NDA-CDS 1 2025

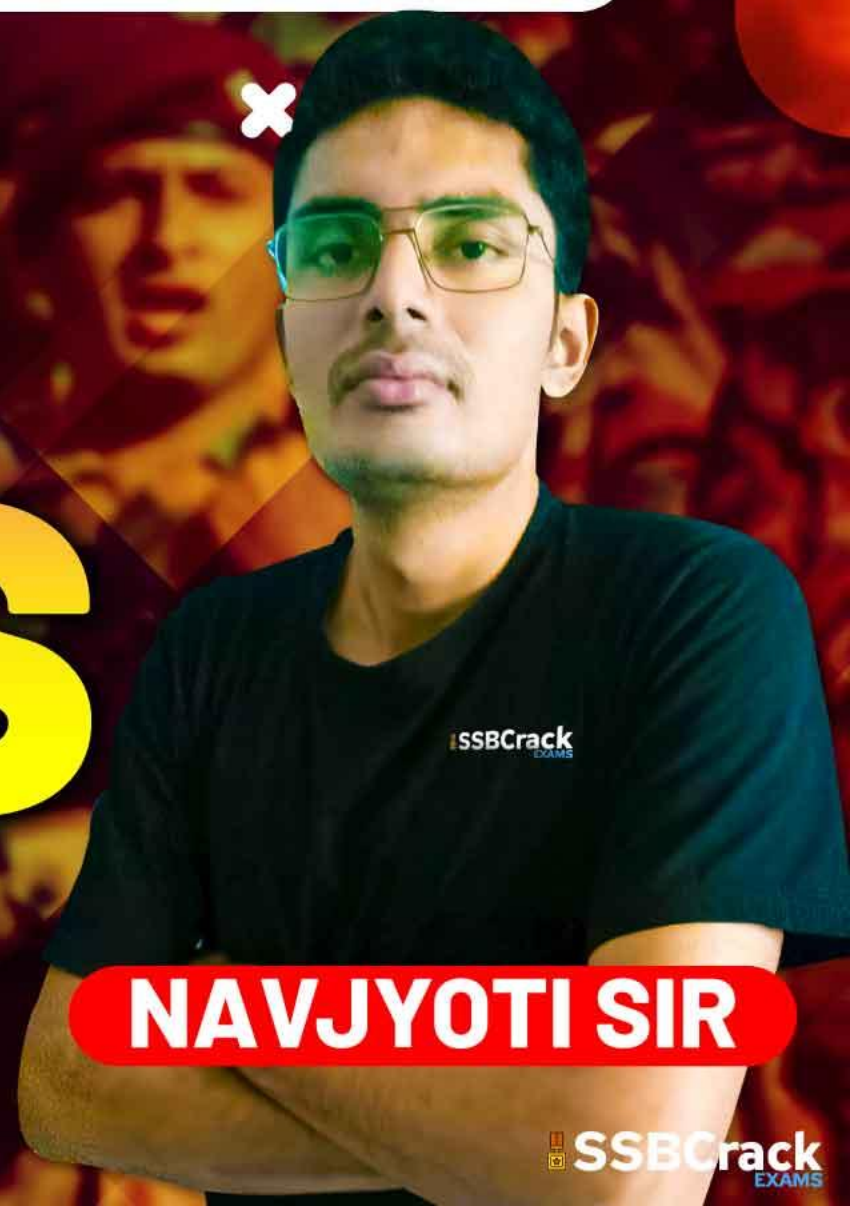
GS

LIVE

PHYSICS

FORCE & LAWS OF MOTION

CLASS 1



NAVJYOTI SIR

SSBCrack EXAMS

13 Dec 2024 Live Classes Schedule

8:00AM	13 DEC 2024 DAILY CURRENT AFFAIRS	RUBY MA'AM
9:00AM	13 DEC 2024 DAILY DEFENCE UPDATES	DIVYANSHU SIR

SSB INTERVIEW LIVE CLASSES

9:30AM	OVERVIEW OF PIQ & PERSONAL INTERVIEW	ANURADHA MA'AM

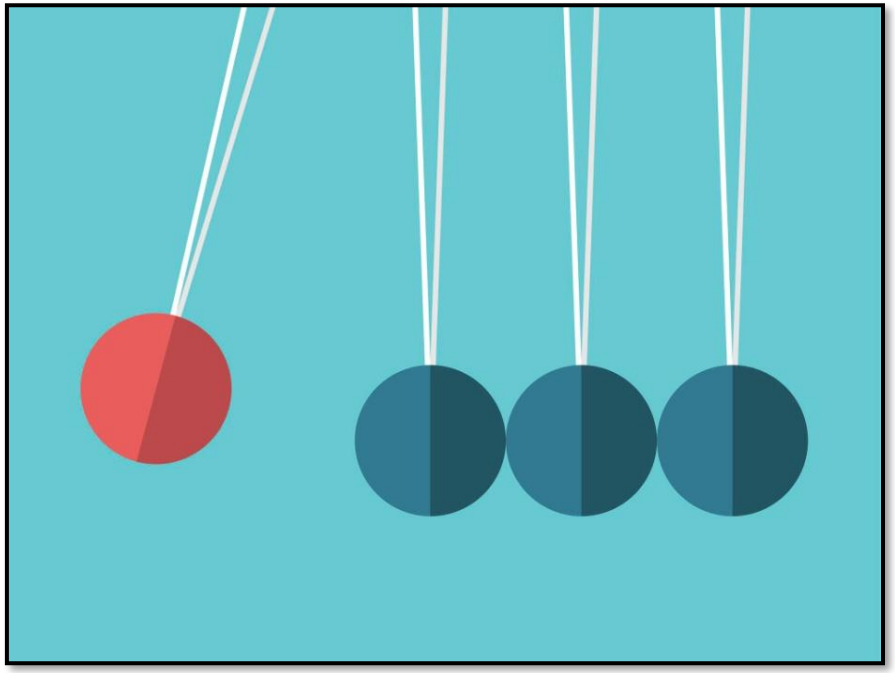
NDA 1 2025 LIVE CLASSES

1:00PM	PHYSICS - FORCE & LAWS OF MOTION - CLASS 1	NAVJYOTI SIR
4:30PM	ENGLISH - ACTIVE PASSIVE VOICE - CLASS 1	ANURADHA MA'AM

CDS 1 2025 LIVE CLASSES

1:00PM	PHYSICS - FORCE & LAWS OF MOTION - CLASS 1	NAVJYOTI SIR
