…istry 2015-2016 **Name:** KEY

Acid Base Review **Date:** **Per:**

Directions: For conceptual questions, answer in complete sentences. For calculation questions, show all work.

1) How does Arrhenius define an acid and a base?

2) How do Brønsted-Lowry define an acid and a base?

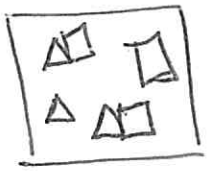
should be in your notes, or do a google search

3) What is the difference between a strong acid/base and a weak acid/base?

Strong acids (or bases) fully dissociate or ionize in water, weak acids/bases only partially ionize

4) Draw a particle view to support your answer to #3.

strong



weak

5) Circle the parts of the chemical formulas shown below that make them an acid or a base. Label each as acid or base.

(H)Cl A (H)F A (H)C$_2$H$_3$O$_2$ A (H)$_2$SO$_4$ A Na(OH) B Ca(OH)$_2$ B

6) What is pH a measure of?

hydrogen ion concentration (how acidic a solution is)

7) Can you raise the pH of an acid above 7 by adding water? Why or why not?

no, you can dilute it to 7 but in order to go above 7 you must add an excess of OH^-, which water cannot provide.

8) What does it mean when we say an acid has been neutralized?

An equal number of moles of base have been added to it, creating water solution now has a pH of 7.

9) Write the neutralization reactions for the following:

a. Sodium hydroxide and nitric acid

$NaOH + HNO_3 \rightarrow NaNO_3 + H_2O$

b. Sulfuric acid and potassium hydroxide

$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$

c. Acetic acid and calcium hydroxide

$2HCH_3COO + Ca(OH)_2 \rightarrow Ca(CH_3COO)_2 + 2H_2O$

d. Phosphoric acid (H_3PO_4) and Barium hydroxide

$2H_3PO_4 + 3Ba(OH)_2 \rightarrow Ba_3(PO_4)_2 + 6H_2O$

10) During a titration, a base with a known concentration is added to an acid of known volume but unknown concentration. When do you know the titration is done?

- when the bromothymol blue indicator turns green, pH = 7, indicating a neutral solution

11) What does "equivalence point" mean and how does it relate to a titration?

there are equal numbers of moles of the acid + base, indicating a neutral solution. This is the point at which the titration data can be used to calculate the concentration of the unknown.

?5M NaOH was titrated against a 45-mL sample of HCl with unknown concentration. It required .ɔmL of NaOH to turn the bromothymol blue indicator green. What is the molarity of the HCl?

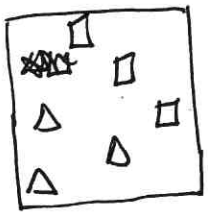
$M_A = ?$
$V_A = 45\ mL$
$M_B = 0.25\ M$
$V_B = 27.3\ mL$

$(45)(M_a) = (0.25)(27.3)$
$M_a = 0.15\ M$

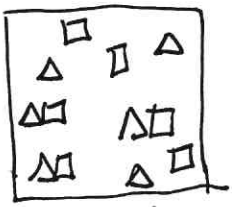
13) Draw particle views representing a strong acid and weak acid of **equal molarity**. Explain why you drew your pictures that way.

see #4

14) Draw particle views representing a strong base and weak base where the weak base has a *higher* molarity than the strong base. Explain why you drew your pictures that way.



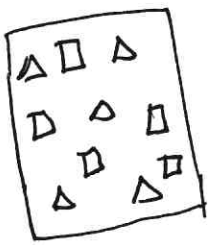
strong



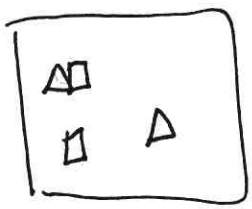
weak

weak has more particles over all (higher molarity) but is still only partially dissociated

15) Draw particle views representing a strong base and weak base where the weak base has a *lower* molarity than the strong base. Explain why you drew your pictures that way.



strong



weak

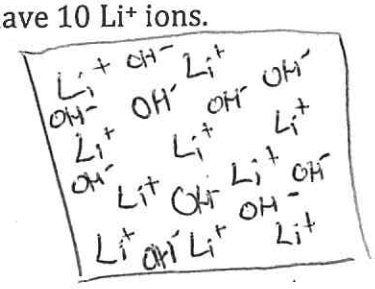
(pretend I drew these boxes to be the same size)

strong has more particles (higher molarity) & all are dissociated.

Problem A (16-21)

☞A student has two solutions, 0.3 M HCl and 0.7 M LiOH.

16) LiOH is a strong base. Draw a particle diagram showing the dissociation of LiOH. Assume that you have 10 Li^+ ions.



