UBC DEPARTMENT OF PHYSICS ASTRONOMY

FYSRE DEADLINE: JAN 31st!

Apply to outreach@phas.ubc.ca

“FYSRE”

First Year Summer Research Experience Award

bitly

Vogt First Year Summer Research Experience - paid full-time summer research positions

The Erich Vogt First Year Summer Research Experience (FYSRE, pronounced phyzze) is a program offering summer research experiences to budding academic stars after their First Year Physics courses. Awardees will receive an opportunity for paid work experience in Physics or Astronomy research in UBC Physics and Astronomy or at TRIUMF.

This award honors Dr. Erich Vogt (1929-2014) one of the most distinguished Canadian nuclear physicists of his generation. For over thirty-five years, Erich Vogt taught bright and eager First Year Physics students here at UBC.

The FYSRE awards give outstanding first year students an opportunity to gain work experience in paid summer research positions. Other such research opportunities usually give preference to second and higher year students.

Eligibility

As a requirement for the program, you should have completed 2 semesters of first year physics including the lab, by the time you start the summer position, and plan to enter a Physics or Astronomy (or any combined Majors or Honors degree including Physics or Astronomy) or Engineering Physics program in your second year of study. You must obtain a cumulative average of at least A- over the first year of university study. This is a full-time paid research position. The internship selection process includes an interview.

Applicants must have first-class standing (an average of at least 80%) -although to date every recipient has had an average of at least 85%,

For full info, including application procedure, forms and past recipients and their work, see:

https://www.phas.ubc.ca/erich-vogt-first-year-summer-research-experience-fysre

Application deadline is Jan 31, 2024

Announcements

- Tutorials start this week!

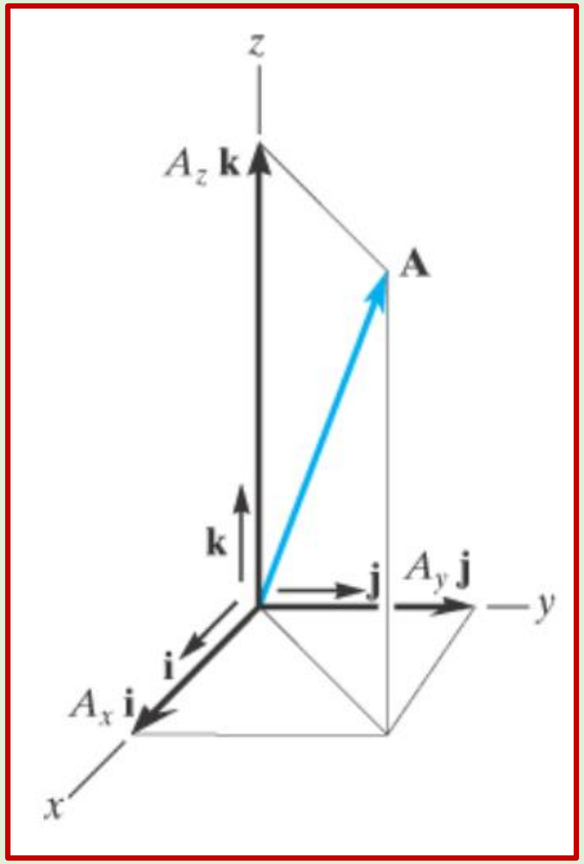
TUTORIALS TIMETABLE

	MON	TUE	WED	THU	FRI
0900	**T2M**	**T2P**	**T2L**		
1000		**T2J**	**T2B**		**T2D**
1100		**T2A**		**T2C** **T2I**	
1300	**T2E** **T2G**	**T2F**		**T2H**	**T2N**
1400					
1500					**T2K**

- HW-1 & Intro Assignment (<u>both</u> are for marks!) are on at Mastering Engineering, due this Sunday

Last Time:

- **Vector $\vec{A}$ in Cartesian coordinates in 3D**:

