

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
- H₂S

Oxyacids (H + more than 1 element)

1. root of polyatomic ion
2. a. If negative ion ends with "-ate", use "-ic" ending
- b. If negative ion ends with "-ite", use "-ous" ending

- HNO₃

- HClO₂

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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 + posOH⁻

~ salt:

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pH and pOH NOTES

Self-Ionization of Water: $\text{H}_2\text{O} + \text{H}_2\text{O} \leftrightarrow \text{H}_3\text{O}^+ + \text{OH}^-$

- Water molecules have the ability to self-ionize.
- This is a naturally-occurring phenomenon.
- In one liter of pure water at 25 °C,
 the concentration of H₃O⁺ or simply H⁺ = 0.0000001 moles/liter
 the concentration of OH⁻ = 0.0000001 moles/liter

or

$$[\text{H}_3\text{O}^+] = [\text{H}^+] = 1.0 \times 10^{-7} \text{ moles/L}$$

$$[\text{OH}^-] = 1.0 \times 10^{-7} \text{ moles/L}$$

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:

$$\text{pH} = -\log [\text{H}_3\text{O}^+] \qquad \text{pOH} = -\log [\text{OH}^-]$$

$$\text{pH} = -\log [1.0 \times 10^{-7}] \qquad \text{pOH} = -\log [1.0 \times 10^{-7}]$$

$$\text{pH} = 7 \qquad \text{pOH} = 7$$

- Equations that will be helpful when solving pH and pOH problems:

$$\text{pH} = -\log [\text{H}^+]$$

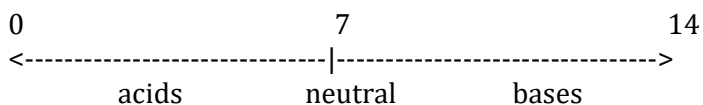
$$[\text{H}^+] = 10^{-\text{pH}}$$

$$\text{pOH} = -\log [\text{OH}^-]$$

$$[\text{OH}^-] = 10^{-\text{pOH}}$$

$$\text{pH} + \text{pOH} = 14$$

$$K_w = [\text{H}^+] \cdot [\text{OH}^-] = 1 \times 10^{-14}$$



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				$8.60 \times 10^{-5} M$	
C			$1.80 \times 10^{-13} M$		
D		3.72			
E	10.84				
F			$3.82 \times 10^{-10} M$		
G		2.85			

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: $H_2SO_4 + 2 NaOH \rightarrow 2 H_2O + Na_2SO_4$

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 = $M = \frac{0.1875 \text{ moles H}_2\text{SO}_4}{0.19 \text{ L}}$ $M = 0.99 \text{ M H}_2\text{SO}_4$

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:

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

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

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...)

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

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

$$380 M = 375$$

$$M = 0.99 \text{ M}$$

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 = NO₃⁻¹; Conjugate Acid (CA) = _____

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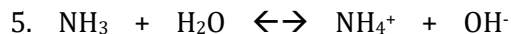
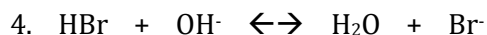
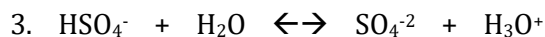
AMPHOTERISM NOTES

Example:



BRØNSTED - LOWRY ACIDS & BASES WORKSHEET

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



CONJUGATE ACID-BASE PAIRS WORKSHEET

ACID	BASE
	HSO ₄ ⁻
H ₃ PO ₄	
	F ⁻
	NO ₃ ⁻
H ₂ PO ₄ ⁻	
H ₂ O	

ACID	BASE
	SO ₄ ⁻²
HPO ₄ ⁻²	
NH ₄ ⁺	
	H ₂ O
	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 NO₂⁻?

Which is a stronger base, HSO₄⁻ or H₂PO₄⁻?

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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 | ___ 6. 1 st element in formula is usually H |
| ___ 2. lose a proton (B-L Theory) | ___ 7. conduct electricity |
| ___ 3. feel slippery | ___ 8. taste sour |
| ___ 4. change color of indicators | ___ 9. gain a proton (B-L Theory) |
| ___ 5. 2 nd part of formula is usually OH | ___ 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 | 14. hydrobromic acid |
| 12. HNO ₂ | 15. carbonic acid |
| 13. H ₃ PO ₄ | 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, ClO₄⁻¹ or S⁻²?

22. Which is a weaker base, I⁻¹ or SO₄⁻²?

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...

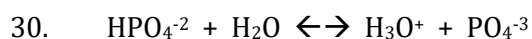
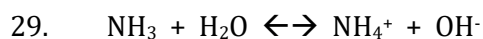
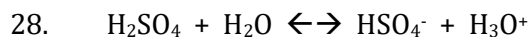
(A) H_2PO_4^-

(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).



Part 5 - Solve the following problems.

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

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

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 $\text{Ca}(\text{OH})_2$ 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	$[\text{OH}^-]$	$[\text{H}^+]$	A, B, or N
4.63				
	11.75			
		$2.96 \times 10^{-8} \text{ M}$		
			$5.27 \times 10^{-9} \text{ M}$	