1. [Q57, in 12.3]: A molecule of methane is structured with the four hydrogen atoms at the vertices of a regular tetrahedron and the carbon atom at the centroid. The bond angle is the angle formed by the H–C–H combination; it is the angle between the lines that join the carbon atom to two of the hydrogen atoms. Show that the bond angle is about 109.5 degrees. Hint: Take the vertices of the tetrahedron to be the points \((1,0,0), (0,1,0), (0,0,1)\) and \((1,1,1)\), as shown in the figure. Then the centroid is \((\frac{1}{2}, \frac{1}{2}, \frac{1}{2})\).

2. Consider a triangle whose vertices are \(P = (1, 0, 0), Q = (0, 1, 0)\) and \(R = (0, 0, 2)\).
   (a) Sketch the triangle \(PQR\) in three dimensional space.
   (b) Find a vector that is in the direction perpendicular to the plane through \(PQR\).
   (c) Find the area of triangle \(PQR\).
   (d) Find the equation of the line that is perpendicular to the plane through \(PQR\) and goes through the point \((1, 1, 1)\).

3. Let \(P\) be a point not on the plane that passes through the points \(Q, R, S\).
   (a) Show that the distance \(d\) from to the point \(P\) to the plane through \(Q, R, S\) is
   \[
   d = \frac{|a \cdot (b \times c)|}{|a \times b|}
   \]
   where \(a = QR\), \(b = QS\), and \(c = QP\).
   (b) Apply this formula in the case where \(P = (0, 0, 0), Q = (1, 0, 0), R = (0, 1, 0),\) and \(S = (0, 0, 2)\).

4. Find the magnitude of the torque about \(P\) if a 5-N force is applied as shown. Also find the direction of the torque vector.

5. The points \(P = (0, 0, 0), Q = (1, -1, 1), R = (1, 0, 0)\) and \(S = (1, 0, a)\) all lie on the same plane. Determine the value of \(a\). Hint: use the formula for the volume of a parallelepiped.

6. (a) Find the equation of the line which is parallel to the planes \(x + y + z = 1\) and \(x = 2\), and which goes through the origin.
   (b) Find the equation of the line which is the intersection of the planes in part (a).