Name: key Date: ______ Class Pd. ____

AP Chemistry: Acids & Bases
Honors Review

Fill in the blank. (30 points)

Directions: Read each question carefully then write the correct answer to the question in the blank provided.

1. A Lewis base donates an electron pair.
2. A Bronsted acid donates a hydrogen ion.
3. A(n) acid has a sour taste.
4. A(n) base is slippery to touch.
5. An acid with 3 hydrogen ions is called a triprotic acid.
6. A substance that is able to act as an acid or a base like water is called amphoteric.
7. A weak acid only ionizes slightly in water.
8. A strong acid is a strong electrolyte.
9. When an acid reacts with a base the reaction produces salt and water.
10. The pH of a base is greater than 7.

MATCHING. (20 points)

	Column A	Column B
A 11.	A weak monoprotic acid	A. $HC_2H_3O_2$
E 12.	A weak diprotic acid	B. HCl
C 13.	A weak triprotic acid	C. H_3PO_3
B 14.	A strong monoprotic acid	D. H_2SO_4
D 15.	A strong diprotic acid	E. H_2SO_3

PROBLEMS. (30 points)

Directions: Solve the following problems. Show ALL of your work.

16. The hydroxide concentration of a solution is 4.5×10^{-9} M.

a. What is the pH?

pH = 14 - 8.3 = 5.7

2 sig figs, so 2 decimal places

b. What is the pOH?

pOH = $-\log(4.5\times10^{-9})$ = 8.35

c. Acid or Base? acid

17. The pH of a solution is 10.00.

a. What is the pOH?

pOH = 4.00

b. What is the [OH-]?

$10^{-4} = 1.0 \times 10^{-4}$

c. Acid or Base? base

18. The pOH of a solution is 3.70.

a. What is the pH?

pH = 14 - 3.70 = 10.3

b. What is the [OH-]?

$10^{-3.70}$ = ~~[illegible]~~ 2.0×10^{-4} M

c. Acid or Base? base

IDENTIFY. (20 points)

Directions: For the following acid-base reactions, identify the following:

Acid (A), Base (B), Conjugate Acid (CA), Conjugate Base (CB)

19. $H_2S + H_2O \rightarrow H_3O^{+1} + HS^{-1}$

A B CA CB

20. $NH_4^{+1} + H_2O \rightarrow H_3O^{+} + NH_3$

A B CA CB

21. $CO_3^{-2} + H_2O \rightarrow HCO_3^{-} + OH^{-1}$

B A CA CB

22. $CN^{-1} + H_2O \rightarrow HCN + OH^{-1}$

B A CA CB

23. $HC_2H_3O_2 + H_2O \rightarrow H_3O^{+1} + C_2H_3O_2^{-1}$

A B CA CB

Conjugate Pairs Practice Questions

1. Identify the acid, base, conjugate acid and conjugate base for each of the following.

a) $HClO_4(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + ClO_4^-(aq)$
A B CA CB

b) $H_2SO_3(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + HSO_3^-(aq)$
A B CA CB

c) $HC_2H_3O_2(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + C_2H_3O_2^-(aq)$
A B CA CB

d) $H_2S(g) + H_2O(l) \rightleftarrows H_3O^+(aq) + HS^-(aq)$
A B CA CB

e) $HSO_3^-(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + SO_3^{2-}(aq)$
A B CA CB

f) $NH_3(g) + H_2O(l) \rightleftarrows NH_4^+(aq) + OH^-(aq)$
B A CA CB

g) $HF(aq) + HSO_3^-(aq) \rightleftarrows F^-(aq) + H_2SO_3(aq)$
A B CB CA

h) $HNO_2(aq) + HS^-(aq) \rightleftarrows NO_2^-(aq) + H_2S(aq)$
A B CB CA

2. Calculate pH and pOH for the following solutions AND Identify as acidic or basic:

A a) [H+] = 1.0×10^{-5} M pH = 5.00 pOH = 9.00
b) [OH-] = 3.0×10^{-8}M pH = 6.5 pOH = 7.5 A

A c) [H+] = 2.5×10^{-2}M pH = 1.60 pOH = 12.40
d) [OH-] = 7.5×10^{-3}M pH = 11.9 pOH = 2.1 B

B e) [H+] = 1.2×10^{-14}M pH = 13.92 pOH = .08
f) [H+] = 0.600 M pH = .223 pOH = 13.8 A

