Statics - TAM 210 & TAM 211

Lecture 3

January 22, 2018

Announcements

- Take practice Quiz 0 on PrairieLearn (not graded)
- MATLAB training sessions
  - Wed 24, Thu 25, Fri 26, and Mon 29
  - DCL 1440, Tutorial: 6:30-7:30 pm, Q&A: 7:30-8:00 pm

- Upcoming deadlines:
- Tuesday (1/23)
  - Prairie Learn HW1
- Thursday (1/25)
  - Written Assignment 1
- Friday (1/26)
  - Mastering Engineering Tutorial3

giphy.com

Chapter 2: Force vectors
Main goals and learning objectives

Define scalars, vectors and vector operations and use them to analyze forces acting on objects

- Add forces and resolve them into components
- Express force and position in Cartesian vector form
- Determine a vector's magnitude and direction
- Introduce the dot product and use it to find the angle between two vectors or the projection of one vector onto another

Recap from Lecture 2

- A force can be treated as a vector, since forces obey all the rules that vectors do.

- Vector representations
  - Rectangular components $\vec{\boldsymbol{A}} = \overrightarrow{\boldsymbol{A_x}} + \overrightarrow{\boldsymbol{A_y}} + \overrightarrow{\boldsymbol{A_z}}$
  - Cartesian vectors $\vec{\boldsymbol{A}} = A_x\hat{\boldsymbol{\imath}} + A_x\hat{\boldsymbol{\jmath}} + A_x\hat{\boldsymbol{k}}$
  - Unit vector $\overrightarrow{\boldsymbol{u_A}} = \frac{\vec{\boldsymbol{A}}}{|\vec{\boldsymbol{A}}|} = \frac{A_x}{|\vec{\boldsymbol{A}}|}\hat{\boldsymbol{\imath}} + \frac{A_y}{|\vec{\boldsymbol{A}}|}\hat{\boldsymbol{\jmath}} + \frac{A_z}{|\vec{\boldsymbol{A}}|}\hat{\boldsymbol{k}}$
  - Direction cosines $cos(\alpha) = \frac{A_x}{A}$, $cos(\beta) = \frac{A_y}{A}$, $cos(\gamma) = \frac{A_z}{A}$

Recall: Magnitude of a vector (which is a scalar quantity) can be shown as a term with no font modification (A) or vector with norm bars ($|\vec{\boldsymbol{A}}|$), such that $A = |\vec{\boldsymbol{A}}| = \sqrt{A_x^2 + A_y^2 + A_z^2}$

