FORCE & IT'S TYPE

Force

Force is a push or pull applied on an object that can change **velocity**, **shape** or **size** of the object.

Electromagnetic

The force that an electromagnetic field exerts on electrically charged particles.

Gravitational

The force that attracts any object with mass. Every object, including you, is pulling on every other object in the entire universe!

Nuclear

Nuclear Force is defined as the force exerted between different nucleons. The force is attractive in nature and it binds protons and neutrons in the nucleus together.

Contact

The force that occurs between bodies due to their contact is contact force.

Electrostatic

It is defined as the attraction or repulsion of different particles and materials based on their electrical charges.

Magnetic

It's the attraction or repulsion that arises between electrically charged particles because of their motion.

Normal

The normal force is the support force exerted upon an object that is in contact with another stable object.

Tension

Tension force is a force that is exerted equally on both ends of a cable, chain, rope, wire or other continuous object and is transmitted between the ends by that object.

Friction

Friction force is the force exerted by a surface as an object moves across it or makes an effort to move across it.

Part I

LAW'S OF MOTION

First Law

Every body remains in a state of rest or uniform motion unless acted upon by a **net external force**.

Second Law

The amount of acceleration of a body is proportional to the acting force and inversely proportional to the mass of the body.

$$F = ma$$

Third Law

For every action there is an equal but opposite reaction. If an object A exerts a force on object B, then object B will exert an equal but opposite force on object A.

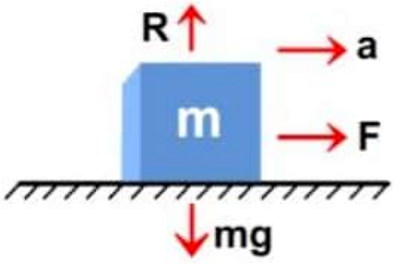
APPLICATION OF N.L.M

Part II

1 Motion of a Block on a Horizontal Smooth Surface

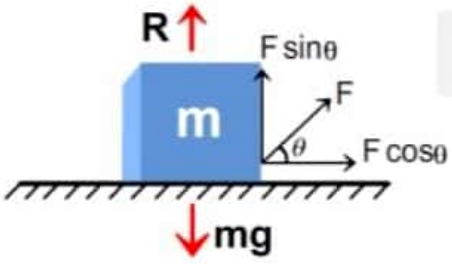
Case (i) Horizontal pull

$$F = ma \quad \text{or} \quad a = \frac{F}{m}$$



Case (ii) Pull acting at an angle (θ)

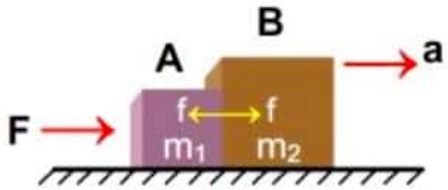
$$R + F\sin\theta = mg \qquad a = \frac{F\cos\theta}{m}$$



2 Motion of Bodies in Contact

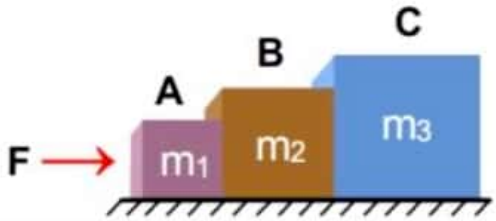
Case (i) Two Body System

$$\Rightarrow a = \frac{F}{m_1 + m_2} \quad \& \quad f = \frac{m_2 F}{m_1 + m_2}$$



