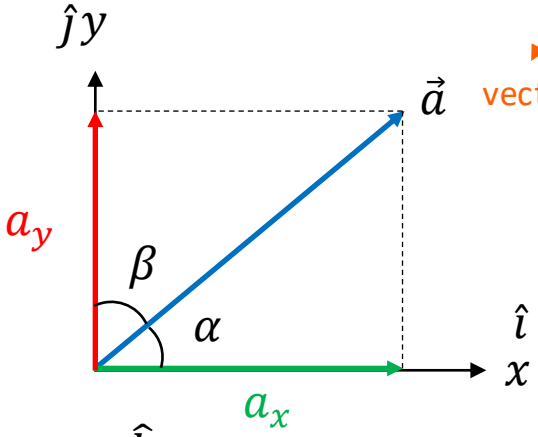
Week 2

ILLINOIS

TAM 210/211 Introduction of Statics

WEEK 2 – Vectors

- **What is a vector?**
  - A physical quantity with **magnitude** and **direction**



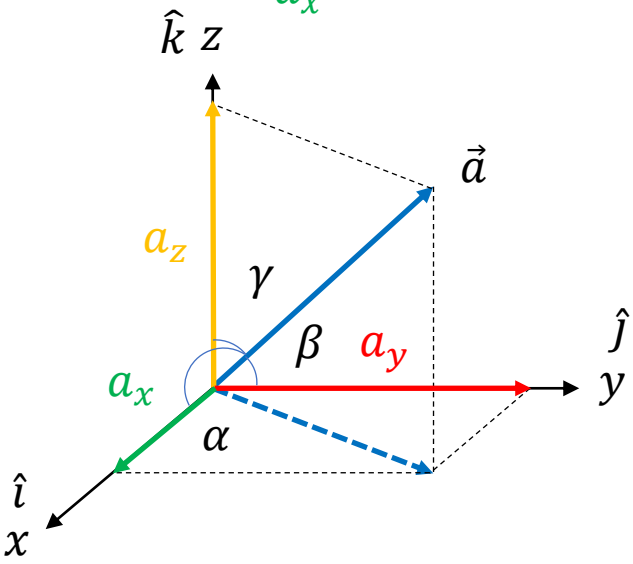
vector $\vec{a} = [a_x, a_y]$ scalar

$$\vec{a} = a_x\hat{\imath} + a_y\hat{\jmath}$$

$$= |\vec{a}|\cos\alpha\,\hat{\imath} + |\vec{a}|\cos\beta\,\hat{\jmath}$$

$$|\vec{a}| = \sqrt{a_x^2 + a_y^2} \quad \alpha = \tan^{-1}\frac{a_y}{a_x}$$

magnitude direction

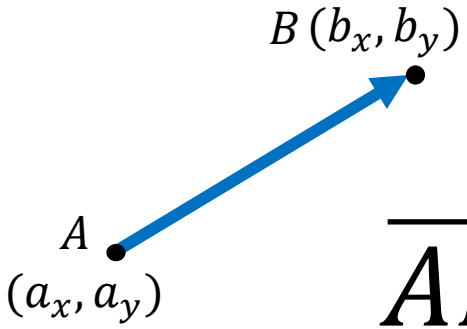


$$\vec{a} = [a_x, a_y, a_z]$$

$$\vec{a} = a_x\hat{\imath} + a_y\hat{\jmath} + a_z\hat{k}$$

$$= |\vec{a}|\cos\alpha\,\hat{\imath} + |\vec{a}|\cos\beta\,\hat{\jmath} + |\vec{a}|\cos\gamma\,\hat{k}$$

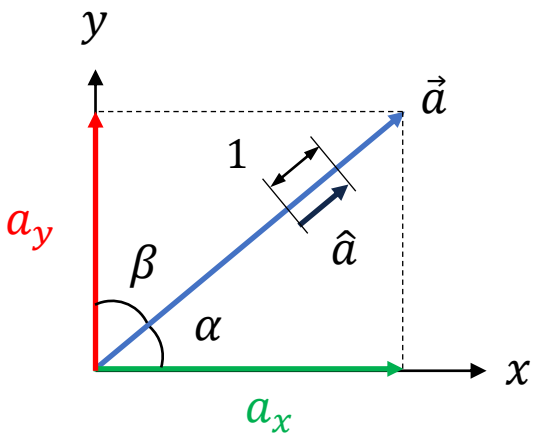
$$|\vec{a}| = \sqrt{a_x^2 + a_y^2 + a_z^2}$$



