RRB - NTPC

Mechanics C - 2

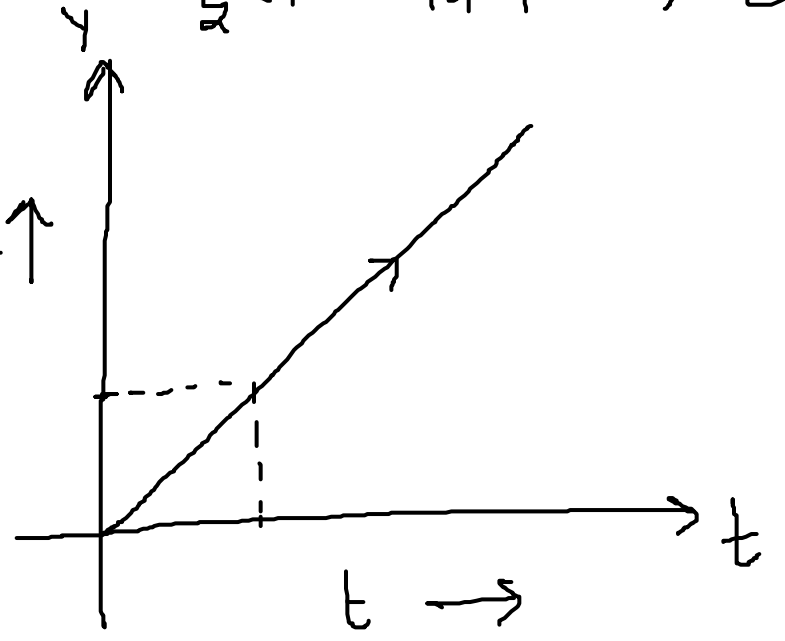
SAFALTA CLASS™

An Initiative by अमर उजाला

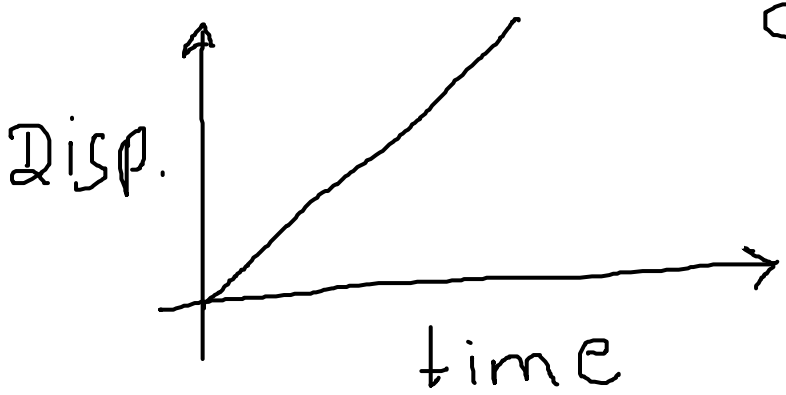
✱

① Distance - Time :- दूरी - समय ⟶ चाल

Speed ✓



② Disp. - Time :-



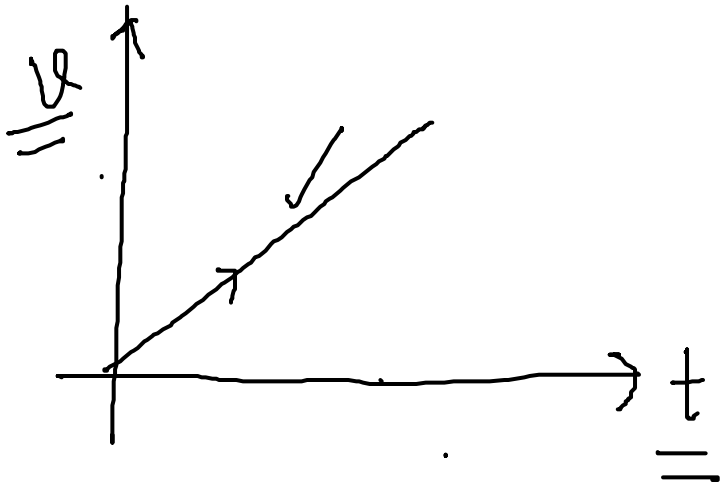
विस्थापन - समय

||

