

Chemistry

Unit 10

Solutions

&

Acids/Bases

SOLUTIONS

WHAT IS A SOLUTION? _____

SOLUTION _____

2 PARTS OF A SOLUTION:

1. SOLUTE _____

2. SOLVENT _____



WHAT IS THE UNIVERSAL SOLVENT? _____

WHY IS IT THE UNIVERSAL SOLVENT? _____

POLAR BOND _____

NONPOLAR BOND _____

DISSOLVES

SOLUBLE- _____

INSOLUBLE- _____

WHY IS OIL INSOLUBLE IN WATER? _____

TRY THESE THREE PROBLEMS USING THE FOLLOWING CHART:

	molecular weight	density	polar	boiling point (°C)
benzene	78.11	.878	no	80
methanol	32.04	.791	yes	65
hexane	86.18	.659	no	98
octane	114.23	.702	no	126
water	18.0	1.0	yes	100

1. A student needed to dissolve a substance that she *knew* was soluble in water. According to the chart above, which other solvent would most likely dissolve the substance?

- (a) benzene (c) methanol
(b) methanol (d) octane

2. What can account for water's high boiling point and high density?

- (a) high molecular weight
(b) large molecular size
(c) hydrogen bonding
(d) ionic bonding

3. Benzene would *probably* float in—

- (a) methanol
(b) hexane
(c) octane
(d) water

TYPES OF SOLUTIONS:

-you must consider the three phases of matter: solids, liquids, gases

-mixtures (solutions) are not always just liquids!

Solid in solid: _____

Solid in liquid: _____

Solid in gas- _____

Liquid in gas- _____

Gas in liquid _____

Gas in gas _____

SOLUBILITY _____

SATURATED SOLUTION _____

UNSATURATED SOLUTION _____

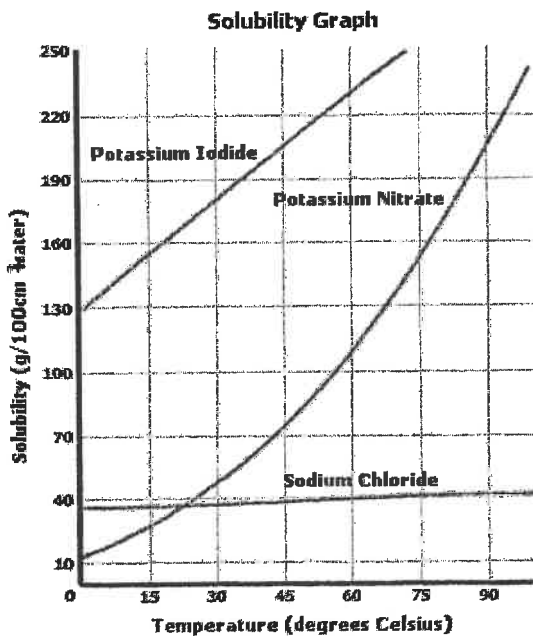
SUPERSATURATED SOLUTION _____

****Draw Pictures Below****

SOLUBILITY CURVE- a graph that shows a substance's solubility against the temperature and/or pressure

The line on a solubility curve represents a _____ solution.

Above the line is a _____ solution and below the line is a _____ solution.



How many grams of potassium chloride are able to dissolve in 100 grams of water at 80°C?

How many gram of potassium nitrate are able to dissolve in 250 grams of water at 45 °C?

electrolyte- _____

nonelectrolyte- _____

colligative property-

- not determined by the type of chemical species present (like size or charge)

Ex: freezing point depression—

Ex: boiling point elevation—

****the more particles/impurities present the greater the effect****

What are separation techniques?

a. decanting-

b. centrifugation-

c. distillation-

d. filtration-

e. evaporation-

f. chromatography-

MOLARITY AND DILUTION PROBLEMS

Concentration-a measure of the amount of solute dissolved in a solvent (usually water);

