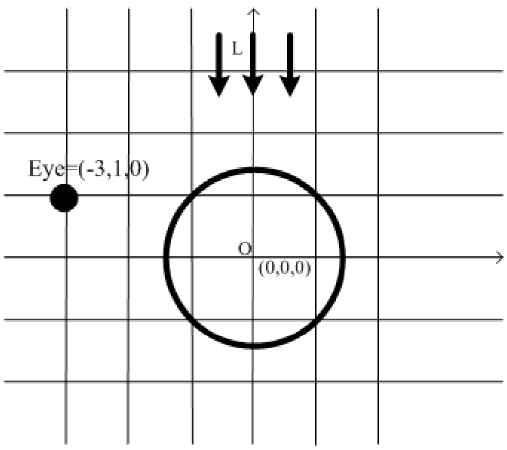
1. Lighting:

   The scene below consists of: a sphere of radius $\sqrt{2}$ centered at origin with $k_d = (1, 0, 0)$ and $k_s = (1, 1, 1)$; a parallel (directional) light $L = (0, -1, 0)$ with $I_d = I_s = (1, 1, 1)$; and an eye location, as shown, at $(-3, 1, 0)$. Assume there are no other light-sources.

   (a) At what point (coordinates) on the sphere will we get maximal specular reflection (white dot)? Explain your answer.

   (b) At what point (coordinates) on the sphere will we get maximal diffuse illumination (red dot)? Explain your answer.

   (c) Given a single ambient light source with $I_a = (1, 0, 0)$ and a triangle P_1, P_2, P_3 with $k_a = (0, 0, 1)$, what color will be assigned to P_1 using the light equation? Show your work.

2. Light and shading

   (a) Given a scene with two non specular objects, one yellow ($k_a = k_d = (1, 1, 0)$) and one red ($k_a = k_d = (1, 0, 0)$), classify the following statement as true or false. Explain.

      i. Given a single point light source with intensity $I_p = (1, 0, 0)$ the objects will have the same shading.

      ii. Given a single ambient light source with intensity $I_a = (1, 0, 0)$ the objects will have the same shading.

   (b) Write the openGL code for defining the following lighting scenario with three light sources: ambient light source with intensity $I_a = (0.3, 0, 0)$; directional light with direction $(1, 0, 0)$ and intensity $(0.6, 0.6, 0.6)$; point light at $(10, 0, 0)$.

   (c) In openGL define the material properties for a triangle with $k_a = (1, .5, .5)$, $k_d = (1, .5, .5)$, $k_s = (.5, .5, .5)$ and specularity coefficient $n = 16$.

3. Clipping

   (a) Write an algorithm (pseudo-code) for clipping a line $L = P_1P_2$ ($P_1 = (P_1^x, P_1^y)$, $P_2 = (P_2^x, P_2^y)$) against a triangle $T = (T_1, T_2, T_3)$ with $T_1 = (T_1^x, T_1^y)$, $T_2 = (T_2^x, T_2^y)$, $T_3 = (T_3^x, T_3^y)$ (in 2D). Follow the framework of the Cohen-Sutherland algorithm for clipping a line against a window.

   (b) Explain how to extend your algorithm for clipping the line L against a convex polygon $T = (T_1, T_2, \ldots, T_n)$.

   (c) Will your algorithm work for non-convex polygons? Explain.

4. Bresenham

   Write the Bresenham algorithm for rasterizing a line from (x_1, y_1) to (x_2, y_2) where $x_1 \geq x_2$, $y_2 > y_1$ and $x_1 - x_2 < y_2 - y_1$.

5. Clipping (Bonus question)

   Use the definition of convexity to prove that the intersection of two convex objects is convex.