

Problem 1) (10 points) Do # 24 in §2.6 of the textbook.

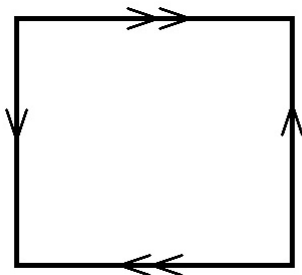
Problem 2) (10 points) A soccer ball can be considered a truncated icosahedron. What is its dual?

Problem 3) (10 points) In class we considered the question of what a cube passing through a plane would look like to inhabitants of the plane, but we always assumed the cube passed through face-first—in this case the flatlanders see a square suddenly appearing, persisting for a time, then suddenly disappearing. If the cube passes through the plane vertex-first instead of face-first, what sequence of shapes do the flatlanders see?

Problem 4) (15 points) If a hypercube were to pass through our 3-dimensional space vertex-first, what sequence of shapes would we see?

- Problem 5)
- a) (10 points) Problem 21 of section 7.2 describes a fractal called the *Koch stool*. What is its dimension? Justify.
 - b) (10 points) Page 471 (in chapter 7.2) describes the fractal known as the *Menger sponge*. What is its dimension? Justify.
 - c) (15 points) Describe the construction of some fractal in 4-Dimensional space which cannot exist in 3-dimensional space. Determine its dimension. Be sure your construction is precise and clear, and justify your dimension calculation.

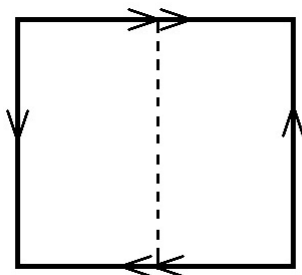
Problem 6) In class we studied the Klein bottle, which is a 2-D shape without any boundary, but with just a single side. There is one other 2-dimensional shape without any boundary, with only one side, and without any self-intersections; it is known as the “projective plane”. It is formed from following the given gluing pattern on the square:



The resulting shape is difficult to image, because any 3-dimensional attempt at making a projective plane would result in an object with bizarre twistings and at least one self-intersection—to truly imagine the projective plane, it has to be embedded in 4 dimensional space.

- a) (10 points) Prove that the projective plane has only one side.

- b) (10 points) Recall that if the Klein bottle is cut in two, you obtain 2 mobius strips. What happens if you cut the projective plane along the indicated line?



Justify.

Problem 7) (10 points) Make at least one comment or ask at least one question on the blog at www.briansteaching.blogspot.com. You'll be graded on the quality of what you say, and several comments will count for more than just one. A banal comment might get you 2 points, and four of them might get you 4 points, whereas a unique and/or interesting contribution, a substantial insight, or a cutting question will get you 10 points. You may make a remark on any current or prior posting.