Acid/Base Homework Booklet #1 Name_____Period_____

Show all work in the homework booklet. The more the work shown, the easier it will be to prepare for exams.

1. An Arrhenius base is defined as a compound that
   A. releases protons in solution
   B. releases OH^- in solution
   C. accepts OH^- in solution
   D. accepts protons in solution

2. A substance which produces hydroxide ions in solution is a definition of which of the following?
   A. a Bronsted-Lowry base
   B. an Arrhenius base
   C. an Arrhenius acid
   D. a Bronsted-Lowry acid

3. Which of the following tests could be used to distinguish between 1.0 M HCl and 1.0 M NaOH?

   I. electrical conductivity + both
   II. reaction with zinc to produce hydrogen gas acid
   III. reaction with red litmus paper turning blue base

   A. II and III only
   B. I and II only
   C. I, II and III
   D. III only

4. Which of the following is generally true of acids, but **not** for bases?
   A. feels slippery
   B. releases protons in solution
   C. pH > 7
   D. conducts electrical current well in solution

5. Which of the following best describes an acidic solution?

	Litmus Colour	Reaction with Zn
A.	blue	reaction
B.	red	reaction
C.	red	no reaction
D.	blue	no reaction

6. When a small solid sample is added to a solution of H_2SO_4, a precipitate forms and the solution becomes less acidic. Which of the following substances could have caused these results?
   A. $Cu(OH)_2$ no precipitate. $H_2SO_4 + \longrightarrow$
   B. $Ba(OH)_2$
   C. $Ba(NO_3)_2$ won't become
   D. $MgSO_4$ less acidic

7. The conjugate base of an acid is produced by
   A. removing an electron from the acid.
   B. adding a proton to the acid.
   C. adding an electron to the acid.
   D. removing a proton from the acid.

8. The conjugage acid of $C_6H_5NH_2$ is
   A. $C_6H_5NH^-$
   B. $C_6H_5NH_3^+$
   C. $C_6H_5NH_3$
   D. $C_6H_5NH_2^+$

9. The conjugage base of HBO_3^{-2} is
   A. $H_2BO_3^{-2}$
   B. $H_2BO_3^-$
   C. BO_3^{-3}
   D. BO_3^{-2}

10. What is the conjugate base of $H_2PO_4^-$?
   A. H_3PO_4
   B. HPO_4^{-2}
   C. OH^-
   D. PO_4^{-3}

11. What is the conjugate acid of HPO_4^{-2}?
   A. H_3PO_4
   B. H_3O^+
   C. PO_4^{-3}
   D. $H_2PO_4^-$

12. Identify a conjugate pair from the equilibrium provided:

$$PO_4^{-3} + HCO_3^- \leftrightarrows HPO_4^{-2} + CO_3^{-2}$$

A. HCO_3^- and HPO_4^{-2}
B. CO_3^{-2} and PO_4^{-3}
C. PO_4^{-3} and HCO_3^-
D. PO_4^{-3} and HPO_4^{-2}

13. Consider the following equilibrium:

$$H_2C_2O_4\,(aq) + HPO_4^{-2}\,(aq) \leftrightarrows H_2PO_4^-\,(aq) + HC_2O_4^-\,(aq)$$

In the above equilibrium, a conjugage pair is
A. $H_2C_2O_4$ and $H_2PO_4^-$
B. $HC_2O_4^-$ and HPO_4^{-2}
C. HPO_4^{-2} and $H_2PO_4^-$
D. $HC_2O_4^-$ and $H_2PO_4^-$

14. Consider the following equilibrium:

$$H_2C_2O_4\,(aq) + HPO_4^{-2}\,(aq) \leftrightarrows H_2PO_4^-\,(aq) + HC_2O_4^-\,(aq)$$

In the above equilibrium, the two acids are
A. $HC_2O_4^-$ and $H_2PO_4^-$
B. $HC_2O_4^-$ and HPO_4^{-2}
C. $H_2C_2O_4$ and $H_2PO_4^-$
D. HPO_4^{-2} and $H_2PO_4^-$

15. Consider the following reaction:

$$H_2SO_3 + CH_3NH_2 \leftrightarrows HSO_3^- + CH_3NH_3^+$$

Which of the following describes a conjugate acid-base pair in the equilibrium above?

	Acid	Base
A.	$CH_3NH_3^+$	CH_3NH_2
B.	H_2SO_3	$CH_3NH_3^+$
C.	$CH_3NH_3^+$	HSO_3^-
D.	HSO_3^-	H_2SO_3

16. Consider the following equilibrium:

$$HCO_3^- + H_2PO_4^- \leftrightarrows HPO_4^{-2} + H_2CO_3$$

What are the Bronsted-Lowry acids in this equilibrium?

A. $H_2PO_4^-$ and HPO_4^{-2}
B. $H_2PO_4^-$ and H_2CO_3
C. HCO_3^- and HPO_4^{-2}
D. HCO_3^- and H_2CO_3

17. Consider the following Bronsted-Lowry equilibrium:

$$C_6H_5NH_{2\,(aq)} + H_2O_{\,(l)} \leftrightarrows C_6H_5NH_3^+{}_{(aq)} + OH^-{}_{(aq)}$$

The substances acting as acids and bases from left to right are:

A. base, acid, acid, base
B. acid, base, acid, base
C. acid, base, base, acid
D. base, acid, base, acid

18. In which of the following is HSO_3^- acting as a Bronsted-Lowry acid?

A. $H_2C_2O_4 + HSO_3^- \rightarrow HC_2O_4^- + H_2SO_3$
B. $NH_3 + HSO_3^- \rightarrow NH_4^+ + SO_3^{-2}$
C. $HSO_3^- + H_2O \rightarrow H_2SO_3 + OH^-$
D. $HSO_3^- + HPO_4^{-2} \rightarrow H_2SO_3 + PO_4^{-3}$

19. Select the equation that best represents the reaction of CH_3NH_2 acting as a base with water.

A. $CH_3NH_{2\,(aq)} + H_2O_{\,(l)} \leftrightarrows CH_3^+{}_{(aq)} + NH_{3\,(aq)} + OH^-{}_{(aq)}$
B. $CH_3NH_{2\,(aq)} + H_2O_{\,(l)} \leftrightarrows CH_3NH_3^+{}_{(aq)} + OH^-{}_{(aq)}$
C. $CH_3NH_{2\,(aq)} + H_2O_{\,(l)} \leftrightarrows CH_3NH^-{}_{(aq)} + H_3O^+{}_{(aq)}$
D. $CH_3NH_{2\,(aq)} + H_2O_{\,(l)} \leftrightarrows CH_3NH_2OH^-{}_{(aq)} + H^+{}_{(aq)}$

20. The ion $H_2PO_4^-$ is an amphiprotic anion.

a. Define the term **amphiprotic**.

ability to act as acid + base

b. Write a balanced equation for the reaction when $H_2PO_4^-$ reacts with HCO_3^-.

$H_2PO_4^- + HCO_3^- \rightleftarrows H_2CO_3 + HPO_4^{-2}$

21. The two reactants in an acid/base reaction are $HSO_3^-{}_{(aq)}$ and $SO_4^{-2}{}_{(aq)}$.

a. Write the equation for the above reaction.

$HSO_3^- + SO_4^{-2} \rightleftharpoons SO_3^{-2} + HSO_4^-$

b. Define the term conjugage acid/base pair.

two species that differ by a proton

c. Write the formulas for a conjugate acid/base pair for the above reaction.

HSO_3^- / SO_3^{-2} or SO_4^{-2} / HSO_4^-

22. The two reactants in an acid/base reaction are $HSO_3^-{}_{(aq)}$ and $H_2CO_3{}_{(aq)}$.

a. Write the equation for the above reaction.

$HSO_3^- + H_2CO_3 \rightleftharpoons HCO_3^- + H_2SO_3$

b. Define the term conjugage acid/base pair.

two species that differ by a proton

c. Write the formulas for a conjugate acid/base pair for the above reaction.

HSO_3^- / H_2SO_3 H_2CO_3 / HCO_3^-

23. An solution of $HC_2O_4^{-1}{}_{(aq)}$ turns blue litmus paper red. Write a balanced equation to represent the equilibrium between the $HC_2O_4^{-1}$ and H_2O.

$HC_2O_4^- + H_2O \rightleftharpoons C_2O_4^{-2} + H_3O^+$

24. Which of the following are amphiprotic in aqueous solutions?

I. H_3BO_3
II. $H_2BO_3^-$
III. HBO_3^{-2}
IV. BO_3^{-3}

A. I and II only B. I only C. IV only D. II and III only

25. Which of the following represents the predominant reaction between NH_3 and H_2O?

A. $NH_3 + H_2O \leftrightarrows H_3O^+ + NH_2^-$
B. $NH_3 + H_2O \leftrightarrows NH_4^+ + OH^-$
C. $NH_3 + H_2O \leftrightarrows NH_3O + H_2$
D. $NH_3 + H_2O \leftrightarrows NH_5^{+2} + O^{-2}$

26. Water will act as an acid when it reacts with which of the following:

I. CN^-
II. NH_3
III. $HClO_4$
IV. CH_3COO^-

A. II, III and IV only
B. I, II, and IV only
C. II and III only
D. I and IV only

27. In which of the following reactions is water behaving as a Bronsted-Lowry acid?

A. $NH_4^+ + H_2O \rightarrow NH_3 + H_3O^+$
B. $2H_2O \rightarrow 2H_2 + O_2$
C. $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$
D. $HCl + H_2O \rightarrow H_3O^+ + Cl^-$

28. Water has the greatest tendency to act as an acid with which of the following?

A. $H_2PO_4^-$
B. Cl^-
C. NO_2^-
D. CH_3COO^-

29. Water has the greatest tendency to act as an acid with which of the following?

strongest base

A. $H_2PO_4^-$
B. HCO_3^-
C. $HC_2O_4^-$
D. HSO_3^-

30. Water has the greatest tendency to act as a base with which of the following?

strongest acid

A. HCO_3^-
B. HSO_3^-
C. $HC_2O_4^-$
D. $H_2PO_4^-$

acid base

31. The predominant acid-base reaction between H_2O_2 and H_2O is

A. $H_2O_2 + H_2O \rightarrow H_3O_2^+ + OH^-$
B. $H_2O_2 + H_2O \rightarrow 3OH^- + H^+$
C. $H_2O_2 + H_2O \rightarrow O_2^{-2} + H_2O$
D. $H_2O_2 + H_2O \rightarrow HO_2^- + H_3O^+$