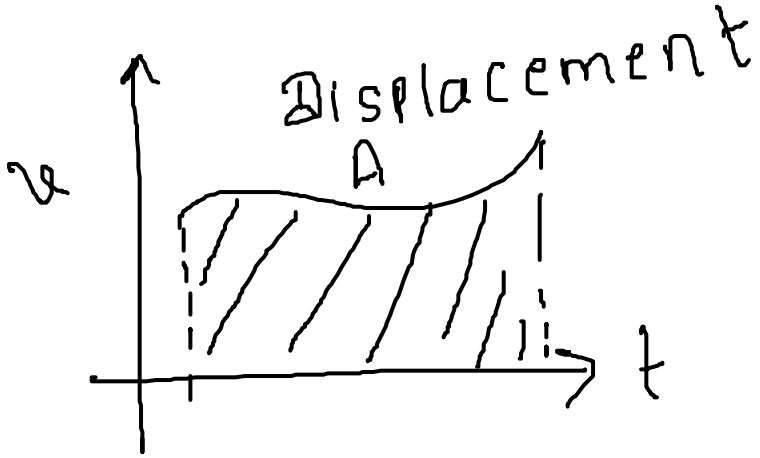
वेग

* Velocity - Time :-

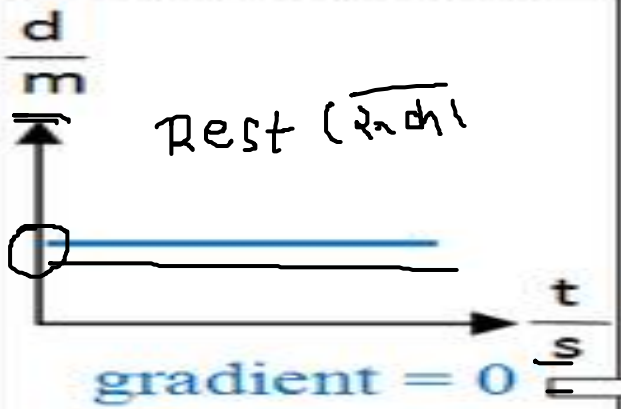
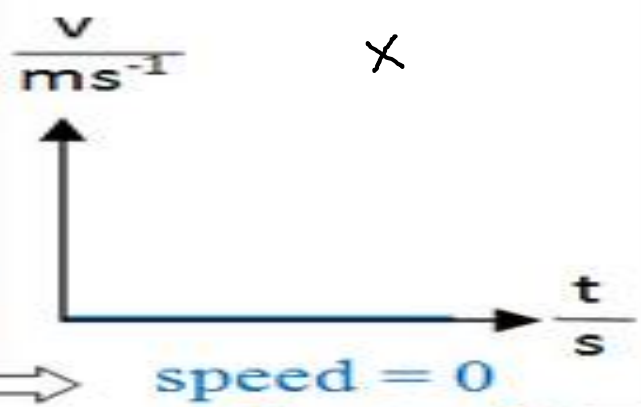
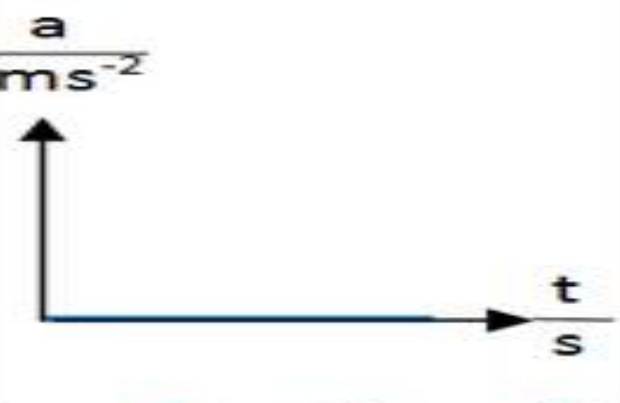
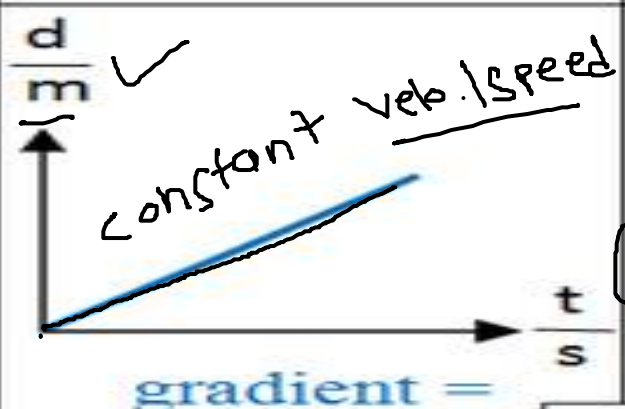
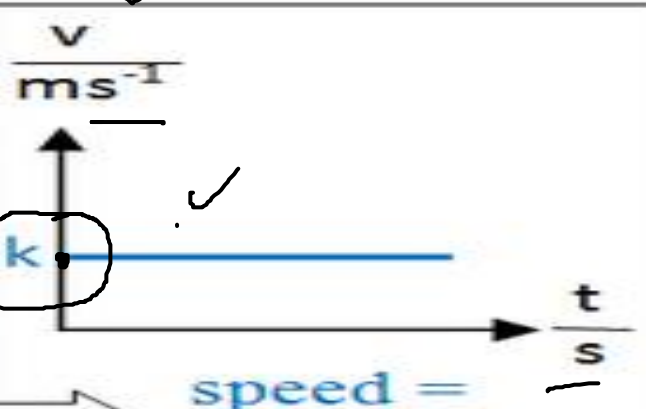
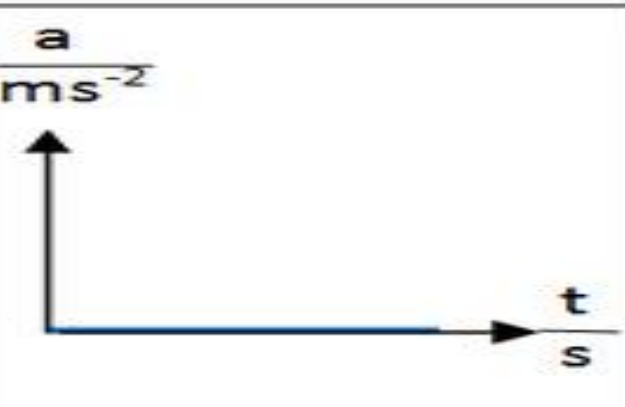
Acceleration

