Acid-Base Review Worksheet-Accel Name: Key Per: ____

Complete the following. Show *all* of your work! Box or circle your answer.

- **Objective: Identify & describe the properties of acids and bases**

1. Compare and contrast the following:

a. Acid properties and base properties

sour	bitter
oily	slippery
litmus turns red	litmus turns blue
pH < 7	pH > 7
conducts electricity	conducts electricity
reacts w/ metal	

b. Strong acid and weak acid (Include a list of strong acids)

Strong completely dissociates or ionizes (strong electrolyte)

weak partially dissociates or ionizes (weak electrolyte)

HCl, HBr, HI, HNO_3, $HClO_4$, H_2SO_4

c. Strong base and weak base (include a list of strong bases)

Strong completely dissociates or ionizes (strong electrolyte)

weak partially dissociates or ionizes (weak electrolyte)

$LiOH$, $NaOH$, KOH, $RbOH$, $Ca(OH)_2$, $Ba(OH)_2$, $Sr(OH)_2$

d. Acid-base indicator and pH meter

indicator is a substance that changes color in the presence of an acid or base

pH meter gives a number which correlates to the pH scale

e. Monoprotic acid and polyprotic acid

Monoprotic means there is one hydrogen available for donation

polyprotic means there is more than one hydrogen available for donation

f. Binary acid and ternary acid

Binary means two elements in the formula

Ternary means three elements in the formula

- **Objective: Identify the difference between Arrhenius' model and Bronsted-Lowry Model**

