You are expected to complete this exam during any two-hour window within the exam period, which runs from Saturday 8:30 AM to Sunday 8:30 AM. The exam is open-book and open-note:

- You may use all of this course's resources: your class notes, your old homework, and the course Moodle site, the course web site. You may not share any resources with any other person while you are taking the exam.
- You may cite material (definitions, algorithms, etc.) from class and the assigned homework. You do not have to redevelop that material in your solution. On the other hand, you may not cite material that we have not studied, without developing it from the material we've learned.
- You may not consult any other books, papers, Internet sites, etc. You may use a computer for viewing the course Moodle/web site, running our course software, optionally typing up your answers, and e-mailing with me. If you want to use a computer for other purposes, then check with me first.
- You may not discuss the exam in any way — spoken, written, etc. — with anyone but me, until everyone has handed in the exam.

Feel free to ask clarifying questions in person or over e-mail. You should certainly ask for clarification if you believe that a problem is mis-stated. If you cannot receive clarification, then explain your interpretation in your solution.

Your solutions should be thorough, self-explanatory, neat, concise, and polished. You might want to work first on scratch paper and then recopy your solutions. Alternatively, you might want to type your solutions. Always show enough work and justification so that a typical classmate could understand your solutions. If you cannot solve a problem, then write a brief summary of the approaches you've tried. Partial credit is often awarded. Please present your solutions in the order assigned.

Good luck. :)

You're talking to your friend about computer graphics. They are a CS major, and they want to understand the big ideas of CS 311, but they're not going to take CS 311, because they don't want to do the actual work. (This premise is not unrealistic.) Answer their two questions below.
A.A. I hear that making graphics by ray tracing is slow. Why is it slow, and how slow is it?
A.B. I hear that making graphics by the triangle rasterization algorithm is fast. Why is it fast, and how fast is it?

In our mesh files, `mesh3DInitializeBox` constructs a parallelepiped (rectangular box) whose sides are aligned with the local coordinate planes. To ray trace such an object, we could treat it like any other mesh, but doing so would not take advantage of the geometric simplicity of the object. Below, I have sketched an algorithm for the `getIntersection` method of such an object.

1. Intersect the ray with the X = `left` plane. Update the query's t_{start} and t_{end}.
2. Intersect the ray with the X = `right` plane. Update the query's t_{start} and t_{end}.
3. Intersect the ray with the Y = `bottom` plane. Update the query's t_{start} and t_{end}.
4. Intersect the ray with the Y = `top` plane. Update the query's t_{start} and t_{end}.
5. Intersect the ray with the Z = `base` plane. Update the query's t_{start} and t_{end}.
6. Intersect the ray with the Z = `lid` plane. Update the query's t_{start} and t_{end}.
7. Determine the time t and nature (`rayNONE`, `rayENTER`, or `rayEXIT`) of the intersection.

B.A. Fill in the details of this algorithm. (For simplicity, I am not asking you to compute texture coordinates or normals. Also, ignore the special case where the ray is parallel to one or more of the box's sides.)
B.B. Explain how you would extend the algorithm to incorporate the `normal` field of the `rayResponse`. (For simplicity, I am still not asking you to compute texture coordinates, and you can continue to ignore the special case.)

In ray tracing, we developed our shadowing algorithm before we introduced transmission. So the algorithm implicitly assumes that all bodies are opaque.
C. How difficult would it be, to adjust our shadowing algorithm to handle the possibility of light passing through translucent bodies? Discuss. (This question is deliberately open-ended. I'm more interested in your thought process, and how it is informed by the material that you've learned, than I am in the final answer.)