Recitation Worksheet Thirteen : Exam 4 Review

Name: | **MyID:**

Textbook:

Chemistry & Chemical Reactivity
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Instructions:

- This recitation worksheet is a review for Exam One.
- Exam coverage: 16.4-16.5, 17.1-17.4
- You **do not** need to submit it to Gradescope.
- The answer key has been posted with this worksheet to eLC.
- The **recitation session during the exam week (November 18th– 21st) is still mandatory**. Your attendance will be recorded.
- A periodic table and formula sheet are attached to the end of this worksheet.

1. What structural features of a molecule may affect the p*K*a of an acid?

A. Electronegativity
B. The strength of the bond to the acidic hydrogen
C. Inductive effect
D. Resonance stabilization
E. All the above

2. Which of the following acidity relationships is true?

A. $H_2SO_3 > H_2SO_4$
B. $H2PO_4^- > HPO_4^{2-}$
C. $HF > HClO_4$
D. $H_2CO_3 > HNO_3$
E. None of these

3. Which acid of the set has the strongest conjugate base?

A. CH_4
B. NH_3
C. H_2S
D. HCl

4. Which of the following acids will be the strongest?

A) H_2SO_4 B) HSO_4^- C) H_2SO_3 D) H_2SeO_4 E) HSO_3^-

5. For which of the pairs of acids is the stronger acid listed first? (Select all that apply).

A. HI or HCl

B. HF or HBr

C. $HClO_3$ or $HBrO_3$

D. $HOSO_2CF_3$ or $HOSO_2CH_3$

6. Which of the following acids will be the strongest?

I. CH_3OH II. CH_3SH III. CH_3PH_2

7. Predict which one is the stronger acid of each of the following pairs of acids?

A. H_2SiO_3 or H_3PO_4

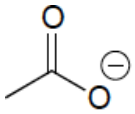
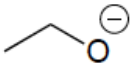
B. H_2CO_3 or H_2BO_3

C. HOClO or HOBr

8. Arrange the following binary compounds in order of increasing acid strength.

I. H_2Te II. HI III. H_2S

9. Rank these molecules in terms of decreasing basicity (strongest to weakest base):

I. II. III.

A. I > II > III

B. II > III > I

C. III > II > I

D. I > III > II

E. II > I > III

10. Which of these species is probably the weakest acid?

A. HCl
B. H_3PO_4
C. $H_2PO_4^-$
D. HPO_4^{2-}
E. HNO_3

11. A solution is prepared by dissolving 0.32 mol of $CH_3CH_2NH_3Cl$ in 1.00 L of 1.5 M $CH_3CH_2NH_2$. If 10. mL of 0.11 M HCl is added to this solution, the pH of the solution will slightly _____ because the HCl reacts with the _____ present in the solution.

A. Increase, $CH_3CH_2NH_3^+$
B. Increase, $CH_3CH_2NH_2$
C. Decrease, $CH_3CH_2NH_2$
D. Decrease, $CH_3CH_2NH_3^+$

12. Identify the **false** statement regarding a solution that contains 0.20 moles of hypochlorous acid.

A. Adding NaOH will increase the dissociation of HOCl, and decrease $[H^+]$

B. Adding HCl will decrease the dissociation of HOCl and decrease $[OCl^-]$

C. Adding NaOCl will increase the dissociation of the original HOCl, and will increase $[H^+]$

D. Adding NaCl will not affect either the dissociation of the original HOCl or the solution pH

13. What volume of 0.80 M HCl will be required to titrate 36.2 grams of NaBrO to the equivalence point?

A. 150 mL

B. 308 mL

C. 381 mL

D. 258 mL

E. None of the above

14. To 60.0 mL of a solution that contains 0.80 M NaF and 0.80 M HF was added 20.0 mL of 0.40 M HCl. Calculate the moles of HF and the concentration of HF after addition.

A. 0.056 moles, 0.70 M

B. 0.056 moles, 0.93 M

C. 0.048 moles, 0.60 M

D. 0.040 moles, 0.67 M

E. none are correct.

15. TRIS $\{(HOCH_2)_3CNH_2\}$ is one of the most common buffers used in biochemistry. A solution is prepared by adding enough TRIS and 12 M HCl(*aq*) to give 1.0 L of solution with [TRIS] = 0.30 M and $[TRISH^+]$ = 0.60 M. What is the pH of this buffered system if the pK_b is 5.92?

