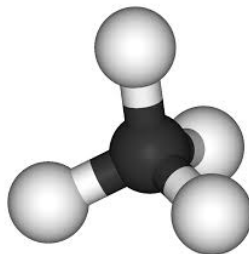


1. A methane molecule has a single carbon atom surrounded by four hydrogen atoms, like so:



The angles formed by the carbon-hydrogen bonds are all equal. Determine this common angle size.

2. A 100 lb weight is suspended from the ceiling by two ropes: one is a 3 ft rope which makes an angle  $\alpha$  with the ceiling, the second a 4 ft rope which makes an angle  $\beta$  with the ceiling. The rope attachment points are 5 ft apart on the ceiling. Determine the angles  $\alpha$  and  $\beta$  as well as the tension forces in the two ropes.
3. Give a parametrization of the line segment joining  $P(1, 2, 0)$  and  $Q(1, 3, -1)$ .

4. What angle does the line of intersection of the planes  $2x + y - z = 0$  and  $x + y + 2z = 0$  make with the positive  $x$ -axis?

5. Let

$$f(x) = \begin{cases} \frac{\sin(x - y)}{|x| + |y|} & \text{if } |x| + |y| \neq 0 \\ 0 & \text{if } (x, y) = (0, 0) \end{cases}.$$

Is  $f$  continuous at the origin?

6. Find parametric equations for the tangent line to the curve of intersection of the surfaces  $x^2 + 2y + 2z = 4$  and  $y = 1$  at the point  $(1, 1, 1/2)$ .

7. Find the plane

$$\frac{x}{a} + \frac{y}{b} + \frac{z}{c} = 1$$

that passes through the point  $(2, 1, 2)$  and cuts off the least volume from the first octant.

8. Compute  $\int_0^8 \int_{\sqrt[3]{x}}^2 \frac{1}{1 + y^4} dy dx$

9. Draw the region in the  $xy$ -plane that lies inside the cardioid  $r = 1 + \cos(\theta)$  but outside the circle  $r = 1$ . This region is the base of a cylinder which has top defined by the plane  $z = 7 - x$ . Express the volume of the resulting solid as a triple integral in cylindrical coordinates.