

Geometric Isomers and Intermolecular Forces

Date: _____ Names: _____ Lab Section: ____

Part A: Solubility of Liquids and Intermolecular Forces

Solvent	Structural Formula	H-Bonding in the pure liquid? (Y/N)	Dipole-dipole in the pure liquid? (Y/N)	London Forces in pure liquid?(Y/N)	Predominant Forces (based on experimental observations)
water					
methanol					
1-propanol					
2-propanol					
1-butanol					
2-butanol					
tert-butanol					
2-methyl-2-butanol					
1-pentanol					
1-hexanol					
hexane					

Solvent Pair	Water/ Methanol	Water/ 1-propanol	Water/ 2-propanol	Water/ 1-butanol	Water/ 2-butanol	Water/ Tert-butanol
Observed Solubility						

Solvent Pair	Water/ 2-methyl-2-butanol	Water/ 1-pentanol	Water/ 1-hexanol	Water/ hexane
Observed Solubility				

Solvent Pair	Hexane/ Methanol	Hexane / 1-propanol	Hexane / 2-propanol	Hexane / 1-butanol	Hexane / 2-butanol
Observed Solubility					

Solvent Pair	Hexane / Tert-butanol	Hexane / 2-methyl-2-butanol	Hexane / 1-pentanol	Hexane / 2-hexanol
Observed Solubility				

Questions:

- 1) What trend can you find in the solubility of alcohols in water as the number of carbons is increased?
- 2) What trend can you find in the water solubility of alcohols containing branched carbon chains?
- 3) Explain these trends in terms of the intermolecular forces in water and the various alcohols.
- 4) What would you predict the solubility of 1,2-ethanediol in water to be? **EXPLAIN**.
- 5) Given a mixture of methanol and hexane (they are immiscible), suggest a liquid used in today's lab that when added to this mixture, makes all three miscible. Try it out.

Part B: Synthesis of Fumaric Acid

	Mass (g)	Melting Point (°C)
Maleic Acid		
Fumaric Acid		300 °C

Calculations: Calculate the % yield of Fumaric Acid

Questions:

- 1) Considering the molecular polarity of the two isomers, which isomer would be expected to have the higher melting point? **Explain.**

- 2) Considering intermolecular and intramolecular H-bonding in the two isomers, which isomer would be expected to have the higher melting point? **Explain.**

- 3) Which factor is predominant based on the observed melting point: molecular polarity or H-bonding? **Explain.**

Part C: Physical Properties of Maleic and Fumaric Acid (Step 2)

Test	Observations
Solubility of Maleic Acid and Water	
Solubility of Fumaric Acid and water	

4) Explain the observed differences in solubility between fumaric and maleic acid based on:
a) molecular polarity

b) H-bonding

Part C: Physical Properties of Maleic and Fumaric Acid (Step 3-8)

Test	Observations	
	Reaction with Mg	Reaction with NaHCO₃
1.0 M HCl		
0.1 M HCl		
0.01 M HCl		
Saturated Fumaric acid (~ 0.05 M)		
Saturated Maleic acid (~7.0 M)		
Unsaturated Maleic acid (~0.05)		

Questions:

- 1) Circle the HCl solution which was the most reactive with Mg metal and solid NaHCO₃ and underline the HCl solution which was the least reactive:
 - a) 1.0M HCl, 0.1M HCl, and 0.01M HCl
 - b) Explain why there was a difference in reactivity.

- 2) Explain the observed difference in reactivity between the saturated maleic acid solution, the saturated fumaric acid solution, and the unsaturated maleic acid solution with Mg metal and solid NaHCO₃. (Hint: Look at the K_{a1} values for maleic and fumaric acid and their solubilities in water.)