CS 240: Computer Graphics
Lab 20: December 9, 2015

Review problems

1. **3D transformations:** You are given a cube centered at $(0, 0, -5)$, with a camera at the origin and a viewport at $z = -1$. The cube's faces are colored as follows. Front: white, right: black, back: blue, left: green, top: yellow, bottom: red. The line below is added right before the cube is drawn.

        glRotate(-30,1,0,0)

   What colors are visible?

2. What is wrong with this picture?
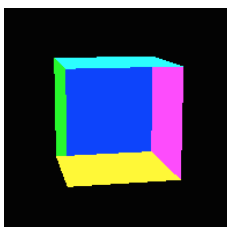
3. **Perspective projection:** The projection in an example program is given by

   glFrustum(-2, 2, -2, 2, 1, 40)

   Does the point $\vec{P} = (0, 5, -3)$ lie inside the viewing frustum or does it get clipped out? *Hint: draw out the right view.*

4. **Lighting:** You are given a unit sphere centered at the origin and light source specified with the following code:

    ```
    glLightfv(GL_LIGHT0, GL_POSITION, [1, 1, 0, 1])
    ```

    What is the (unit) normal vector of the sphere at the point $(\frac{\sqrt{2}}{2}, \frac{\sqrt{2}}{2}, 0)$? What is the (unit) direction of the light ray pointing towards this point? Compute the dot product of these two unit vectors. What does this tell us about the color of sphere at this point?

5. **Hierarchical models:** Draw a hierarchical tree for the robot below, assuming the shoulder is at the origin. Use objects as nodes first, then add transformations.
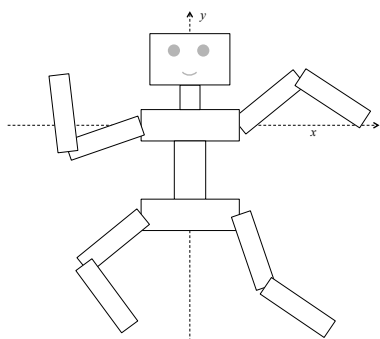
6. **Name this algorithm:**

    ```
    for all p in pixels:
        create a ray r from camera to p
        for all o in objects of the world:
            calculate intersection of o with r
            keep if closest
        color p based on material of o & angle of surface to light
    ```

7. **Texture mapping:** Design a texture mapping algorithm for a triangle. Think about how to map a 4×4 checkboard texture as a concrete example.