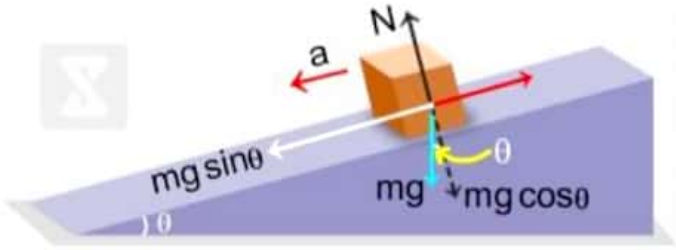
Case (ii) Three Body System

$$\Rightarrow a = \frac{F}{m_1 + m_2 + m_3}$$



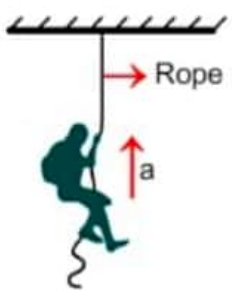
3 Motion of a Body on a Smooth Inclined Plane

$$a = g\sin\theta \qquad N = mg\cos\theta$$



4 Climbing on the Rope

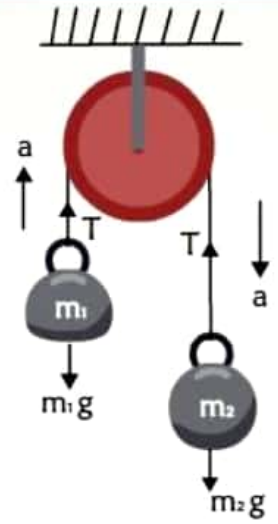
- T > mg, man accelerates in upward direction
- T < mg, man accelerates in downward direction



F.B.D of man

PULLEY BLOCK SYSTEM

1

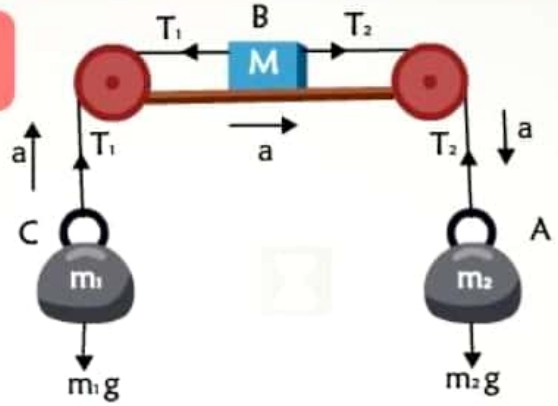


$m_2 > m_1$

$m_2 g - T = m_2 a$

$T - m_1 g = m_1 a$

2

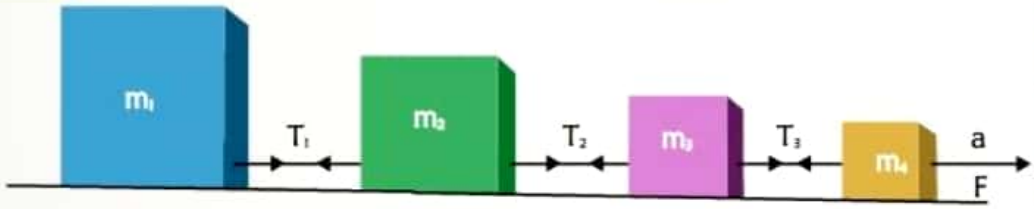


For body A, $m_2 g - T = m_2 a$

For body B, $T_2 - T_1 = Ma$

For body C, $T_1 - m_1 g = m_1 a$

3



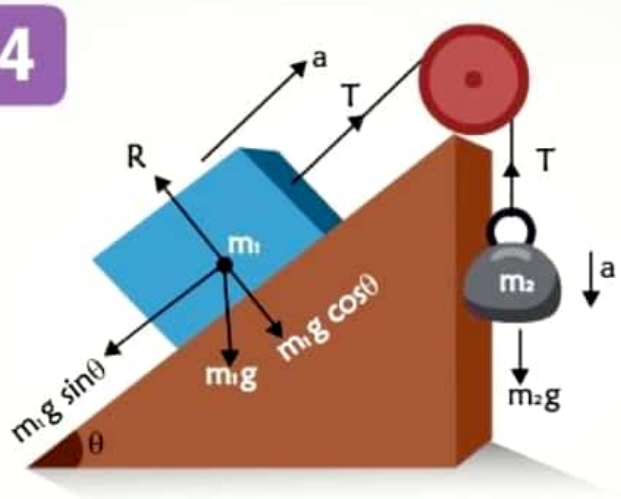
$$a = \frac{F}{(m_1 + m_2 + m_3 + m_4)}$$

