1. (20 points)
   a) Suppose a light ray is reflected and refracted by a surface. The refractive index is $\sqrt{2}$. The viewing direction $v$ and the unit normal $n$ are:
   
   $$
   v = \frac{1}{\sqrt{6}} \begin{pmatrix} 1 \\ 1 \\ 2 \end{pmatrix}, \quad n = \begin{pmatrix} 0 \\ 1 \\ 0 \end{pmatrix}
   $$

   Find the perfect reflection direction $r_v$ and the transmission direction $t$ (the vectors should be normalized).

   b) Suppose a specular light source is located at $(2, 10, 0)$ with illumination,

   $$
   I = \begin{pmatrix} R \\ G \\ B \end{pmatrix} = \begin{pmatrix} 0.4 \\ 0.6 \\ 0.8 \end{pmatrix}
   $$

   The camera (eye) is located at $(5, 4, 0)$. A reflective sphere with radius 2 and reflection coefficient $\rho_{rg} = 0.6$ is located at $(0, 3, 0)$. Another sphere with radius 1 is located at $(3, 0, 0)$. What is the illumination at the point $(3, 1, 0)$ on the surface of the sphere? Assume that the material types for both spheres are specular, a Phong model is used, the experimentally adjusted constant $f = 1$, and the specular reflectivity coefficients are 0.6.

2. (20 points) Make use of the raytracing package to render a scene consisting of a sphere and a shadow like the one shown below:

   ![Sphere and Shadow](image.png)

3. (20 points) Add to the above question a reflective cylinder at the left side of the sphere. The image of the sphere should appear in the cylinder.

4. (Extra Credit: 10 points) Add to question 3 a translucent sphere situated between the original sphere and the cylinder.