32. Consider the following equilibrium:

$$H_2C_2O_4\,(aq) + HPO_4^{-2}\,(aq) \leftrightarrows H_2PO_4^-\,(aq) + HC_2O_4^-\,(aq)$$

In the above equilibrium, the strongest acid is

A. $H_2PO_4^-$ B. HPO_4^{-2} C. $HC_2O_4^-$ D. $H_2C_2O_4$

33. The strength of the acids HCl, H_2SO_3 and H_3PO_4 from weakest to strongest is

A. $HCl < H_2SO_3 < H_3PO_4$
B. $HCl < H_3PO_4 < H_2SO_3$
C. $H_3PO_4 < H_2SO_3 < HCl$
D. $H_2SO_3 < H_3PO_4 < HCl$

34. The strength of the ions $HC_2O_4^-$, HSO_3^- and $H_2PO_4^-$ from weakest to strongest **acid** is

A. $HC_2O_4^- < HSO_3^- < H_2PO_4^-$
B. $HSO_3^- < H_2PO_4^- < HC_2O_4^-$
C. $H_2PO_4^- < HSO_3^- < HC_2O_4^-$
D. $HC_2O_4^- < H_2PO_4^- < HSO_3^-$

35. Which of the following is the weakest base?

A. F^-
B. IO_3^-
C. HS^-
D. CN^-

36. Which of the following is the weakest acid?
    A. $H_2PO_4^-$
    B. HSO_3^-
    C. $HC_2O_4^-$
    D. HCO_3^-

37. Which of the following is the weakest base?
    A. HSO_3^-
    B. $HC_2O_4^-$
    C. $H_2PO_4^-$
    D. HCO_3^-

38. Aqua regia is a concentrated aqueous solution of HCl and HNO_3. The strongest acid in aqua regia is
    A. HNO_3
    B. HCl
    C. H_2O
    D. H_3O^+

39. Which of the following is the strongest base that can exist in an aqueous solution?
    A. H_3O^+
    B. NH_2^-
    C. PO_4^{-3}
    D. OH^-

40. Which of the following reactions favours the formation of products?
    A. $HCN + HCOO^- \rightleftharpoons HCOOH + CN^-$
    B. $NH_4^+ + C_2O_4^{-2} \rightleftharpoons HC_2O_4^- + NH_3$
    C. $H_2CO_3 + IO_3^- \rightleftharpoons HIO_3 + HCO_3^-$
    D. $HNO_2 + F^- \rightleftharpoons HF + NO_2^-$

41. In which of the following are reactants favoured?
    A. $CH_3COOH + PO_4^{-3} \rightleftharpoons CH_3COO^- + HPO_4^{-2}$
    B. $HNO_2 + CN^- \rightleftharpoons NO_2^- + HCN$
    C. $H_3PO_4 + NH_3 \rightleftharpoons H_2PO_4^- + NH_4^+$
    D. $H_2S + HCO_3^- \rightleftharpoons HS^- + H_2CO_3$

42. Consider the following equilibrium:

$$HF_{(aq)} + HPO_4^{-2}{}_{(aq)} \leftrightarrows F^-_{(aq)} + H_2PO_4^-{}_{(aq)}$$

For the above equilibrium, identify the weaker acid and determine whether reactants or products are favored.

	Weaker Acid	Side favored
A.	$H_2PO_4^-$	reactants
B.	$H_2PO_4^-$	products
C.	HF	reactants
D.	HF	products

43. Consider the following equilibrium:

$$H_2SO_{3\,(aq)} + H_2PO_4^-{}_{(aq)} \leftrightarrows HSO_3^-{}_{(aq)} + H_3PO_{4\,(aq)}$$

For the above equilibrium, identify the stronger acid and determine whether reactants or products are favored.

	Stronger Acid	Side favored
A.	H_2SO_3	products
B.	H_3PO_4	reactants
C.	H_2SO_3	reactants
D.	H_3PO_4	products

44. Consider the following equilibrium:

$$HCO_3^- + H_2PO_4^- \leftrightarrows H_2CO_3 + HPO_4^{-2}$$

Which of the following statements is true?

A. Products are favored because $H_2PO_4^-$ is a stronger acid than HPO_4^{-2}
B. Reactants are favored because H_2CO_3 is a stronger acid than $H_2PO_4^-$
C. Reactants are favored because HCO_3^- is a stronger base than H_2CO_3
D. Products are favored because $H_2PO_4^-$ is a stronger acid than H_2CO_3

45. An acid-base reaction occurs between $H_2PO_4^-$ and $HC_2O_4^-$. Write the equation for the equilibrium that results.

A. $H_2PO_4^- + HC_2O_4^- \leftrightarrows HPO_4^{-2} + C_2O_4^{-2}$
B. $H_2PO_4^- + HC_2O_4^- \leftrightarrows H_3PO_4 + H_2C_2O_4$
C. $H_2PO_4^- + HC_2O_4^- \leftrightarrows HPO_4^{-2} + H_2C_2O_4$
D. $H_2PO_4^- + HC_2O_4^- \leftrightarrows H_3PO_4 + C_2O_4^{-2}$

46. Consider the following equilibrium:

$$H_3AsO_3 + HSeO_3^- \rightleftharpoons H_2AsO_3^- + H_2SeO_3$$

Products are favored in this equilibrium. Which of the following describes the relative strengths of the acids?

	Stronger Acid	Weaker Acid
A.	$H_2AsO_3^-$	$HSeO_3^-$
B.	H_2SeO_3	H_3AsO_3
C.	$HSeO_3^-$	$H_2AsO_3^-$
D.	H_3AsO_3	H_2SeO_3

47. Consider the following acid-base equilibria and their K_{eq}:

(A) $H_2AsO_4^{-1} + HSO_3^- \leftrightarrows HAsO_4^{-2} + H_2SO_3$ $K_{eq} = 4.2 \times 10^{-3}$ ∴ reactants favoured

(B) $HSeO_3^{-1} + H_2AsO_4^{-1} \leftrightarrows HAsO_4^{-2} + H_2SeO_3$ $K_{eq} = 1.2 \times 10^{1}$ ∴ products

(C) $H_3AsO_4 + HSO_3^- \leftrightarrows H_2AsO_4^{-1} + H_2SO_3$ $K_{eq} = 7.9 \times 10^{4}$ ∴ products

a. Write the formula of the weaker acid in equation (A) $H_2SO_3 > H_2AsO_4^-$

b. Write the formula of the weaker acid in equation (B) $H_2AsO_4^- > H_2SeO_3$

c. Write the formula of the weaker acid in equation (C) $H_3AsO_4 > H_2SO_3$

d. List the acids from the equilibria above in order from **weakest acid to strongest acid.**

$H_2SeO_3 < H_2AsO_4^- < H_2SO_3 < H_3AsO_4$

48. An acid-base reaction occurs between HSO_3^- and HCO_3^-

a. Write the equation for the equilibrium that results.

$HSO_3^- + HCO_3^- \rightleftharpoons H_2CO_3 + SO_3^{-2}$

b. Identify one conjugate acid-base pair in the reaction.

HSO_3^- / SO_3^{-2} HCO_3^- / H_2CO_3

c. State whether reactants or products are favored and explain how you arrived at your answer.

reactants favoured

because $H_2CO_3 > HSO_3^-$

equilibrium

49. a. Write the equation to represent the reaction that results when $HC_6H_5O_7^{-2}$ ions are mixed with $H_2PO_4^-$ ions.

$HC_6H_5O_7^{-2} + H_2PO_4^- \rightleftharpoons H_3PO_4 + C_6H_5O_7^{-3}$

b. Identify the two bases in the reaction in part a)

$C_6H_5O_7^{-3}$ + HPO_4^{-2}

c. Predict whether the reaction will favour the reactants or products. Justify your answer.

Prediction: reactants favoured

Justification: $H_2C_6H_5O_7^- > H_2PO_4^-$

50. Consider the following equilibrium:

base acid

$HCO_3^- + H_2C_6H_5O_7^- \leftrightarrows$

What are the Bronsted-Lowry acids in this equilibrium?

A. ~~HCO_3^-~~ and ~~$HC_6H_5O_7^{-2}$~~

B. ~~$H_3C_6H_5O_7$~~ and H_2CO_3

C. $H_2C_6H_5O_7^-$ and ~~CO_3^{-2}~~

D. $H_2C_6H_5O_7^-$ and H_2CO_3

51. a. Write an equation to represent the predominant reaction when $HC_2O_4^-$ is mixed with HSO_4^-.

$HC_2O_4^- + HSO_4^- \rightleftharpoons SO_4^{-2} + H_2C_2O_4$

b Identify a conjugate acid-base pair.

$HC_2O_4^- / H_2C_2O_4$ HSO_4^- / SO_4^{-2}

c. Predict whether the equilibrium will favour the formation of reactants or products. Explain.

favours reactants because

$H_2C_2O_4 > HSO_4^-$

equilibrium

52. a. Write an equation to represent the predominant reaction when $H_2C_6H_5O_7^-$ is mixed with $HC_2O_4^-$.

$H_2C_6H_5O_7^- + HC_2O_4^- \rightleftharpoons C_2O_4^{-2} + H_3C_6H_5O_7$

b. Identify a conjugate acid-base pair.

$H_2C_6H_5O_7^- / H_3C_6H_5O_7$ or $HC_2O_4^- / C_2O_4^{-2}$

c. Predict whether the equilibrium will favour the formation of reactants or products.

reactants

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53. Which of the following relationships is used to calculate K_w at 30°C?