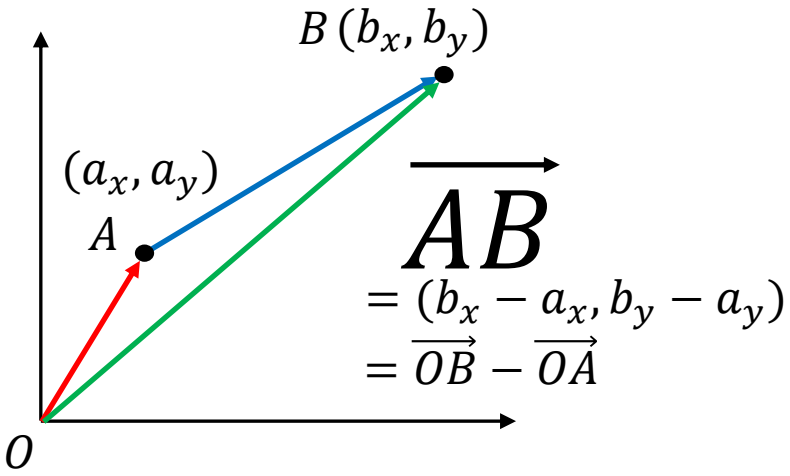
$$\overrightarrow{AB} = (b_x - a_x, b_y - a_y)$$

WEEK 2 – Vectors

- **Unit vector**
  - A vector which has **the magnitude of 1**



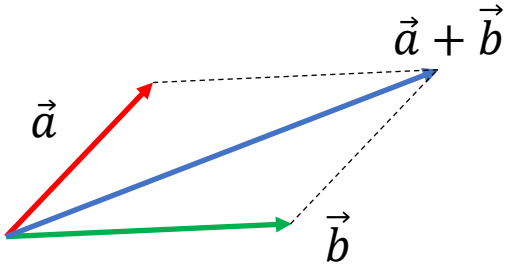
$$\hat{a} = \frac{\vec{a}}{|\vec{a}|} \qquad |\hat{a}| = 1$$

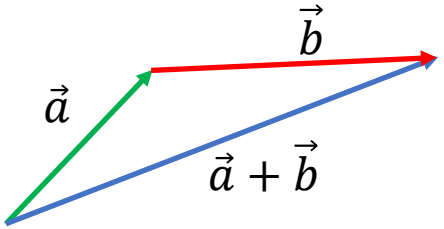


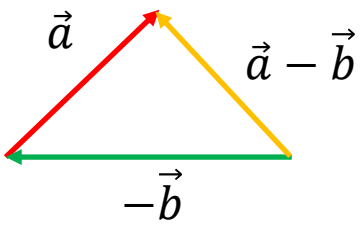
$$\overrightarrow{AB} = (b_x - a_x, b_y - a_y)$$
$$= \overrightarrow{OB} - \overrightarrow{OA}$$

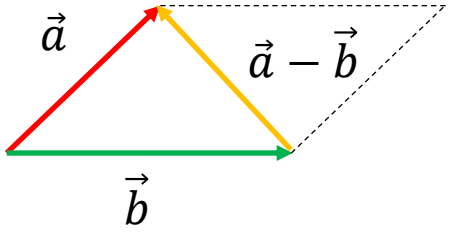
- **Vector operation**
  - Addition and subtraction

$$\vec{a} = a_x\hat{\imath} + a_y\hat{\jmath} + a_z\hat{k}$$
$$\vec{b} = b_x\hat{\imath} + b_y\hat{\jmath} + b_z\hat{k}$$
$$\vec{a} \pm \vec{b} = (a_x \pm b_x)\hat{\imath} + (a_y \pm b_y)\hat{\jmath} + (a_z \pm b_z)\hat{k}$$