4:30PM	ENGLISH - ACTIVE PASSIVE VOICE - CLASS 1	ANURADHA MA'AM

LAWS OF MOTION



WHAT WILL WE STUDY ?

- Inertia ✓
- First Law of Motion ✓
- Momentum and Force ✓
- Second Law of Motion ✓
- Third Law of Motion ✓
- Conservation of Momentum ✓

INERTIA

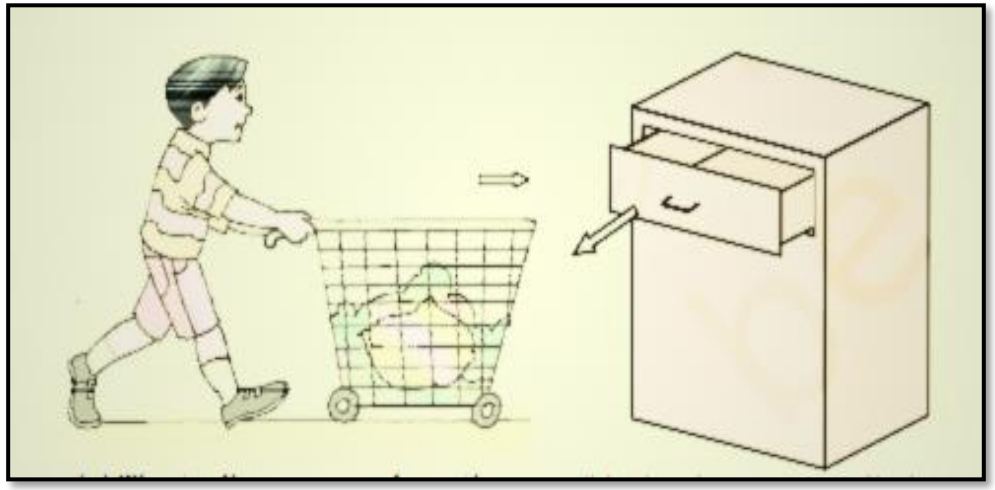
- The property of an object by virtue of which it cannot change its state of rest or of uniform motion along a straight line on its own, is called inertia.
- Greater the mass of a body greater will be its inertia and vice-versa.
- Inertia is of three types :

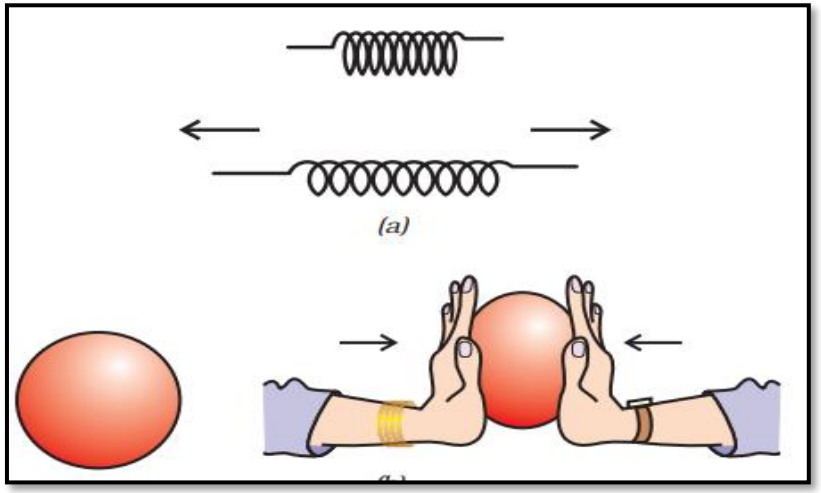
1. Inertia of Rest
2. Inertia of Motion
3. Inertia of Direction