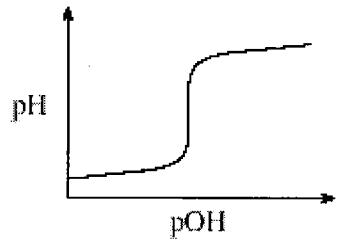
A. $K_w = [H_3O^+] + [OH^-]$
B. $K_w = pH + pOH$
C. $K_w = -\log [H_3O^+]$
D. $K_w = [H_3O^+]\,[OH^-]$

54. When the $[H_3O^+]$ in a solution is increased to twice the original concentration, the change in pH could be from

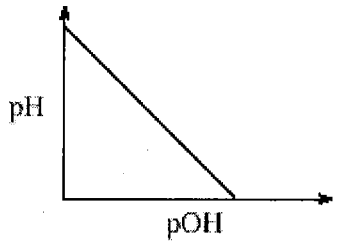
A. 8.5 to 6.5 → 3×10^{-9} to 3×10^{-7}
B. 5.0 to 2.5 1×10^{-5} to 3×10^{-3}
C. 2.0 to 4.0 1×10^{-2} to 1×10^{-4}
D. 1.7 to 1.4 2×10^{-2} to 4×10^{-2}

55. Which of the following graphs describes the relationship between pH and pOH in pure water?

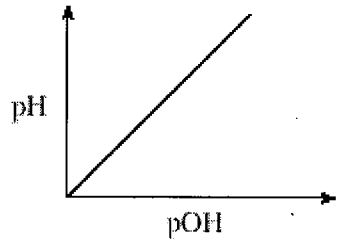
A.



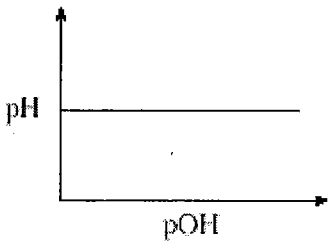
B.



C.

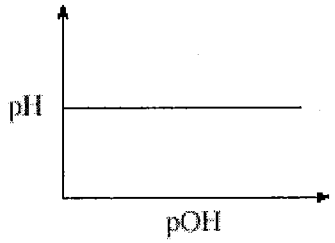


D.

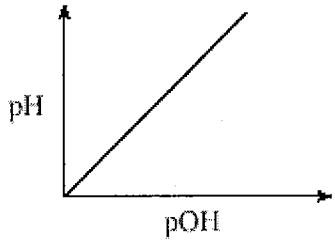


56. Which of the following graphs describes the relationship between pH and pOH in an aqueous solution?

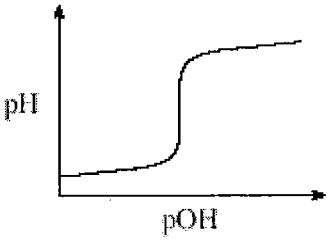
A.



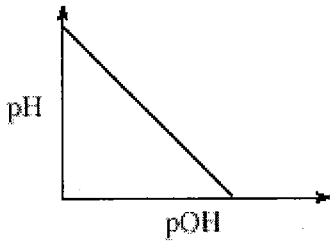
B.



C.



D.



57. What is the $[Sr(OH)_2]$ in a solution with the pH = 11.00?

A. 1.0×10^{-3} M
B. 2.0×10^{-11} M
C. 5.0×10^{-4} M
D. 1.0×10^{-11} M

so pOH = 3.00 $[OH^-] = 1.0 \times 10^{-3}$ M

$Sr(OH)_2 \rightarrow Sr^{+2} + 2OH^-$

5.0×10^{-4} 1.0×10^{-3}

58. What is the pH of a 0.10 M $Sr(OH)_2$ solution?

A. 0.70
B. 13.30
C. 1.00
D. 13.00

$Sr(OH)_2 \xrightarrow{100\%} Sr^{+2} + 2OH^-$

.10 .20

59. What is the pOH of a solution prepared by adding 0.50 moles of NaOH to 0.50 L of water?

A. 13.70
B. 0.00
C. 0.30
D. 14.00

$\frac{0.50 \text{ moles } OH^-}{.50 \text{ L}} = 1.00$ M

0.20 M

$[H_3O^+] \times [OH^-] = 1.00 \times 10^{-14}$

$-\log$ 10^{-pH} 10^{-pOH}

$pH + pOH = (14.00)$

60. The pH of 0.10 M HNO_3 is
   A. 13.00
   B. 0.79
   C. 1.00
   D. 1.26

61. How many moles of HI are needed to prepare 3.0 L of an HI solution with a pH of 1.00?
   A. 30. mol
   B. 0.030 mol
   C. 3.0 mol
   D. 0.30 mol

pH = 1.00 so $[H_3O^+] = 1.0 \times 10^{-1}$ M

$\frac{1.0 \times 10^{-1} \text{ mole}}{\text{L}} \times 3.0\text{L} = 3.0 \times 10^{-1}$ moles

62. Calculate the pOH of a 0.050 M HBr solution.
   A. 13.70
   B. 0.30
   C. 1.30
   D. 12.70

$[H_3O^+] = .050$ M

$[OH^-] = 2.0 \times 10^{-13}$ M pOH =

63. What is the pH of a 0.50 M NaOH solution?
   A. 13.70
   B. 0.30
   C. 12.70
   D. 1.30

64. What is the pH of a 0.0050 M $Sr(OH)_2$ solution?
   A. 12.00
   B. 12.70
   C. 2.30
   D. 2.00

$Sr(OH)_2 \rightarrow Sr^{+2} + 2OH^-$

.0050 → .010M

65. Which of the following equations can be used to calculate pOH?
   A. pOH = $-\log[H_3O^+]$
   B. pOH = $-\log Kw$
   C. pOH = pKw - pH
   D. pOH = pKw + pH

66. What is the pOH of 0.05 M $Sr(OH)_2$?
   A. 1.0
   B. 13.0
   C. 1.3
   D. 12.7

67. Complete the following table:

$[H_3O^+]$	$[OH^-]$	pH	pOH
5×10^{-4} M	2×10^{-11} M	3.3	10.7
4×10^{-13} M	3×10^{-2}	12.4	1.6
1.21×10^{-7} M	8.25×10^{-8} M	6.916	7.084
2.34×10^{-4} M	4.28×10^{-4} M	3.631	10.369

68. Calculate the pH of a saturated solution of $Mg(OH)_2$.

$Mg(OH)_{2(s)} \rightleftharpoons Mg^{+2} + 2OH^-$

$K_{sp} = [Mg^{+2}][OH^-]^2$

$4s^3 = 5.6 \times 10^{-12}$

$s^3 = 1.4 \times 10^{-12}$

$s = 1.1186... \times 10^{-4}$

$\therefore [OH^-] = 2.2373 \times 10^{-4}$ M

$pOH = 3.65$

$pH = 10.35$

69. Calculate the pH of 0.025 M $Sr(OH)_2$.

$Sr(OH)_2 \rightarrow Sr^{+2} + 2OH^-$

.025 .050

$pOH = 1.3010$

$pH = 12.70$

70. In order to change the pH of a solution from 2.0 to 4.0 the $[H_3O^+]$ must

A. decrease by a factor of 100
B. increase by a factor of 2
C. decrease by a factor of 2
D. increase by a factor of 100

71. What is the $[H_3O^+]$ in a solution with a pOH = 5.20?

A. 7.1×10^{-1} M
B. 1.4×10^{-14} M
C. 6.3×10^{-6} M
D. 1.6×10^{-9} M

pH = 8.80

72. Which of the following 1.0×10^{-3} M solutions has a pH of 3.00?

A. K_2SO_4
B. HCN
C. HCl
D. NaOH

$[H^+] = 1.0 \times 10^{-3}$ M
∴ must be strong acid

73. What is the pOH of 0.2 M HNO_3?

A. 13.3
B. 5×10^{-14}
C. 0.2
D. 0.7

pH = .7
∴ pOH = 13.3

74. A sample of pure NaOH (s) is dissolved in water to make 10.0 L of solution and a pH = 11.75 results. Calculate the mass of pure NaOH that was dissolved.

if pH = 11.75 then pOH = 2.25
∴ $[OH^-] = 5.6234 \times 10^{-3}$ M

$$10.0\ L \times \frac{5.6234 \times 10^{-3}\ \text{moles of } OH^-}{L} \times \frac{1\ \text{mole NaOH}}{1\ \text{mole } OH^-} \times \frac{40.0\ g\ \text{NaOH}}{1\ \text{mole NaOH}}$$

$= 2.2493653$ g of NaOH

$= 2.2$ g

75. Which of the following solutions will have the lowest [OH-]?

weakest base or strongest acid

A. NaCl
B. NaF
C. NaH_2PO_4
D. $NaHCO_3$

76. Consider the following statements about water at 60°C:

I. The pH of water at 60°C < 7.00 ✓
II The pOH of water at 60°C >7.00 ✗
III. The pH = pOH of water at 60°C. ✓

Which of the above statements are true?

A. III only B. I and II C. I and III D. I, II and III

77. Which of the following is a definition of pK_w?

A. $pK_w = [H_3O^+][OH^-]$
B. $pK_w = pH - pOH$
C. $pK_w = -\log K_w$
D. $pK_w = 7.0$ at 25° C

78. What is the value of pK_w for water at 25°C?

A. 7.00
B. 1.0×10^{-14}
C. 1.0×10^{-7}
D. 14.00

79. Consider the following equilibrium at 25 °C:

$$2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

What happens to $[OH^-]$ and pH as 0.1 M HCl is added?

	$[OH^-]$	pH
A.	increases	decreases
B.	decreases	increases
C.	decreases	decreases
D.	increases	increases

80. Consider the following equilibrium:

$$2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

What changes occur to $[H_3O^+]$ and pH when NaOH is added?

	$[H_3O^+]$	pH
A.	decreases	decreases
B.	increases	increases
C.	increases	decreases
D.	decreases	increases

81. What happens to the ion concentrations in water when a small amount of $HCl_{(aq)}$ is added?

A. $[H_3O^+]$ increases and $[OH^-]$ stays unchanged
B. $[H_3O^+]$ increases and $[OH^-]$ decreases
C. $[H_3O^+]$ and $[OH^-]$ both increase
D. $[H_3O^+] = [OH^-] = 1.0 \times 10^{-7}$ M

82. Consider the ionization of water:

$$2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

What happens to the pH when 0.1 M NaOH is added to the water?