WEEK 2 – Vectors

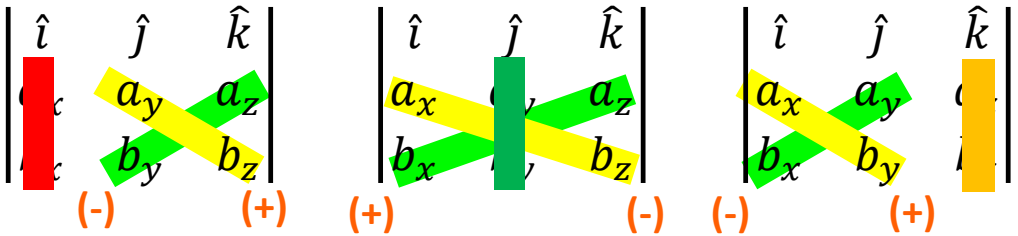
- **Vector operation**
  - Dot product and cross product

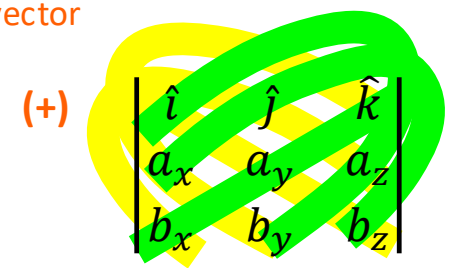
$$\vec{a} = a_x\hat{\imath} + a_y\hat{\jmath} + a_z\hat{k}$$

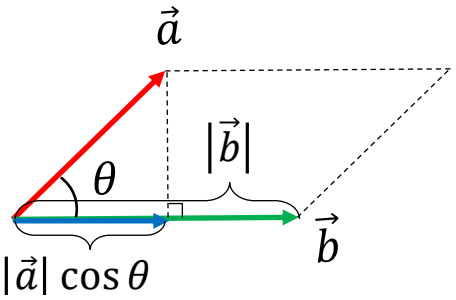
$$\vec{b} = b_x\hat{\imath} + b_y\hat{\jmath} + b_z\hat{k}$$

$$\vec{a}\cdot\vec{b} = a_xb_x + a_yb_y + a_zb_z = |\vec{a}||\vec{b}|\cos\theta$$ scalar

$$\vec{a}\times\vec{b} = (a_yb_z - a_zb_y)\hat{\imath} - (a_xb_z - a_zb_x)\hat{\jmath} + (a_xb_y - a_yb_x)\hat{k}$$ vector



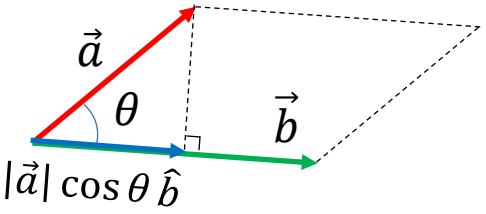


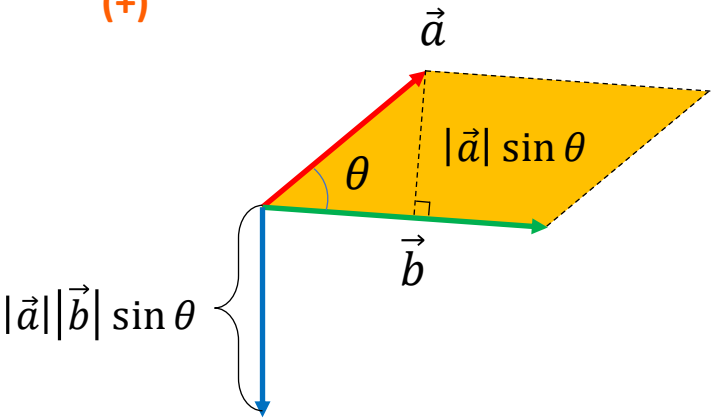


  - Projection

$$proj(\vec{a},\vec{b}) = \frac{\vec{a}\cdot\vec{b}}{|\vec{b}|}\hat{b} = (\vec{a}\cdot\hat{b})\hat{b}$$