$T_3 = (m_1 + m_2 + m_3)a$

$T_2 = (m_1 + m_2)a$

$T_1 = m_1 a$

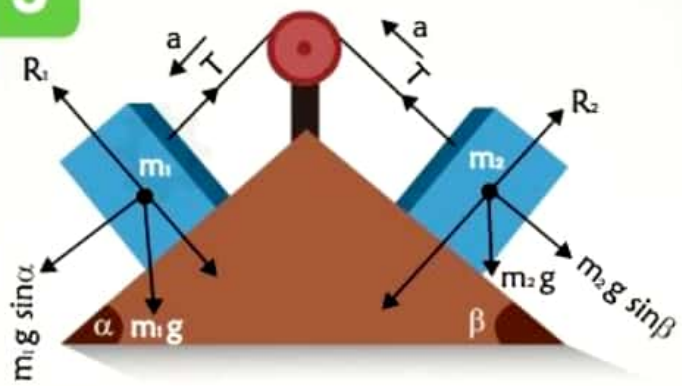
4



$m_2 g - T = m_2 a$

$T - m_1 g \sin\theta = m_1 a$

5



$m_1 g \sin\alpha - T = m_1 a$

$T - m_2 g \sin\beta = m_2 a$

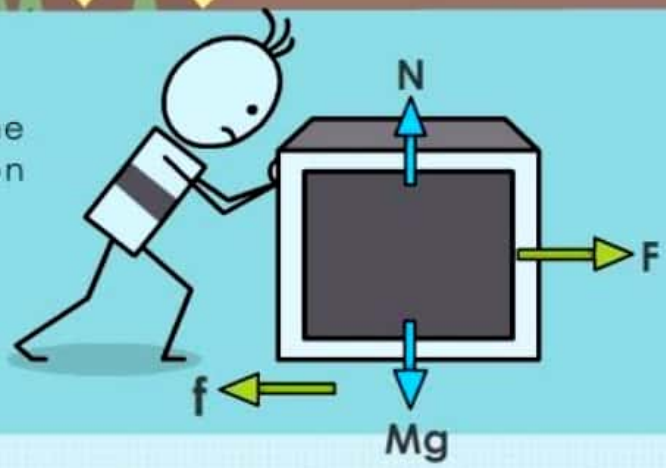
FRICTION

Part I

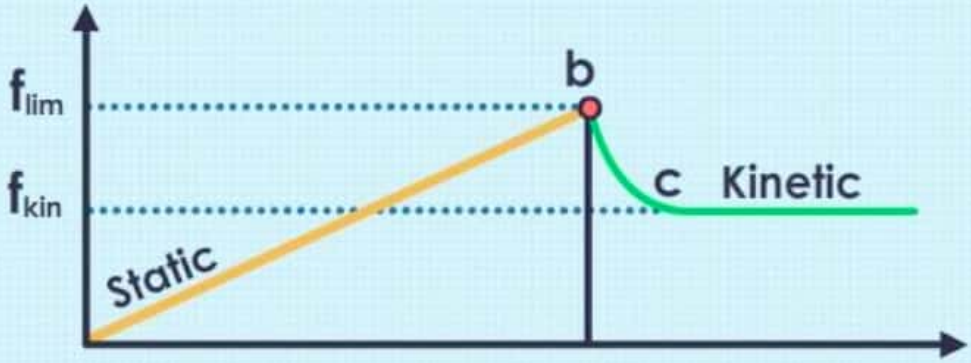
FRICTION

Friction is a contact force that opposes the relative motion or tendency of relative motion between two bodies.

$$f = \mu N = \mu mg$$



TYPES OF FRICTION FORCES



1.STATIC FRICTIONAL FORCE

The opposing force due to which there is no relative motion between the bodies in contact is called **static friction force**. It's a self-adjusting force.
Coefficient of static friction is μ_s.

