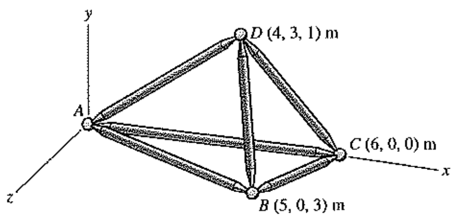
Problem 2.72 Determine the components of the position vector $\mathbf{r}_{BD}$ from point B to point D. Use your result to determine the distance from B to D.



Solution: We have the following coordinates: $A(0, 0, 0)$, $B(5, 0, 3)$ m, $C(6, 0, 0)$ m, $D(4, 3, 1)$ m

$$\mathbf{r}_{BD} = (4\text{ m} - 5\text{ m})\mathbf{i} + (3\text{ m} - 0)\mathbf{j} + (1\text{ m} - 3\text{ m})\mathbf{k} = (-\mathbf{i} + 3\mathbf{j} - 2\mathbf{k})\text{ m}$$

$$r_{BD} = \sqrt{(-1\text{ m})^2 + (3\text{ m})^2 + (-2\text{ m})^2} = 3.74\text{ m}$$

Problem 2.73 What are the direction cosines of the position vector $\mathbf{r}_{BD}$ from point B to point D?

Solution:

$$\cos\theta_x = \frac{-1\text{ m}}{3.74\text{ m}} = -0.267, \quad \cos\theta_y = \frac{3\text{ m}}{3.74\text{ m}} = 0.802,$$

$$\cos\theta_z = \frac{-2\text{ m}}{3.74\text{ m}} = 0.535$$

Problem 2.74 Determine the components of the unit vector $\mathbf{e}_{CD}$ that points from point C toward point D.

Solution: We have the following coordinates: $A(0, 0, 0)$, $B(5, 0, 3)$ m, $C(6, 0, 0)$ m, $D(4, 3, 1)$ m

$$\mathbf{r}_{CD} = (4\text{ m} - 6\text{ m})\mathbf{i} + (3\text{ m} - 0)\mathbf{j} + (1\text{ m} - 0)\mathbf{k} = (-2\mathbf{i} + 3\mathbf{j} + 1\mathbf{k})$$

$$r_{CD} = \sqrt{(-2\text{ m})^2 + (3\text{ m})^2 + (1\text{ m})^2} = 3.74\text{ m}$$

Thus

$$\mathbf{e}_{CD} = \frac{1}{3.74\text{ m}}(-2\mathbf{i} + 3\mathbf{j} + \mathbf{k})\text{ m} = (-0.535\mathbf{i} + 0.802\mathbf{j} + 0.267\mathbf{k})$$

Problem 2.75 What are the direction cosines of the unit vector $\mathbf{e}_{CD}$ that points from point C toward point D?

Solution: Using Problem 2.74

$$\cos\theta_x = -0.535, \quad \cos\theta_y = 0.802, \quad \cos\theta_z = 0.267$$

Problem 2.94 Consider the tower described in Problem 2.93. The magnitude of the force $\mathbf{F}_{AB}$ is 2 kN. The x and z components of the vector sum of the forces exerted on the tower by the three cables are zero. What are the magnitudes of $\mathbf{F}_{AC}$ and $\mathbf{F}_{AD}$?

Solution: From the solution of Problem 2.93, the unit vectors are:

$$\mathbf{u}_{AC} = \frac{\mathbf{r}_{AC}}{|\mathbf{r}_{AC}|} = -\frac{40}{90}\mathbf{i} - \frac{70}{90}\mathbf{j} + \frac{40}{90}\mathbf{k}$$

$$= -0.4444\mathbf{i} - 0.7778\mathbf{j} + 0.4444\mathbf{k}$$

$$\mathbf{u}_{AD} = \frac{\mathbf{r}_{AD}}{|\mathbf{r}_{AD}|} = \frac{-60}{110}\mathbf{i} - \frac{70}{110}\mathbf{j} - \frac{60}{110}$$

$$= -0.5455\mathbf{i} - 0.6364\mathbf{j} - 0.5455\mathbf{k}$$

From the solution of Problem 2.93 the force $\mathbf{F}_{AB}$ is

$$\mathbf{F}_{AB} = |\mathbf{F}_{AB}|\mathbf{u}_{AB} = 0.9926\mathbf{i} - 1.737\mathbf{j} + 0\mathbf{k}$$