2. Compare and contrast the following:

a. Arrhenius acid and Arrhenius base

Arrhenius acid contains hydrogen

Arrhenius base contains hydroxide

b. Bronsted-Lowry acid and Bronsted-Lowry base

BA - hydrogen ion donor

BB - hydrogen ion acceptor

c. Conjugate acid and conjugate base

Ca - shows the gain in hydrogen

Cb - shows the loss of hydrogen

3. Identify the acid/base pairs (use BA, BB, ca and cb):

a. $HC_2H_3O + H_2O \leftrightarrow H_3O^+ + C_2H_3O_2^-$

BA BB Ca Cb

b. $H_2O + C_2H_3O_2^- \leftrightarrow HC_2H_3O_2 + OH^-$

BA BB Ca Cb

- **Objective: Calculate pH and pOH**

4. What are the hydroxide ion concentrations for solutions that have the following pH values?

a. 4.0 $pOH = 14 - 4 = 10$

$[OH^-] = 10^{-10} = \boxed{1 \times 10^{-10}\ M}$

or

$[H^+] = 10^{-4} = 1 \times 10^{-4}$

$\frac{1 \times 10^{-14}}{1 \times 10^{-4}} = \boxed{1 \times 10^{-10}\ M}$

b. 8.0 $pOH = 14 - 8 = 6$

$[OH^-] = 10^{-6} = \boxed{1 \times 10^{-6}\ M}$

or

$[H^+] = 10^{-8} = 1 \times 10^{-8}$

$\frac{1 \times 10^{-14}}{1 \times 10^{-8}} = \boxed{1 \times 10^{-6}\ M}$

5. What are the pH values for the following?

a. $[H^+] = 2.4 \times 10^{-6}$ M

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

$pH = -\log 2.4 \times 10^{-6}$

$pH = 5.62$

b. 9.1×10^{-9} M HCl

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

$pH = -\log 9.1 \times 10^{-9}$

$pH = 8.04$

6. What are the $[H^+]$ for the following?

a. pH= 13.2

$[H^+] = 10^{-pH}$

$10^{-13.2}$

6.31×10^{-14} M

b. pOH = 6.7

$pH = 14 - 6.7 = 7.3$

$[H^+] = 10^{-7.3} = 5.01 \times 10^{-8}$ M

c. $[OH^-] = 3.2 \times 10^{-6}$ M

$[H^+] = \frac{1 \times 10^{-14}}{3.2 \times 10^{-6}} = 3.13 \times 10^{-9}$ M

d. 1.3×10^{-12} M NaOH

$[H^+] = \frac{1 \times 10^{-14}}{1.3 \times 10^{-12}} = .00769$ M

7. Calculate the pH from the following $[OH^-]$.

a. 4.3×10^{-4} M

$[H^+] = \frac{1 \times 10^{-14}}{4.3 \times 10^{-4}} = 2.33 \times 10^{-11}$ M

$pH = -\log 2.33 \times 10^{-11}$

$pH = 10.6$

or $pOH = -\log[OH^-]$

$pOH = -\log 4.3 \times 10^{-4}$

$pOH = 3.37$

$14 - 3.37 = pH$

$pH = 10.63$

b. 3.33×10^{-7} M

$[H^+] = \frac{1 \times 10^{-14}}{3.33 \times 10^{-7}} = 3.00 \times 10^{-8}$ M

$pH = -\log(H^+)$ $pH = -\log 3.00 \times 10^{-8} = 7.52$

or $pOH = -\log 3.33 \times 10^{-7}$

$pOH = 6.48$

$14 - 6.48 = pH$

$7.52 = pH$

- **Objective: Calculate using the ion product constant for water**

8. Calculate the $[OH^-]$ for the following.

a. $[H^+] = 1 \times 10^{-2}$ M

$[OH^-] = \frac{1 \times 10^{-14}}{1 \times 10^{-2}} = 1 \times 10^{-12}$ M

b. 2.7×10^{-4} M H_2SO_4

$[OH^-] = \frac{1 \times 10^{-14}}{2.7 \times 10^{-4}} = 3.7 \times 10^{-11}$ M

9. What are the $[H^+]$ for the following?

a. $[OH^-] = 3.2 \times 10^{-6}$ M

$[H^+] = \frac{1 \times 10^{-14}}{3.2 \times 10^{-6}} = 3.13 \times 10^{-9}$ M

b. 1.3×10^{-12} M NaOH

$[H^+] = \frac{1 \times 10^{-14}}{1.3 \times 10^{-12}} = .00769$ M or 7.69×10^{-3} M

- Objective: Write balanced equations for neutralization reactions and do the calculations required for titrations

10. Determine the concentration of 15 mL of nitric acid (HNO_3) that is titrated with 10.5 mL of 2.5 M NaOH.

$HNO_3 + NaOH \rightarrow H_2O + NaNO_3$

15mL, ?M 10.5mL, 2.5M

$10.5\text{mL NaOH} \left|\frac{1\text{L NaOH}}{1000\text{mL NaOH}}\right| \left|\frac{2.5\text{mol NaOH}}{1\text{L NaOH}}\right| \left|\frac{1\text{mol HNO}_3}{1\text{mol NaOH}}\right| = \frac{.0263\text{mol HNO}_3}{.015\text{L}} = 1.75\text{M HNO}_3$

11. What volume of 0.25 M acetic acid would be necessary to neutralize 50.0 mL of 2.0 M potassium hydroxide?

$KOH + CH_3COOH \rightarrow KCH_3COO + H_2O$

2.0M, 50mL .25M, ?mL

$50\text{mL KOH} \left|\frac{1\text{L KOH}}{1000\text{mL KOH}}\right| \left|\frac{2.0\text{mol KOH}}{1\text{L KOH}}\right| \left|\frac{1\text{mol CH}_3\text{COOH}}{1\text{mol KOH}}\right| = \frac{.1\text{mol CH}_3\text{COOH}}{.25\text{M}} = .4\text{L} \left|\frac{1000\text{mL}}{1\text{L}}\right| = 400\text{mL CH}_3\text{COOH}$

12. 25.5 mL of 0.75 M hydrochloric acid is used to titrate 10.0 mL of calcium hydroxide. What is the concentration of the base? $2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$

25mL, .75M 10mL, ?M

$25.5\text{mL HCl} \left|\frac{1\text{L HCl}}{1000\text{mL HCl}}\right| \left|\frac{.75\text{mol HCl}}{1\text{L HCl}}\right| \left|\frac{1\text{mol Ca(OH)}_2}{2\text{mol HCl}}\right| = \frac{.00956\text{ mol Ca(OH)}_2}{.010\text{L}} = .956\text{M Ca(OH)}_2$

13. When titrating, what would you expect the equivalence point pH to be for the following:

a. A strong acid with a strong base — around 7
b. A strong acid with a weak base — less than 7
c. A weak acid with a strong base — greater than 7

14. Complete the following statements.

a. The process used to determine the concentration of an unknown solution is called titration.
b. A reaction where an acid and a base react to form salt and water is called a neutralization reaction.
c. A substance that can act as both an acid and a base is called a(n) amphoteric or amphiprotic substance.
d. A hydrogen ion and a water molecule form a hydronium ion.
e. The equilibrium (ion product) constant of water has a symbol of K_w and a value of 1×10^{-14}.
f. The pH scale has values of 0-14 and tells us whether a substance is an acid or a base.
g. The equivalence point is reached when the $[H^+]$ and $[OH^-]$ are equal.
h. The end point is reached when the indicator changes color during a titration.