FORCE

- Force is a push or pull which changes or tries to change the state of rest, the state of uniform motion, size or shape of a body.
- It is a vector quantity. Its SI unit is Newton (N).
- Forces can be categorised into two types:

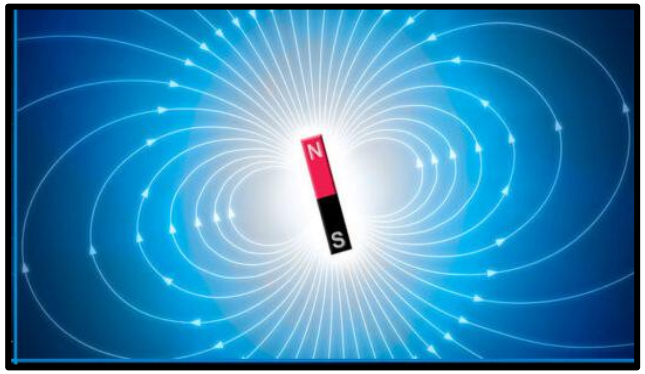
1. Contact Forces : Frictional , Spring Force etc. (that needs physical touch for application)
2. Non – Contact Forces : Gravitational , Electrostatic etc. (does not needs physical touch between the bodies)



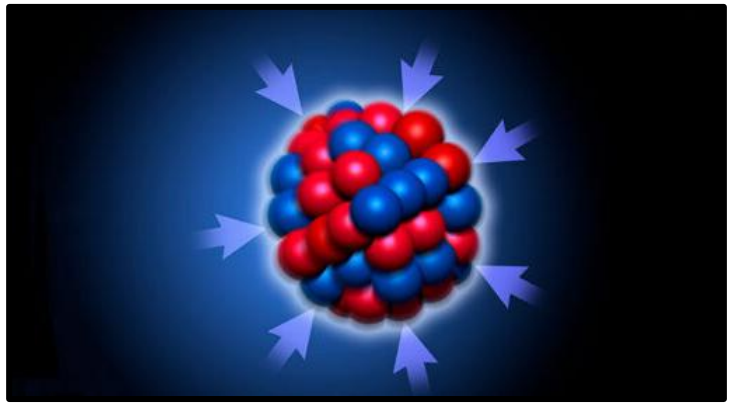


FUNDAMENTAL FORCES IN NATURE

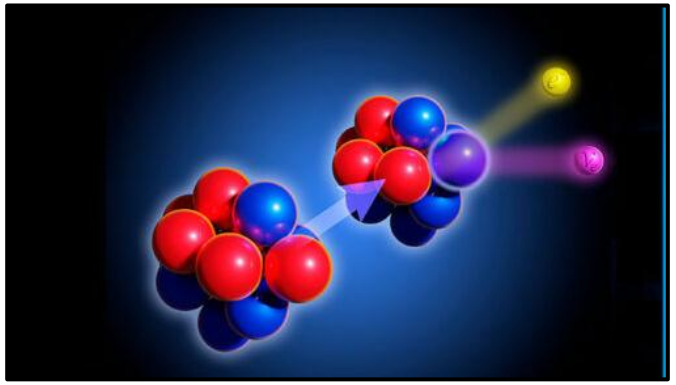
Gravitational force



Electromagnetic force



strong nuclear force (strongest)



