DATE: NAME: CLASS:

Investigation 14.A: Comparing Organic and Inorganic Compounds

Of the millions and millions of organic compounds that exist, each one is based on a “skeleton” of carbon atoms covalently bonded to one another and to other atoms. Hydrocarbons containing only non-polar covalent bonds between carbon and hydrogen will be somewhat unreactive and insoluble in water. They will tend to interact only with one another. The presence of polar covalent bonds between carbon and oxygen in hydrocarbon derivatives, such as alcohols and carboxylic acids, is expected to produce different characteristics. How will the properties of hydrocarbon derivatives compare with those of hydrocarbons? How will the properties of hydrocarbons and their derivatives compare with those of inorganic compounds? Your teacher will assign either Part I or Parts II and III to each group. You will share data with another group before completing the Analysis section.

Question

Do the observed properties of solubility, conductivity, miscibility, and viscosity of hydrocarbons, hydrocarbon derivatives, and inorganic compounds agree with the expected properties?

Hypothesis

Knowing that water is a substance with polar chemical bonds and using your previous knowledge of chemical bonding, formulate a hypothesis about the solubility of hydrocarbons and of hydrocarbon derivatives in water. Knowing that viscosity is the resistance of a liquid to a change in its position, formulate a hypothesis about the relative viscosities of liquids (a) in which the molecules have many polar bonds and (b) in which the molecules have very few polar bonds.

Safety Precautions

- Organic solvents are flammable. Extinguish all flames in the laboratory area.
- Propylene glycol is toxic. Do not ingest it.

Materials

- deionized (or distilled) water, $H_2O(\ell)$
- ethanoic (acetic) acid, $C_2H_4O_2(\ell)$
- propanol, $C_3H_8O(\ell)$
- pentane, $C_5H_{12}(\ell)$
- sodium chloride crystals (table salt), $NaCl(s)$
- sodium hydrogen carbonate (baking soda), $NaHCO_3(s)$
- calcium carbonate, $CaCO_3(s)$
- salicylic acid crystals, $C_7H_6O_3(s)$
- sucrose crystals (table sugar), $C_{12}H_{22}O_{11}(s)$
- naphthalene, $C_{10}H_8(s)$
- food colouring (red, green, or blue)
- hexane, $C_6H_{14}(\ell)$/cyclohexane, $C_6H_{12}(\ell)$
- propane-1,2-diol (propylene glycol), $C_3H_8O_2(\ell)$
- propane-1,2,3-triol (glycerol), $C_3H_8O_3(\ell)$
- 1 mL pipette or medicine dropper
- well plate (12 or 24 wells are preferable)
- conductivity tester
- microspatulas or wood splints
- test tubes
- grease pen or marker
- plastic wrap or Parafilm™
- test tube rack
- four 50 mL burettes
- two double burette clamps
- two ring stands
- four 250 mL Erlenmeyer flasks
- stopwatch
- 4 funnels

Investigation 14.A: Comparing Organic and Inorganic Compounds

Procedure

Part I: Testing for Solubility and Conductivity

1. Use the pipette or medicine dropper to place 1 mL of each liquid listed below (the solvents) into its own well on your well plate. Label each well:
   A deionized water, **B** ethanoic acid, **C** propanol, **D** pentane
2. Measure the conductivity of each solvent using a conductivity tester. Remember to clean the electrical contacts after each test. Record the conductivity of each solvent in the following table:

Solute	**Conductivity**				**Solubility**			
	A	B	C	D	A	B	C	D
None								
Sodium chloride								
Baking soda								
Calcium carbonate								
Salicylic acid								
Sugar								
Naphthalene								

3. Place a small quantity of sodium chloride into each solvent using a microspatula or wood splint. Stir to determine whether the crystals will dissolve. Record your results.
4. Measure the conductivity of each well again using a conductivity tester. Remember to clean the electrical contacts after each test. Record the conductivity of each solution and note any differences from the results in Procedure Step 2.
5. Repeat Procedure Steps 1–4 using baking soda as the solute.
6. Repeat Procedure Steps 1–4 using calcium carbonate as the solute.
7. Repeat Procedure Steps 1–4 using salicylic acid as the solute.
8. Repeat Procedure Steps 1–4 using table sugar as the solute.
9. Repeat Procedure Steps 1–4 using naphthalene as the solute.