The forces $\mathbf{F}_{AC}$ and $\mathbf{F}_{AD}$ are:

$$\mathbf{F}_{AC} = |\mathbf{F}_{AC}|\mathbf{u}_{AC} = |\mathbf{F}_{AC}|(-0.4444\mathbf{i} - 0.7778\mathbf{j} + 0.4444\mathbf{k})$$

$$\mathbf{F}_{AD} = |\mathbf{F}_{AD}|\mathbf{u}_{AD} = |\mathbf{F}_{AD}|(-0.5455\mathbf{i} - 0.6364\mathbf{j} - 0.5455\mathbf{k})$$

Taking the sum of the forces:

$$\mathbf{F}_R = \mathbf{F}_{AB} + \mathbf{F}_{AC} + \mathbf{F}_{AD} = (0.9926 - 0.4444|\mathbf{F}_{AC}| - 0.5455|\mathbf{F}_{AD}|)\mathbf{i}$$

$$+ (-1.737 - 0.7778|\mathbf{F}_{AC}| - 0.6364|\mathbf{F}_{AD}|)\mathbf{j}$$

$$+ (0.4444|\mathbf{F}_{AC}| - 0.5455|\mathbf{F}_{AD}|)\mathbf{k}$$

The sum of the x- and z-components vanishes, hence the set of simultaneous equations:

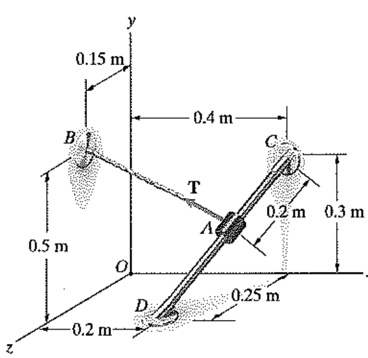
$$0.4444|\mathbf{F}_{AC}| + 0.5455|\mathbf{F}_{AD}| = 0.9926 \text{ and}$$

$$0.4444|\mathbf{F}_{AC}| - 0.5455|\mathbf{F}_{AD}| = 0$$

These can be solved by means of standard algorithms, or by the use of commercial packages such as TK Solver Plus ® or Mathcad®. Here a hand held calculator was used to obtain the solution:

$$\boxed{|\mathbf{F}_{AC}| = 1.1163 \text{ kN}} \quad \boxed{|\mathbf{F}_{AD}| = 0.9096 \text{ kN}}$$

Problem 2.95 In Example 2.10, suppose that the distance from point C to the collar A is increased from 0.2 m to 0.3 m, and the magnitude of the force $\mathbf{T}$ increases to 60 N. Express $\mathbf{T}$ in terms of its components.



Solution: The position vector from C to A is now
$\mathbf{r}_{CA} = (0.3 \text{ m})\mathbf{e}_{CD} = (-0.137\mathbf{i} - 0.205\mathbf{j} + 0.171\mathbf{k})m$
The position vector form the origin to A is

$$\mathbf{r}_{OA} = \mathbf{r}_{OC} + \mathbf{r}_{CA} = (0.4\mathbf{i} + 0.3\mathbf{j}) \text{ m} + (-0.137\mathbf{i} - 0.205\mathbf{j} + 0.171\mathbf{k}) \text{ m}$$

$$\mathbf{r}_{OA} = (0.263\mathbf{i} + 0.0949\mathbf{j} + 0.171\mathbf{k}) \text{ m}$$

The coordinates of A are (0.263, 0.0949, 0.171) m.
The position vector from A to B is

$$\mathbf{r}_{AB} = ([0 - 0.263]\mathbf{i} + [0.5 - 0.0949]\mathbf{j} + [0.15 - 0.171]\mathbf{k}) \text{ m}$$

$$\mathbf{r}_{AB} = (-0.263\mathbf{i} + 0.405\mathbf{j} - 0.209\mathbf{k}) \text{ m}$$

The force $\mathbf{T}$ is

$$\mathbf{T} = (60 \text{ N})\frac{\mathbf{r}_{AB}}{|\mathbf{r}_{AB}|} = (-32.7\mathbf{i} + 50.3\mathbf{j} - 2.60\mathbf{k}) \text{ N}$$

$$\boxed{\mathbf{T} = (-32.7\mathbf{i} + 50.3\mathbf{j} - 2.60\mathbf{k}) \text{ N}}$$

Problem 2.98 The cable AB in Problem 2.97 exerts a 60-N force $\mathbf{T}$ on the collar at A that is directed along the line from A toward B. Express $\mathbf{T}$ in terms of components.