A. pH decreases since $[H_3O^+]$ decreases
B. pH increases since $[H_3O^+]$ decreases
C. pH increases since $[H_3O^+]$ increases
D. pH decreases since $[H_3O^+]$ increases

83. In a solution of 0.10 M H_2SO_4, the ions present in order of decreasing concentration are

A. $[H_3O^+] > [HSO_4^-] > [SO_4^{-2}] > [OH^-]$
B. $[SO_4^{-2}] > [HSO_4^-] > [OH^-] > [H_3O^+]$
C. $[H_3O^+] > [SO_4^{-2}] > [HSO_4^{-2}] > [OH^-]$
D. $[OH^-] > [HSO_4^-] > [SO_4^{-2}] > [H_3O^+]$

84. Consider the following equilibrium:

$$2H_2O_{(l)} + \text{energy} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

The temperature is decreased and a new equilibrium is established. The new equilibrium can be described by

A. pH < pOH and $K_w = 1.0 \times 10^{-14}$
B. pH > pOH and $K_w = 1.0 \times 10^{-14}$
C. pH = pOH and $K_w < 1.0 \times 10^{-14}$
D. pH = pOH and $K_w > 1.0 \times 10^{-14}$

85. Consider the following equilibrium:

pH ↓ pOH ↑

$$2H_2O_{(l)} + \text{energy} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

A few drops of HCl are added and a new equilibrium is established. The new equilibrium can be described by

A. pH < pOH and $K_w = 1.0 \times 10^{-14}$
B. pH = pOH and $K_w \neq 1.0 \times 10^{-14}$
C. pH = pOH and $K_w \neq 1.0 \times 10^{-14}$
D. pH > pOH and $K_w = 1.0 \times 10^{-14}$

86. Which of the following is true for pure water?

A. $[H_3O^+] < [OH^-]$
B. $[H_3O^+] > [OH^-]$
C. $[H_3O^+] = [OH^-]$
D. $[H_3O^+] = 0.0\ M$

87. Which of the following is true for pure water at 5° C in which the pH = 7.53?

A. $[H_3O^+] < [OH^-]$
B. $[H_3O^+] = K_w$
C. $[H_3O^+] = [OH^-]$
D. $[H_3O^+] > [OH^-]$

88. Which of the following is true for pure water at 75° C in which the pH = 6.83?

A. $[H_3O^+] < [OH^-]$
B. $[H_3O^+] > [OH^-]$
C. $[H_3O^+] = [OH^-]$
D. $[H_3O^+] = K_w$

89. Which of the following statements is true for an acidic solution at 25°C?

A. $[H_3O^+] > [OH^-]$
B. pH > 7.0
C. pOH < 7.0
D. $[H_3O^+] < [OH^-]$

90. Consider the following equilibrium:

$$2H_2O_{(l)} + \text{energy} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

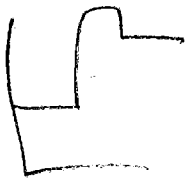
The [OH^-] will decrease and the K_w will decrease when

A. the temperature is decreased
B. the temperature is increased
C. a strong base is added
D. a strong acid is added

temp ↓

91. The ionization of water is endothermic. How is K_w related to the temperature of water?

A. K_w remains constant as temperature decreases.
B. K_w increases as temperature decreases.
C. K_w decreases as temperature increases.
D. K_w increases as temperature increases.



92. The ionization of pure water is shown by the reaction:

$$2H_2O_{(l)} + 57.1\ kJ \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

At a certain temperature the K_w of the water is 4.6×10^{-15}.

a. Is the temperature above or below 25°C? Explain your answer using the words exothermic or endothermic and Le Chatelier's Principle.

temp < 25°C since forward reaction is endothermic only temp ↓ will cause shift ← which is needed to $[H_3O^+]$↓ and $[OH^-]$↑

b. Calculate the pH and pOH of this water

$pK_w = 14.3372$

$pH = pOH = 7.1686 \approx 7.17$

c. Is the water acidic, basic or neutral? Explain your answer.

neutral because

$[H_3O^+] = [OH^-]$

93. The ionization of pure water is shown by the reaction:

$$2H_2O_{(l)} + 57.1\ kJ \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

At a certain temperature the pH of the water is 7.27.

a. Is the temperature above or below 25°C? Explain your answer using the words exothermic or endothermic and Le Chatelier's Principle.

below 25 °C if pH = 7.27 $[H_3O^+] = [OH^-] = 5.4 \times 10^{-8}$

and $K_w = 2.9 \times 10^{-15}$

b. Is the water acidic, basic or neutral? Explain your answer.

neutral because pH = pOH

c. Calculate the K_w of water at this temperature.

2.9×10^{-15}

94. Consider the following equilibrium:

$$\text{energy} + 2H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + OH^-_{(aq)}$$

a. Explain how pure water can have a pH = 6.80.

if temp > 25°C

b. Calculate the value of K_w for the sample of water with a pH of 6.80.

$pK_w = 13.60$

$K_w = 2.5 \times 10^{-14}$

95. At 10°C, the pH of pure water is 7.265.

a. Determine the pOH of water at 10°C.

pOH = 7.265

b. Calculate Kw of pure water at 10°C.

pKw = 14.530

$K_w = 2.95 \times 10^{-15}$

---

96. The relationship $\frac{[H_2P_2O_7^{-2}][H_3O^+]}{[H_3P_2O_7^-]}$ is the — Ka

> acid

A. ~~K_b~~ for ~~$H_2P_2O_7^{-2}$~~

B. K_a for $H_3P_2O_7^-$

C. ~~K_b~~ for $H_3P_2O_7^-$

D. K_a for ~~$H_2P_2O_7^{-2}$~~

97. The relationship $\frac{[H_3BO_3][OH^-]}{[H_2BO_3^-]}$ is the expression for — Kb

> base

A. ~~K_a~~ for ~~H_3BO_3~~

B. K_b for $H_2BO_3^-$

C. K_b for ~~H_3BO_3~~

D. ~~K_a~~ for $H_2BO_3^-$

> acid

98. The K_a expression for HTe^- is

A. $K_a = \frac{[HTe^-][OH^-]}{[Te^{-2}]}$ — on bottom

B. $K_a = \frac{[Te^{-2}][H_3O^+]}{[HTe^-]}$

C. $K_a = \frac{[H_2Te][OH^-]}{[HTe^-]}$

D. $K_a = \frac{[HTe^-][H_3O^+]}{[H_2Te]}$

base

99. The K_b expression for HSe^- is

A. $K_b = \frac{[Se^{-2}][H_3O^+]}{[HSe^-]}$ bottom

B. $K_b = \frac{[HSe^-][H_3O^+]}{[H_2Se]}$

C. $K_b = \frac{[HSe^-][OH^-]}{[Se^{-2}]}$

D. $K_b = \frac{[H_2Se][OH^-]}{[HSe^-]}$

100. Consider the following acid equilibrium:

$$HCN_{(aq)} + H_2O_{(l)} \leftrightarrows H_3O^+_{(aq)} + CN^-_{(aq)}$$

When writing the K_a expression for HCN, why is $H_2O_{(l)}$ not included in the expression?

A. The concentration of $H_2O_{(l)}$ is relatively constant.

B. The concentration of $H_2O_{(l)}$ is too large.

C. The concentration of $H_2O_{(l)}$ is too small.

D. The concentration of $H_2O_{(l)}$ does not exist.

101. What is the K_a expression for H_3PO_4?

A. $K_a = \frac{[H_3O^+][H_2PO_4^-]}{[H_3PO_4]}$

B. $K_a = \frac{[PO_4^{-3}]}{[H^+]^3}$

C. $K_a = \frac{[H_3O^+][PO_4^{-3}]}{[H_3PO_4]}$

D. $K_a = \frac{[H_3O^+]^3[PO_4^{-3}]}{[H_3PO_4]}$

102. Which of the following 1.0 M solutions will have the highest pOH?

∴ strongest acid

A. HCN

B. H_3PO_4

C. $H_2C_2O_4$

D. HCl

103. Which of the following 1.0 M solutions will have the lowest pH?

strongest acid

A. H_2CO_3

B. H_3PO_4

C. HCN

D. $HClO_4$

104. Which of the following will be the most basic?

A. 1.0 M NO_3^-
B. 1.0 M PO_4^{-3}
C. 1.0 M SO_4^{-2}
D. 1.0 M CO_3^{-2}

105. Which of the following will be the most acidic?

A. 1.0 M NO_2^-
B. 1.0 M SO_4^{-2}
C. 1.0 M SO_3^{-2}
D. 1.0 M CO_3^{-2}

least basic

106. Which of the following Ka values represents the acid with the strongest conjugate base?

A. $K_a = 7.8 \times 10^{-3}$
B. $K_a = 4.2 \times 10^{-12}$
C. $K_a = 9.5 \times 10^{-9}$
D. $K_a = 2.0 \times 10^{-5}$

so weakest acid

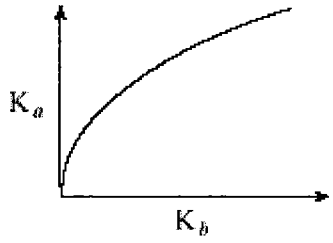
107. Which of the following will have the smallest K_b value?

A. HPO_4^{-2}
B. IO_3^-
C. NH_3
D. CN^-

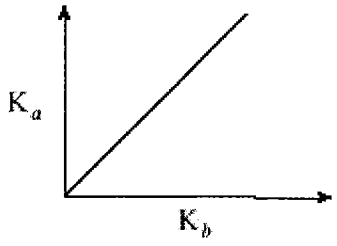
conjugate strongest acid

108. Which of the following graphs describes the relationship between K_a and K_b for all conjugage pairs?

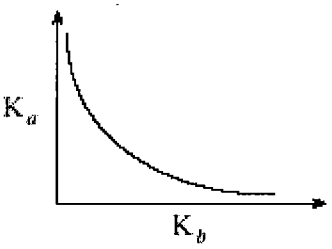
A.



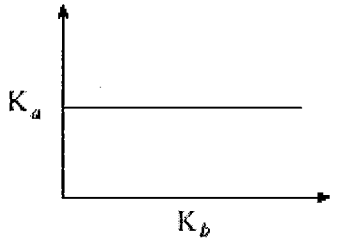
B.



