Announcements

- Sign-up for Quiz 1
  - Practice quiz available on PL
  - Be familiar with MATLAB commands

- Upcoming deadlines:
- Tuesday (9/5)
  - Prairie Learn HW2
- Thursday (9/7)
  - Mastering Engineering HW3

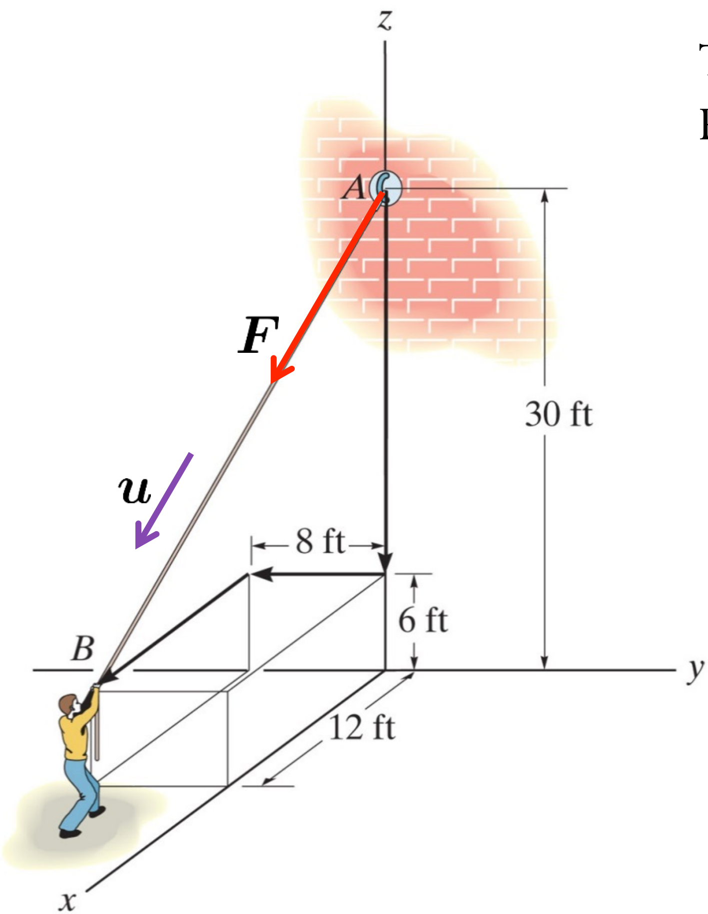
Recap

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

- Vector representations
  - Rectangular components
  - Cartesian vectors
  - Unit vector
  - Direction cosines

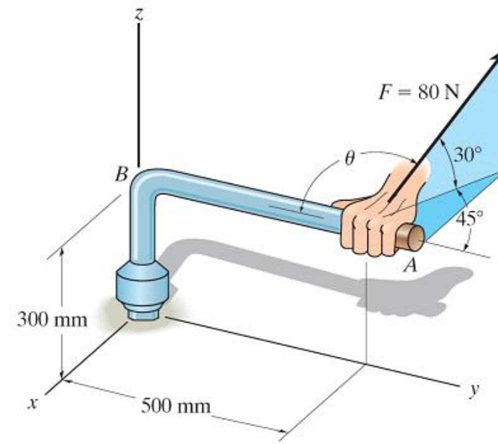
- Position vectors

Force vector directed along a line

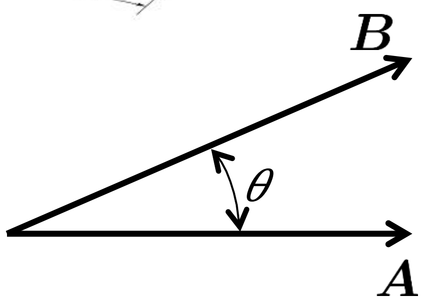


The man pulls on the cord with a force of 70 lb. Represent the force F as a Cartesian vector.

