1. Suppose the tilt of the earth’s axis were increased from 23.5° to 90°.
   
   a. What portion of the earth’s surface would now be considered to be in the tropics?
   
   b. What would be the latitudes of the Arctic and Antarctic circles?

   Explain your answer using sketches like the ones shown in class. Your explanations should make use of the discussion of the tropics and the Arctic circle given in class.

2. Figure 3.10 shows that on June 21st the noontime sun is south of the local vertical (the zenith), but at dawn the sun rises in the northeast.

   Draw a sketch like the ones shown in class to demonstrate that the sun rises north of the horizon at the summer solstice. Start the sketch like this (but larger), and add more detail to answer the question:

   ![Sketch of sun rise at summer solstice](Note that the line perpendicular to the axis of rotation represents the latitude of the observer.)

   Indicate the point on the earth where the observer is watching the sunrise. Draw a line representing the sun ray seen at dawn by the observer, and label the directions east “E” and west “W” as seen by the observer.

   Based on your figure, explain how can you tell that the sun rises on the horizon to the northeast of the observer.

3. According to the isotherms in figures 3.21 and 3.22,
   
   a. where on earth do you find the most extreme seasonal temperature variation? How large is the seasonal variation at that location?
   
   b. Based on class discussion, explain why this location has such a large seasonal variation in surface air temperature.

4. Consider the lag (i.e. the time beyond noon) in maximum daily temperature at the surface of Lake Wingra, a shallow lake which freezes over in the winter. In which season would you find the smallest lag in daily maximum temperature? Explain.

Note: homework is due at the beginning of class on the due date. Please explain your answers and show all work.