Part II: Testing for Miscibility

1. Using the pipette or medicine dropper, place 1 mL of deionized water into each of five small test tubes. Label the tubes A to E. Add a drop of food colouring to each tube and swirl gently to mix.
2. Into the test tube labelled with its letter, place 1 mL of the following liquids:

   A deionized water, **B** ethanoic acid, **C** propanol, **D** pentane, **E** hexane or cyclohexane

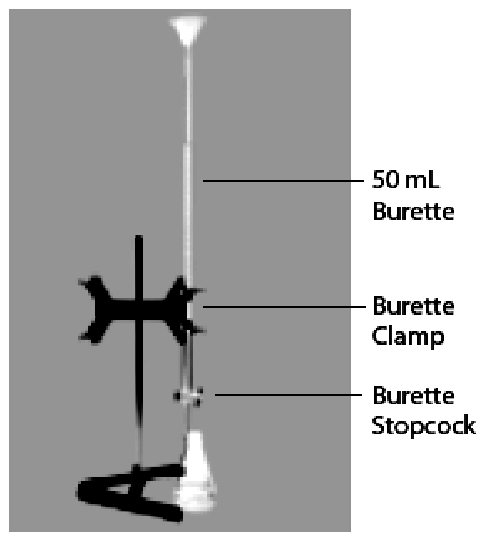
Investigation 14.A: Comparing Organic and Inorganic Compounds (continued)

3. Seal the end of each test tube with plastic wrap or Parafilm™. Place your thumb over the opening and shake the tube several times to mix the contents.
4. Let the test tubes stand undisturbed in the test tube rack for 1 min.
5. Observe each tube for evidence of mixing between the liquids. Use tube A as a standard against which to compare the other tubes. Record your results in the following table:

Tube	Miscibility

Part III: Testing for Relative Viscosity

1. Proceed to the lab station your instructor has set up. There you will find four burettes. Burette 1 contains 25 mL of ethanoic acid, Burette 2 contains 25 mL of propanol, Burette 3 contains 25 mL of propane-1, 2-diol, and Burette 4 contains 25 mL of propane-1,2,3-triol.
2. Position an empty Erlenmeyer flask under each burette. Be ready to start the stopwatch when you open the stopcock. Open the stopcock on Burette 1 and start the stopwatch. Stop the watch when 10 mL of liquid has flowed into the Erlenmeyer flask. Record that time in the table on the following page.



	Burette 1	Burette 2	Burette 3	Burette 4
Time required for 10 mL of liquid to flow out of the burette				

3. Repeat Procedure Step 2 for Burette 2, Burette 3, and Burette 4.
4. Close the stopcock on each burette. Use the funnels to transfer the contents of each Erlenmeyer flask back into their original burettes.

Analysis

1. Using the definition of organic compounds, classify each liquid and solid in this investigation as either organic or inorganic.

Investigation 14.A: Comparing Organic and Inorganic Compounds (continued)

2. Use your knowledge of chemical bonding to classify the solids used in this investigation as either ionic or molecular. Repeat for each liquid used.

3. Is it appropriate to conclude that organic solids dissolve in organic solvents and that inorganic solids dissolve in inorganic solvents? Explain.

4. Would it be reasonable to conclude that "like dissolves like" in regard to polar and non-polar substances? Explain.

5. Electrical conductivity is the result of the presence of ions in solution. Another student suggests that only ionic substances can conduct electricity. Do your results support this? Explain.

Investigation 14.A: Comparing Organic and Inorganic Compounds (continued)

6. How does the presence of carbon–oxygen polar covalent bonds in an organic liquid affect the viscosity of that liquid? Use your knowledge of hydrogen bonding to explain why.

Conclusion

7. How well do the results you observed in this investigation support your hypotheses?