Name: _____

Homework 2

15-462 Computer Graphics, Spring 2012

Due 4/24 at the beginning of class

75 points

Please show all of your work.

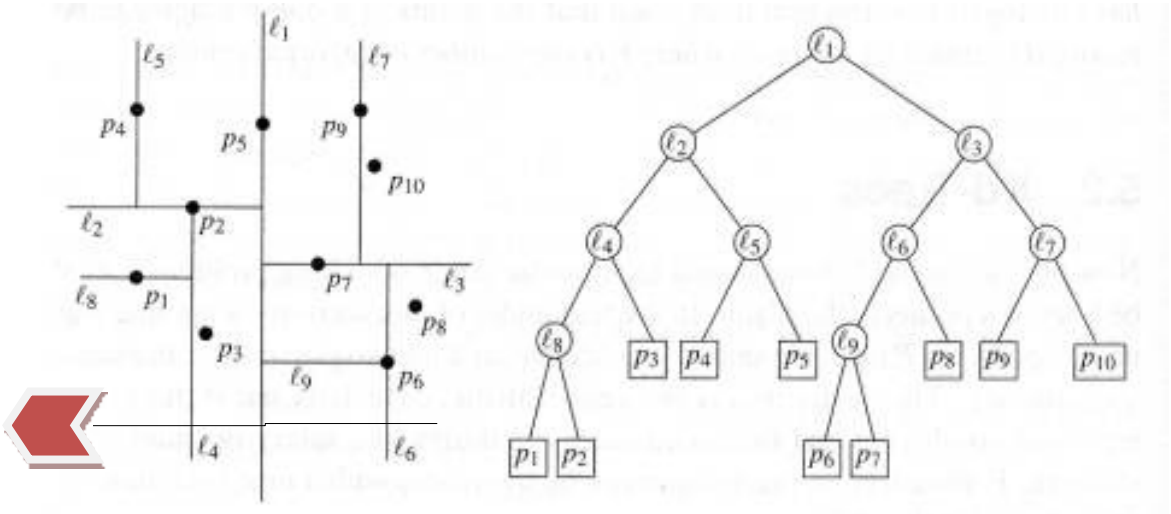
Please list any references that you used to research or obtain your solution.

1. **(20 points)** Describe how to create shadows as part of the following algorithms / systems. Draw diagrams where it is helpful to illustrate your answer.
   a. (5 points) Within the standard OpenGL pipeline
   b. (5 points) In a ray tracer
   c. (5 points) As part of a radiosity solution
   d. (5 points) In photon mapping

2. **(10 points)** Rays of light hit the surface of a rectangular glass prism at a 45 degree angle from the surface normal. Draw a diagram showing the path of light as it passes through the prism and out the other side. Compute exact angles of incidence of all rays and label them in the figure. You may assume the prism is 1 inch thick. Show only rays of light that enter the front, travel through this 1 inch thickness and exit the back face.

3. **(15 points)** The figure below shows a set of points on the left and a corresponding KD-tree on the right.

   a. (10 points) Write pseudocode to traverse the tree from front to back from a given viewpoint (e.g., to find the first intersection from a viewpoint along a ray).
   b. (5 points) Give the complete traversal for a viewpoint in the lower left corner, looking towards the right, as shown in red below.



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4. **(5 points)** In the radiosity global illumination algorithm, we solve a system of equations that express a certain equilibrium state of light rays passing through a scene and affecting the appearance of that scene. What is this equilibrium in plain language?

5. **(10 points)** Solve the radiosity equations for a system of three patches with the following properties. Patch 1 is an emitter, emitting light of magnitude 1 and reflecting nothing. Patches 2 and 3 reflect half the light incident on them. All form factors between all pairs of patches are 0.5.

6. **(5 points)** Lecture 19 described a technique to separate out global and direct illumination from a scene. Under what circumstances will this technique fail to identify subsurface scattering effects as global illumination? Hint: the subsurface scattering will be lumped in with direct illumination effects instead.

7. **(10 points)** Physically based simulation is widely used to create animated characters and their clothing, hair, supporting objects in the environment, etc. There is some sense, however, that physical simulation is at odds with the Principles of Traditional Animation (reference Lecture 20). In your opinion, which of these principles emerge naturally from physically based simulation and which are orthogonal to physics or in opposition to physical realism? Explain your answers.