Dot (or scalar) product



The dot product of vectors **A** and **B** is defined as such

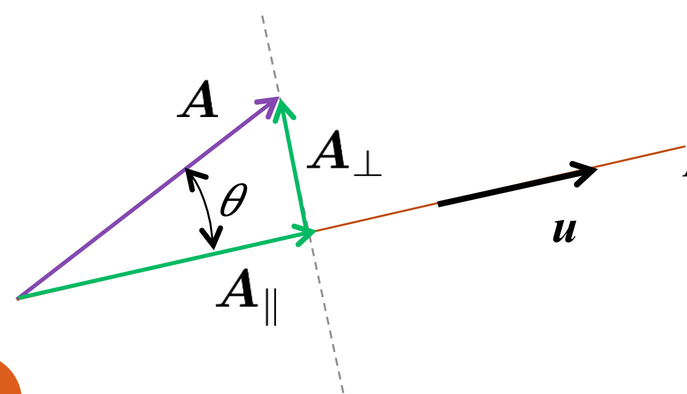


Cartesian vector formulation:

$$\boldsymbol{A} \cdot \boldsymbol{B} \quad =$$

Projections

The scalar component $A_{\|}$ of a vector $\boldsymbol{A}$ along (parallel to) a line with unit vector $\boldsymbol{u}$ is given by:



$$A_{\|} =$$

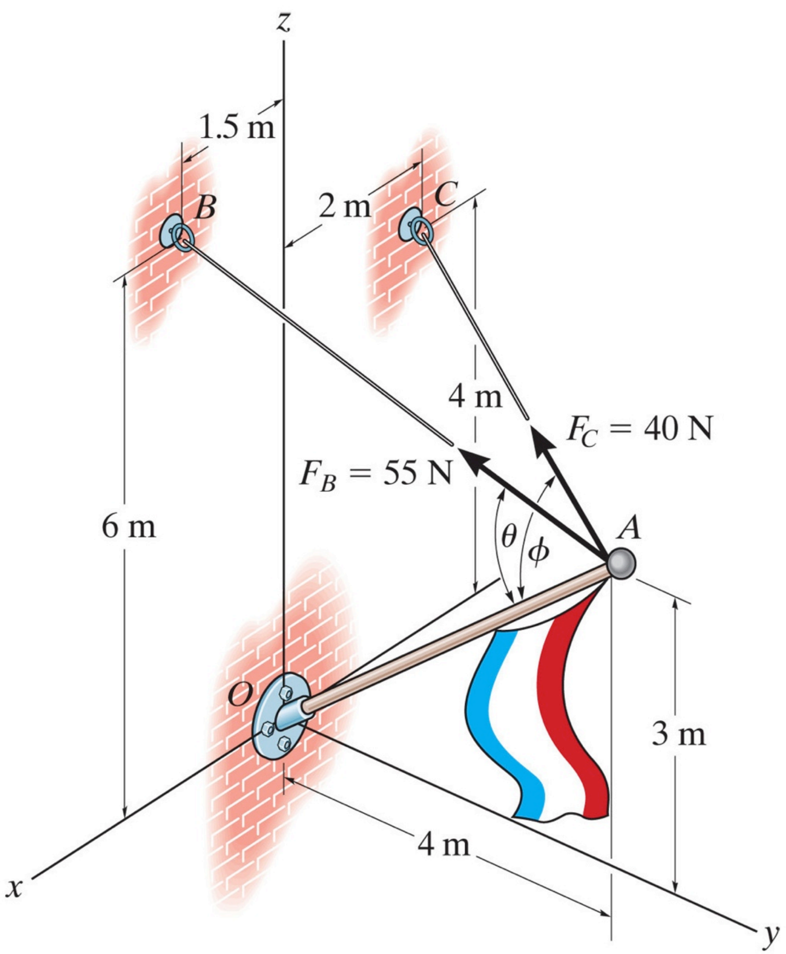
And thus the <u>vector</u> components $\boldsymbol{A}_{\|}$ and $\boldsymbol{A}_{\perp}$ are given by:

$$\boldsymbol{A}_{\|} =$$

$$\boldsymbol{A}_{\perp} =$$

Example

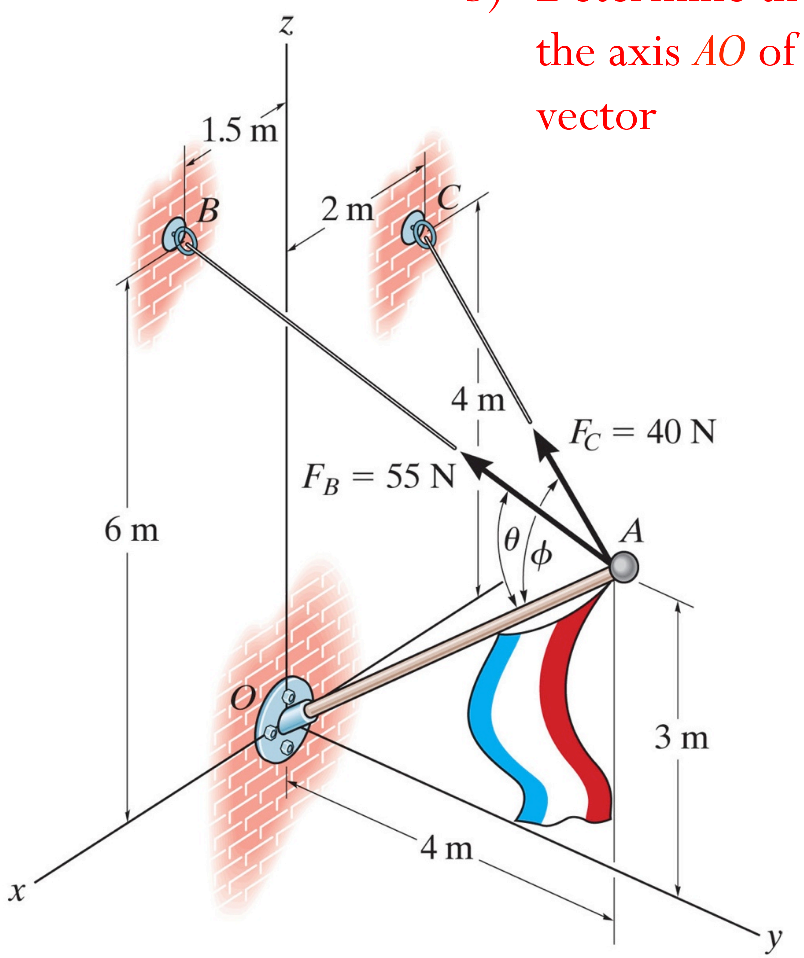
a) Determine the angle between AB and the flag pole.



Example

a) Determine the angle between AB and the flag pole.

b) Determine the projected component of the force vector $\boldsymbol{F}_C$ along the axis AO of the flag pole. Express your result as a Cartesian vector

