This is ACA # 9. It is OK to use your textbook, but if you can answers the questions without it that is OK too.

I recommend you print out this page and bring it to class. Click here to show a set of five ACA9 student responses, randomly selected from all of the student responses thus far, in a new window.

John , here are your responses to the ACA and the Expert's response.

1. Indicate whether the following substance is polar or nonpolar. Support your answer with a brief explanation.

Substance	Polar or nonpolar	Brief reasoning
a) CO_2	non polar nonpolar 91%	Terminal atoms are identical and the central atom has no lone-pairs of electrons. The CO bond dipoles cancel due to the molecular geometry. Rule: central atom has no nonbonding pairs of electrons and the terminal atoms are identical. Explanation: The linear molecular geometry of the molecule allow the CO bond dipoles to exactly cancel each other out.
b) CH_3CH_2OH	polar polar 100%	The oxygen atom has different bonds, one bond to a hydrogen the other to a carbon (ethyl group), alone with two lone pair of electrons. The molecular geometry do not allow the bond dipoles, or the lone pair electrons to cancel. While the CH_3CH_2 portion of the molecule is nonpolar the OH is very polar due to the large electronegativity difference between oxygen and hydrogen, so the molecule is polar. The OH bond dipole is not cancelled out by the CH_3CH_2 portion of the molecule.
c) $CH_3CH_2CH_2CH_2CH_3$	non polar 95% nonpolar	C-C bonds are non polar and C-H bonds are essentially non polar so the molecule is non polar. Carbon and hydrogen have very similar

		electronegativities so the molecule is nonpolar.
d) CH_2Cl_2	polar polar 82%	Terminal atoms are different, two chlorine atoms and two hydrogen atoms. The molecular geometry does not allow the bond dipoles to cancel. Rule: The carbon is tetrahedral with no nonbonding electrons, and the terminal atoms are different, so the molecule is polar. Explanation: The tetrahedral molecular geometry of the molecule does NOT allow the CH and CCl bond dipoles to cancel each other out.
e) H_2O	polar polar 100%	The central oxygen atom has two lone pairs of electrons, and the OH bonds are at an angle of 105 degrees, so the molecular geometry does not allow the bond dipoles or the electrons to cancel. Rule: The central oxygen has two lone pairs of electrons, and the polar O-H bonds dipoles do not cancel out, so the molecule is polar. Explanation: The bent molecular geometry of the molecule does NOT allow the OH bond dipoles to cancel each other out.

2. For each of the following combinations from Q1 predict whether the mixture is homogeneous (a solution) or heterogeneous.

Mixture of	homogeneous mixture or heterogeneous mixture
H_2O and CO_2 68%	heterogeneous mixture heterogeneous mixture because H_2O is polar and hydrogen-bonding IMF while CO_2 is nonpolar and has only dispersion forces.
	homogeneous mixture

H_2O and CH_3CH_2OH 91%	**homogeneous mixture because H_2O is polar and hydrogen-bonding IMF. CH_3CH_2OH is also polar and hydrogen-bonding IMF.**
CH_3CH_2OH and $CH_3CH_2CH_2CH_2CH_3$ 73%	**heterogeneous mixture** **heterogeneous mixture because CH_3CH_2OH is polar and hydrogen-bonding IMF while $CH_3CH_2CH_2CH_2CH_3$ is nonpolar and has only dispersion forces.**
CO_2 and CH_2Cl_2 78%	**heterogeneous mixture** **heterogeneous mixture because CO_2 is nonpolar and dispersion forces IMF while CH_2Cl_2 is polar and has dipole-dipole forces.**
CH_3CH_2OH and CH_2Cl_2 78%	**homogeneous mixture** **homogeneous mixture because CH_3CH_2OH is polar and hydrogen-bonding IMF. CH_2Cl_2 is also polar and dipole-dipole IMF.**
82% **H_2O and $CH_3CH_2CH_2CH_2CH_3$**	**heterogeneous mixture** **heterogeneous mixture because H_2O is polar and hydrogen-bonding IMF while**

	$CH_3CH_2CH_2CH_2CH_3$ is nonpolar and has only dispersion forces.
H_2O and CH_2Cl_2 73%	**homogeneous mixture** **homogeneous mixture because H_2O is polar and hydrogen-bonding IMF. CH_2Cl_2 is also polar and dipole-dipole IMF.**

3. Briefly explain why H_2O and CH_3CH_2OH will form a homogeneous mixture.

For the ΔH term, since the solute and solvent particles all have hydrogen bonding as the most important IMAF the ΔH for forming hydrogen bonds between solute and solvent particles will be comparable to the the ΔH terms for overcoming the hydrogen bonding between solute particles and between solvent particles. Also the ΔS term will be positive since the mixture of solute and solvent particles is more dispersed compared to the particles in the pure solute or pure solvent.

ΔH of solution is most likely exothermic because of the similarity of the hydrogen-bonding intermolecular attractive forces. That is the energy required to overcome the hydrogen bonds between water molecules, plus the energy required to overcome the hydrogen bonds between ethanol molecules, is less than the energy released when hydrogen bonds form between water molecules and ethanol molecules. ΔS of solution is positive because in the homogeneous mixture the solute and solvent particles are more dispersed compared to the particles in the pure solute and solvent. When ΔH is negative and ΔS is positive, than ΔG will be negative at any temperature.

4. Is there anything about the questions that you feel you do not understand? List your concerns/questions.

nothing

5. If there is one question you would like to have answered in lecture, what would that question be?

nothing

How to identify mixtures given chemical formula

What happens when nonpolar and nonpolar mix

(explaining) What are the steps for predicting formation of a solution.