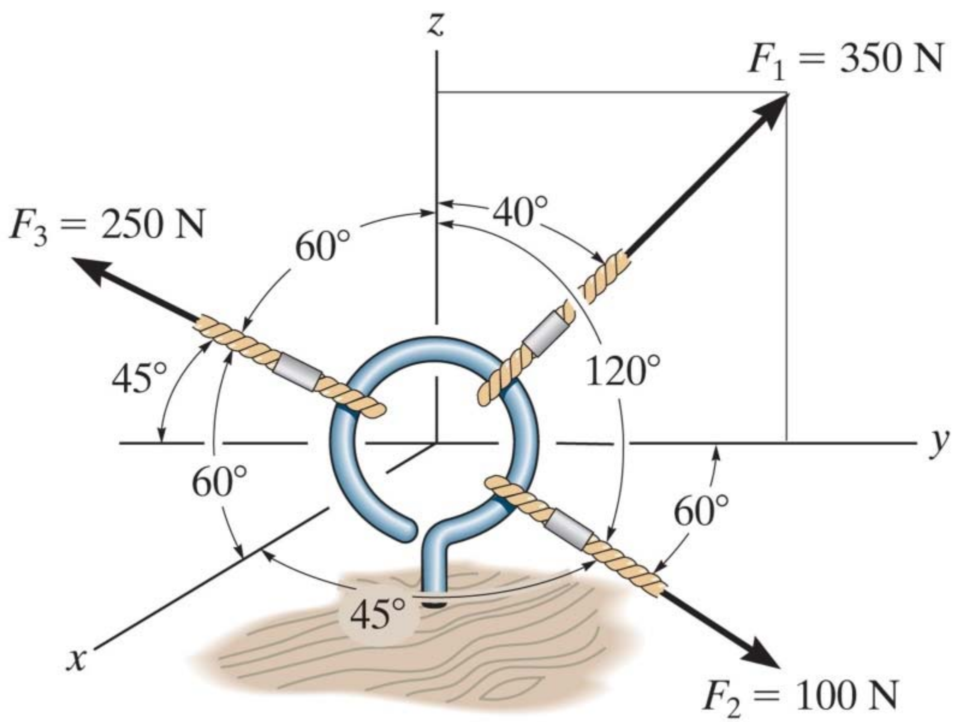
Example

The cables attached to the screw eye are subjected to three forces shown.

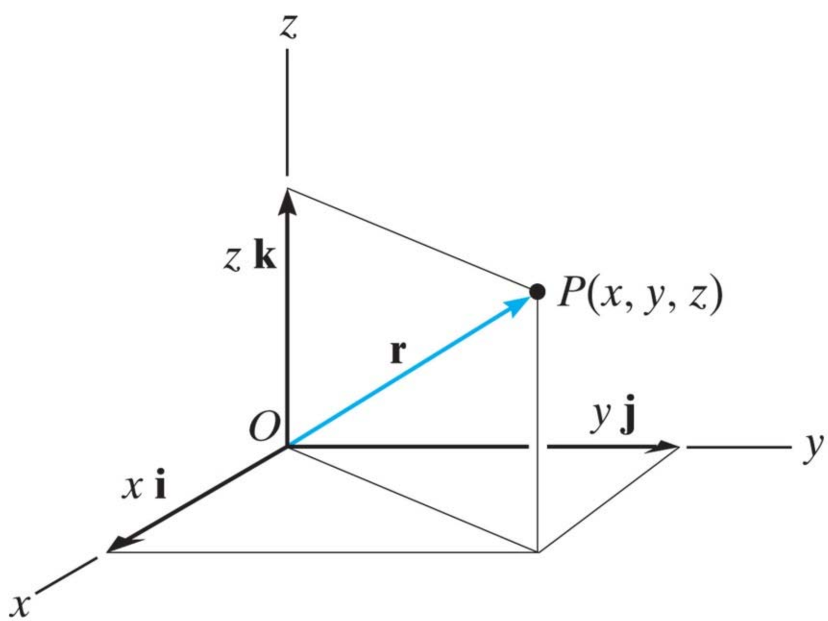
(a) Express each force vector using the Cartesian vector form (components form).

(b) Determine the magnitude of the resultant force vector

(c) Determine the direction cosines of the resultant force vector



Position vectors



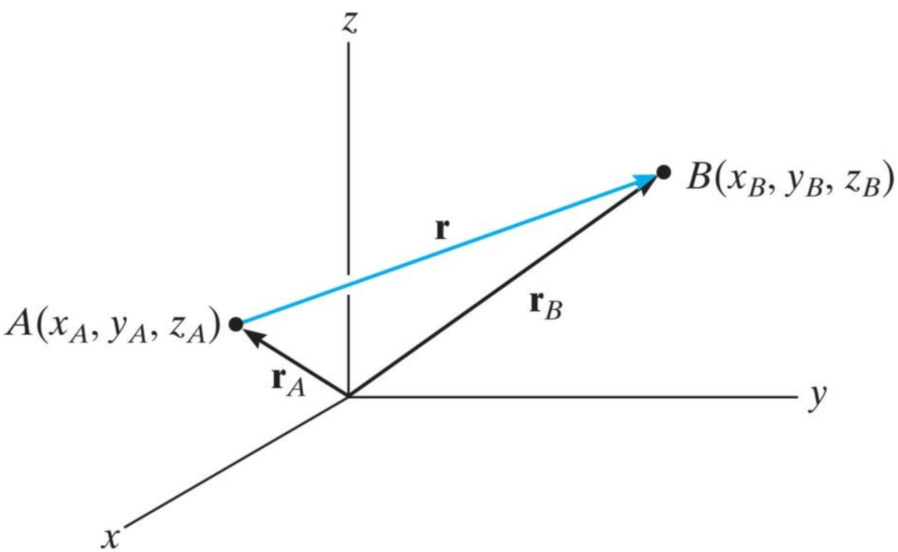
A position vector $\boldsymbol{r}$ is defined as a fixed vector which locates a point in space relative to another point. For example,

$$\boldsymbol{r} = x\,\boldsymbol{i} + y\,\boldsymbol{j} + z\,\boldsymbol{k}$$

expresses the position of point $P(x,y,z)$ with respect to the origin O.