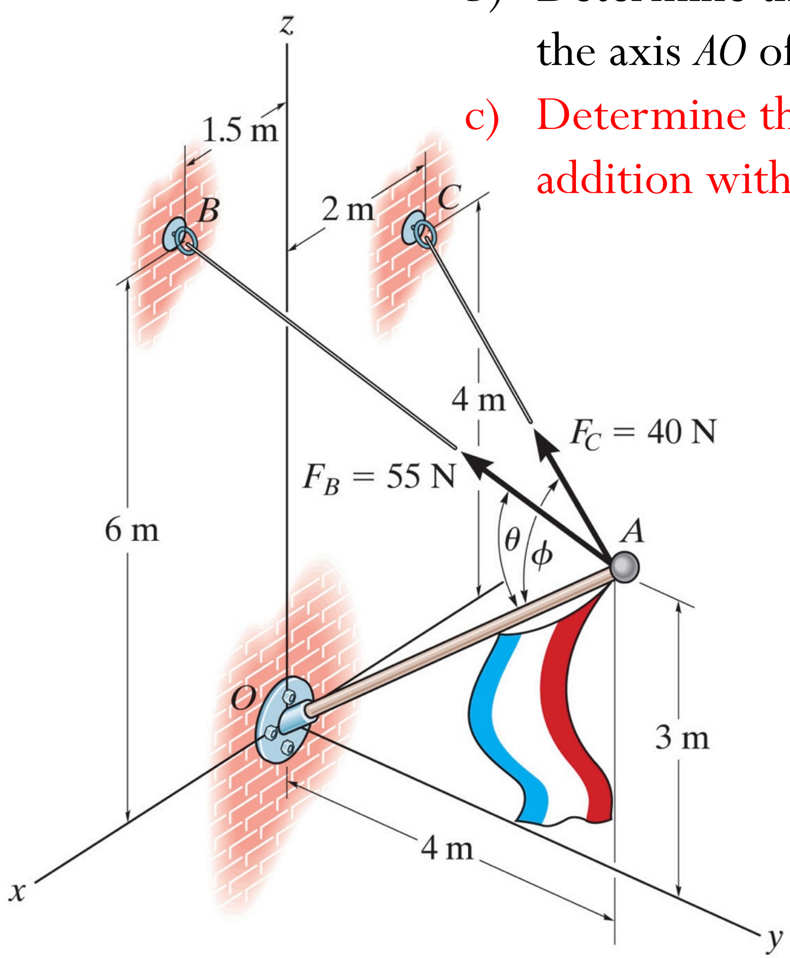


Example

a) Determine the angle between AB and the flag pole.

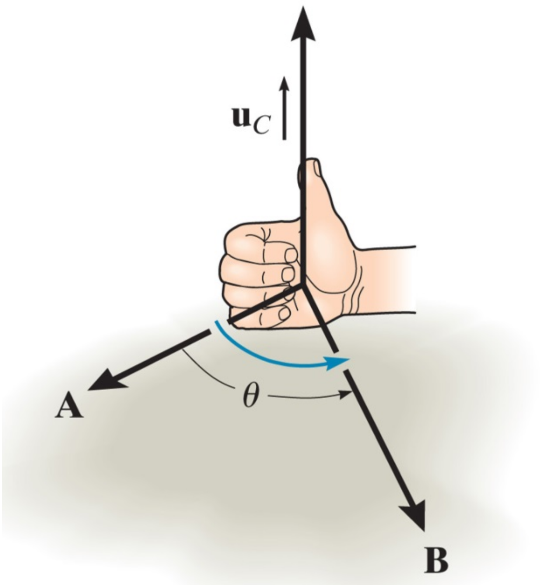
b) Determine the projected component of the force vector $\boldsymbol{F}_C$ along the axis AO of the flag pole.

c) Determine the perpendicular component such at its vector addition with the projected component equals $\boldsymbol{F}_C$.



Cross (or vector) product

The cross product of vectors **A** and **B** yields the vector **C**, which is written



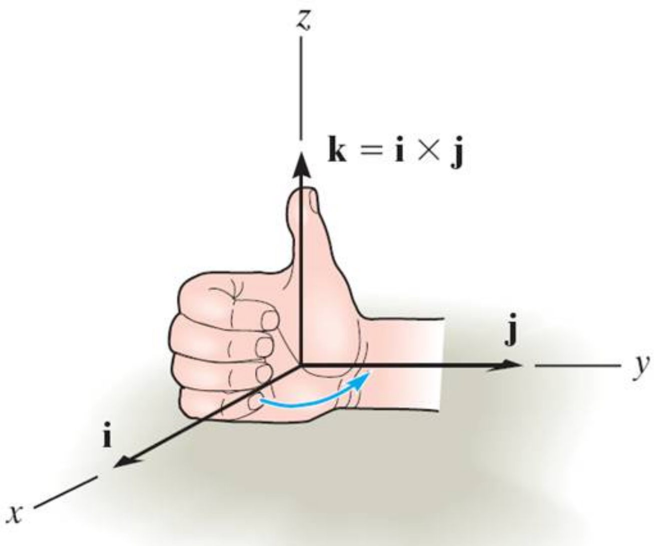
$$\boxed{\boldsymbol{C} = \boldsymbol{A} \times \boldsymbol{B}}$$

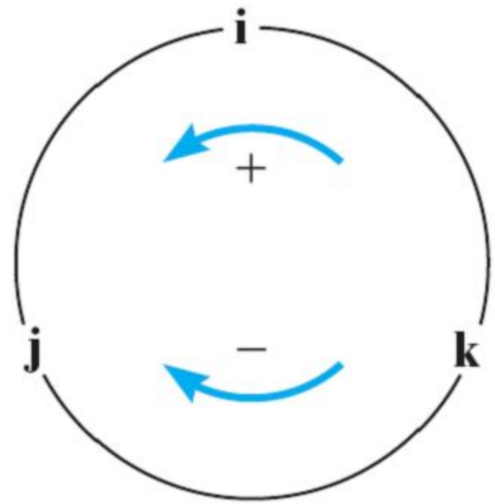
The magnitude of vector **C** is given by:

The vector **C** is perpendicular to the plane containing **A** and **B** (specified by the **right-hand rule**). Hence,

Cross (or vector) product

The right-hand rule is a useful tool for determining the direction of the vector resulting from a cross product. Note that a vector crossed into itself is zero, e.g., $\boldsymbol{i} \times \boldsymbol{i} = 0$





Considering the cross product in Cartesian coordinates

$$\boldsymbol{A} \times \boldsymbol{B} \quad = \quad (A_x\,\boldsymbol{i} + A_y\,\boldsymbol{j} + A_z\,\boldsymbol{k}) \times (B_x\,\boldsymbol{i} + B_y\,\boldsymbol{j} + B_z\,\boldsymbol{k})$$

Cross (or vector) product

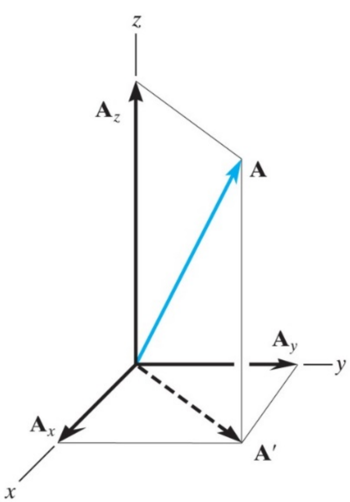
Also, the cross product can be written as a determinant.

$$\mathbf{A} \times \mathbf{B} = \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ A_x & A_y & A_z \\ B_x & B_y & B_z \end{vmatrix}$$

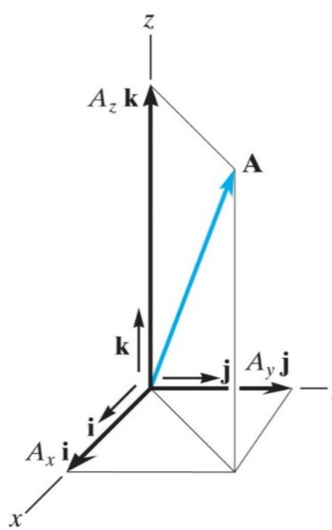
Each component can be determined using 2×2 determinants.

Chap 2 - recap

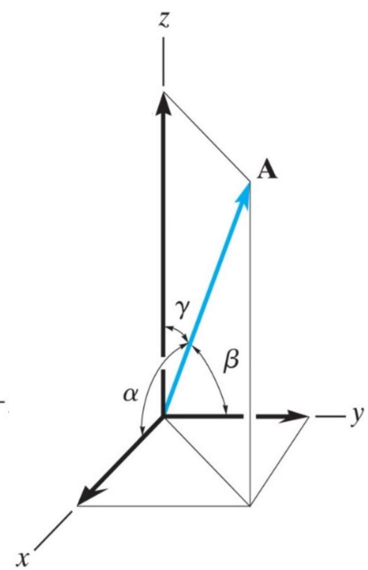
- Scalars –
- Vectors –
- Dot product –
- Cross product –



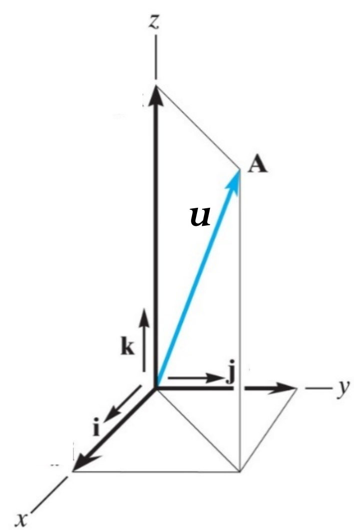
Rectangular components of a vector



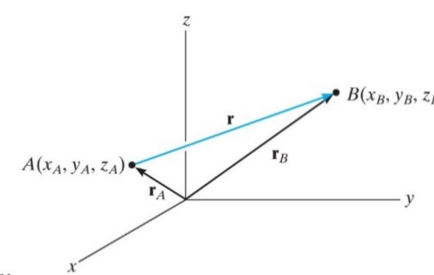
Cartesian vector representation



Cartesian vector using direction cosines



Cartesian vector using unit vector



Cartesian position vectors