1. **(4 pts)** The figure below is a molecular view of the solution process portrayed as taking place in three steps. Explain, in terms of the 3 steps shown, how a solution process can be exothermic. If you wish, you can simply write down an equation rather than explaining in words.

\[
\Delta H_1 + \Delta H_2 + \Delta H_3 < 0
\]

A dissolving process is exothermic if it takes less energy to disrupt the solvent-solvent interactions (step 1) and the solute-solute interactions (step 2) than you get back again when you form the solute-solvent interactions (step 3).

2. **(4 pts)** Arrange the following substances in order of decreasing solubility in water at 25°C and 1 atm.

   a. O₂ (g) (non-polar gas with small atoms)
   b. LiCl (s) (soluble ionic compound)
   c. Br₂ (l) (non-polar liquid with bigger atoms than O₂)
   d. Ethanol; C₂H₅OH (l) (ethanol is miscible with water)

Put the letters (rather than the formulas) in the proper order.

\[ \text{d} > \text{b} > \text{c} > \text{a} \]

Most soluble \hspace{1cm} Least soluble
3. **(2 pts)** Which of the substances in problem #2 is amphiphilic?

Ethanol is amphiphilic. It has a polar head group (O-H) and a non-polar tail (C₂H₅). Since the tail is very short, this compound behaves more like it is a polar molecule but it will dissolve in non-polar solvents such as hexane or benzene.

4. Consider the dissolving of calcium chloride in water.

a. **(2 pts)** Write the balanced equation for the dissolving reaction.

   \[ \text{CaCl}_2(s) \rightarrow \text{Ca}^{2+}(aq) + 2 \text{Cl}^-(aq) \]

b. **(1 pt)** What is the molarity of calcium ions in a 2.0 M solution of calcium chloride? (There is no need to show your work for this problem.)

   \[ [\text{Ca}^{2+}] = 2.0 \text{ M} \text{ (every mole of calcium chloride produces a mole of calcium ions.)} \]

c. **(1 pt)** What is the total molarity of particles in a 2.0 M solution of calcium chloride? (There is no need to show your work.)

   \[ [\text{particles}] = [\text{Ca}^{2+}] + [\text{Cl}^-] = 2.0 \text{ M} + 4.0 \text{ M} = 6.0 \text{ M} \]

5. **(6 pts)** Calculate the molality of sucrose (mw = 180 g/mol) in a 0.100 M solution? Assume the density of the solution is 1.00 g/mL. Show your work and include units on all numbers. Sig. Figs count.

   In one liter there are 0.100 moles of sucrose

   One liter of solution weighs 1.00 \times 10^3 \text{ g} = 1.00 \text{ kg}

   \[
   \begin{align*}
   0.100 \text{ mol sucrose} & \quad 180.0 \text{ g sucrose} = 18.00 \text{ g sucrose} = 0.01800 \text{ kg} \\
   1.00 \text{ kg} - 0.0180 \text{ kg} & \quad 0.982 \text{ kg water} \\
   \frac{0.100 \text{ mol sucrose}}{0.982 \text{ kg water}} & \quad \frac{0.102 \text{ m}}{}
   \end{align*}
   \]

   a bit higher than molarity as expected.