The position vector $\boldsymbol{r}$ of point $\boldsymbol{B}$ with respect to point $\boldsymbol{A}$ is obtained from

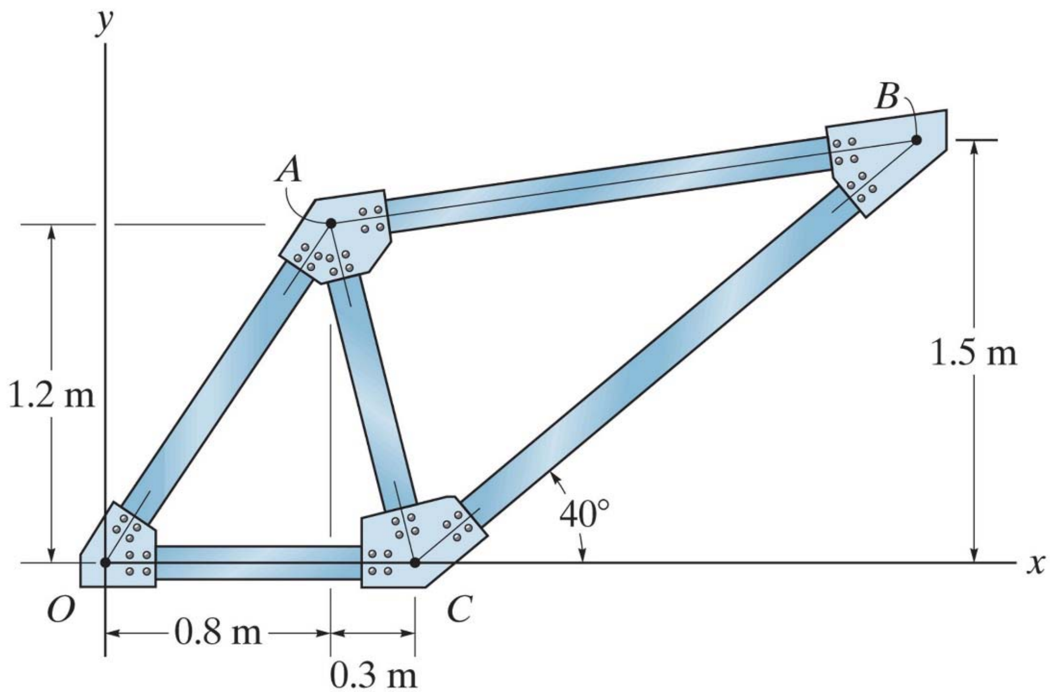
Hence,

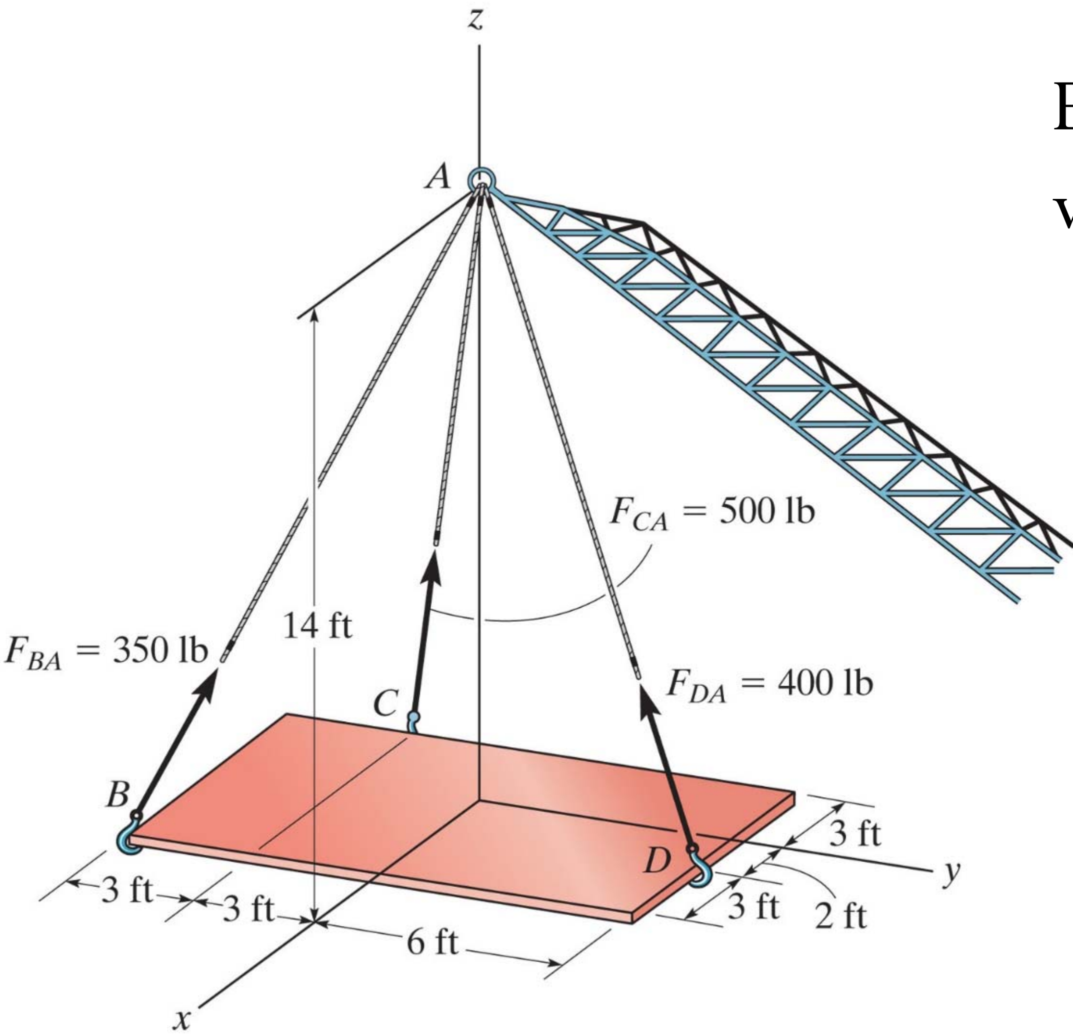


Thus, the $(\boldsymbol{i},\ \boldsymbol{j},\ \boldsymbol{k})$ components of the positon vector $\boldsymbol{r}$ may be formed by taking the coordinates of the tail (point A) and subtracting them from the corresponding coordinates of the head (point B).

Example

Determine the lengths of bars AB, BC and AC.