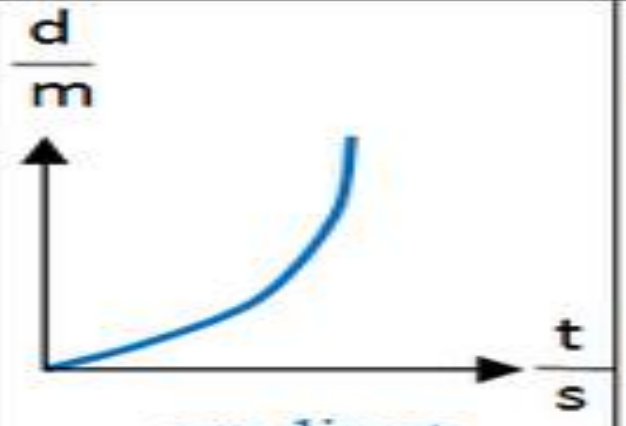
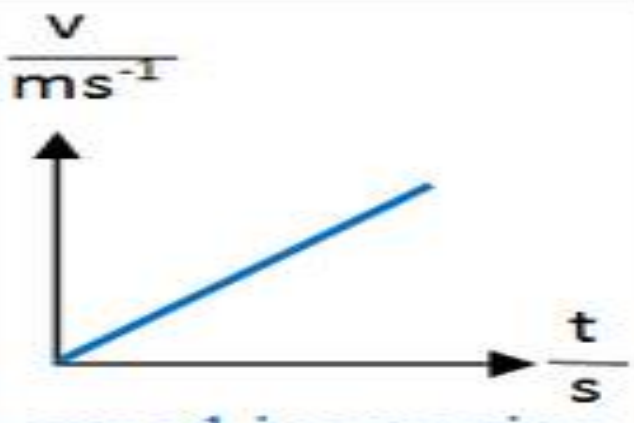
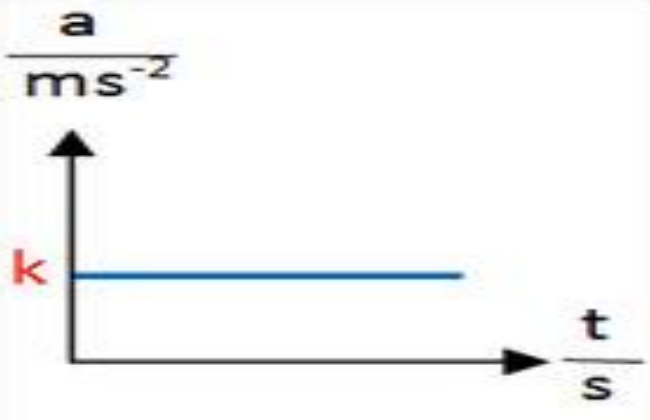
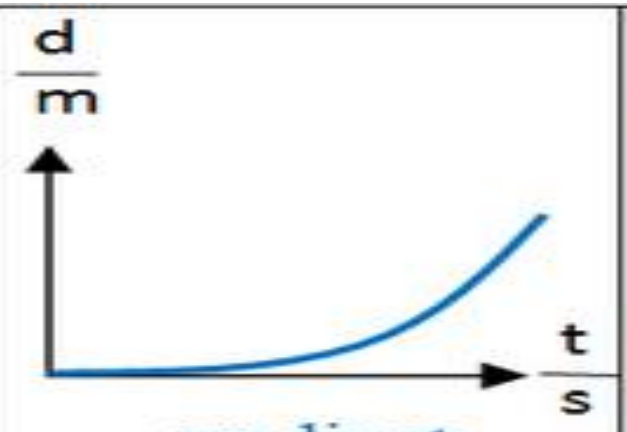
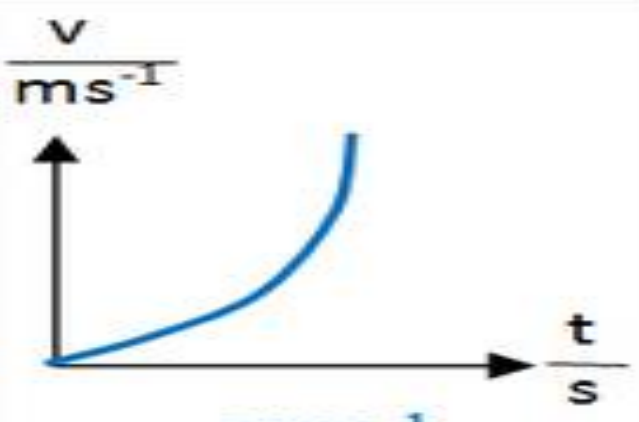
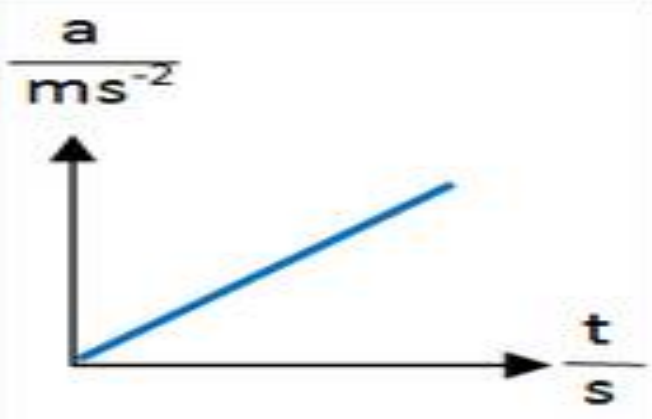


