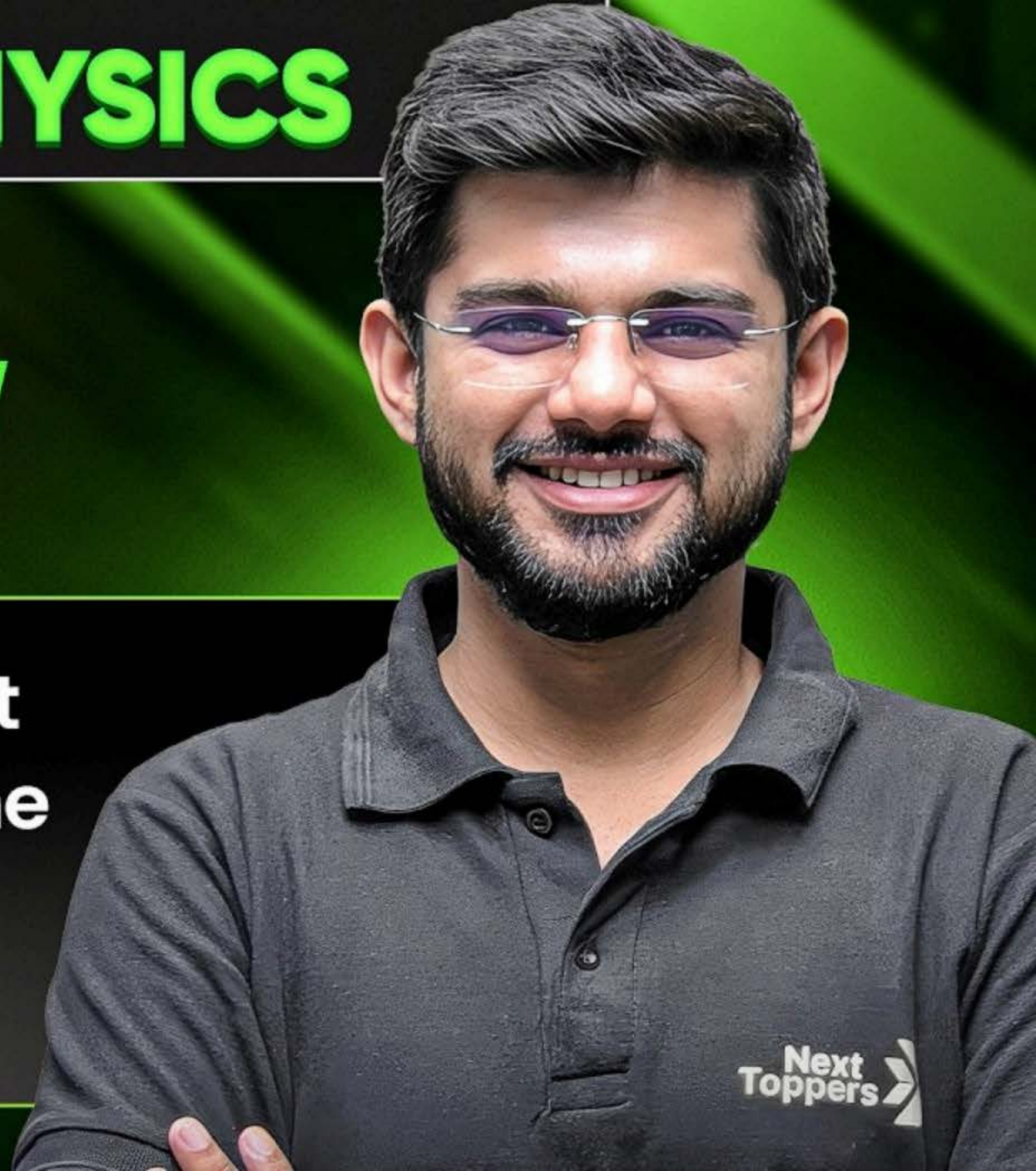
LIVE

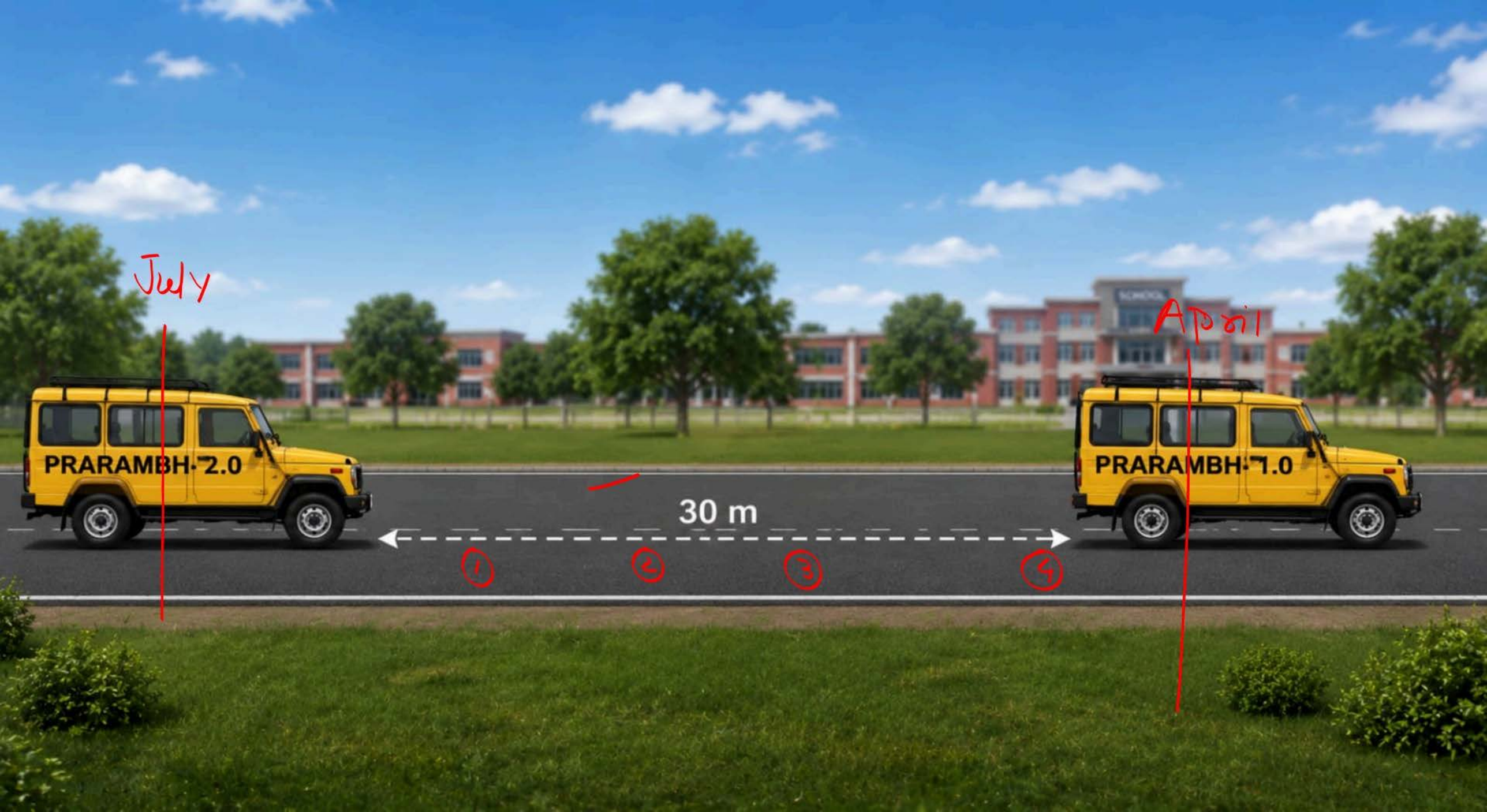
CLASS 11th PHYSICS

BACKLOG MARATHON

SERIES

1. Unit and Measurement
2. Motion in a Straight Line
3. Motion in a Plane
4. Laws of Motion




July
PRARAMBH 2.0
30 m
1
2
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April
PRARAMBH 1.0

How's
THE JOSH
Next
Toppers
प्रारंभ
BATCH

What is Physics ?

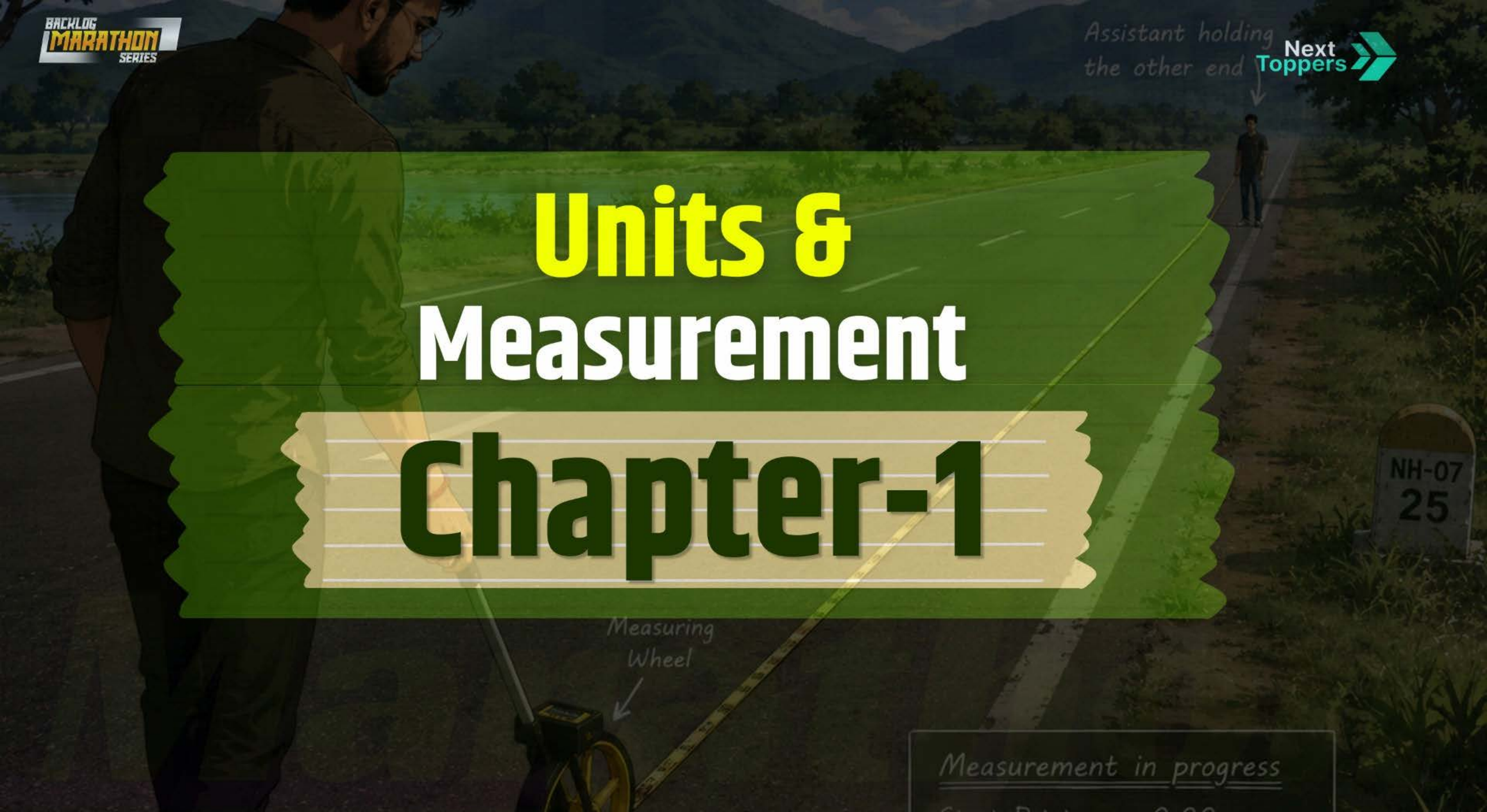
Physics is the branch of science that studies the basic laws of nature and how they work in real life .

tech ⇌ laws

Steam Engine

Radio & T.V. & Mobile & Computers

Rocket propulsion



Units & Measurement

Chapter-1

Physical Quantities

Physical quantities are those quantities which can be measured directly or indirectly using instruments and are used to describe the laws of physics.

- A unit is a standard reference used to measure a physical quantity.

Length = 5 feet 7 inches

Mass = 47 kg

Marathon

Classification On Basis Of Directional Properties

Scalar Quantities	Vector Quantities
• Has only magnitude. • Direction is not important. • Follows simple algebra rules. • Examples : 1. Speed, 2. Distance, 3. Time	• Has both magnitude and direction. • Direction is essential. ? • Follows vector algebra rules. • Examples : 1. Velocity, 2. Displacement, 3. Force

Classification On Basis Of Dependency

Fundamental Quantities	Derived Quantities
Which can be treated as a independent of other physical quantities	Whose defining Operations are based on other physical quantities.

	Physical quantity	Unit	Symbol
1	Length	metre	m
2	Mass	kilogram	kg
3	Time	second	s
4	Temperature	kelvin	K
5	Electric current	ampere	A
6	Luminous intensity	candela	cd
7	Amount of substance	mole	mol

* $\text{SPEED} = \frac{\text{DISTANCE}}{\text{TIME}}$

* $\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}} = \frac{\text{mass}}{(l)^3}$

(SI : The international system of units)

Supplementary Physical Quantities

(i) Plane Angle (2D)

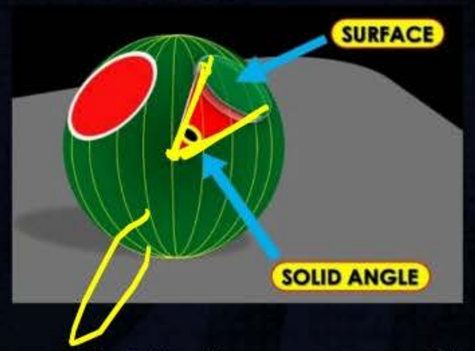
The angle formed at the intersection of two straight lines in the same plane is called a plane angle.

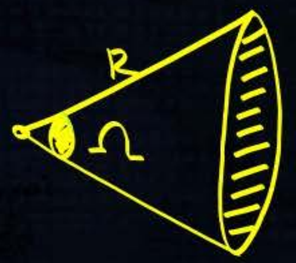
$$\theta = \frac{Arc}{R} \Rightarrow \text{degree} \times \text{rad} \checkmark$$

- SI Unit: radian (rad)
- Complete Circle = 2π Radian

(ii) Solid angle (3D)

The angle formed at a point by an area of a surface surrounding it is called a solid angle.





$$\Omega = \frac{S.Area}{R^2}$$

- SI Unit: steradian (sr)
- Whole Sphere = 4π Steradian

Some common Practical Units

School

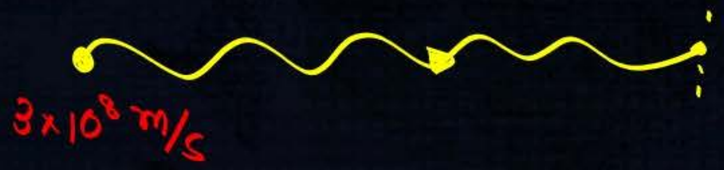
(i) Astronomical Unit

mean distance of earth from sun

1 astronomical unit
= 1 AU
= 1.496×10^{11} m

(ii) Light year

It is distance travelled by light in vacuum in one year.



1 light year
= 1 ly
= 9.467×10^{15} m

(iii) Parsec (parallactic second)

Largest practical unit of distance used in astronomy to measure distance of planets.

1 parsec
= 3.08×10^{16} m
= 3.26 ly

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"Class-12th"

Dimensions of Physical Quatities

Dimensions of a physical quantity are the powers (or exponents) to which the base quantities are raised to express that quantity

Physical Quantity	Dimension
Length	L
Mass	M
Time	T
Electric Current	A OR I
Temperature	K OR θ
Amount of Substance	mol
Luminous Intensity	Cd

(i) Velocity $= \frac{m}{s} = \frac{L^1}{T^1} = [L^1 T^{-1}]$ (m → meters)

(ii) Acceleration $= m/s^2 = [L^1 T^{-2}]$

(iii) Force $= ma = kg \cdot \frac{m}{s^2} = [M^1 L^1 T^{-2}]$ (Ratt Law)

$\theta = \text{rad} = M^0L^0T^0$

$\Omega = \text{sr} = M^0L^0T^0$

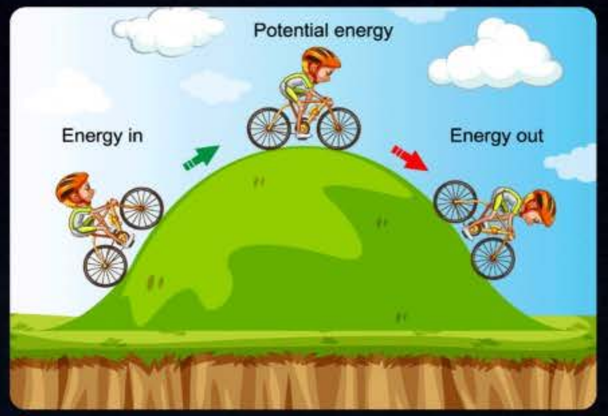
Kinetic Energy

$K.E. = \frac{1}{2}(\text{mass})(\text{velocity})^2$

$= \frac{1}{2}mv^2$

$[M^1L^2T^{-2}]$

Potential Energy

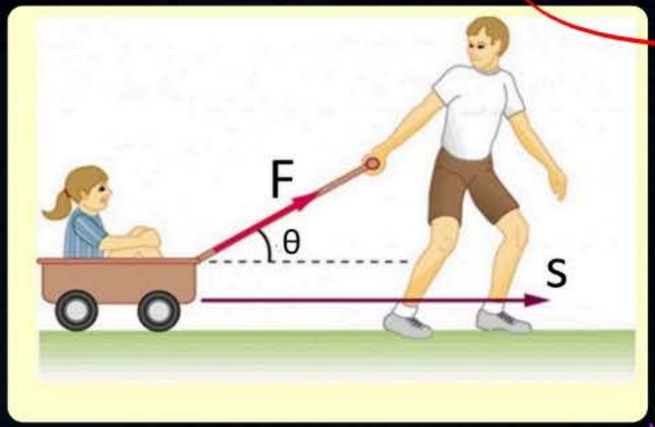


$P.E. = mgh$

$= (\text{mass})(\text{acc.})(\text{Length})$

$[M^1L^2T^{-2}]$

Work



$$W = Fs\cos\theta$$

$W = (\text{Force})(\text{disp.})\cos\theta$

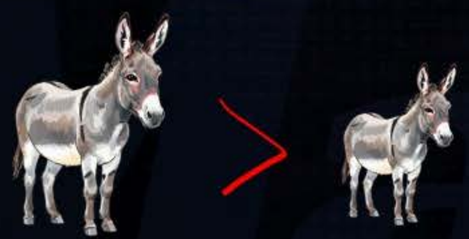
$= [M^1L^1T^{-2}][L^1]$

$= [M^1L^2T^{-2}]$

e
log
sin
cos
tan
$M^0L^0T^0$

Principle of Homogeneity :

- In any correct physical equation, the dimensions of all terms on both sides must be the same.
- Only quantities with the same dimensions can be added, subtracted, or compared.



