ARRHENIUS THEORY OF ACIDS & BASES NOTES

Acids increase concentration of _____ ions in aqueous solution.
~ Acids have more ____ ions than ____ ions.
~ Formulas for acids begin with ____.

Bases increase concentration of _____ ions in aqueous solution.
~ Bases have more ____ ions than ____ ions.
~ Formulas for bases end with ____.

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NAMING ACIDS NOTES

Binary acids (H + one element)
1. "hydro-"
2. root of name of second element
3. "-ic"

Practice:
- HF
- H_2S

Oxyacids (H + more than 1 element)
1. root of polyatomic ion - HNO_3
2. a. If negative ion ends with "-ate", use "-ic" ending
   b. If negative ion ends with "-ite", use "-ous" ending - $HClO_2$

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MONOPROTIC & POLYPROTIC ACIDS NOTES

~ How many hydrogens does each type contain?
* MONOPROTIC = ___ H's * DIPROTIC = ___ H's * TRIPROTIC = ___ H's

NEUTRALIZATION REACTIONS

~ ACID + BASE → _____ + _____
H^+neg^- + pos^+OH^-

~ salt:

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pH and pOH NOTES

Self-Ionization of Water: $H_2O + H_2O \leftrightarrow H_3O^+ + OH^-$
- Water molecules have the ability to self-ionize.
- This is a naturally-occurring phenomenon.
- In one liter of pure water at 25 ^oC,
  the concentration of H_3O^+ or simply H^+= 0.0000001 moles/liter
  the concentration of OH^- = 0.0000001 moles/liter
  or
  $[H_3O^+] = [H^+] = 1.0 \times 10^{-7}$ moles/L
  $[OH^-] = 1.0 \times 10^{-7}$ moles/L

pH: the negative log of the hydrogen ion concentration $[H^+]$
pOH: the negative log of the hydroxide ion concentration $[OH^-]$
- Solve for the pH of pure water:
  $pH = -\log [H_3O^+]$ $pOH = -\log [OH^-]$
  $pH = -\log [1.0 \times 10^{-7}]$ $pOH = -\log [1.0 \times 10^{-7}]$
  $pH = 7$ $pOH = 7$
- Equations that will be helpful when solving pH and pOH problems:
  $pH = -\log [H^+]$ $[H^+] = 10^{-pH}$
  $pOH = -\log [OH^-]$ $[OH^-] = 10^{-pOH}$
  $pH + pOH = 14$
  $K_w = [H^+] \cdot [OH^-] = 1 \times 10^{-14}$

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0                          7                          14
<--------------------------|--------------------------->
        acids           neutral          bases
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pH and pOH WORKSHEET

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

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

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

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

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

11.) $[H^+] = 4.2 \times 10^{-6}$ M $[OH^-]$ = _____ M A B N
12.) $[H^+]$ = _____ M $[OH^-] = 8.7 \times 10^{-5}$ M A B N

Part 4 - Complete the following chart.

Solution	pH	pOH	$[H^+]$	$[OH^-]$	A, B, N
A	3.68				
B				8.60×10^{-5} M	
C			1.80×10^{-13} M		
D		3.72			
E	10.84				
F			3.82×10^{-10} M		
G		2.85			

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ACID - BASE TITRATION NOTES

TITRATION: process used in Chemistry lab to determine the concentration of an acid or a base; use a base or an acid with a known concentration to neutralize the acid or base with the unknown concentration
Titration problems are stoichiometry problems in disguise.

What is the molarity of a H_2SO_4 solution if 190 mL of the acid is required to exactly neutralize 150 mL of a 2.5 M NaOH solution? Eqn for neutralization: $H_2SO_4 + \mathbf{2}\ NaOH \rightarrow \mathbf{2}\ H_2O + Na_2SO_4$

Reminder! Steps for stoichiometry:
1) Find moles of given substance. 2) Use mole ratio from balanced equation. 3) Find answer.

The problem says that there are 150 mL of a 2.5 M NaOH solution.

Molarity (M) = $\frac{\text{moles of solute}}{\text{Liters of solution}}$ Use the molarity definition equation to calculate the number of moles of the given substance (in this case, NaOH).

