Chapter 14
Study Guide - Answers

Name: _____

Date: _____ Per: _____

Directions:

1. ***Label each of the following characteristics as belonging to an acid (A) or (B).***

a.	feels slimy	***B***	g.	$[H^+] > [OH^-]$	***A***
b.	turns litmus blue	***B***	h.	tastes bitter	***B***
c.	turns phenolphthalein pink	***B***	i.	turns litmus pink	***A***
d.	has a pH greater than 7	***B***	j.	has a pH less than 7	***A***
e.	neutralizes bases	***A***	k.	tastes sour	***A***
f.	reacts with metal to form $H_2(g)$	***A***	l.	neutralizes acids	***B***

2. An acidic solution is characterized by having a higher ___$[H^+]$___ than ___$[OH^-]$___ . Bases have a higher ___$[OH^-]$___ than ___$[H^+]$___. In neutral solutions, these concentrations would be equal.

3. Svante Arrhenius defined acids as substances that ___produce $[H^+]$___ in aqueous solution and bases as substances that ___produce $[OH^-]$___ in aqueous solution. His theory only pertained to substances dissolved in water. Generally, the formula of an Arrhenius acid begins with the letter ___H___, denoting the hydrogen ion(s) being ionized. Bases typically will end with ___OH___, the formula of the hydroxide ion. His theory explained why ___salt___ and ___water___ are produced in a neutralization reaction.

4. The Brønsted-Lowry theory of acids and bases relates to the donation/acceptance of a(n) ___proton___. Acids are defined as substances that ___donate protons___ and bases as substances that ___accept protons___. Brønsted-Lowry bases always have ___an unshared pair of electrons___ to bond with the "accepted" proton since it has no ___electrons___ of its own. The use of the terms "donated" and "accepted" are commonly used to describe Brønsted-Lowry acids/bases, but really the proton is ripped from the acid in a process called ___deprotonation___. The ease with which the proton is torn from the acid relates to the ___polarity___ of the bond holding the proton to its conjugate base. The greater the polarity of the bond, the ___stronger the___ acid.

5. Name the following acids.

a. $HClO$ ___hypochlorous acid___
b. $HC_2H_3O_2$ ___acetic acid___
c. HCl ___hydrochloric acid___
d. CH_3COOH ___acetic acid___
e. HNO_3 ___nitric acid___
f. HBr ___hydrobromic acid___
g. HNO_2 ___nitrous acid___
h. $H_2C_4H_4O_6$ ___tartaric acid___
i. H_2S ___hydrosulfuric acid___
j. H_2O ___hydrohydroxic acid___
k. H_3PO_4 ___phosphoric acid___
l. H_3N ___hydronitric acid___
m. H_2SO_3 ___sulfurous acid___
n. HI ___hydroiodic acid___

6. A strong acid ___ionizes completely___ in water, whereas a weak acid ___only ionizes partially___ in water. The strength of an acid can be represented mathematically using the acid-dissociation constant, ___K_a___. The higher the value of ___K_a___, the stronger the acid. The strong acids are: ___HCl___, ___HBr___, ___HI___, ___HNO_3___, ___H_2SO_4___, ___$HClO_4$___, and ___$HClO_3$___. Equations representing strong acids have a ___single___ arrow, whereas equations for weak acids have a ___double___ arrow.

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7. Write the ionization equation and acid ionization constant expression for the acid HIO_3.

$$HIO_3(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + IO_3^-(aq)$$

$$K_a = \frac{[H_3O^+][IO_3^-]}{[HIO_3]}$$

8. Acetic acid is a weak monoprotic acid. It is the active ingredient in vinegar. If the initial concentration of acetic acid is 0.200 *M* and the equilibrium concentration of H_3O^+ is 0.0019 *M*, calculate K_a for acetic acid.

1. $HC_2H_3O_2(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + C_2H_3O_2^-(aq)$
2. Write the acid ionization expression.

$$K_a = \frac{[H_3O^+][C_2H_3O_2^-]}{[HC_2H_3O_2]}$$

3. *(Unlike the problems in class – the $[H_3O^+]$ is given here, so no antilog necessary.)*
4. The equilibrium conc. of $[HC_2H_3O_2]$ = initial conc. of $[HC_2H_3O_2]$ – conc. of $[H_3O^+]$ at equil.

$$[HC_2H_3O_2] = 0.200M - 0.0019M$$

5. Substitute values into K_a.

$$K_a = \frac{[0.0019][0.0019]}{[0.1981]} = 1.82 \times 10^{-5}$$

9. Cyanic acid is a weak monoprotic acid. If the initial concentration of cyanic acid is 0.150 *M* and the equilibrium concentration of H_3O^+ is 4.8×10^{-2} *M*, calculate K_a for cyanic acid.

