1. Be able to do the calculations in Exercise 11.5, pages 424-425, from the textbook, using the lighting equation given below.

   When you calculate the lighting equation given below, be sure to use the equation for the reflection vector, $\mathbf{r}$, given on page 423 of the textbook.

   $$\mathbf{r} = 2(\mathbf{n} \cdot \mathbf{l})\,\mathbf{n} - \mathbf{l}$$

   The solution for Exercise 11.5, using the lighting equation given below, is

   $$[r, g, b] = [0.0871, 0.5560, 0.2436]$$

   The solution for Exercise 11.5, using the lighting equation given in the textbook (with the "half vector" $\mathbf{s}$), is

   $$[r, g, b] = [0.4621, 0.7810, 0.3186]$$

2. Here is the equation for the Phong light model (for one color of light).

   $$I = k_e + k_a\, L_{aGlobal} + \sum_{each\,light} (\, k_a L_a + k_d \max(\mathbf{l} \cdot \mathbf{n},\, 0)\, L_d + k_s \max((\mathbf{r} \cdot \mathbf{v})^{\alpha},\, 0)\, L_s\,)$$

   (a) The Phong model describes three kinds of light. For each kind of light, give its name, a brief description, and specify which term in the above equation is for that kind of light.

   (b) The Phong model specifies five material properties for a vertex. What are the names of these properties and what mathematical symbol is used in the above equation for each property?

   (c) The Phong model uses four vectors. What do each of those vectors represent? Draw a picture and label each vector in your picture with the correct mathematical symbol from the above equation. Be sure your picture makes clear the meaning of each vector.

   (d) In the term $k_d \max(\mathbf{l} \cdot \mathbf{n},\, 0)\, L_d$, explain what the dot product is there for (what physical phenomena does it model and how does it model it?) and explain what the purpose of the max function is.

   (e) What does k_e represent and why is it in the model?

3. In OpenGL, what is the difference between a spotlight and a regular light?

4. In OpenGL, how do you move a light?