1. **dilute**- solution that does not have much solute dissolved (unsaturated); also known as a "**weak**" solution

2. **concentrated**- solution that has a high amount of solute dissolved (saturated or supersaturated); also known as a "**strong**" solution

Molarity (M)- a measure of concentration expressed as the **moles of solute** divided by the **liters of solution**;

$$\text{molarity (M)} = \frac{\text{moles}}{\text{liters}}$$

-or-

$$M = \frac{\text{mol}}{L}$$

← MEMORIZE THIS EQUATION

-you must convert the grams to moles (divide by molar mass) and milliliters to liters (divide by 1,000 mL)

Examples—

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 AgNO_3 are dissolved in 500 mL of solution?

Sometimes, however, you know what the molarity and the amount (volume) you need, you need to figure out how many grams you need:

1. How many grams of KNO_3 should be used to prepare 2.00L of a 0.500 M solution?
2. How many grams of CuSO_4 are needed to prepare a 100.0 mL solution at 0.10 M?

Finally, sometimes, you may be required to figure out the volume when the molarity and the grams/moles are known—

1. To what volume should 5.0 g of KCl be diluted to prepare a 0.25 M solution?
2. What volume of solution is needed to prepare a 10.0 M solution of NaCl that uses 25.0 g of NaCl ?

Dilution problems:

A dilution involves adding more solvent to the current solution; making the solution "weaker" than before or more dilute.

Use the following formula to solve dilution problems:

$$M_1V_1 = M_2V_2$$

M_1 = initial molarity (concentration)

V_1 = initial volume (L)

M_2 = final molarity (concentration)

V_2 = final volume (L)

EXAMPLE: How do you prepare a 100 mL solution of 0.40M $MgSO_4$ from a stock solution of 2.0M $MgSO_4$?

Step 1: Write the equation

Step 2: Write what you know from the problem

Step 3: Plug numbers and unknown into equation

Step 4: Solve for unknown

Step 5: Describe how you would prepare the solution

Step 1:

Step 2:

Step 3:

Step 4:

Step 5:

Example 2: What volume in ml of a 2M $CaCl_2$ solution would you need to make .5L of .3M $CaCl_2$ solution?

Acids and Bases:

Characteristics of acids:

Characteristics of Bases:

Arrhenius Acid—

Arrhenius Base—

Bronsted-Lowry Acid—

Bronsted-Lowry Base—

pH stands for the _____

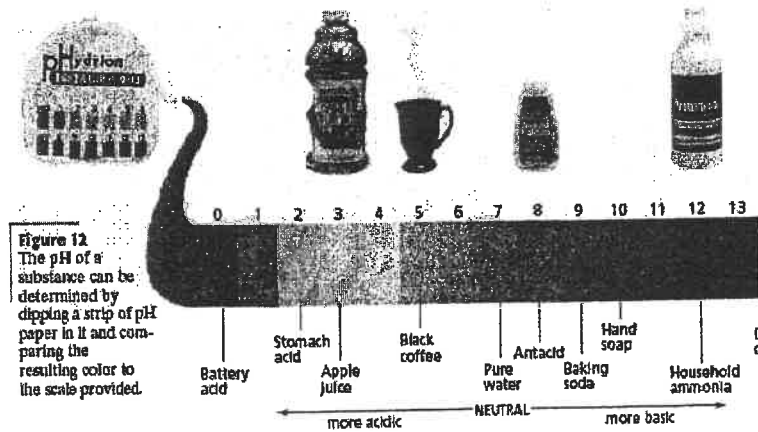
****Have to know
formulas!****

pH = _____

[H] = _____

pOH = _____

[OH] = _____



Neutralization reactions:

Reaction between an _____ & _____ to produce _____ & _____

◆ Ex:

- $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$
- $\text{BaOH} + \text{HCl} \rightarrow$

fancy double replacement reaction

Indicators: reversibly change color depending on the pH of the solution

Name: _____ Date: _____ Class _____

Solubility Curve Practice Problems Worksheet



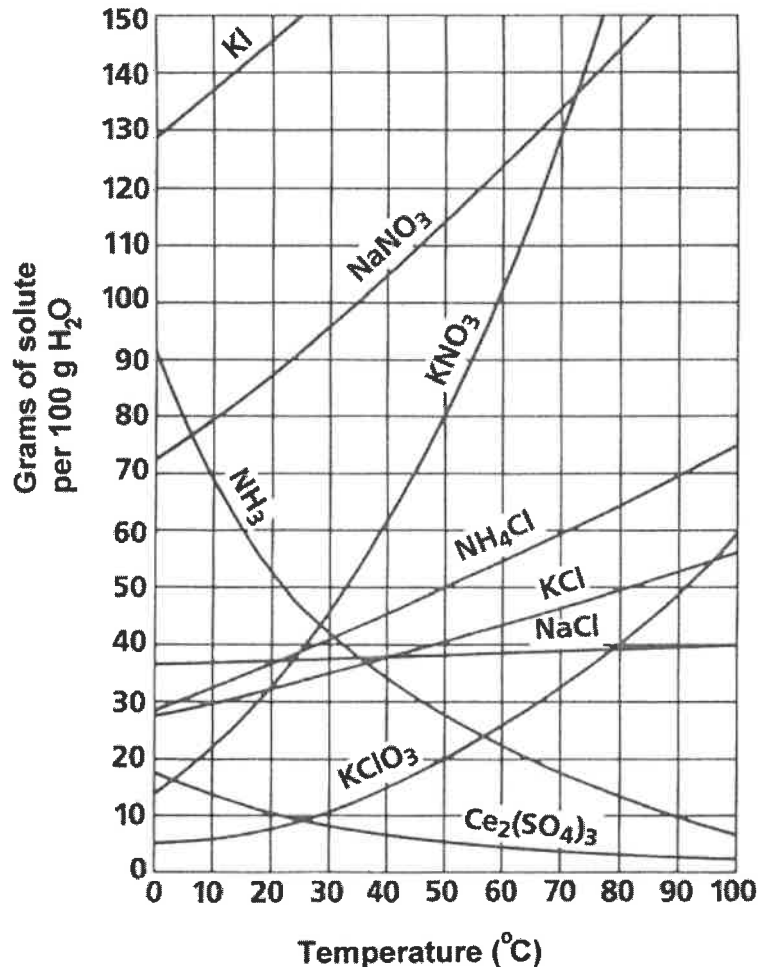
You'll notice that for most substances, solubility increases as temperature increases. As discussed earlier in solutions involving liquids and solids typically more solute can be dissolved at higher temperatures. Can you find any exceptions on the graph below? _____

Here's an example of how to read the graph. Find the curve for KClO_3 .

At 30°C approximately 10g of KClO_3 will dissolve in 100g of water. If the temperature is increased to 80°C , approximately _____ of the substance will dissolve in 100g (or 100mL) of water.

Directions: Use the graph to answer the following questions. REMEMBER UNITS!

- 1) What mass of solute will dissolve in 100mL of water at the following temperatures?
 - a. KNO_3 at 70°C = _____
 - b. NaCl at 100°C = _____
 - c. NH_4Cl at 90°C = _____
 - d. Which of the **above** three substances is most soluble in water at 15°C . = _____



2) Types of Solutions

On a solubility curve, the lines indicate the concentration of a _____ **solution** - the maximum amount of solute that will dissolve at that specific temperature.

Values on the graph _____ a curve represent **unsaturated solutions** - more solute could be dissolved at that temperature.

Label the following solutions as saturated or unsaturated. If unsaturated, write how much more solute can be dissolved in the solution.

