- WARNING: As usual, I am squeezed for time as I write this, so please do not assume that it is a stand-alone study resource.
- ADVICE:
  - Part of what I hope to learn on a test is the extent to which you can take ideas we've learned and apply them to situations that are different from what you've seen before. So your goal is to learn not only how to do problems we've covered before, but to understand *why* we do them that way – in other words, to understand the ideas behind them. Of course, in some cases there are only so many questions to ask, and so I may not be able to come up with dramatically new and different questions, but if you understand the concepts and can apply them, you should be prepared for most anything that comes along.
  - I remind you once again to spread studying for this exam out over several days. Information sinks in better; if you get frustrated, you can take breaks; if some calamity occurs on the day before the exam, you've already done a fair amount of studying; you can get plenty of sleep the night before the exam; etc
  - Review your notes and the readings. In the notes from class, remind yourself of the connections between math and art that may not have been covered much in the readings.
  - Your main focus should be to *do* (not to read) as great a variety of problems as possible. In addition to doing the few problems I've included on this study guide, you'll also want to redo as many problems as you can from the first three problem sets. (Notice again that I said "redo" – simply reading through solutions doesn't do it.)
  - It's important enough that I'll mention it again – When you're doing problems, focus on *why* the steps are what they are. Spare some of your thoughts for how different problems are connected, and why various steps make sense.
  - When doing a problem that you've done before, don't waste your time trying to remember how you did before–often, memory proves to be false and can lead you astray. Just focus on doing what makes sense. The whole joy of math is the logical path your thoughts make – when you look back upon a solution, it should look like an inexorable journey, where no other choices really made sense.
  - Should you study alone or with other people? That varies from person to person, but in general I'd say most of your studying should be on your own, particularly as it gets closer to the day of the exam. I think group study is best for most people at the beginning of the study process. Since the exam is individual, at some point in your studying, you have to be doing problems individually.
  - How long should you study for this? Alot. "Alot" will vary from person to person also, but I'd suggest an absolute minimum of 6 hours. I know one person in your class studied 20 hours for the last test – and it worked! If you've struggled with

the problem sets, then leave more. If you breezed through the problem sets on your own, then you *may* be able to get away with less – but why risk it?!

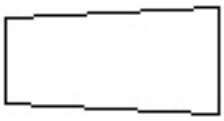
- Topics:
  - The rules of perspective (remember, I gave you a handout with several such rules)
  - Subdividing rectangles into halves, fourths, eighths.
  - Subdividing rectangles into portions that are *not* powers of 2 – thirds, fifths, etc. (This is from homework)
  - Duplicating a rectangle immediately next to (attached to) your original.
  - Duplicating a rectangle so that there's an arbitrary amount of separation between the two, including the possibility of overlap. (This is also from homework).
  - Anamorphic art – drawing a picture that appears distorted unless viewed from an extreme viewpoint. We focused on planar anamorphic art. Be sure you understand the ideas behind it, as well as how to *do* it. I will not be including any new problems on this in this study guide, but that doesn't mean you don't need to know it.
  - The connection between the 4th dimension, non-Euclidean geometry, and early 20th century art – who were some of the artists that we know were influenced by these mathematical notions? (Juan Gris, Jean Metzinger, Albert Gleizes, Marcel DuChamp, and Max Weber are the ones whose work we saw in class.)
  - What a Linelander would see when a 2 dimensional object passes through its space, what a Flatlander would see when a 3 dimensional object passes through its space, and what we would see when a 4 dimensional object passes through our space.
  - Looking for patterns in the number of vertices, edges, faces, solids, etc in a point, line segment, square and cube, and using the patterns to predict how many vertices, edges, faces, solids, 4-d regions and 5-d regions are in the hypercube, hyperhypercube, and hypertetrahedron.
  - Ways to represent the hypercube in 2 and 3 dimensions.