Eg.

$5m + 3m - 1m = 7m$

$5m + 3kg - 1sec = 7A$ ✗

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The Vander Wall's equation for a gas is (p = pressure & V = Volume)

$$(p + \frac{a}{V^2})(V - b) = RT$$

Determine the dimensions of a and b. Hence write the SI units of a and b.

[Central Schools 14]

$[P] = \left[\frac{a}{V^2}\right]$: $[a] = [M^1 L^5 T^{-2}]$

$\frac{N}{m^2} = \frac{[a]}{(m^3)^2}$

$[V] = [b]$

$[b] = m^3$

$[b] = [L^3]$

$\frac{N}{m^2} = \frac{a}{m^6}$

$[a] = N \cdot m^4 = [M^1 L^1 T^{-2}][L^4]$

Pressure $= \frac{F}{Area} = \frac{N}{m^2}$

Vol. $= m^3$

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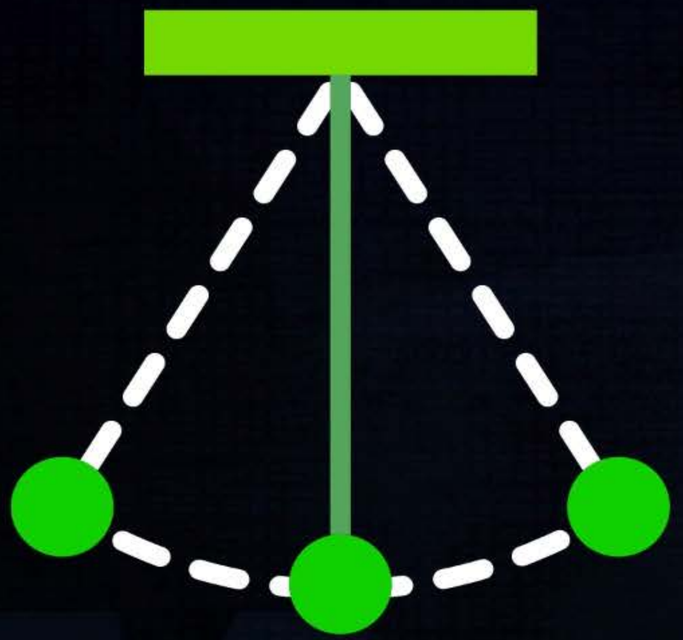
Establish the relation between given PQ

School ★★

dimensionaless

[Delhi 24]



Timeperiod $\propto$ mass

$\propto$ acc.(g)

$\propto$ (l)

$$T = k\, m^a\, g^b\, l^c \Longrightarrow T = k\, m^0 g^{-1/2} l^{1/2}$$

$$[T^1] = [M]^a\, [L^1 T^{-2}]^b\, [L^1]^c$$

$$[M^0 L^0 T^1] = M^a\, L^{b+c}\, T^{-2b}$$

M	L	T
$a=0$	$b+c=0$	$1=-2b$
	$c=-b$	$b=-1/2$
	$c=\frac{1}{2}$	

$$T = k\frac{\sqrt{l}}{\sqrt{g}}$$

$$\boxed{T = 2\pi\sqrt{\frac{l}{g}}}$$

Limitations of Dimensional Analysis

1. The value of dimensionless constant cannot be calculated.
2. The equation containing trigonometrical, exponential and logarithmic terms cannot be analysed.
3. It cannot be used if a PQ depends on sum or difference of two quantities.

$v = \frac{x}{t}$

$x = vt$

$x = vt + 5$

$T = 2\pi\sqrt{\frac{l}{g}} + T_0$

$v = \frac{x}{t}\sin\theta$

$M^0L^0T^0$

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Significant Figures

The reliably digits plus the first uncertain digit are known as significant digit.

Rules

1. All non-zero digits are significant. 13.75

2. All zeros between two non-zero digits are significant. 10005

3. Ending zeros after decimal places are significant. 16.000

   500

4. Initial zeros are not significant. 0405

   0.000405

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5. The powers of ten are not counted as significant figures. 1.4×10^{10}

6. Change in units of measurement of a quantity does not change the number of significant figures

$8.7\ cm = 8.7 \times 10^{-2}\ m \Rightarrow n_1u_1 = n_2u_2$

$n \propto \frac{1}{u}$

7. Exact measurements have infinite number of significant figures

Case 1: Addition/Subtraction

final result should retain as many decimal places as are there in the number with the least decimal places

(a) 13.214 + 234.6 + 7.0350 + 6.38

= 261.229 ≈ 261.2

Case 2: Multiplication/Division

final result should retain as many significant figures as are there in the original number with the least significant figures

(b) $\frac{1101}{10.2}$ = 107.9411764 ≈ 107 ?

3 5 5

Rounding OFF (upto 2 5 5)

+1

1.371 = 1.4

1.325 ≈ 1.3

+1

1.350 = 1.4

1.450 = 1.4

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Que.

Count total number of significant figures in the following measurements:

(a) 4.080 = 4 SF

(b) 10.00 = 4 SF

(c) 0.079 = 2 SF

(d) 4.07080

(e) 950

(f) 7.090×10^5

Least Count

- The smallest measurement that can be measured accurately by an instrument is called its least count.

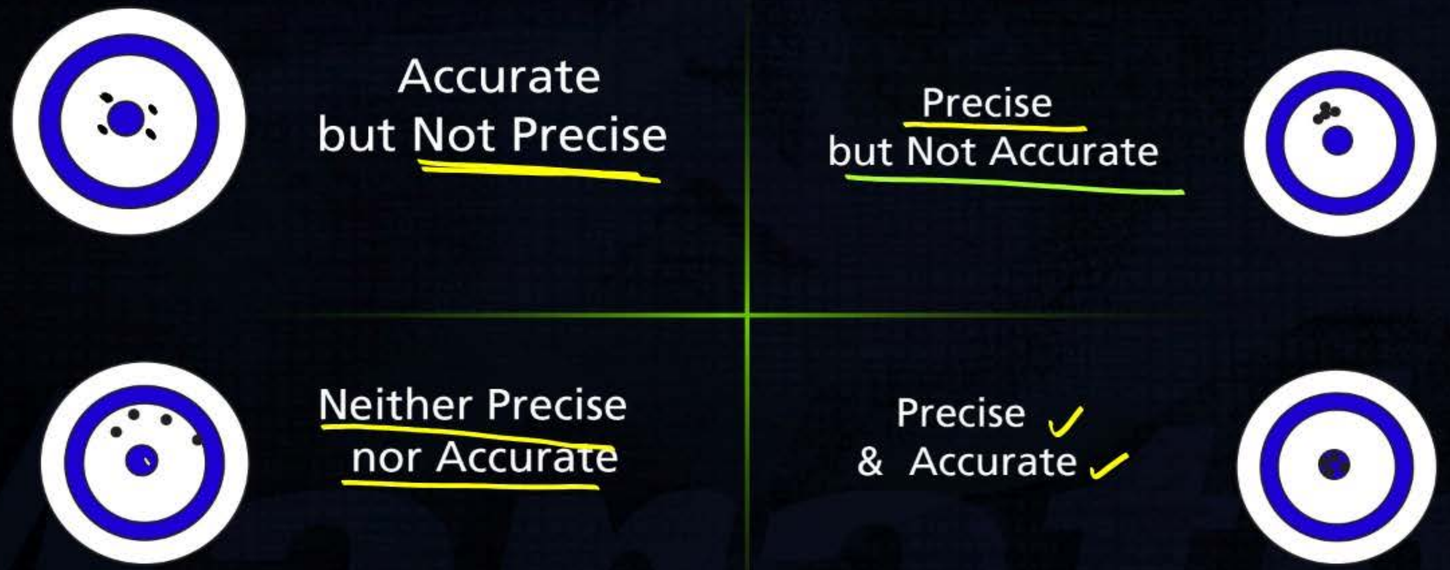
LC = 0.1 cm

LC of Vernier Caliper = 0.01 cm

LC of Screw Gauge = 0.001 cm

Accuracy : It is the measure of how close the measured value is to the true value of that quantity.

Precision : It tells us to what limit or resolution the quantity is measured and the degree of repetitiveness of the measured values.



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Motion in a
Straight line
Chapter-2

Mechanics

Kinematics

we study ways to describe motion without going into the causes of motion

(2) & (3)

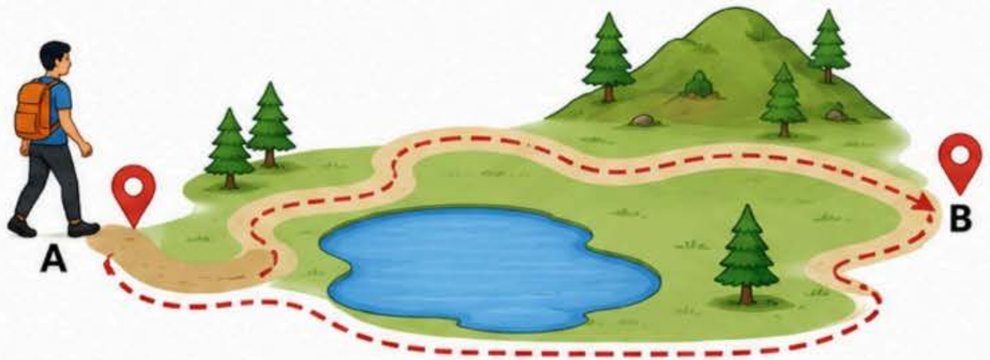
Dynamics

Cause of motion

4. Laws of Motion
5. Work, Energy & Power

DISTANCE

Distance is the **total length of the actual path** traveled by an object.



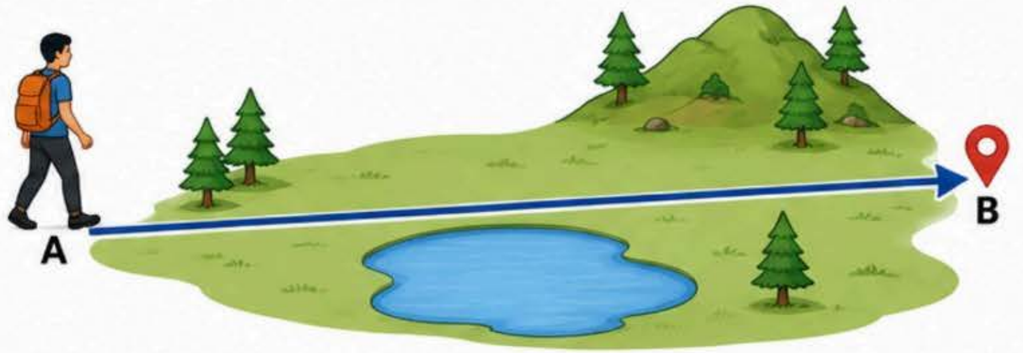
Actual Path

Key Points

- It is a **scalar** quantity (has magnitude only).
- It is always **positive** or zero.
- It depends on the path taken.
- Unit: meter (m)

DISPLACEMENT

Displacement is the **shortest straight line distance** from the initial position to the final position.



Straight Line Path (Displacement)

Key Points

- It is a **vector** quantity (has magnitude and direction).
- It can be positive, negative, or zero.
- It depends only on the **initial and final positions**.
- |Displacement| ≤ Distance
- Unit: meter (m)

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SPEED = Distance / time

Speed tells us **how fast** an object is moving.

Key Points

- It is a **scalar** quantity (has magnitude only).
- It has no direction.
- It is always positive or zero.
- It depends on the distance traveled.
- Unit: meter per second (m/s)

The speedometer of a car shows **speed**.

Example

A car travels 120 km in 2 hours.

Speed = 120/2 = **60 km/h**

VS

VELOCITY = Displacement / time

Velocity tells us **how fast** an object is moving in a **particular direction**.

Key Points

- It is a **vector** quantity (has magnitude and direction).
- It has both magnitude and direction.
- It can be positive, negative, or zero.
- It depends on the **displacement**.
- Unit: meter per second (m/s)

Velocity of the car is **60 km/h towards East**.

Example

A car moves 120 km towards North in 2 hours.

Velocity = 120/2 = **60 km/h towards North**

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ACCELERATION $= \frac{\Delta v}{\Delta t}$

Acceleration is the rate of change of velocity with time.
It tells us how quickly the velocity of an object is changing.

KEY POINTS

- It is a vector quantity (has magnitude and direction).
- It can be positive, negative or zero.
- It depends on the change in velocity and time taken.
- SI Unit: metre per second square (m/s^2)
- Symbol: a

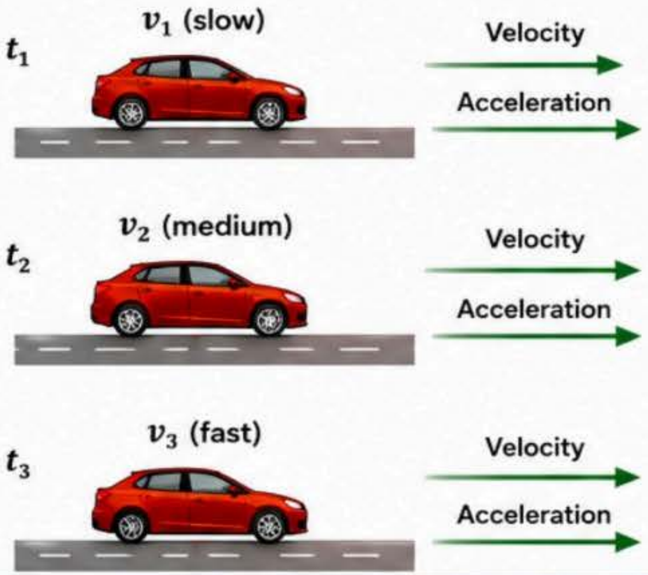
MATHEMATICAL EXPRESSION

$$a = \frac{\Delta v}{\Delta t} = \frac{v - u}{t}$$

where, u = initial velocity
v = final velocity
t = time taken

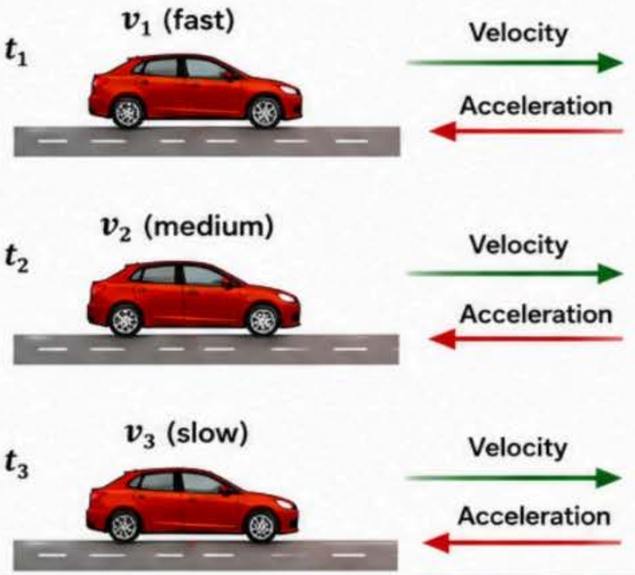
1. SPEED INCREASES

When speed increases in a direction, acceleration is in the same direction.



2. SPEED DECREASES

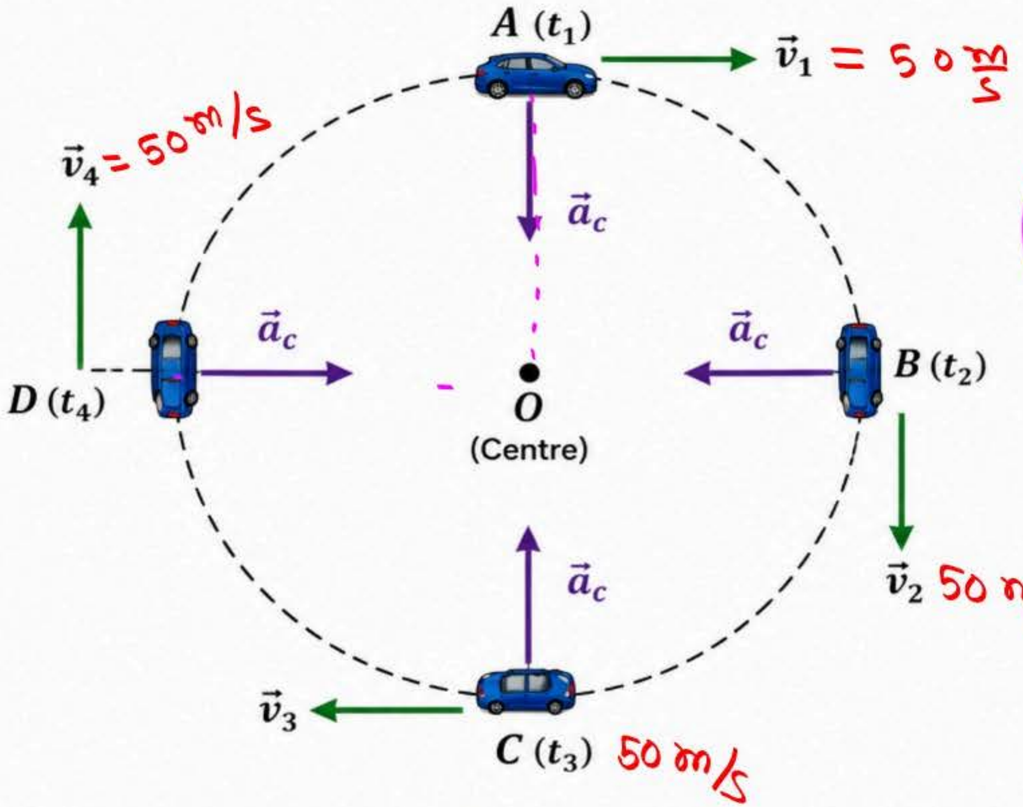
When speed decreases in a direction, acceleration is in the opposite direction.



3. ONLY CHANGING DIRECTION OF VELOCITY

(Circular Motion – Only Centripetal Acceleration)

When direction changes, but speed remains constant,
acceleration is in the direction of change (towards the centre).



Key Idea

- Speed is constant.
- Velocity direction keeps changing.
- Acceleration is always towards the centre (centripetal acceleration).
- Acceleration is perpendicular to velocity at every point.

Formula

Centripetal acceleration : $a_c = \frac{v^2}{r}$

where, v = speed (constant)

r = radius of the circle

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Que.