Solution: We know $\mathbf{r}_{BA} = 3.76\mathbf{i} - 2.63\mathbf{j} - 3\mathbf{k}$ m from Problem 2.97. The unit vector $\mathbf{u}_{AB} = -\mathbf{r}_{BA}/|\mathbf{r}_{BA}|$. The unit vector is $\mathbf{u}_{AB} = -0.686\mathbf{i} + 0.480\mathbf{j} + 0.547\mathbf{k}$. Hence, the force vector $\mathbf{T}$ is given by

$$\boxed{\mathbf{T} = |\mathbf{T}|(-0.686\mathbf{i} + 0.480\mathbf{j} + 0.547\mathbf{k})\text{ N} = -41.1\mathbf{i} + 28.8\mathbf{j} + 32.8\mathbf{k}\text{ N}}$$

Problem 2.99 In Active Example 2.11, suppose that the vector $\mathbf{V}$ is changed to $\mathbf{V} = 4\mathbf{i} - 6\mathbf{j} - 10\mathbf{k}$.

(a) What is the value of $\mathbf{U}\cdot\mathbf{V}$?
(b) What is the angle between $\mathbf{U}$ and $\mathbf{V}$ when they are placed tail to tail?

Solution: From Active Example 2.4 we have the expression for $\mathbf{U}$. Thus

$$\mathbf{U} = 6\mathbf{i} - 5\mathbf{j} - 3\mathbf{k},\ \mathbf{V} = 4\mathbf{i} - 6\mathbf{k} - 10\mathbf{k}$$

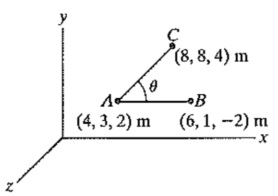
$$\mathbf{U}\cdot\mathbf{V} = (6)(4) + (-5)(-6) + (-3)(-10) = 84$$

$$\cos\theta = \frac{\mathbf{U}\cdot\mathbf{V}}{|\mathbf{V}||\mathbf{V}|} = \frac{84}{\sqrt{6^2 + (-5)^2 + (-3)^2}\sqrt{4^2 + (-6)^2 + (-10)^2}} = 0.814$$

$$\theta = \cos^{-1}(0.814) = 35.5^\circ$$

$$\boxed{(a)\ \mathbf{U}\cdot\mathbf{V} = 84,\ (b)\ \theta = 35.5^\circ}$$

Problem 2.100 In Example 2.12, suppose that the coordinates of point B are changed to (6, 4, 4) m. What is the angle θ between the lines AB and AC?



Solution: Using the new coordinates we have

$$\mathbf{r}_{AB} = (2\mathbf{i} + \mathbf{j} + 2\mathbf{k})\text{ m},\ |\mathbf{r}_{AB}| = 3\text{ m}$$

$$\mathbf{r}_{AC} = (4\mathbf{i} + 5\mathbf{j} + 2\mathbf{k})\text{ m},\ |\mathbf{r}_{AC}| = 6.71\text{ m}$$

$$\cos\theta = \frac{\mathbf{r}_{AB}\cdot\mathbf{r}_{AC}}{|\mathbf{r}_{AB}||\mathbf{r}_{AC}|} = \frac{((2)(4) + (1)(5) + (2)(2))\text{ m}^2}{(3\text{ m})(6.71\text{ m})} = 0.845$$

$$\theta = \cos^{-1}(0.845) = 32.4^\circ$$

$$\boxed{\theta = 32.4^\circ}$$

Problem 2.101 What is the dot product of the position vector $\mathbf{r} = -10\mathbf{i} + 25\mathbf{j}$ (m) and the force vector

$\mathbf{F} = 300\mathbf{i} + 250\mathbf{j} + 300\mathbf{k}$ (N)?

