BRONSTED - LOWRY ACIDS & BASES WORKSHEET

According to Bronsted-Lowry theory, an acid is a proton (H^{+1}) donor, and a base is a proton acceptor. Label the Bronsted-Lowry acids (A), bases (B), conjugate acids (CA), and conjugate bases (CB) in the following reactions.

EXAMPLE: H_2O + Cl^{-1} ←→ OH^{-1} + HCl
A B CB CA

1. $C_6H_5NH_2$ + H_2O ←→ $C_6H_5NH_3^{+1}$ + OH^{-1}

2. H_2SO_4 + OH^{-1} ←→ HSO_4^{-1} + H_2O

3. HSO_4^{-1} + H_2O ←→ SO_4^{-2} + H_3O^{+1}

4. HBr + OH^{-1} ←→ H_2O + Br^{-1}

5. NH_3 + H_2O ←→ NH_4^{+1} + OH^{-1}

CONJUGATE ACID-BASE PAIRS WORKSHEET

A conjugate base is what is left after an acid gives up its proton.
A conjugate acid is what is made once a base gains a proton.

ACID	BASE
	HSO_4^{-1}
H_3PO_4	
	F^{-1}
	NO_3^{-1}
$H_2PO_4^{-1}$	
H_2O	
	SO_4^{-2}
HPO_4^{-2}	
NH_4^{+1}	
	H_2O

The stronger the acid, the weaker its conjugate base.
The weaker the acid, the stronger the conjugate base.

Which is a weaker base, Cl^{-1} or NO_2^{-1}?

Which is a stronger base, HSO_4^{-1} or $H_2PO_4^{-1}$?

pH and pOH WORKSHEET

Part 1 - Calculate the pH and identify as acidic, basic, or neutral.

1.) $[H^{+1}] = 1.0 \times 10^{-6}$ M pH = ____ A B N
2.) $[H^{+1}] = 2.61 \times 10^{-2}$ M pH = ____ A B N
3.) $[H^{+1}] = 4.0 \times 10^{-9}$ M pH = ____ A B N
4.) $[H^{+1}] = 5.9 \times 10^{-12}$ M pH = ____ A B N
5.) $[H^{+1}] = 1.0 \times 10^{-7}$ M pH = ____ A B N

Part 2 - Calculate the $[H^{+1}]$ and identify as acidic, basic, or neutral.

6.) pH = 4.00 $[H^{+1}]$ = _________ M A B N
7.) pH = 5.89 $[H^{+1}]$ = _________ M A B N
8.) pH = 7.00 $[H^{+1}]$ = _________ M A B N
9.) pH = 12.25 $[H^{+1}]$ = _________ M A B N
10.) pH = 9.11 $[H^{+1}]$ = _________ M A B N

Part 3 - Calculate the missing $[H^{+1}]$ or $[OH^{-1}]$ and identify as acidic, basic, or neutral.

11.) $[H^{+1}] = 4.2 \times 10^{-6}$ M $[OH^{-1}]$ = _________ M A B N
12.) $[H^{+1}]$ = _________ M $[OH^{-1}] = 4.3 \times 10^{-5}$ M A B N

Part 4 - Complete the following chart.

Solution	pH	pOH	$[H^{+1}]$	$[OH^{-1}]$
A	3.68			
B				8.60×10^{-5} M
C			1.80×10^{-9} M	
D		5.48		
E	10.84			
F			3.82×10^{-11} M	
G		2.85		

<u>ACID-BASE TITRATION WORKSHEET</u>

1.) A 25.0 mL sample of HCl was titrated to the endpoint with 15.0 mL of 2.0 M NaOH. What is the molarity of the HCl?

2.) A 10.0 mL sample of H_2SO_4 was exactly neutralized by 13.5 mL of 1.0 M KOH. What is the molarity of the H_2SO_4?

3.) How much 1.5 M NaOH is necessary to exactly neutralize 20.0 mL of 2.5 M H_3PO_4?

