Calculations involving Ka, Kb & Hydrolysis Review

Name: _____ Block:_____

Calculating $[HA]_{initial}$, given K_a and pH

1. Citric acid is one of the acids responsible for the sour taste of lemons. What concentration of citric acid would be required to produce a solution with a pH of 2.50?

$[H_3C_6H_5O_7]$ = _____

2. Rhubarb's sour taste is due in part to the presence of oxalic acid. A solution of oxalic acid has had the label removed. What concentration should appear on the label if the pH of the solution is found to be 0.55?

$[H_2C_2O_4]$ = _____

3. Nitrous acid is one of the components of acid rain. An aqueous solution of nitrous acid is found to have a pH of 1.85. Calculate the concentration of the acid.

$[HNO_2]$ = _____

Calculating K_a, given $[HA]_{initial}$ and pH

4. One form of vitamin C is ascorbic acid, $H_2C_6H_6O_6$. The name originates from the fact that ascorbic acid prevents scurvy — a fact first discovered in 1747 by British surgeon John Lind. This subsequently resulted in citrus juice (from limes and lemons) being supplied to sailors in the Royal Navy. A 0.100 M solution of ascorbic acid is found to have a pH of 3.00. Calculate the K_a for ascorbic acid.

K_a= _____

5. Lactic acid ($C_3H_6O_3$) is a weak acid produced in muscle tissue during anaerobic respiration and is the acid present in sour milk. It's also responsible for the sour taste of sauerkraut. A 0.025 M solution of lactic acid is found to have a pH of 2.75. Calculate the K_a for lactic acid.

K_a= _____

Calculating [OH^-] and pH using K_b and $[B]_{initial}$

6. Hydrazine, N_2H_4 is used in rocket fuel, in producing polymer foams, and in the production of air bags. The K_b for hydrazine is 1.7×10^{-6}. Calculate the pH of the solution prepared by dissolving 12.0 g of hydrazine in 500.0 mL of solution.

pH= _____

7. Calculate the [OH^-], [H^+], pOH, and pH of a 0.60 M solution of $HCOO^-$.

[OH^-] =_____ pOH= _____ [H_3O^+] =_____ pH= _____

Calculating $[B]_{initial}$ given K_b and pH (or pOH)

8. Ethylamine ($C_2H_5NH_2$) is a pungent colourless gas used extensively in organic synthesis reactions. It is also a weak base with $K_b = 5.6 \times 10^{-4}$. What mass of ethylamine is dissolved in 250.0 mL of a solution having a pH of 11.80?

mass = _____

9. What concentration of CN^- would produce a solution with a pH of 11.50?

$[CN^-]$= _____

10. Using the K_b provided above for hydrazine, calculate the $[N_2H_4]$ required to produce a solution with a $[H_3O^+] = 1.0 \times 10^{-10}$ M.

$[N_2H_4]$ = _____

Calculating K_b, given $[B]_{initial}$ and pH (or pOH)

11. A 0.400 M solution of the weak base methylamine, CH_3NH_2, is found to have a pH of 12.90. Calculate the K_b of methylamine and the percentage ionization. Compare your calculation of this K_b value with the sample problem above involving methylamine. What might this indicate about the temperature of this solution?

K_b= _____ % ionization= _____

12. One of the most effective substances at relieving intense pain is morphine. First developed in about 1810, the compound is also a weak base. In a 0.010 M solution of morphine, the pOH is determined to be 3.90. Calculate the K_b and pK_b for morphine. (Let "Mor" and "$HMor^+$" represent the conjugate pair in your equilibrium reaction.)

K_b= _____

13. Quinine, $C_{20}H_{24}N_2O_2$, is a naturally occurring white crystalline base used in the treatment of malaria. It is also present in tonic water. Calculate the K_b for this weak base if a 0.0015 M solution has a pH of 9.84. *(Let "Qui" and "$HQui^+$" represent the conjugate pair in your equilibrium reaction.)*

K_b= _____

Review of Hydrolysis of Salts

> ***Hydrolysis*** *is the reaction of an ion with water to produce either the conjugate base of the ion and hydronium ions or the conjugate acid of the ion and hydroxide ions.*

Consider the neutralization reactions described below.

14. (a) When equal volumes of 0.10 M HNO_3 and 0.10 M KOH solutions react together, what salt solution exists in the reaction vessel following the reaction?

(b) Consider the dissociated ions of this salt. Is either of the ions located on the table of relative strengths of Brønsted-Lowry acids and bases (*consult acid base table*)? If so, where? Does this help you predict if the pH of this solution will be equal to, above, or below 7?

15. (a) When equal volumes of 0.10 M CH_3COOH and 0.10 M NaOH solutions react together, what salt solution exists in the reaction vessel following the reaction?

(b) Consider the dissociated ions of the salt. Is either of the ions located on the table of relative strengths of acids and bases ? If so, where? Does this help you predict if the pH of this solution will be equal to, above, or below 7?

16. **Circle** the ions in the following list that represent cations of strong bases.

Al^{3+} Rb^{+} Fe^{3+} Cr^{3+} Ca^{2+} Sn^{4+} Cs^{+} Ba^{2+}

17. **Circle** the ions in the following list that represent the ***conjugate bases*** of strong acids.

F^{-} ClO_2^{-} ClO_4^{-} SO_4^{2-} Cl^{-} NO_2^{-} CH_3COO^{-} CN^{-} NO_3^{-}

18. **Circle** the following salts whose ions will **not** hydrolyze when dissociated in water.

NH_4Cl Na_2CO_3 $RbClO_4$ Li_2SO_3 BaI_2 NH_4HCOO KIO_3 CsF $CaBr_2$

19. **Circle** which of the following salts contain the anion of a weak acid?

NH_4Cl $NaClO_4$ $Fe(CH_3COO)_3$ KF $LiCl$

$Al(NO_3)_3$ NH_4HSO_4 $Pb(NO_2)_2$ NH_4I $Ba(CN)_2$

20. **Circle** which of the following salts will produce a basic aqueous solution due to anionic hydrolysis?

$AlBr_3$ $Ca(HCOO)_2$ $RbClO_4$ $SrCO_3$ $Mg(CN)_2$

$NaCH_3COO$ $Cr(NO_3)_3$ LiC_6H_5COO FeI_3 K_3PO_4

21. A sample of $Mg(CN)_2$ is dissolved in water to make a solution. Predict if the solution is acid or basic. *(show all work)*

22. **Circle** the salts below that will produce acidic aqueous solutions.

$NaNO_2$ NH_4I $CaBr_2$ $CrCl_3$ $Sr(CN)_2$ $RbCH_3COO$ Li_2SO_3

23. Write the hydrolysis reactions for the following hydrated cations:

(a) $Sn(H_2O)_4^{2+}$

(b) $Cu(H_2O)_4^{2+}$

(c) $Fe(H_2O)_6^{3+}$

24. **Circle** which of the following salts will dissociate into ions that will *both* react with water?

KI NH_4NO_2 $Fe(CN)_3$ $Sn(NO_3)_2$ $Rb_2C_2O_4$ $CrBr_3$ $NaCH_3COO$ AlF_3

25.

a) Write out the two hydrolysis reactions that occur when a sample of NH_4F dissolves in water.

b) Which of the two hydrolysis reactions in question 2 above will occur to a greater extent? How do you know?