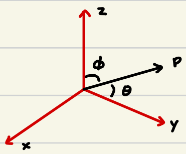
Expressing vector in 3D spaces

easiest way to resolve is by breaking vector in its components (rectangular cordinates)

Similar to 2D vector representation, we can use angles or side lengths. However, it is slightly more tricky as it takes a different method to resolve into components

angles (in 3D)



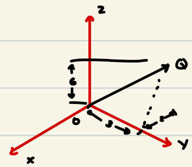

In order to resolve into components with angles, we need the angle between the z axis ($\phi$) and angle betwen y ($\theta$) * REMEMBER axis are arbitrary so may not always be z/y axis'!

z component: $P\cos\phi$

y component: $P\sin\phi\cos\theta$

x component: $P\sin\phi\sin\theta$

lengths (3D)



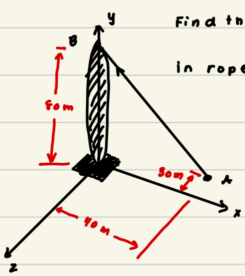

To resolve with length, we find $\lambda$ which is the unit vector of our force

$$\vec{Q} = Q \frac{\vec{OQ}}{|\vec{OQ}|}$$

magnitude ↑ direction ↑

$$\vec{Q} = Q \frac{\langle -2, 3, 6 \rangle}{\sqrt{2^2+3^2+6^2}}$$

Example (3D)




Find the components of the tension in rope AB given the force = 2500N

① Find our unit vector $\vec{\lambda}_{AB}$

- Find the cordinates point A and point B

$A(40,0,-30)$ ; $B(0,80,0)$

- Find $\vec{AB}$ (B-A)

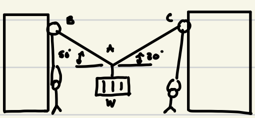
. $\vec{AB} = \langle 0-40, 80-0, 0+30 \rangle \rightarrow \langle -40, 80, 30 \rangle$

- Find $|\vec{AB}|$ $|\vec{AB}| = \sqrt{40^2+80^2+30^2}$

② multiply magnitude & direction

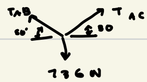
$$\vec{F}_{AB} = 2500 \frac{\langle -40, 80, 30 \rangle}{\sqrt{40^2+80^2+30^2}}$$

Example (2D)




Draw FBD given $W = 736\,N$

① FBD




Note: Since tension is pulled from 2 sides, we'll have 2 tension forces

Solving would just add all y together, all x together. Pay attention to direction ($T_{AB}$ has a negative x and W has a negative y)

# CHAPTER 3: RIGID BODIES; EQUIVALENT SYSTEMS OF FORCES

External Forces: forces of the system as a whole

Internal Forces: Forces within the system; not forces applied/affected externally

internal forces will not be looked at until later

Principle of transmissibility: moving force on the body won't affect the equilibrium/motion

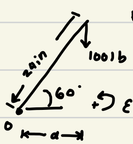
If you know equilbrium, then we can use such principle to simplify calculations

## Vector Products: moment of a force

To find the moment, we find cross product of distance and force. (2D will just be Fd)

Total moment of system = find cross product of each force and its distance from point you are taking a moment about and adding them. Remember that the direction the force would cause rotation about point = determine +/-. I will be using counterclockwise as + (denoted as ↺)

### Example (2D)




Find moment about point O

we must first find d (distance of force from O)

$+\circlearrowleft \Sigma M_O = 100 \cdot d \quad d = 24\cos 60 = 12$

$= -1200 \text{ lb}\cdot\text{in}$

## Equivalent systems

In a equivalent system, we must not set our equations of each component = 0.

we are simply trying to find resultant of all forces

CHAPTER 4: EQUILIBRIUM OF RIGID BODIES

**Reaction forces**: Single forces extered on rigid Bodies by Surface. unknown direction + magnitude

CHAPTER 5: DISTRIBUTED FORCES; centriod & center of gravity

$\bar{x} = \frac{\Sigma \bar{x} dA}{\Sigma dA}$ $\bar{y} = \frac{\Sigma \bar{y} dA}{\Sigma dA}$ - can also use double integration

- Simple Shapes can avoid integration by looking at composite shape table.

**Theorem of Pappus-Guldinus**: surface generated w/ rotation about an axis

$A = 2\pi \bar{y} L$

$V = 2\pi \bar{y} A$

**Distributed forces**: Breakdown into shapes, find magnitude + whe force applied & treat as anyother force

CHAPTER 6: ANALYSIS OF STRUCTURE

**TRUSS**: Structure with only force applied at the joints.

Composed of **two member forces** (only force at the ends). Helps solved b/c no need to draw structure but rather just resolved as equal opposite force

| **method of Joints** | **method of section** |
|---|---|
| one way to find force of each member of structure where you look at each individual joint and use equalibrium equation to solve. | easier to use if you only want to find the force of specific members. This method would allow you to cut the truss and simplify cut members as just the force |

**machines and frames**: They are different but same method to solve for forces for both system.

Difference from truss = force can be applied on the member (not just joint)

To solve, usually good to find global equilibrium then break system into parts to resolve for unknown forces

* remember to simplify with two member force

* force appear in different parts should be equal and opposite.

CHAPTER 8: FRICTION

In statics, we focus on only friction that is before kinetic friction

Friction: resistance to motion between surfaces

Friction $= \mu_s N$

coefficient of friction (static) — Normal force

- Friction is dependant force so it can be written with normal force with $\phi$ being angle result from friction and normal force $\phi = \tan^{-1}(\mu_s)$