A. 5.92

B. 6.22

C. 7.78

D. 8.08

16. All of the following solutions would be considered buffers **except**

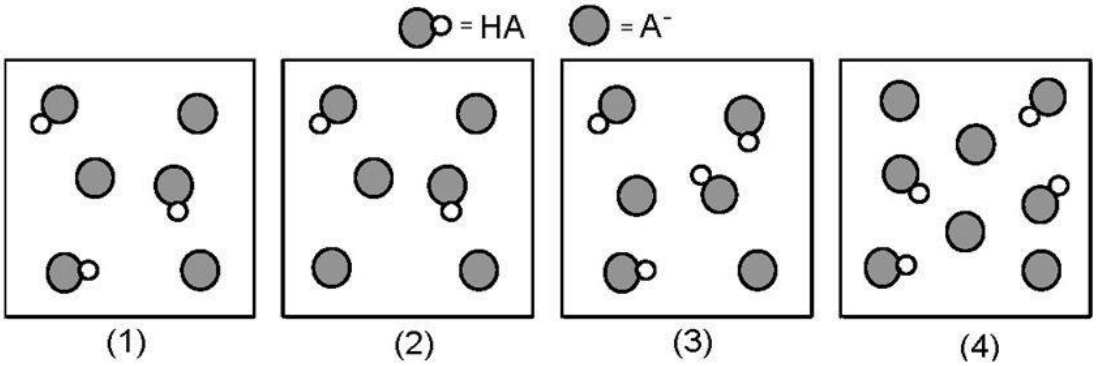
A. CH_3COOH/ CH_3COO^-.

B. NaCl/ HCl.

C. $H_2PO_4^-$/ HPO_4^{2-}.

D. HPO_4^{2-}/ PO_4^{3-}.

17. These pictures represent solutions that contain a weak acid HA (pK_a = 5.0) and its sodium salt NaA. Unshaded spheres represent H atoms and shaded spheres represent A- ions. (Na^+, H_3O^+, OH^-, and solvent H_2O molecules have been omitted for clarity.)



Which solution has the greatest buffer capacity?

E. (1)

F. (2)

G. (3)

H. (4)

18. Which titration curve corresponds to an initial pH of 10.7 and an equivalence point at pH = 4.5?

A. A strong acid to which strong base is added

B. A strong base to which strong acid is added

C. A weak acid to which strong acid is added

D. A weak base to which strong acid is added

E. A weak base to which strong base is added

19. What is the percent dissociation of glycine if the solution has a pH = 8.60 and a pK_a = 9.60?

A. 50

B. 9%

C. 5%

D. 1%

20. Twenty-five milliliters of 0.10 M HCl(aq) is titrated with 0.10 M NaOH(aq). What is the pH after 15 mL of NaOH(aq) has been added?

A. 1.4

B. 1.2

C. 1.0

D. 2.0

E. 1.6

21. In a titration experiment, it was determined that a 50.0 mL sample of HNO_3 required 66.0 mL of 0.80 M NaOH to reach the equivalence point. What was the molarity of the HNO_3?

A. 0.61 M

B. 0.86 M

C. 1.06 M

D. 1.24 M

E. none of these are correct

22. HN_3 has $K_a = 2.0 \times 10^{-5}$. What is the concentration of N_3^- in a solution that is 0.50 M in HN_3 and 0.40 M in HNO_3?

A. 3.5×10^{-3}

B. 2.5×10^{-5}

C. 2.0×10^{-6}

D. 8.0×10^{-6}

E. None of these are correct

23. Which combination will give a pH of lower than 7.00 at the equivalence point?

A. $HClO_4$ + NaF

B. HNO_3 + KOH

C. NH_4Cl + NaOH

D. HF + NaOH

E. None of these are correct

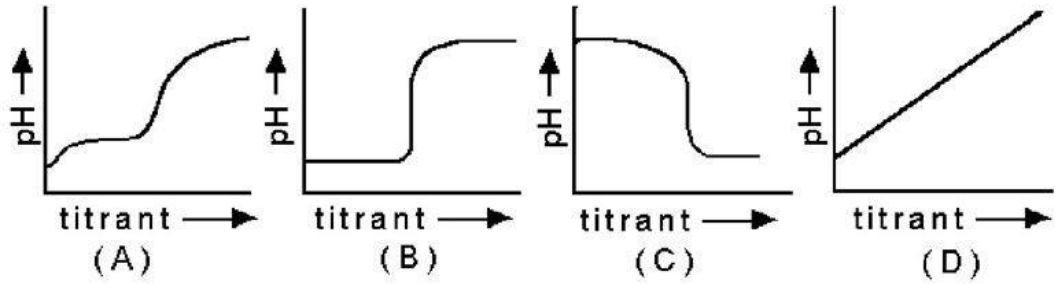
24. Which is a net ionic equation for the neutralization of a weak acid with a strong base?

