

SOLUBILITY (POLAR VS. NONPOLAR) Name _____

Generally, "like dissolves like." Polar molecules dissolve other polar molecules and ionic compounds. Nonpolar molecules dissolve other nonpolar molecules. Alcohols, which have characteristics of both, tend to dissolve in both types of solvents, but will not dissolve ionic solids.

Check the appropriate columns as to whether the solute is soluble in a polar or nonpolar solvent.

SOLUTES	SOLVENTS		
	Water	CCl ₄	Alcohol
1. NaCl			
2. I ₂			
3. ethanol			
4. benzene			
5. Br ₂			
6. KNO ₃			
7. toluene			
8. Ca(OH) ₂			

Does it dissolve in H₂O?

Water is a polar covalent solvent. Therefore, it will dissolve all polar covalent compounds and most ionic compounds. Some ionic compounds are held together too tightly and will not dissolve. Check Solubility Rules to see if ionic compounds will dissolve.

Solutes	Polar Covalent, Nonpolar Covalent, or Ionic?	Will it dissolve in H ₂ O? (Use Solubility Rules for Ionic Compounds!)
KCl		
Methane (CH ₄)		
SnS ₂		
Bromine (Br ₂)		
Carbon (C)		
HCl		
CuSO ₄		
BaSO ₄		
NH ₃		
CBr ₄		
CaCO ₃		

*Reminders:

To be Polar Covalent:

- 1) $0.4 \leq \Delta EN \leq 1.7$
- 2) Shape must allow separation of charge

Electronegativities:

C - 2.5
Br - 2.8
H - 2.1
N - 3.0
Cl - 3.0

ELECTROLYTES

Name _____

Electrolytes are substances that break up (dissociate or ionize) in water to produce ions. These ions are capable of conducting an electric current.

Generally, electrolytes consist of acids, bases and salts (ionic compounds). Nonelectrolytes are usually covalent compounds, with the exception of acids.

Classify the following compounds as either an electrolyte or a nonelectrolyte.

Compound	Electrolyte	Nonelectrolyte
1. NaCl		
2. CH ₃ OH (methyl alcohol)		
3. C ₃ H ₅ (OH) ₃ (glycerol)		
4. HCl		
5. C ₆ H ₁₂ O ₆ (sugar)		
6. NaOH		
7. C ₂ H ₅ OH (ethyl alcohol)		
8. CH ₃ COOH (acetic acid)		
9. NH ₄ OH (NH ₃ + H ₂ O)		
10. H ₂ SO ₄		

SOLUBILITY CURVES

Name _____

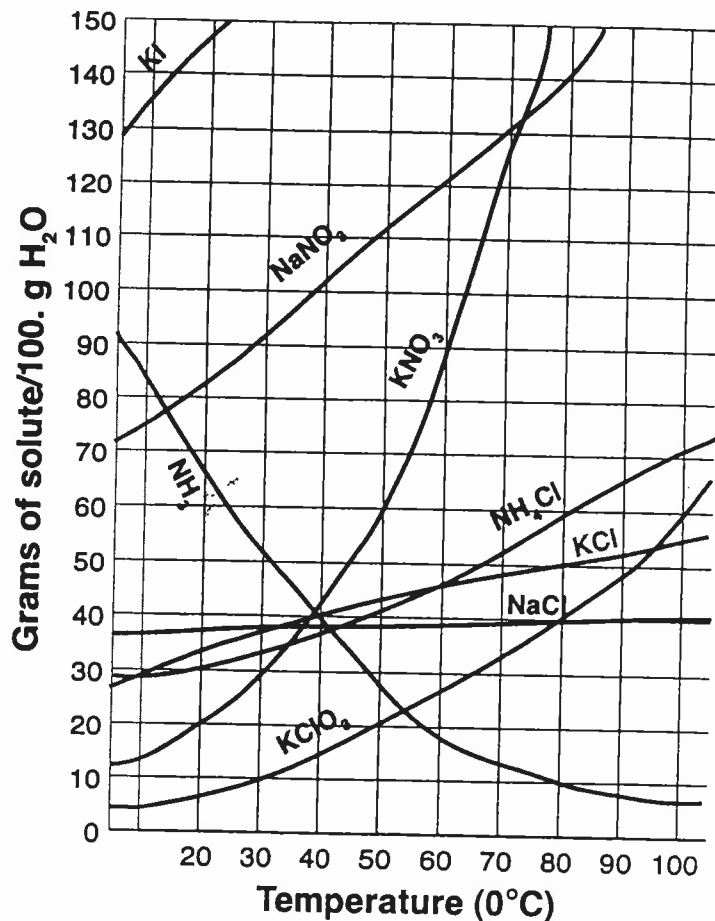
Answer the following questions based on the solubility curve below.

