**CHE2060 Lecture 4: Example Problems**

We’ll work on some / most of these problems during class or lab to clarify concepts, and test and solidify understanding of specific points. Please print these pages and bring them to class and lab meetings.

**4.1: Physical properties of organic molecules**

1. What forces hold molecules together in a solid?

Attractive forces that occur between molecules (intermolecular interactions) hold molecules together in solid and liquid phases. Intermolecular interactions include: van der Waals bonding; dipole interations; hydrogen bonding and salt bridges (aka charge-charge interactions).

2. Why are molecules with several arenes likely to form liquid crystals?

Arene rings are flat, non-polar structures that stack upon on another. The stacking rings tend to align, or order, molecules to form liquid crystalline arrays.

**4.2: Types of intermolecular interactions**

3. What is unusual about the melting point of spherical molecules? Why?

The melting point of spherical molecules is notably higher than the melting points of elongated (or linear) molecules with the same number of carbons. Spherical molecules tend to maintain their shape even as their bonds rotate. Their compact shapes pack neatly like stacked grapefruit. Linear (or elongated) molecules with the same number of carbons have less stable shapes because of the free rotation that occurs continuously throughout their structures. These dynamic and unstable shapes don not pack together as consistently. Looser packing allows fewer intermolecular interactions and less energy is needed to melt arrays of elongated molecules.

4. Rank the likely boiling points of these compounds from low to high. Of course, you can use the web to discover these bps, so I’d like you to include an explanation of why the boiling points increase as they do.

a. butane

b. chlorobutane

c. butanol (CH3CH2CH2CH2OH)

d. butanoic acid (CH3CH2CH2COOH)

butanoic acid > butanol > chlorobutane > butane

All have vdW interactions. The first three also experience dipolar interactions with these polarity rankings: butanoic acid > butanol > chlorobutane. Both butanoic acid and butanol can hydrogen bond. The polarity and hydrogen bonding ability of butanoic acid is greater than that of butanol.

5. Do linear or branched molecules of the same carbon number experience greater van der Waals attraction? Why?

Linear (normal) molecules experience greater vdW attractions than branched molecules because linear shape facilitates contact along the entire length of adjacent molecules. A branch can interfere with (or break up) the area of contact along adjacent molecules.

6. What are the essential similarities and differences between dipolar and hydrogen bonding interactions?

Hydrogen bonds are an extreme and specific form of dipolar bond. In both dipolar and hydrogen bonds the atoms and bonds involved must be highly polarized. Dipolar bonds occur between any (oppositely) polarized molecules or groups. Hydrogen bonds require specifically polarized hydrogen and oxygen atoms.

**4.3: Solubility**

7. You need to find a solvent that will help to create a single phase solution from hexane and formic acid solutes. Which solvent should you choose? *And why?*

a. octane

b. water

c. isopropanol

Octane is more non-polar than either solute. Water is more polar than both solutes.

Isopropanol is the best choice because it is more polar than hexane but less polar than formic acid. The hydroxyl group of isopropanol can hydrogen bond with the carboxylic acid group of formic acid while the hydrocarbon chain of isopropanol can bond with hexane via van der Waals interactions

**4.4: Surfactants**

8. Why do fatty acids, surfactants, lipids and other amphipathic molecules form micelles when added to water?

All amphipathic molecules have two regions with opposite physical & chemical characteristics: a polar & hydrophilic; and a nonpolar & hydrophobic end. When these molecules form a micelle their hydrophobic regions form the center of the structure and are separated from water; they interact only with one another. The hydrophilic ends of the molecules face outward forming the surface of the micelle and interact with water.