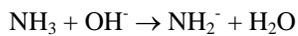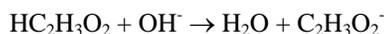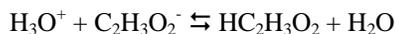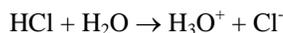**Unit 12 Practice Problems (with answers at end)**

> Balloonists have an unsurpassed
> view of the scenery, but there
> is always the possibility that
> it may collide with them.
> --H.L. Mencken

Conjugate acid/base pairs

1. In each of the following, identify the conjugate acid/base pairs:

$HCl + H_2O \rightarrow H_3O^+ + Cl^-$

$H_3O^+ + C_2H_3O_2^- \leftrightarrows HC_2H_3O_2 + H_2O$

$HC_2H_3O_2 + OH^- \rightarrow H_2O + C_2H_3O_2^-$

$2 H_2O \leftrightarrows H_3O^+ + OH^-$

$NH_3 + OH^- \rightarrow NH_2^- + H_2O$

K_w and pH

2. What is the $[H^+]$ in a 0.25 M solution of NaOH (strong). What is $[OH^-]$?

3. Calculate the $[H^+]$ and $[OH^-]$ in a 0.50 M solution of HNO_3 (strong).

4. Calculate the $[H^+]$ and $[OH^-]$ in a 0.35 M $HClO_4$ solution (strong).

5. KOH is a strong base. Calculate $[H^+]$ and $[OH^-]$ in a 5.0 M solution.

6. Calculate the pH and pOH of a solution of NaOH (strong base) which is 0.0010 M.

7. Calculate the $[H^+]$ of a solution with a pH of 3.7.

8. Calculate the $[H^+]$ of a solution with a pOH of 4.5

Acid/Base reactions

9. The neutralization reactions of each of the following pairs of acids and bases produce soluble salts. If the water were removed from such mixtures, what salts would remain?

sodium hydroxide + sulfuric acid
calcium hydroxide + nitric acid
hydrochloric acid + ammonia
aluminum hydroxide + acetic acid
potassium hydroxide + acetic acid

> The world gets its stimuli
> from the genius, but it
> lives on talent.--A. Flexner

Weak acids and bases, K_a and K_b

10. Calculate $[OH^-]$ for a 0.50 M solution of ammonia. $K_b = 1.8 \times 10^{-5}$.

11. Calculate $[H^+]$ in a 0.10 M solution of formic acid. $K_a = 1.7 \times 10^{-4}$.

12. Determine the value of K_a for acetic acid from the following data: 0.10 mol of the acid is dissolved in enough water for a total volume of 1.0 Litre. The resulting $[H^+]$ is 1.35×10^{-3}.

13. The K_a of HF is 7.1×10^{-4}. For a solution concentration of 0.150 M, what is the % ionization?

14. Lactic acid, $CH_3CHOCOOH$, gets its name from sour milk, from which it was first isolated in 1780 (L. *lactis*, milk). K_a for lactic acid is 8.4×10^{-4}. Find the $[H^+]$ in a sample of sour milk containing 0.100 M lactic acid.

15. Many of the common organic acids got their original names from their odors and/or sources. Another case in point is Caproic acid (hexanoic acid), found in the skin secretions of goats (L. *caper*, goat). Caproic acid is $CH_3(CH_2)_4COOH$ and has a structure similar to acetic acid, but with a longer carbon chain. The concentration of H^+ in a solution prepared by dissolving 0.030 mol of caproic acid in 1.0 L of water solution was measured and found to be 6.5×10^{-4} M. Find K_a for caproic acid.

16. Two solutions are needed in the lab, each with a volume of 10 L (to the nearest 1 Litre) and a pH equal to 11.00. How many moles of each solute would it take if one solution is to be made with NaOH (strong base) and the other with NH_3? $(K_b = 1.8 \times 10^{-5})$ (approximate for NH_3)

Buffer solutions

17. A buffer solution contains acetic acid and sodium acetate. The concentration of each substance is 0.50 M. Determine the pH of the solution. $K_a = 1.8 \times 10^{-5}$. (approximate)

18. Which of the following pairs of solutions could be used to make a buffer solution?
a. NaOH and HCl
b. HNO_2 and $NaNO_2$
c. HNO_2 and NaOH
d. Na_3PO_4 and HCl

19. Blood is buffered mainly by the H_2CO_3-HCO_3^- system in which the ratio of $[HCO_3-]$ to $[H_2CO_3]$ is about 20:1. What would the pH of blood be if this were the only buffer? (K_a for $H_2CO_3 = 4.2 \times 10^{-7}$) (approximate)

Answers:

1. A,B,A,B
   A,B,A,B
   A,B,A,B
   A&B,A,B
   A,B,B,A
2. $[H^+] = 4.0 \times 10^{-14}$ M, $[OH^-] = 0.25$ M
3. $[H^+] = 0.50$ M, $[OH^-] = 2.0 \times 10^{-14}$ M
4. $[H^+] = 0.35$ M, $[OH^-] = 2.9 \times 10^{-14}$ M
5. $[H^+] = 2.0 \times 10^{-15}$ M, $[OH^-] = 5.0$ M
6. pH = 11, pOH = 3
7. 2.0×10^{-4} M
8. 3.2×10^{-10} M
9. sodium sulfate
   calcium nitrate
   ammonium chloride
   aluminum acetate
   potassium acetate
10. 3.0×10^{-3} M
11. 4.1×10^{-3} M
12. 1.8×10^{-5}
13. [quadratic solution required for H^+ conc.] 6.7%
14. [quadratic solution required] 8.8×10^{-3} M
15. 1.4×10^{-5}
16. for NaOH, 0.010 mol; for NH_3, 0.56 mol
17. pH = 4.74
18. only b
19. pH = 7.7