

Chapter 4 Problem Set

These problems follow through the chapter in order. The easiest way to do the work is to start an interactive Python session and load your `vec3` and `util` files to give you a sort of interactive vector RGB calculator. Note: it would be a good idea to show your work as well so that we can diagnose where you may have gone wrong.

1. Write the parametric ray equation for a ray starting at $(1,1,2)$ and passing through the point $(3,-3,1)$.
2. Consider setting up a perspective view with the following information: the eye is at $(5,2, -10)$, the viewing plane is 20 units in front of the eye, and the window is size 40×30 . We are looking towards the point $(0,5,0)$, and “up” for the camera is generally in the direction of positive y .
 - (a) compute the unit vectors U , V , and N that define the camera’s coordinate system.
 - (b) Suppose we are creating an image with resolution: 640×480 . Compute the start and direction of the ray for the pixel at position $(200, 350)$.
3. Consider the ray $(3, 1, -4) + t(-3, -2, 3)$ and a sphere of radius 10 centered at the point $(0, 2, -6)$.
 - (a) Compute the A, B, C coefficients of the quadratic equation to solve for the time t when the ray hits the sphere.
 - (b) Does the ray intersect the sphere? How do you know?
 - (c) If possible, compute the first point of intersection.
 - (d) Compute the normal vector at the point for intersection
4. There is a light at position $(100,100,100)$ shining on an object with the diffuse color $(.75, .5, .25)$. The light has intensity $(.7, .7, .9)$. Consider a point on the surface of the object located at $(5, 4, -3)$ and having surface normal $(0,1,1)$.
 - (a) Compute the light vector for shading purposes (l in the book, `lvec` in class).
 - (b) What is the pixel color for this point using Lambertian shading?
 - (c) Suppose the ambient light in the scene has the intensity $(.2, .2, .3)$ and the object’s ambient color is the same as the diffuse color. What is Lambert + ambient color of the pixel?
 - (d) Suppose a viewer is looking at the object from the location $(0,2,0)$, compute the half-vector (h) used for Blinn-Phong shading.
 - (e) Compute the final color value for the pixel assuming the objects specular color is $(1,1,1)$ and it’s shininess exponent is 50.
5. The ray $(1,2,3) + t(4,5,6)$ is reflected off a surface having the normal $(-.67, -.67, -.33)$ what is the direction of the reflected ray?