Lec03

Thursday, September 17, 2020 9:45 AM

Announcements

- PrairieLearn quiz 0:
  - Only practice
  - Thursday 8:10-9:10 pm
  - Location: D326

http://tam2xx.intl.zju.edu.cn/tam211/sched.html

1

Lecture Objectives

- Cartesian Vectors
- Position Vector
- Force Vector along a Line

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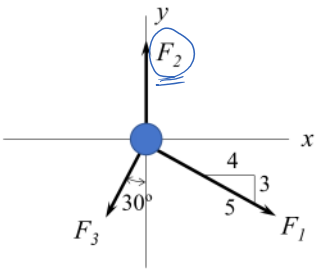
Given that $F_2 = 40$ N, determine the unit vector that represents the direction of $\mathbf{F}_2$.



(A) $(0\mathbf{i} + 1\mathbf{j})$

(B) $(0\mathbf{i} + 1\mathbf{j})$ N

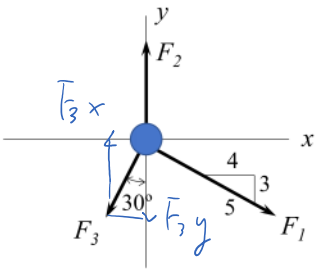
(C) $(0\mathbf{i} + 40\mathbf{j})$

(D) $(0\mathbf{i} + 40\mathbf{j})$N

(E) None of the above

i-Clicker

Given that $F_3 = 20$ N, express force $\mathbf{F}_3$ in Cartesian vector form.



(A) $(20\sin30^\circ\,\mathbf{i} + 20\cos30^\circ\,\mathbf{j})$ N

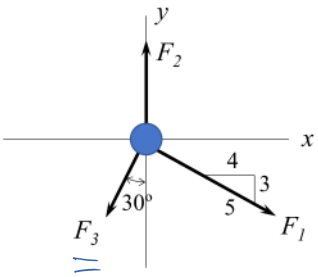
(B) $(-20\sin30^\circ\,\mathbf{i} - 20\cos30^\circ\,\mathbf{j})$ N

(C) $(20\cos30^\circ\,\mathbf{i} + 20\sin30^\circ\,\mathbf{j})$ N

(D) $(-20\cos30^\circ\,\mathbf{i} - 20\sin30^\circ\,\mathbf{j})$ N

(E) None of the above

Example



Given that $F_1 = 50$ N and $F_3 = 20$ N, determine of resultant force of $\mathbf{F_1}$ and $\mathbf{F_3}$ in Cartesian vector form.

$\vec{R} = \vec{F_1} + \vec{F_3}$

$\vec{F_1} = 50N\hat{u} = 50N\left(\frac{4}{5}\hat{i} - \frac{3}{5}\hat{j}\right)$

$= 40\hat{j} - 30\hat{j}\ N$

$\vec{F_3} = 20N \cdot \hat{u} = 20N(-\sin 30^\circ \hat{i} - \cos 30^\circ \hat{j})$

$\vec{R} = (40 - 20\sin 30^\circ)\hat{i} - (30 + 20\cos 30^\circ)\hat{j}$

Numerical Calculations

Significant figures

- The number of significant figures contained in any number determines the accuracy of the number.
- Use 3 or > significant figures for final answers.
- For intermediate steps, use symbolic notation, store numbers in calculators or use more significant figures, in order to maintain precision.

0.00135428 |

Practice:

- **How many significant figures are in each of the following numbers?**

a) **0.0035**--- **2 sig. fig.** *(leading zeros are not significant).*(Rule #4).

0.0013 ✗

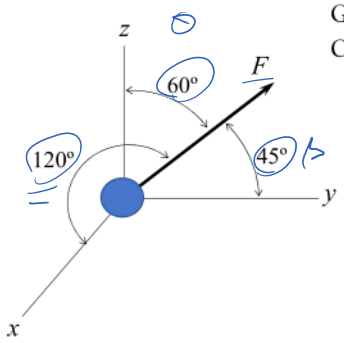
b) **1.080**--- **4 sig. fig.** *(zeros after the decimal & interior zeros are significant).* (Rules #2 & 3).