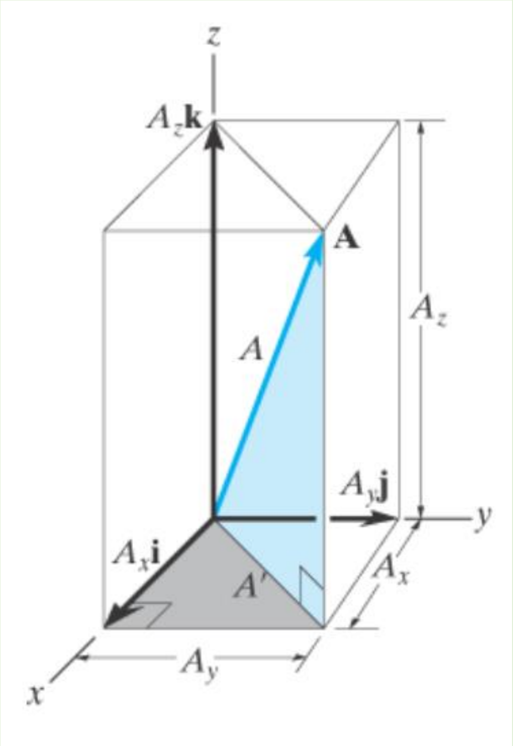


- Any vector $\vec{A}$ in 3D can be uniquely **resolved into three components** along x, y and z:

$$\vec{A} = \vec{i}\ A_x + \vec{j}\ A_y + \vec{k}\ A_z$$

- The magnitude of a 3D vector:

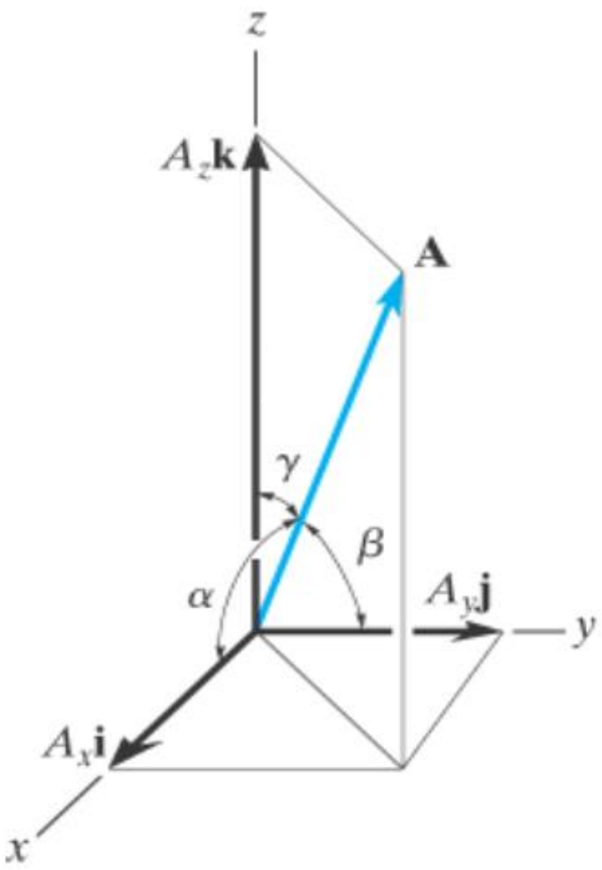
$$A = \left|\vec{A}\right| = \sqrt{A_x^2 + A_y^2 + A_z^2}$$



- Everything we discussed in 2D (positive / negative projections, component-wise vector addition, etc.) applies also in 3D

DIRECTON ANGLES: Three Dimensions (3D)

- **Another description**:



Let us define the angles between the vector $\vec{A}$ and the **positive** directions of x,y,z-axes: α, β, γ

$$A_x = A\cos\alpha \qquad A_y = A\cos\beta \qquad A_z = A\cos\gamma$$

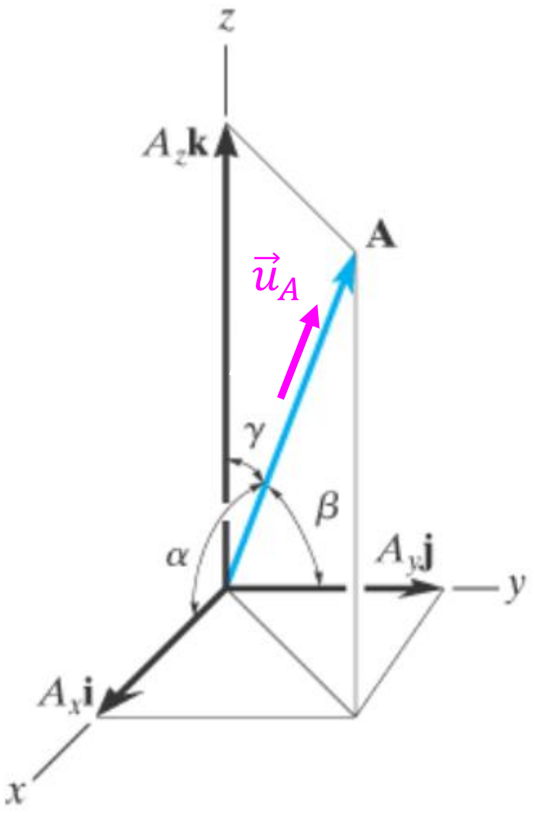
- You can use direction angles to project vector $\vec{A}$!