Which of the following is/ are true?

a. Distance $\geqslant$ Displacement
b. Distance $\leqslant$ Displacement
c. Distance = Displacement always
d. Distance can be negative

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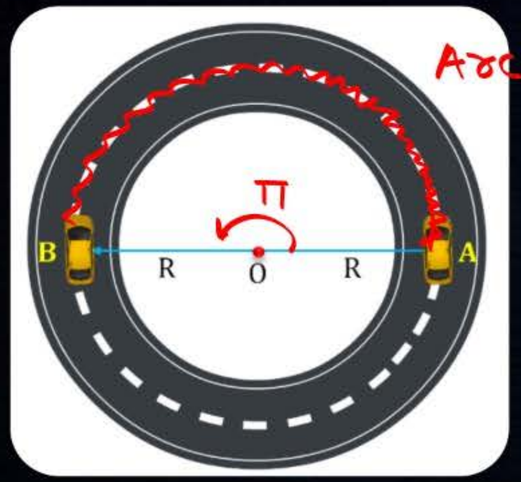
Que.

$\theta = \frac{Arc}{R}$

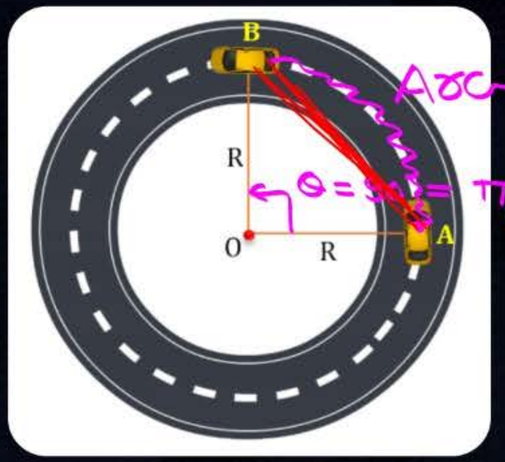
Find Distance & Displacement



$Arc = R \cdot \pi$

Distance $= R\pi$

Displacement $= 2R$



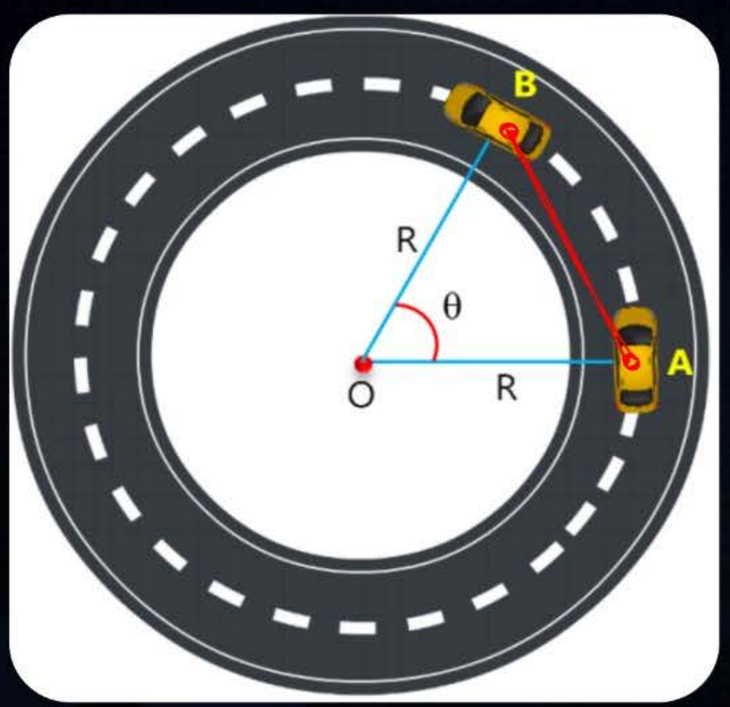
Distance $= Arc = \theta \cdot R = \frac{\pi}{2} R$

Displacement $= 2R \sin\left(\frac{90}{2}\right) = 2R \sin 45^\circ$

$= 2R \cdot \frac{1}{\sqrt{2}}$

$= \sqrt{2}R$

SMT



Displcement = $2R\sin\frac{\theta}{2}$

Instantaneous Velocity & Acceleration

It is the velocity or Acceleration of a particle at a particular instant of time.

$v_{avg} = \frac{\Delta x}{\Delta t} \longrightarrow v_{inst.} = \frac{dx}{dt}$

$a_{avg.} = \frac{\Delta v}{\Delta t} \longrightarrow a_{inst} = \frac{dv}{dt}$

$* \; x = t^n \implies \frac{dx}{dt} = n t^{n-1}$

Eg. $x = t^3 \implies \frac{dx}{dt} = 3t^2$

$* \; x = 5 \implies \frac{dx}{dt} = 0$

$* \; x = 5t^3 \implies \frac{dx}{dt} = 5\left[\frac{d}{dt}(t^3)\right]$

$= 5(3t^2)$

$= 15t^2$

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The position of a particle related to time is given by $x = (5t^2 - 4t + 5)$ m. The magnitude of velocity of the particle at $t = 2$ s will be:

a. $10 ms^{-1}$
b. $14\ ms^{-1}$
c. $16\ ms^{-1}$
d. $06\ ms^{-1}$

$$x = 5t^2 - 4t + 5$$

$$\frac{dx}{dt} = 5(2t) - 4 + 0$$

$$v = 10t - 4$$

$$v_{(t=2)} = (10)(2) - 4 = 16\ m/s$$

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The position of a particle related to time is given by $x = (5t^2 - 4t + 5)$ m. The magnitude of velocity of the particle at t = 2 s will be: [JEE Mains 2023]

a. $10ms^{-1}$
b. $14\ ms^{-1}$
c. $16\ ms^{-1}$
d. $06\ ms^{-1}$

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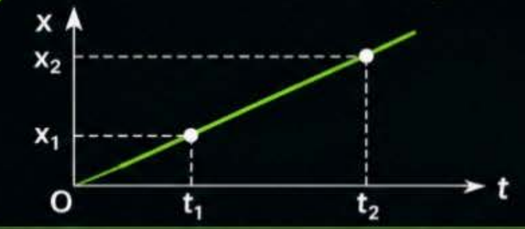
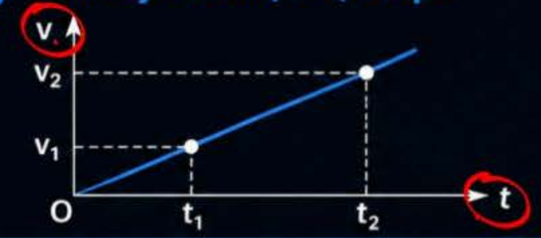
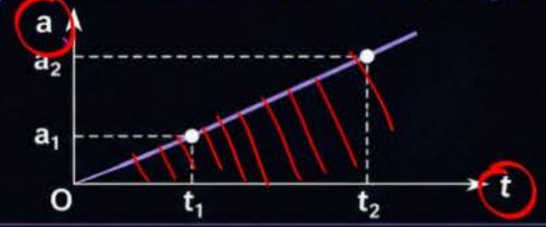
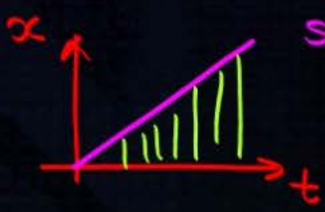
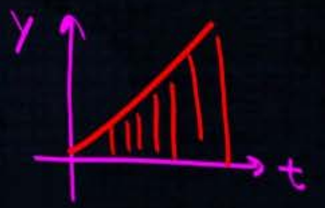
Graphical Analysis

GRAPH	SLOPE / AREA
1 Position - Time (x - t) Graph 	• Slope $= \frac{dx}{dt}$ = Velocity
2 Velocity - Time (v - t) Graph 	• Slope $= \frac{dv}{dt}$ = Acceleration • Area $= \int v\,dt$ = Displacement
3 Acceleration - Time (a - t) Graph 	• Area $= \int a\,dt$ = Change in velocity $= \Delta v$

Basic Maths



slope $= \frac{dx}{dt}$



Area $= \int y \cdot dt$

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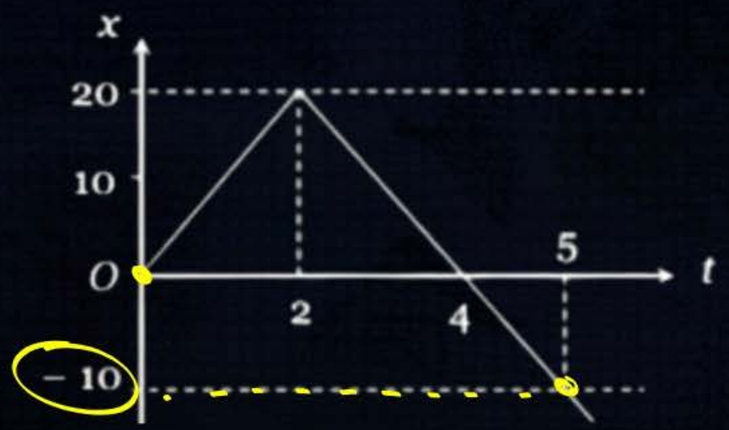
The diagram shows the displacement-time graph for a particle moving in a straight line. The average velocity for the interval t = 0 to t = 5 is:

a. 0 m/s
b. 40 m/s
c. –2 m/s
d. 45 m/s



$\langle v \rangle = \frac{\text{Displacement}}{t} = \frac{-10}{5} = -2\ m/s$

Marathon

BACKLOG MARATHON SERIES

Next Toppers

Equation Of Motion

a = constant

1 VELOCITY EQUATION

Relates initial velocity (u), acceleration (a), time (t) and final velocity (v)

$$v = u + at$$

2 DISPLACEMENT EQUATION

Relates initial velocity (u), acceleration (a), time (t) and displacement (s)

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

3 VELOCITY-DISPLACEMENT EQUATION

Relates initial velocity (u), acceleration (a), displacement (s) and final velocity (v)

$$v^2 = u^2 + 2as$$

(s) x ||

(v) x ||

(t) x ||

BACKLOG MARATHON SERIES

Next Toppers

QUESTION

Roshaniji starts cycling from rest and moves with a constant acceleration of 5 m/s^2. After t seconds, her velocity becomes 100 m/s.

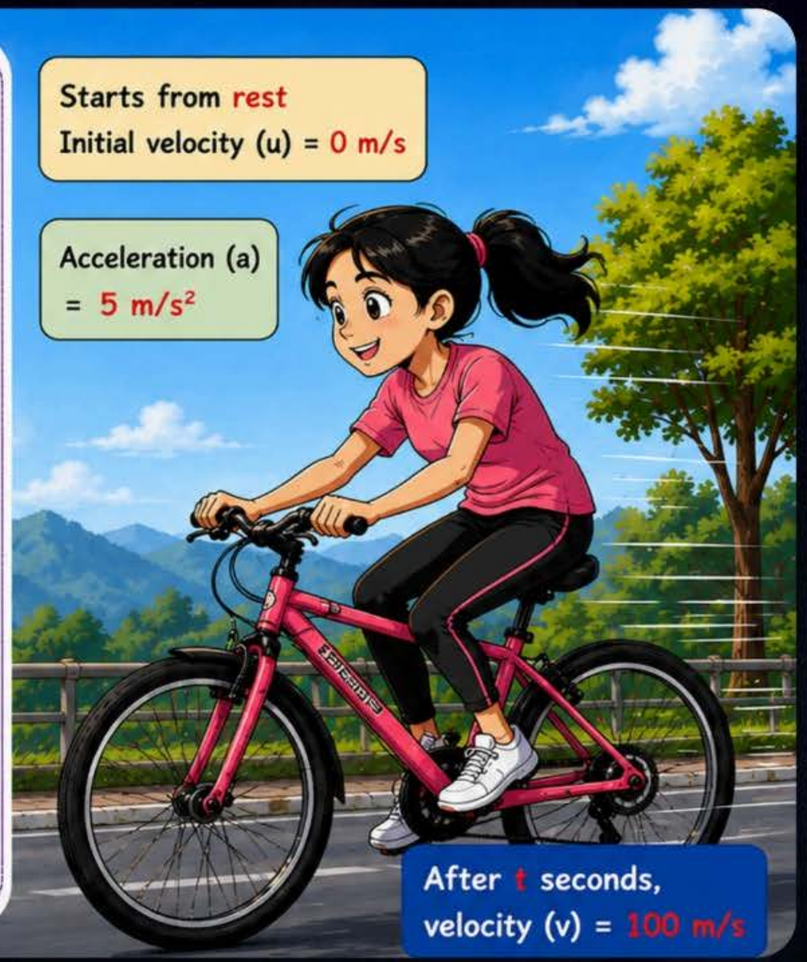
What is the value of t?

(A) 10 s

(B) 15 s

(C) 20 s

(D) None of these



SOLUTION:

- Initial velocity, u = 0 m/s
- Acceleration, a = 5 m/s²
- After t seconds, velocity, v = 100 m/s
- Using the equation of motion: v = u + at

$v = u + at$

$100 = 0 + (5)t$

$100 = 5t$

$t = \frac{100}{5}$

$t = 20$ s

Therefore, $t = 20$ s

A. 10 s

B. 15 s

C. 20 s ✓

D. None of these

Marathon

BACKLOG MARATHON SERIES

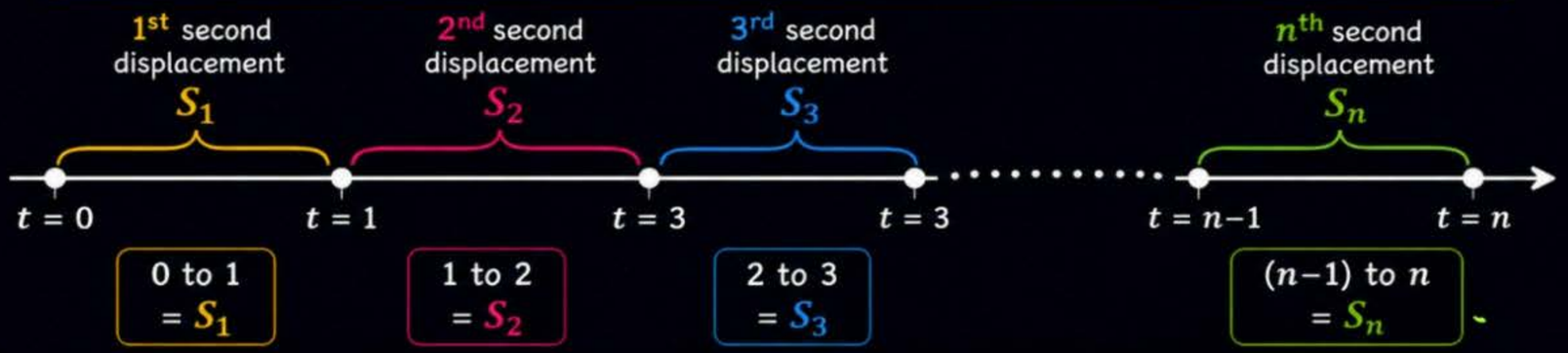
Next Toppers

Displacement in n^{th} second

The displacement of a particle in the nth second is the specific distance covered during exactly one second interval (from t = n-1 to t = n)

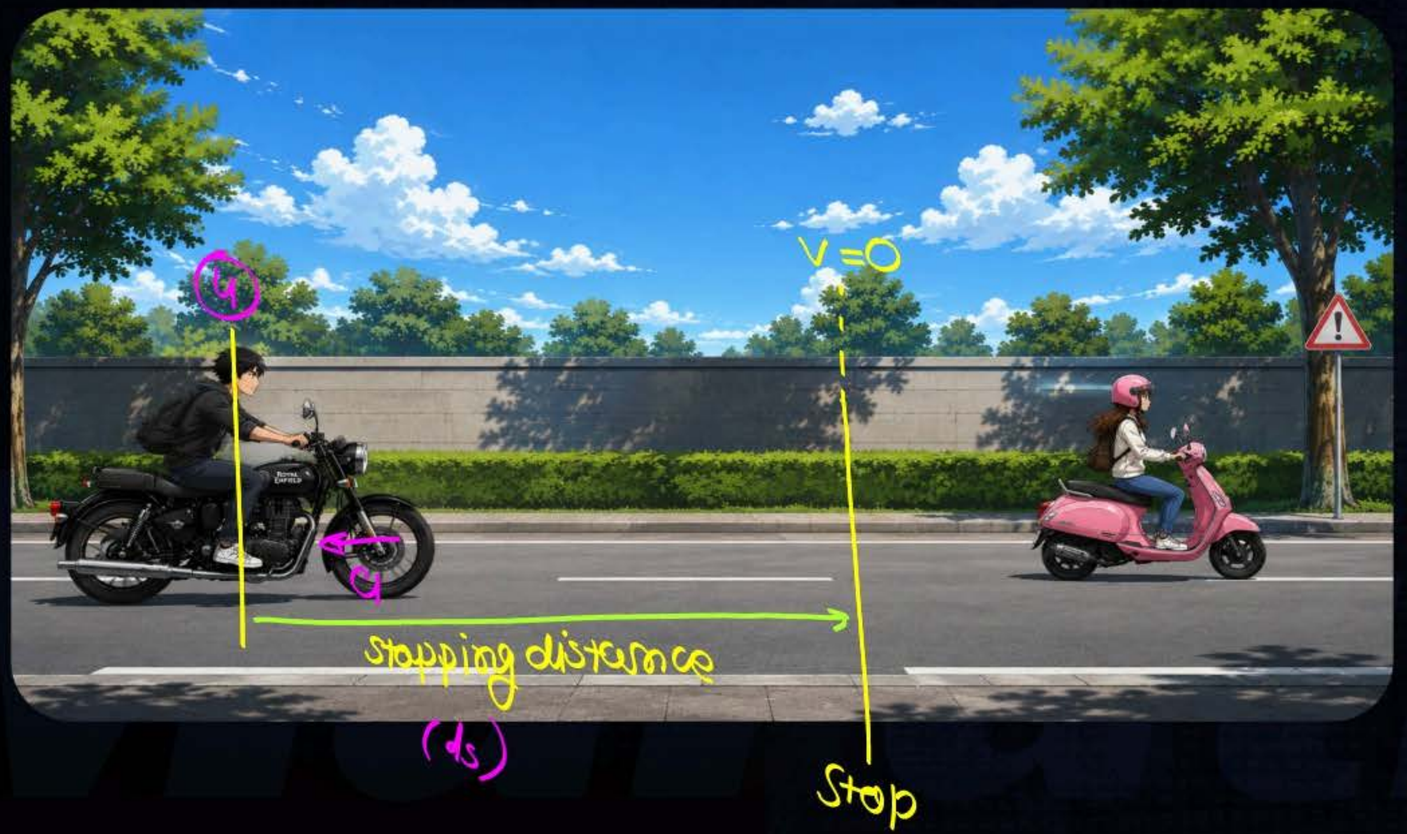
$$S_{n^{th}} = u + \frac{1}{2} a (2n - 1)$$

- S_n = Displacement in n^{th} second
- u = Initial velocity
- a = Constant acceleration
- n = The specific second (1, 2, 3, ...)



