Week 3 study sheet:
Geometric Modeling

Problem 1 (18 points) Projections in computer graphics can be broken down into two major types: "perspective projection" and "parallel projection."

a) (6 points) Complete the following table, summarizing properties of these two types of projections:

Property	Perspective	Parallel
Parallel lines remain parallel [Y/N]:	______	______
Angles are preserved [Y/N]:	______	______
Lengths vary with distance to eye [Y/N]:	______	______

Under perspective projections, any set of parallel lines that are not parallel to the projection plane will converge to a "vanishing point." Vanishing points of lines parallel to a principal axis x, y, or z are called "principal vanishing points."

b) (3 points) How many different vanishing points can a perspective drawing have?

c) (3 points) How many different principal vanishing points can a perspective drawing have?

Problem 1 (continued)

Parallel projections can be further broken down into two types: "orthographic projections," where the direction of projection is perpendicular to the projection plane; and "oblique projections," where the direction of projection makes some angle $\theta \neq 90°$ with respect to the projection plane.

Two common types of oblique projections are the "cavalier projection" and the "cabinet projection." In a cavalier projection the foreshortening factors for all three principal directions are equal, whereas in a cabinet projection the edges perpendicular to the plane of projection are foreshortened by one-half.

d) (6 points) Suppose you wanted to use an oblique projection that foreshortened the edges perpendicular to the plane of projection by one-third instead of one-half. What angle θ between the direction of projection and the projection plane is required?

Problem 2 (20 points) Suppose that you wanted to rotate a cube with vertices $\{(\pm 1, \pm 1, \pm 1)\}$ about its main diagonal through an angle of θ. Derive a transformation matrix to achieve this rotation. (You don't need to write out the matrices; instead, you may express your answer as a product of transformations about principal axes such as "$R(x, \theta)$.")

Problem 5 (12 points) Short answers:

a) (4 points) What is the difference between "kinematics" and "dynamics"?

b) (4 points) What do the terms "inverse kinematics" and "inverse dynamics" mean?

c) (4 points) Which types of problems tend to be more difficult, the "forward" problems of part (a), or the "inverse" problems of part (b), and why?