- Writing a vector in terms of these **direction cosines**:

$$\cos\alpha = \frac{A_x}{A} \qquad \cos\beta = \frac{A_y}{A} \qquad \cos\gamma = \frac{A_z}{A}$$

$$\boxed{\vec{A} = \vec{i}\,A_x + \vec{j}\,A_y + \vec{k}\,A_z = \vec{i}\,A\cos\alpha + \vec{j}\,A\cos\beta + \vec{k}\,A\cos\gamma}$$

UNIT VECTOR IN THE DIRECTION OF $\vec{A}$: Three Dimensions (3D)



- Hence, we have:

$$\vec{A} = \vec{i}\,A_x + \vec{j}\,A_y + \vec{k}\,A_z = \vec{i}\,A\cos\alpha + \vec{j}\,A\cos\beta + \vec{k}\,A\cos\gamma =$$

$$= \underbrace{A\left(\vec{i}\,\cos\alpha + \vec{j}\,\cos\beta + \vec{k}\,\cos\gamma\right)}_{\vec{u}_A} = A\,\vec{u}_A$$

Magnitude

Direction

$\vec{u}_A$

unit vector (length 1) in the direction of $\vec{A}$.

- Hence, for any vector $\vec{A}$ with known direction angles α, β, γ we can define a unit vector $\vec{u}_A$, that carries the information about its direction, as follows:

$$\boxed{\vec{u}_A = \vec{i}\,\cos\alpha + \vec{j}\,\cos\beta + \vec{k}\,\cos\gamma = \vec{i}\,\frac{A_x}{A} + \vec{j}\,\frac{A_y}{A} + \vec{k}\,\frac{A_z}{A}}$$

- Since $\vec{u}_A$ is a unit vector, we have: $\boxed{\cos^2(\alpha) + \cos^2(\beta) + \cos^2(\gamma) = 1}$

Practice: Expressing a 3D vector in Cartesian form

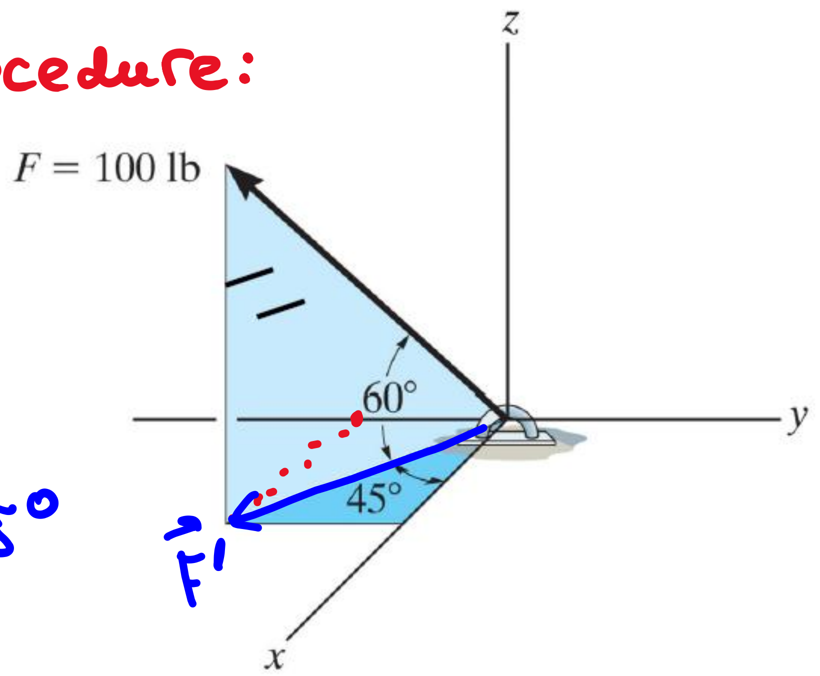
Express $\vec{F}$ as a Cartesian vector.

Two-step projection procedure:

$F' = F \cos 60°$

$F_x = F' \cos 45° =$

$= F \cos 60° \cdot \cos 45°$



To start with: $F_x = ?$

A. (100 lb) cos(60º)

B. (100 lb) cos(60º+45º)

C. (100 lb) cos(60º) cos(45º)

D. (100 lb) cos(60º) sin(45º)

E. Something else

What about F_y ?

$F_y = -(F \cos 60°) \sin 45°$

NB: to project, you need the angle between the vector and the direction on which you project!