C.



D.



109. What is the value of K_b for $HC_2O_4^-$?

A. 1.7×10^{-13}
B. 5.9×10^{-2}
C. 1.6×10^{-10}
D. 6.4×10^{-5}

base

$\frac{1.0 \times 10^{-14}}{5.9 \times 10^{-2}} = 1.694 \times 10^{-13}$

base acid

$HC_2O_4^- + H_2O \rightleftharpoons H_2C_2O_4 + OH^-$

110. What is the value of K_b for $HC_6H_5O_7^{-2}$?

A. 5.9×10^{-10}
B. 1.7×10^{-5} Ka of
C. 4.1×10^{-7} Ka of
D. 2.1×10^{-8} Kb of

K_b $\frac{1.0 \times 10^{-14}}{1.7 \times 10^{-5}} = 5.9 \times 10^{-10}$

base acid

$HC_6H_5O_7^{-2} + H_2O \rightleftharpoons H_2C_6H_5O_7^- + OH^-$

111. What is the value of K_b for $H_2C_6H_5O_7^-$?

A. 1.4×10^{-11}
B. 7.1×10^{-4} ka
C. 5.9×10^{-10} Kb
D. 1.7×10^{-5} kb

$K_b = \frac{1.0 \times 10^{-14}}{7.1 \times 10^{-4}} =$

$H_2C_6H_5O_7^- + H_2O \rightleftharpoons H_3C_6H_5O_7 + OH^-$

112. What is the K_b value for $H_2PO_4^-$?

A. 7.5×10^{-3} Ka
B. 1.6×10^{-7} Kb
C. 6.2×10^{-8} Ka
D. 1.3×10^{-12}

$K_b = \frac{1.0 \times 10^{-14}}{7.5 \times 10^{-3}} = 1.33 \times 10^{-12}$

113. What is the K_b value for HPO_4^{-2}?

A. 1.6×10^{-7}
B. 6.2×10^{-8} Ka
C. 7.5×10^{-3} Ka
D. 1.3×10^{-12} kb

$K_b = \frac{1.0 \times 10^{-14}}{6.2 \times 10^{-8}} = 1.6 \times 10^{-7}$

$HPO_4^{-2} + H_2O \rightleftharpoons H_2PO_4^- + OH^-$

basic character 11.46 Should be 2.4×10^{-11}

114. A 0.0200 M solution of methylamine, CH_3NH_2, has a pH = 11.40. Calculate the K_b for methylamine.

$CH_3NH_2 + H_2O \rightleftharpoons CH_3NH_3^+ + OH^-$

.0200		0	0
$-x$		$+x$	$+x$
$.0200 - 2.51\times10^{-3}$		$2.51..\times10^{-3}$	$2.51..\times10^{-3}$

pH = 11.40

pOH = 2.60

$[OH^-] = x = 2.512\times10^{-3}$

$$K_b = \frac{[CH_3NH_3^+][OH^-]}{[CH_3NH_2]} = \frac{(2.51188\times10^{-3})^2}{(.0200 - 2.51188\times10^{-3})}$$

$= 3.6079\times10^{-4}$

$= 3.6\times10^{-4}$

115. A 0.20 M solution of a weak acid HA has a pH = 1.32. Use calcaulations and the table of "Relative Strengths of Bronsted-Lowry Acids and Bases" from the Data Booklet to determine the identity of the acid.

$HA + H_2O \rightleftharpoons A^- + H_3O^+$

.20		0	0
$-x$		$+x$	$+x$
$.20 - .047863$		.047863	.047863

pH = 1.32

$[H_3O^+] = x = .047863$

$$K_a = \frac{[A^-][H_3O^+]}{[HA]} = \frac{(.047863)^2}{(.20 - .047863)} = .0150579$$

$K_a = 1.5\times10^{-2}$

∴ HA is H_2SO_3

Comment on how high it is on pg 6

but % = 24%.

if pH > 2.00 dissociation < 5%. or $K_a < 5.3 \times 10^{-4}$

116. A 0.20 M solution of a weak acid HA has a pH = 3.87. Use calcaulations and the table of "Relative Strengths of Bronsted-Lowry Acids and Bases" from the Data Booklet to determine the identity of the acid.

$HA + H_2O \rightleftharpoons A^- + H_3O^+$

.20		0	0
$-x$		$+x$	$+x$
$(.20 - 1.35\times10^{-4}\,M)$		$1.35\times10^{-4}\,M$	$1.35\times10^{-4}\,M$

pH = 3.87

$[H_3O^+] = x = 1.35 \times 10^{-4}\,M$

$$K_a = \frac{[A^-][H_3O^+]}{[HA]} = \frac{(1.34896\times10^{-4})^2}{(.20 - 1.34896\times10^{-4})}$$

$$= 9.1046\times10^{-8} = 9.1\times10^{-8}$$

Comment on dissociation

∴ HA is H_2S

117. A 0.20 M solution of a weak base NaX has a pH = 8.744. Use calcaulations and the table of "Relative Strengths of Bronsted-Lowry Acids and Bases" from the Data Booklet to determine the identity of the NaX.

$X^- + H_2O \rightleftharpoons HX + OH^-$

.20		0	0
$-x$		$+x$	$+x$
$.20 - 5.5\times10^{-6}$		5.5×10^{-6}	5.5×10^{-6}

pH = 8.744

pOH = 5.256

∴ $[OH^-] = x = 5.546257\times10^{-6}\,M$

$$K_b = \frac{[HX][OH^-]}{[X^-]} = \frac{(5.546257\times10^{-6})^2}{(.20 - 5.546257\times10^{-6})}$$

$$= 1.538\times10^{-10}$$

∴ $K_a = 6.5\times10^{-5}$ ∴ HX is C_6H_5COOH

∴ X^- is $C_6H_5COO^-$

sodium benzoate (preservative)

118. A 2.00 M diprotic acid has a pH of 0.50. Calculate its K_a value.

$H_2A + H_2O \rightleftharpoons HA^- + H_3O^+$

2.00		0	0
$-x$		$+x$	$+x$
$2.00 - .316$		.316	.316

$pH = .50$

$[H_3O^+] = x = .316227$

$$K_a = \frac{[HA][H_3O^+]}{[H_2A]} = \frac{(.316227)^2}{(2.00 - .316227)} = .05939$$

$= .059$

$(H_2C_2O_4)$

119. A 0.360 M diprotic acid has a pH of 4.50. Calculate its K_a value.

$H_2A + H_2O \rightleftharpoons HA^- + H_3O^+$

.360		0	0
$-x$		$+x$	$+x$
$.360 - 3.16 \times 10^{-5}$		3.16×10^{-5}	3.16227×10^{-5}

$pH = 4.50$

$[H_3O^+] = x = 3.16227 \times 10^{-5}$

$$K_a = \frac{[HA][H_3O^+]}{[H_2A]} = \frac{(3.16227 \times 10^{-5})^2}{(.360 - 3.16227 \times 10^{-5})} = 2.8 \times 10^{-9}$$

120. A 0.875 M solution of an unknown base has a pH of 8.16. Calculate the K_b of the weak base.

$A^- + H_2O \rightleftharpoons HA + OH^-$

.875		0	0
$-x$		$+x$	$+x$
$.875 - 1.445 \times 10^{-6}$		1.445×10^{-6}	1.445×10^{-6}

$pH = 8.16 \quad pOH = 5.84$

$[OH^-] = 1.445 \times 10^{-6}$

$$K_b = \frac{[HA][OH^-]}{[A^-]}$$

$$K_b = \frac{(1.445 \times 10^{-6})^2}{(.875 - 1.445 \times 10^{-6})}$$

$= 2.38797 \times 10^{-12}$

$= 2.4 \times 10^{-12}$

121. A unknown solution has a concentration of 0.560 M has a pH of 5.44. Calculate the unknown solution's K_a or K_b.

acid

	$HA + H_2O \rightleftarrows A^- + H_3O^+$		
	.560	0	0
	$-x$	$+x$	$+x$
	$.560 - 3.63\times10^{-6}$	$3.63\times10^{-6}M$	$3.63\times10^{-6}M$

$pH = 5.44$

$[H_3O^+] = 3.63\times10^{-6}M$

$$K_a = \frac{[A^-][H_3O^+]}{[HA]} = \frac{(3.63\times10^{-6})^2}{(.560 - 3.63\times10^{-6})}$$

$$= 2.354\times10^{-11}$$

$$= 2.4\times10^{-11}$$

122. Which of the following is the net ionic equation describing the hydrolysis of KCN?

A. $CN^-_{(aq)} + H_2O_{(l)} \leftrightarrows HCN_{(aq)} + OH^-_{(aq)}$

B. $K^+_{(aq)} + H_2O_{(l)} \leftrightarrows KOH_{(aq)} + H^+_{(aq)}$

C. $KCN_{(aq)} + H_2O_{(l)} \leftrightarrows K^+_{(aq)} + CN^-_{(aq)}$

D. $CN^-_{(aq)} + H_2O_{(l)} \leftrightarrows 2H^+_{(aq)} + CNO^-_{(aq)}$

123. Which of the following is the net ionic equation describing the hydrolysis of KHC_2O_4?

A. $HC_2O_4^-_{(aq)} + H_2O \leftrightarrows C_2O_4^{-2}_{(aq)} + H_3O^+_{(aq)}$

B. $KHC_2O_4{}_{(aq)} + H_2O_{(l)} \leftrightarrows H_2C_2O_4{}_{(aq)} + KOH_{(aq)}$

C. $KHC_2O_4{}_{(aq)} + H_2O_{(l)} \leftrightarrows KC_2O_4^-{}_{(aq)} + H_3O^+_{(aq)}$

D. $HC_2O_4^-{}_{(aq)} + H_2O_{(l)} \leftrightarrows H_2C_2O_4{}_{(aq)} + OH^-_{(aq)}$

$K_a = 6.4\times10^{-5}$

$K_b = 1.7\times10^{-13}$

124. Which of the following represents the equilibrium constant expression for the hydrolysis reaction that occurs in $NaF_{(aq)}$?