weak nuclear force

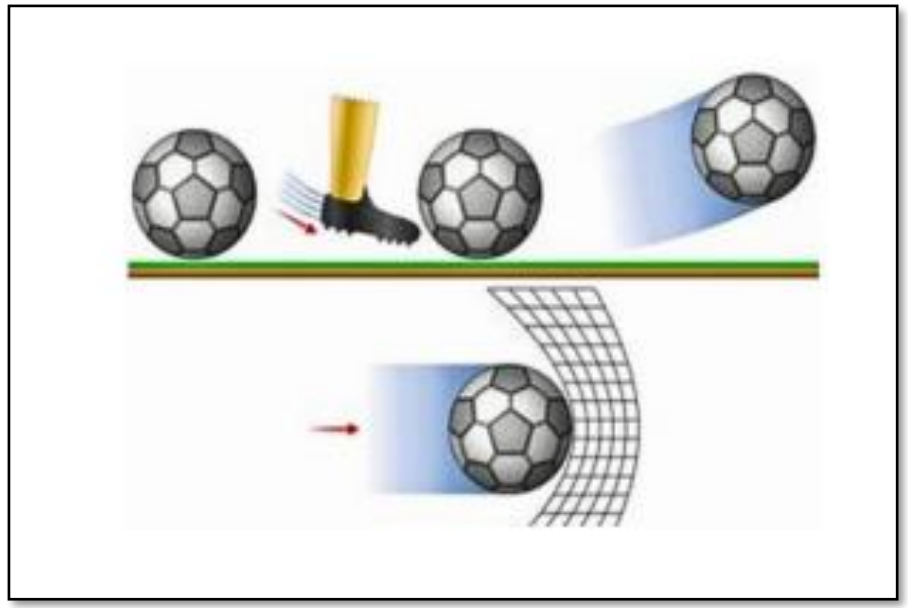
Weak nuclear forces are responsible for the **radioactive decay**, specifically the beta decay neutrino interactions.

MOMENTUM

- The total amount of motion present in a body.
- Linear momentum of a body is equal to the product of its mass and velocity. It is denoted by p. Linear momentum, $p = mv$.
- It is a vector quantity and its direction is in the direction of velocity of the body. Its SI unit is kg m/s.

FIRST LAW OF MOTION

- A body continues to be in its state of rest or in uniform motion along a straight line unless an external force is applied on it.
- This law is also called law of inertia.



SECOND LAW OF MOTION

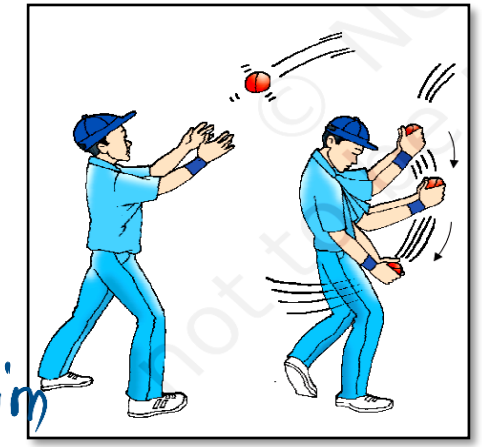
- The rate of change of linear momentum is proportional to the applied force and change in momentum takes place in the direction of applied force.

$$F \propto \frac{dp}{dt} \Rightarrow F = k\frac{dp}{dt}$$

$$F = k\frac{d}{dt}(mv) \Rightarrow F = km\frac{dv}{dt}$$

For $k = 1$; $F = m\frac{dv}{dt} = ma$

change in velocity w.r.t. time = acceleration



Force = Mass x acceleration

kg ms^{-2}

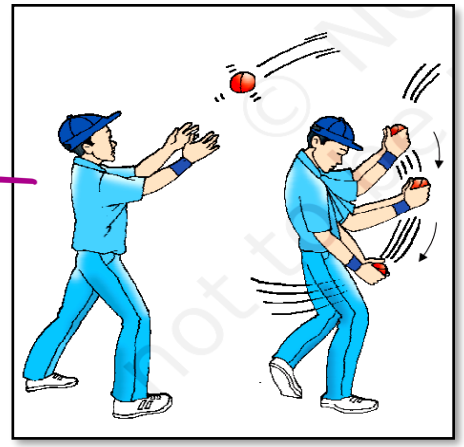
($1\ N = 1\ kg\ ms^{-2}$)

- It is easier for a person to push an empty shopping cart than a full one.

IMPULSE

- The product of Force and time for which it acts is called impulse.
- **Impulse = Force × Time = Change in momentum**
- It is a vector quantity and its direction is in the direction of force.