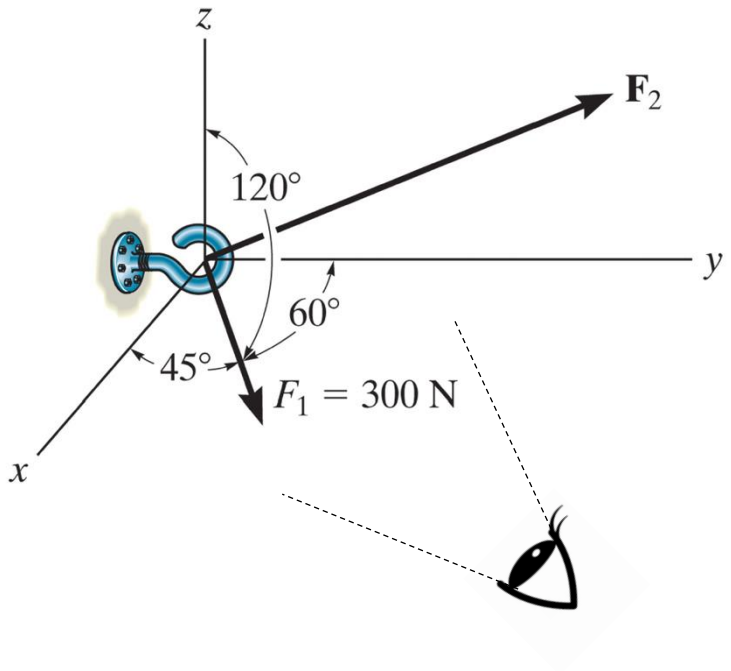
vector

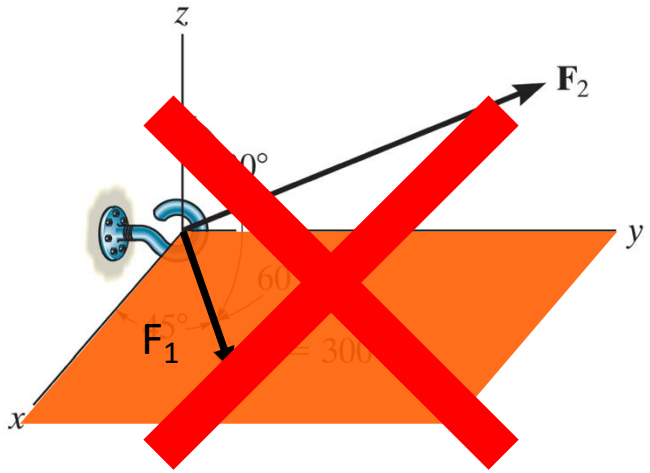


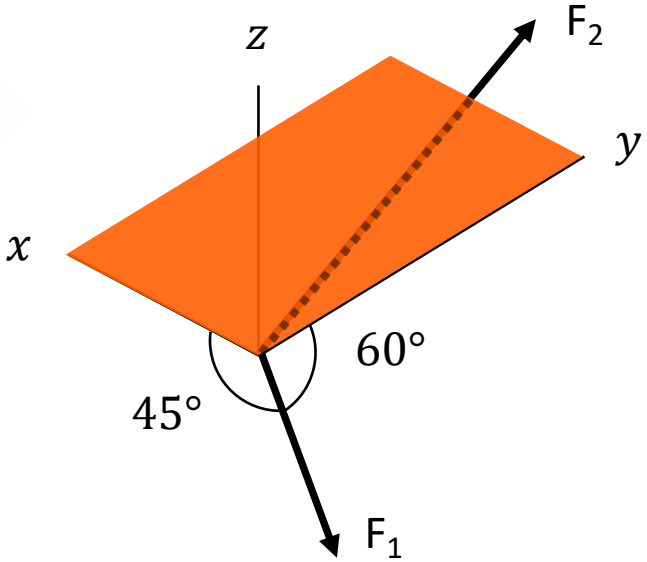


WEEK 2 – Vectors

- **Clarification**







WEEK 2 – Vectors

- Go to PrairieLearn and access to **'Disc2 – Worksheet 2 – Vector Operations'**
- Click **Disc2.1 Discussion 2: Vector Operations**
- Open workspace 

- **VectorOperations.ipynb** → today's activity
- #grade → fill out the box

```
#grade (Write your code in this cell and do NOT delete or edit this line)
vectorA = np.array([9, -5, 0])
vectorB = np.array([-2, 4, 0])

#Find the resultant vector C
vectorC = ...

#Find the magnitude and direction, theta (degrees), of C
C_mag = ...
theta = ... #degrees
```

- Save the notebook **([File] – [Save Notebook])**, go back to the PrairieLearn
- page, and click **Save & Grade**

Don't use GPT!