Announcements

- Extra notes and example available on Compass2g
- Sign-up for Quiz 1
  - Practice quiz available on PL
- Upcoming deadlines:
- Thursday (9/6)
  - Prairie Learn HW1
- Friday (9/7)
  - Written Assignment 1

Lecture Objectives

- Vector Projection
- Vector Cross Product
- Engineering Idealization
- General Procedure of Analysis

Vector Projections

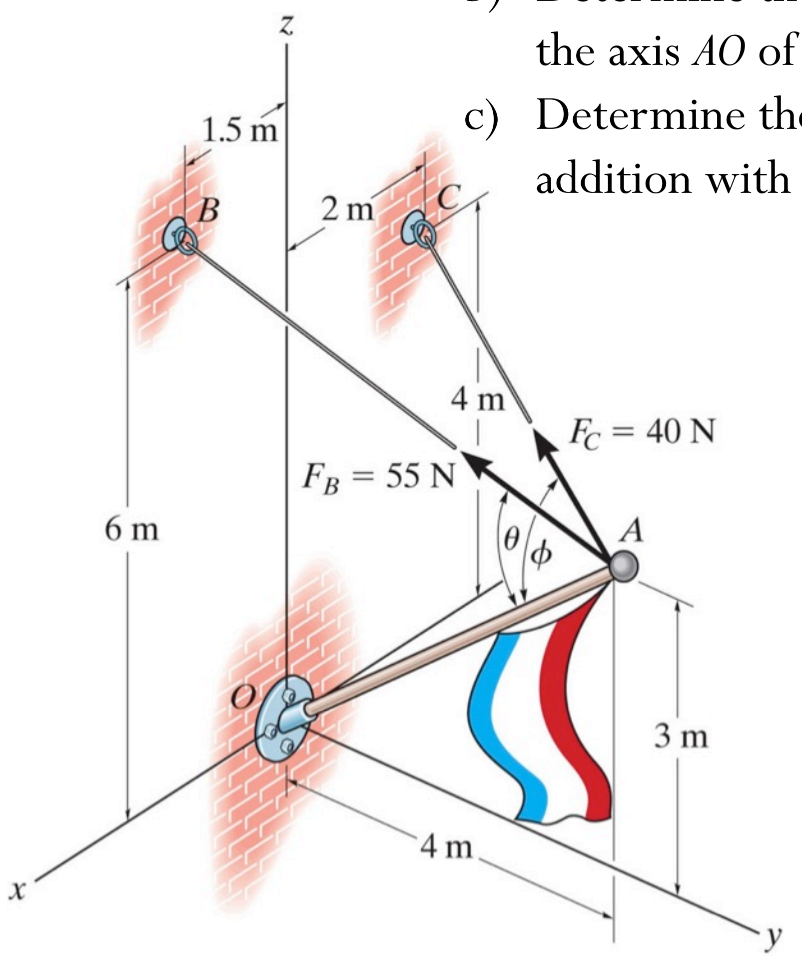
https://www.youtube.com/watch?v=pP92q68KG24

Example

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

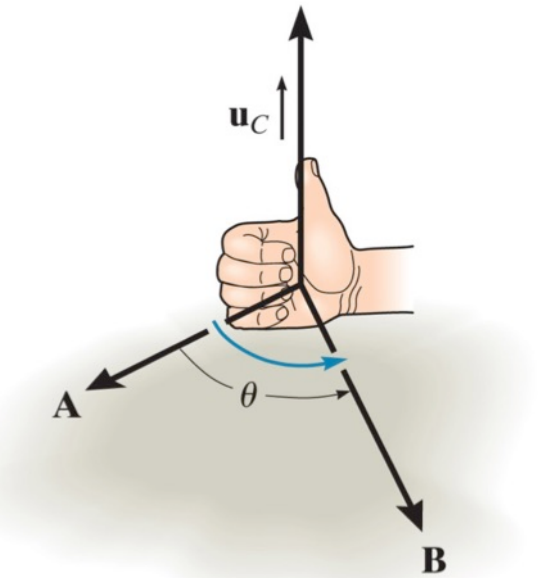
b) Determine the projected component of the force vector $\boldsymbol{F}_C$ along the axis *AO* of the flag pole.