Solution: Use Eq. (2.23).

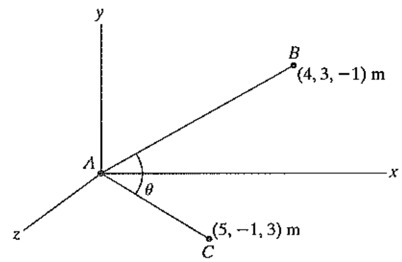
$$\boxed{\mathbf{F}\cdot\mathbf{r} = (300)(-10) + (250)(25) + (300)(0) = 3250\text{ N-m}}$$

Problem 2.102 Suppose that the dot product of two vectors $\mathbf{U}$ and $\mathbf{V}$ is $\mathbf{U}\cdot\mathbf{V} = 0$. If $|\mathbf{U}| \neq 0$, what do you know about the vector $\mathbf{V}$?

Solution:

$$\boxed{\text{Either } |\mathbf{V}| = 0 \text{ or } \mathbf{V} \perp \mathbf{U}}$$

Problem 2.108 Determine the angle θ between the lines AB and AC (a) by using the law of cosines (see Appendix A); (b) by using the dot product.



Solution:

(a) We have the distances:

$$AB = \sqrt{4^2 + 3^2 + 1^2}\text{ m} = \sqrt{26}\text{ m}$$

$$AC = \sqrt{5^2 + 1^2 + 3^2}\text{ m} = \sqrt{35}\text{ m}$$

$$BC = \sqrt{(5-4)^2 + (-1-3)^2 + (3+1)^2}\text{ m} = \sqrt{33}\text{ m}$$

The law of cosines gives

$$BC^2 = AB^2 + AC^2 - 2(AB)(AC)\cos\theta$$

$$\cos\theta = \frac{AB^2 + AC^2 - BC^2}{2(AB)(AC)} = 0.464 \quad \Rightarrow \boxed{\theta = 62.3^\circ}$$

(b) Using the dot product

$$\mathbf{r}_{AB} = (4\mathbf{i} + 3\mathbf{j} - \mathbf{k})\text{ m}, \quad \mathbf{r}_{AC} = (5\mathbf{i} - \mathbf{j} + 3\mathbf{k})\text{ m}$$

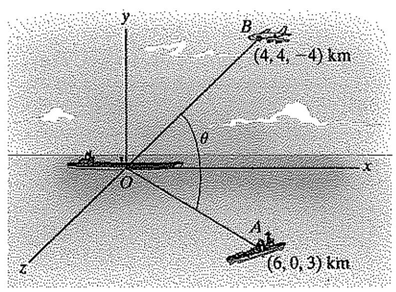
$$\mathbf{r}_{AB} \cdot \mathbf{r}_{AC} = (4\text{ m})(5\text{ m}) + (3\text{ m})(-1\text{ m}) + (-1\text{ m})(3\text{ m}) = 14\text{ m}^2$$

$$\mathbf{r}_{AB} \cdot \mathbf{r}_{AC} = (AB)(AC)\cos\theta$$

Therefore

$$\boxed{\cos\theta = \frac{14\text{ m}^2}{\sqrt{26}\text{ m}\sqrt{35}\text{ m}} = 0.464 \Rightarrow \theta = 62.3^\circ}$$

Problem 2.109 The ship O measures the positions of the ship A and the airplane B and obtains the coordinates shown. What is the angle θ between the lines of sight OA and OB?



Solution: From the coordinates, the position vectors are:

$\mathbf{r}_{OA} = 6\mathbf{i} + 0\mathbf{j} + 3\mathbf{k}$ and $\mathbf{r}_{OB} = 4\mathbf{i} + 4\mathbf{j} - 4\mathbf{k}$

The dot product: $\mathbf{r}_{OA} \cdot \mathbf{r}_{OB} = (6)(4) + (0)(4) + (3)(-4) = 12$

The magnitudes: $|\mathbf{r}_{OA}| = \sqrt{6^2 + 0^2 + 3^2} = 6.71$ km and

$$|\mathbf{r}_{OA}| = \sqrt{4^2 + 4^2 + 4^2} = 6.93\text{ km}.$$

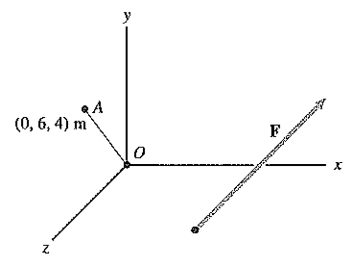
From Eq. (2.24) $\cos\theta = \frac{\mathbf{r}_{OA} \cdot \mathbf{r}_{OB}}{|\mathbf{r}_{OA}||\mathbf{r}_{OB}|} = 0.2581$, from which $\theta = \pm 75^\circ$.