$f \times t$ = constant



From second law of motion,

$$F = k\frac{dp}{dt}$$

$$F = \frac{dp}{dt} \quad (\text{for } k = 1)$$

$$F = \frac{p_2 - p_1}{t_2 - t_1}$$

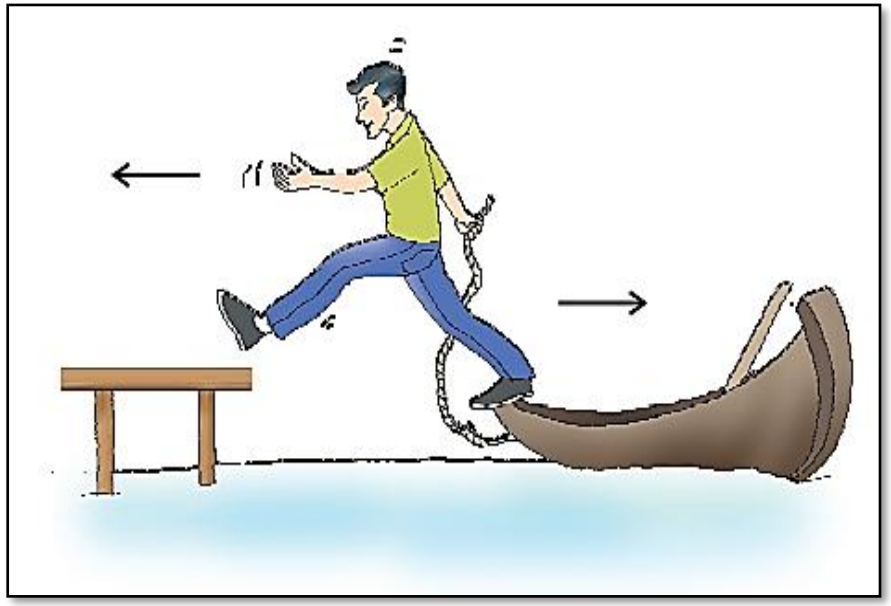
For small time interval,

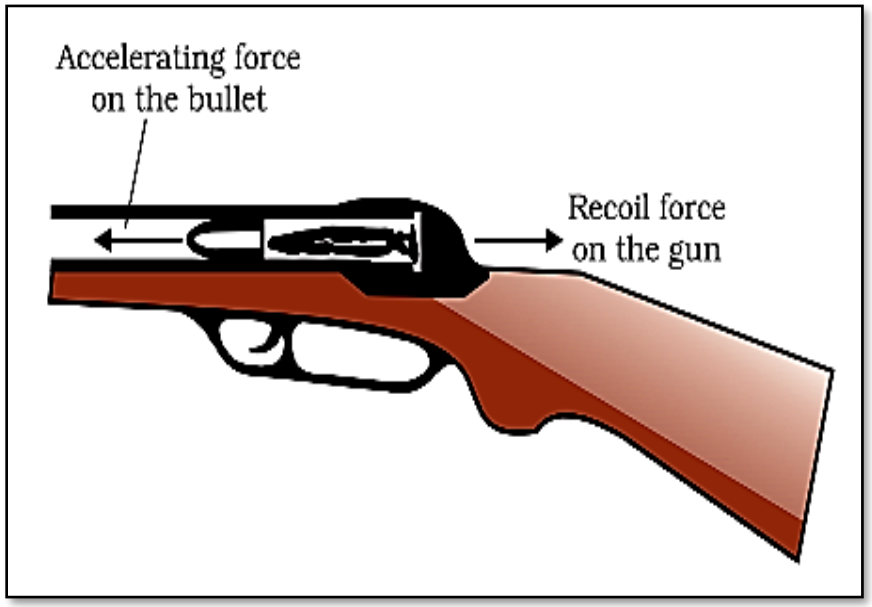
Impulse

change in momentum = F (change in time)