- Which salt is least soluble in water at 20° C? _____
- How many grams of potassium chloride can be dissolved in 200 g of water at 80° C?

- At 40° C, how much potassium nitrate can be dissolved in 300 g of water? _____
- Which salt shows the least change in solubility from 0° - 100° C?

- At 30° C, 90 g of sodium nitrate is dissolved in 100 g of water. Is this solution saturated, unsaturated or supersaturated?

- A saturated solution of potassium chlorate is formed from one hundred grams of water. If the saturated solution is cooled from 80° C to 50° C, how many grams of precipitate are formed? _____
- What compound shows a decrease in solubility from 0° to 100° C? _____
- Which salt is most soluble at 10° C? _____
- Which salt is least soluble at 50° C? _____
- Which salt is least soluble at 90° C? _____



MOLARITY (M)

Name _____

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

Solve the problems below.

1. What is the molarity of a solution in which 58 g of NaCl are dissolved in 1.0 L of solution?

2. What is the molarity of a solution in which 10.0 g of AgNO₃ is dissolved in 500. mL of solution?

3. How many grams of KNO₃ should be used to prepare 2.00 L of a 0.500 M solution?

4. To what volume should 5.0 g of KCl be diluted in order to prepare a 0.25 M solution?

5. How many grams of CuSO₄•5H₂O are needed to prepare 100. mL of a 0.10 M solution?

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MOLARITY BY DILUTION

Name _____

Acids are usually acquired from chemical supply houses in concentrated form. These acids are diluted to the desired concentration by adding water. Since moles of acid before dilution = moles of acid after dilution, and moles of acid = $M \times V$ then, $M_1 \times V_1 = M_2 \times V_2$. Solve the following problems.

1. How much concentrated 18 M sulfuric acid is needed to prepare 250 mL of a 6.0 M solution?

2. How much concentrated 12 M hydrochloric acid is needed to prepare 100 mL of a 2.0 M solution?

3. To what volume should 25 mL of 15 M nitric acid be diluted to prepare a 3.0 M solution?

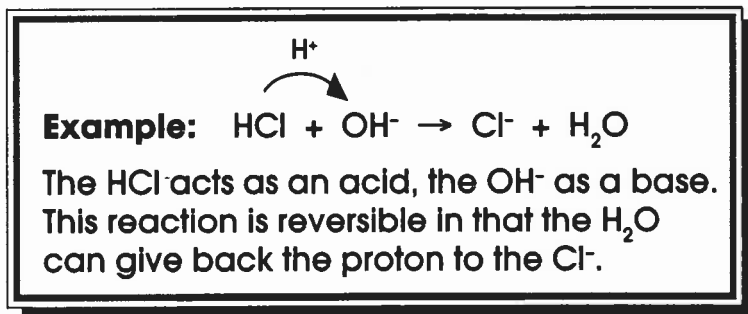
4. To how much water should 50. mL of 12 M hydrochloric acid be added to produce a 4.0 M solution?

