1.5 MOMENT and MOMENTUM

Moment of a force

Moment of a force This is the Product of force and its Perpendicular distance from the Pivot.

Moment = Force X distance

Moment= Fxd

Its units are Nm (Newton meter)

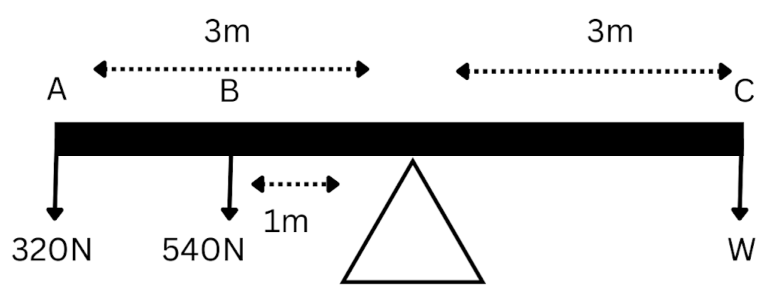
The law of moments (Law of the lever) states that:

When a body is in equilibrium, the sum of the clockwise moments About any point equals the sum of anticlockwise moments about the same point. There is no resultant moment on an object in equilibrium.

Clockwise moment = anticlockwise moment

$F_1 x d_1 = F_2 x\ d_2$

Example: The seesaw balances when Shani of weight 320 N is at A. Tom of weight 540N is at B and Harry of weight W is at C. Find W.



Clockwise moment:
Moment= Fxd
Moment= 3 x W = 3W Nm

Anticlockwise moment:
Moment = (Fxd) + (Fxd) = (540X1) + (320 x3) = 540 +960
Moment= 1500 Nm

Clockwise moment= Anticlockwise moment

3W= 1500
W= 500 N

Note: The further the distance, the lesser the force needed to be used E.g the distance between the door handle and the hinge is far apart so that it does not require a lot of energy to open the door.

Conditions for equilibrium:

- The sum of forces in one direction equals the forces in the opposite direction.

- The law of the moment must apply. When there is no resultant force and no resultant moment, an object is in equilibrium.

Equilibrium: When there is no resultant force and resultant moment.

Momentum

Momentum is the product of the mass of a body and its velocity.

It is measured in Kilogram meter Per second (kg m/s)

Momentum = mass x velocity
P= mv
ΔP= Δ(mv)
P is rho

Momentum is a *vector quantity* and has both magnitude (size) and direction

The Conservation of Momentum Principle

In a closed system, the total momentum before an event like a Collision is the same as the total momentum after the event

To find the Force used to change the momentum:

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

mv is the Final Momentum
mu is the Initial Momentum
t is Time

Example 1:

Ball A has a mass of 4500 kg and its velocity is 12m/s On the other hand ball B has a mass of 1200 kg and its velocity is 20m/s. Calculate their momentum Separately, and their velocity after collision.

Ball A is moving to the right
Ball B is moving to the left.

Ball A:
P=mv = 4500 x 12 = 54,000 Kg m/s
P= + 54,000 kg m/s

Ball B:
P=mv= 1200×20 = 24000 kgm/s
P= - 24,000kg m/s

Find their momentum

Ball A + Ball B momentum.
54,000+ - 24,000
P=+30,000 kg mls
V= p/m

Find their total mass:

$m_1 + m_2 = m_{total}$
4500+1200=5700 kg
V= 30,000kg m/s / 5700 kg
V= 5.3m/s after collision.

Note: If the object is moving to the right, it has positive momentum and if it is moving to the left, it has negative momentum.

Example 2:

Calculate the force required to accelerate a 750g ball from rest to 18m/s in 0.25s.

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

V= 18 mls
m= 750 g or 0.75 kg
t=0.25s

$$F=\frac{(0.75\ x\ 18)-(0.75\ x\ 0)}{0.25}$$

$$F=\frac{13.5-0}{0.25}$$

F=54N

Impulse

Impulse is the product of force and time.

Impulse = Force x time
I = Fxt

It is measured in Newton Seconds (Ns)

Impulse = Change in Momentum
Force x Time = Mass x Velocity

A force acting on an object for a given time is equal to the mass times the change in velocity of the Object.
Force is the rate at which the momentum of an object changes.

Force $=\frac{Change\ in\ Momentum}{Change\ in\ Time}$

Force $=\frac{Mass\ x\ Velocity}{Change\ in\ Time}$

Acceleration$=\frac{Change\ in\ Velocity}{Change\ in\ Time}$

Force= m x $\frac{Change\ in\ Velocity}{Change\ in\ Time}$

Force = mass x acceleration