A. $K_w = [H_3O^+][OH^-]$

B. $K_a = \dfrac{[H_3O^+][F^-]}{[HF]}$

C. $K_b = \dfrac{[HF][OH^-]}{[F^-]}$

D. $K_{eq} = \dfrac{[Na^+][F^-]}{[NaF]}$

125. Which of the following represents the equilibrium constant expression for the hydrolysis reaction that occurs in $NH_4NO_{3(aq)}$?

A. $K_b = \dfrac{[NH_3][OH^-]}{[NH_4^+]}$

B. $K_{eq} = \dfrac{[NH_4^+][NO_3^-]}{[NH_4NO_3]}$

C. $K_b = \dfrac{[HNO_3][OH^-]}{[NO_3^-]}$

D. $K_a = \dfrac{[H_3O^+][NH_3]}{[NH_4^+]}$

126. Which of the following describes the net ionic equation for the hydrolysis of a $NaNO_2$ solution?

A. $NaNO_{2\,(s)} + H_2O_{\,(l)} \leftrightarrows NaOH + HNO_{2\,(aq)}$

B. $NO_2^-{}_{(aq)} + H_2O_{\,(l)} \leftrightarrows HNO_{2\,(aq)} + OH^-{}_{(aq)}$

C. $NaNO_{2\,(s)} \leftrightarrows Na^+{}_{(aq)} + NO_2^-{}_{(aq)}$

D. $Na^+{}_{(aq)} + 2H_2O\,(l) \leftrightarrows H_3O^+{}_{(aq)} + NaOH_{\,(aq)}$

127. Which of the following describes the net ionic equation for the hydrolysis of a $NaCH_3COO$ solution?

A. $Na^+{}_{(aq)} + 2H_2O\,(l) \leftrightarrows H_3O^+{}_{(aq)} + NaOH_{\,(aq)}$

B. $CH_3COO^-{}_{(aq)} + H_2O_{\,(l)} \leftrightarrows HCH_3COO_{\,(aq)} + OH^-{}_{(aq)}$

C. $NaCH_3COO_{\,(s)} + H_2O_{\,(l)} \leftrightarrows NaOH + HCH_3COO_{\,(aq)}$

D. $NaCH_3COO_{\,(s)} \leftrightarrows Na^+{}_{(aq)} + CH_3COO^-{}_{(aq)}$

128. What is the equilibrium expression for the predominant equilibrium in HCO_3^- (aq) ?

A. $K_b = \frac{[HCO_3^-]}{[H_2CO_3]\,[OH^-]}$

B. $K_a = \frac{[H_3O^+]\,[CO_3^{-2}]}{[HCO_3^-]}$

C. $K_b = \frac{[H_2CO_3]\,[OH^-]}{[HCO_3^-]}$

D. $K_a = \frac{[HCO_3^-]}{[H_3O^+]\,[CO_3^{-2}]}$

$K_a = 5.6 \times 10^{-11}$

$K_b = \frac{1.0 \times 10^{-14}}{4.3 \times 10^{-7}} = 2.3 \times 10^{-8}$

129. Consider the following reaction:

$$NO_2^-_{(aq)} + H_2O_{(l)} \leftrightarrows HNO_{2\,(aq)} + OH^-_{(aq)}$$

This reaction represents which of the following?

A. the dissociation of $NaNO_2$

B. the titration of NO_2^-

C. the ionization of HNO_2

D. the hydrolysis of $NaNO_2$

130. Which of the following is the net ionic equation that describes the hydrolysis that occurs in a K_2CO_3 solution?

A. $K_2CO_{3\,(aq)} + 2H_2O_{(l)} \leftrightarrows H_2CO_{3\,(aq)} + 2\,KOH_{(aq)}$

B. $K_2CO_{3\,(aq)} + 2H_2O_{(l)} \leftrightarrows H_2CO_{3\,(aq)} + 2\,K^+_{(aq)} + 2\,OH^-_{(aq)}$

C. $CO_3^{-2}{}_{(aq)} + H_2O_{(l)} \leftrightarrows HCO_3^-{}_{(aq)} + OH^-_{(aq)}$

D. $CO_3^{-2}{}_{(aq)} + 2H_2O_{(l)} \leftrightarrows H_2CO_{3\,(aq)} + H_3O^+_{(aq)}$

131. Which of the following salt solutions is acidic?

A. $NaHCO_3$ — $K_b > K_a$

B. KBr — neutral

C. $K_2C_2O_4$ — K_b

D. $FeCl_3$ — K_a

132. For each of the following salts:
- write out all hydrolysis equilibria that the salts would participate in
- calculate the appropriate K_a or K_b for each hydrolysis
- predict whether the solution will be acidic, basic or neutral

a. $Fe(NO_3)_3 \rightarrow Fe^{+3} + 3NO_3^-$

$Fe(H_2O)_6^{+3} + H_2O \rightleftharpoons Fe(H_2O)_5OH^{+2} + H_3O^+$ $\quad K_a = 6.0 \times 10^{-3}$

cationic hydrolysis acidic solution

b. $NaNO_2 \rightarrow Na^+ + NO_2^-$

$NO_2^- + H_2O \rightleftharpoons HNO_2 + OH^-$ $\quad K_b = \frac{1.0 \times 10^{-14}}{4.6 \times 10^{-4}} = 2.2 \times 10^{-11}$

cationic hydrolysis basic solution

c. $Ca(HC_2O_4)_2 \rightarrow Ca^{+2} + 2HC_2O_4^-$

amphiprotic hydrolysis

$HC_2O_4^- + H_2O \rightleftharpoons H_2C_2O_4 + OH^-$ $\quad K_b = \frac{1.0 \times 10^{-14}}{5.9 \times 10^{-2}} = 1.7 \times 10^{-13}$

$HC_2O_4^- + H_2O \rightleftharpoons C_2O_4^{-2} + H_3O^+$ $\quad K_a = 6.4 \times 10^{-5}$

∴ acidic because $K_a > K_b$

d. $NH_4IO_3 \rightarrow NH_4^+ + IO_3^-$

both

$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$ $\quad K_a = 5.6 \times 10^{-10}$

$IO_3^- + H_2O \rightleftharpoons HIO_3 + OH^-$ $\quad K_b = \frac{1.0 \times 10^{-14}}{1.7 \times 10^{-1}} = 5.9 \times 10^{-14}$

∴ acidic because $K_a > K_b$

133. For each of the following salts:
- write out all hydrolysis equilibria that the salts would participate in
- calculate the appropriate K_a or K_b for each hydrolysis
- predict whether the solution will be acidic, basic or neutral

a. $AlBr_3 \rightarrow Al^{+3} + 3Br^-$

cationic hydrolysis $Al(H_2O)_6^{+3} + H_2O \rightleftharpoons Al(H_2O)_5OH^{+2} + H_3O^+$ $K_a = 1.4 \times 10^{-5}$

∴ acidic solution

b. $K_2SO_3 \rightarrow 2K^+ + SO_3^{-2}$

anionic hydrolysis $SO_3^{-2} + H_2O \rightleftharpoons HSO_3^- + OH^-$ $K_b = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-7}} = 1.0 \times 10^{-7}$

∴ basic solution

c. $Ca(H_2PO_4)_2 \rightarrow Ca^{+2} + 2H_2PO_4^-$

amphiprotic hydrolysis $H_2PO_4^- + H_2O \rightleftharpoons H_3PO_4 + OH^-$ $K_b = \frac{1.0 \times 10^{-14}}{7.5 \times 10^{-3}} = 1.3 \times 10^{-12}$

$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{-2} + H_3O^+$ $K_a = 6.2 \times 10^{-8}$

∴ acidic because $K_a > K_b$

d. $NH_4CN \rightarrow NH_4^+ + CN^-$

both $NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$ $K_a = 5.6 \times 10^{-10}$

$CN^- + H_2O \rightleftharpoons HCN + OH^-$ $K_b = \frac{1.0 \times 10^{-14}}{4.9 \times 10^{-10}} = 2.0 \times 10^{-5}$

∴ basic because $K_a > K_b$

134. Which of the following solutions has a pH less than 7.00? acidic
A. KCH_3COO^- K_b ∴ basic
B. NaCl neutral
C. NH_4NO_3 K_a ∴ acidic
D. KOH strong base

135. Which of the following solutions has a pH less than 7.00? same
A. $LiNO_3$
B. KF^-
C. NH_4Cl
D. $NaCN^-$

136. In a solution of 0.10 M NaCN, the order of ion concentration, from highest to lowest is

A. $[Na^+] > [CN^-] > [OH^-] > [H_3O^+]$
B. $[Na^+] > [OH^-] > [CN^-] > [H_3O^+]$
C. $[OH^-] > [Na^+] > [CN^-] > [H_3O^+]$
D. $[H_3O^+] > [OH^-] > [CN^-] > [Na^+]$

$NaCN \rightarrow Na^+ + CN^-$
.10 .10
$CN^- + H_2O \rightleftharpoons HCN + OH^-$
.10 −.005 .095 .0050 .0050
so $[H_3O^+] = \frac{1.0\times10^{-14}}{.0050} = 2.0\times10^{-12}$

137. Which of the following salts will dissolve to produce a basic solution?

A. NH_4CH_3COO Ka = Kb so neutral
B. $KHSO_4$ Ka only
C. $Al(NO_3)_3$ Ka only
D. NH_4CN Kb > Ka

138. In an aqueous solution of NaCl, the pH is

A. greater than 7 and the solution is acidic
B. less than 7 and the solution is acidic
C. equal to 7 and the solution is neutral
D. greater than 7 and the solution is basic

139. In an aqueous solution of NaCN, the pH is

A. equal to 7 and the solution is neutral
B. greater than 7 and the solution is basic
C. greater than 7 and the solution is acidic
D. less than 7 and the solution is acidic

140. Dissolving $NaCH_3COO$ in water will produce a solution which is

A. acidic with pH < 7
B. acidic with pH > 7
C. basic with pH < 7
D. basic with pH > 7

141. Which of the following salt solutions will be neutral?

A. 1.0 M NH_4Cl
B. 1.0 M $LiClO_4$
C. 1.0 M HNO_2
D. 1.0 M K_2CO_3

142. Which of the following salt solutions will be acidic?

A. $NaHPO_4$ Kb > Ka
B. NH_4Br
C. CaC_2O_4
D. $KClO_4$

143. Which of the following salt solutions will be acidic?

A. $CaSO_4$

B. $FeBr_3$

C. KI

D. $Na_3C_6H_5O_7$

144. Which of the following salt solutions will be acidic?

A. Na_3BO_3

B. $CrBr_3$

C. $Ca(CH_3COO)_2$

D. KBr

145. Which of the following solutions has the lowest pH? most acidic or least basic

A. 0.1 M NH_4NO_3 acidic

B. 0.1 M Na_3PO_4 basic

C. 0.1 M Na_2CO_3 basic

D. 0.1 M NaCN basic

146. Consider the salt ammonium acetate, NH_4CH_3COO.

a. Write the dissociation equation of NH_4CH_3COO. $\rightarrow NH_4^+ + CH_3COO^-$

b. Write the hydrolysis equations which occur.

