1a) What is the vapor pressure of 100 mol of water with 50 mol of a non-volatile solute at 100 °C (the normal boiling point of water)? Assume ideal behavior.

1b) How would the vapor pressure in part (1a) change if the solute-solvent interactions became more favorable?

1c) If each of the following were added to methanol (CH_3OH), which would be most likely to conform to Raoult's Law? Explain your answer.

CH_3OCH_3	CH_3SH	C_6H_6	CH_3CH_2OH
(*dimethyl ether*)	(*methanethiol*)	(*benzene*)	(*ethanol*)

2. Given the following values, calculate the lattice energy (U) of $CaCl_2$.

$\Delta H_f^o[CaCl_2\ (s)] = -795.4$ kJ/mol $\quad \Delta H_{sub}[Ca\ (s)] = 154$ kJ/mol $\quad \Delta H_{BE}[Cl_2] = 240$ kJ/mol

$IE_1[Ca] = 590$ kJ/mol $\quad IE_2[Ca] = 1145$ kJ/mol $\quad EA[Cl] = -349$ kJ/mol

Draw a picture, with energy on the y-axis, of the Born-Haber cycle that enables you to calculate the lattice energy (U). Would you expect the lattice energy of $MgCl_2$ to larger or smaller than that of $CaCl_2$?

3. Arrange the following in order of increasing melting points and explain your answer.

   C_8H_{18} NaO_2 MgO CaO

4. A capsid is a protein that self-assembles into the shell of a virus, and is made up of uncharged proteins called protomers. You have discovered a new protomer with molecular weight 180 kilodaltons (kDa), where 1 kDa = 1000 amu.

   A 5 mM solution of this protomer gives an osmotic pressure of 2.0 mbar (or 0.0020 atm) at 298 K. How many protomers make up this virus shell?

5. You're feeling sweet after Thanksgiving, and so you would like to know the freezing temperature of an aqueous solution made by adding 186 mg of saccharin ($C_7H_5O_3NS$) to 1.00 mL of water.

   First, calculate the molality of the saccharin solution.
   Second, determine the freezing point of the saccharin solution if K_f = 1.86 °C/mol.