- Problems:

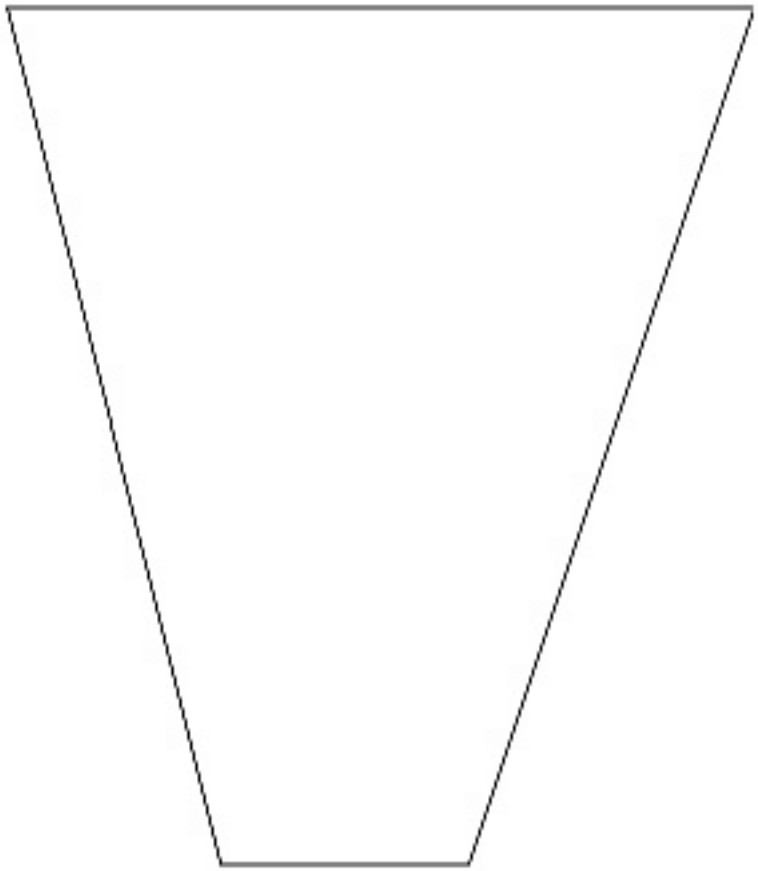
  The following problems are intended as a supplement to your review; they are not intended to replace reviewing the reading and class notes, or redoing homework problems.

  1. Be sure you can do all of the problems on PS 10. Because you already have these problems to do, I am not putting many extra problems on the 4th dimension on this study guide.

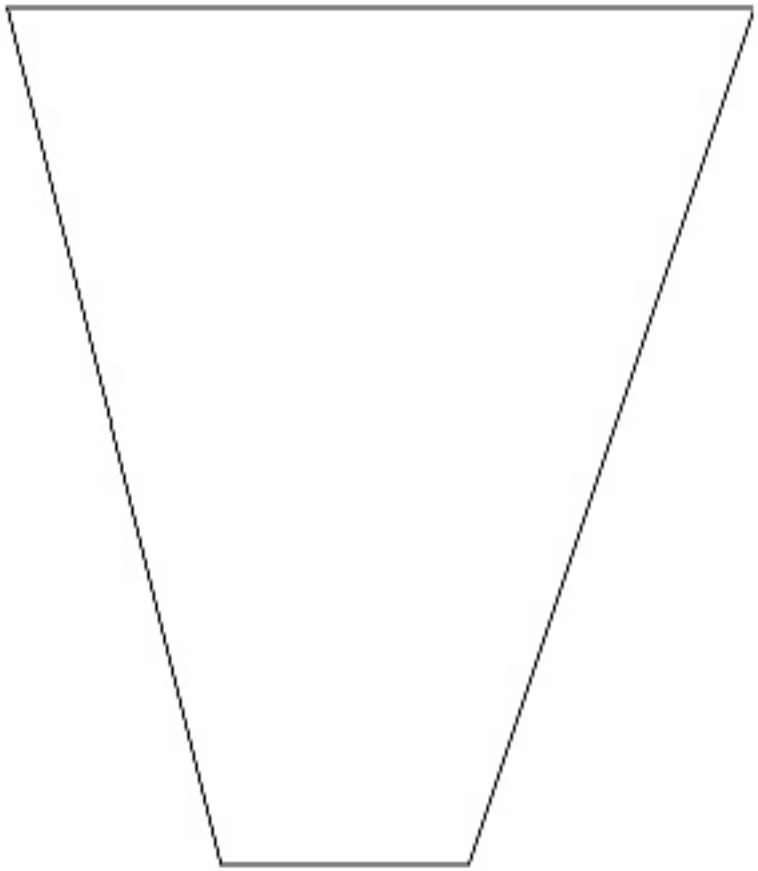
2. Beginning with the rectangle shown below, draw a portion of a brick wall 3 bricks wide and 4 bricks high. Remember that in order to do this so it really looks like a brick wall, the second row of bricks must be offset from the first row, so that the end of one brick divides the brick below it in half.