THIRD LAW OF MOTION

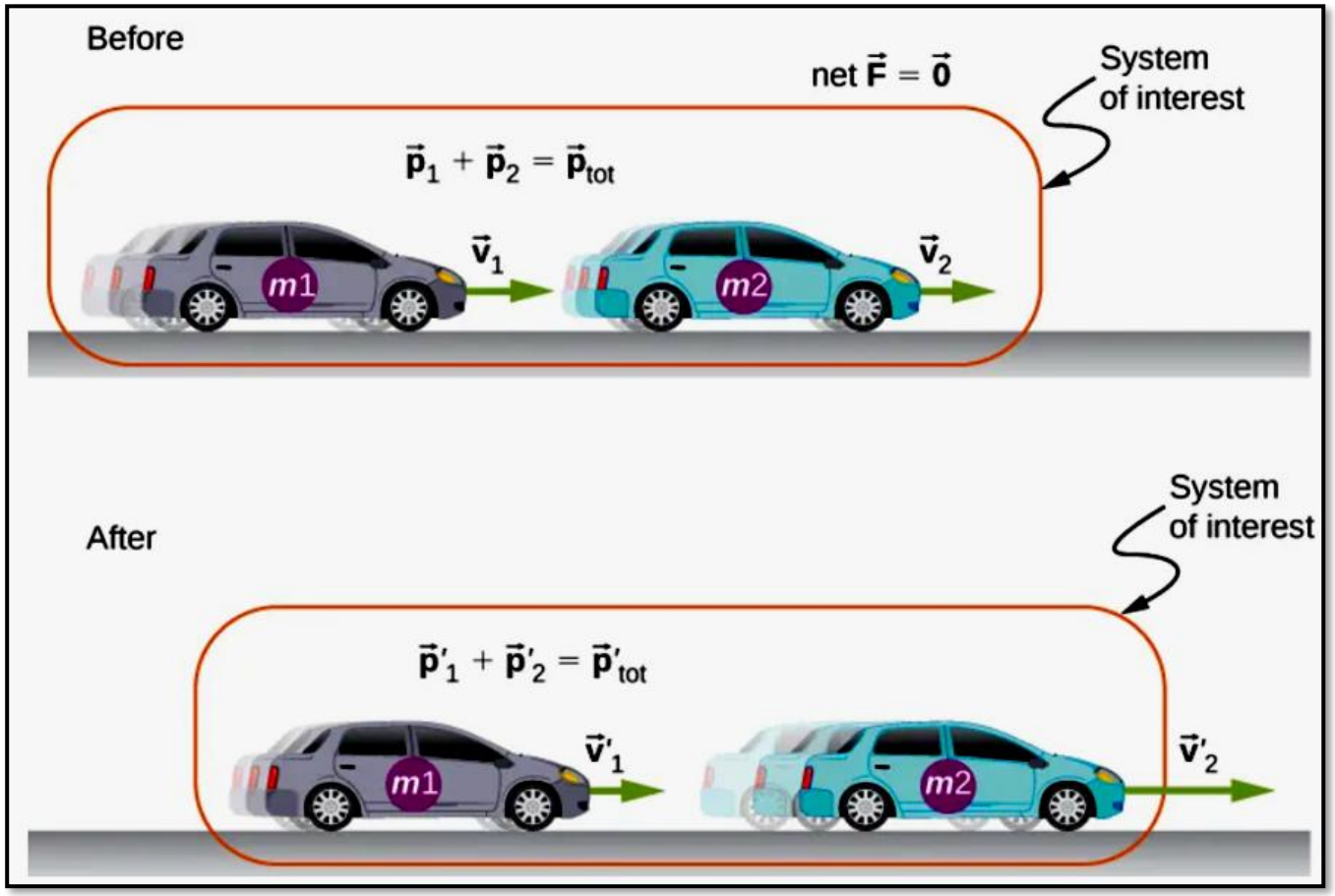
- For every action there is an equal and opposite reaction.
- Forces always occur in pairs. Force on a body A by B is equal and opposite to the force on the body B by A.
- There is no cause- effect relation implied in the third law. The force on A by B and the force on B by A act at the same instant.





CONSERVATION OF LINEAR MOMENTUM

- If no external forces acts on a system, then its total linear momentum remains conserved.



$$P_{initial} = P_{final}$$

$$P_{initial} = m_1 v_1 + m_2 v_2$$

$$P_{final} = m_1 v_1' + m_2 v_2'$$

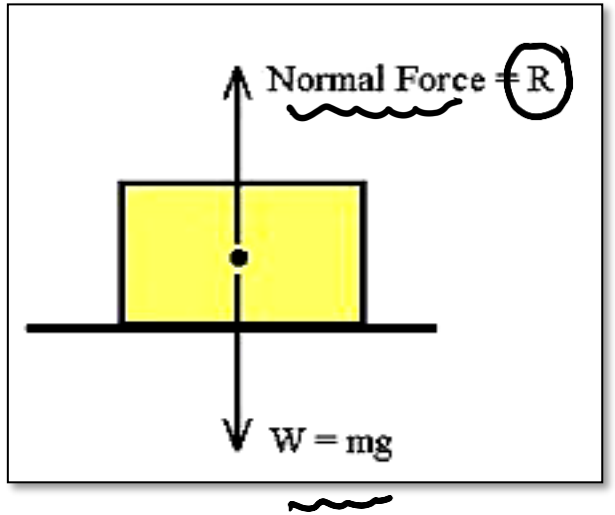
$$m_1 v_1 + m_2 v_2 = m_1 v_1' + m_2 v_2'$$

COMMON FORCES IN MECHANICS

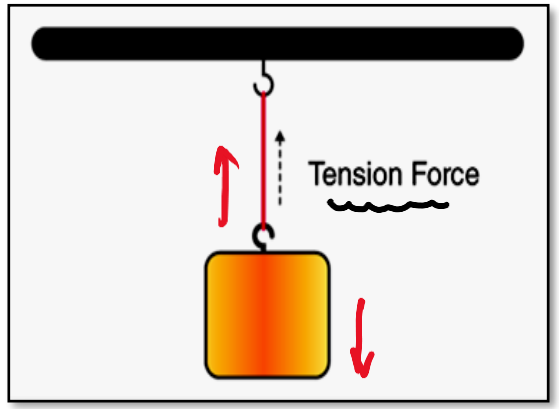
- **WEIGHT** : It is the force with which a body is pulled towards the centre of the earth due to gravity.

$W = mg$ — mass x acceleration due to gravity.

- **NORMAL REACTION** : It is the force between two surfaces in contact, which is always perpendicular to the surfaces in contact.