Stopping Distance

The total distance a vehicle travels from the moment the driver decides to stop until the vehicle comes to a complete stop.



3rd EoM

$v^2 - u^2 = 2as$

$0 - u^2 = 2(-a)d_s$

$$d_s = \frac{u^2}{2a}$$

BACKLOG MARATHON SERIES

Next Toppers

Que.

A car is moving with speed 25 m/s (u) and comes to rest in 5 s.
Find retardation and stopping distance. [Central School & NCERT]

$$d_{stopping} = \frac{u^2}{2a} = \frac{(25)^2}{2(5)}$$

$$= \frac{25 \times 25}{10}$$

$$= 62.5 \text{ m}$$

1st EOM

$$v = u + at$$

$$0 = 25 + a(5)$$

$$\frac{-25}{5} = a$$

$$a = -5 \text{ m/s}^2$$

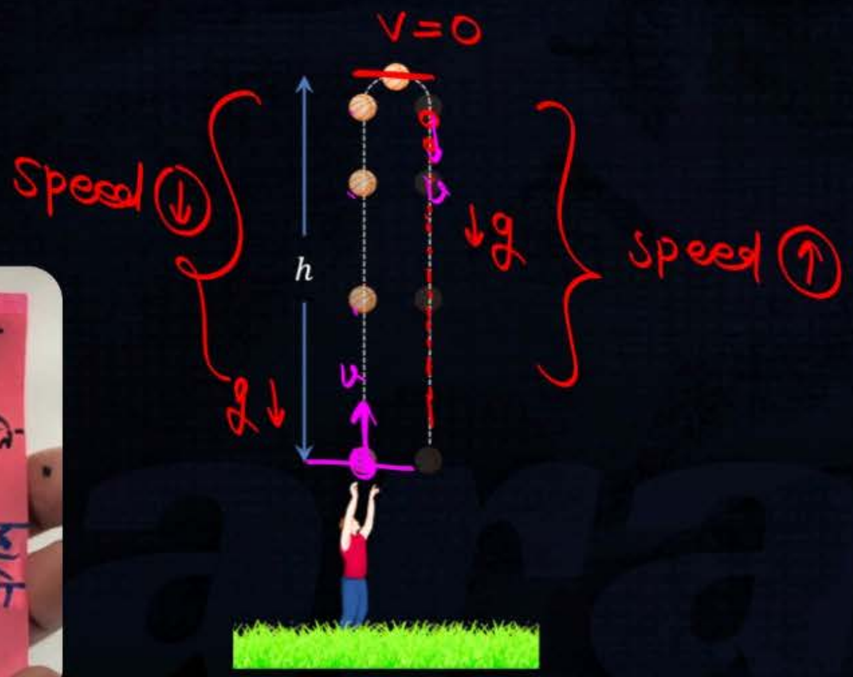
Marathon

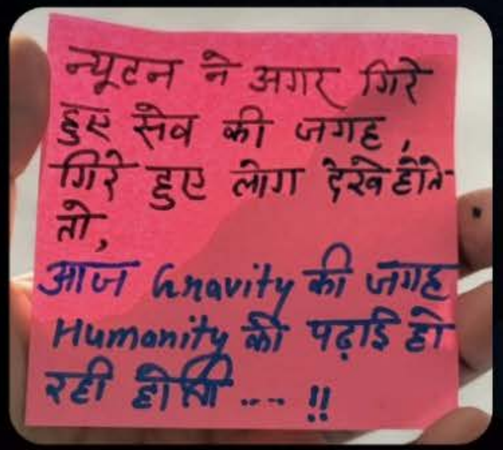
BACKLOG MARATHON SERIES

Next Toppers

Motion Under Gravity

- When the only force acting on it is Earth's gravitational force.
- Acceleration due to gravity is constant near Earth's surface. $\Rightarrow g = 9.8\ m/s^2 \approx 10\ m/s^2$
- It acts vertically downward.





BACKLOG MARATHON SERIES

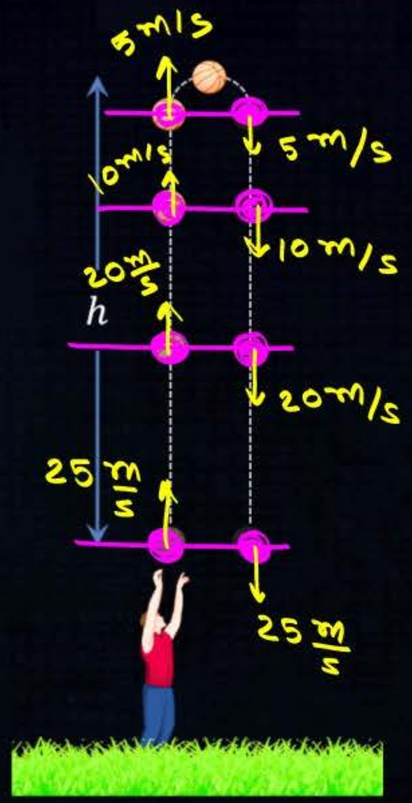
Next Toppers

SMT

- Highest points for a instant velocity zero
- Upar jane ka samay = niche aane ka samay $\Rightarrow t_a = t_d$

$\Rightarrow T = t_a + t_d$

- Same hight pe speed same & velocity ki direction opposite



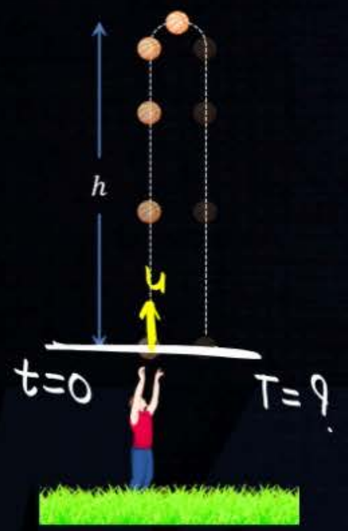
Marathon

BACKLOG MARATHON SERIES

Next Toppers

Time of Flight

Total duration an object spends in the air.



2nd EOM

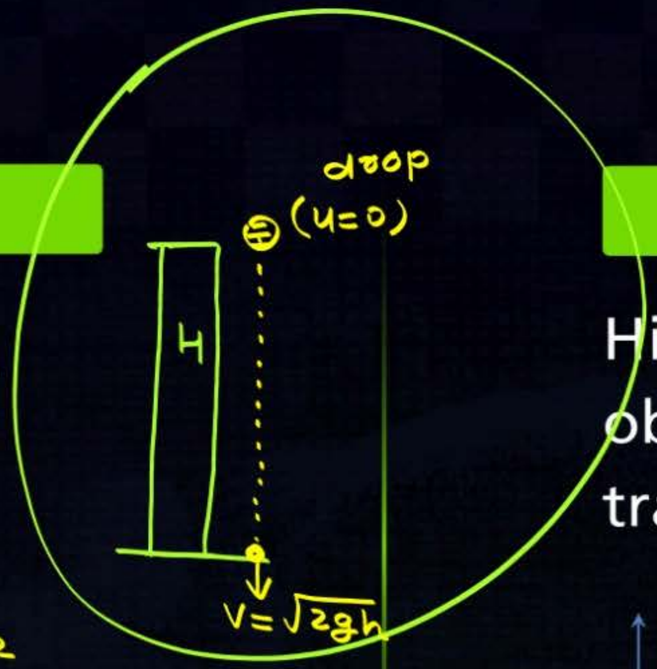
$s = ut + \frac{1}{2}at^2$

$0 = u(T) + \frac{1}{2}(-g)(T^2)$

$-u = -\frac{g}{2}(T)$

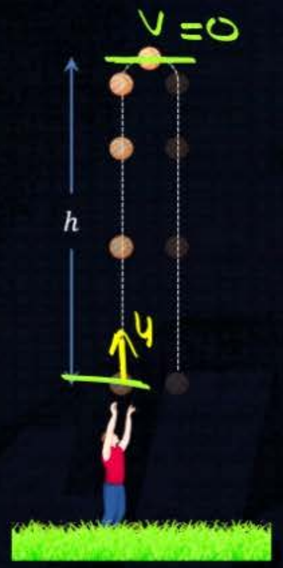
$$T = \frac{2u}{g}$$

$t_u = \frac{u}{g}$ & $t_d = \frac{u}{g}$



Maximum Height

Highest vertical position an object reaches during its trajectory.



3rd EOM

$v^2 - u^2 = 2as$

$-u^2 = 2(-g)H$

$$H = \frac{u^2}{2g}$$

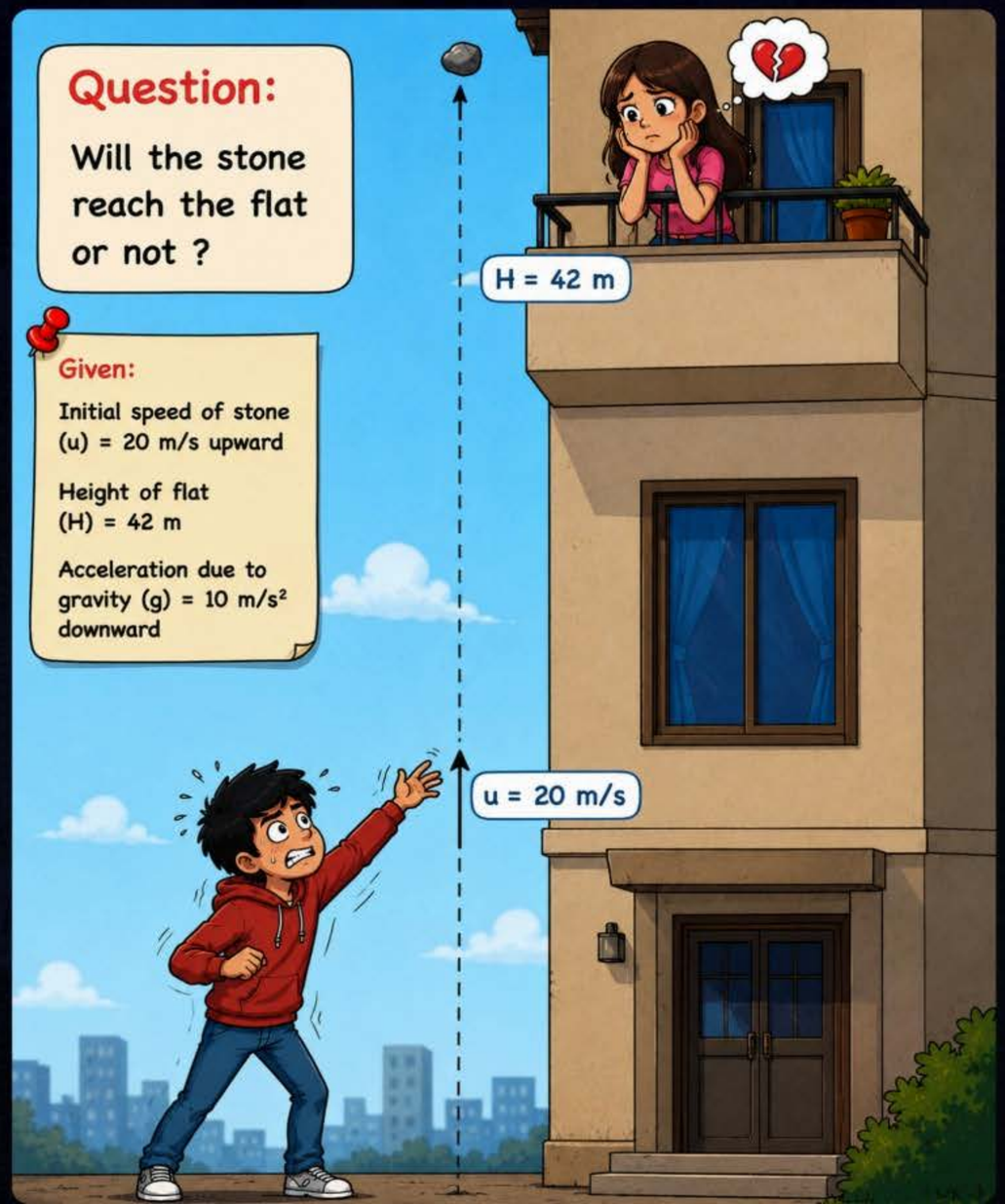
BACKLOG MARATHON SERIES

Next Toppers

Que.

(i) $H_{max} = \frac{u^2}{2g} = \frac{(20 \times 20)}{2(10)} = 20\ m$

(ii) $T = \frac{2u}{g} = \frac{2(20)}{10} = 4\ sec..$



Sol.

Will the stone reach the flat?	Time of flight (to reach ground)	Maximum height reached by stone
No	4 s	20 m

Galileo's law of odd numbers

When body falling freely from rest, distance travelled during equal time intervals are in ratio

1 : 3 : 5 : 7 : 9 : 11 ..

Time (second)	Distance from start, s (m)	Distance covered in that second (m)
1	5	5 = 1 × 5
2	20	15 = 3 × 5
3	45	25 = 5 × 5
4	80	35 = 7 × 5
5	125	45 = 9 × 5

Observation

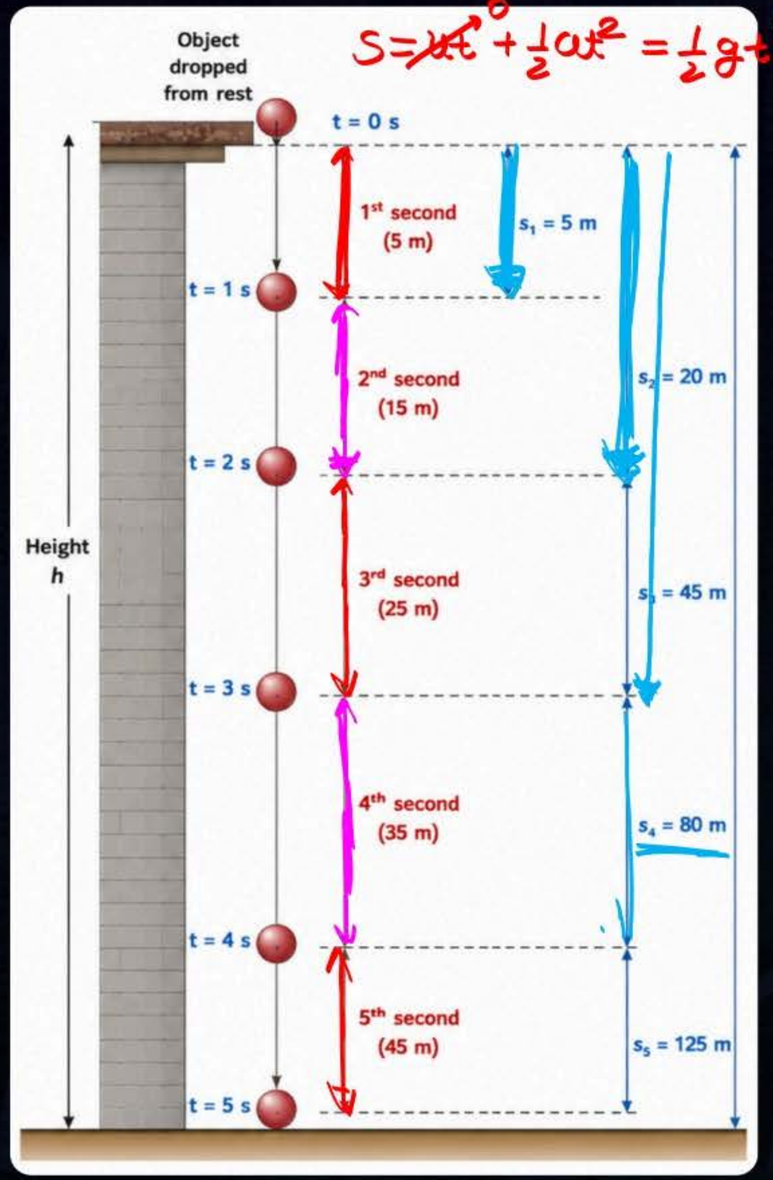
Distance covered in each second:

5 m, 15 m, 25 m, 35 m, 45 m, ...

↓

Ratio

1 : 3 : 5 : 7 : 9 : ...



