

Momentum & Forces

Momentum : A physical quantity to express the difficulty to stop a moving object

$$p = m \times v$$

Newton's second law of motion

The net force acting on an object is the rate of change of its momentum

$$F = \frac{mv - mu}{t}$$

Law of conservation of momentum

For an isolated system, the total momentum of a system is conserved

Isolated system : no external forces act in the direction of motion

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$$

Relative Velocity

relative velocity of approach = -relative velocity of separation

$$U_A - U_B = -(V_A - V_B)$$

For inelastic collision:

- Conservation of momentum
- Conservation in K.E.

For elastic collision:

- Conservation of momentum
- **NO** conservation in K.E.

Energy lost as work done against friction

2D collisions

1. Resolve velocities
 2. Apply conservation of linear momentum
 - Total momentum in y direction before collision = after collision
 - Total momentum in x direction before collision = after collision
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Newton's First Law Of Motion

- A mass at rest remains at rest until it is affected by an external force
- A mass in motion remains in motion until it is affected by an external force

Inertia : The property of resisting the change in state.

Newton's Third Law Of Motion

For every Action there is a reaction Equal and opposite in direction

Forces

$$F = ma$$

- Force does not change the mass
 $\frac{d}{da}ma = m \rightarrow$ mass is the gradient

Types Of Forces

1. **Weight**
2. **Reaction**
3. **Tension**
4. **Upthrust**
5. **Resisting** (Friction, Air Resistance, Viscosity)

Weight

Definition : The gravitational force acting downwards on an object

$$W = mg$$

mass : Its the content of matter in an object, in proportion to it's inertia

Upthrust

It is an **Upward** force due to the pressure difference of pressure between the top and the bottom of the submerged object

$$P = \rho gh$$

$$F = \rho gV$$

Size of the upthrust force = the weight of liquid displaced

Resisting / Friction

A force that opposes relative motion

$$R \propto v$$

Differences

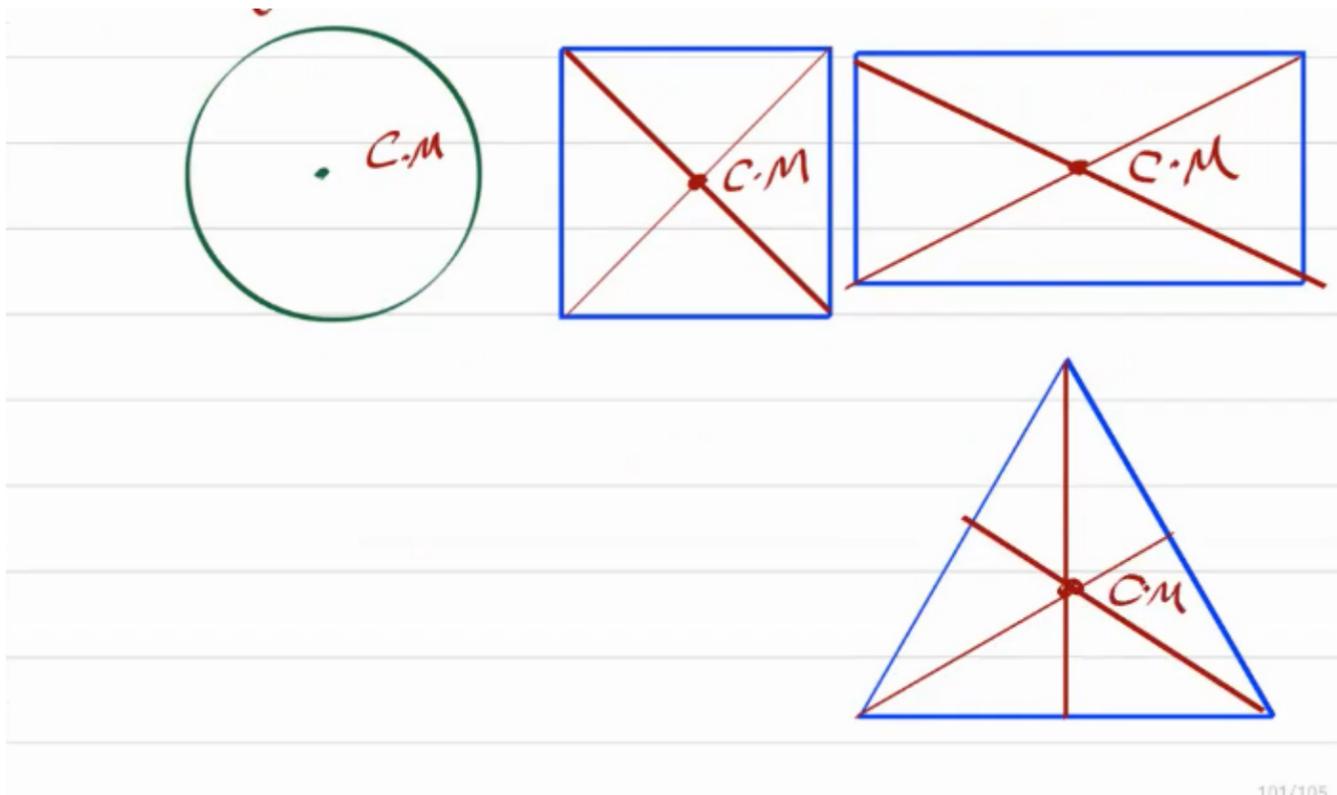
Reaction \rightarrow 2 solids

Resisting \rightarrow Motion

Upthrust \rightarrow 2 fluids

Center of mass

Definition : The point through which the mass of an object is considered to be concentrated in.



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- For 3 forces to be at equilibrium
 1. The 3 lines of action must intersect at one point
 2. The 3 forces should form a closed triangle

Moment

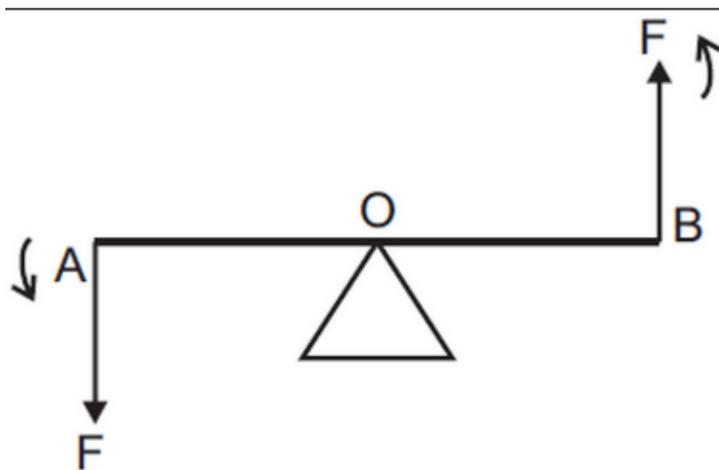
Definition : It is the turning effect of a force around a pivot.

$$\text{Moment} = F \times \perp d$$

Torque

Definition : Turning effect of a couple

Couple : 2 equal opposite forces not on the same line of action



$$\text{Torque} = F \times \perp d$$

3 conditions for equilibrium

1. Net Force = Zero
2. Net Moment = Zero
3. Net Torque = Zero