A. $HBr(aq) + NaOH(aq) \rightleftharpoons H_2O(l) + NaBr(aq)$
B. $H_3O^+(aq) + OH^-(aq) \rightleftharpoons 2\ H_2O(l)$
C. $HF(aq) + LiOH(aq) \rightleftharpoons H_2O(l) + LiF(aq)$
D. $HF(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + F^-(aq)$

25. What is the hydronium ion concentration in a solution prepared by mixing 50.00 mL of 0.10 M HCN with 50.00 mL of 0.010 M NaCN? Assume that the volumes of the solutions are additive and that $K_a = 4.9 \times 10^{-10}$ for HCN.

A. 4.9×10^{-11} M
B. 4.9×10^{-10} M
C. 4.9×10^{-9} M
D. 7.0×10^{-6} M

26.



I. What is the characteristic pH-titrant curve for the titration of a strong acid by a strong base?

II. What is the characteristic pH-titrant curve for the titration of a strong base by a strong acid?

III. What is the characteristic pH-titration curve for the titration of a weak acid by a strong base?

27. Phosphoric acid is a triprotic acid, ionizing in sequential steps:

$$H_3PO_4 + H_2O \leftrightharpoons H_2PO_4^- + H_3O^+$$

$$H_2PO_4^- + H_2O \leftrightharpoons HPO4^{2-} + H_3O^+$$

$$HPO4^{2-} + H2O \leftrightharpoons PO4^{3-} + H_3O^+$$

Which equilibrium is most important in determining the pH of a solution of sodium phosphate?

A. $HPO4^{2-} + H_2O \leftrightharpoons PO4^{3-} + H3O^+$

B. $H_2PO_4^- + H_2O \leftrightharpoons H_3PO_4 + OH^-$

C. $H_3PO_4 + H_2O \leftrightharpoons H_2PO_4^- + H3O^+$

D. $2\ H_2O \leftrightharpoons H_3O^+ + OH^-$

E. $PO_4^{3-} + H_2O \leftrightharpoons HPO_4^{2-} + OH^-$

28. What is the pH of a solution prepared by mixing 50.00 mL of 0.10 M NH_3 with 20.00 mL of 0.10 M NH_4Cl? $K_b = 1.8 \times 10^{-5}$ for NH_3.

29. Solutions of sodium salts of the acids in the table are prepared with an initial concentration of 0.500 M. Which solution will have the highest pH and be the most basic?

Acid	pKa
HA	4.00
HB	7.00
HC	10.00
HD	11.00

A. NaA

B. NaB

C. NaC

D. NaD

E. All will have the same pH because the concentrations are the same.

30. Which of the groups, A–D, consist of salts that all form basic solutions in water?

A. $NaNO_3$, NH_4CN, $NaOOCH_3$, NH_4Cl

B. $NaHCO_3$, NaF, NH_4Cl, Na_2SO_3

C. Na_2CO_3, KCl, $NaOOCH_3$, NH_4Cl

D. Na_2CO_3, NaF, $NaOOCCH_3$, NaCN

E. All of the above.

31. Which one of these is correct?

A. K_2SO_3 is a stronger base than $KHSO_3$.

B. Na_2HPO_4 is a weaker base than NaH_2PO_4.

C. K_2CO_3 is a weaker base than $KHCO_3$.

D. $NaHSO_3$ is a stronger acid than $NaHSO_4$.

E. All of these statements are correct.

32. An aqueous solution of an unknown acid had a pH of 3.70. Titration of a 25.0 mL aliquot of the acid solution required 21.7 mL of 0.104 M aqueous sodium hydroxide for complete reaction. Assuming that the acid is monoprotic, what is its ionization constant?