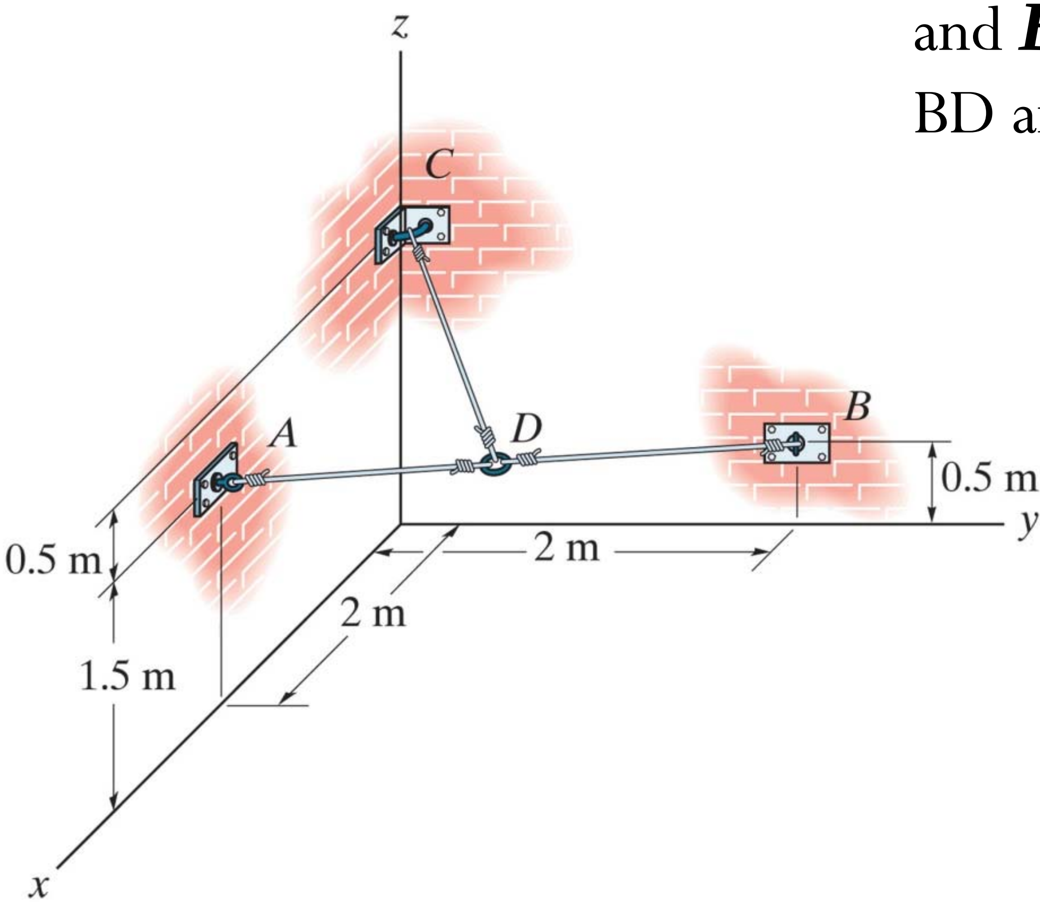




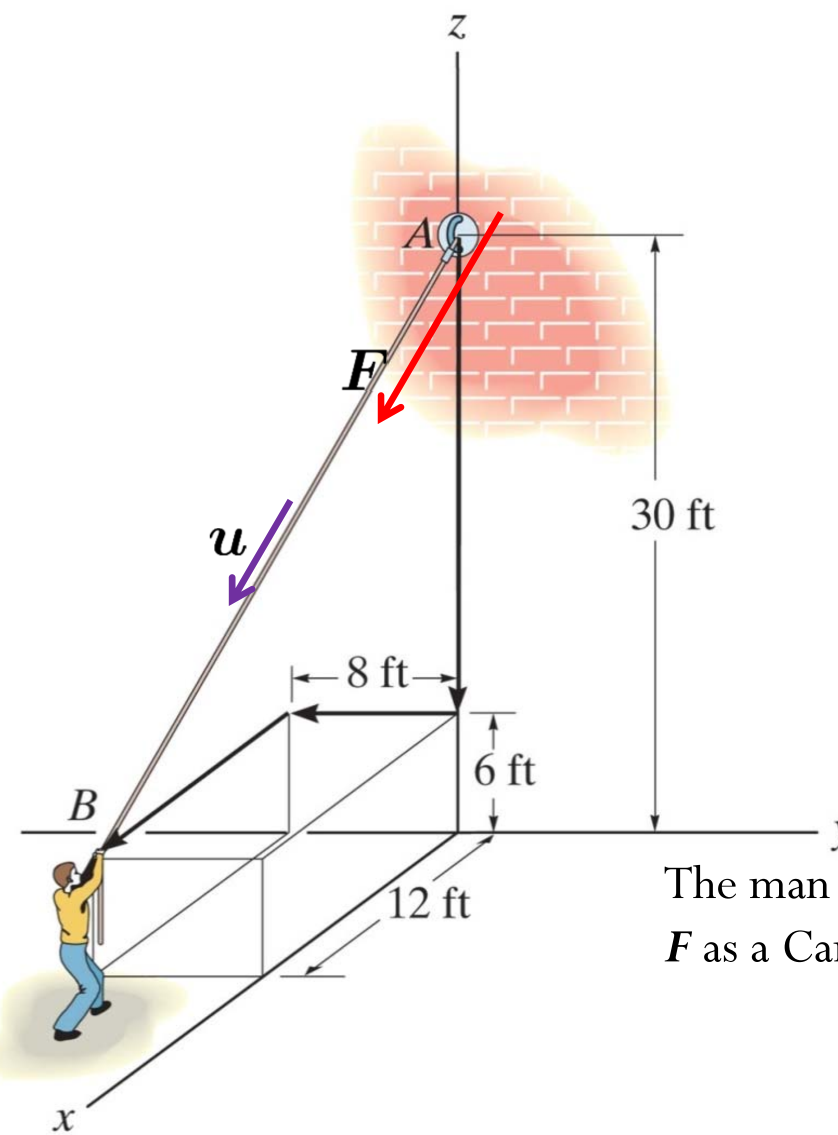
Express each force as a Cartesian vector