2.LIMITING FRICTIONAL FORCE

The maximum frictional force that acts when the body is about to move is called **limiting frictional force**.

3.KINETIC FRICTIONAL FORCE

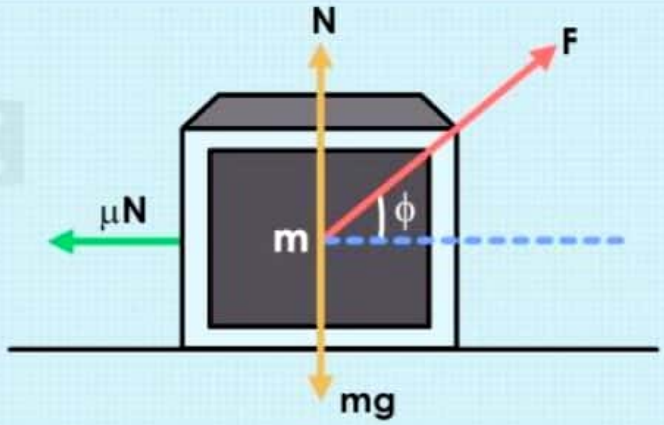
The frictional force between the surfaces in contact when relative motion starts between them is called **Kinetic Frictional Force**. Coefficient of kinetic friction is μ_k.

$$\mu_k < \mu_s$$

FRICTION

Part II

MINIMUM FORCE REQUIRED TO MOVE THE BODY



$$F_{min} = \frac{\mu mg}{1 + \mu^2}$$

N = Normal force

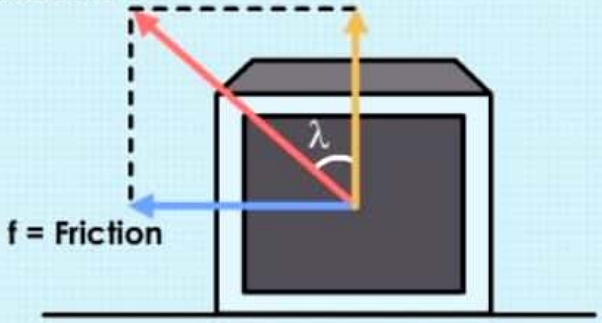
FRICTION AS A COMPONENT OF CONTACT FORCE

$$F_{c\,max} = \sqrt{\mu^2 N^2 + N^2} \quad \{\because f_{max} = \mu N\}$$

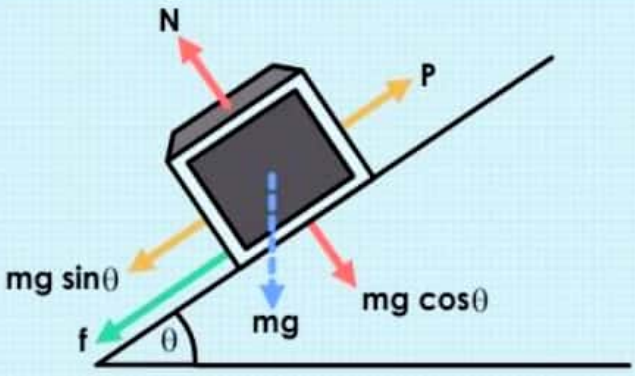
$$F_{c\,max} = N\sqrt{\mu^2 + 1}$$

F_c = Contact force

N = Normal force



MOTION ON A ROUGH INCLINED PLANE



Balancing Vertical Forces

$$N = mg\cos\theta$$

Balancing Horizontal Forces

$$f = \mu N = \mu\, mg\cos\theta$$

When sliding with acceleration 'a'

$$mg\sin\theta - \mu mg\cos\theta = ma$$

ANGLE OF REPOSE

The angle of repose is the maximum angle that a surface can be tilted from the horizontal, such that an object on it is just able to stay on the surface without moving.

or $\tan\theta_c = \mu$

where θ_c is called angle of repose.