

1. An infinite cylinder is given by the equation

$$(x - a)^2 + (z - c)^2 = R^2.$$

Outline a procedure for computing the closest intersection point of a ray starting at $o = (x_o, y_o, z_o)$ and with a direction vector $d = (d_x, d_y, d_z)$ with that cylinder. Be sure to include and precisely state all the essential formulas. What is the formula for the normal vector at the intersection point?

2. In the raytracer you wrote for project 1, a large triangle can smoothly vary in shade over the surface. Why?

3. What is a triangle with vertices $(0, 0, 1)$, $(1, 2, 1)$, $(1, 0, 0)$ mapped to by the transformation with the following matrix in the homogenous coordinates

$$\begin{bmatrix} 1 & 1 & 3 & 1 \\ -1 & 0 & 0 & 2 \\ 5 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}?$$

How about the sphere centered at the origin and with radius 1 (write the equation of the resulting surface)?

4. The vertices of a triangle project to $(0, 0)$, $(1, 3)$ and $(3, 1)$. Let's say that the depth values (computed using the perspective transformation matrix) at these vertices are 1, 3 and 4 (respectively). What is the depth of the point on that triangle which projects to $(1, 1)$?

5. Can one obtain an 8-gon as a result of clipping a triangle with respect to a rectangle (in 2D)? How about an 10-gon resulting from clipping a triangle against a cube (in 3D)? Is it possible? Explain your answers.

6. Write a pseudocode for a loop that would output consecutive vertices defining a triangle strip beginning at a triangle whose one of the bounding half-edges is h (assuming that your triangle mesh is represented using the half-edge datastructure). Use the half edge notation: $h.o$, $h.n$, $h.p$ for the opposite, next, previous half-edges and $h.s$ for the starting vertex of h .