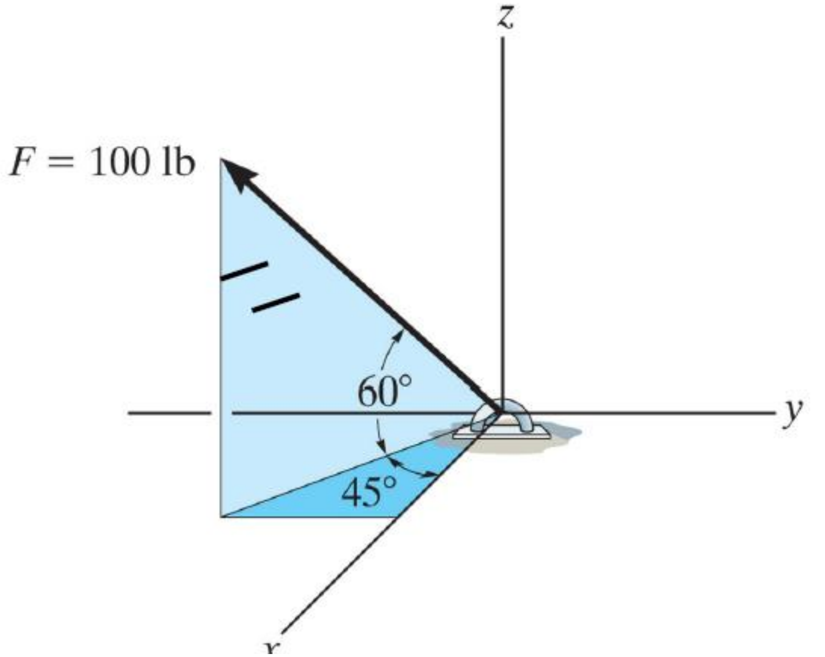
Practice: Expressing a 3D vector in Cartesian form

Express $\vec{F}$ as a Cartesian vector.

Here 60º and 45º are NOT direction angles (they are NOT the angles between the vector and the coordinate axes.)

Two determine F_x and F_y we need to follow a **two-step procedure**:

- First, we project the vector $\vec{F}$ onto (x,y)-plane; let's call the result $\vec{F}'$;
- Second, we project $\vec{F}'$ onto x- and y-axes.

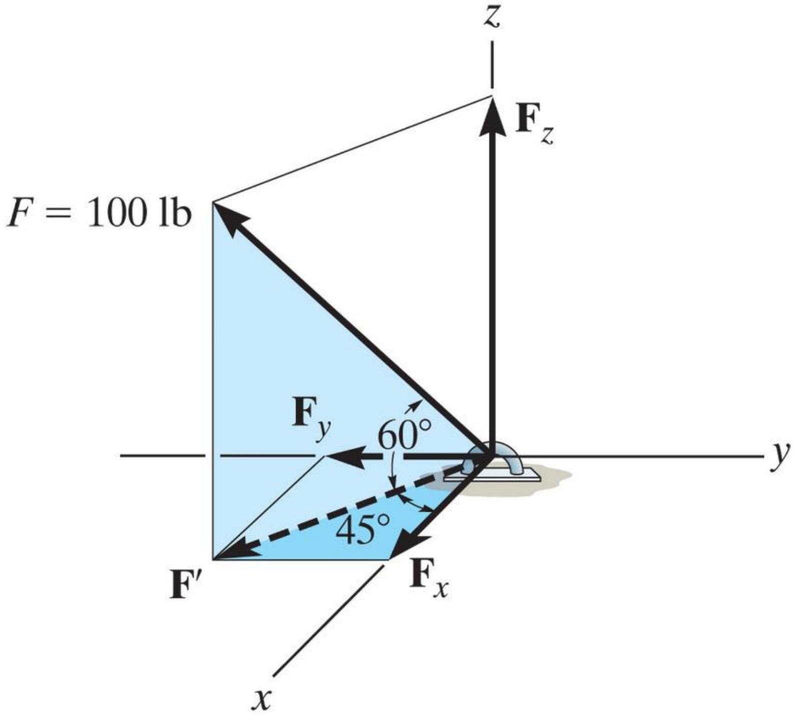


Solution:

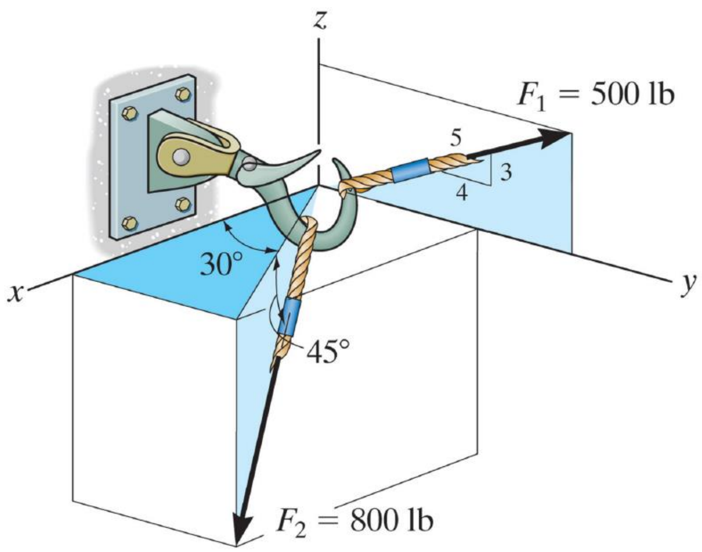
- $F' = F\cos(60^o)$
- $F_x = F'\cos(45^o) = F\cos(60`^o)\cos(45^o) = 35.4$ lb

  $F_y = -F'\sin(45^o) = -F\cos(60^o)\sin(45^o) = -35.4$ lb

  $F_z = F\sin(60^o) = 86.6$ lb



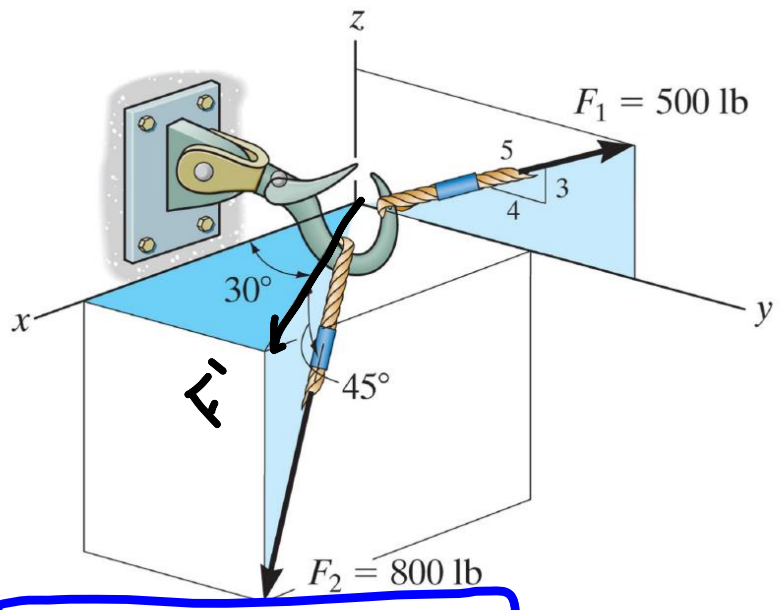
W2-1. Determine the resultant force acting on a block.



W2-1. Determine the resultant force acting on a block.

Two-step projection:

$$F' = 800\cos 45^\circ \begin{cases} F_x = F'\cos 30^\circ \\ F_y = F'\sin 30^\circ \end{cases}$$



$$\boxed{\vec{F}_R = (490)\vec{i} + (683)\vec{j} + (-266)\vec{k}}$$

$$\vec{F}_1 = (0)\,\vec{i} + \left(500\cdot\frac{4}{5}\right)\vec{j} + \left(500\cdot\frac{3}{5}\right)\vec{k}$$

$$+ \qquad\qquad + \qquad\qquad +$$

$$\vec{F}_2 = (800\cos 45^\circ)\cdot\cos 30^\circ\,\vec{i} + (800\cos 45^\circ)\sin 30^\circ\,\vec{j} + (-800\sin 45^\circ)\,\vec{k}$$

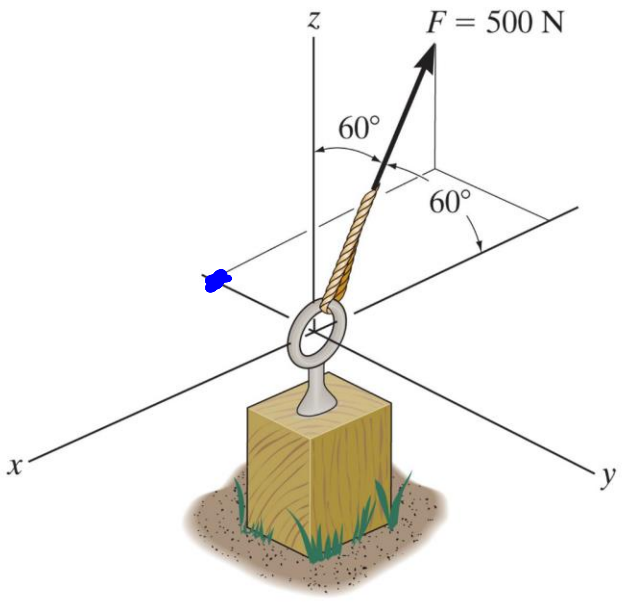
$$\parallel \qquad\qquad \parallel \qquad\qquad \parallel$$