BACKLOG MARATHON SERIES

Next Toppers

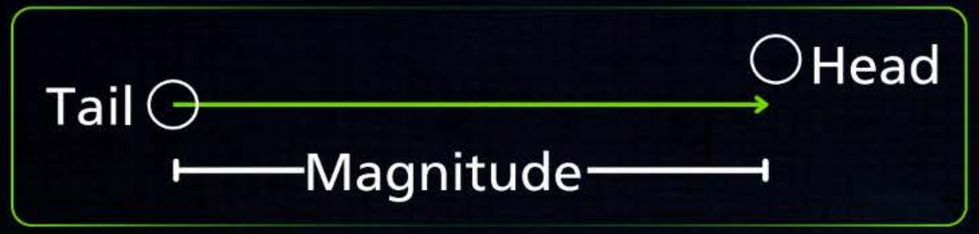
Motion In a Plane

Chapter-3

Vector Quantities

Scalar Quantities	Vector Quantities
• Has only magnitude. • Direction is not important. • Follows simple algebra rules. • Examples : 1. Speed, 2. Distance, 3. Time	• Has both magnitude and direction. • Direction is essential. • Follows vector algebra rules. • Examples : 1. Velocity, 2. Displacement, 3. Force

Graphically Representation



- Tail → Starting point of the vector
- Head → Arrow end showing direction
- Length of arrow → Represents magnitude

Algebraic Representation

$\vec{A}$ = (Magnitude) (Direction)

- i → unit vector along x-axis
- j → unit vector along y-axis
- k → unit vector along z-axis

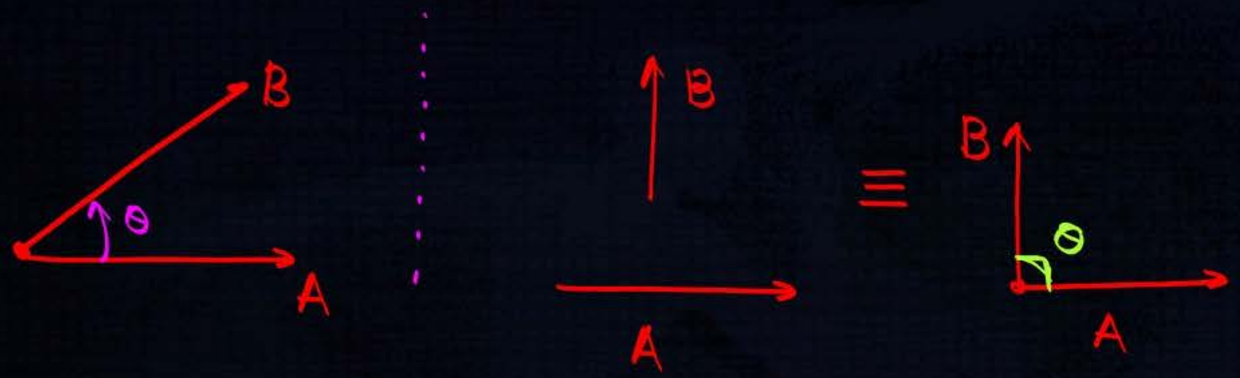
$\overrightarrow{5} \Rightarrow 5\hat{i}$

$\uparrow 10 \Rightarrow 10\hat{j}$

Marathon

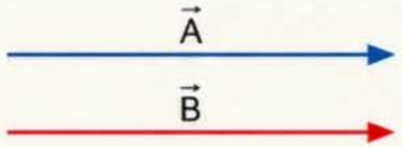
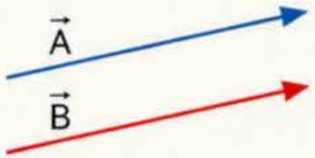
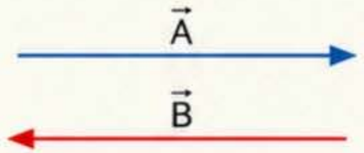
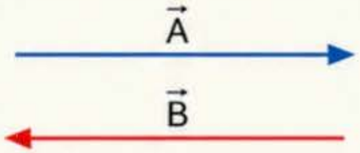
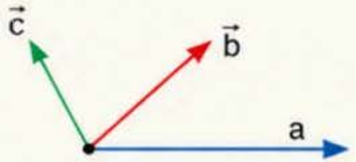
Angle between Vectors

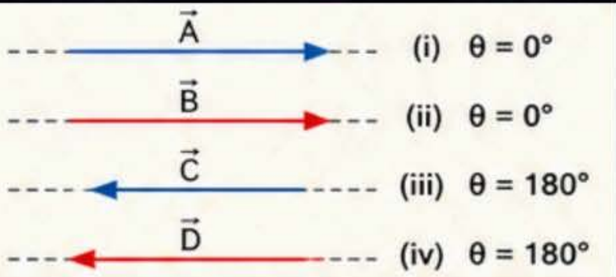
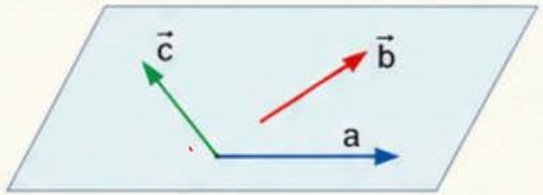
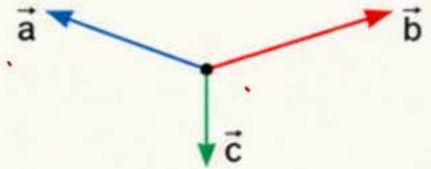
- Angle between two vectors means smaller of the two angles between the vectors when they are placed tail to tail.



A vector can be displaced parallel to itself without changing its magnitude and direction.

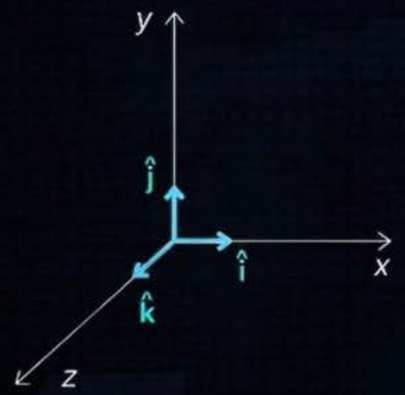
Marathon

Type of Vector	Definition	Diagram	Key Points
1. Parallel Vectors	Vectors having the same direction are called parallel vectors.		• Same direction • Angle between them is 0°
2. Equal Vectors	Vectors having the same magnitude and same direction are called equal vectors.		• Same magnitude • Same direction • $\vec{A} = \vec{B}$
3. Anti-parallel Vectors	Vectors having opposite directions but along the same line are called anti-parallel vectors.		• Opposite direction • Angle between them is 180°
4. Negative (Opposite) Vectors	Vectors having equal magnitude but opposite direction are called negative vectors of each other.		• Equal magnitude • Opposite direction • $\vec{B} = -\vec{A}$
5. Co-initial Vectors	Vectors having the same initial point are called co-initial vectors.		• Same initial point • $\vec{a}$, $\vec{b}$ and $\vec{c}$ are co-initial vectors

6. Collinear Vectors	Vectors lying along the same line are called collinear vectors.		• Angle between them is 0° or 180°
7. Coplanar Vectors	Vectors lying in the same plane are called coplanar vectors.		• All vectors are in the same plane • Any two vectors are always coplanar
8. Concurrent Vectors	Vectors passing through a common point are called concurrent vectors.		• Common point • $\vec{a}$, $\vec{b}$ and $\vec{c}$ are concurrent vectors
9. Null (Zero) Vector	A vector having zero magnitude is called null or zero vector.	$\vec{0}$	• Magnitude = 0 • $\vec{A} + (-\vec{A}) = \vec{0}$
10. Unit Vector	A vector having unit magnitude is called unit vector.	$\vec{A} \rightarrow \hat{A} = \frac{\vec{A}}{\lvert\vec{A}\rvert}$	• Magnitude = 1 • Used to specify direction • $\vec{A} = \lvert\vec{A}\rvert \hat{A}$

Unit Vector

- It is a vector of unit magnitude and points in a particular direction.



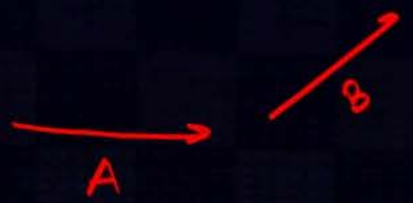
- Vector divided by its own magnitude is a vector with unit magnitude and direction along the parent vector.

Marathon

BACKLOG MARATHON SERIES

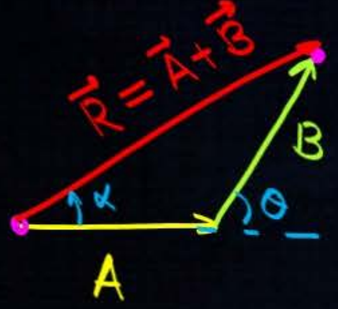
Next Toppers

$\vec{A}+\vec{B}=\vec{R}$

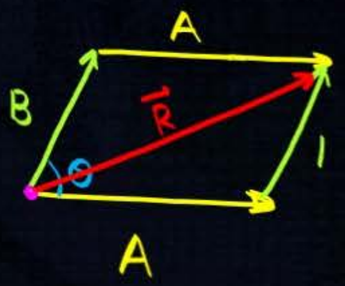


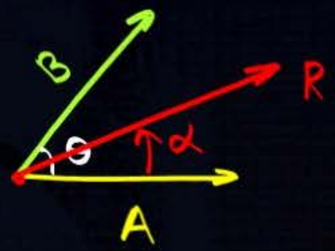
Addition of Vectors by Graphical Methods

(i) Triangle law



(ii) Parallelogram Law





$$R=\sqrt{A^2+B^2+2AB\cos\theta}$$

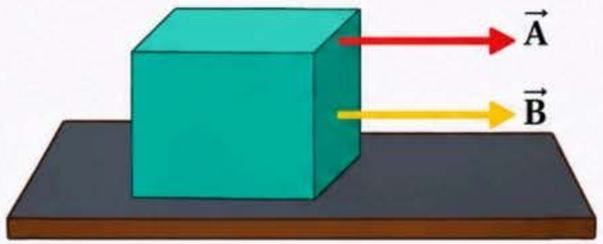
- $\theta=0^\circ$ → $R=A+B$
- $\theta=90^\circ$ → $R=\sqrt{A^2+B^2}$
- $\theta=180^\circ$ → $R=|A-B|$

$$\tan\alpha=\frac{B\sin\theta}{A+B\cos\theta}$$

Marklion

1) IF TWO VECTORS ARE PARALLEL

Same direction



$\theta = 0°$

$$|\vec{R}| = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

$$|\vec{R}| = \sqrt{A^2 + B^2 + 2AB\cos 0°}$$

$$|\vec{R}| = A + B$$

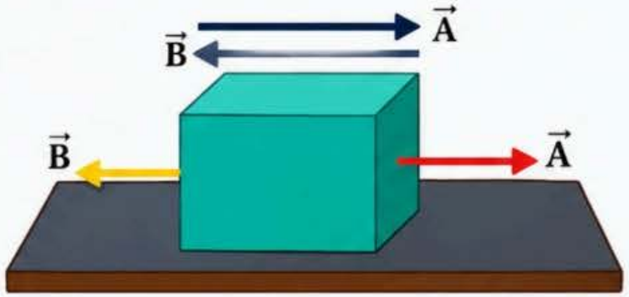
Resultant is the **SUM**

KEY IDEA

When vectors point in the **same direction**, their magnitudes **add up**!

2) IF TWO VECTORS ARE ANTI-PARALLEL

Opposite direction



$\theta = 180°$

$$R = \sqrt{A^2 + B^2 + 2AB\cos 180°}$$

$$R = \sqrt{A^2 + B^2 - 2AB}$$

$$|\vec{R}| = |A - B|$$

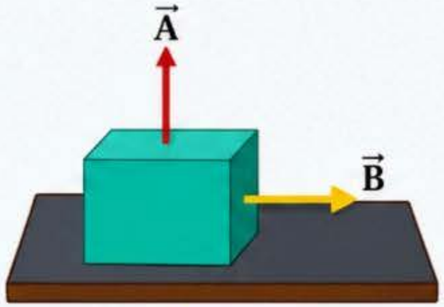
Resultant is the **DIFFERENCE**

KEY IDEA

When vectors point in **opposite directions**, their magnitudes **subtract**!

3) IF TWO VECTORS ARE PERPENDICULAR

At right angles



$\theta = 90°$

$$|\vec{R}| = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

$$|\vec{R}| = \sqrt{A^2 + B^2 + 2AB\cos 90°}$$

$$|\vec{R}| = \sqrt{A^2 + B^2}$$

KEY IDEA

When vectors are **perpendicular**, use **Pythagoras theorem**!

BACKLOG MARATHON SERIES

Next Toppers

Que.

Two vectors A and B have magnitudes 3 and 4. Calculate the maximum and minimum resultant magnitudes.

$\theta = 0$

$R = A + B$

$= 3 + 4$

$= 7$

$\theta = 180^\circ$

$R = |A - B|$

$= |3 - 4|$

$= 1$

Marathon

Que.

Two vectors A and B have magnitudes 3 and 4. Calculate the maximum and minimum resultant magnitudes. [NCERT; Delhi 24]

Ans.

$R_{max} = A + B = 3 + 4 = 7$

$R_{min} = |A - B| = |3 - 4| = 1$

Marathon

BACKLOG MARATHON SERIES

Next Toppers

Que.

(2)

If the magnitude of sum of two vectors is equal to the magnitude of difference of the two vectors, the angle between these vectors is.

a. 90°
b. 180°
c. 45°
d. 0°

"Comment"

5A

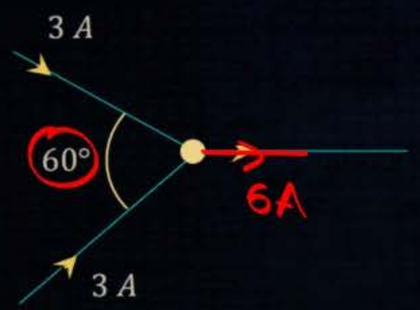
Maitalk

BACKLOG MARATHON SERIES

Next Toppers

Que.

Explain the statement: "Current is a scalar although we represent current with an arrow". [CBSE 2026]



$$R = \sqrt{A^2 + B^2 + 2AB\cos\theta}$$

- It does not follow vector addition laws,
- Currents at a junction are added algebraically, not vectorially.

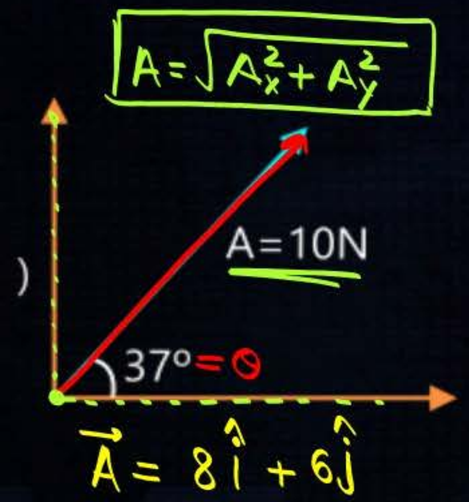
BACKLOG MARATHON SERIES

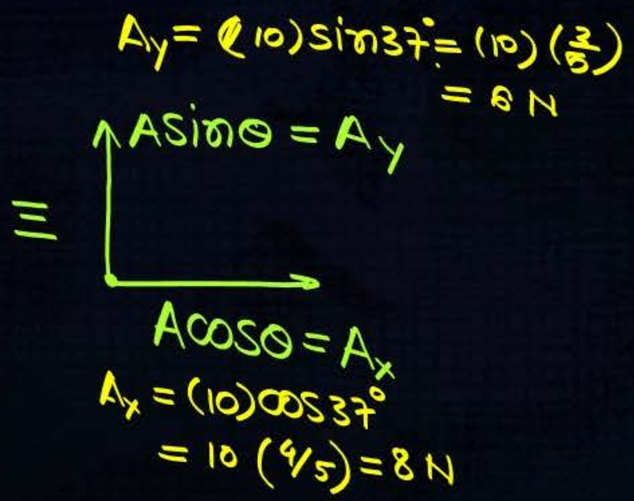
Next Toppers

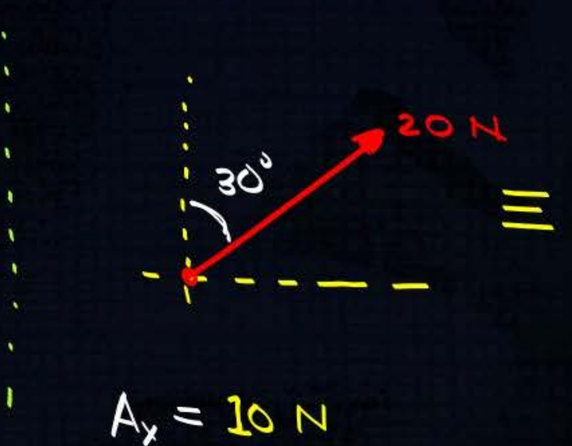
Vector Resolution

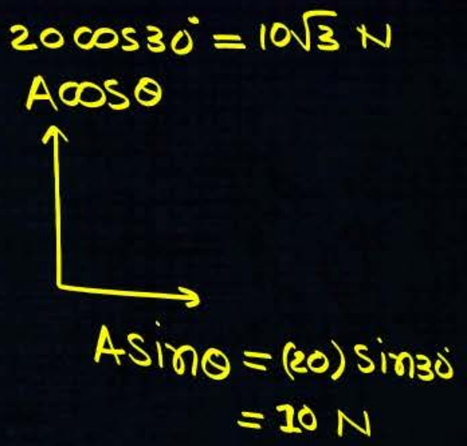
(12th)

- To break a vector in components is called resolution of vector
- Any vector can be split in two or more than two components.









- θ के पास वाला component = A cosθ
- θ के सामने वाला component = A sinθ

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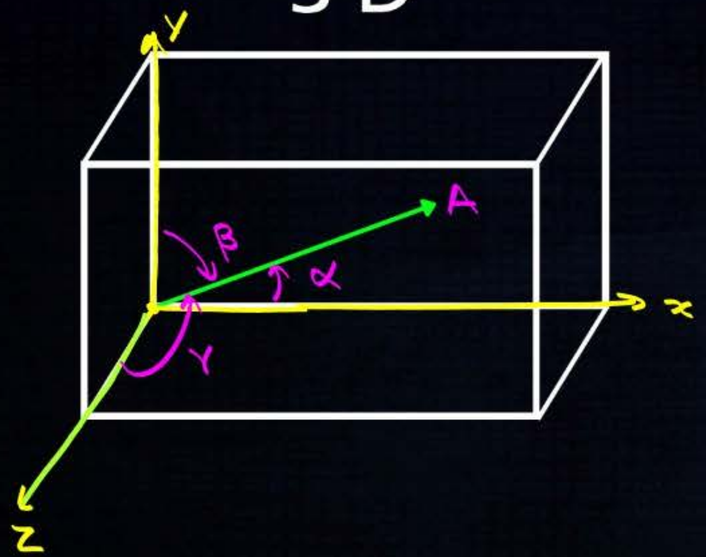
Next Toppers

Rectangular Components

3 D



$$A_x = A\cos\alpha$$

$$A_y = A\sin\beta$$

$$A_z = A\sin\gamma$$

$$A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

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Motion in a Plane

- When the motion of an object is restricted within a plane, it is said to undergo a Motion in a Plane or 2D
- 2D Motion can be studied as two independent 1D motions

1. Motion of a Carrom Coin

2. Projectile Motion

3. Circular Motion

$\vec{v} = v_x \hat{i} + v_y \hat{j}$

$\vec{a} = a_x \hat{i} + a_y \hat{j}$

x	y
v_x, a_x	v_y, a_y

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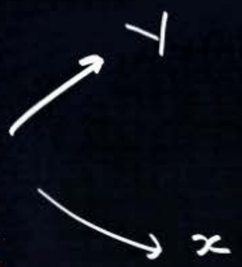
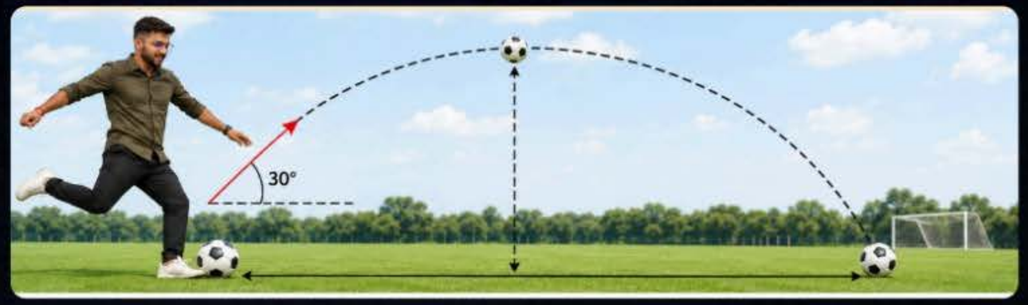
Projectile Motion

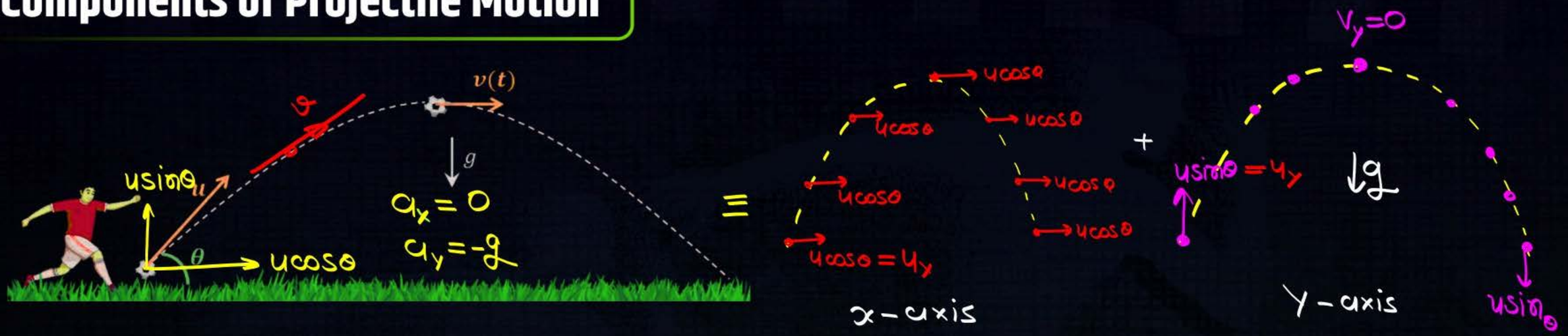
A body thrown in air with some initial velocity that moves under gravity only is called projectile motion.