1. $HCN(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + CN^-(aq)$
2. Write the acid ionization expression.

$$K_a = \frac{[H_3O^+][CN^-]}{[HCN]}$$

3. *(Unlike the problems in class – the $[H_3O+]$ is given here, so no antilog necessary.)*
4. The equilibrium conc. of [HCN] = initial conc. of [HCN] – conc. of $[H_3O^+]$ at equil.

$$[HIO_3] = 0.150M - 4.8 \times 10^{-2}M$$

5. Substitute values into K_a.

$$K_a = \frac{[4.8 \times 10^{-2}][4.8 \times 10^{-2}]}{[0.102]} = 0.0226$$

10. A strong base dissociates completely in water, whereas a weak base dissociates only partially in water. The strength of a base may be quantified using the base dissociation constant, K_b. The higher the value of K_b, the stronger of the base. Strong bases are typically ionic and include the following: LiOH, NaOH, KOH, RbOH, CsOH, $Ca(OH)_2$, $Sr(OH)_2$, and $Ba(OH)_2$. Weak bases generally have covalent bonds.

11. Write the ionization equation and base ionization constant expression for the base $COOH^-$.

$$COOH^-(aq) + H_2O(l) \rightleftarrows OH^-(aq) + HCOOH(aq)$$

$$K_b = \frac{[OH^-][HCOOH]}{[COOH^-]}$$

12. Acids may provide one or more hydrogen ions as they are deprotonated. An acid that provides only a single hydrogen ion is referred to as a(n) monoprotic acid. Acids that contribute multiple hydrogen ions are called polyprotic acids. When acids contribute multiple hydrogen ions, they are removed one at a time and each hydrogen ion is more difficult to remove.

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13. Write the deprotonation sequence for arsenic acid, H_3AsO_4.

    Step 1: $H_3AsO_4(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + H_2AsO_4^-(aq)$

    Step 2: $H_2AsO_4^-(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + HAsO_4^{2-}(aq)$

    Step 3: $HAsO_4^{2-}(aq) + H_2O(l) \rightleftarrows H_3O^+(aq) + AsO_4^{3-}(aq)$

14. Substances that may act as either an acid or a base are called amphoteric substances. Water is probably the most common of these substances, but hydroxyl groups and carboxyl groups are also examples.

15. Define

    a. conjugate base: substance formed when an acid loses a hydrogen ion. Considered a base because it can gain a hydrogen ion to reform the acid.

    b. conjugate acid: substance formed when a base gains a hydrogen ion. Considered an acid because it can lose a hydrogen ion to reform the base.

16. How does an acid differ from its conjugate base? It has an additional hydrogen ion in the formula

17. How does a base differ from its conjugate acid? It has one fewer hydrogen ion in the formula

18. Determine the acid-base conjugate pairs for the following reaction:

$$CO_3^{2-}(aq) + H_2O(l) \rightarrow HCO_3^-(aq) + OH^-(aq)$$

$CO_3^{2-}(aq)$ is a base because it can accept H^+ to form HCO_3^-
$H_2O(l)$ is an acid because it can donate H^+ to form OH^-
$HCO_3^-(aq)$ is an acid because it can donate H^+ to form CO_3^-
$OH^-(aq)$ is a base because it can accept H^+ to form H_2O

19. Determine the acid-base conjugate pairs for the following reaction:

$$HF(aq) + H_2O(l) \rightarrow H_3O^+(aq) + F^-(aq)$$

$HF(aq)$ is an acid because it can donate H^+ to form F^-
$H_2O(l)$ is a base because it can accept H^+ to form H_3O^+
$H_3O^+(aq)$ is an acid because it can donate H^+ to form H_2O
$F^-(aq)$ is a base because it can accept H^+ to form HF

20. Strong acids have weak conjugate bases. Weak bases have strong conjugate bases. Strong bases have weak conjugates acids. Weak bases have strong conjugate bases.

21. In neutralization reactions the products will include salt and water. Carbonates and hydrogen carbonates will also produce CO_2. SO_2 gas may be produced in neutralization reactions if sulfites or bisulfites ions are present.