3NH^-
e. H_3O^+ and CH_3NH^-

____ 3. One water molecule can donate a proton to another in a process called _____; the equilibrium constant expression for this reaction is _____.
a. neutralization; $\frac{[H_3O^+][OH^-]}{[H_2O]}$
b. autoionization; $\frac{[H_3O^+][OH^-]}{[H_2O]}$
c. protonation; $\frac{[H_3O^+][OH^-]}{[H_2O]^2}$
d. hydrolysis; $\frac{[H_3O^+][OH^-]}{[H_2O]^2}$
e. autoionization; $[H_3O^+][OH^-]$

____ 4. A solution is not neutral. Which one of these statements is true?
a. $[H_3O^+] = 1.0 \times 10^{-7}$ M
b. $[H_3O^+] = [OH^-]$
c. $[H_3O^+][OH^-] = 1.0 \times 10^{-7}$
d. $[OH^-] = 1.0 \times 10^{-7}$ M
e. $[H_3O^+][OH^-] = 1.0 \times 10^{-14}$

____ 5. In a 1.2 M solution of KOH, a strong base, $[H_3O^+]$ = _____,and $[OH^-]$ = _____.
a. 1.0×10^{-7} M; 1.0×10^{-7} M
b. 8.3×10^{-15} M; 1.0×10^{-14} M
c. 8.3×10^{-15} M; 1.2 M
d. 1.2 M; 8.3×10^{-15} M
e. 1.2 M; 1.2 M

____ 6. An acidic solution is diluted until $[H_3O^+]$ is exactly half as much as before. The pH of the solution is now _____ than before.
a. 2.00 higher
b. 0.69 higher
c. 0.30 higher
d. 0.30 lower
e. 2.00 lower

____ 7. Arrange the solutions in order of increasing acidity:

I a solution with $[H_3O^+] = 4.2 \times 10^{-6}$ M
II lemonade, pH = 2.65
III 0.25 M nitric acid
IV pickle juice, pH = 3.10

a. I-IV-II-III
b. II-IV-III-I
c. III-II-IV-I
d. IV-I-II-III
e. III-II-I-IV

____ 8. Consider a 0.50 M solution of HNO_2, a weak acid with $K_a = 4.5 \times 10^{-4}$. Which statement is true?
a. [H3O$^+$] > 0.50 M.
b. The acid is mostly ionized.
c. pH = 3.35.
d. pH = 0.32.
e. pH > 0.32.

____ 9. The pH of a solution of a 0.15 M solution of HOCl is 4.14. What is the K_a for HOCl?
a. 5.7×10^{-2}
b. 8.8×10^{-3}
c. 4.8×10^{-4}
d. 7.2×10^{-5}
e. 3.5×10^{-8}

____ 10. The pH of a 0.172 M solution of benzoic acid ($pK_a = 4.20$) is
a. 2.48.
b. 3.44.
c. 4.37.
d. 4.96.
e. 5.63.

____ 11. Calculate the pH of a 0.051 M solution of sodium lactate. The K_a for lactic acid is 1.4×10^{-4}.
a. 1.29
b. 2.57
c. 8.28
d. 11.43
e. 12.71

____ 12. Which of the following is a Lewis acid but not a Bronsted-Lowry acid?
a. acetic acid
b. $NH_4^+(aq)$
c. $HCO_3^-(aq)$
d. CO_2
e. CO_3^{2-}

____ 13. A buffer solution may result if K_3PO_4 is mixed with
a. HCl.
b. K_2HPO_4.
c. NaOH.
d. either HCl or K_2HPO_4.
e. either K_2HPO_4 or NaOH.

____ 14. A buffer solution is one which
a. contains more than the expected amount of solute for a particular temperature and is therefore unstable.
b. contains the maximum amount of solute possible for a particular temperature.
c. changes color upon addition of strong base.
d. contains an equal number of hydronium and hydroxide ions.
e. resists changes in pH upon addition of acid or base.

____ 15. To make a buffer using acetic acid one would add
a. carbonic acid.
b. sodium acetate.
c. sodium chloride.
d. ammonium chloride.
e. ammonium phosphate.

____ 16. A buffer solution is 0.080 M in lactic acid ($K_a = 1.8 \times 10^{-4}$) and 0.070 M in sodium lactate. The pH of the solution is
a. 2.86.
b. 3.68.
c. 3.80.
d. 4.18.
e. 4.62.

