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?

$\frac{58\text{g NaCl}}{} \left| \frac{1\text{mol}}{58\text{g}} \right. = \frac{1.0\text{mol}}{1.0\text{L}} = 1.0\text{ M}$

1.0 M

2. What is the molarity of a solution in which 10.0 g of $AgNO_3$ is dissolved in 500. mL of solution?

$\frac{10.0\text{g AgNO}_3}{} \left| \frac{1\text{mol}}{169.88\text{g}} \right.$ 0.118 M

$M = \frac{0.0589\text{mol}}{.500\text{L}}$

0.118 M

3. How many grams of KNO_3 should be used to prepare 2.00 L of a 0.500 M solution?

101 g

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

$L = \frac{\text{mol}}{M}$ 270 mL

5. How many grams of $CuSO_4 \cdot 5H_2O$ are needed to prepare 100. mL of a 0.10 M solution?

$\frac{.100\text{L}}{} \left| \frac{0.10\text{mol}}{1\text{L}} \right| \frac{249.68\text{g}}{1\text{mol}} = 2.5\text{g}$

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 x 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?

$$V_1 = \frac{M_2 V_2}{M_1} = \frac{(6.0)(250\text{mL})}{(18\text{M})} = 83\text{ mL}$$

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

$$V_1 = \frac{(100\text{mL})(2.0\text{M})}{(12\text{M})} = 17\text{ mL}$$

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

$$\frac{(25\text{mL})(15\text{M})}{(3.0\text{M})} = 125\text{ mL}$$

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

100 mL (150 mL total solution)

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

1.1 liters (1.2 liters or 1200 mL total solution)

Name _____

MOLALITY (m)

Molality = $\frac{\text{moles of solute}}{\text{Kg of solvent}}$

Solve the problems below.

1. What is the molality of a solution in which 3.0 moles of NaCl is dissolved in 1.5 Kg of water?

$\frac{3.0 \text{ mol}}{1.5 \text{ kg}} = 2.0 \text{ m}$

2. What is the molality of a solution in which 25 g of NaCl is dissolved in 2.0 Kg of water?

$25 \text{ g NaCl} \left| \frac{1 \text{ mol}}{58.44 \text{ g}} \right| \frac{1}{2.0 \text{ kg}} = 0.22 \text{ m}$

3. What is the molality of a solution in which 15 g of I_2 is dissolved in 500. g of alcohol?

$\frac{(15 \text{ g } I_2 / 253.8 \text{ g/mol})}{(.500 \text{ kg})} = 0.12 \text{ m}$

4. How many grams of I_2 should be added to 750 g of CCl_4 to prepare a 0.020 m solution?

$.750 \text{ kg} \left| \frac{0.020 \text{ mol}}{1 \text{ kg}} \right| \frac{254 \text{ g}}{1 \text{ mol}} = 3.8 \text{ g}$

$m = \frac{\text{mol}}{\text{kg}}$

$126.9 \times 2 = 253.8$

5. How much water should be added to 5.00 g of KCl to prepare a 0.500 m solution?

$5.00 \text{ g KCl} \left| \frac{1 \text{ mol}}{74.5 \text{ g}} \right| \frac{1 \text{ kg}}{0.500} = 135 \text{ g}$

$\text{kg } H_2O = \frac{\text{moles}}{m}$

$.135 \text{ kg} = 135 \text{ g}$

F.P. Depression
B.P. Elevation

1. $\frac{25\text{g NaCl}}{58.45\text{g}} \left/ \frac{1\text{mol}}{} \right. = 0.43\text{mol}$

$m = \frac{0.43\text{mol}}{1.0\text{kg}} = 0.43\,m$

$\Delta T = (2)(0.52°C/m)(0.43m) = 0.44°C$

New B.P. $= 100°C + 0.44°C = 100.44°C$

2. $\Delta T = (2)(1.86°C/m)(0.43m)$

$= 1.6°C$

New F.P. $= 0°C - 1.6°C = -1.6°C$

3. $\frac{50.\text{g E.G.}}{62\text{g}} \left/ \frac{1\text{mol}}{} \right. = 0.81\text{ mol}$

$m = \frac{0.81\text{mol}}{0.050\text{kg}} = 16\,m$

$\Delta T = (1)(0.52°C/m)(16m) = 8.4°C$

New BP $= 100°C + 8.4°C = 108.4°C$

$\Delta T = (1)(1.86°C/m)(16m) = 29.8°C$

New F.P. $= 0°C - 29.8°C = -29.8°C$

4. $m = \frac{\Delta T}{i \times K_f} = \frac{2.5°C}{1 \times 1.86°C/m} = 1.3\,m \times \text{kg } H_2O = \text{mol}$

so

$1.3m \times .025\text{kg} = 0.033\text{mol}$

Molar Mass $= \frac{5.0\text{g}}{0.033\text{mol}} = 150\text{g/mol}$

ANSWE

EFFECT OF A SOLUTE ON FREEZING AND BOILING POINTS

Name _____

We use the following formulas to calculate changes in freezing and boiling point due to the presence of a nonvolatile solute. Freezing point is always lowered, boiling point is always raised.