$$\vec{F}_R = (F_{Rx})\vec{i} + (F_{Ry})\vec{j} + (F_{Rz})\vec{k}$$

Example: $F_{Rx} = 0 + 800\cos 45^\circ\cos 30^\circ = 490$

Practice: Translating between Cartesian and direction cosine representations

W2-2. Express $\vec{F}$ as a Cartesian vector.



02_FUND-PROB_014

$\alpha = 120°$

$\beta = ?$

$\gamma = 60°$

$$F_x = -500 \cos 60° = -250\ N$$

$$F_y = 500 \cos\beta = -354\ N$$

$$F_z = 500 \cos 60° = 250\ N$$

$$F^2 = 500^2 = F_x^2 + F_y^2 + F_z^2 = (250)^2 + F_y^2 + (-250)^2$$

$$F_y^2 = 125000 \longrightarrow \cancel{354\ N}$$

$$\longrightarrow -354\ N \quad ✓$$

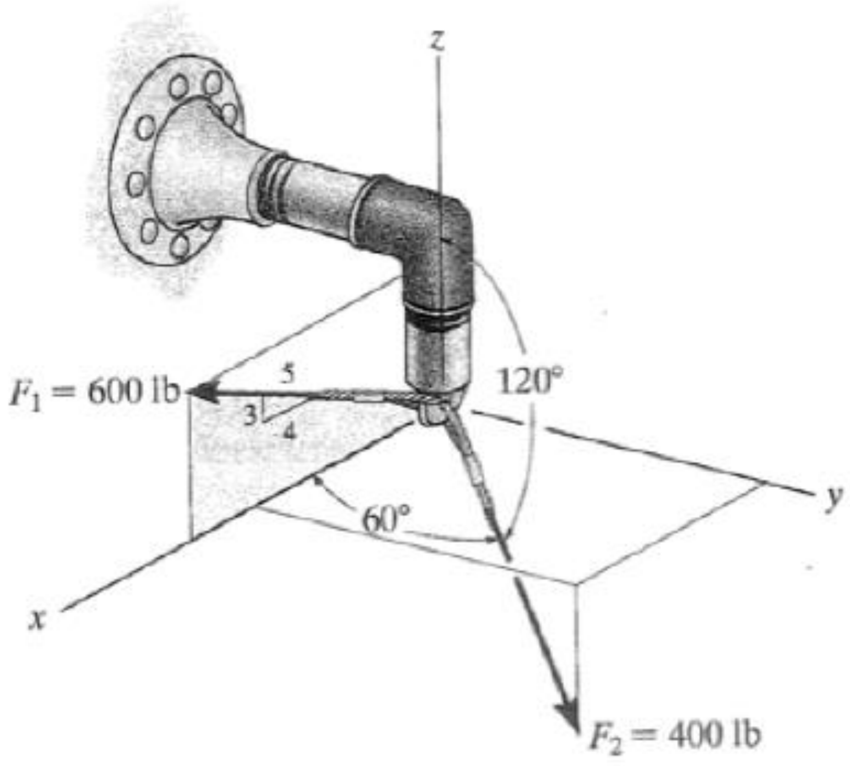
$$\cos^2\alpha + \cos^2\beta + \cos^2\gamma = 1$$

$$\cos^2\beta = 1/2 \qquad \cos\beta = \pm\frac{1}{\sqrt{2}} \rightarrow \beta = 45° \ ✗ \qquad \rightarrow \beta = 135° \ ✓$$