5. To how much water should 100. mL of 18 M sulfuric acid be added to prepare a 1.5 M solution?

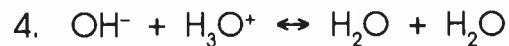
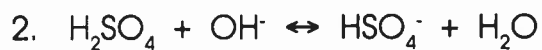
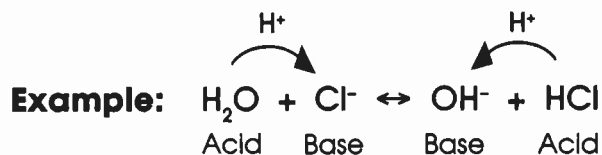
BRONSTED-LOWRY ACIDS AND BASES

Name _____

According to Bronsted-Lowry theory, an acid is a proton (H^+) donor, and a base is a proton acceptor.



Label the Bronsted-Lowry acids and bases in the following reactions and show the direction of proton transfer.



CONJUGATE ACID-BASE PAIRS

Name _____

In the exercise, Bronsted-Lowry Acids and Bases, it was shown that after an acid has given up its proton, it is capable of getting back that proton and acting as a base. Conjugate base is what is left after an acid gives up a proton. The stronger the acid, the weaker the conjugate base. The weaker the acid, the stronger the conjugate base.

Fill in the blanks in the table below.

Conjugate Pairs

	ACID	BASE	EQUATION
1.	H_2SO_4	HSO_4^-	$\text{H}_2\text{SO}_4 \leftrightarrow \text{H}^+ + \text{HSO}_4^-$
2.	H_3PO_4		
3.		F^-	
4.		NO_3^-	
5.	H_2PO_4^-		
6.	H_2O		
7.		SO_4^{2-}	
8.	HPO_4^{2-}		
9.	NH_4^+		
10.		H_2O	

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

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

pH AND pOH

Name _____

The pH of a solution indicates how acidic or basic that solution is.

pH range of 0 - 7 acidic

7 neutral

7-14 basic

Since $[H^+][OH^-] = 10^{-14}$ at $25^\circ C$, if $[H^+]$ is known, the $[OH^-]$ can be calculated and vice versa.

$pH = -\log [H^+]$ So if $[H^+] = 10^{-6} M$, $pH = 6$.

$pOH = -\log [OH^-]$ So if $[OH^-] = 10^{-8} M$, $pOH = 8$.

Together, $pH + pOH = 14$.

Complete the following chart.

	$[H^+]$	pH	$[OH^-]$	pOH	Acidic or Basic
1.	$10^{-5} M$	5	$10^{-9} M$	9	Acidic
2.		7			
3.			$10^{-4} M$		
4.	$10^{-2} M$				
5.				11	
6.		12			
7.			$10^{-5} M$		
8.	$10^{-11} M$				
9.				13	
10.		6			

pH AND pOH CONTINUED

Name _____

Calculate the pH of the solutions below.

1. 0.01 M HCl

2. 0.0010 M NaOH

3. 0.050 M Ca(OH)_2

4. 0.030 M HBr

5. 0.150 M KOH

6. 2.0 M $\text{HC}_2\text{H}_3\text{O}_2$ (Assume 5.0% dissociation.)

7. 3.0 M HF (Assume 10.0% dissociation.)

8. 0.50 M HNO_3

9. 2.50 M NH_4OH (Assume 5.00% dissociation.)

10. 5.0 M HNO_2 (Assume 1.0% dissociation.)

Acid-Base Titration: Uses a neutralization reaction to determine the concentration of an acid or base.

- **Standard Solution:** the reactant that has a known molarity
- **Endpoint:** the point at which the unknown has been neutralized.

Titration Example Problems

- 1) 8.0 mL of 0.100M NaOH is used to neutralize 20.0 mL of HCl. What is the molarity of HCl?



- 2) A 0.1M Mg(OH)₂ solution was used to titrate an HBr solution of unknown concentration. At the endpoint, 21.0 mL of Mg(OH)₂ solution had neutralized 10.0 mL of HBr. What is the molarity of the HBr solution?

Practice

- 1) What is the molarity of an Al(OH)₃ solution if 30.0 mL of the solution is neutralized by 26.4 mL of a 0.25 M HBr solution?