* Velocity - Time :-

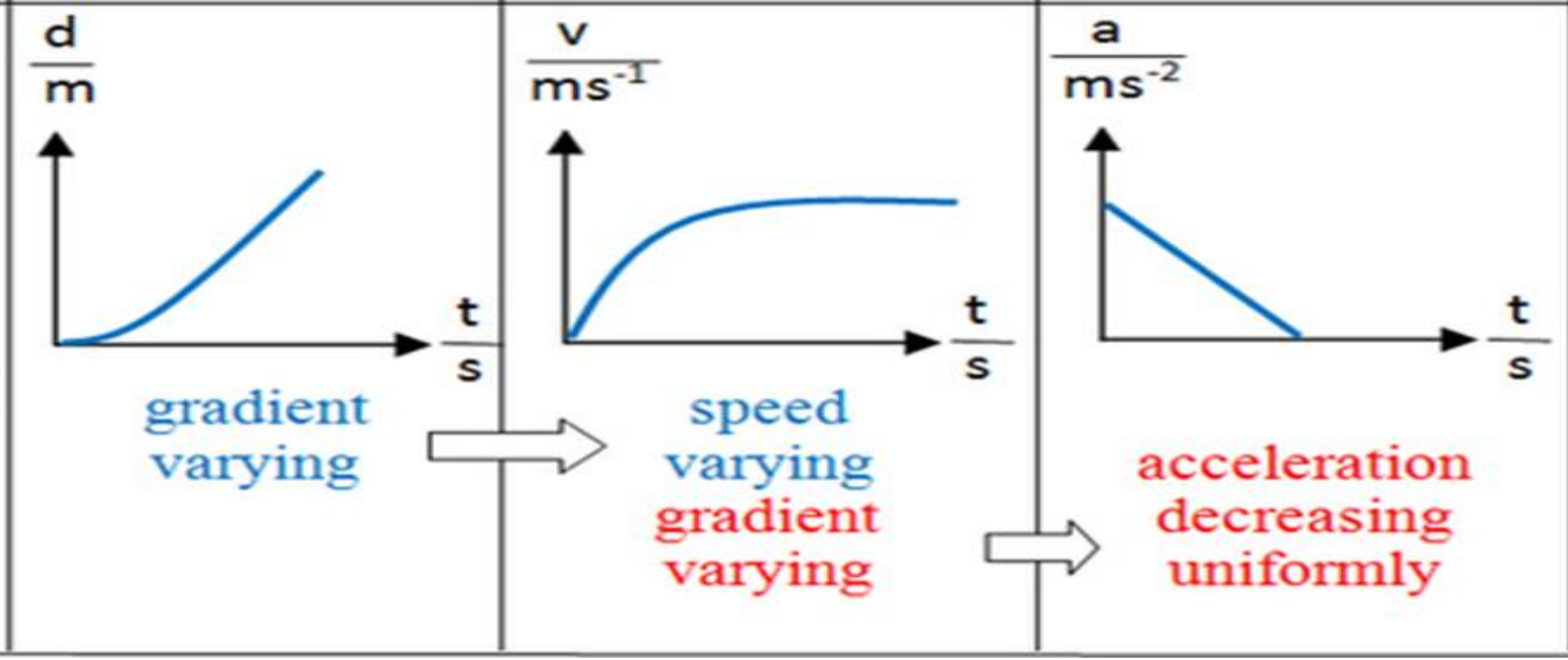


KINEMATICS GRAPH

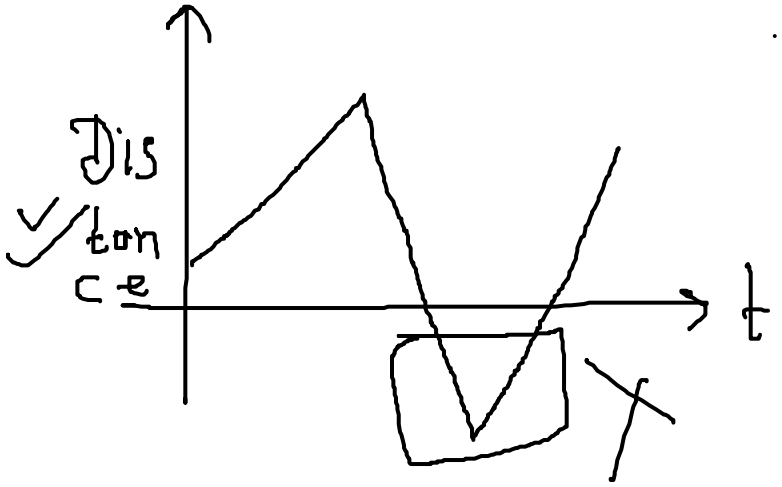
Motion of object	Distance-Time graph	Speed-Time graph	Acceleration-Time graph
At rest			
At constant speed or uniform speed			

Uniform acceleration	 gradient varying	 speed increasing uniformly gradient = constant, k	 acceleration = constant, k
Increasing acceleration (non-uniform acceleration)	 gradient varying	 speed varying gradient varying	 acceleration increasing uniformly