Solution	Saturated or Unsaturated?	If unsaturated: How much more solute can dissolve in the solution?
a solution that contains 70g of NaNO_3 at 30°C (in 100 mL H_2O)		
a solution that contains 50g of NH_4Cl at 50°C (in 100 mL H_2O)		
a solution that contains 20g of KClO_3 at 50°C (in 100 mL H_2O)		
a solution that contains 70g of KI at 0°C (in 100 mL H_2O)		

Use the Solubility Graphs on Page 1

- What is the solubility of KCl at 5°C ? _____
 - What is the solubility of KCl at 25°C ? _____
 - What is the solubility of $\text{Ce}_2(\text{SO}_4)_3$ at 10°C ? _____
 - What is the solubility of $\text{Ce}_2(\text{SO}_4)_3$ at 50°C ? _____
- At 90°C , you dissolved 10 g of KCl in 100. g of water. Is this solution saturated or unsaturated?
 - How do you know?
- A mass of 100 g of NaNO_3 is dissolved in 100 g of water at 80°C .
 - Is the solution saturated or unsaturated? _____
 - As the solution is cooled, at what temperature should solid first appear in the solution? Explain.

1. Sea water contains roughly 28.0 g of NaCl per liter. What is the molarity of sodium chloride in sea water?
2. What is the molarity of 245.0 g of H_2SO_4 dissolved in 1.00 L of solution?
3. What is the molarity of 5.30 g of Na_2CO_3 dissolved in 400.0 mL solution?
4. What is the molarity of 5.00 g of NaOH in 750.0 mL of solution?
5. How many moles of Na_2CO_3 are there in 10.0 L of 2.0 M solution?
6. How many moles of Na_2CO_3 are in 10.0 mL of a 2.0 M solution?
7. How many moles of NaCl are contained in 100.0 mL of a 0.20 M solution?
8. What weight (in grams) of NaCl would be contained in problem 7?
9. What weight (in grams) of H_2SO_4 would be needed to make 750.0 mL of 2.00 M solution?
10. What volume (in mL) of 18.0 M H_2SO_4 is needed to contain 2.45 g H_2SO_4 ?

Dilutions Worksheet

- 1) If I dilute 250 mL of 0.10 M lithium acetate solution to a volume of 750 mL, what will the concentration of this solution be?
- 2) If I have 340 mL of a 0.5 M NaBr solution, what will the concentration be if I add 560 mL more water to it?
- 3) If I leave 750 mL of 0.50 M sodium chloride solution uncovered on a windowsill and 150 mL of the solvent evaporates, what will the new concentration of the sodium chloride solution be?
- 4) To what volume would I need to add water to the evaporated solution in problem 3 to get a solution with a concentration of 0.25 M?
- 5) What is the concentration (molarity) of a solution of NaCl if 40 mL of a 2.5 M NaCl solution is diluted to a total volume of 500 mL?
- 6) What is the concentration of a solution of $\text{Fe}(\text{NO}_3)_3$ if 80 mL of a 3.0 M $\text{Fe}(\text{NO}_3)_3$ solution is diluted to a total volume of 1500 mL?
- 7) What is the concentration of a solution of KOH if 75 mL of a 2.25 M KOH solution is diluted to a total volume of 250 mL?
- 8) What is the concentration of a solution of CaSO_3 if 8.0 mL of a 1.0 M CaSO_3 solution is diluted to a total volume of 100 mL?
- 9) How many mL of 6.0 M HCl is needed to make 250 mL of a 1.5 M HCl solution?