____ 17. Which acid, in combination with its conjugate base, would be the best choice to make a buffer of pH = 4.20?
a. acetic acid ($K_a = 1.8 \times 10^{-5}$)
b. benzoic acid ($K_a = 6.3 \times 10^{-5}$)
c. formic acid ($K_a = 1.8 \times 10^{-4}$)
d. hydrofluoric ($K_a = 7.2 \times 10^{-4}$)
e. nitrous acid ($K_a = 4.5 \times 10^{-4}$)

____ 18. A buffer solution is 0.500 M in ascorbic acid and 0.500 M in sodium ascorbate. Its pH is 4.10. After addition of 10 mL of 1 M NaOH to 1.00 L of this buffer, the most likely value of the pH is
a. 4.08.
b. 4.10.
c. 4.12.
d. 5.95.
e. 10.15.

____ 19. Which of the following indicator(s) would be most suitable for the titration of acetic acid (pK_a = 4.74) with NaOH?
a. bromothymol blue (transition range pH 6 to 8)
b. methyl red (transition range pH 4 to 6.3)
c. phenolphthalein (transition range pH 8.3 to 11)
d. all of the above
e. none of the above

____ 20. A 50.00 mL sample of 0.0950 M acetic acid ($K_a = 1.8 \times 10^{-5}$) is being titrated with 0.0848 M NaOH. What is the pH after 28.00 mL of NaOH has been added?
a. 5.04
b. 4.74
c. 4.44
d. 3.18
e. 3.06

____ 21. Isotonic saline solution is 0.154 M NaCl(aq) What is the solubility of AgCl ($K_{sp} = 1.8 \times 10^{-10}$) in such a solution?
a. 2.8×10^{-11} M
b. 1.2×10^{-9} M
c. 5.3×10^{-6} M
d. 3.4×10^{-5} M
e. 0.077 M

____ 22. In which of the following would calcium phosphate have the greatest solubility?
a. 0.1 M aqueous sodium phosphate
b. distilled water
c. 0.1 M aqueous calcium nitrate
d. saturated aqueous calcium hydroxide
e. 0.1 M aqueous phosphoric acid

____ 23. The solubility of silver chloride in water is increased by the addition of NH_3. Why?
a. The solubility of many salts is affected by the pH of the solution.
b. The formation of complex ions displaces the solubility equilibrium to the right.
c. The solubility of most salts increases as temperature increases.
d. Some insoluble compounds are amphoteric.
e. A common ion displaces the solubility equilibrium toward the undissolved solute.

____ 24. What is the largest mass of solid NaCl that can be dissolved in 1.000 L of 5.00×10^{-3} M $AgNO_3$ without a precipitate of AgCl forming? K_{sp} for AgCl is 1.8×10^{-10}.

a. 0.78 mg
b. 86 g
c. 13 g
d. 2.1 g
e. 36 ng

____ 25. A mixture of two metal ions in solution is to be separated by selective precipitation. As the concentration of the precipitating ion is increased, which metal ion precipitates first?

a. The one with the lower value of K_{sp} for its precipitate
b. The one with the higher value of K_{sp} for its precipitate
c. The one present at higher concentration
d. The one present at lower concentration
e. Cannot answer the question without more information

Short Answer

26.

a. Explain why the solubility of carbonates and phosphates is increased by lowering the pH, but the solubility of chlorides is unaffected by lowering the pH.

b. The solubility of copper(II) carbonate is dramatically increased by the addition of NH_3, but the solubility of copper(II) phosphate is not. Referring to the data below, explain why.

K_{sp} for copper(II) carbonate = 2.5×10^{-10}

K_{sp} for copper(II) phosphate = 1.4×10^{-37}

$K_f = 1.1 \times 10^{13}$

$Cu^{2+}(aq) + 4NH_3(aq) \rightleftharpoons Cu(NH_3)_4^{2+}(aq)$

27. A solution contains 0.100 M $Pb(NO_3)_2$ and 1.00×10^{-5} M $AgNO_3$. It is intended to separate out the silver by selective precipitation of AgI. What is the maximum percentage of the total silver that can be recovered free of contamination by PbI_2?
(K_{sp} for AgI = 1.5×10^{-13}; K_{sp} for PbI_2 = 8.7×10^{-9}).