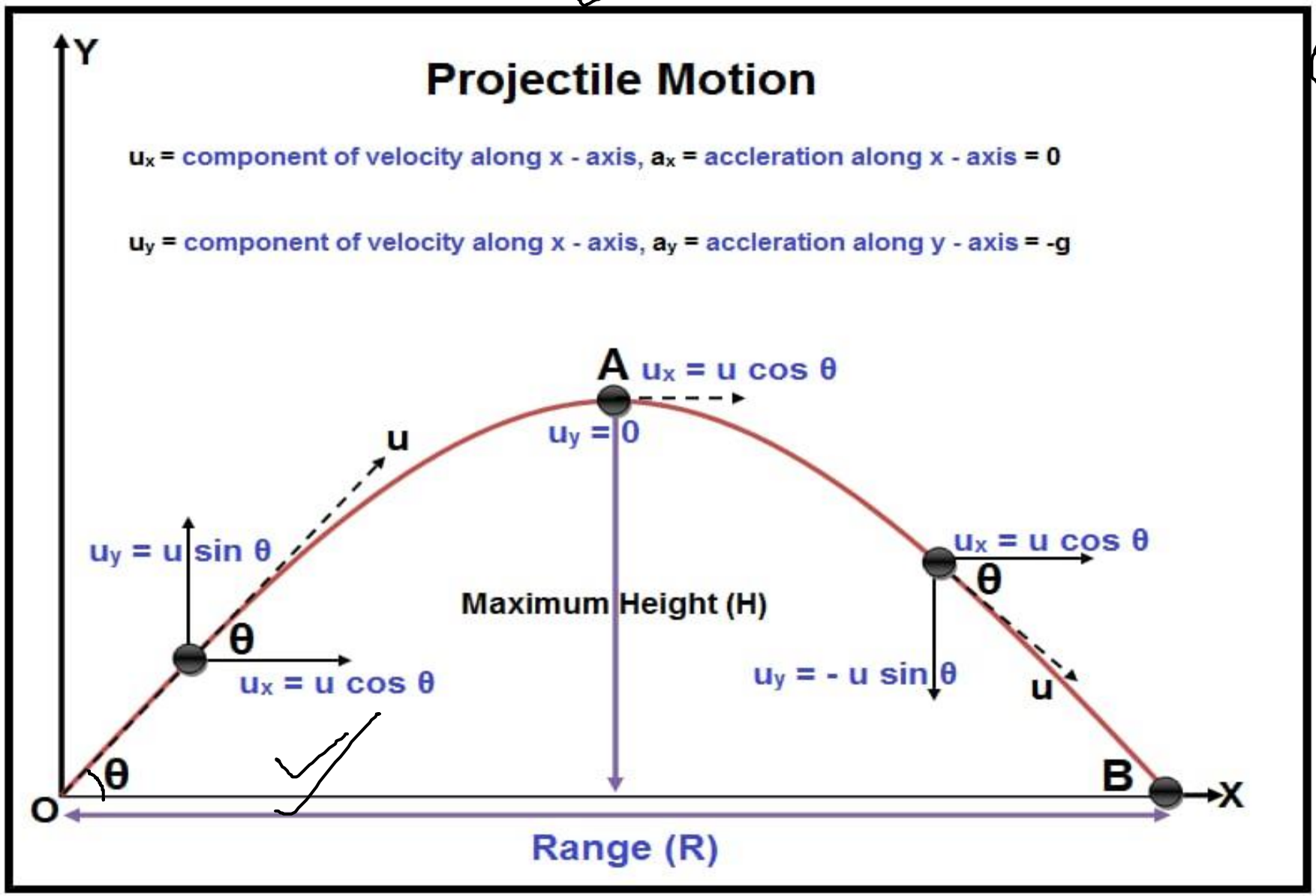
Decreasing acceleration (non-uniform acceleration)



EXAMPLES:



PROJECTILE MOTION (प्रक्षेप्य पथ पर गति)



① Path (पथ)

→ Parabolic परवलयाकार

Motion in a Plane - Part I

SALIL

Motion in a plane

Examples of motion in two dimensions.

Circular motion

Projectile motion

Equations of motion in a straight line

$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

v = final velocity of the particle
u = initial velocity of the particle
s = displacement of the particle
a = acceleration of the particle
t = the time interval in which the particle is in consideration

Equations of motion in a plane

Apply equations of motion in a straight line separately in both directions, X and Y.

$v_x = u_x + a_x t$ $\quad$ $v_y = u_y + a_y t$

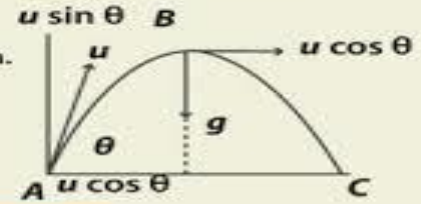
$s_x = u_x t + \frac{1}{2}a_x t^2$ $\quad$ $s_y = u_y t + \frac{1}{2}a_y t^2$

$v^2_x = u^2_x + 2a_y s$ $\quad$ $v^2_y = u^2_y + 2a_y s$

Projectile motion

- Projectile refers to an object that is in flight along the horizontal and vertical direction simultaneously.
- Acceleration acts only in the vertical direction due to acceleration due to gravity (g).
- No acceleration in the horizontal direction.
- Projectile motion is always in the form of parabola.

