NAME _____

Science 265, Fall 2002

I. Acids and Bases

Read **Explorations, Ch. 25**; Chem. Comp. Ch. 8
Related computer lessons: Acids and Bases, Acids and Bases, Acid Base Reactions

1. Acids and bases

1. (a) How do acids taste? (b) How do bases taste and feel?
(a) sour; (b) bitter, slippery

2. What are the modern definition of acids and bases?

They are defined by their characteristic reactions: An acid is a hydrogen ion (H^+) donor, a base is a hydrogen ion (H^+) acceptor.

Acids usually have formulas that begin with H:
HCl is an acid in water: $HCl(g) + H_2O(l) \longrightarrow H_3O^+(aq) + Cl^-(aq)$

Bases often end in OH or have nitrogen atoms:
Ammonia, NH_3, is a base in water: $NH_3(g) + H_2O(l) \longrightarrow NH_4^+(aq) + OH^-(aq)$

3. What are **hydronium ions** and **hydroxide ions**?

A hydronium ion is a water molecule with one extra proton, H_3O^+. The additional H^+ has no electrons, so it attaches to one of the nonbonding electrons pairs in the water molecule.

A hydroxide ion is a water molecule that has lost a proton, but kept both of the electrons in the bond, $OH^?$.

4. What is **neutralization**?
The reaction of an acid and a base to produce a salt and (for hydroxides) water. We say a base neutralizes an acid and vice-versa. Notice that HCl (acid) has donated a proton and OH^- (base) has accepted it:

HCl(aq)	+	*NaOH(aq)*	—>	*NaCl(aq)*	+	*$H_2O(l)$*
acid		*base*		*salt*		*water*

5. What is the general definition of a salt?
An ionic compound formed from the reaction of an acid and a base. Examples: NaCl, as above, also: *$HNO_3(aq)$ + $KOH(aq)$ —> $KNO_3(aq)$ + $H_2O(l)$*

6. What acid and what base could you mix to make NaBr?

NaOH and HBr; $CaCl_2$ would come from $Ca(OH)_2$ and HCl. Note that the positive ion of the salt comes from the base and the negative ion from the acid.

7. Where would you find acids around the house?
Many foods are acidic (juices, coffee, vegetables like tomatoes). The colors of flowers, fruits, and leaves are due to anthocyanins, which are natural acid/base indicators.

8. What are bases used for around the house?
Cleaning (lye, which is KOH), water treatment (bases precipitate metal hydroxides)

2. Strong and weak acids and bases

9. What do we mean by acid strength?

The ability of an acid to donate a hydrogen ion. The stronger an acid, the greater this ability. There are only seven common strong acids. Two are HCl, HNO_3. Weak acids: acetic acid (and most other acids). Strong acids are more hazardous because they have such a strong tendency to react.

10. What do we mean by base strength?

Base strength refers to the ability of a base to accept a hydrogen ion. The stronger a base, the greater is this ability. NaOH and KOH are strong bases, ammonia is a weak base. This is why oven cleaners, which use KOH, have strong precautions.

11. What is the difference between **acidic**, **neutral**, and **basic** solutions?

An acidic solution is a solution in which the hydronium ion is more concentrated than the hydroxide ion. It contains an acid.

A neutral solution is one in which the hydronium ion concentration equals that of the hydroxide ion. Pure water is neutral.

A basic solution is one in which the hydroxide ion concentration is greater than that of the hydronium ion. It contains a base.

3. The pH scale

12. Describe the pH scale.
*The pH scale is a way to express the acidity of a solution as a power of ten. The **smaller** the number on the scale, the more acidic the solution. The **larger** the number, the more basic the solution. A solution in which the concentration of $H_3O^+ = 0.1$ has a pH of 1. A solution in which the concentration of $H_3O^+ = 0.01$ has a pH of 2, and so on.*

13. A change in 1 pH unit means that the acid concentration has changed by how much?
(a) 1 x, (b) 10 x.
10 times, because it is a logarithm, so gives the "power of ten" of the concentration.

14. Indicate in each case whether the solution is acidic, basic, or neutral: (a) pH = 1; (b) pH = 14; (c) pH = 7; (c) pH = 9.
(a) acidic; (b) basic; (c) neutral; (c) basic. Any solution with pH < 7 is acidic, with pH = 7 is neutral, with pH > 7 is basic.

15. The pH of some common household products (see Fig. 25.11, p. 436): soap, vinegar, pure water, stomach acid, oven cleaner, tomatoes, ammonia

pH	
0	
1	*Stomach acid*
2	
3	*Vinegar*
4	*Tomatoes*
5	
6	
7	*Pure water (neutral)*
8	
9	*Soap*
10	
11	*Ammonia*
12	
13	
14	*Oven cleaner*

16. What is acid rain and why is it a problem?

All rain contains some weak acids, particularly carbonic acid, H_2CO_3,. Acid rain contains the strong acids nitric acid, HNO_3, and H_2SO_4, sulfuric acid, which are produced when nitrogen and sulfur oxides are emitted from factories, power plants, and automobiles. Because these acids are strong, they cause more damage. Some fish and other aquatic animals cannot live in acid conditions. Also, buildings are damaged.

Acids react with carbonates, such as marble and limestone, in a reaction similar to that between vinegar and baking soda. This reaction causes problems when acid rain falls on statues and buildings of limestone and marble (BALANCE):

$$2\ HNO_3(aq) + CaCO_3(aq) \longrightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$$