$\Delta T_f = m \times d.f. \times k_f$

$\Delta T_b = m \times d.f. \times k_b$

$k_b H_2O = 0.52^\circ C/m$

$k_f H_2O = 1.86^\circ C/m$

m = molality of solution

k_f and k_b = constants for particular solvent

d.f. = dissociation factor (how many particles solute breaks up into: for a nonelectrolyte, d.f. = 1)

(Theoretical Association Factor is always greater than observed effect.)

Solve the problems below.

1. What is the new boiling point if 25 g of NaCl is dissolved in 1.0 Kg of water?

$m = \frac{(25\,g / 58.44\,g/mol)}{1.0\,Kg} = 0.43m$ Δt_b 100.45°C

2. What is the freezing point of the solution in Problem 1?

-1.6°C

3. What are the new freezing and boiling points of water if 50. g of ethylene glycol (molecular mass = 62 g/mol) is added to 50. g of water?

$\Delta t_f = (1.86^\circ C/m)(1.6m)(1)$

$m = \frac{(50.g / 62 g/mol)}{0.050 Kg} = \frac{0.806}{0.050} = 16m$

108.4°C $= B.P. = 30.0^\circ C$

$F.P. = -30^\circ C$

$\Delta t_b = (0.52^\circ C)(16m)(1) = 8.32^\circ C$

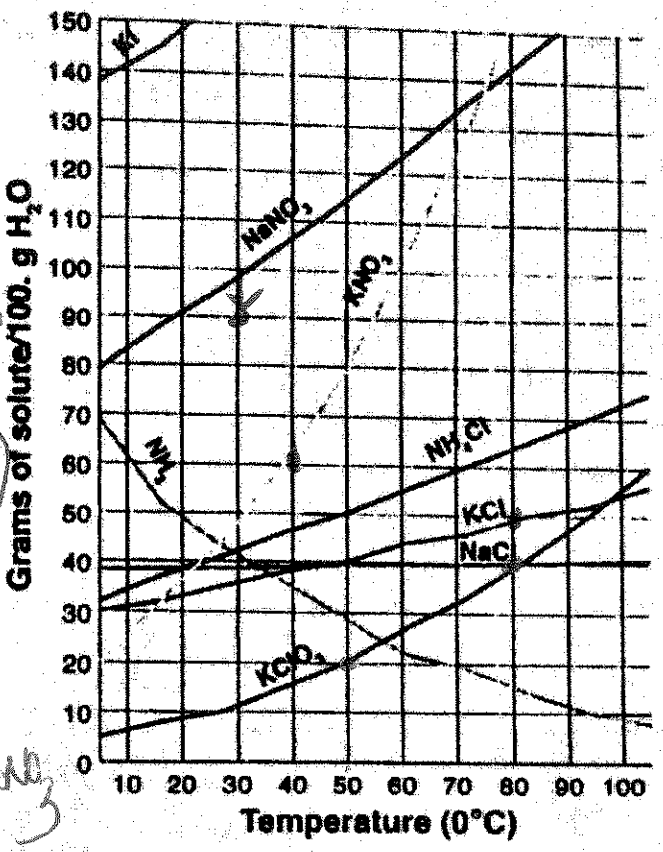
4. When 5.0 g of a nonelectrolyte is added to 25 g of water, the new freezing point is -2.5° C. What is the molecular mass of the unknown compound?

149 g/mol

SOLUBILITY CURVES

Name _____

Answer the following questions based on the solubility curve below.