33. Which of these mixtures would result in a buffered solution when 1.0 L of each of the two solutions are mixed.

A. 0.2 M HNO_3 and 0.2 M $NaNO_3$

B. 0.2 M HNO_3 and 0.4 M HF

C. 0.2 M HNO_3 and 0.4 M NaF

D. 0.2 M HNO_3 and 0.4 M NaOH

34. The pH of a solution of $NH_4C_2H_3O_2$ is approximately 7. The best explanation is:

A. This salt does not react with water.

B. Ammonium acetate is a weak electrolyte.

C. All salts of weak acids and weak bases are neutral.

D. Aqueous ammonia and acetic acid have approximately equal ionization constants.

E. The salt is a product of a strong acid and a strong base.

35. What is the $[HPO_4^{2-}]$ of a solution labeled "0.10 M phosphoric acid"?

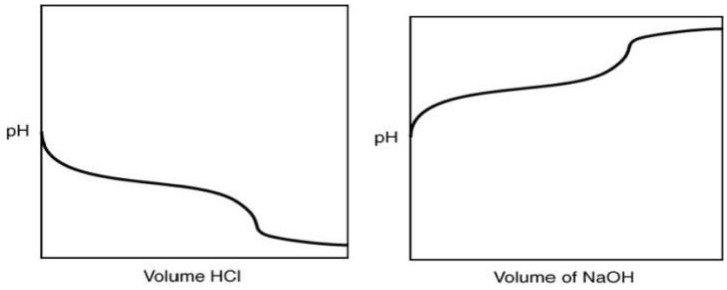
$[K_{a1} = 7.1 \times 10^{-3}; K_{a2} = 6.3 \times 10^{-8}; K_{a3} = 4.2 \times 10^{-13}]$

36. A pH 4.88 buffer was prepared by dissolving 0.10 mol of benzoic acid ($K_a = 6.3 \times 10^{-5}$) and 0.50 mol of sodium benzoate in sufficient pure water to form a 1.00 L solution. To a 70.0 mL aliquot of this solution was added 2.00 mL of 2.00 M aqueous HI solution. What was the pH of the new 72.0 mL solution?

37. What is the pH of the solution when 52.60 mL of 0.35 M acetic acid is added to 22.08 mL of 0.20 M NaOH? The K_a for acetic acid is 1.8×10^{-5}.

38. A 0.500 g sample of an unknown substance was titrated with a 0.1 M HCl solution. Another 0.500 g sample of it was titrated with a 0.1 M NaOH solution. The resulting titration curves are illustrated here. Given the following possibilities, what is the sample?

A. Na_2CO_3
B. CO_2
C. $NaHCO_3$
D. H_2CO_3
E. There is no way to tell.



39. Consider 1.00 L of a solution initially containing 0.500 mol ammonia (NH_3) and 0.300 mol of ammonium ion (NH_4^+). What is the pH after addition of 40. mL of 0.800M NaOH to this solution? (NH_4^+ $K_a = 5.6 \times 10^{-10}$)?

40. Of the following substances, which one(s) will form basic solutions (select all that apply).
(H_2CO_3 $K_{a1} = 4.4 \times 10^{-7}$, $K_{a2} = 4.7 \times 10^{-11}$; H_2S $K_{a1} = 1.1 \times 10^{-7}$, $K_{a2} = 1.0 \times 10^{-19}$)

☐ **NaHS** **$Cu(NO_3)_2$** **$KHCO_3$** **NaF**

A. NaHS, $Cu(NO_3)_2$
B. $KHCO_3$, NaHS
C. NaF only
D. NaF, $KHCO_3$
E. NaHS, $KHCO_3$ and NaF

41. An aqueous solution of NaF is prepared by dissolving 0.350 mol of NaF in sufficient water to yield 1.0 L of solution. The pH of the solution was 8.93 at 25.0 °C. What is the K_b of F^-?

☐ × 10 ☐

42. The acid-dissociation constant, K_a, for an unknown acid HA is 4.57×10^{-3}. What is the base-dissociation constant, K_b, for the unknown anion A^-?