$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$ $\quad K_a = 5.6\times10^{-10}$

$CH_3COO^- + H_2O \rightleftharpoons HCH_3COO + OH^-$ $\quad K_b = \frac{1.0\times10^{-14}}{1.8\times10^{-5}} = 5.6\times10^{-10}$

c. Explain why a solution of NH_4CH_3COO has a pH = 7.00. Support your answer with calculations

$K_a = K_b$

147. Water will act as an acid with which of the following?

I. H_2CO_3 ✗ Ka only
II. HCO_3^- ✓ Kb > Ka
III. CO_3^{-2} ✓ Kb only

A. I and II only
B. I only
C. III only
(D) II and III only

148. Which of the following represents the predominant reaction between HCO_3^- and water?

(A) $HCO_3^- + H_2O \rightarrow H_2CO_3 + OH^-$ Kb > Ka use for
B. $2HCO_3^- \rightarrow H_2O + CO_2$
C. $2HCO_3^- + H_2O \rightarrow H_3O^+ + CO_3^{-2} + OH^- + CO_2$
D. $HCO_3^- + H_2O \rightarrow CO_3^{-2} + H_3O^+$

149. Water will act as an acid when it reacts with which of the following:

I. NO_2^- ✓ Kb
II. NO_3^- ✗ nothing
III. $HC_2O_4^-$ ✗ Ka > Kb
IV. HCO_3^- ✓ Kb > Ka

A. II, III and IV only
(B) I and IV only
C. II and III only
D. I, II, and IV only

150. Which of the following will form a basic aqueous solution?

A. $HC_2O_4^-$ Ka > Kb
(B) HPO_4^{-2} Kb > Ka
C. HSO_4^- Ka only
D. HSO_3^- Ka > Kb

151. Which of the following will form a basic aqueous solution?

A. HSO_4^- Ka only
(B) HCO_3^- Kb > Ka
C. $HC_2O_4^-$ Ka > Kb
D. HSO_3^- Ka > Kb

almost the same

152. Which of the following 1.0 M salt solutions will be acidic?

A. $NaHCO_3$ $K_b > K_a$

B. $NaHC_2O_4$ $K_a > K_b$ 5.6×10^{-10} 1.0×10^{-4}

C. $(NH_4)_2SO_3$ $K_b > K_a$

D. NaCl neutral

153. What is the equilibrium constant expression representing the predominant reaction for the hydrolysis of $NaHC_2O_4$ (aq) ?

A. $K_{eq} = \dfrac{[Na^+][HC_2O_4^-]}{[NaHC_2O_4]}$

B. $K_w = [H_3O^+][OH^-]$

C. $K_b = \dfrac{[H_2CO_3][OH^-]}{[HC_2O_4^-]}$

D. $K_a = \dfrac{[H_3O^+][C_2O_4^{-2}]}{[HC_2O_4^-]}$

154. What is the equilibrium constant expression representing the predominant reaction for the hydrolysis of $NaHSO_3$ (aq) ?

A. $K_b = \dfrac{[H_2SO_3][OH^-]}{[HSO_3^-]}$

B. $K_w = [H_3O^+][OH^-]$

C. $K_{eq} = \dfrac{[Na^+][HSO_3^-]}{[NaHSO_3]}$

D. $K_a = \dfrac{[H_3O^+][SO_3^{-2}]}{[HSO_3^-]}$

155. Which of the following salts will produce a solution with the highest pH?

most basic > least acidic

A. 1.0 M $NaHSO_4$

B. 1.0 M $NaHSO_3$

C. 1.0 M Na_2HPO_4

D. 1.0 M NaH_2PO_4

156. Consider the following equilibrium:

$Kb = \frac{1.0\times10^{-14}}{6.2\times10^{-8}} = 1.6\times10^{-7}$

$Ka = 2.2\times10^{-13}$

$$HPO_4^{-2}{}_{(aq)} + H_2O_{(l)} \leftrightarrows ?$$

What is the equilibrium expression?

A. $K_b = \frac{[H_2PO_4^-][OH^-]}{[HPO_4^{-2}]}$

B. $K_a = \frac{[HPO_4^{-2}]}{[H_3O^+][PO_4^{-3}]}$

C. $K_b = \frac{[HPO_4^{-2}]}{[H_2PO_4^-][OH^-]}$

D. $K_a = \frac{[H_3O^+][PO_4^{-3}]}{[HPO_4^{-2}]}$

157. The $HC_2O_4^-{}_{(aq)}$ ion will act as

A. a acid since $K_a > K_b$

B. a base since $K_a < K_b$

C. a base since $K_a > K_b$

D. a acid since $K_a > K_b$

158. The $H_2PO_4^-{}_{(aq)}$ ion will act as

A. a acid since $K_a > K_b$

B. a acid since $K_a < K_b$

C. a base since $K_a > K_b$

D. a base since $K_a < K_b$

159. What is the equilibrium expression for the predominant equilibrium in $NaHCO_3{}_{(aq)}$?

A. $K_b = \frac{[HCO_3^-]}{[H_2CO_3][OH^-]}$

B. $K_a = \frac{[HCO_3^-]}{[H_3O^+][CO_3^{-2}]}$

C. $K_b = \frac{[H_2CO_3][OH^-]}{[HCO_3^-]}$

D. $K_a = \frac{[H_3O^+][CO_3^{-2}]}{[HCO_3^-]}$

160. Which of the following amphiprotic ions will act predominantly as a base in solution?

A. HPO_4^{-2}

B. HSO_3^-

C. HSO_4^-

D. $H_2PO_4^-$

161. Calculate the pH in 0.50 M NH_3.

$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

.50		0	0
$-x$		$+x$	$+x$
$.50-x$		x	x

$K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$

$\frac{1.00\times10^{-14}}{5.6\times10^{-10}} = \frac{x^2}{.50-x}$

Assume $.50 - x \approx .50$

$\frac{1.00\times10^{-14}}{5.6\times10^{-10}} = \frac{x^2}{.50}$

$x^2 = 8.9285714\times10^{-6}$

$x = [OH^-] = 2.988\times10^{-3}$

$\therefore$ pH = 11.48

162. Calculate the pH in 0.050 M $Al_2(C_2O_4)_3$. $\rightarrow 2Al^{+3} + 3C_2O_4^{-2}$

Al^{+3} $K_a = 1.4\times10^{-5}$ $\quad C_2O_4^{-2}$ $K_b = \frac{1.0\times10^{-14}}{6.4\times10^{-5}} = 1.6\times10^{-10}$

$Al(H_2O)_6^{+3} + H_2O \rightleftharpoons Al(H_2O)_5OH^{+2} + H_3O^+$

.10		0	0
$-x$		$+x$	$+x$
$.10-x$		x	x

$K_a = \frac{[Al(H_2O)_5OH^{+2}][H_3O^+]}{[Al(H_2O)_6^{+3}]}$ $\quad 1.4\times10^{-5} = \frac{x^2}{.10-x}$ $\quad$ Assume $.10-x \approx .10$