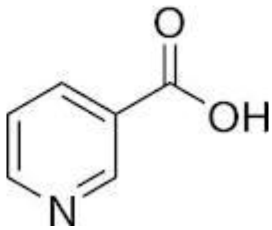
4.) How much of 0.50 M HNO_3 is necessary to titrate 25.0 mL of 0.050 M $Ca(OH)_2$ solution to the endpoint?

5.) What is the molarity of NaOH solution if 15.0 mL is exactly neutralized by 7.5 mL of a 0.020 M $HClO_3$ solution?

<u>Weak Acids & K_a WORKSHEET</u> (taken from *Chemistry – The Central Science*)

Before solving the problem, write out the dissociation equation for the weak acid. Then, write the Keq expression for each. (This K_{eq} expression gets renamed K_a when used with acids.)

1. A student prepared a 0.10 M solution of formic acid, $HCHO_2$ (monoprotic), and measured its pH at 25°C to be 2.38. Calculate the K_a for formic acid at this temperature.



2. Niacin, one of the B vitamins, has the following molecular structure: (When writing the dissociation equation for niacin, use "H-Nia" as the formula for niacin.)
A 0.020 M solution of niacin has a pH of 3.26. What is the acid dissociation constant, K_a, for the ionizable proton?

3. The K_a value for acetic acid at 25°C is 1.8×10^{-5}. What is the pH of a 0.30 M acetic acid solution at 25°C?

4. Calculate the pH of a 0.20 M solution of HCN. (The K_a for HCN is 4.9×10^{-10}.)

5. The K_a for niacin is 1.5×10^{-5}. What is the pH of a 0.010 M solution of niacin?

6. Lactic acid, $HC_3H_5O_3$, has one acidic hydrogen. A 0.10 M solution of lactic acid has a pH of 2.44. Calculate the K_a for lactic acid.

Answers:
1. $K_a = 1.8 \times 10^{-4}$, 2. $K_a = 1.5 \times 10^{-5}$, 3. pH = 2.64, 4. pH = 5.00, 5. pH = 3.41, 6. $K_a = 1.4 \times 10^{-4}$

UNIT 14 REVIEW WORKSHEET

Part 1 – Tell whether each of the following properties describes an acid (A), a base (B), or both (AB).

_____ 1. taste bitter
_____ 2. lose a proton (B-L Theory)
_____ 3. feel slippery
_____ 4. change color of indicators
_____ 5. 2nd part of formula is usually OH
_____ 6. 1st element in formula is usually H
_____ 7. conduct electricity
_____ 8. taste sour
_____ 9. gain a proton (B-L Theory)
_____ 10. react with metals to form H_2 gas

Part 2 – Acid Nomenclature – Write the name or the formula for the following acids.

11. HI
12. HNO_2
13. H_3PO_4
14. hydrobromic acid
15. carbonic acid
16. sulfurous acid

Part 3 – Answer the following questions.

17. According to the Arrhenius theory, acids increase _____ ion concentration in aqueous solution. Bases increase _____ ion concentration
18. List the six (6) strong acids.

19. How do you know if a base is strong or weak?

20. Define conjugate acid.

21. Define conjugate base.

22. The stronger an acid is, the __________ its conjugate base.
23. Which is a stronger base, ClO_4^{-1} or S^{-2}?

24. Which is a weaker base, I^{-1} or SO_4^{-2}?

25. What does it mean if a compound is said to be amphoteric?

26. Can SO_4^{-2} be amphoteric? Why or why not?

27. What is the conjugate base of…
    (A) NH_3 (B) H_2SO_4 (C) $H_2PO_4^{-1}$

28. What is the conjugate acid of…
    (A) $H_2PO_4^{-1}$ (B) HSO_4^{-1} (C) HCO_3^{-1}

29. When an acid and a base react with each other, what are the two (2) products?

Part 4 – Draw lines between the conjugate acid-base pairs and label the acid (A), base (B), conjugate acid (CA), and conjugate base (CB).