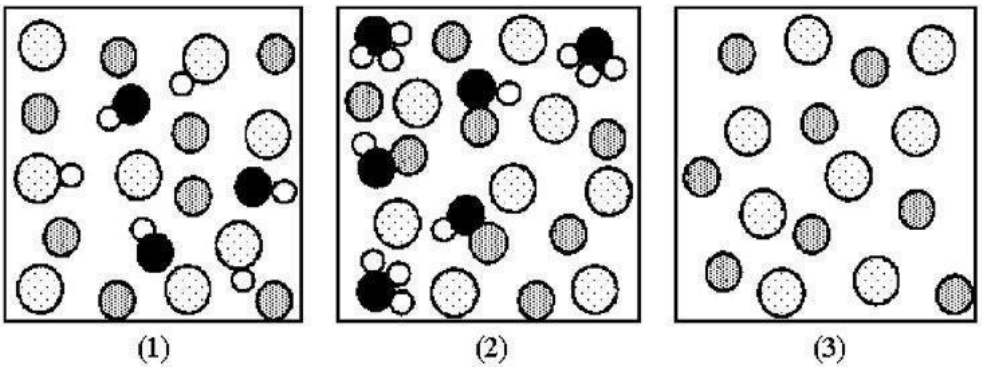
$\square \times 10^{\square}$

43. A certain acid, HA, has a Ka given by:

$$HA + H_2O \rightleftharpoons H_3O^+ + A^- \qquad Ka = 6.25 \times 10^{-5}$$

What is the pH of a 0.345 M aqueous solution of the acid's potassium salt, KA, which undergoes the hydrolysis reaction?

44. The pictures represent solutions of three salts MA; water molecules have been omitted for clarity. Dotted spheres represent A^- ions; gray spheres represent M^+ ions; black spheres represent oxygen atoms; and unshaded spheres represent hydrogen atoms.



Which picture represents a basic salt?

A. (1) Only drawing with hydroxide ions present.
B. (2)
C. (3)
D. none of these

45. Which of the following salts will produce an acidic solution?

A) $Sr(ClO_4)_2$
B) KBr
C) NH4I
D) K_2CO_3
E) $NaNO_3$

46. Calculate the pH of a 0.100 M CH_3NH_3Cl solution. K_b for methylamine, CH_3NH_2, is 3.7×10^{-4}.

47. Calculate the pH of a 0.800 M KBrO solution. K_a for hypobromous acid, HBrO, is 2.0×10^{-9}.

48. Ascorbic acid, $H_2C_6H_6O_6$ is a diprotic acid, with $K_{a1} = 1.0 \times 10^{-5}$ and $K_{a2} = 5.0 \times 10^{-12}$. It is often abbreviated as **H_2Asc**. **Using this abbreviation** to write out the equilibria of this acid with water. If you type your answers in the pdf, please use **"^" for superscripts** and **"_" for subscripts**.

[ ] → [ ] $K_{a1} = 1.0 \times 10^{-5}$

[ ] → [ ] $K_{a2} = 5.0 \times 10^{-12}$

49. Predict whether each of the following salt solutions will be **A**) acidic, **B**) basic, or **C**) neutral. Remember that ionic compounds dissociate completely in water.

K_a for $HNO_2 = 4.0 \times 10^{-4}$ K_b for $NH_3 = 1.8 \times 10^{-5}$

H_3PO_4: $K_{a1} = 7.5 \times 10^{-3}$ $K_{a2} = 6.2 \times 10^{-8}$ $K_{a3} = 4.8 \times 10^{-13}$

[ ] a. NaCl (aq)

[ ] b. NH_4NO_3 (aq)

[ ] c. $NaCH_3CO_2$ (aq)

[ ] d. NH_4NO_2 (aq)

[ ] e. $(NH_4)_3PO_4$ (aq)

50. Arsenic acid, H_3AsO_4 is a triprotic acid. It has three equilibrium associated with its reaction with water:

$H_3AsO_4 + H_2O \rightleftharpoons H_2AsO_4^- + H_3O^+$ $\quad K_{a1} = 5.0 \times 10^{-3}$
$H_2AsO_4^- + H_2O \rightleftharpoons HAsO_4^{2-} + H_3O^+$ $\quad K_{a2} = 8.0 \times 10^{-8}$
$HAsO_4^{2-} + H_2O \rightleftharpoons AsO_4^{3-} + H_3O^+$ $\quad K_{a3} = 6.0 \times 10^{-10}$

If we have a 5.00 M solution of H_3AsO_4, what are the concentrations of all of the species present?

a. First, calculate the following concentrations using the first ionization.

$[H_3AsO_4]$ = ☐ M

$[H_2AsO_4^-]$ = ☐ M

$[H_3O^+]$ = ☐ M

b. What is the pH of this solution?

pH = ☐

c. Calculate the $[HAsO_4^{2-}]$ by solving for K_{a2}

$[HAsO_4^{2-}]$ = ☐ M

d. Calculate the $[AsO_4^{3-}]$ by solving for K_{a3}?