3. Calculate [H+] and [OH-] for the following AND Identify as acidic or basic:

A a) pH = 3.0
[H+] = .001 M
[OH-] = 1×10^{-11} M

B b) pOH = 2.60
[H+] = 4.0×10^{-12} M
[OH-] = .0025 M

B c) pOH = 5.63
[H+] = 4.3×10^{-9} M
[OH-] = 2.3×10^{-6} M

B d) pH = 7.51
[H+] = 3.1×10^{-8} M
[OH-] = 3.2×10^{-7} M

B e) pOH = 1.13
[H+] = 1.4×10^{-13} M
[OH-] = .074 M

A f) pH = 0.03
[H+] = .93 M
[OH-] = 1.0×10^{-14} M

Calculating pH and [H⁺] for Weak Acids and Bases

Weak acids and bases are usually *less than 5% ionized*. The equilibrium constant for a weak acid equilibrium the *acid ionization constant* K_a, and for a weak base equilibrium is the *base ionization constant* K_b.

A typical monoprotic weak acid equilibrium can be written in two forms, the second of which emphasizes the Brønsted acid-base nature of the reaction:

$$HA \leftrightarrow H^+(aq) + A^-(aq)$$
$$HA + H_2O \leftrightarrow H_3O^+(aq) + A^-(aq)$$

In Eq(9) the Brønsted acid HA donates a proton H^+ to the Brønsted base H_2O to form H_3O^+ and the conjugate base A^-. The acid ionization constant (using the second form) is

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

A typical weak base equilibrium is

$$B + H_2O \leftrightarrow BH^+(aq) + OH^-(aq)$$

In Eq(10) the Brønsted base B accepts a proton H^+ from the Brønsted base H_2O to form the conjugate acid BH^+ and OH^-. The base ionization constant is

$$K_b = \frac{[BH^+][OH^-]}{[B]}$$

Percent Ionization:

$$\%\text{ Ionization of Weak Acid} = \frac{[H_3O^+]}{[HA]_0} \times 100$$

$$\%\text{ Ionization of Weak Base} = \frac{[OH^-]}{[B]_0} \times 100$$

Example 1:

Calculate (a) the pH and (b) the percent ionization of a 0.250 M $HC_2H_3O_2$ solution. $K_a(HC_2H_3O_2) = 1.8 \times 10^{-5}$. (The formula for acetic acid may also be written as CH_3COOH.)

a) $HC_2H_3O_2 \rightarrow H^+ + C_2H_3O_2^-$

	$HC_2H_3O_2$	H^+	$C_2H_3O_2^-$
I	.250	0	0
C	−x	+x	+x
E	.250 −x	x	x

$1.8 \times 10^{-5} = \frac{x^2}{.25}$

x = .00212 M

pH = −log(.00212)

pH = 2.67

b) $\frac{.00212}{.250} \times 100$

.85%

Answer: (a) $x = 2.12 \times 10^{-3} = [H^+]$. pH = 2.67. (b) 0.085%

Practice Problem 1.

Calculate the pH and % ionization of a 0.600 M solution of methylamine (CH_3NH_2). $K_b = 4.4 \times 10^{-4}$. HINT: Methylamine is a weak base. First write the equation for the reaction following. Then fill out the equilibrium table below.

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

	CH_3NH_2	$CH_3NH_3^+$	OH^-
I	.600	0	0
C	−x	+x	+x
E	.6−x	x	x

$4.4 \times 10^{-4} = \frac{x^2}{.6}$

x = .0162M

[OH] = .0162M

~~pOH~~

pOH = 1.79

pH = 12.2

% ionization = $\frac{.0162}{.6} \times 100$

2.7

Answer: $x = 1.62 \times 10^{-2} = [OH^-]$, and pOH = 1.79.

Example Problem 2.

The pH of a 0.10 M solution of a weak base is 9.67. What is the K_b of the base?

pOH = 4.33

$[OH^-] = 4.677 \times 10^{-5} M$

$K_b = \frac{(4.677 \times 10^{-5})^2}{.1}$

$K_b = 2.2 \times 10^{-8}$

Answer: $K_b = 2.2 \times 10^{-8}$

Practice Problem 2.

The pH of a 0.012M solution of a weak acid is 5.66. What is the K_a of the acid?

$[H^+] = 2.19 \times 10^{-6}$

$K_a = \frac{(2.19 \times 10^{-6})^2}{.012}$

$K_a = 3.99 \times 10^{-10}$