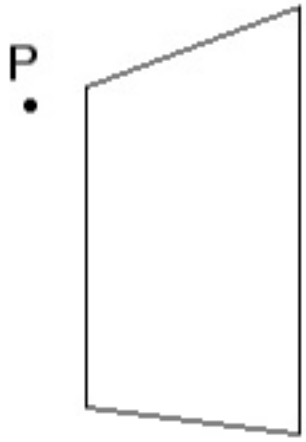
3. Divide the rectangle below in half. (Cut the lines which no longer appear parallel in half.) Then divide the nearer of your halves in half; the nearer of your quarters in half, and the nearer of your eighths in half. In the end, the rectangle should have one half, one fourth, one eighth and two sixteenths.



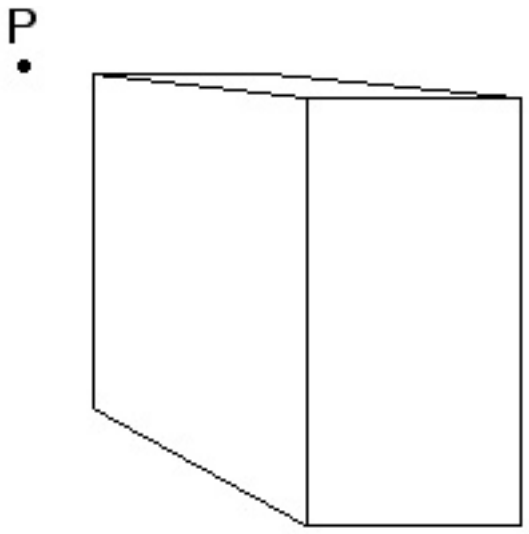
4. Draw a horizontal line cutting the sides which no longer appear parallel into the division one-ninth/eight-ninths. Probably the easiest way to do this, using the "stacking rectangle" technique we developed for the homework, is to divide the rectangle into thirds, and then one of the thirds on an end into thirds again.



5. Below is a perspective drawing of a window, retreating orthogonal to the picture plane. Draw a duplicate of this window, so that it's upper rear corner is located at the point P, to create the appearance of a partially open sliding glass door.



6. Below is a perspective drawing of a box, along with a point P. Draw a duplicate of the box, using the techniques we've developed. Place the duplicate so that it's front left corner (as we face it) is located at the point P.



7. What would A. Square observe if a cube passed through Flatland edge first? Assume A. Square has the time to walk around, and perhaps even touch it?
8. A circle is the set of all points in a plane equidistant from the center. A sphere is the set of all points in space equidistant from the center.
   (a) How would you define a fourth dimensional sphere, called a hypersphere?
   (b) What would we see if a hypersphere passed through our space? Determine this by thinking analogously – what did A. Square observe as the sphere passed through his space?
9. What is the most likely intersection of a line and a 3-space in 4-space?
10. Briefly discuss what a 4th dimensional creature could do to or for us.