$[AsO_4^{3-}]$ = ☐ M

51. Copper(II) fluoride has a solubility of 0.0020 mol/L. What is the value of K_{sp}?

A. 1.8×10^{-7}

B. 4.0×10^{-6}

C. 3.2×10^{-8}

D. 8.0×10^{-9}

E. None of these are correct

52. A small amount of solid magnesium hydroxide is shaken vigorously in a test tube almost full of water until no further change occurs and most of the solid settles out. The resulting solution is:

A. concentrated and saturated
B. dilute and saturated
C. dilute and unsaturated
D. dilute and supersaturated
E. concentrated and supersaturated

53. In which of the following pairs is the oxidation number for the underlined element **incorrect**?

A. $\underline{Mn}O_4^-/(+7)$

B. $\underline{S}O_4^{2-}/(+4)$

C. $\underline{N}H_4^+/(-3)$

D. $\underline{N}O_3^-/(+5)$

E. $\underline{Cr}_2O_7^{2-}/(+6)$

54. Identify the reaction(s) that are redox reactions:

A. $HOCl(aq) + NaOH(aq) \rightarrow NaOCl(aq) + H_2O(l)$

B. $5\ I^-(aq) + IO_3^-(aq) + 6\ H^+(aq) \rightarrow 3\ I_2(s) + 3\ H_2O(l)$

C. $2\ NaCl(s) + H_2SO_4(aq) \rightarrow 2\ HCl(g) + Na_2SO_4(s)$

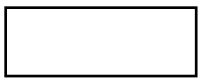
D. $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq)$

E. $2\ H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(g)$

55. Balance the oxidation-reduction reaction in acidic solution. What is the sum of the coefficients?

$$MnO_4^-(aq) + H_2C_2O_4(aq) \rightarrow Mn^{2+}(aq) + CO_2(g) + H_2O(l)$$

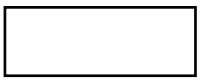
56. What species is the oxidizing agent in the following redox reaction?



$$Cr(OH)_4^-(aq) + ClO^-(aq) \rightarrow CrO_4^{2-}(aq) + Cl^-(aq)$$

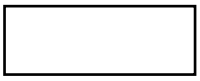
57. What element is being oxidized in the following redox reaction?

$$C_3H_8O_2(aq) + K_2Cr_2O_7(aq) \rightarrow C_3H_4O_4(aq) + Cr^{3+}(aq)$$



A. C
B. H
C. O
D. K

58. The solubility product constant of calcium chlorate ($Ca(ClO_3)_2$) of water is 7.1×10^{-7} at 25 °C. How many grams of $Ca(ClO_3)_2$ is dissolved in 750 mL of saturated solution?

 g

59. Which one of these is the solubility product constant for $Mn(OH)_2$?

A. $K_{sp} = [Mn^{2+}][OH^-]^2$
B. $K_{sp} = [Mn^{2+}][2\ OH^-]^2$
C. $K_{sp} = [Mn^{2+}]^2[OH^-]^2$
D. $K_{sp} = [Mn^{2+}]^2[OH^-]$
E. $K_{sp} = [Mn^{2+}]^2[2\ OH^-]^2$

60. The table lists five compounds and their K_{sp} value. Which is least soluble?

ZnS	2×10^{-25}
TlBr	3.4×10^{-6}
AgCl	1.8×10^{-10}
FeS	6×10^{-19}
CuI	1.1×10^{-12}

A. ZnS
B. TlBr
C. AgCl
D. FeS
E. CuI

61. Which statement is true about redox reactions?

A. A half-reaction can occur by itself
B. A redox reaction in base can include excess H^+ after it has been balanced
C. Two oxidations can occur instead of one oxidation and one reduction
D. At least 2 atoms must have their oxidation states change during a redox reaction
E. None of these statements are true

62. Which of these statements is **false**?

A. Addition of NaOH will increase dissociation of HF, and the pH of the final solution will be higher
B. Addition of NaF will decrease dissociation of HF, and the pH of the final solution will be higher
C. Addition of HCl will decrease dissociation of HF, and the pH of the final solution will be lower
D. Addition of NaCl will decrease dissociation of HF, and the pH of the final solution will be lower

63. For the buffer solutions below, in which case would the buffer capacity not be exhausted either by the addition of 0.5 moles of HCl or by the addition of 0.5 moles of NaOH?

A. 0.80 M HF and 0.20 M NaF
B. 0.80 M HF and 0.90 M NaF
C. 0.10 M HF and 0.20 M NaF
D. 0.10 M HF and 0.60 M NaF

64. To prepare a buffer solution with pH = 4.70, how many moles of solid NaN_3 should be added to a 1.0-L solution that is 0.40 M in HN_3? (Ka for $HN_3 = 2.6 \times 10^{-5}$).