CALCULATING pH:

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

EXAMPLES:

1. What is the pH of a solution that has a hydrogen ion concentration $[\text{H}^+]$ of $1.0 \times 10^{-5} \text{ M}$? Is the solution acidic or basic?
2. What is the pH of a solution that has a hydrogen ion concentration $[\text{H}^+]$ of $1.0 \times 10^{-2} \text{ M}$? Is the solution acidic or basic?
3. What is the hydrogen ion concentration $[\text{H}^+]$ of a solution, if the pH is 4?
4. What is the hydrogen ion $[\text{H}^+]$ concentration of a solution, if the pH is 14?

pOH

-the exact opposite of the pH

CALCULATING pOH:

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

Since acids and bases are OPPOSITES,

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

-therefore, if you know the pH of a solution, you can figure out the pOH and vice-versa

Examples:

1. If the hydroxide ion concentration of a solution is 1.0×10^{-10} , what is the pOH?

2. If the hydroxide ion concentration of a solution is 1.0×10^{-3} , what is the pOH?
3. If the pH of a solution is 3, what is the pOH?
4. If the pOH of a solution is 13, what is the pH of the solution?
5. If the hydrogen ion concentration is 1.0×10^{-4} ,
 - a. what is the pH of the solution?
 - b. What is the pOH of the solution?
 - c. Is the solution acidic or basic?
6. If the hydroxide ion concentration of a solution is 1.0×10^{-8} ,
 - a. what is the pOH of the solution?
 - b. What is the pH of the solution?
 - c. Is the solution acidic or basic?

Name: _____
 Hour: _____ Date: _____

Chemistry: pH and pOH calculations

Part 1: Fill in the missing information in the table below.

pH	[H ₃ O ¹⁺]	pOH	[OH ¹⁻]	ACID or BASE?
3.78				
	3.89 x 10 ⁻⁴ M			
		5.19		
			4.88 x 10 ⁻⁸ M	
8.46				
	8.45 x 10 ⁻¹³ M			
		2.14		
			2.31 x 10 ⁻¹¹ M	
10.91				
	7.49 x 10 ⁻⁶ M			
		9.94		
			2.57 x 10 ⁻⁸ M	
4.16				
	1.06 x 10 ⁻¹ M			
		3.82		
			8.53 x 10 ⁻⁷ M	
7.05				
	4.73 x 10 ⁻¹⁰ M			
		1.33		
			9.87 x 10 ⁻³ M	
11.68				
	9.22 x 10 ⁻⁸ M			
		12.24		
			5.39 x 10 ⁻¹² M	

Acids & Bases Calculations Practice Worksheet

Directions: Solve the following pH calculations. Write the formula, plug numbers into formula, & give answer with correct units and significant figures.

1. If the pH of a solution is 10.3, what is the $[H^+]$ concentration?
2. If the $[H^+]$ is 2.1×10^{-12} M $HClO_4$, what is the pH? Is the solution ACIDIC, BASIC, or NEUTRAL?
3. Calculate the pOH if the $[OH^-]$ concentration is 5.9×10^{-1} M? Is the solution ACIDIC, BASIC, or NEUTRAL?
4. What is the pH of a 0.033 M KOH solution?
5. What is the pH of an aqueous solution with a hydroxide ion concentration of 1.8×10^{-3} M?
6. What is the pH of an aqueous solution with a hydroxide ion concentration of 1.2×10^{-6} M?
7. What is the hydrogen ion concentration of a solution with a pH = 8.25?
8. What is the pH of a 0.235 M $Ba(OH)_2$ solution?

Name _____ Date _____

9. Determine the concentration of $[\text{OH}^-]$ ions in an aqueous solution where the $\text{pH} = 5.22$.

10. What is the hydroxide ion concentration in an aqueous solution with a hydrogen ion concentration of $2.70 \times 10^{-2} \text{ M}$?

11. Calculate the pH of a solution that is 0.147 M HCl ?

12. Complete the table below.

pH	$[\text{H}^+]$	$[\text{OH}^-]$	pOH	Acid / Base
	$1 \times 10^{-3} \text{ M}$			
		$1 \times 10^{-8} \text{ M}$		
6				
			2	
	$2.3 \times 10^{-10} \text{ M}$			
		$8.5 \times 10^{-1} \text{ M}$		
	$6.9 \times 10^{-4} \text{ M}$			
		$5.1 \times 10^{-11} \text{ M}$		

Study Guide

Name _____

The Nature of Solutions

Define the following terms.