W2-E1. Extra practice

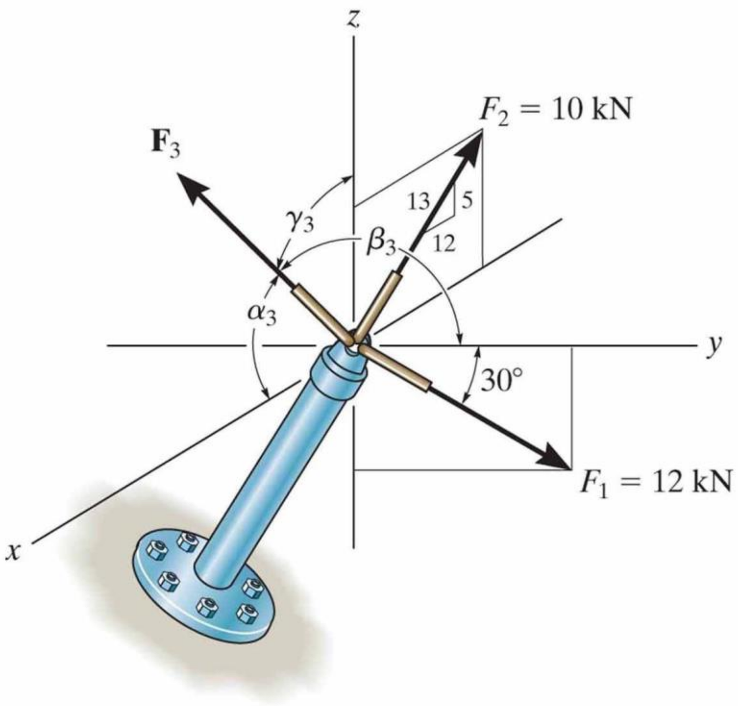
a) Express each force acting on the pipe assembly in the Cartesian vector form.

b) Determine the magnitude and the direction of the resultant force on the pipe assembly.

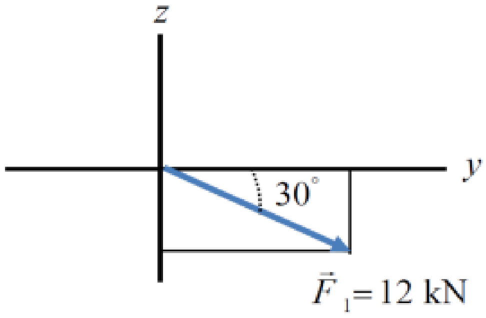


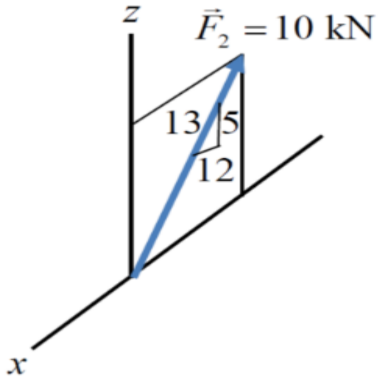
Extra practice worksheet, first problem – highly recommended.

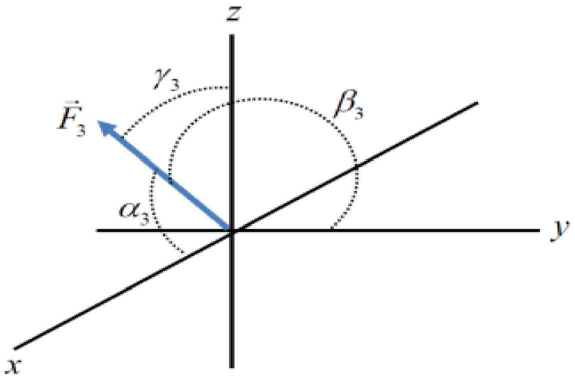
W2-3. Specify the magnitude of $\vec{F}_3$ and its coordinate direction angles α_3, β_3 and γ_3 so that the resultant force is $9\,\vec{j}$ kN.