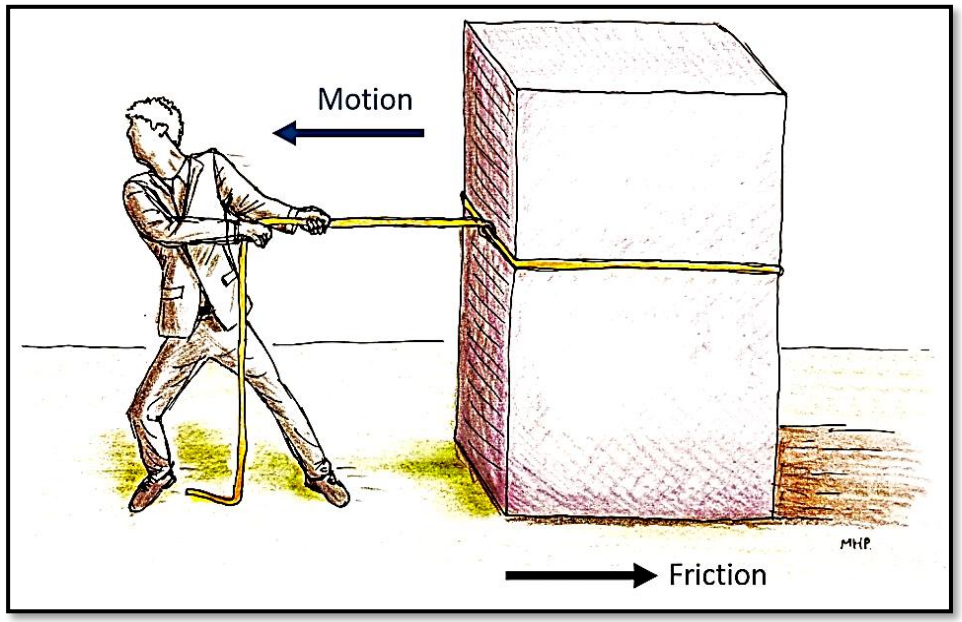


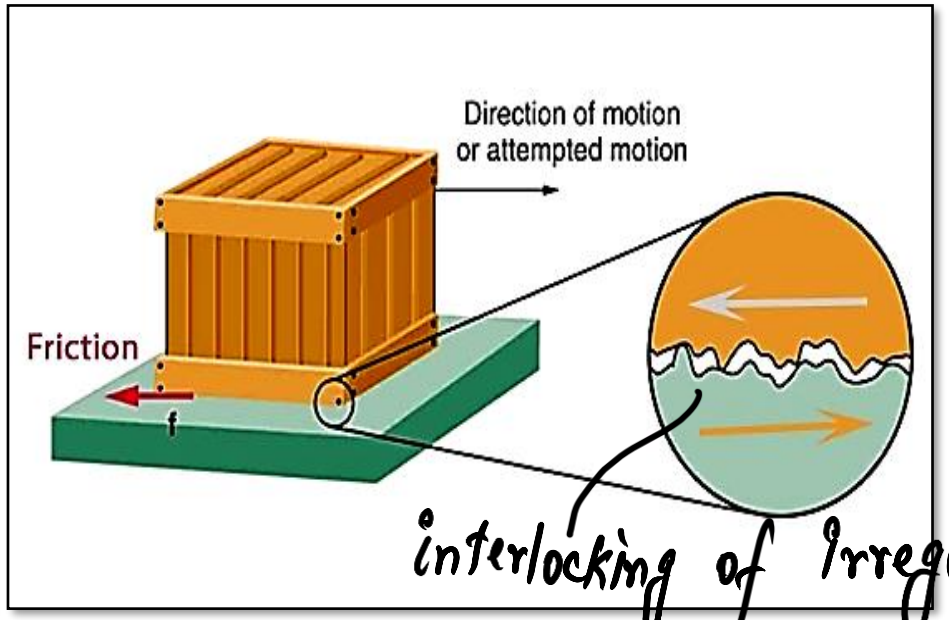
- **TENSION** : A pulling Force that stretches a material.



FRICTION

- A force acting on the point of contact of the objects, which opposes the relative motion.
- It acts parallel to the contact surfaces.
- Frictional forces are produced due to intermolecular interactions acting between the molecules of the bodies in contact.



