Math 53 Homework 2

Due Tuesday 9/13/11 in section

(The problems in parentheses are for extra practice and optional. Only turn in the underlined problems.)

Wednesday 9/7 – Dot product continued; determinant

- Read: section 12.3.
- Work: 12.3: (1), (11), <u>19</u>, <u>23</u>, (25), (27), (34), <u>35</u>, (39), (45), (51), <u>56</u>, <u>59</u>, (60). <u>Problem 1</u> below.

Friday 9/9 - Cross product

- **Read:** section 12.4.
- Work: 12.4: (3), (9), (13), $\underline{16}$, (19), (27), $\underline{31}$, $\underline{35}$, (37), (43), $\underline{44}$, $\underline{49}$.

p. 794 "The geometry of a tetrahedron", parts 1^\dagger and 3.

† Hint: for part 1, don't introduce coordinates; instead, express everything in terms of the vectors $\vec{a} = \overrightarrow{SP}$, $\vec{b} = \overrightarrow{SQ}$, and $\vec{c} = \overrightarrow{SR}$ and use vector identities.

Problem 1. The eight vertices of a cube centered at (0,0,0) of side length 2 are at $(\pm 1, \pm 1, \pm 1)$.

a) Find the four vertices of the cube, starting with (1, 1, 1), that form a regular tetrahedron. Confirm your answer by finding the length of an edge and explaining why all edges have the same length.

(Recall: a tetrahedron is a solid with four triangular faces, like a pyramid with a triangular base; it is *regular* if all faces are equilateral triangles. Draw pictures and look at cubical objects in order to figure out how equilateral triangles fit on a cube).

b) Use dot product to find the angle between two adjacent edges (edges sharing a common vertex) of the regular tetrahedron; and the angle between two opposite edges (edges that lie on skew lines; even though they don't intersect, you can still compute the angle made by their directions). Explain your answers using symmetry.

c) A methane molecule CH_4 consists of a hydrogen atom at each of the vertices of a regular tetrahedron and a carbon atom at the center. Find the "bond angle", i.e. the angle made by vectors from the carbon atom to two hydrogen atoms (use a calculator; round your answer).