From the problem and the construction, only the positive angle makes sense, hence $\boxed{\theta = 75^\circ}$

Problem 2.115 Consider the cables AB and AC shown in Problem 2.114. Let $\mathbf{r}_{AB}$ be the position vector from point A to point B. Determine the vector component of $\mathbf{r}_{AB}$ parallel to the cable AC.

Solution: From Problem 2.114, $\mathbf{r}_{AB} = 0\mathbf{i} - 7\mathbf{j} + 10\mathbf{k}$, and $\mathbf{e}_{AC} = 0.6667\mathbf{i} - 0.3333\mathbf{j} + 0.6667\mathbf{k}$. Thus $\mathbf{r}_{AB} \cdot \mathbf{e}_{AC} = 9$, and $(\mathbf{r}_{AB} \cdot \mathbf{e}_{AC})\mathbf{e}_{AC} = (6\mathbf{i} - 3\mathbf{j} + 6\mathbf{k})$ ft.

Problem 2.116 The force $\mathbf{F} = 10\mathbf{i} + 12\mathbf{j} - 6\mathbf{k}$ (N). Determine the vector components of $\mathbf{F}$ parallel and normal to line OA.



Solution: Find $\mathbf{e}_{OA} = \dfrac{\mathbf{r}_{OA}}{|\mathbf{r}_{OA}|}$

Then

$$\mathbf{F}_P = (\mathbf{F} \cdot \mathbf{e}_{OA})\mathbf{e}_{OA}$$

and $\mathbf{F}_N = \mathbf{F} - \mathbf{F}_P$

$$\mathbf{e}_{OA} = \frac{0\mathbf{i} + 6\mathbf{j} + 4\mathbf{k}}{\sqrt{6^2 + 4^2}} = \frac{6\mathbf{j} + 4\mathbf{k}}{\sqrt{52}}$$

$$\mathbf{e}_{OA} = \frac{6}{7.21}\mathbf{j} + \frac{4}{7.21}\mathbf{k} = 0.832\mathbf{j} + 0.555\mathbf{k}$$

$$\mathbf{F}_P = [(10\mathbf{i} + 12\mathbf{j} - 6\mathbf{k}) \cdot (0.832\mathbf{j} + 0.555\mathbf{k})]\mathbf{e}_{OA}$$

$$\mathbf{F}_P = [6.656]\mathbf{e}_{OA} = 0\mathbf{i} + 5.54\mathbf{j} + 3.69\mathbf{k} \text{ (N)}$$

$$\mathbf{F}_N = \mathbf{F} - \mathbf{F}_P$$

$$\mathbf{F}_N = 10\mathbf{i} + (12 - 5.54)\mathbf{j} + (-6 - 3.69\mathbf{k})$$

$$\mathbf{F}_N = 10\mathbf{i} + 6.46\mathbf{j} - 9.69\mathbf{k} \text{ N}$$

Problem 2.125 Two vectors $\mathbf{U} = 3\mathbf{i} + 2\mathbf{j}$ and $\mathbf{V} = 2\mathbf{i} + 4\mathbf{j}$.

(a) What is the cross product $\mathbf{U} \times \mathbf{V}$?
(b) What is the cross product $\mathbf{V} \times \mathbf{U}$?

Solution: Use Eq. (2.34) and expand into 2 by 2 determinants.