$$y = ax + bx^2$$



Formulas for projectile motion

Components of velocity at time t	$u_x = u\cos\theta$ $u_y = u\sin\theta - gt$
Position at time t	$x = (u\cos\theta)t$ $y = (u\sin\theta)t - 1/2\ gt^2$
Equation of path of projectile motion	$y = (\tan\theta)x - gx^2/2(u\cos\theta)^2$
Time of maximum height	$t_m = u\sin\theta/g$
Time of flight	$2t_m = 2(u\sin\theta/g)$
Maximum height of projectile	$h_m = (u\sin\theta)^2/2g$
Horizontal range of projectile	$R = u^2\sin 2\theta/g$
Maximum horizontal range ($\theta_o = 45°$)	$R_m = u^2/g$

① Time of Flight (उड़यन काल) :-

$$T = \frac{2u\sin\theta}{g}$$

② Maximum Height :-

$$H_{max} = \frac{u^2\sin^2\theta}{2g}$$

③ Range :-

$$R = \frac{u^2\sin 2\theta}{g}$$

Inertia जड़त्व :

inertia depends on → mass

- *An object will continue to be in the state of rest or in a state of motion unless an external force acts on it.*
- जब तक कोई बाहरी बल उस पर कार्य नहीं करता तब तक कोई वस्तु विश्राम की स्थिति

  या गति की स्थिति में बनी रहेगी।

Inertia of Rest	Inertia of Direction	Inertia of Motion
When the resistance is offered by the body to continue in the state of rest unless an external force acts on it.	*When the resistance is offered by the body to continue the motion in the same direction unless an external force acts on it.*	*When the resistance is offered by the body to continue to be in the uniform motion unless an external force acts on it.*

FORCE (बल):

- A **force** is a push or pull upon an object resulting from the object's *interaction* with another object.

- **बल वह कारक है जो किसी भी रुकी हुई अथवा थमी हुई वस्तु में परिवर्तन ला सकता है जब कोई वस्तु किसी भी सीधे रस्ते पे चल रही होती है तो उसे रोकने के लिए या उसकी गति को और तेज करने के लिए जिस कारक का उपयोग किया जाता है उसे ही बल (force) कहते है**

F → Symbol

Force → Vector

$\vec{F} = m\vec{a}$

Unit ⇒ Newton (N) / kg-m/s²

Dimension (विमा):

$[MLT^{-2}]$

सम्पर्क बल Contact

मैकेनिकल फोर्स

घर्षण बल Friction

अनुप्रयुक्त बल

असम्पर्क बल (Non-contact)

गुरुत्वाकर्षण बल

स्थिर विद्युत बल

चुंबकीय बल

Fundamental forces:-

1. Gravitational
2. Electromagnetic → Friction
3. Strong force
4. Weak force

NEWTON'S LAWS OF MOTION

जड़त्व का नियम

- **Newton's first law (law of inertia) :** Newton's 1st law states that a body at rest or uniform motion will continue to be at rest or uniform motion until and unless a net external force acts on it.

वस्तु अपनी विरामावास्था या एक सीध में एकरूप गत्यावस्था में तब तक रहती है, जब तक बाह्य बल

(external force) द्वारा उसकी विरामावस्था या गत्यावस्था में कोई परिवर्तन न लाया जाए. वस्तु के विराम की

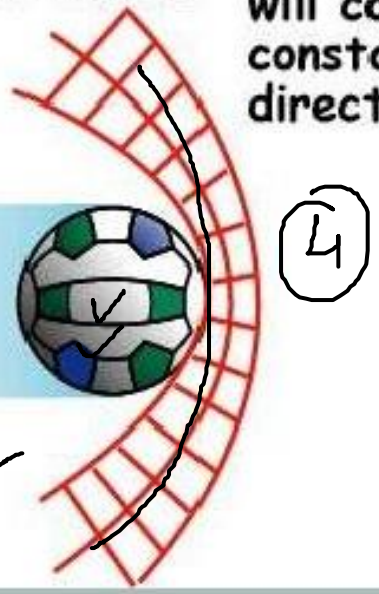
अवस्था (Inertia) का बोध होता है. अतः इस नियम को विराम का नियम भी कहते हैं.

Newton's First Law of Motion

An object at rest will remain at rest...

Unless acted on by an unbalanced force.

An object in motion will continue with constant speed and direction,...



...Unless acted on by an unbalanced force.

• Newton's 2nd law of motion : (Law of force)

Newton's 2nd law states that the acceleration of an object as produced by a net force is directly proportional to the magnitude of the net force.

वस्तु के संवेग (Momentum) में परिवर्तन की दर उस पर लगाये गये बल के अनुक्रमानुपाती (Directly proportional) होती है ।

1. $F = ma$ ✗
2. $F \propto ma$ ✗
3. $F = \frac{dp}{dt}$ ✗
4. $F \propto \frac{dp}{dt}$ ✓