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



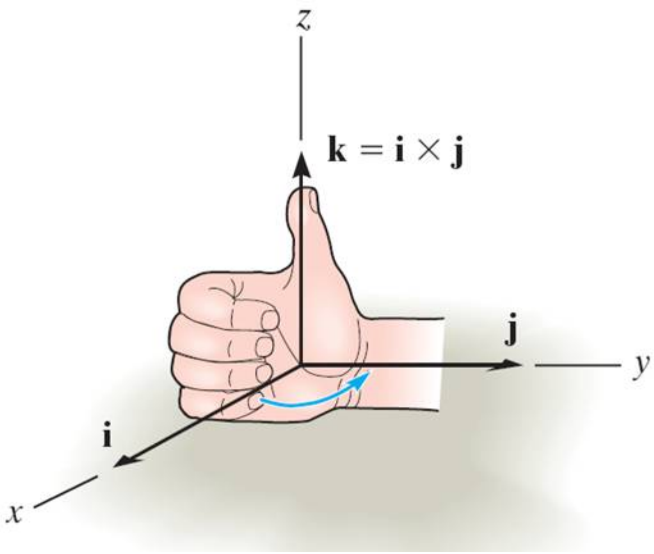
$$\boldsymbol{C} = \boldsymbol{A} \times \boldsymbol{B}$$

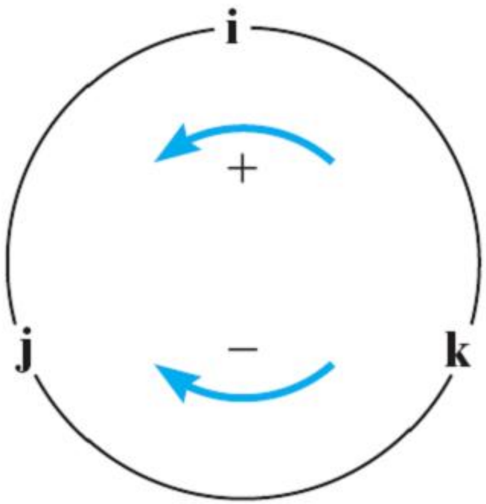
The magnitude of vector **C** is given by:

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

$$
\begin{aligned}
\boldsymbol{A} \times \boldsymbol{B} &= (A_x\,\boldsymbol{i} + A_y\,\boldsymbol{j} + A_z\,\boldsymbol{k}) \times (B_x\,\boldsymbol{i} + B_y\,\boldsymbol{j} + B_z\,\boldsymbol{k}) \\
&= +A_xB_x(\boldsymbol{i} \times \boldsymbol{i}) + A_xB_y(\boldsymbol{i} \times \boldsymbol{j}) + A_xB_z(\boldsymbol{i} \times \boldsymbol{k}) \\
&\quad +A_yB_x(\boldsymbol{j} \times \boldsymbol{i}) + A_yB_y(\boldsymbol{j} \times \boldsymbol{j}) + A_yB_z(\boldsymbol{j} \times \boldsymbol{k}) \\
&\quad +A_zB_x(\boldsymbol{k} \times \boldsymbol{i}) + A_zB_y(\boldsymbol{k} \times \boldsymbol{j}) + A_zB_z(\boldsymbol{k} \times \boldsymbol{k}) \\
&= (A_yB_z - A_zB_y)\boldsymbol{i} - (A_xB_z - A_zB_x)\boldsymbol{j} + (A_xB_y - A_yB_x)\boldsymbol{k}
\end{aligned}
$$

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.

Chapter 3: Equilibrium of a particle

Fundamental concepts

Idealizations:

- <u>Particle</u>:

- <u>Rigid Body</u>:

- <u>Concentrated Force</u>:

Understanding and applying these things allows for amazing achievements in engineering!

General procedure for analysis

1. Read the problem carefully; write it down carefully.

2. MODEL THE PROBLEM: Draw given diagrams neatly and construct additional figures as necessary.

3. Apply principles needed.

4. Solve problem symbolically. Make sure equations are dimensionally homogeneous.

5. Substitute numbers. Provide proper units *throughout*. Check significant figures. Box the final answer(s).