$1.4\times10^{-5} = \frac{x^2}{.10}$

$x^2 = 1.4\times10^{-6}$

$x = [H_3O^+] = 1.1832\times10^{-3}\,M$

pH = 2.93

163. Calculate the pH of 0.25 M HNO_2

$HNO_2 + H_2O \rightleftharpoons NO_2^- + H_3O^+$

.25		0	0
$-x$		$+x$	$+x$
$.25-x$		x	x

$K_a = \frac{[NO_2^-][H_3O^+]}{[HNO_2]}$

$4.6\times10^{-4} = \frac{x^2}{.25-x}$

$\frac{-b^2 \pm \sqrt{\quad -4ac}}{2a}$

assume $.25 - x \approx .25$

$4.6\times10^{-4} = \frac{x^2}{.25}$

$1.15\times10^{-4} = x^2$

$x = [H_3O^+] = 1.07\times10^{-2}$

$pH = 1.97$

164. Calculate the pH of 0.25 M $NaHCO_3$

$HCO_3^- + H_2O \rightleftharpoons CO_3^{-2} + H_3O^+$

$K_a = 5.6\times10^{-11}$

$K_b = \frac{1.00\times10^{-14}}{4.3\times10^{-7}} = 2.3\times10^{-8}$

$HCO_3^- + H_2O \rightleftharpoons H_2CO_3 + OH^-$

.25		0	0
$-x$		$+x$	$+x$
$.25-x$		x	x

$K_b = \frac{[H_2CO_3][OH^-]}{[HCO_3^-]}$

$\frac{1.00\times10^{-14}}{4.3\times10^{-7}} = \frac{x^2}{.25-x}$

Assume $.25 - x \approx .25$

$\frac{1.00\times10^{-14}}{4.3\times10^{-7}} = \frac{x^2}{.25}$

$x^2 = 5.81395\times10^{-9}$

$x = [OH^-] = 7.625\times10^{-5}M$

$pOH = 4.11776$

$pH = 9.88$

165. Calculate the pH of 0.50 M H_2S.

$H_2S + H_2O \rightleftharpoons HS^- + H_3O^+$

.50		0	0
$-x$		$+x$	$+x$
$.50 - x$		x	x

$pH = 3.67$

$K_a = \frac{[HS^-][H_3O^+]}{[H_2S]}$

$9.1 \times 10^{-8} = \frac{x^2}{.50 - x}$

Assume $.50 - x \approx .50$

$9.1 \times 10^{-8} = \frac{x^2}{.50}$

$x^2 = 4.55 \times 10^{-8}$

$x = [H_3O^+] = 2.133 \times 10^{-4}$

166. Calculate the pH of 0.25 M Na_2HPO_4 HPO_4^{-2}

$HPO_4^{-2} + H_2O \rightleftharpoons H_2PO_4^- + OH^-$

.25		0	0
$-x$		$+x$	$+x$
$.25 - x$		x	x

$K_b = 1.6129 \times 10^{-7}$ ✓

$K_a = 2.2 \times 10^{-13}$

$K_b = \frac{[H_2PO_4^-][OH^-]}{[HPO_4^{-2}]}$

$\frac{1.0 \times 10^{-14}}{6.2 \times 10^{-8}} = \frac{x^2}{.25 - x}$

Assume $.25 - x \approx .25$

$4.03 \times 10^{-8} = x^2$

$2.00 \times 10^{-4} M = x = [OH^-]$

$pOH = 3.6972$

$pH = 10.30$

167. Calculate the pH of a saturated SrF_2 solution.

$SrF_2 \rightleftharpoons Sr^{+2} + 2F^-$

$K_{sp} = [Sr^{+2}][F^-]^2$

$4.3 \times 10^{-9} = 4y^3$

$y = 1.0243998 \times 10^{-3} M$

$\therefore F^- = 2.0487996 \times 10^{-3}$

$F^- + H_2O \rightleftharpoons HF + OH^-$

$2.048... \times 10^{-3}$		0	0
$-x$		$+x$	$+x$
$2.05 \times 10^{-3} - x$		x	x

$K_b = \frac{[HF][OH^-]}{[F^-]}$

Assume $2.05 \times 10^{-3} - x \approx 2.05 \times 10^{-3}$

$\frac{1.0 \times 10^{-14}}{3.5 \times 10^{-4}} = \frac{x^2}{2.05 \times 10^{-3} - x}$

$x^2 = 5.85 \times 10^{-14}$ $x = [OH^-] = 2.419 \times 10^{-7} M$

$pOH = 6.616$ $pH = 7.38$

168. Calculate the pH of a 0.50 M KCN.

$CN^- + H_2O \rightleftharpoons HCN + OH^-$

.50		0	0
$-x$		$+x$	$+x$
$.50 - x$		x	x

$K_b = \frac{[HCN][OH^-]}{[CN^-]}$

$\frac{1.0 \times 10^{-14}}{4.9 \times 10^{-10}} = \frac{x^2}{.50 - x}$

Assume $.50 - x \approx .50$

$\frac{1.0 \times 10^{-14}}{4.9 \times 10^{-10}} = \frac{x^2}{.50}$

$x^2 = 1.02... \times 10^{-5} M$

$x = [OH^-] = 3.194 \times 10^{-3} M$

$pOH = 2.4956$

$pH = 11.50$

169. Calculate the pH of a 0.50 M NaC_6H_5O. $\rightarrow Na^+ + C_6H_5O^-$

$C_6H_5O^- + H_2O \rightleftharpoons C_6H_5OH + OH^-$

		0	0
.50			
$-x$		$+x$	$+x$
$.50-x$		x	x

$K_b = \frac{[C_6H_5OH][OH^-]}{[C_6H_5O^-]}$

$\frac{1.00\times10^{-14}}{1.3\times10^{-10}} = \frac{x^2}{.50-x}$

Assume $.50 - x \approx .50$

$\frac{1.00\times10^{-14}}{1.3\times10^{-10}} = \frac{x^2}{.50}$

$x^2 = 3.846\times10^{-5}$

$x = [OH^-] = 6.2017\times10^{-3}$

$pOH = 2.2075$

$pH = 11.79$

170. Calculate the pH of a 0.60 M NH_4I. Start by writing the equation for the predominant equilibrium reaction.

$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$

		0	0
.60			
$-x$		$+x$	$+x$
$.60-x$		x	x

$K_a = \frac{[NH_3][H_3O^+]}{[NH_4^+]}$

$5.6\times10^{-10} = \frac{x^2}{.60-x}$

Assume $.60 - x \approx .60$

$5.6\times10^{-10} = \frac{x^2}{.60}$

$3.36\times10^{-10} = x^2$

$1.833\times10^{-5} = x = [H_3O^+]$

$pH = 4.736\,83$

$= 4.74$

171. Calculate the pH of 3.0 M Na_2CO_3. Start by wrting the equation for the predominnat equilibrium reaction.

$CO_3^{-2} + H_2O \rightleftharpoons HCO_3^- + OH^-$

		0	0
3.0	⇌	+x	+x
−x			
3.0 − x		x	x

$K_b = \frac{[HCO_3^-][OH^-]}{[CO_3^{-2}]}$

$\frac{1.00\times10^{-14}}{5.6\times10^{-11}} = \frac{x^2}{3.0}$

$\frac{1.00\times10^{-14}}{5.6\times10^{-11}} = \frac{x^2}{3.0-x}$

$x^2 = 5.357\times10^{-4}$

$x = [OH^-] = 2.31455\times10^{-2}\,M$

Assume $3.0 - x \approx 3.0$

$pOH = 1.6355$

$pH = 12.36$

172. Calculate the pH of a 0.025 M $Ca(H_2PO_4)_2$ solution.

$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{-2} + H_3O^+$ $K_a = 6.2\times10^{-8}$

		0	0
.050	⇌	+x	+x
−x			
.050 − x		x	x

$K_a = \frac{[HPO_4^{-2}][H_3O^+]}{[H_2PO_4^-]}$

$6.2\times10^{-8} = \frac{x^2}{.050}$

$6.2\times10^{-8} = \frac{x^2}{.050-x}$

$x^2 \approx 3.1\times10^{-9}$

$x = [H_3O^+] = 5.56\times10^{-5}\,M$

Assume $.050 - x \approx .050$

$pH = 4.25$

173. Which of the following acids will have the lowest conductivity?

A. 0.010 M HNO_2
B. 0.010 M H_3BO_3 all acids so weakest acid
C. 0.010 M H_2SO_3
D. 0.010 M HCl

174. Which of the following will have the lowest electrical conductivity?

A. 1.00 M NaH_2PO_4 salt soluble
B. 1.00 M HCl strong acid
C. 1.00 M $LiNO_2$ salt soluble
D. 1.00 M H_2SO_3 weak acid

175. Which of the following is correct if the four solutions listed are compared to one another?

	Concentration	Relative Conductivity	Ionization
A. strong base	1.0 M	highest	complete
B. strong acid	0.50 M	highest	complete
C. weak acid	0.50 M	lowest	complete
D. weak base	1.0 M	lowest	complete

176. Which of the following 1.0 M solutions will have the highest electrical conductivity?

A. HNO_2
B. HF
C. HI strongest acid.
D. HCN

177. Which of the following 1.0 M solutions will have the lowest electrical conductivity?

A. HCN
B. H_2CO_3 weakest acid
C. HCOOH
D. HNO_2

178. Which of the following 1.0 M solutions will have the lowest electrical conductivity?

A. HNO_3 SA
B. NH_4Cl salt
C. H_2CO_3 WA
D. NaCN salt

179. Which of the following solutions will show the greatest electrical conductivity?

A. 0.1 M HCl SA
B. 0.1 M $H_2C_2O_4$ WA
C. 0.5 M H_2CO_3 WA
D. 0.5 M H_3BO_3 WA

180. Which of the following saturated salt solutions would have the greatest electrical conductivity?

A. $Ba_3(PO_4)_2$ (s)

B. PbS (s)

C. $CsNO_3$ (aq)

D. Ag_2CrO_4 (s)

181. Which of the following saturated salt solutions would have the greatest electrical conductivity?

A. $CaCO_3$ (s) $y^2 = 5.0 \times 10^{-9}$ $y = 7.1 \times 10^{-5}$ ∴ $1.4 \times 10^{-4} M$

B. Ag_2CO_3 (s) $4y^3 = 8.5 \times 10^{-12}$ $y = 1.28 \times 10^{-4}$ ∴ 3.85×10^{-4}

C. $Pb(IO_3)_2$ (s) $4y^3 = 3.7 \times 10^{-13}$ $y =$ ∴ $1.4 \times 10^{-4} M$

D. $PbSO_4$ (s) $y^2 = 1.8 \times 10^{-8}$ $y = 1.34 \times 10^{-4}$ ∴ $2.7 \times 10^{-4} M$

182. When comparing equal volumes of 0.10 M HNO_3 with 0.10 M HNO_2, what would be observed?

A. The amount of NaOH needed for neutralization would be different.

B. The pH values would be the same.

C. The effects on blue litmus paper would be the different.

D. The electrical conductivities would be the different.

183. Which of the following solutions would typically show the greatest electrical conductivity?

A. 0.5 M $NaCH_3COO \rightarrow Na^+ + CH_3COO^-$ $[ions] = 1.0$

B. 0.8 M $NH_3 \rightleftharpoons$

C. 0.1 M KOH $\rightarrow K^+ + OH^-$ $= 1.2$

D. 1.0 M $HNO_2 \rightleftharpoons$

184. Describe two lab tests and how their outcomes could be used to distinguish between a strong acid and weak acid of equal molar concentrations.

Test #1: pH meter

Outcome: pH of stronger acid would be lower than pH of weaker acid

Test #2: conductivity apparatus.

Outcome: Conductivity of weaker acid would be lower than for stronger acid

SA WA

185. Which of the following is a property of 1.0 M HCl but not a property of 1.0 M CH_3COOH?

A. produces H_3O^+ in solution
B. ionizes completely
C. turns litmus paper red
D. has a pH less than 7.0

WB SB

186. Which of the following statements applies to 1.0 M $NH_{3\,(aq)}$ but not to 1.0 M $NaOH_{(aq)}$?

A. is a weak acid
B. partially ionizes
C. has $[H_3O^+] > [OH^-]$
D. has a pH greater than 7.0

187. Which of the following best describes a weak acid?

A. It must be of low solubility and completely ionized.
B. It may be very soluble, but only partially ionized.
C. Its 0.10 M solution will have a pH = 1.00.
D. It must be very soluble and completely ionized.