$F \rightarrow p$

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

$F \propto \frac{d(mv)}{dt}$

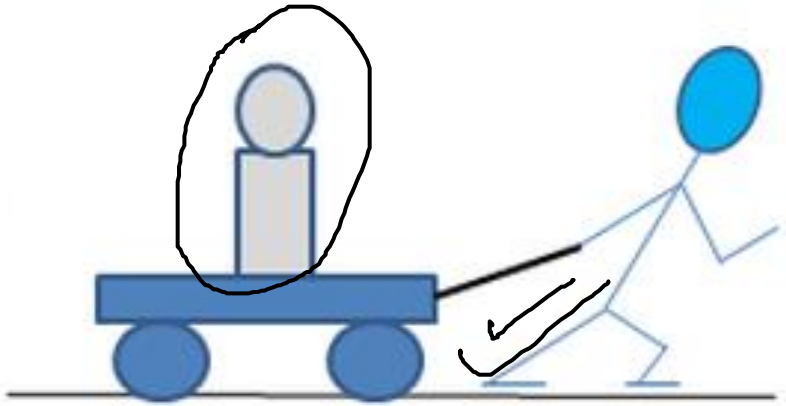
$F \propto m\frac{dv}{dt}$

$p = mv$ → velocity

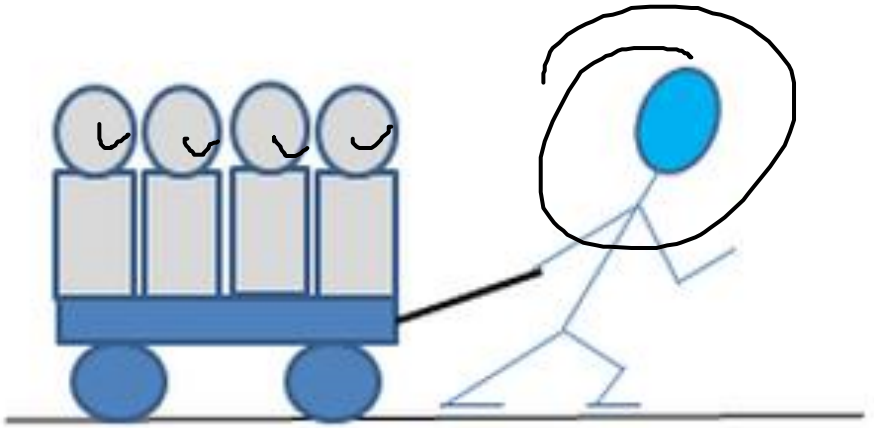
mass

$F = ma$

To get the wagon to *accelerate*, you have to apply a PULL (Force).



If the MASS of the wagon increases, a greater PULL is necessary to accelerate it.



• Newton's Third Law of Motion :

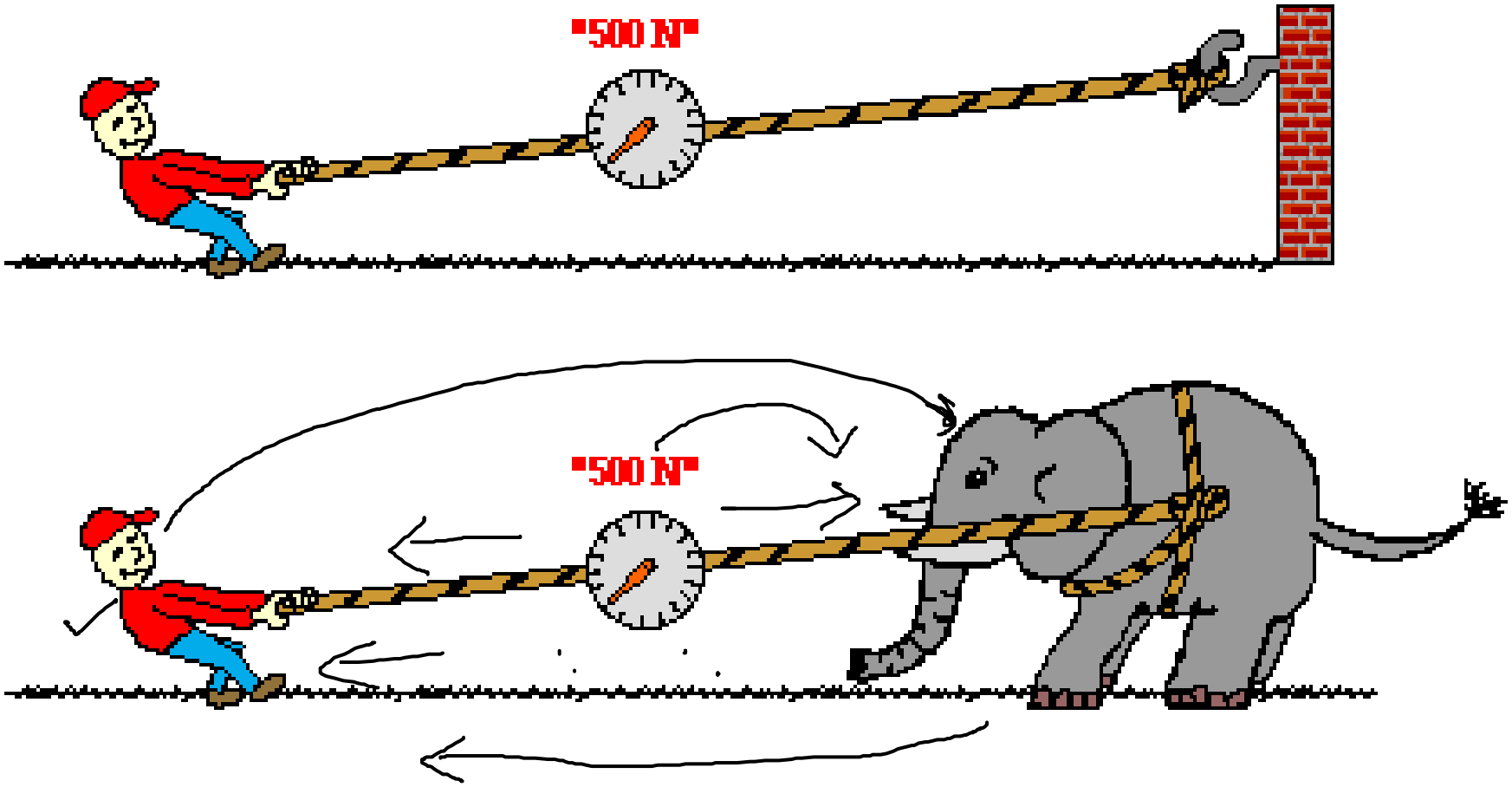
The Newton's 3rd law states that for every action there is an equal and opposite reaction.