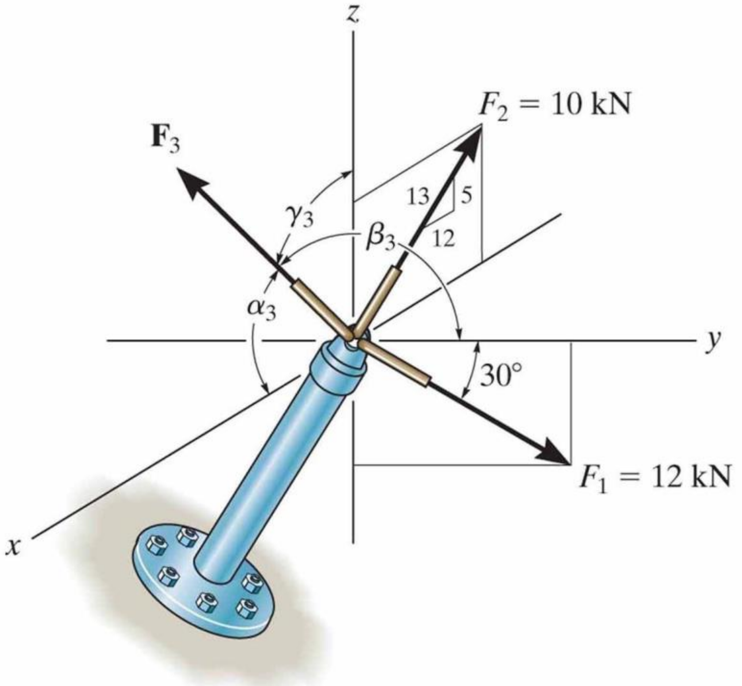


W2-3. Specify the magnitude of $\vec{F}_3$ and its coordinate direction angles α_3, β_3 and γ_3 so that the resultant force is $9\,\vec{j}$ kN.









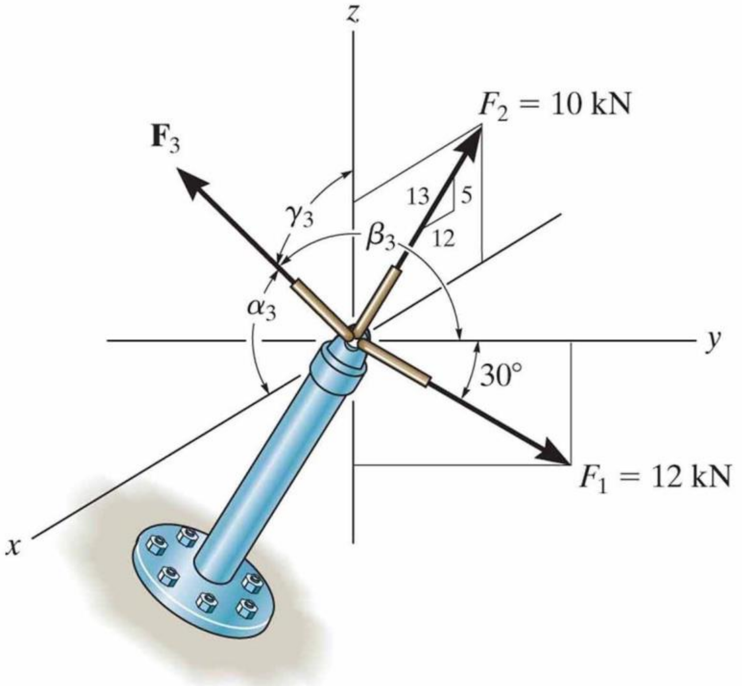
$$\vec{F}_1 = (0)\,\vec{i} + (12\cos 30^\circ)\,\vec{j} + (-12\cdot\sin 30)\,\vec{k}$$

$$\vec{F}_2 = \left(-10\,\frac{12}{13}\right)\vec{i} + (0)\,\vec{j} + \left(10\cdot\frac{5}{13}\right)\vec{k}$$

$$\vec{F}_3 = (F_{3x})\,\vec{i} + (F_{3y})\,\vec{j} + (F_{3z})\,\vec{k}$$

$$\vec{F}_R = \underbrace{(0)}_{F_{Rx}}\,\vec{i} + \underbrace{(9)}_{F_{Ry}}\,\vec{j} + \underbrace{(0)}_{F_{Rz}}\,\vec{k}$$

W2-3. Specify the magnitude of $\vec{F}_3$ and its coordinate direction angles α_3, β_3 and γ_3 so that the resultant force is $9\vec{j}$ kN.



$$F_{3x} = F_{Rx} - F_{1x} - F_{2x} = 0 - 0 \quad + 9.231 = 9.231$$

$$F_{3y} = F_{Ry} - F_{1y} - F_{2y} = 9 - 10.39 - 0 \quad = -1.390$$

$$F_{3z} = F_{Rz} - F_{1z} - F_{2z} = 0 + 6 \quad - 3.846 = 2.154$$

$$F = \sqrt{F_{3x}^2 + F_{3y}^2 + F_{3z}^2} = 9.5804 \rightarrow \boxed{F_3 = 9.58\text{ kN}}$$

$$\cos\alpha_3 = \frac{F_{3x}}{F} = \frac{9.231}{9.5804} = 0.9635 \rightarrow \alpha_3 = 15.5^\circ$$

$$\cos\beta_3 = \frac{F_{3y}}{F} = \frac{-1.390}{9.5805} = -1.1451 \rightarrow \beta_3 = 98.3^\circ$$

$$\cos\gamma_3 = \frac{F_{3z}}{F} \rightarrow \gamma_3 = 77.0^\circ$$