1. Which salt is least soluble in water at 20° C? $KClO_3$

2. How many grams of potassium chloride can be dissolved in 200 g of water at 80° C?

$\frac{50\text{g KCl}}{100\text{g H}_2O} = \frac{x\text{g}}{200\text{g H}_2O}$ = 100g KCl

3. At 40° C, how much potassium nitrate can be dissolved in 300 g of water? 180 g (126g)

$\frac{63\text{g}}{100\text{g}} = \frac{x\text{g}}{300\text{g}}$

4. Which salt shows the least change in solubility from 0° – 100° C?

NaCl

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

unsaturated

NaNO3

6. 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? 20g 22g

7. What compound shows a decrease in solubility from 0° to 100° C? NH_3

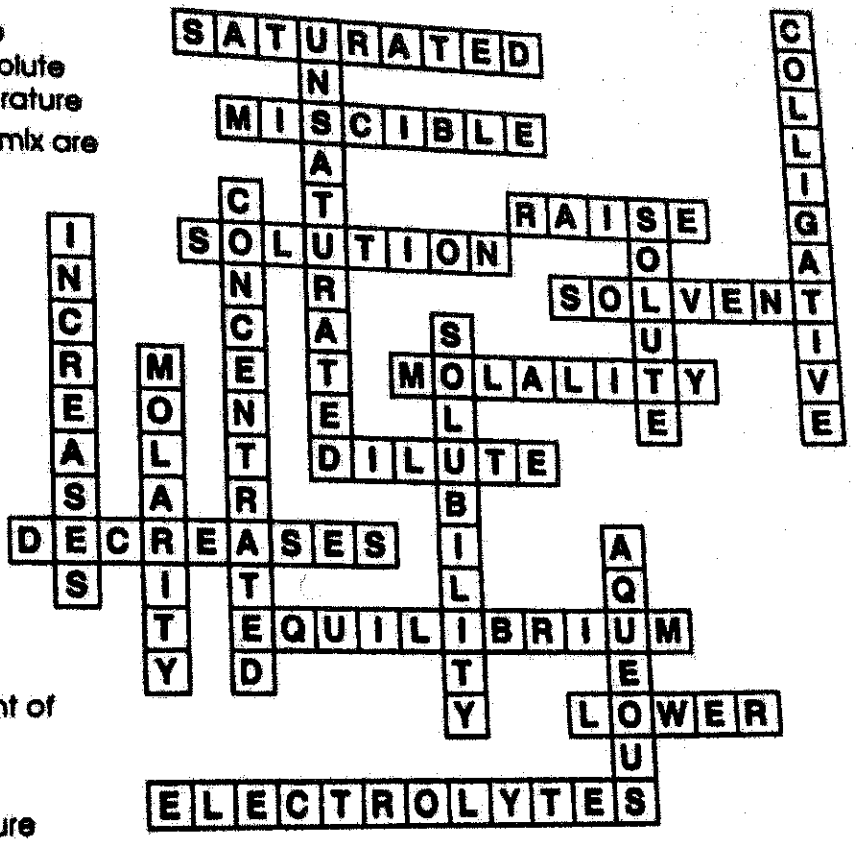
8. Which salt is most soluble? KI

9. Which salt is least soluble at 50° C? $KClO_3$

10. Which salt is least soluble at 80° C? NaCl

SOLUTIONS CROSSWORD

Name _____



Across

2. Solution containing the maximum amount of solute possible at that temperature
4. Two liquids which can mix are said to be _____ .
6. The presence of a nonvolatile solute will _____ the boiling point of a solvent.
9. A homogeneous mixture
10. Substance present in larger amount in a mixture
13. Moles of a solute per kilogram of solvent
14. Solution containing a relatively large amount of solvent
15. The solubility of gases _____ as temperature increases.
17. State in which the rate of dissolving is equal to the rate of precipitation
18. The presence of a nonvolatile solute will _____ the freezing point of a solvent.
19. These substances dissociate or ionize in water and are then able to conduct an electric current.

Down

1. Properties that depend on the number of particles in solution
3. Solution in which more solute can be dissolved
5. Solution containing a relatively large amount of dissolved solute
7. Substance present in smaller amount in a mixture
8. The solubility of most solids _____ as temperature increases.
11. Maximum amount of solute that can dissolve in a stated amount of solute at a given temperature
12. Moles of solute per liter of solution
16. Solutions in which water is the solvent are called _____ .

WER KEY

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	X		
2. I_2		X	X
3. ethanol	X	X	X
4. benzene		X	X
5. Br_2		X	X
6. KNO_3	X		
7. toluene		X	X
8. $Ca(OH)_2$	X		

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	X	
2. CH_3OH (methyl alcohol)		X
3. $C_3H_6(OH)_3$ (glycerol)		X
4. HCl	X	
5. $C_6H_{12}O_6$ (sugar)		X
6. NaOH	X	
7. C_2H_5OH (ethyl alcohol)		X
8. CH_3COOH (acetic acid)	X	
9. NH_4OH ($NH_3 + H_2O$)	X	
10. H_2SO_4	X	