0.00135 ✓

c) **2371**--- **4 sig. fig.** *(all non zeros digits are significant).*(Rule #1).

d) **2.97** × 10^5--- **3 sig. fig.** *(all non zeros digits are significant)* (Rule #1).

Example



Given that F = 30 lb, express force vector **F** using the Cartesian vector form.

$F_x = F \cdot \cos\alpha = 30 \cdot \cos 120^\circ$ lb

$F_y = F \cdot \cos\beta = 30 \cdot \cos 45^\circ$ lb

$F_z = F \cdot \cos\theta = 30 \cdot \cos 60^\circ$ lb

$\vec{F} = F_x \hat{i} + F_y \hat{j} + F_z \hat{k}$

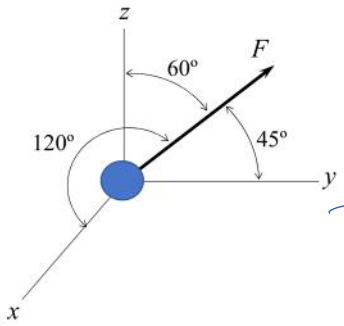
$\vec{F} = F \hat{u}$

$\hat{u} = \cos\alpha \hat{i} + \cos\beta \hat{j} + \cos\theta \hat{k}$

Approximate Conversion Facts

Metric Unit	Imperial Unit
1 Kilogram	2.2 pounds
1 Litre	1.75 pints
4.5 Litres	1 Gallon
8km	5 Miles
30 cm	1 Foot
2.54 cm	1 Inch

i-Clicker



Given that F = 30 lb, what is the correct expression for $\mathbf{F}_x$?

(A) (30 sin 120° **i**) lb

(B) (30 cos 120° **i**) lb

(C) (30 cos 45° **j**) lb

(D) (30 cos 60° **k**) lb

(E) None of the above

3-D Vectors

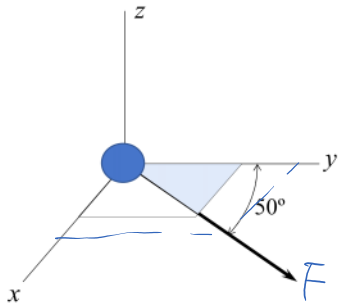
If the vector ties on the plane of xy, yz, xz, it is a 2D vector.