Step 1 = $2.5 = \frac{x}{0.15}$ x = 0.375 moles NaOH

Step 2 = $\frac{0.375 \text{ moles NaOH}}{2} = \frac{x \text{ moles } H_2SO_4}{1}$ x = 0.1875 moles H_2SO_4

Step 3 = $M = \frac{0.1875 \text{ moles } H_2SO_4}{0.19 \text{ L}}$ $M = 0.99 \text{ M } H_2SO_4$

Because titrations always involve an acid and a base neutralizing each other, we don't have to go through all of these steps, the process can be shortened…

EQUATION TO USE FOR SOLVING TITRATION PROBLEMS: $\boxed{n_A \cdot M_A \cdot V_A = n_B \cdot M_B \cdot V_B}$

n_A = number of Hs at the beginning of the formula for the acid

M_A = molarity of the acid V_A = volume of the acid

n_B = number of OHs in the formula for the base

M_B = molarity of the base V_B = volume of the base

EXAMPLE PROBLEM:

What is the molarity of a H_2SO_4 solution if 190 mL of the acid is required to exactly neutralize 150 mL of a 2.5 M NaOH solution? (Same problem as above. Just so you can see that we get the same answer...)

$n_A \cdot M_A \cdot V_A = n_B \cdot M_B \cdot V_B$

$2 \cdot M \cdot 190 = 1 \cdot 2.5 \cdot 150$

$380\ M = 375$

$M = 0.99$ M

What is the volume of a sample of 0.25 M HCl that requires 26.15 mL of 0.58 M NaOH to neutralize it?

ACID-BASE TITRATION WORKSHEET

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?

STRONG VS. WEAK ACIDS & BASES (ARRHENIUS THEORY) NOTES

Strong acid:

- The 6 strong acids are

Weak acid:

- any acid besides the 6 mentioned above

Strong base:

- Solution of strong base is called
- Strong bases contain any Group 1 or 2 metal (except Be) with OH^-

Weak base:

- any base other than ones mentioned above

PROPERTIES OF ACIDS

1.
2.
3.
4.
5.

PROPERTIES OF BASES

1.
2.
3.
4.
5.

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BRONSTED-LOWRY ("B-L") THEORY OF ACIDS & BASES NOTES

~ Involve the transfer of a "proton". A proton is

Acid:

conjugate base (CB):

Base:

conjugate acid (CA):

How do you determine an acid's conjugate base and a base's conjugate acid?

~ An acid is a proton donor. So, conjugate base is the formula for the acid _____ _____.

** EXAMPLE: Acid = HCl; Conjugate Base (CB) =

~ A base is a proton acceptor/recipient. So, conjugate acid is the formula for the base _____ _____.

** EXAMPLE: Base = NO_3^{-1}; Conjugate Acid (CA) =

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AMPHOTERISM NOTES

Example:

$HNO_3 + H_2O \leftrightarrow NO_3^- + H_3O^+$ Water acts as (acid / base)

$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$ Water acts as (acid / base)

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BRØNSTED - LOWRY ACIDS & BASES WORKSHEET

Label the Brønsted-Lowry acids (A), bases (B), conjugate acids (CA), and conjugate bases (CB) in the following reactions.

EXAMPLE: $H_2O + Cl^- \leftrightarrow OH^- + HCl$

A B CB CA

1. $C_6H_5NH_2 + H_2O \leftrightarrow C_6H_5NH_3^+ + OH^-$

2. $H_2SO_4 + OH^- \leftrightarrow HSO_4^- + H_2O$

3. $HSO_4^- + H_2O \leftrightarrow SO_4^{-2} + H_3O^+$

4. $HBr + OH^- \leftrightarrow H_2O + Br^-$

5. $NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$

CONJUGATE ACID-BASE PAIRS WORKSHEET

ACID	BASE
	HSO_4^-
H_3PO_4	
	F^-
	NO_3^-
$H_2PO_4^-$	
H_2O	

ACID	BASE
	SO_4^{-2}
HPO_4^{-2}	
NH_4^+	
	H_2O
	NO_2^-
NH_3	

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STRENGTH RULE OF ACIDS & BASES (B-L theory):

**The stronger a base is, the _____ its conjugate acid.

**The weaker a base is, the _____ its conjugate acid.

**The stronger an acid is, the _____ its conjugate base.

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

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

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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 (in Arrhenius theory)?

20. The stronger a base is, the _____ its conjugate acid.

21. Which is a stronger base, ClO_4^{-1} or S^{-2}?

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

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

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

25. What is the conjugate base of…
(A) NH_3 (B) H_2SO_4 (C) $H_2PO_4^-$

26. What is the conjugate acid of…
(A) $H_2PO_4^-$ (B) HSO_4^- (C) HCO_3^-

27. 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).

28. $H_2SO_4 + H_2O \leftrightarrows HSO_4^- + H_3O^+$

29. $NH_3 + H_2O \leftrightarrows NH_4^+ + OH^-$

30. $HPO_4^{-2} + H_2O \leftrightarrows H_3O^+ + PO_4^{-3}$

Part 5 - Solve the following problems.

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

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

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

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