- 2) A 0.3 M Ca(OH)₂ solution was used to titrate an HCl solution of unknown concentration. At the endpoint, 35.0 mL of Ca(OH)₂ solution had neutralized 10.0 mL of HCl. What is the molarity of the HCl solution?

- 3) When 34.2 mL of a 1.02 M NaOH solution is added from a buret to 25.00 mL of a phosphoric acid solution that contains phenolphthalein, the solution changes from colorless to pink. What is the molarity of the phosphoric acid?

Chapter 15-16 Study Guide -- Solutions

Vocabulary

Solute	Solution	Unsaturated solution
Solvent	Alloy	Supersaturated solution
Aqueous solution	Homogeneous mixture	Dilute
Colloid	Heterogeneous mixture	Concentrated
Suspension	Saturated solution	Dissociation

1. Specifically, how are hydrogen bonds created in water? (Draw a picture.)
2. Which atom in water is more electronegative, oxygen or hydrogen?
3. What type of bond is formed between the oxygen and hydrogen within a water molecule?
4. Hydrogen bonds explain what 4 unique properties of water?
 - a.
 - b.
 - c.
 - d. high thermal energy required to melt ice
5. The high surface tension of water explains why droplets are round. Surface area is _____.
6. Water has a lower vapor pressure than other liquids because _____.
7. Water has such a high surface tension that some insects can _____.
8. For solid solutes, increasing the temperature of the solution will _____ solubility.
9. For gas solutes, increasing the temperature of the solution will _____ solubility.
10. Increasing the pressure over a solution _____ the solubility of gases in liquids.
11. If the pressure above a solution containing a gaseous solute decreases, the amount of gas dissolved will _____.
12. At what temperature is water at its maximum density?
13. Compared to water alone, a salt-water solution will have a _____ freezing point and a _____ boiling point.
14. Explain how the presence of a solute in a solution depresses the freezing point relative to the pure solvent: _____.
15. Explain how the presence of a solute in a solution elevates the boiling point relative to the pure solvent. _____.
16. What changes when you add more solvent to dilute a solution? (Check ALL that change.)

_____ mass of solvent	_____ moles of solute
_____ moles of solvent	_____ volume of solvent
_____ mass of solute	_____ volume of solution
17. What 3 things can you do in order to increase the speed at which a solute dissolves in a solvent?
 - a.
 - b.
 - c.
18. Polar solvents will dissolve _____ solutes.
19. Nonpolar solvents will dissolve _____ solutes.
20. Alcohols will dissolve _____ solutes, but not _____ solutes.
21. Water will dissolve _____ solutes, except for _____ compounds that are _____.
22. What three types of substances form electrolytes when dissolved in water?
 - 1)
 - 2)
 - 3)
23. How does the dissolving of sugar differ from the dissolving of salt?

Name: _____ Date: _____ Block: _____

Quiz – Acids and Bases

Fill in the Blank:

1. Acids produce _____ ions when dissolved in water.
2. Acids are _____ donors.
3. Acids are _____ acceptors.
4. Bases produce _____ ions when dissolved in water.
5. Bases are _____ donors.
6. Bases are _____ acceptors.
7. Identify each as an acid or a base.
 - a. KOH: _____
 - b. HBr: _____
 - c. NH₃: _____
 - d. H₃PO₄: _____
8. a) Calculate the pH if $[H^+] = 2.5 \times 10^{-2}$ M.

b) Is this solution acidic or basic? _____
9. a) Calculate the pH if $[OH^-] = 1 \times 10^{-3}$ M

b) Is this solution acidic or basic? _____
10. Calculate the pH if pOH = 9
11. A 0.3 M solution of HCl was used to titrate a Ca(OH)₂ solution of unknown molarity. At the endpoint, 40 mL of HCl had neutralized 15 mL of Ca(OH)₂.
 - a) Write a balanced equation for this neutralization reaction.

 - b) Calculate the molarity of the calcium hydroxide solution.