Example

The ring at D is midway between points ***A*** and ***B.*** Determine the lengths of wires AD, BD and CD



Force vector directed along a line



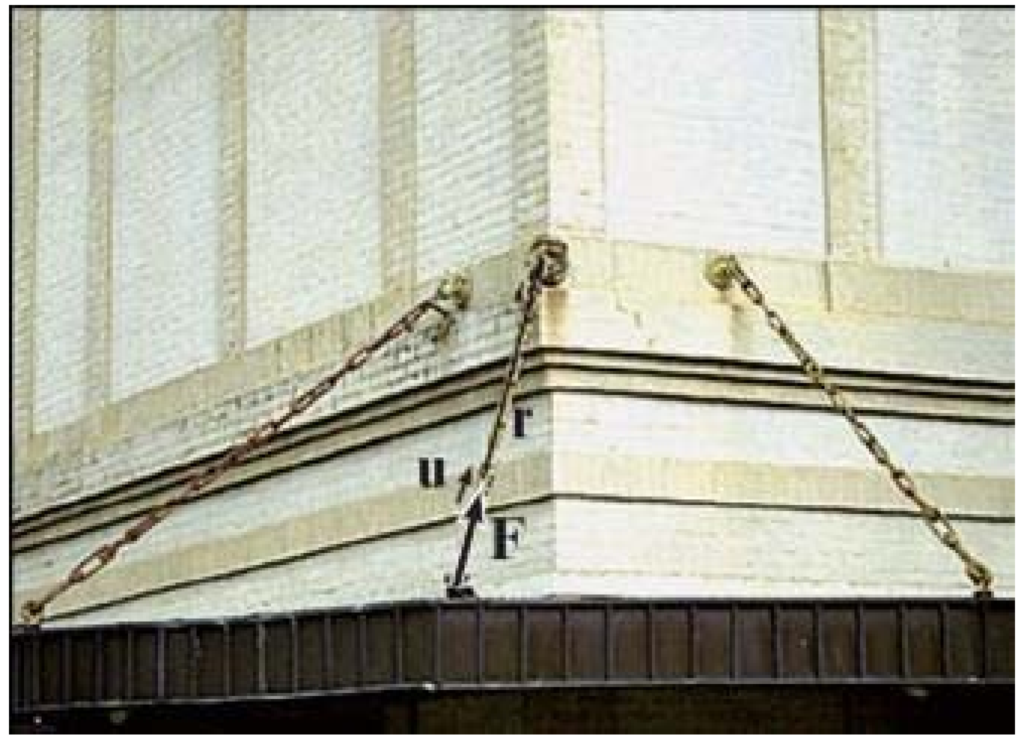
The force vector ***F*** acting a long the rope can be defined by the unit vector ***u*** (defined the <u>direction</u> of the rope) and the <u>magnitude</u> of the force.

$$\boldsymbol{F} = F\,\boldsymbol{u}$$

The unit vector ***u*** is specified by the position vector ***r***:

The man pulls on the cord with a force of 70 lb. Represent the force ***F*** as a Cartesian vector.

Force vector directed along a line



Don’t look up!