10 of each

17) Calculate the [H+], [OH-], and pH of the LiOH solution.

$[OH^-] = 0.7\ M$

$0.7 \times [H^+] = 1 \times 10^{-14}$

$[H^+] = 1.43 \times 10^{-14}\ M$ $pH = -\log(1.43 \times 10^{-14}) = 13.85$

18) Calculate the [H+], [OH-], and pH of the HCl solution.

$[H^+] = 0.3\ M$

$[OH^-] = \frac{1 \times 10^{-14}}{0.3} = 3.33 \times 10^{-14}\ M$

$pH = -\log(0.3) = 0.52$

19) According to the Arrhenius theory of acids and bases, why is HCl considered an acid and why is LiOH considered a base?

puts OH^- ions into solution

puts H^+ ions into solution

20) Write the balanced equation showing the neutralization reaction between LiOH and HCl. Label the acid, base and ionic salt produced. Give the name of the ionic salt

$LiOH + HCl \rightarrow H_2O + LiCl$

base acid water lithium chloride ionic salt

21) What volume of 0.3 M HCl is required to titrate 10 mL of the 0.7 M LiOH to neutrality?

$M_a = 0.3$
$V_a = ?$
$M_b = 0.7$
$V_b = 10$

$(0.3)(V_a) = (0.7)(10)$

$V_a = 23.3\ mL$

Problem B (22-26)

☞A student has a solution of ammonium hydroxide with a pH of 10.

22) Calculate the [H+], [OH-], and pH of the solution.

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

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

$pH = -\log(1 \times 10^{-10}) = 10$

23) The student is asked to dilute a 1 mL of the ammonium hydroxide sample from its pH of 10 to a neutral pH. Explain how to do this using:

a. Serial Dilution (1 mL at a time – like we did in the lab)

Adding 9 mL of water will change the pH to 9. Take 1mL out, and add 9 mL water to that. pH now is 8. Repeat for a pH of 7.

b. A one-step dilution ($M_1V_1 = M_2V_2$)

pH = 10
pOH = 4
$M_1 = 10^{-4}$ $V_1 = 1$ mL
$M_2 = 10^{-7}$ $V_2 = ?$

$(10^{-4})(1) = (10^{-7})(V_2)$

$V_2 = 1000$ mL

$V_w = 1000 - 1 =$ **Add 999 mL of H_2O**

24) If you have a 25 mL sample of the ammonium hydroxide solution, how many moles of OH^- do you have?

$[OH^-]M = 10^{-4}$

$10^{-4} = \frac{x\ mol}{.025\ L}$ $\quad x = 2.5 \times 10^{-6}$ moles OH^-

25) If you add 50 mL of water to the ammonium hydroxide solution, what is the new OH^- concentration of the solution?

$V_1 = 25$ mL
$M_1 = 10^{-4}$
$M_2 = ?$
$V_2 = 75$ mL

$(25)(10^{-4}) = (75)(M_2)$

$M_2 = 3.3 \times 10^{-5}\ M$

26) What is the new pH of the solution?

$[OH^-] = 3.3 \times 10^{-5}$

$pOH = -\log(3.3 \times 10^{-5}) = 4.477$

$pH = 14 - pOH$
$14 - 4.477$
$pH = 9.52$

27) What are the products of the neutralization reaction of an acid and a base?

Ionic salt + H_2O

28) What is the pH of a neutralization reaction that has gone to completion?

7

29) Complete these neutralization equations (*neutralization reaction = double displacement*):

$HCl + LiOH \rightarrow H_2O + LiCl$

$HNO_3 + CsOH \rightarrow H_2O + CsNO_3$

$HBr + KOH \rightarrow KBr + H_2O$

30) In a titration of $HClO_4$ with NaOH, 100.0 mL of the base was required to neutralize 20.0 mL of 5.0 M $HClO_4$. Write the neutralization reaction. What is the molarity of the NaOH?

$HClO_4 + NaOH \rightarrow NaClO_4 + H_2O$

$M_A = 5 \quad M_B = ?$
$V_A = 20 \quad V_B = 100$

$(5)(20) = (100)(M_B)$

$M_B = 1.0\ M$

31) In a titration of HNO_3 with NaOH, 60.0 mL of 0.020 M NaOH was needed to neutralize 15.0 mL of HNO_3. Write the neutralization reaction. What is the molarity of the acid?

$V_B = 60 \quad V_A = 15$
$M_B = 0.02 \quad M_A = ?$

$(15)(M_A) = (60)(.02)$

$M_A = 0.08\ M$

32) If 10.0 mL of 0.300 M KOH are required to neutralize 30.0 mL of stomach acid (HCl), what is the molarity of the stomach acid?

