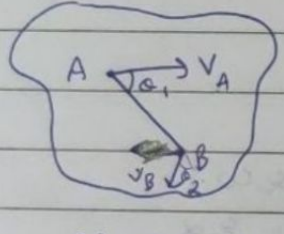
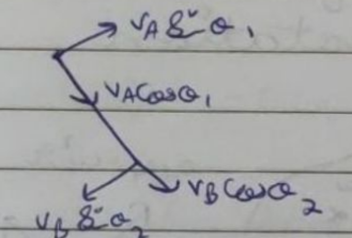
Rotation

Rigid body.

• Rigid body is a system of particles in which distance b/w each pair of particles don't vary with time.



Rigid body.



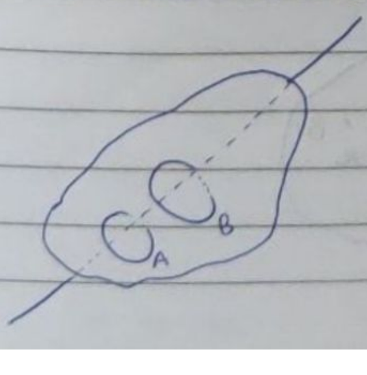
• $V_A \cos\theta_1 = V_B \cos\theta_2$

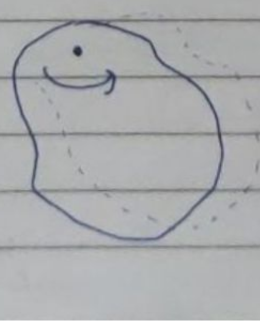
• w.r.t any particle motion of other particle is circular

Rotation

• A rigid body is said to be in pure rotation if every particle of the body moves in a circle and centers of all circles lie on a straight line called axis of rotation.

• All points in body which are ⊥rd to axis of rotation turn through the same angle in same time interval.





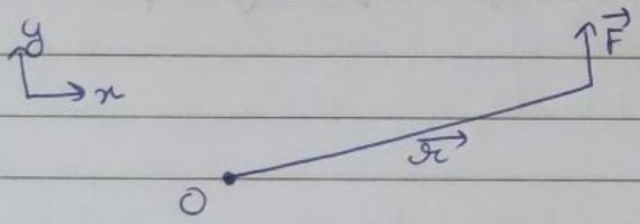
TORQUE

→ It is moment of force

→ $\vec{\tau} = \vec{r} \times \vec{F}$

→ $\vec{\tau} = \frac{d\vec{L}}{dt}$ = Rate of change of angular momentum.

→ for finding direction we use right hand rule. from $\vec{r} \times \vec{F}$ right hand thumb shows the direction of axis along which τ acts and ~~right~~ fingers of right hand curl in direction of motion that torque tends to cause.

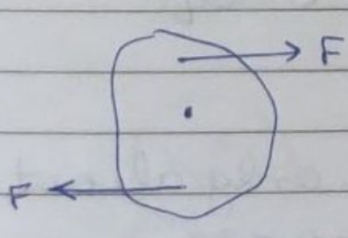


Axis Along which τ acts is along $\hat{k}$. Rotates about O in anti-clockwise sense.

Force Couple system.

→ Two equal and opposite forces whose lines of action don't concide makes a couple.

Eg



τ about any point in a couple system remains same.

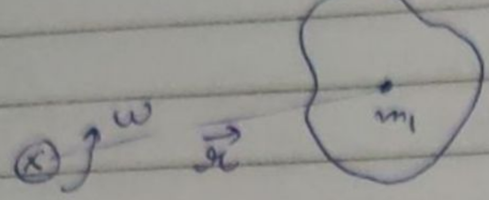
Angular Momentum

→ It is defined as moment of linear Momentum

$$\vec{L} = \vec{r} \times \vec{P}$$

→ L has a direction same as that of ω

→ Sometimes in Q, angular momentum magnitude remain same but direction is varying. Beaware of such Q.



$$dL = m_1 \vec{r} \times \vec{P}$$
$$dL = \vec{r} \times (m_1 \vec{\omega} \times \vec{r})$$
$$dL = m_1 (r^2 \vec{\omega} - (\vec{\omega} \cdot \vec{r}) \vec{r})$$

→ zero because ω, v, r are ⊥rd to each other

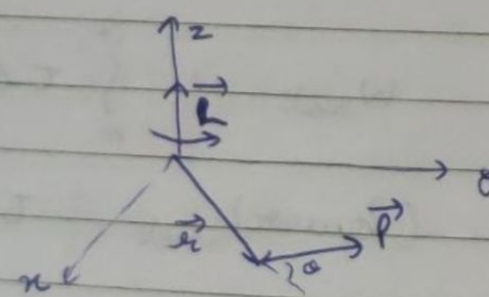
$$dL = m_1 r^2 \vec{\omega}$$

$$\vec{L} = \Sigma dL = \Sigma m_1 r^2 \vec{\omega} = \vec{\omega} \Sigma m_1 r^2$$

$$\boxed{\vec{L} = I \vec{\omega}}$$

→ only valid when $\vec{\omega}$ and $\vec{r}$ are ⊥rd to each other.

- Direction of Angular Momentum



direction of both ω & L are same and given by right hand rule.

Q

The particle P is executing circular motion. Is Angular Momentum

No.