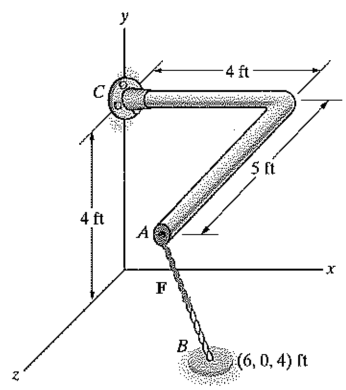
$$\mathbf{U} \times \mathbf{V} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 3 & 2 & 0 \\ 2 & 4 & 0 \end{vmatrix} = \mathbf{i}((2)(0) - (4)(0)) - \mathbf{j}((3)(0) - (2)(0))$$

$$+ \mathbf{k}((3)(4) - (2)(2)) = 8\mathbf{k}$$

$$\mathbf{V} \times \mathbf{U} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 2 & 4 & 0 \\ 3 & 2 & 0 \end{vmatrix} = \mathbf{i}((4)(0) - (2)(0)) - \mathbf{j}((2)(0) - (3)(0))$$

$$+ \mathbf{k}((2)(2) - (3)(4)) = -8\mathbf{k}$$

Problem 2.126 The two segments of the L-shaped bar are parallel to the x and z axes. The rope AB exerts a force of magnitude $|\mathbf{F}| = 500$ lb on the bar at A. Determine the cross product $\mathbf{r}_{CA} \times \mathbf{F}$, where $\mathbf{r}_{CA}$ is the position vector form point C to point A.



Solution: We need to determine the force $\mathbf{F}$ in terms of its components. The vector from A to B is used to define $\mathbf{F}$.

$\mathbf{r}_{AB} = (2\mathbf{i} - 4\mathbf{j} - \mathbf{k})$ ft

$$\mathbf{F} = (500 \text{ lb})\frac{\mathbf{r}_{AB}}{|\mathbf{r}_{AB}|} = (500 \text{ lb})\frac{(2\mathbf{i} - 4\mathbf{j} - \mathbf{k})}{\sqrt{(2)^2 + (-4)^2 + (-1)^2}}$$

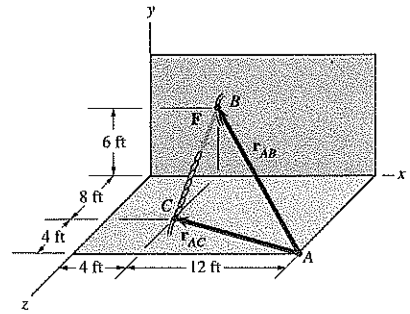
$$\mathbf{F} = (218\mathbf{i} - 436\mathbf{j} - 109\mathbf{k}) \text{ lb}$$

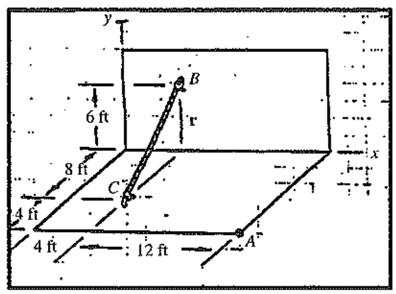
Also we have $\mathbf{r}_{CA} = (4\mathbf{i} + 5\mathbf{k})$ ft
Therefore

$$\mathbf{r}_{CA} \times \mathbf{F} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 4 & 0 & 5 \\ 218 & -436 & -109 \end{vmatrix} = (2180\mathbf{i} + 1530\mathbf{j} - 1750\mathbf{k}) \text{ ft-lb}$$

$$\boxed{\mathbf{r}_{CA} \times \mathbf{F} = (2180\mathbf{i} + 1530\mathbf{j} - 1750\mathbf{k}) \text{ ft-lb}}$$

Problem 2.136 The cable BC exerts a 1000-lb force $\mathbf{F}$ on the hook at B. Determine $\mathbf{r}_{AB} \times \mathbf{F}$.