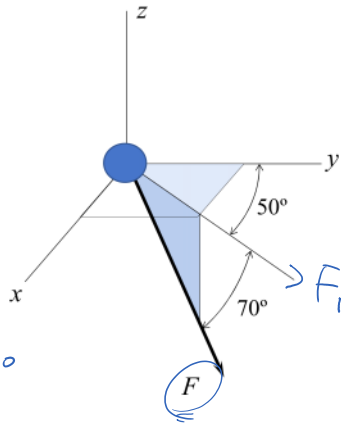
$|F_1| = F \cdot \cos 70^\circ$

$F_x = +F \cdot \cos 70^\circ \cdot \sin 50^\circ$

$F_y = +F \cos 70^\circ \cdot \cos 50^\circ$

$F_z = -F \cdot \sin 70^\circ$





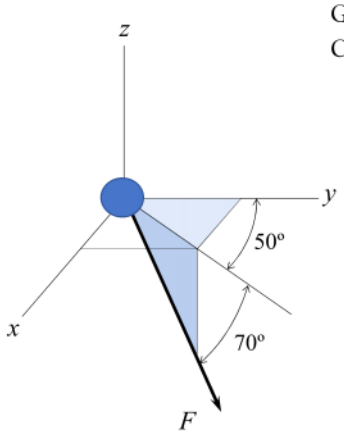
F $F_x = F \cdot \sin 50^\circ$

$F_y = F \cdot \cos 50^\circ$

$F_z = 0$

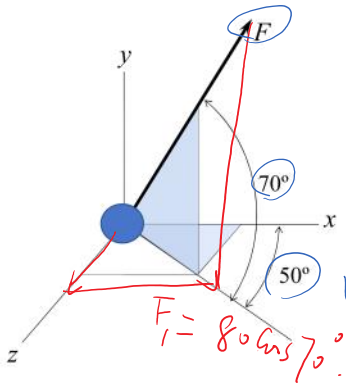
Example

Given that F = 80 lb, express force vector **F** using the Cartesian vector form.



$\vec{F} = F_x \hat{i} + F_y \hat{j} + F_z \hat{k}$

i-Clicker



Given that F = 80 lb, what is the correct expression for F_z?

(A) (80 sin 70° **k**) lb

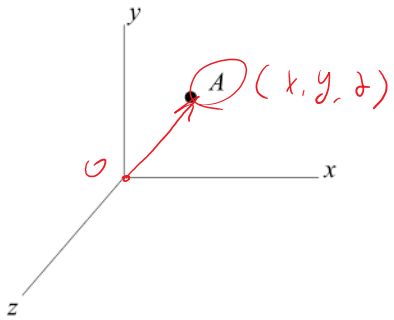
(B) (80 cos 70° **k**) lb

(C) (80 cos 70° sin 50° **k**) lb

(D) (80 cos 70° cos 50° **k**) lb

(E) None of the above

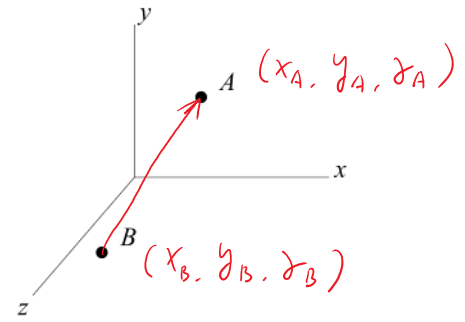
Position vectors



$\vec{r}_A$ = from origin to the point

$\vec{r}_A = (x-0)\hat{i} + (y-0)\hat{j} + (z-0)\hat{k}$

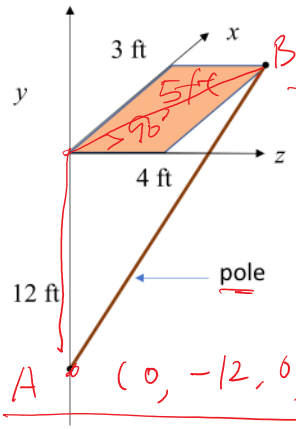
$= x\hat{i} + y\hat{j} + z\hat{k}$



$\vec{r}_{BA}$: from point B to point A

$\vec{r}_{BA} = (x_A - x_B)\hat{i} + (y_A - y_B)\hat{j} + (z_A - z_B)\hat{k}$

Force vector directed along a line



B (3, 0, 4)

Given that the force on the pole = 80 lb, represent the force as a cartesian vector?

$\vec{F} = 80\ \hat{u}\ lb$

A (0, −12, 0)

$\vec{AB}\ (3, 12, 4)$

$\hat{u}_{AB} = \frac{(3, 12, 4)}{\sqrt{9+144+16}} = \frac{(3, 12, 4)}{13}$

$\vec{F} = 80\left(\frac{3}{13}\hat{i} + \frac{12}{13}\hat{j} + \frac{4}{13}\hat{k}\right) lb$

Summary

F_x
F_y $|F|\hat{u} = \vec{F}$
F_z

You should now be able to…

- break down vectors into Cartesian components in 2D and 3D
- express a vector using the starting and ending positions of a vector

$\vec{r}_{AB} =$

- determine the Cartesian representation of a force vector given the line along with the force is acting