30. $H_2SO_4 + H_2O \leftrightarrow HSO_4^{-1} + H_3O^{+1}$

31. $NH_3 + H_2O \leftrightarrow NH_4^{+1} + OH^{-1}$

32. $HPO_4^{-2} + H_2O \leftrightarrow H_3O^{+1} + PO_4^{-3}$

Part 5 - Solve the following problems.

33. What is the pH of a solution whose $[OH^{-1}]$ is 3.08×10^{-3} M?

34. What is the $[OH^{-1}]$ of a solution whose $[H^{+1}]$ is 5.92×10^{-2} M?

35. What is the concentration (molarity) of NaOH if 15.3 mL are needed to completely neutralize 20.4 mL of 2.50 M H_2SO_4?

36. What volume of 1.50 M $Ca(OH)_2$ is needed to reach the endpoint of a titration using 17.2 mL of 3.00 M H_3PO_4?

Part 6 – Fill in the following chart.

pOH	pH	$[OH^{-1}]$	$[H^{+1}]$	A, B, or N
4.63				
	11.75			
		2.96×10^{-8} M		
			5.27×10^{-9} M	

ACID – BASE TITRATION LAB

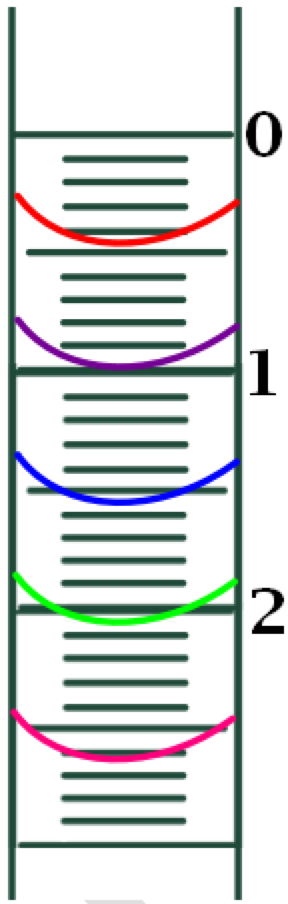
PURPOSE: - to determine the molarity of an aqueous solution of hydrochloric acid (HCl)
- to learn and practice the technique for titration

MATERIALS:

EQUIPMENT
- 2 burets (labeled "A" and "B")
- double buret clamp
- ring stand
- Erlenmeyer flask

CHEMICALS
- _________ M NaOH
- phenolphthalein
- ? M HCl

READING A BURET:



PROCEDURE:

1.) Obtain approximately 10 mL of HCl from the buret labeled "A" for acid in the Erlenmeyer flask. (It is not necessary to have EXACTLY 10.00 mL. However, the volume of the HCl should be measured to the nearest hundredth.)

2.) Add 3 or 4 drops of phenolphthalein. (Only a few drops are needed. Adding more than 3 or 4 drops will not make the reaction any bigger or better.)

3.) Add NaOH from the buret labeled "B" for base SLOWLY until the solution changes color. (When the solution changes color, the acid is neutralized. Ideally, the solution in the flask should be a very faint shade of the color.)

DATA TABLE:

		TRIAL 1	TRIAL 2	TRIAL 3
1	Reading of HCl (at start)	mL	mL	mL
2	Reading of HCl (at end)	mL	mL	mL
3	Volume of HCl used	mL	mL	mL
4	Reading of NaOH (at start)	mL	mL	mL
5	Reading of NaOH (at end)	mL	mL	mL
6	Volume of NaOH used	mL	mL	mL

QUESTIONS AND CALCULATIONS:

1.) Write a balanced equation for the neutralization reaction that occurs between hydrochloric acid (HCl) and sodium hydroxide (NaOH).

2.) What is the mole ratio between HCl and NaOH in the balanced equation?

3.) What volume of HCl was used in TRIAL 1? Show how you determined this volume.

4.) What volume of NaOH was used in TRIAL 1? Show how you determined this volume.

5.) The NaOH had a concentration of __________ M. Using your data, what is the concentration (molarity) of the hydrochloric acid? (CLEARLY and LEGIBLY show your calculations in detail!)

6.) If your group was able to do more than one trial, what was the average molarity?