प्रत्येक क्रिया (Action) की उसके बराबर तथा उसके विरुद्ध दिशा में प्रतिक्रिया (Reaction) होती है. इस

नियम को क्रिया-प्रतिक्रिया (Law of action and reaction) का नियम कहा जाता है.

⇒ e.g:- Rocket.

$$F_{12} = -F_{21}$$

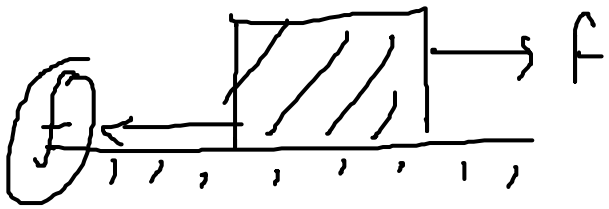

"500 N"
"500 N"

Frictional Force (घर्षण बल) :

(electrostatic)

Frictional force refers to the force generated by two surfaces that contacts and slide against each other.

घर्षण बल एक प्रकार का बल होता है जो जो दो तलों के बीच सापेक्षिक स्पर्शी गति का विरोध करता है ।



- **A few factors affecting the frictional force:**

1. These forces are mainly affected by the surface texture and amount of force impelling them together.

ये बल मुख्य रूप से सतह की बनावट और उन्हें एक साथ लगाने वाले बल की मात्रा से प्रभावित होते हैं।

2. The angle and position of the object affect the amount of frictional force.

ऑब्जेक्ट का कोण और स्थिति घर्षण बल की मात्रा को प्रभावित करती है।

3. If an object is placed flat against an object, then the frictional force will be equal to the weight of the object.

यदि किसी वस्तु को किसी वस्तु के खिलाफ सपाट रखा जाता है, तो घर्षण बल होगा वस्तु के भार के बराबर।

- 4. If an object is pushed against the surface, then the frictional force will be increased and becomes more than the weight of the object.

यदि किसी वस्तु को सतह के विरुद्ध धकेला जाता है, तो घर्षण बल को बढ़ाया जाएगा और वस्तु के भार से अधिक हो जाएगा।

- **Calculating the Force of Friction :**

$$F_{frict} = \mu \bullet F_{norm}$$

• घर्षण बल की विशेषताऐं – Features of frictional force

- दो सतहों के मध्य लगने वाला घर्षण बल उनके सम्पर्क क्षेत्रफल पर निर्भर नहीं करता है यह केवल सतहों की प्रकृति पर निर्भर करता है

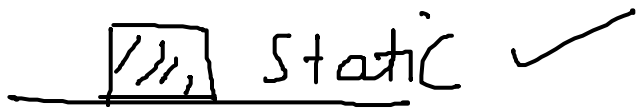
- लोटनिक घर्षण बल का मान सबसे कम और स्थैतिक घर्षण बल का मान सबसे अधिक है

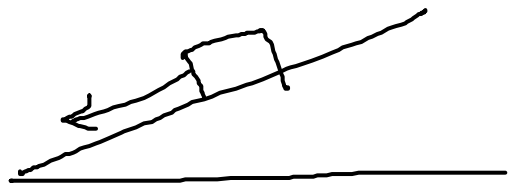
- घर्षण बल के कारण ही मनुष्य सीधा खडा रह पाता है तथा चल पाता है

- घर्षण बल न होने पर हम केले के छिल्के तथा बरसान में चिकनी सडक पर फिसल जाते हैं

Different Types of Frictional Force

- Dry Friction
  - Static Friction
  - Kinetic Friction
  - Rolling Friction
  - Sliding Friction
- Fluid Friction





• घर्षण बल के प्रकार – Types of frictional force

- स्थैतिक घर्षण बल (Static friction force) – जब किसी बस्तु को खिसकाने के लिए बल लगया जाता है बस्तु अपने स्थान न खिसके तो बस्तु और उस सतह के मध्य लगने वाले बल को स्थैतिक घर्षण बल इसका परिमाण लगाए गए बल के बराबर तथा दिशा बल की दिशा के विपरीत होती है

- सर्पी घर्षण बल (Sliding frictional force) – जब कोई बस्तु किसी सतह पर सरकती है तो बस्तु और उस सतह के बीच लगने वाला बल सर्पी घर्षण बल कहलाता है

- लोटनिक घर्षण बल (Rolling frictional force) – जब कोई बस्तु किसी सतह पर लुढकती हैं तो बस्तु और उस सतह के बीच लगने वाला बल लोटिनिक घर्षण बल कहलाता है

- **Examples of Fluid Friction :**

To avoid creaking sounds from doors, we lubricate the door hinges which leads to the smooth functioning of door hinges.

When you drop the ball in a full bucket of water, water splashes out of the bucket and is all because of buoyancy of fluid.

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