Solution: The coordinates of points A, B, and C are A (16, 0, 12), B (4, 6, 0), C (4, 0, 8). The position vectors are

$$\mathbf{r}_{OA} = 16\mathbf{i} + 0\mathbf{j} + 12\mathbf{k},\ \mathbf{r}_{OB} = 4\mathbf{i} + 6\mathbf{j} + 0\mathbf{k},\ \mathbf{r}_{OC} = 4\mathbf{i} + 0\mathbf{j} + 8\mathbf{k}.$$

The force $\mathbf{F}$ acts along the unit vector

$$\mathbf{e}_{BC} = \frac{\mathbf{r}_{BC}}{|\mathbf{r}_{BC}|} = \frac{\mathbf{r}_{OC} - \mathbf{r}_{OB}}{|\mathbf{r}_{OC} - \mathbf{r}_{OB}|} = \frac{\mathbf{r}_{AB}}{|\mathbf{r}_{AB}|}$$

Noting $\mathbf{r}_{OC} - \mathbf{r}_{OB} = (4-4)\mathbf{i} + (0-6)\mathbf{j} + (8-0)\mathbf{k} = 0\mathbf{i} - 6\mathbf{j} + 8\mathbf{k}$

$|\mathbf{r}_{OC} - \mathbf{r}_{OB}| = \sqrt{6^2 + 8^2} = 10$. Thus

$\mathbf{e}_{BC} = 0\mathbf{i} - 0.6\mathbf{j} + 0.8\mathbf{k}$, and $\mathbf{F} = |\mathbf{F}|\mathbf{e}_{BC} = 0\mathbf{i} - 600\mathbf{j} + 800\mathbf{k}$ (lb).

The vector

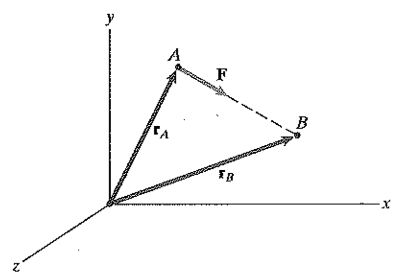
$$\mathbf{r}_{AB} = (4-16)\mathbf{i} + (6-0)\mathbf{j} + (0-12)\mathbf{k} = -12\mathbf{i} + 6\mathbf{j} - 12\mathbf{k}$$

Thus the cross product is

$$\mathbf{r}_{AB} \times \mathbf{F} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ -12 & 6 & -12 \\ 0 & -600 & 800 \end{vmatrix} = -2400\mathbf{i} + 9600\mathbf{j} + 7200\mathbf{k} \text{ (ft-lb)}$$

Problem 2.137 The force vector $\mathbf{F}$ points along the straight line from point A to point B. Its magnitude is $|\mathbf{F}| = 20$ N. The coordinates of points A and B are $x_A = 6$ m, $y_A = 8$ m, $z_A = 4$ m and $x_B = 8$ m, $y_B = 1$ m, $z_B = -2$ m.

(a) Express the vector $\mathbf{F}$ in terms of its components.
(b) Use Eq. (2.34) to determine the cross products $\mathbf{r}_A \times \mathbf{F}$ and $\mathbf{r}_B \times \mathbf{F}$.



Solution: We have $\mathbf{r}_A = (6\mathbf{i} + 8\mathbf{j} + 4\mathbf{k})$ m, $\mathbf{r}_B = (8\mathbf{i} + \mathbf{j} - 2\mathbf{k})$ m,

(a)
$$\mathbf{F} = (20\text{ N})\frac{(8-6)\text{ m}\mathbf{i} + (1-8)\text{ m}\mathbf{j} + (-2-4)\text{ m}\mathbf{k}}{\sqrt{(2\text{ m})^2 + (-7\text{ m})^2 + (-6\text{ m})^2}}$$
$$= \frac{20\text{ N}}{\sqrt{89}}(2\mathbf{i} - 7\mathbf{j} - 6\mathbf{k})$$

(b)
$$\mathbf{r}_A \times \mathbf{F} = \frac{20\text{ N}}{\sqrt{89}}\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 6\text{ m} & 8\text{ m} & 4\text{ m} \\ 2 & -7 & -6 \end{vmatrix}$$
$$= (-42.4\mathbf{i} + 93.3\mathbf{j} - 123.0\mathbf{k})\text{ Nm}$$
$$\mathbf{r}_B \times \mathbf{F} = \frac{20\text{ N}}{\sqrt{89}}\begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 8\text{ m} & 1\text{ m} & -2\text{ m} \\ 2 & -7 & -6 \end{vmatrix}$$
$$= (-42.4\mathbf{i} + 93.3\mathbf{j} - 123.0\mathbf{k})\text{ Nm}$$

Note that both cross products give the same result (as they must).