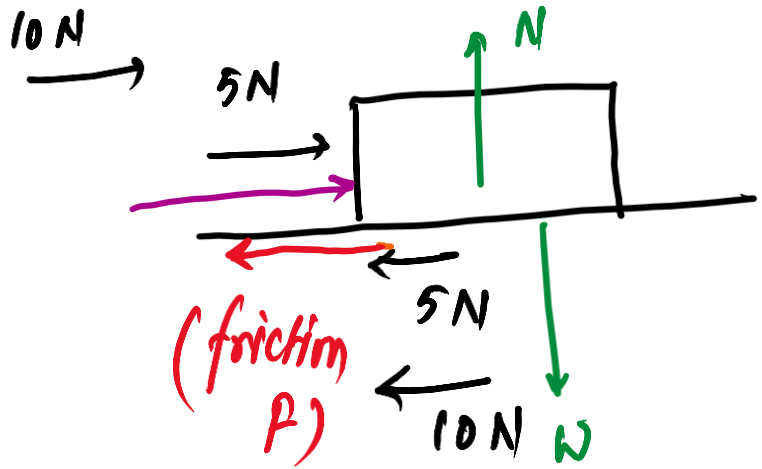


interlocking of irregularities,

TYPES OF FRICTION

1. **STATIC FRICTION : It is an opposing force which comes into play when one body tends to move over the surface of the other body but actual motion is not taking place. Static friction is a self-adjusting force which increases as the applied force is increased. Static friction opposes impending motion.**

$$f_s \leq \mu_s N$$



force of friction,

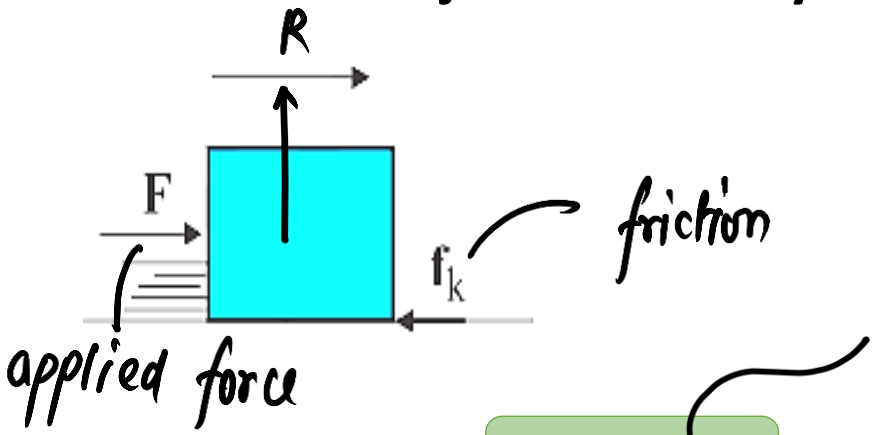
$f \propto N$ — normal reaction

$f = \mu_s N$

coefficient of static friction (different for different surfaces)

TYPES OF FRICTION

2. KINETIC OR SLIDING FRICTION : It is an opposing force that comes into existence when one object is actually moving over the surface of other object.

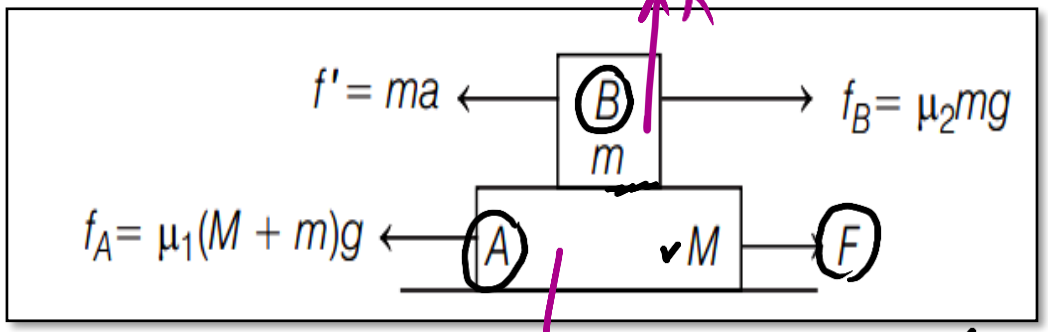


Kinetic friction $(f_k) = \mu_k R$ where, μ_k = coefficient of kinetic friction and R = normal reaction.

- As, rolling friction < sliding friction, therefore it is easier to roll a body than to slide.

Motion of Two Bodies, One Resting on the Other

Let the coefficient of friction between the given surface and body A is μ_1 and the coefficient of friction between the surfaces of bodies A and B is μ_2 . If a force F is applied on the lower body A.



$f_A = \mu_1 R$ $(R = W)$

$f_A = \mu_1 (M+m) g$ generally

W applied force - friction

Net accelerating force $F - f_A = F - \mu_1(M+m)g$

$\therefore$ Net acceleration

$$a = \frac{F - \mu_1(M+m)g}{(M+m)} = \frac{F}{(M+m)} - \mu_1 g$$

$a = \dfrac{\text{Net force}}{\text{Total mass}}$

SUMMARY

- Inertia
- Momentum , Force and Impulse
- First , Second and Third Law of Motion
- Conservation of Momentum
- Other Forces
- Friction