The projectile forms a parabolic path

Components of Projectile Motion



- Projectile motion can be treated as :
  - Horizontal motion → Uniform motion
  - Vertical motion → Accelerated motion under gravity g
- Curve's Tangent = Direction of Velocity
- Time is common for both x and y motions.

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Que.

At the highest point of a projectile, which component of velocity becomes zero and why?

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Next Toppers

Que.

At the highest point of a projectile, which component of velocity becomes zero and why?

Ans.

At the Highest Point of a Projectile

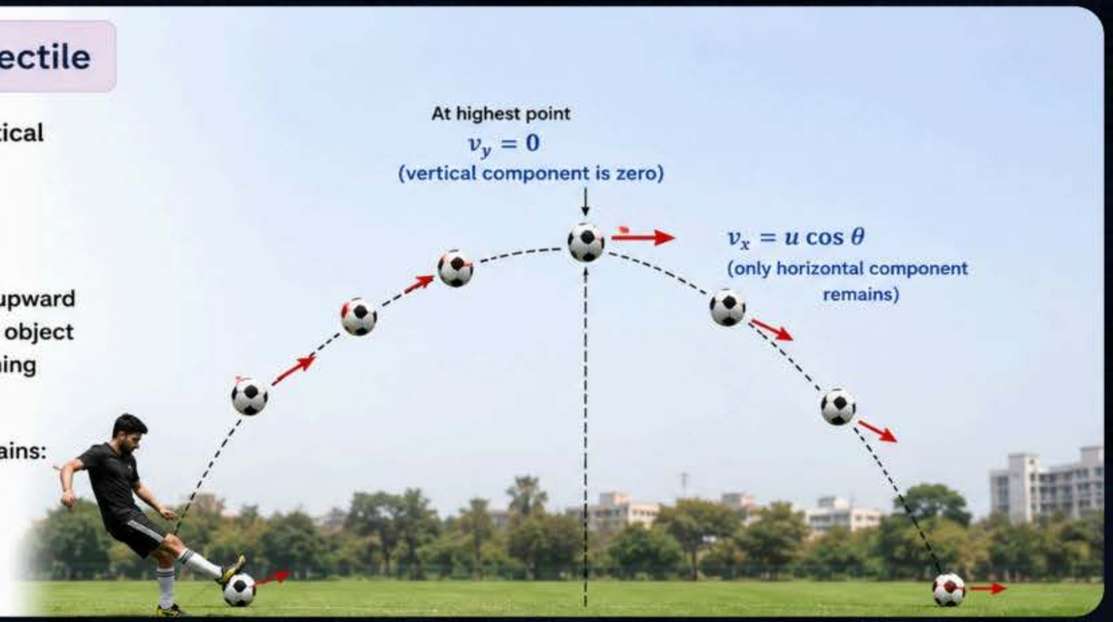
At the highest point of a projectile, the vertical component of velocity becomes zero.

$$v_y = 0$$

This happens because gravity slows down the upward motion of the object. At the topmost point, the object stops moving upward for an instant before coming downward.

Only the horizontal component of velocity remains:

$$v_x = u \cos \theta$$



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Que.

Why is horizontal velocity constant in projectile motion?

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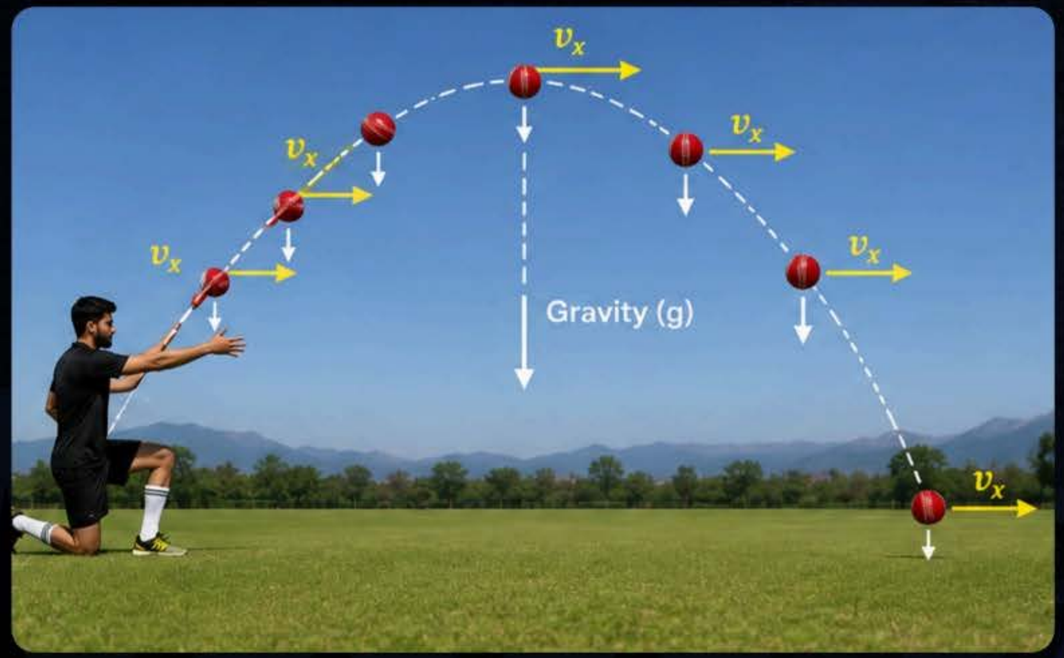
Que.

Why is horizontal velocity constant in projectile motion?

Ans.



Horizontal velocity remains constant because there is no force acting on the projectile in the horizontal direction (ignoring air resistance).

- The only force acting on the projectile is gravity, which acts vertically downward.
- Since gravity has no horizontal component, it cannot change the horizontal motion.
- Therefore, the horizontal velocity remains constant throughout the flight.

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Que.

Why is vertical velocity not constant?

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Next Toppers

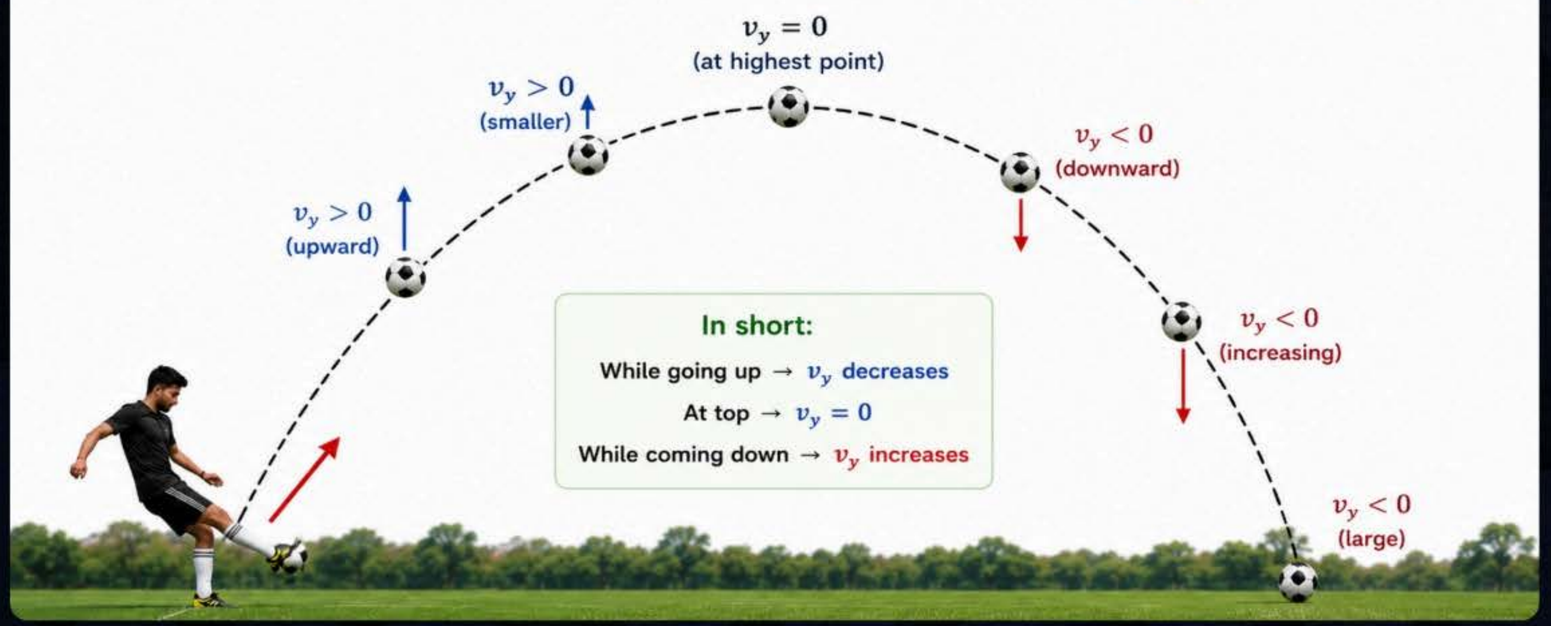
Que.

Why is vertical velocity not constant?

Ans.

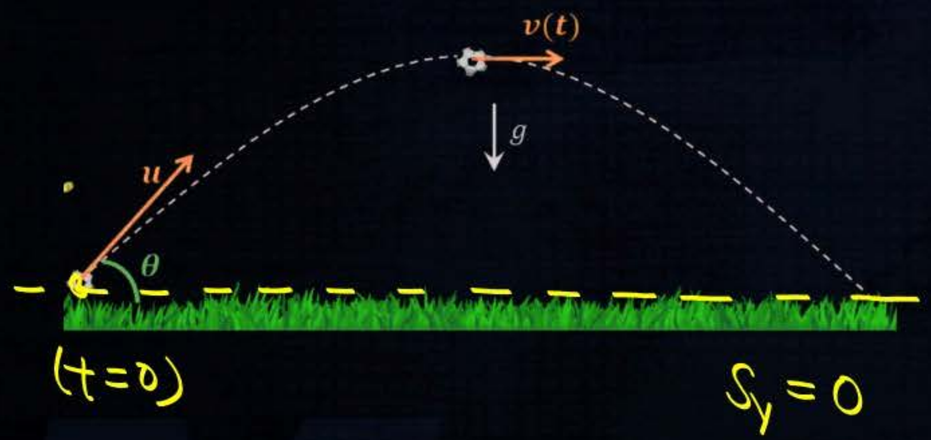
Because gravity acts on the ball in the vertical direction all the time.

Gravity pulls the ball downward, so its vertical velocity keeps changing.



Time of Flight (T)

The total time taken by a projectile to complete its motion in air is called time of flight.



y-axis

$S_y = ut + \frac{1}{2}at^2$

$0 = u_y T + \frac{1}{2}(-g)T^2$

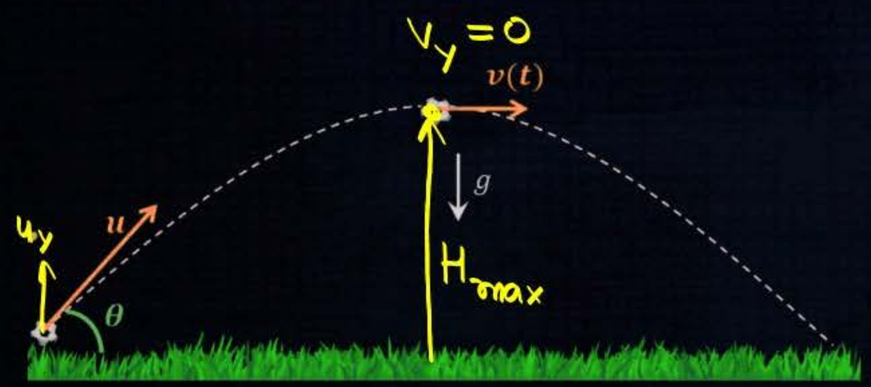
$$T = \frac{2u_y}{g}$$

$t_{up} = \frac{u_y}{g}$ & $t_{down} = \frac{u_y}{g}$

Marathon

Maximum Height (H_{max})

Maximum height is the highest vertical position reached by a projectile during its trajectory.



y-axis

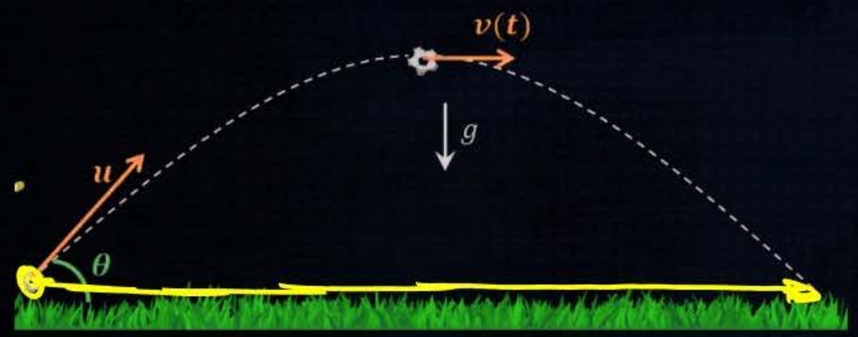
$$v_y^2 - u_y^2 = 2as_y$$

$$0 - u_y^2 = 2(-g)(H)$$

$$\boxed{H = \frac{u_y^2}{2g}}$$

Horizontal Range (R)

Horizontal range is the total horizontal distance travelled by a projectile during its motion.



x-axis

Uniform Motion

Distance = speed × time

$= u_x \left(\frac{2u_y}{g}\right)$

$$R = \frac{2u_x u_y}{g}$$

$$R = \frac{2(u\cos\theta)(u\sin\theta)}{g}$$

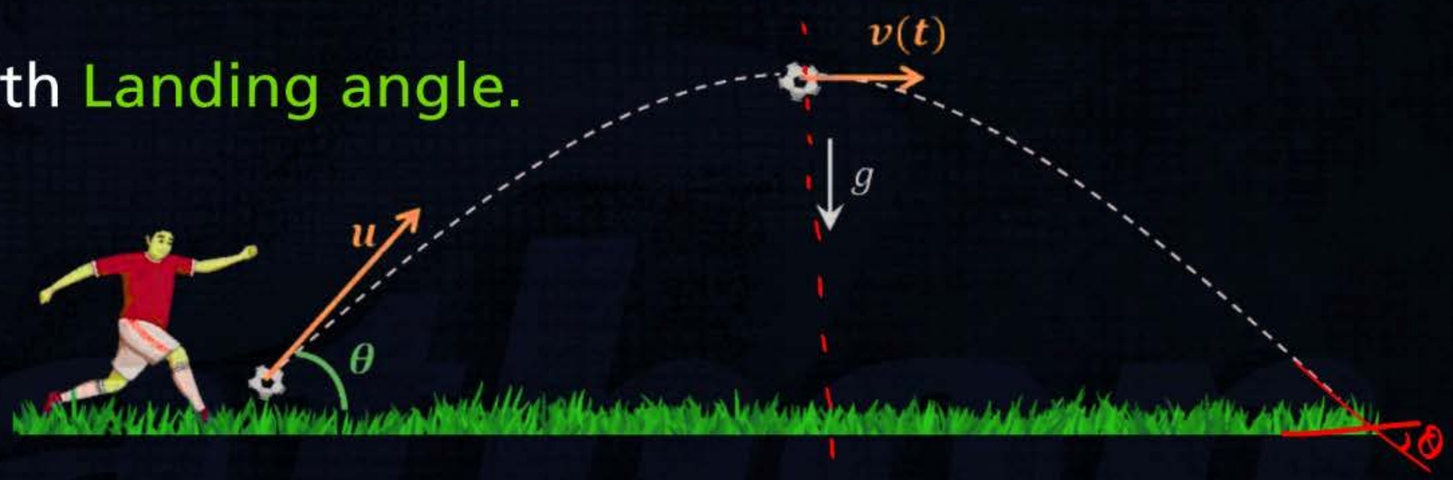
$$= \frac{u^2}{g}(2\sin\theta\cdot\cos\theta)$$

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

$\theta = ?$ (↑ 45°) $\Rightarrow R_{max} = \frac{u^2}{g}$

IMP Points about Projectile Motion

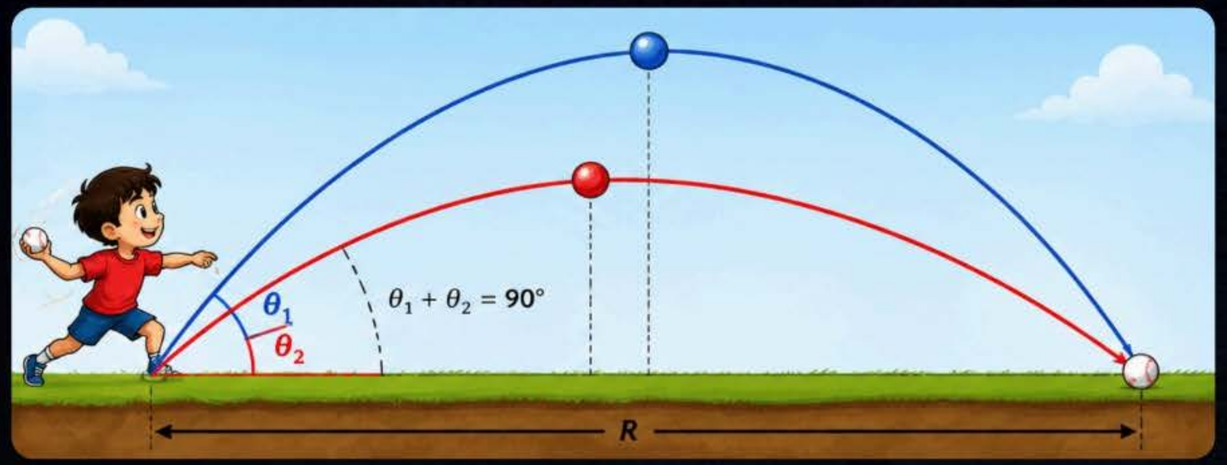
1. Path is symmetric about vertical line at R/2.
2. Maximum height occurs halfway through the flight of the projectile.
3. Time of ascent = Time of descent $= \frac{u_y}{g}$
4. On the same horizontal level vertical velocity is the same, only the direction is reversed.
5. Launch angle is symmetric with Landing angle.



