You have 150 minutes. No computers, notes, or other aids are allowed.

The best answers are not just factually and logically correct. They emphasize the most important information, de-emphasize less-important information, and exclude irrelevant information. They convince the grader that the student understands the context and motivation of the question. They are concise. Frequently they employ diagrams or pictures.

If you believe that a question is ambiguous, then ask for clarification. If the clarification does not help, then explain your interpretation of the problem in your solution.

Good luck. :)

A.A. Explain the distinction between local and global (world) coordinates, as they apply to ray tracing. Pictures often help.

A.B. How does one transform between them in our software?

A.C. Should recursive ray casts be done in local or global coordinates?

A.D. Should lighting (ambient, diffuse, specular) calculations be done in local or global?

B. This question applies to every part of our course: software rasterization, hardware rasterization, and ray tracing. Explain any notation that you use. Pictures often help.

B.A. Which quantities enter into the calculation of Lambertian diffuse reflection?

B.B. In mathematical detail, what is the calculation?

B.C. Which quantities enter into the calculation of Phong specular reflection?

B.D. In mathematical detail, what is the calculation?

C. Which major feature, which we have used heavily, was introduced to OpenGL in version 2.0?

D. As far as your ray-tracing refraction code goes, how are these two situations different: light enters a glass body from air, and light exits a glass body into air? How do you use Snell's law in each? Pictures can help — especially if they are precise.

E.A. In ray tracing, which contributions are summed to obtain the final color at a pixel?

E.B. Of the many quantities that enter into the calculation of those contributions, which are determined by the geometry of the body?

E.C. Which are determined by the material properties?

E.D. Which are determined by the light(s)?

F. This problem about triangular mesh bodies is spread over two pages. For simplicity, assume that all vectors (points and directions) are in local coordinates.

A triangle is specified by three vertices $\vec{a}$, $\vec{b}$, $\vec{c}$ (in counterclockwise order when viewed from outside the mesh). Suppose that the vertices have attributes XYZSTNOP. Suppose that a ray intersects the triangle's plane at time t, so that $\vec{x} = \vec{e} + t\vec{d}$ is a point on the plane. Using linear algebra, one can compute p and q such that $\vec{x} = \vec{a} + p(\vec{b} - \vec{a}) + q(\vec{c} - \vec{a})$ in the XYZ components.
F.A. How can one test, using p and q, whether the ray intersects the triangle?

F.B. How can one compute, using the NOP attributes, the unit outward-pointing normal at $\vec{x}$?

F.C. How can one compute, using the ST attributes, the texture coordinates at $\vec{x}$?

F.D. Are they perspective-correct? If not, then how should one correct them?

This page is scratch space. If you want me to grade any of your work here, then clearly mark which problems go with which work.