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## TAM 210/211 - Worksheet 2

Objectives:

- Write forces as Cartesian vectors.
- Perform vector calculations, such as summation, dot and cross product.
- Write unit vectors.
- Understand some important applications of vectors in engineering.

1) Mechanical equilibrium is a major focus of statics. Examples of equilibrium in everyday life include sitting in a chair and a stack of books resting on a table. What are examples of things that were designed to be in equilibrium?

2) For vectors  $\mathbf{A} = 9\mathbf{i} - 5\mathbf{j}$  and  $\mathbf{B} = -2\mathbf{i} + 4\mathbf{j}$ , determine:

- a) an expression for the resultant vector  $\mathbf{C} = \mathbf{A} + \mathbf{B}$ .
  - b) the magnitude and direction of the resultant vector  $\mathbf{C}$ .
- Make a graphical representation of your results.

a)  $\mathbf{C} = 7\mathbf{i} - \mathbf{j}$

b)  $|\mathbf{C}| = 5\sqrt{2}$  at angle  $\arctan -\frac{1}{7}$

3) What is the *unit vector* that points along  $\mathbf{A} = -1\mathbf{i} - 8\mathbf{j}$ ?

$$-\frac{1}{\sqrt{65}}\mathbf{i} - \frac{8}{\sqrt{65}}\mathbf{j}$$

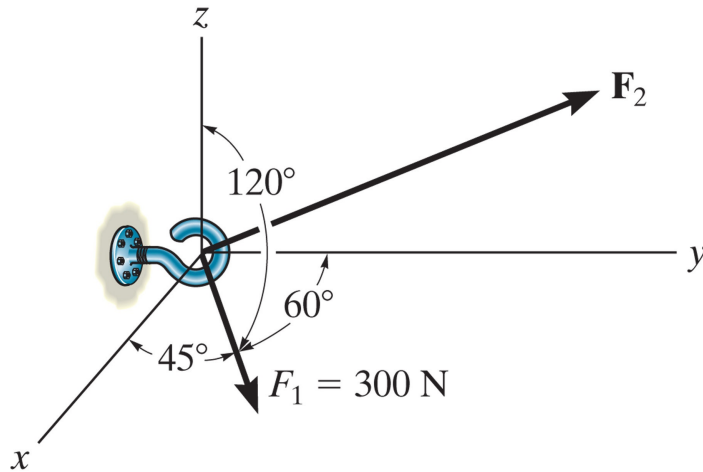
4) For vectors  $\mathbf{A} = -5\mathbf{i} + 1\mathbf{j} - 8\mathbf{k}$  and  $\mathbf{B} = 6\mathbf{i} - 3\mathbf{j} + 4\mathbf{k}$ , what is the cross (vector) product  $\mathbf{A} \times \mathbf{B}$ ?

$$-20\mathbf{i} - 28\mathbf{j} + 9\mathbf{k}$$

5) For vectors  $\mathbf{A} = -1\mathbf{i} + 6\mathbf{j}$  and  $\mathbf{B} = 4\mathbf{i} - 4\mathbf{j}$ , what is the component of  $\mathbf{A}$  onto  $\mathbf{B}$ ?

$$-\frac{7}{\sqrt{2}}$$

6) Two forces act on the hook as indicated below. Assume that the resultant force acts along the positive  $z$ -axis and has magnitude of 600 N.



a) Express the force  $\mathbf{F}_1$  as a Cartesian vector

$$\mathbf{F}_1 = 150\sqrt{2}\mathbf{i} + 150\mathbf{j} - 150\mathbf{k}$$

b) Express the force  $\mathbf{F}_2$  as a Cartesian vector

$$\mathbf{F}_2 = -150\sqrt{2}\mathbf{i} - 150\mathbf{j} + 750\mathbf{k}$$

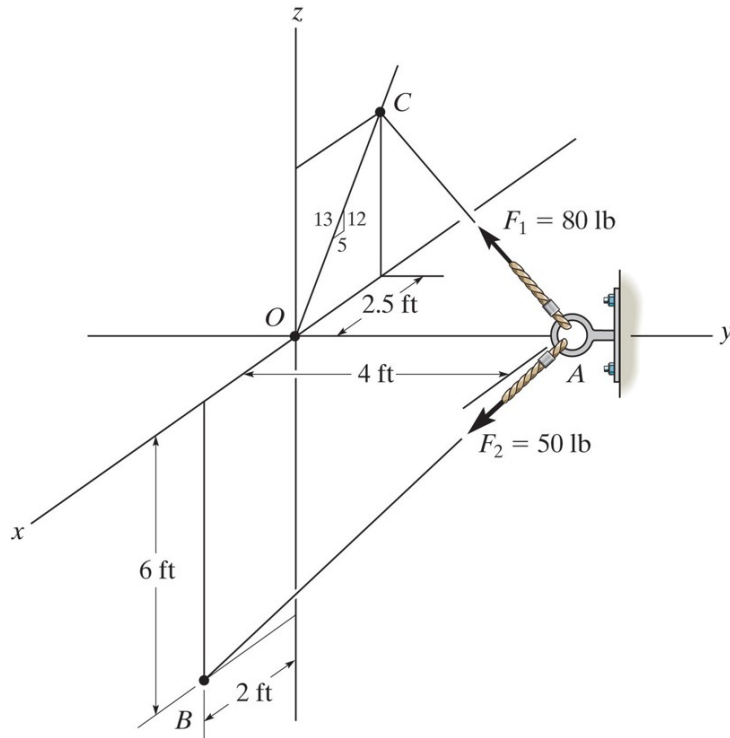
c) Write the unit vector that points along  $\mathbf{F}_R$

$$\mathbf{k}$$

d) Making sure that your designs are able to handle their required loads is an important aspect of engineering. Suppose that the hook only handles the force  $\mathbf{F}_1$ , and that the hook can withstand 100 N along the negative  $z$ -axis before failure. Does the hook fail? What are some potential improvements that could be made to the hook's design?

Yes

7) Two forces act on the ring located at point A as indicated below.



a) Express the force  $\mathbf{F}_1$  as a Cartesian vector

$$80\text{lbs}\left\{\frac{-2.5}{7.63}\mathbf{i}, \frac{-4}{7.63}\mathbf{j}, \frac{6}{7.63}\mathbf{k}\right\}$$

b) Express the force  $\mathbf{F}_2$  as a Cartesian vector

$$50\text{lbs}\left\{\frac{2}{7.48}\mathbf{i}, \frac{-4}{7.48}\mathbf{j}, \frac{-6}{7.48}\mathbf{k}\right\}$$

c) Write the unit vector that indicates the direction of the resultant force,  $\mathbf{F}_R$

$$\{-0.1748\mathbf{i}, -0.9345\mathbf{j}, 0.3103\mathbf{k}\}$$

d) Determine the coordinate direction angles for  $\mathbf{F}_R$ , assuming that the origin is located at A.

$$\alpha = 100.1^\circ$$

$$\beta = 159.1^\circ$$

$$\gamma = 71.9^\circ$$