Marathon

$\theta_1 + \theta_2 = 90^\circ \Rightarrow R_{\theta_1} = R_{\theta_2}$

6. Two projectiles having complementary angles ($\theta_1 + \theta_2 = 90°$) when projected from the same point will cover the same horizontal range.



MATHEMATICAL PROOF

Let the two complementary angles be θ_1 and θ_2 such that

$\theta_1 + \theta_2 = 90°$

$\Rightarrow \theta_2 = 90° - \theta_1$

Range for θ_1:

$$R_1 = \frac{u^2 \sin 2\theta_1}{g}$$

Range for θ_2:

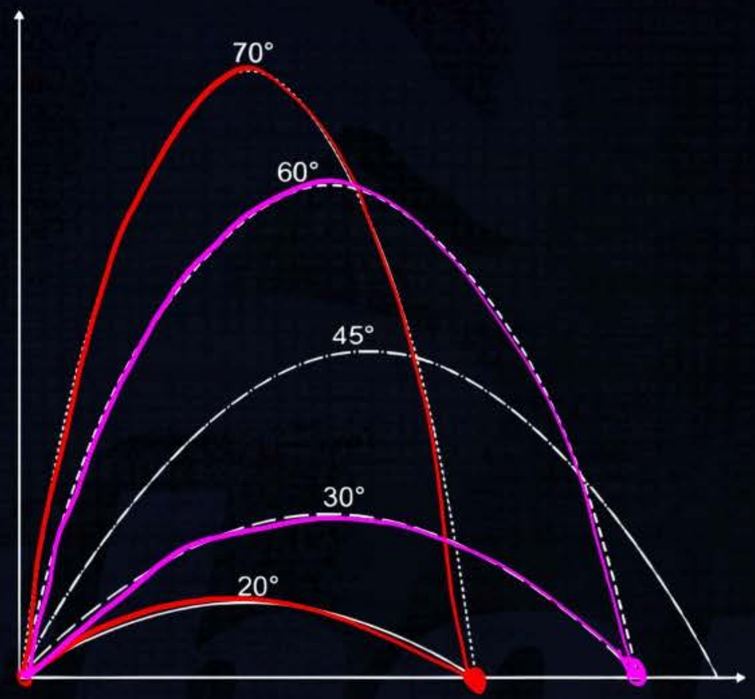
$$R_2 = \frac{u^2 \sin 2\theta_2}{g} = \frac{u^2 \sin 2(90° - \theta_1)}{g}$$

USING TRIGONOMETRY

$$R_2 = \frac{u^2 \sin (180° - 2\theta_1)}{g}$$

$$R_2 = \frac{u^2 \sin 2\theta_1)}{g}$$

$\star$ $R_1 = R_2$



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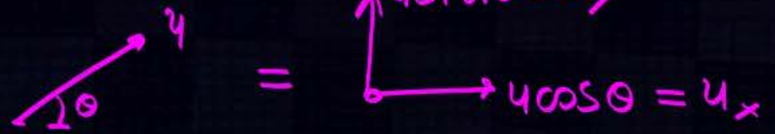
Que.



A cricket ball is thrown at a speed of 28 m s^{-1} in a direction 30° above the horizontal. Calculate

(a) the maximum height, $\Rightarrow H_{max} = \frac{u_y^2}{2g}$

(b) the time taken by the ball to return to the same level, and $T = \frac{2u_y}{g}$

(c) the distance from the thrower to the point where the ball returns to the same level. $\Rightarrow R = \frac{2u_x u_y}{g}$

[NCERT Example 8, Central Schools , Delhi 2023]

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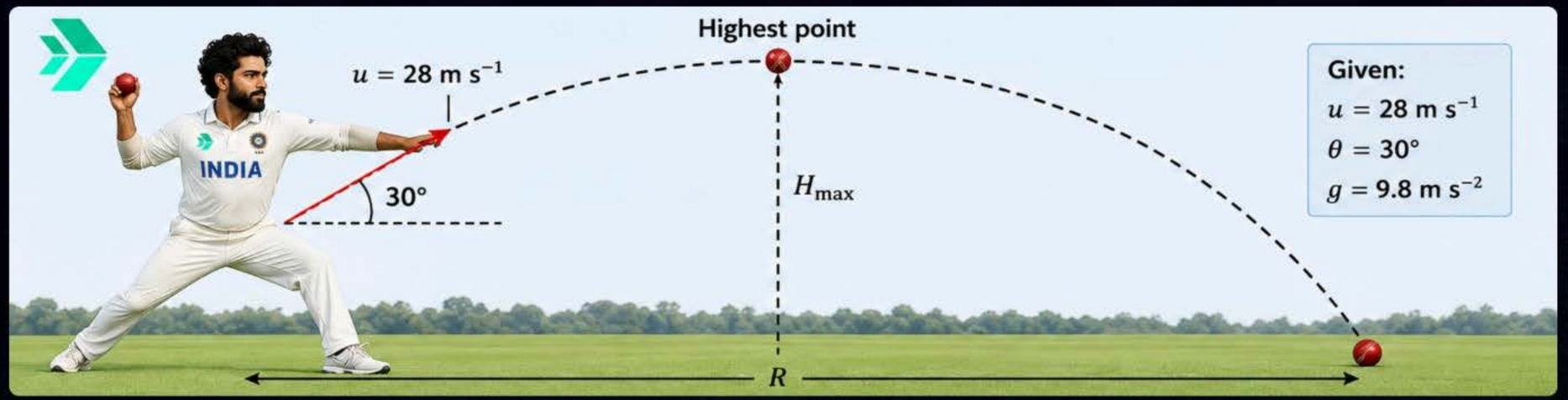

Marathon

(a) Maximum height (H_{max})

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

$$= \frac{(28)^2 (\sin 30°)^2}{2 \times 9.8}$$

$$= \frac{784 \times (0.5)^2}{19.6}$$

$$= \frac{784 \times 0.25}{19.6}$$

$$= 10 \text{ m}$$

(b) Time of flight (T)

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

$$= \frac{2 \times 28 \times \sin 30°}{9.8}$$

$$= \frac{56 \times 0.5}{9.8}$$

$$= \frac{28}{9.8}$$

$$= 2.86 \text{ s}$$

(c) Horizontal range (R)

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

$$= \frac{(28)^2 \sin(60°)}{9.8}$$

$$= \frac{784 \times (\sqrt{3}/2)}{9.8}$$

$$= \frac{784 \times 0.866}{9.8}$$

$$= 69.3 \text{ m}$$

Answer: (a) 10 m (b) 2.86 s (c) 69.3 m

Marathon

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Que.

A bullet is fired from a gun at the speed of 280 ms^{-1} in the direction 30° above the horizontal. The maximum height attained by the bullet is.. ($g = 9.8\ m/s^2$)

a. 2000 m
b. 1000 m
c. 3000 m
d. 2800 m

$$H = \frac{u_y^2}{2g} = \frac{(u\sin\theta)^2}{2g}$$

Marathon

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Next Toppers

Que.

A bullet is fired from a gun at the speed of 280 ms^{-1} in the direction 30° above the horizontal. The maximum height attained by the bullet is..

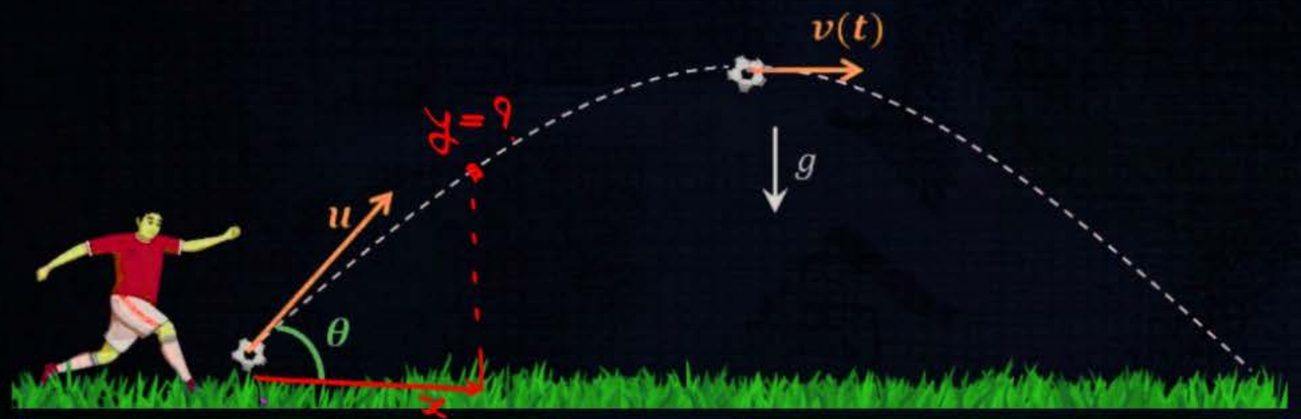
[Central School]

a. 2000 m
b. 1000 m
c. 3000 m
d. 2800 m

Marathon

Equation of Trajectory

- It is the equation that shows the path of a projectile, relating y and x, and proves that the path is a parabola



(1) $$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

$y = xb - ax^2 = bx - ax^2$

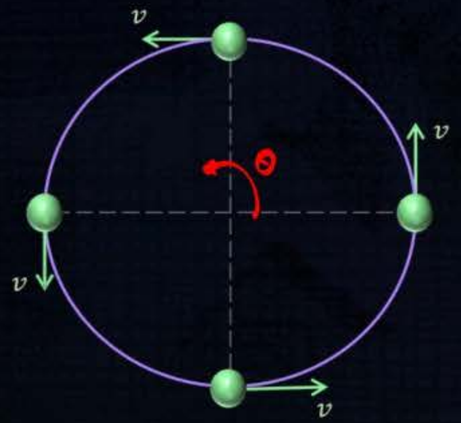
$y \propto -x^2$

(2) $$y = x\tan\theta\left(1 - \frac{x}{R}\right)$$

R → Range

Uniform Circular Motion (UCM)

When a particle moves on a circular path with constant speed, then its motion is called uniform circular motion



$v_t = R\omega$

- Tangential Speed(v) is constant.
- Angular Speed (ω) is constant. $= \omega = \frac{\theta}{t}$
- UCM is a periodic motion.

$\text{Speed} = \frac{\text{Distance}}{t}$

$v = \frac{2\pi R}{T}$

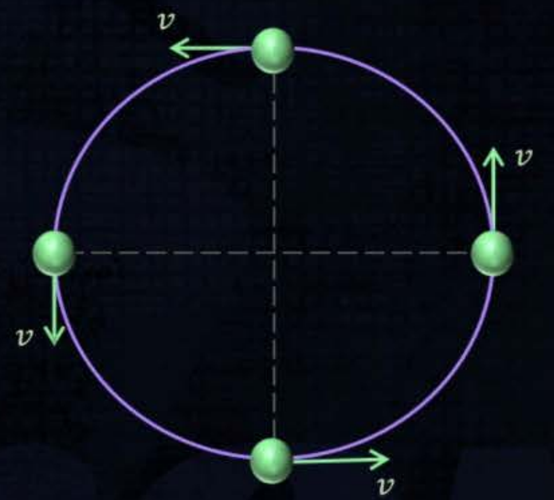
$T = \frac{2\pi R}{v}$

$T = \frac{2\pi R}{R\omega}$

$T = \frac{2\pi}{\omega}$

Que.

The particle is moving with a constant speed (v) along a circular path. Is the particle accelerating ?



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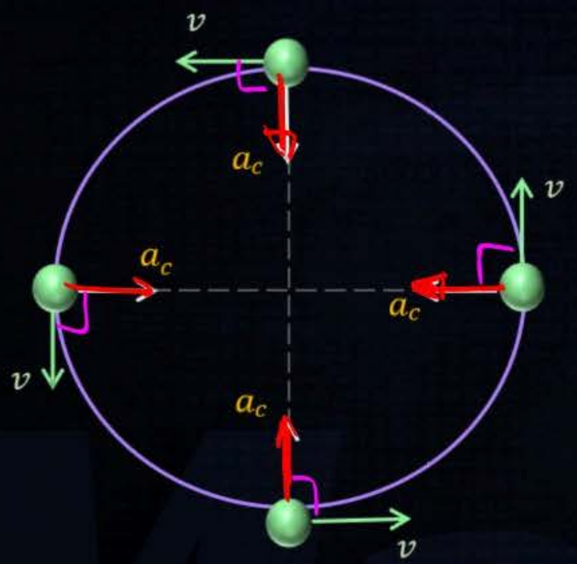
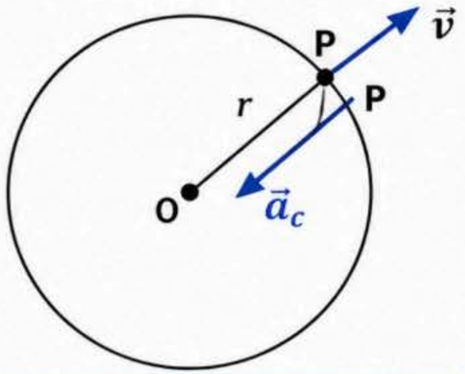
Que.

The particle is moving with a constant speed(v) along a circular path. Is the particle accelerating ?



- UCM is accelerated.
- Acceleration changes only the direction of linear velocity.
- It is perpendicular to the velocity at all times.
- It is also radially inwards at all times.

CENTRIPETAL ACCELERATION



$$a_c = \frac{v^2}{r} = \omega^2 r$$

- Directed towards the center (radially inward).
- Causes change in direction of velocity.
- Responsible for circular motion.
- Depends on speed and radius.
- If speed or radius changes, its magnitude changes.
- Perpendicular to velocity.

Exists even in uniform circular motion

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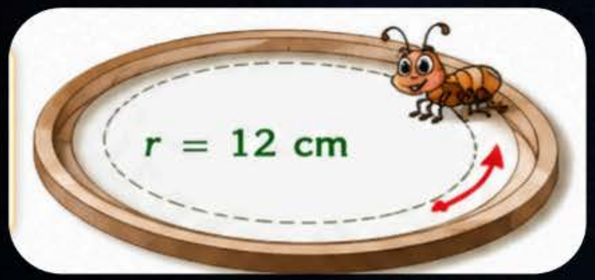
Que. 3

An insect trapped in a circular groove of radius 12 cm moves along the groove steadily and completes 7 revolutions in 100 s. (a) What is the angular speed, and the linear speed of the motion ? (b) Is the acceleration vector a constant vector ? What is its magnitude ?



(a) Angular speed and linear speed

Radius, $r = 12\ \text{cm} = 0.12\ \text{m}$

Number of revolutions, $n = 7$

Time taken, $t = 100\ \text{s}$

Angular speed,

$$\omega = \frac{2\pi n}{t} = \frac{2\pi \times 7}{100}$$

$$= 0.44\ \text{rad s}^{-1}$$

Linear speed,

$$v = \omega r = 0.44 \times 0.12$$

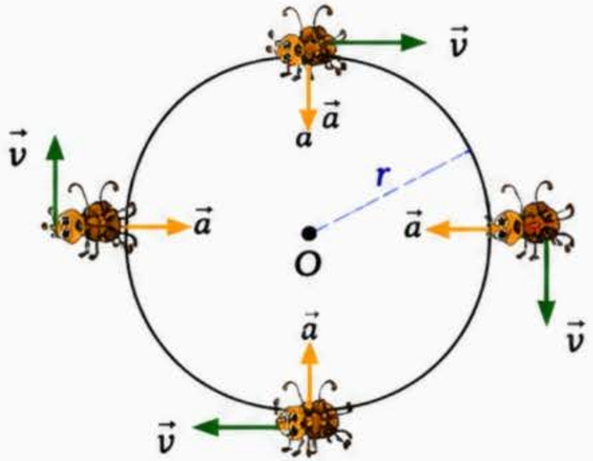
$$= 0.0528\ \text{m s}^{-1}$$

☆ The insect moves with a constant speed along the circular groove.

(b) Nature and magnitude of acceleration

The acceleration vector is NOT a constant vector.

Although the speed is constant, the direction of velocity keeps changing, so acceleration (which is towards the center) also changes direction continuously.



Magnitude of acceleration,

$$a = \frac{v^2}{r} = \frac{(0.0528)^2}{0.12}$$

$$= 0.0232\ \text{m s}^{-2}$$

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Next Toppers

8:45 PM

Laws of Motion

Chapter-4

How's
THE JOSH
Next
Toppers
प्रारंभ
BATCH

BACKLOG MARATHON SERIES

Next Toppers

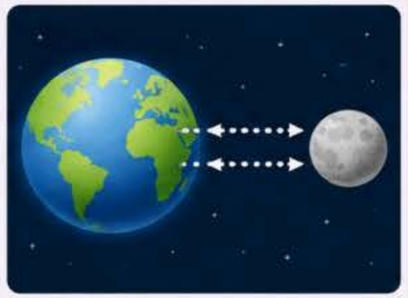
Force

A push or pull that changes or tends to...

- change the state of motion
- change direction of motion
- size or shape of a body.

1. Fundamental Forces in Nature

1. GRAVITATIONAL FORCE



Acts between masses.

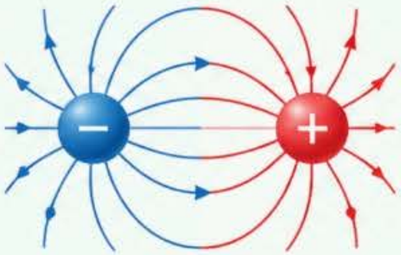
Always attractive.

Infinite range but very weak.

EXAMPLES

- Falling of objects
- Motion of planets
- Tides in oceans

2. ELECTROMAGNETIC FORCE



Acts between charged particles.

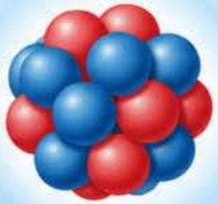
Can be attractive or repulsive.

Infinite range.

EXAMPLES

- Electricity
- Magnetism
- Light

3. STRONG NUCLEAR FORCE



Acts between nucleons (protons and neutrons).

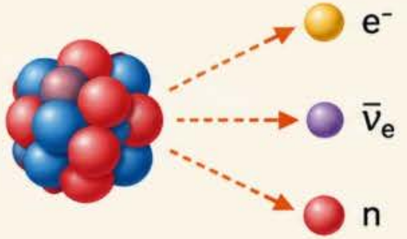
Always attractive.

