Name Jason Wilcox Date _____ Class _____

20/20

Solubility and Bond Type

Lab 20

Text reference: ***Chapter 7***

Introduction

Compounds may contain ionic bonds, polar covalent bonds, nonpolar covalent bonds, or a combination of these bond types. Several of the investigations in this book provide clues that allow you to predict which type of bond a compound contains. Investigation 21, for example, explores the electrical conductivity of solutions of various compounds. In Investigation 23, the tendency of a liquid to rise in a narrow space is examined. Both of these behaviors depend on bond type. Another way to predict whether a substance has ionic, polar covalent, or nonpolar covalent bonds is to measure its solubility—its ability to dissolve—in different liquids. Substances with polar covalent or ionic bonds tend to dissolve in liquids that contain polar covalent bonds, while substances with nonpolar covalent bonds tend to dissolve in liquids with nonpolar covalent bonds.

In this investigation, you will compare the solubilities of sodium chloride, potassium chloride, sodium iodide, iodine, and camphor in water, ethanol, vegetable oil, and glycerol. You will also determine the solubility of the liquids in each other. Based on your data, you will then classify these substances by bond type.

Pre-Lab Discussion

Read the entire laboratory investigation and the relevant pages of your textbook. Then answer the questions that follow.

1. What are three types of chemical bonds? Do all compounds contain a single type of bond? Polar covalent, non-polar covalent, ionic

2. What special precautions should be taken when working with iodine crystals? Iodine is toxic so it should be done in the fume hood (but we aren't doing that)

3. Compound X dissolves in water but not in vegetable oil. Compound Y dissolves in ethanol but not in water. Which of the two more likely contains polar covalent bonds? Explain.

Like substances dissolve in like substances, compound x has either polar covalent or ionic bonds.

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Problem

How can a compound's solubility be used to predict the type of bonds it contains?

Materials

chemical splash goggles
laboratory apron
marking pen
4 test tubes
test-tube rack
graduated cylinder, 10-mL
tap water
ethanol (C_2H_5OH)
glycerol ($C_3H_8O_3$)
vegetable oil
laboratory balance
microspatula
sodium chloride (NaCl)
potassium chloride (KCl)
sodium iodide (NaI)
iodine (I_2)
camphor ($C_{10}H_{16}O$)
forceps
4 stoppers to fit test tubes

Safety

Wear your goggles and lab apron at all times during the investigation. Ethanol and iodine are toxic. Avoid breathing their vapors. All work with iodine should be done in a fume hood. Avoid skin contact with iodine; use forceps to handle it. If iodine does come in contact with skin, rinse the affected area with plenty of water. Ethanol is flammable; be sure there are no open flames in the laboratory. Note the caution alert symbols here and with certain steps of the Procedure. Refer to page *xi* for the specific precautions associated with each symbol.

Procedure

Part A 

1. Put on your goggles and lab apron. Label four test tubes from 1–4. Place them in a test-tube rack.

2. Put 5.0 mL of the listed liquids into separate test tubes as follows. **CAUTION:** *Ethanol is toxic as a liquid and a vapor. Avoid direct contact with it. It is also flammable. Be sure there are no open flames in the laboratory.*

   test tube 1: water
   test tube 2: ethanol
   test tube 3: glycerol
   test tube 4: vegetable oil

3. Measure four 0.5-g samples of sodium chloride. Using a microspatula, add a few grains of sodium chloride to test tube 1. Stopper and shake the tube. If the solid dissolves, add a few more grains. Keep adding grains until no more will dissolve or until you have used all of the sample.
4. If all the solid dissolves, write *soluble* in Data Table 1. If none of the solid dissolves, write the word *insoluble* in Data Table 1. If some of the solid dissolves, write the words *partially soluble* in Data Table 1.

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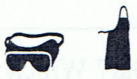
5. Repeat Steps 3 and 4 for each of the other three test tubes.

6. Pour the contents of the test tubes into the container provided by your teacher. Rinse and dry the test tubes and repeat the procedure, using potassium chloride instead of sodium chloride.

7. Dispose of the materials and clean the test tubes as before. Repeat the procedure for sodium iodide, iodine, and camphor. **CAUTION:** *Iodine crystals and vapors are toxic. Do this part of the procedure in the fume hood. Avoid skin contact with the iodine. Use forceps when handling it.*

8. Dispose of the materials and clean the test tubes. Iodine compounds should be collected in a specially marked container. If you are not going on directly to Part B, clean up your work area and wash your hands before leaving the laboratory.

Part B



9. Put on your goggles and lab apron. Put 3.0 mL of water into each of three test tubes. Add 3.0 mL of ethanol to the water in one of the tubes. Stopper and shake the tube for about 30 seconds. Let it sit for another 30 seconds. Note the appearance of the liquid. If you can see layers, write the word *insoluble* in Data Table 2. If no layers are present, write the word *soluble*.

10. Repeat Step 9 using vegetable oil, and then glycerol, instead of ethanol. Dispose of the materials as before, and rinse out and dry all the test tubes.

11. Following the same procedure as in Step 9, test mixtures of ethanol with vegetable oil, ethanol with glycerol, and vegetable oil with glycerol. Write your observations in Data Table 2.

12. Dispose of the liquids and solids as directed by your teacher. Clean up your work area and wash your hands before leaving the laboratory.

Observations

DATA TABLE 1 Solubility of Solids

	Water	Ethanol	Vegetable oil	Glycerol
NaCl	Soluble	insoluble	slightly solut	insoluble
KCl	Soluble	insoluble	slightly solul	insoluble
NaI	soluble	slightly solut	insoluble	insoluble
I_2	insoluble	soluble	soluble	
camphor	insoluble	soluble	slightly solut	slightly solut

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DATA TABLE 2 Solubility of Two Liquids

	Ethanol	Vegetable oil	Glycerol
water	soluble	insoluble	insoluble
ethanol	soluble	slightly soluble	slightly soluble
vegetable oil	insoluble	soluble	slightly soluble

Critical Thinking: Analysis and Conclusions

1. Predict the type of bonds each of the solids you tested contains. Explain your reasoning. *(Classifying)* NaCL, KCl are all ionic because they are all metal and nonmetal, and are soluble with water. Camphor is non polar

2. Which of the liquids can be considered polar? Which are nonpolar? *(Drawing conclusions)* They are polar if they dissolve in water, so Ethanol is polar, Vegetable oil and Glycerol are nonpolar

3. Why did NaCl not dissolve in vegetable oil? *(Drawing conclusions)* They do not have the same type of bonds

4. Why did iodine dissolve in vegetable oil but not in water? *(Drawing conclusions)* Iodine dissolves in oil because they have like bonds

Critical Thinking: Applications

1. Salad dressing is a mixture of vegetable oil and vinegar (acetic acid). Why does the dressing have to be shaken before it is used? *(Developing hypotheses)* The two liquids are not the same bonds, so to get a mixed liquid you must shake the test tube

2. What kind of liquid cleaning agents would be most effective at dissolving oily stains? *(Making judgments)* Ones with nonpolar covalent bonds.

Going Further

1. You are given a mixture of iodine and NaCl powders. Suggest a method for separating the two. Design an experiment employing your method. Perform the experiment only under a teacher's supervision. Report on your results.