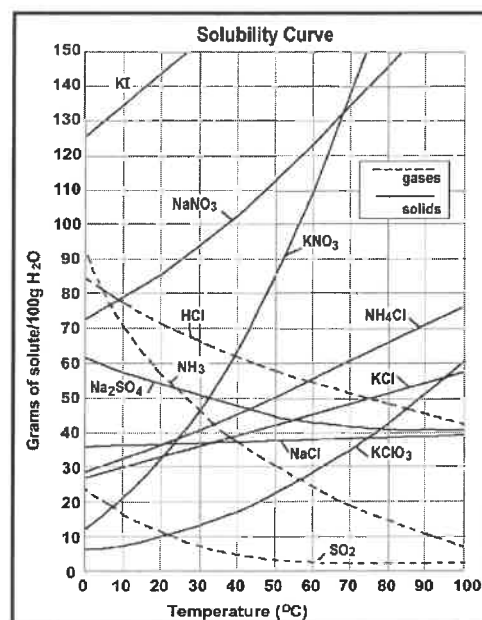
1. Solution –
2. Solute –
3. Solvent –
4. Saturated –
5. Unsaturated –
6. Supersaturated –
7. Molarity –
8. What is the difference between a strong electrolyte and a weak electrolyte?

Predict whether the following substances will be soluble or insoluble when mixed.

9. water and methane (CH_4) _____
10. water and CH_3Cl _____
11. You have a flask containing a solution of NaCl . How could you determine whether the solution is saturated or unsaturated?

Use the solubility curve to answer questions 6 – 8.

12. How many grams of potassium nitrate can dissolve in 100 g of water at 50°C ?
13. At 20°C , a solution contains 120 g of NaNO_3 in 100 g of water. Is this solution saturated, unsaturated, or supersaturated?
14. You need to make a solution containing 150 g of potassium chloride in 300 g of water. What temperature is required?
15. How many grams of potassium chlorate are required for a supersaturated solution at 70°C ?



16. What is the molarity of a solution in which 20.0 g of **NaCl** is dissolved in 500 mL of a solution?
17. How many grams of **NaOH** should be used to prepare a 500 mL solution with a concentration of 1.00 M?
18. What is the concentration of a solution in which 65.0 grams of **CuSO₄** is dissolved in 250 mL of solution?
19. How many grams of **KI** are required to make a 6.00 M solution in 1.00L of water?

Dilutions Worksheet

- 1) If I add 25 mL of water to 125 mL of a 0.15 M NaOH solution, what will the molarity of the diluted solution be?
- 2) If I add water to 100 mL of a 0.15 M NaOH solution until the final volume is 150 mL, what will the molarity of the diluted solution be?
- 3) How much 0.05 M HCl solution can be made by diluting 250 mL of 10 M HCl?
- 4) I have 345 mL of a 1.5 M NaCl solution. If I boil the water until the volume of the solution is 250 mL, what will the molarity of the solution be?
- 5) How much water would I need to add to 500 mL of a 2.4 M KCl solution to make a 1.0 M solution?

pH and pOH Worksheet

Name _____ Period ____

1. Calculate the pH and pOH of solutions having the following concentrations:

a. 0.00010 mol H⁺ per liter

b. 0.010 mol OH⁻ per liter

2. Calculate the [H⁺] and [OH⁻] of the following solutions:

a. pH = 3

d. pOH = 6

3. Calculate the pH and pOH of solutions having the following concentrations:

Remember that H₂SO₄ is diprotic (assume 100% ionization)

a. 0.0025 M NaOH

b. 0.0025 M H₂SO₄

4. State if each of the following pHs indicate an acid or base, and then calculate the [H⁺] and [OH⁻] of the following solutions:

a. pH = 2.5

b. pOH = 3.2

NOTES

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NOTES

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