A. 0.12 moles
B. 0.31 moles
C. 0.40 moles
D. 0.52 moles
E. none of the above

65. Which of the following equilibria best represents the hydrolysis reaction that occurs in an aqueous solution of NH_4Cl?

A. $Cl^-(aq) + H_3O^+(aq) \leftrightharpoons HCl(aq) + H_2O(l)$
B. $NH_4^+(aq) + H_2O(l) \leftrightharpoons NH_3(aq) + H_3O^+(aq)$
C. $NH_4^+(aq) + OH^-(aq) \leftrightharpoons NH_3(aq) + H_2O(l)$
D. $Cl^-(aq) + H_2O(l) \leftrightharpoons HCl(aq) + OH^-(aq)$
E. $NH_4^+(aq) + Cl^-(aq) \leftrightharpoons NH_4Cl(s)$

Use this information for questions 67-69:

A 24.8 mL solution of 0.399 M aqueous hydrofluoric acid, HF, is titrated with a 0.235 M aqueous potassium hydroxide, KOH, solution. (K_a for HF = 7.2×10^{-4})

66. What volume of potassium hydroxide is required to reach the equivalence point?

A. 14.6 mL
B. 24.8 mL
C. 28.6 mL
D. 32.4 mL
E. 42.1 mL

67. What is the pH of the above solution at the equivalence point?

A. above 7.00
B. below 7.00
C. exactly 7.00

68. What is the pH of the solution after the addition of 21.1 mL of potassium hydroxide? Keep 3 **decimal places**.

69. An initial pH of 10.7 and an equivalence point at pH = 4.5 corresponds to a titration curve for a

A. Strong acid to which strong base is added
B. Strong base to which strong acid is added
C. Weak acid to which strong acid is added
D. Weak base to which strong acid is added
E. Weak base to which strong base is added

70. Consider the following redox reaction. What are the coefficients for $C_2O_4^{2-}$ and H_2O in the balanced reaction under acidic conditions?

$$MnO_4^-(aq) + C_2O_4^{2-}(aq) \rightarrow Mn^{2+}(aq) + CO_2(g)$$

A. $C_2O_4^{2-} = 5$, $H_2O = 8$
B. $C_2O_4^{2-} = 1$, $H_2O = 1$
C. $C_2O_4^{2-} = 5$, $H_2O = 1$
D. $C_2O_4^{2-} = 1$, $H_2O = 4$
E. $C_2O_4^{2-} = 3$, $H_2O = 2$

71. Which of the copper(II) salts will dissolve to the greatest extent in water?

A. $Cu(OH)_2$ $K_{sp} = 4.8 \times 10^{-20}$
B. CuC_2O_4 $K_{sp} = 4.4 \times 10^{-10}$
C. $Cu_3(PO_4)_2$ $K_{sp} = 1.4 \times 10^{-37}$
D. CuS $K_{sp} = 8.0 \times 10^{-37}$
E. $Cu_3(AsO_4)_2$ $K_{sp} = 8.0 \times 10^{-36}$

Formula Sheet

Length
1 kilometer = 0.62137 mile
1 inch = 2.54 centimeters (exactly)
1 Ångstrom = 1×10^{-10} meter

Energy
1 joule = 1 kg·m^2/s^2
1 calorie = 4.184 joules
1 Calorie = 1 kilocalorie = 1000 calories
1 L·atm = 101.325 joules

Pressure
1 pascal = 1 N/m^3 = 1 kg/m·s^2
1 atmosphere = 101.325 kilopascals = 760 mm Hg = 760 torr = 14.70 lb/in^2
1 bar = 1×10^5 Pa (exactly)

Temperature
0 K = −273.15°C
K = °C + 273.15
°C = (5/9)(°F − 32)

Mass
1 kg = 2.205 lbs

Volume
1 mL = 1 cm^3 = 1 cc

Constants
c = 2.998×10^8 m/sec
h = 6.626×10^{-34} J·sec^{-1}
R = 0.08206 L·atm/mol·K = 8.314 J/mol·K
Specific heat of water = 4.184 J/g·K
Mass of an electron: 9.109 x 10^{-31} kg
Mass of a proton: 1.673 x 10^{-27} kg
RH = 2.18 x 10^{-18} J
Specific heat of water = 4.184 J/g·K
STP = 273.15 K and 1 atm
Avogadro's number: 6.022×10^{23}