$M_A = ? \quad M_B = 0.3$
$V_A = 30 \quad V_B = 10$

$(30)(M_A) = (0.3)(10)$

$M_A = 0.1\ M$

33) How many mLs of 0.22 M CsOH solution is needed to neutralize 26.4 mL of 0.250 M HBr?

$M_A = 0.250 \quad V_B = ?$
$V_A = 26.4\ mL \quad M_B = 0.22$

$(0.250)(26.4) = V_B \times 0.22$

$V_B = 30\ mL$

34) 25.0 mL 1.00 M HCl are required to neutralize a Drano solution (NaOH). How many moles of NaOH are present in the solution?

Moles acid = moles base

$1 = \frac{\text{moles}}{.025}$ moles = .025

35) A 100 mL sample of H_2SO_4 is titrated with 2.0 M NaOH. After 50 mL of NaOH are added, an indicator changes color at pH 7. What is the starting concentration of H_2SO_4?

$M_A = ?$ $M_B = 2$

$V_A = 100$ $V_B = 50$

$(100)(M_A) = (2)(50)$

$M_A = 1.0M$

↑ this is $[H^+]$, not $[H_2SO_4]$

$2[H_2SO_4] = [H^+]$

so $[H_2SO_4] =$ 0.5M

36) Lulu Labwrecker carefully pipets 25.0 mL of 0.525 M NaOH into a test tube. She places the test tube into a small beaker to keep it from spilling and then pipets 75.0 mL of 0.355 M HCl into another test tube. When Lulu reaches to put this test tube of acid into the beaker along with test tube of base she accidentally knocks the test tubes together hard enough to break them and their respective contents combine in the bottom of the beaker. Is the solution formed from the contents of the two test tubes acidic or basic? What is the pH of the resulting solution?

$0.525 = \frac{\text{moles}}{0.025}$

0.013125 moles OH^-

$0.355 = \frac{\text{moles}}{.075}$

0.026625 moles H^+

Acidic solution, $H^+ > OH^-$

0.026625 − 0.013125 → 0.0135 excess H^+ moles

$[H^+] = \frac{0.0135}{0.1\,L} = 0.135\,M$

$pH = -\log(0.135) =$ 0.87

37) A student mixes 100 mL of 0.20 M HCl with different volumes of 0.5 M NaOH. Are the final solutions acidic, basic, or neutral? Explain your thinking.

a. 100 mL of 0.20 M HCl + 20 mL of 0.50 M NaOH

acidic, less than 40 mL base added

b. 100 mL of 0.20 M HCl + 40 mL of 0.50 M NaOH

neutral, see right →

c. 100 mL of 0.20 M HCl + 60 mL of 0.50 M NaOH

basic - more than 40 mL base added

When solution is neutral:

$(100)(.2) = (0.5)(V_B)$

$V_B = 40\,mL$

40 mL of Base added = neutral solution

M_B

38) Imagine you use 0.95 M NaOH to titrate several water samples. The volume of base needed to neutralize a specified amount of acid is given. For each, determine the acid concentration and the pH of the acid before the neutralization.

d. 25 mL acid, 46 mL NaOH

$V_A \quad V_B$

$(25)(M_A) = (46)(.95)$

$M_A = 1.748\ M$

$-\log(1.748) = -0.24$

e. 10 mL acid, 17 mL NaOH

$(10)(M_A) = (17)(.95)$

$M_A = 1.615\ M$

$-\log(1.615) = -0.21$

f. 25 mL acid, 12 mL NaOH

$(25)(M_A) = (12)(.95)$

$M_A = 0.456 M$

$-\log(0.456) = 0.34$

39) What is the pH of a solution with a volume of 5.4 L that contains 15 grams of hydrochloric acid and 25 grams of nitric acid?

$15\ g\ HCl \times \frac{1\ mol}{36.46\ g} = 0.411\ mol$

$+$

$25\ g\ HNO_3 \times \frac{1\ mol}{63.01\ g} = 0.397\ mol$

0.808 total moles of acid

$\frac{0.808}{5.4} = 0.1496\ M$

$-\log(0.1496) =$

0.82

40) A swimming pool has a volume of one million liters. How many grams of HCl would need to be added to that swimming pool to bring the pH down from 7 to 4? (Assume the volume of the HCl is negligible)

$1 \times 10^6\ L$

Initial $[H^+] = 10^{-7}\ M$

Final $[H^+] = 10^{-4}\ M$

Initial

$10^{-7} = \frac{moles}{1 \times 10^6\ L}$

$moles = 0.1$

Final

$10^{-4} = \frac{moles}{1 \times 10^6}$

$moles = 100$

$100 - 0.1 = 99.9$

$99.9\ moles\ HCl \times \frac{36.46\ g}{1\ mole} = 3642\ g$

must be added

$(3.6\ kg)$