

Lab [15 pts]
Polarity and Solubility

Name _____
 Lab Partner(s) _____
 Period _____ Date _____

- Purpose:**
- (1) To observe the solubility of liquids and solids.
 - (2) To make a connection between a substance's polarity and its solubility.
 - (3) To formulate a molecular model that helps to explain solubility.
 - (4) To predict the polarity of an unknown substance based on our model.

Write-Up Requirements: You will work with your lab partner for this lab, but each person will hand in their own individual write ups. The write-up will consist of this handout neatly completed with all questions thoroughly answered. **Do in PENCIL!!!!**

Part I: Determining polarities based on molecular structures.

- a) [2 pts] Fill in the following chart by drawing the 3D diagrams and labeling each as being nonpolar covalent (NPC), polar covalent (PC) or ionic (I). Look at the molecular models of these liquids to help you draw the 3D diagrams and to determine their polarities.

	Water	Ethylene Glycol	Cyclohexane	Hexane	Ethanol
Lewis Dot					
3D Diagram with partial charges					
Polarity (NPC, PC, Ionic)					

- b) [1 pt] Rank these liquids as best you can according to their polarities by placing each of them appropriately on this polarity "number line."
- You will not be able to differentiate between nonpolar covalent molecules-- just write all nonpolars near the same spot on the line.
 - In order to differentiate between slightly polar covalent, polar covalent and very polar covalent, look at the **percent of the molecule that is partially charged**. (Do all of the atoms have partial charges? some of them?) Do NOT base your decision on how large the electronegativity differences are.

nonpolar
covalent

slightly polar
covalent

polar
covalent

very polar
covalent

ionic

Part II: Data Collection-- Solubility of Five Liquids, NaCl and I₂ (as a demo)

- Obtain a test tube rack and five dry, clean test-tubes. Obtain the 5 dropper bottles of the 5 liquids.
- LIQUIDS:** Choose two liquids to mix. Put in 2-3 dropper-fulls of each liquid into the same test tube. Put on a stopper and shake. Let the liquids settle and observe whether they are soluble or insoluble. *(If there is a line about halfway down, there are two layers and the liquids are INSOLUBLE. Make all combinations of liquids and record results in the data chart below.*
 - You **MUST** use a DRY test tube each time you are using ETHANOL!!
 - Cyclohexane and hexane must be disposed of in the WASTE bottle. Other liquids may go down sink.
- NaCl test:** Put a tiny pinch of NaCl into five test tubes *(Try to use about the same amount in each test tube.)* In each of the test tubes, you will add a different liquid. Again use 2-3 dropper-fulls of the liquids. Put on a stopper and shake. Look carefully to see if NaCl is soluble, slightly soluble or insoluble in each liquid. (Did ALL, SOME or NONE of the NaCl dissolve?)

	water	ethylene glycol	cyclohexane(waste)	Hexane (waste)	Ethanol (dry tt)
water	XXXXX				
ethylene glycol	XXXXX	XXXXX			
cyclohexane(waste)	XXXXX	XXXXX	XXXXX		
hexane (waste)	XXXXX	XXXXX	XXXXX	XXXXX	
ethanol (dry tt)	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX
NaCl (s)			XXXXX		XXXXX
I ₂ (s) -- as a demo!					

Part III: Making a Hypothesis using just your data concerning the LIQUIDS

Compare the polarities of the five liquids (Part I) with the solubility results of the five liquids (Part II). Try to look for patterns. Then, make a HYPOTHESIS or generalization which is able to PREDICT the solubility of the liquids from their polarities. Write your hypothesis by completing the statement below. This should be a GENERAL statement which can be used in all situations. No EXCEPTIONS are allowed. *You must show me your hypothesis before you move on in the lab.*

Hypothesis: [1 pt] Two substances will be soluble if _____

Part IV: TESTING YOUR HYPOTHESIS (Solubility of NaCl and I₂)

- What is the polarity of NaCl? _____ *On the front page, write in NaCl appropriately on the polarity number line.*
- [1 pt] Look at your solubility data above. Is NaCl more soluble in water or in ethylene glycol? _____ State the polarity of each substance and use your hypothesis to explain why.

- What is the polarity of I₂? _____ *On the front page, write in I₂ appropriately on the polarity number line.*
- Make a prediction: Which liquid should I₂ be most soluble in? _____
- I will demo the solubility of I₂. Record results in the chart above. Does hypothesis fit data results? _____

Part V: EXPLAINING the HYPOTHESIS at the MOLECULAR LEVEL

At this point I will lead a discussion to hash out what is happening at the molecular level to explain the solubility results.

Part VI: TESTING an UNKNOWN -- PUTTING YOUR HYPOTHESIS TO WORK:

- Get an unknown substance from me. What is your unknown number? _____.
- Your task is to determine the **polarity** of your unknown substance by testing its solubility in the 5 liquids. Record your solubility data here. (Soluble? slightly soluble? insoluble?)

	water	ethylene glycol	cyclohexane(waste)	Hexane (waste)	Ethanol (dry tt)
Unknown #					

- 1) [1 pt] Based on your solubility data, what is the polarity of your unknown? _____
(*nonpolar covalent, slightly polar covalent, polar covalent, very polar covalent, or ionic*)
- 2) Come up to my front desk and show me what you think the polarity of your unknown is.
If you are correct, I will write down the name of your unknown here. _____
Write the name of your unknown on the polarity number line on the front.
- 3) [2 pts] From the projector, copy down the 3D structure of your unknown below.
 - If your unknown is covalent, write in any partial charges on the 3D structure. If none, write "NONE"
 - If your unknown is ionic, in the space below, show the Lewis dot structure as we have done them in the past. (*Write all atoms separately, put in valence electrons, show transfer of electrons using arrows, and show ions formed with correct charges.*)
- 4) [3 pts] You have already determined the polarity of your unknown based on its solubility results. Now, let's assume you have not tested the solubility of your unknown. Explain how you would be able to determine your unknown's polarity by just knowing its structure. [*First, is your unknown ionic or covalent? How do you know? Second, if it is covalent, is it non-polar, slightly polar, polar or very polar? How do you know?*]
- 5) [4 pts] Suppose that your unknown is put into some water, shaken and allowed to settle. Describe what happens to the molecules of your unknown and of water. Explain why the molecules of your unknown separate or mix with water as you have described. Explain in words and draw a diagram of molecules to support your answer. *Your explanation must include the words- attracted and entropy. The diagram must include at least two molecules of water and one molecule of your unknown. Put in any full/partial charges and you must draw at least one dotted line to show attraction between molecules. (Please answer this question on the back or on a separate sheet of paper.)*