STUDENT INFO

Name: _____Date:_____

Pre-lab Questions

Solutions, Electrolytes, Concentration

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1. Define electronegativity.

2. Compare the electronegativity of hydrogen and chlorine. Will HCl be polar or nonpolar?

3. Compare the electronegativity of two hydrogen atoms. Will H_2 be polar or nonpolar?

4. Classify the following chemicals as ionic, covalent, organic chemical, organic acid or organic base: NaCl, CH_3-COOH, CH_3NH_2, HF, CO.

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Experiment

Solutions, Electrolytes, Concentration

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1. Polarity and miscibility The goal of this mini-experiment is to identify the polarity of a given solute by mixing it with a polar and nonpolar solvent. To chemicals with the same polarity will mix with each other due to favorable interactions. Think about oil and soap, both are nonpolar chemicals and hence they mix well. Differently, chemicals with different polarity do not mix well. Think this time about water and oil. Water is polar and oil is nonpolar. Both chemicals do not mix well. By using a polar solvent (water) and a nonpolar solvent (cyclohexane) you will be able to track the polarity of a given solute by studying the miscibility of the solute with both solvents. Ultimately, polarity is due to differences in electronegativity an the existence of a permanent dipolar moment in the molecule. Small molecules (diatomic) made of different elements will always be polar, as the differences of electronegativity will not compensate with each other leading to a permanent dipole moment. Molecules made mainly of C and H will normally be nonpolar as both elements have not appreciable electronegativity differences.

☐ *Step 1:* – Use eight test tubes in a rack. Four of these will be filled with 5 drops of water–a polar solvent–whereas the remaining four tubes will be filled with cyclohexane–a nonpolar solvent.

☐ *Step 2:* – Add a few drops of a few crystals of the following solutes both in water and in cyclohexane. If the solute mixes with water that means it will be polar. If the solute mixes with cyclohexane that would mean it is nonpolar.

Solute	Soluble in Water (H_2O)?	Soluble in Cyclohexane (C_6H_{10})?	Polar/Nonpolar
I_2 (iodine)			
Sucrose			
$KMnO_4$ (potassium permanganate)			
Vegetable oil			

2. Electrolytes Chemicals can be classified as electrolytes or nonelectrolytes depending on whether they conduct the electricity in solution. Electrolytes conduct the electricity as they produce ions, positive and negative, in solution. For example, NaCl is an electrolyte and conducts the electricity when dissolved in water, as NaCl breaks down in water to produce Na^+ and Cl^-. These ions conduct the electricity. At the same time, electrolytes can be strong of weak depending of their degree of dissociation. *Strong electrolytes* completely dissociate in water and hence they heavily conduct the electricity in water. In solution, strong electrolytes produce ions. Differently, *weak electrolytes* dissociate only partially in water and hence their conduction character is weak and in solution you will have both molecules and ions. *Nonelectrolytes* do not dissociate in water and hence they do not conduct the electricity and you will only have molecules in solution. The following table will help you classify chemicals as electrolytes. In general, ionic compounds (metal+nonmetal) are strong electrolytes and organic compounds (carbon based compounds) are nonelectrolytes. Weak electrolytes are rare. A few examples are HF, H_2O, organic bases like ammonia, and organic acids like acetic acid.

Electrolyte Classification			
Electrolyte Type	Dissociation	Particles in solution	Examples
Strong	Fully	Ions	Ionic Compounds: NaCl, NaOH, HCl, $MgCl_2$
Weak	Partially	Ions & molecules	HF, H_2O, Organic bases (e.g. NH_3), organic acids (e.g. CH_3COOH)
Nonelectrolytes	No	molecules	C-based compounds: CH_3OH(methanol), CH_3CH_2OH(ethanol), $C_{12}H_{22}O_{11}$ (sucrose),CH_4NO_2(urea)

In this mini-experiment you will study the electrolyte character of a series of solutes with different nature. By means of two electrodes connected to a lightbulb you will be able to appreciate the degree these chemicals conduct electricity. If the lightbulb glows the chemical will be an electrolyte. Depending on the brightness of the glow the chemical will be a strong or weak electrolyte.

☐ *Step 1:* – You or the professor will use a setup with two electrodes connected to a lightbulb. Place 20mL of the different solutions in the table below in a beaker.

☐ *Step 2:* – Lower the electrodes to the solution and observe the glow.

☐ *Step 3:* – Observe the glow and classify the chemical as nonelectrolyte, strong electrolyte or weak electrolyte.

Chemical	Light intensity (No light, weak light, strong light)	Electrolyte type (Non electrolyte/weak electrolyte/strong electrolyte)	Particles in solution (Molecules/ions/Molecules+Ions)
NaCl			
Sucrose			
HCl			
CH_3-COOH			
NH_3			
CH_3-CH_2OH			
NaOH			

3. Molarity of a solution The goal of this mini-experiment is to calculate the molarity of an already prepare solution. In order to calculate molarity, we need the moles of solute and the volume of solution. You will take a given solution volume by using a pipet. At the same time you will learn how to use a pipet–a very common chemistry measuring tool. Then you will evaporate the solution so that only the solute will remain. By weighting this solute and given the molar mass you will convert grams into moles and compute molarity.

☐ *Step 1:* – Fill a 250mL beaker with 200mL of water. Set the beaker on a hot plate and start heating at medium high heat.

☐ *Step 2:* – Weight an evaporating dish. Write down the mass in the table below.

☐ *Step 3:* – Place the evaporating dish on top of the beaker so that it receives indirect heat. Use a metallic ring to secure the beaker.

☐ *Step 4:* – Use a small beaker to measure approximately 20mL of the solution. Use a 10-mL graduated pipet to transfer exactly 10mL of the solution into the evaporating dish. Weight the evaporating dish with the solution.

☐ *Step 5:* – The solution will start to dry. When the evaporating dish is completely dry, stop the heater and wait for the dish to cool down. Weight the evaporating dish with the solute.

(1)	Mass of the evaporating dish (g)	_____
(2)	Volume of solution, $v_{solution}$ (L)	_____
(3)	Mass of the evaporating dish with the solution (g)	_____
(3) – (1)	Mass of the solution (g)	_____
(4)	Mass of the evaporating dish with dry solute	_____
(4) – (1)	Mass of solute, m_{Solute}	_____
((4) – (1)) $\times \frac{1\text{ mol NaCl}}{58\text{ g NaCl}}$	Moles of solute, n_{solute} (mol)	_____

Calculate the molarity of the solution by using the following formula:

$$M = \frac{n_{solute}}{v_{solution}}$$

M =_____

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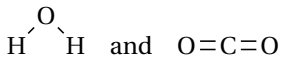
Post-lab Questions

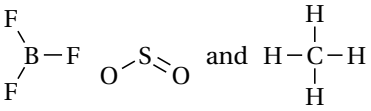
Solutions, Electrolytes, Concentration

1. Indicate whether the following diatomic molecules are polar or nonpolar: Cl_2, N_2, O_2, HCl, HI, and HF.

2. Given the geometry of the following small polyatomic molecules are polar or nonpolar:



3. Given the geometry of the following small polyatomic molecules are polar or nonpolar:



4. Indicate whether the following chemicals are nonelectrolytes, weak electrolytes or strong electrolytes: NaF, CH_3-CH_3, $CH_3-CH_2-CH_2OH$, HF, and CH_3-CH_2-COOH.

5. Use your results to calculate the mass percent of the solution.

6. Calculate the volume of a 3M solution that contains 4 moles of solute.

7. Calculate the number of moles in 20mL of a 4M solution.