Equations
d (density) = m/V
$P_1V_1=P_2V_2$
$V_1/T_1=V_2/T_2$
$P_1V_1/n_1T_1=P_2V_2/n_2T_2$
PV=nRT
$(P + a(n^2/V^2))\cdot(V - nb) = nRT$
molar mass (M) = mRT/PV
density (d) = MP/RT
$x_A = n_A/n_{tot} = P_A/P_{tot} = V_A/V_{tot}$
$P_{tot} = P_A + P_B + \ldots$
$n_{tot} = n_A + n_B + \ldots$

$$\mu_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{Rate\ of\ effusion\ A}{Rate\ of\ effusion\ B} = \sqrt{\frac{MW_B}{MW_A}}$$

$Q = C \times \Delta T = c_{specific} \times m \times \Delta T$
$Q = n \times \Delta H\ (kJ/mol) = m \times \Delta H\ (kJ/g)$
$w = -P\Delta V$
$\Delta E = q + w$
$\Delta H° = \Sigma n\Delta Hf°(products) - \Sigma n\Delta Hf°(reactants)$
$\Delta H° = \Sigma n\Delta H°(bonds\ broken) - \Sigma n\Delta H°(bonds\ formed)$
$E=h\nu$
$c=\lambda\nu$
$\lambda = h/m\nu$

$$\Delta E = -2.18 \times 10^{-18} J(\frac{1}{n_f^2} - \frac{1}{n_i^2})$$

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$C_g = kP_g$
$P_{solution}=P_{solvent}\ X_{solvent}$
$P_{solution}=\sum P_j=\sum P_j X_j$
$\Delta T_b = K_b m i$
$\Delta T_f = K_f m i$
$\pi = MRTi$

Thermodynamic and Electrochemistry

$S = k_b \times \ln(W)$
$k_b = 1.381 \times 10^{-23}\ J/K$
$\Delta S = q_{rev}/T$
$\Delta S_{surr} = q_{surr}/T = -q_{rev}/T$
$\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr}$
$\Delta S°_{rxn} = \Sigma \nu S°_{products} - \Sigma \nu S°_{reactants}$
$\Delta H°_{rxn} = \Sigma \nu H°_{products} - \Sigma \nu H°_{reactants}$
$\Delta G°_{rxn} = \Sigma \nu G°_{products} - \Sigma \nu G°_{reactants}$
$\Delta G = \Delta H - T\Delta S$
$\Delta G = \Delta G° + RT \cdot \ln Q$
$R=8.314\ J/mol.K$
$\Delta G° = -RT \cdot \ln K$
$\Delta G= -nFE_{cell}$
$F = 96485\ J/(V \cdot mol\ e^-)$
$E°_{cell} = RT/nF\ \ln K$
$E°_{cell} = (0.0257/n)\ \ln K = (0.0592/n)\ \log K$
$E_{cell} = E°_{cell} - (RT/nF)\ \ln Q$
$E_{cell} =E°_{cell} - (0.0257/n)\ \ln Q$
Electrolysis: $Q\ (total\ charge) = I \times t = n \times F$

Integrated Rate Laws & half-life

$$\ln\frac{[A]}{[A]_0} = -kt$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$[A] = -kt + [A]_0$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

$$ln\frac{k_2}{k_1} = -\frac{\mathrm{E_a}}{\mathrm{R}}(\frac{1}{\mathrm{T_2}} - \frac{1}{\mathrm{T_1}})$$

Equilibrium and Acid / Base

$K_P = K_c \times (RT)^{\Delta n}$

$pH = -\log[H_3O^+]$

$K_w = 1.0 \times 10^{-14}$ at 25 °C

$K_w = [H_3O^+] \times [OH^-]$

$K_w = K_a \times K_b$

$pK_a = -\log[K_a]$

Buffer: $pH = pK_a + \log\frac{[A^-]}{[HA]}$

$$ln\frac{K_2}{K_1} = \frac{\Delta H^\circ_{rxn}}{R}(\frac{1}{T_1} - \frac{1}{T_2})$$

Periodic Table of the Elements

1												13	14	15	16	17	18
1 H 1.01	2																2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc [97]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
37 Cs 132.91	56 Ba 137.33		72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]		104 Rf [267]	105 Db [268]	106 Sg [269]	107 Bh [270]	108 Hs [269]	109 Mt [277]	110 Ds [281]	111 Rg [282]	112 Cn [285]	113 Nh [286]	114 Fl [290]	115 Mc [290]	116 Lv [293]	117 Ts [294]	118 Og [294]

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [262]