Very short range ($\sim 10^{-15}$ m) but very strong.

EXAMPLES

- Holds the nucleus of an atom together
- Binding of protons and neutrons

4. WEAK NUCLEAR FORCE



Acts in some nuclear processes.

Responsible for radioactive decay.

Very short range.

EXAMPLES

- Beta decay
- Neutrino interactions
- Nuclear reactions in stars

1. Newton's First Law of Motion

- A body remains in the state of rest or uniform motion in a straight line unless and until an net external force acts on it

Law of Inertia

- Inertia is the natural tendency of a body to resist any change in its state of rest or motion.
- Inertia $\propto$ Mass

Types of Inertia

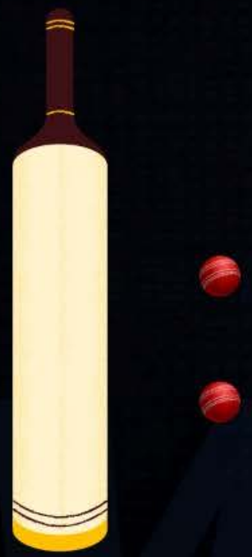
Of Rest

Of Motion

Of Direction

2. Newton's Second Law of Motion

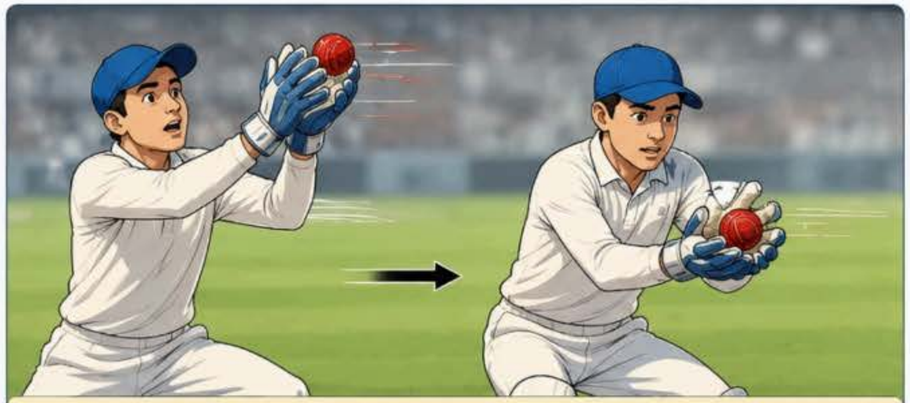
The rate of change of momentum of an object equals the net external force and is in the direction of net force applied



Marathon

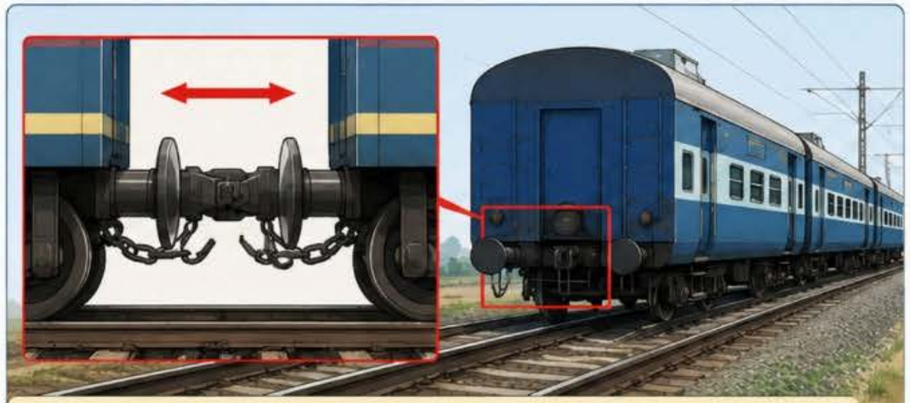
Impulse

When a large force is applied on a body for a very short interval of time, then the product of force and time interval is known as impulse.



(i) A cricketer lowers his hands while catching a ball so as to increase the time interval of momentum change, consequently the average reaction force on his hands decreases. So he can save himself from getting hurt.

(ii) Shockers are provided in vehicles to avoid jerks.



(iii) Buffers are provided in bogies of train to avoid jerks.

(iv) A person jumping on a hard cement floor receives more injury than a person jumping on muddy or sandy road.

BACKLOG MARATHON SERIES

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Que.

A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 m s^{-1}. How long does the body take to stop ?

[NCERT EXERCISE 5]

Mathon

BACKLOG MARATHON SERIES

Next Toppers

8:45 PM

Laws of Motion

Chapter-4

How's
THE JOSH
Next
Toppers
प्रारंभ
BATCH

BACKLOG MARATHON SERIES

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Force

A push or pull that changes or tends to...

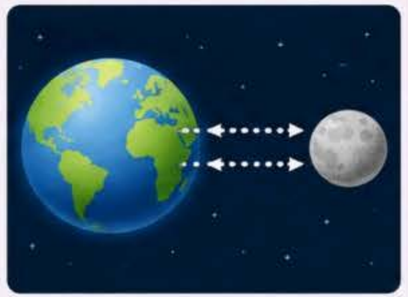
- change the state of motion
- change direction of motion
- size or shape of a body.

BACKLOG MARATHON SERIES

Next Toppers

1. Fundamental Forces in Nature

1. GRAVITATIONAL FORCE



Acts between masses.

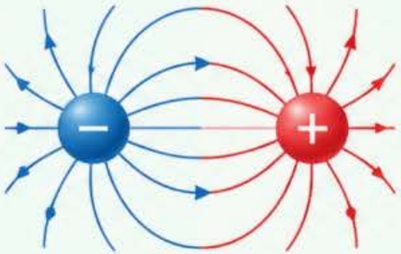
Always attractive.

Infinite range but very weak.

EXAMPLES

- Falling of objects
- Motion of planets
- Tides in oceans

2. ELECTROMAGNETIC FORCE



Acts between charged particles.

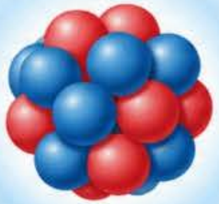
Can be attractive or repulsive.

Infinite range.

EXAMPLES

- Electricity
- Magnetism
- Light

3. STRONG NUCLEAR FORCE



Acts between nucleons (protons and neutrons).

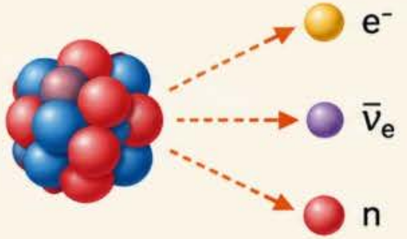
Always attractive.

Very short range ($\sim 10^{-15}$ m) but very strong.

EXAMPLES

- Holds the nucleus of an atom together
- Binding of protons and neutrons

4. WEAK NUCLEAR FORCE



Acts in some nuclear processes.

Responsible for radioactive decay.

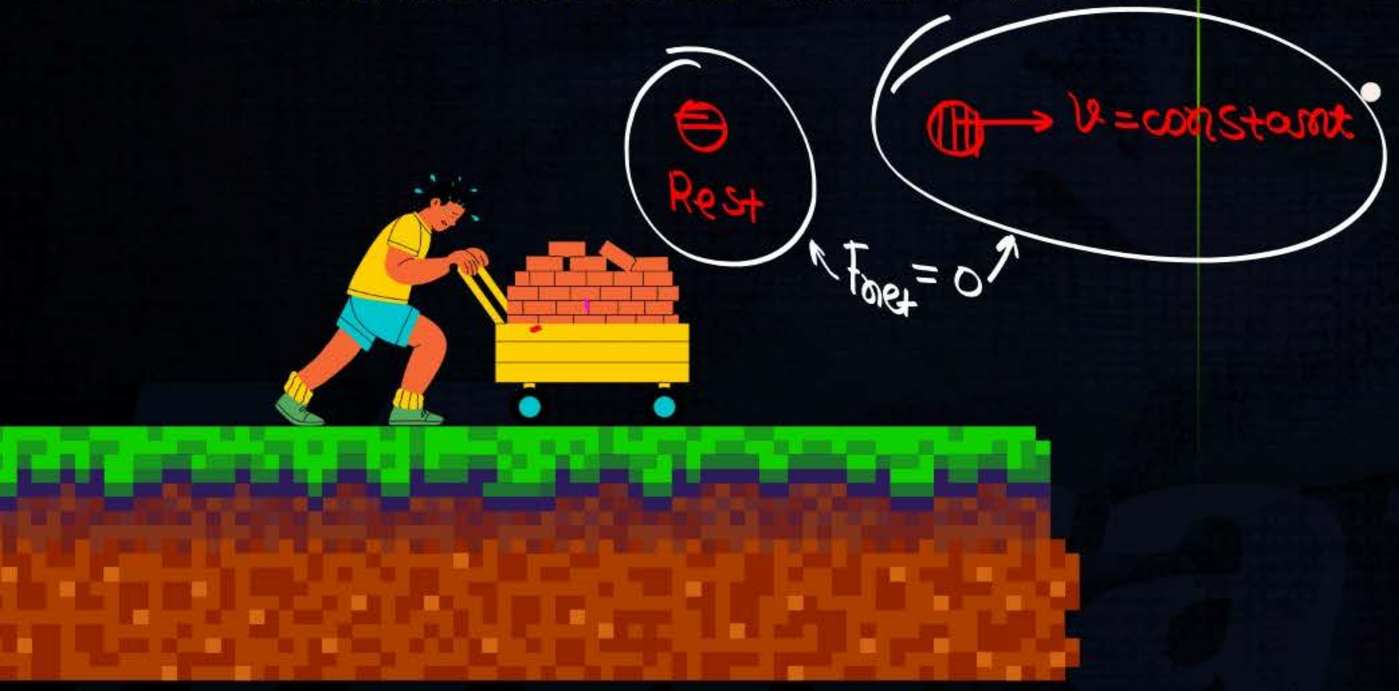
Very short range.

EXAMPLES

- Beta decay
- Neutrino interactions
- Nuclear reactions in stars

1. Newton's First Law of Motion

- A body remains in the state of rest or uniform motion in a straight line unless and until an net external force acts on it



Law of Inertia

- Inertia is the natural tendency of a body to resist any change in its state of rest or motion.
- Inertia ∝ Mass

Types of Inertia

Of Rest

Of Motion

Of Direction

2. Newton's Second Law of Motion

The rate of change of momentum of an object equals the net external force and is in the direction of net force applied

$$F = \frac{\Delta P}{\Delta t}$$

(F) → v (ii) $P_f = mv$

v ← (i) $P_i = -mv$

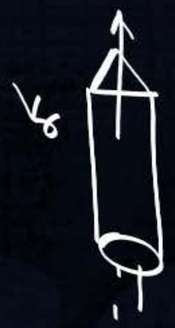
& $F_{inst.} = \frac{dP}{dt} = \frac{d(mv)}{dt}$ ($P \to mv$)

(i) $m = \text{const.}$ (ii) $m \neq \text{const.}$

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

$\boxed{F = ma}$ → $a = \text{const.}$

EOM ✓

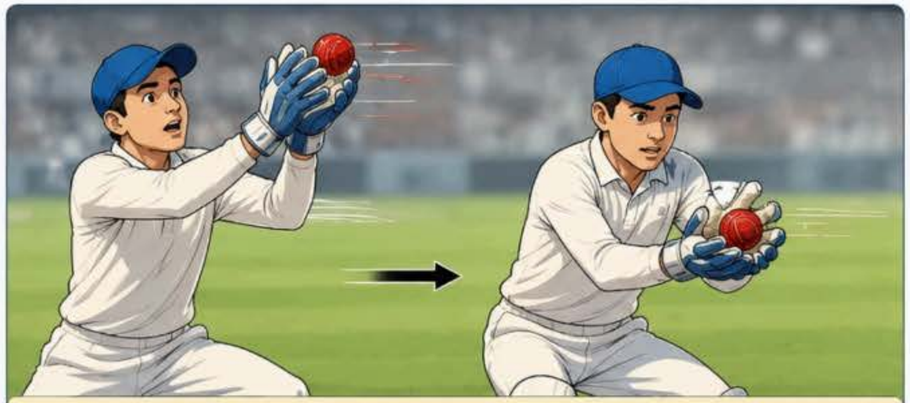


$\boxed{F_{thrust} = v_r \frac{dm}{dt}}$

Impulse

When a large force is applied on a body for a very short interval of time, then the product of force and time interval is known as impulse.

$$F_{large\,(avg.)} \downarrow = \frac{I}{t_{small} \uparrow}$$



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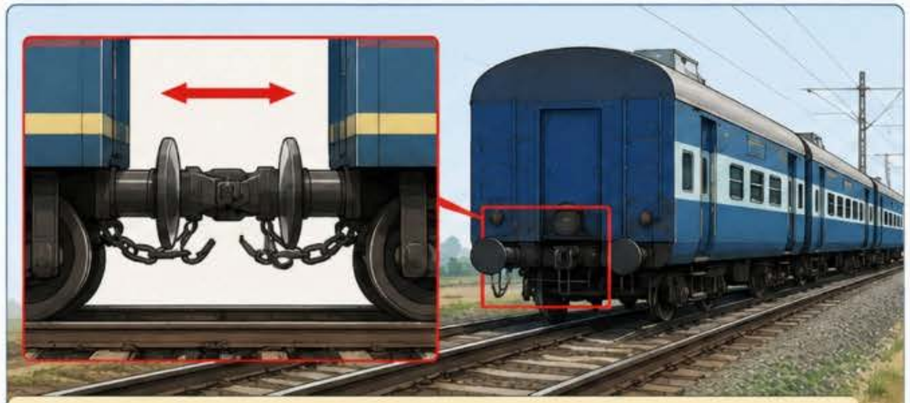


(iii) Buffers are provided in bogies of train to avoid jerks.

(iv) A person jumping on a hard cement floor receives more injury than a person jumping on muddy or sandy road.

BACKLOG MARATHON SERIES

Next Toppers

Que.

(NLM + 1D)

$f = ma$
$50 = (20)a$
$\Rightarrow a = \frac{5}{2}\ m/s^2$

A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 m s^{-1}. How long does the body take to stop ?

[NCERT EXERCISE 5]

$v = u + at$

$0 = 15 + (-\frac{5}{2})(t)$

$-15 = -\frac{5}{2}t$

$t = 6\ sec.$

$a = -\frac{5}{2}\ m/s^2$

Mahima

BACKLOG MARATHON SERIES

Next Toppers

Que.

A constant retarding force of 50 N is applied to a body of mass 20 kg moving initially with a speed of 15 m s^{-1}. How long does the body take to stop ?

[NCERT EXERCISE 5]

Ans.

45 m & 6 sec

Mathon

BACKLOG MARATHON SERIES

Next Toppers

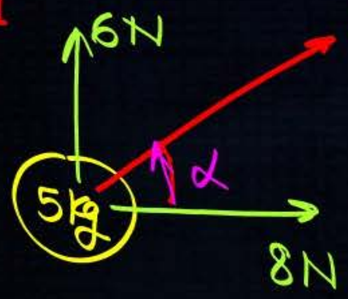
Que.

(NLM + Motion in 2D)

A body of mass 5 kg is acted upon by two perpendicular forces 8 N and 6 N. Give the magnitude and direction of the acceleration of the body

[NCERT EXERCISE 7]

Method-1



$F_{net} = \sqrt{F_x^2 + F_y^2}$

$= \sqrt{8^2 + 6^2}$

$= 10\ N$

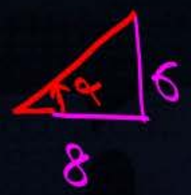
$F = ma$

$10 = 5(a)$

$a = 2\ m/s^2$

$\tan\alpha = \frac{6}{8}$

$= \frac{3}{4}$



Marathon

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Next Toppers

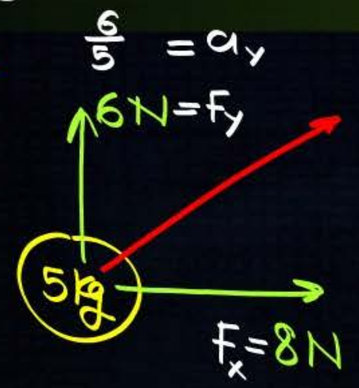
Que.

(NLM + Motion in 2D)

A body of mass 5 kg is acted upon by two perpendicular forces 8 N and 6 N. Give the magnitude and direction of the acceleration of the body

[NCERT EXERCISE 7]

Method-2



$a_x = \frac{8}{5}\ m/s^2$

$$\vec{a} = a_x \hat{i} + a_y \hat{j}$$

$$= \left(\frac{8}{5}\right)\hat{i} + \left(\frac{6}{5}\right)\hat{j}$$

$$|\vec{a}| = \sqrt{\left(\frac{8}{5}\right)^2 + \left(\frac{6}{5}\right)^2}$$

$$= 2\ m/s^2$$

$$F_{net} = ma$$

$$a = \frac{F_{net}}{m}$$

$$F_{net} = F_{\text{lejane wala}} - F_{\text{Rakne wala}}$$

BACKLOG MARATHON SERIES

Next Toppers

Que.

A body of mass 5 kg is acted upon by two perpendicular forces 8 N and 6 N. Give the magnitude and direction of the acceleration of the body

Ans.

[NCERT EXERCISE 7]

2 m/s & 37

Marathon

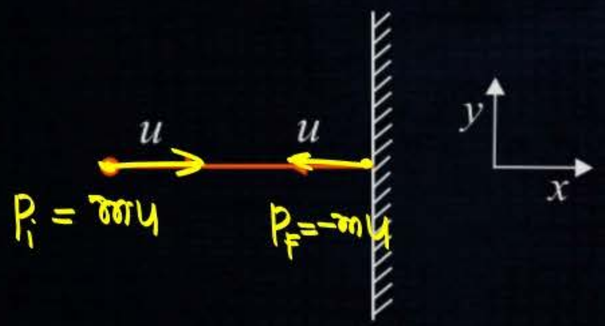
BACKLOG MARATHON SERIES

Next Toppers

Que.

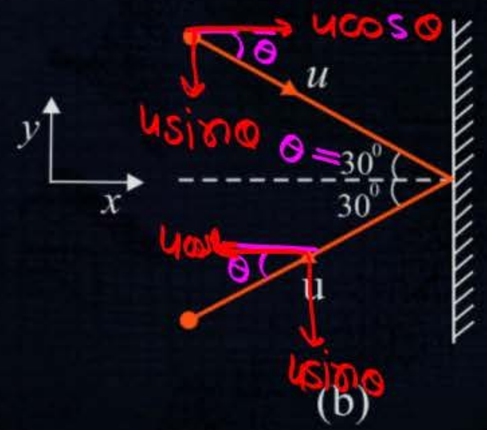
School

Two identical billiard balls strike a rigid wall with the same speed but at different angles, and get reflected without any change in speed, as shown. What is (i) the direction of the force on the wall due to each ball? [NCERT EX 5]

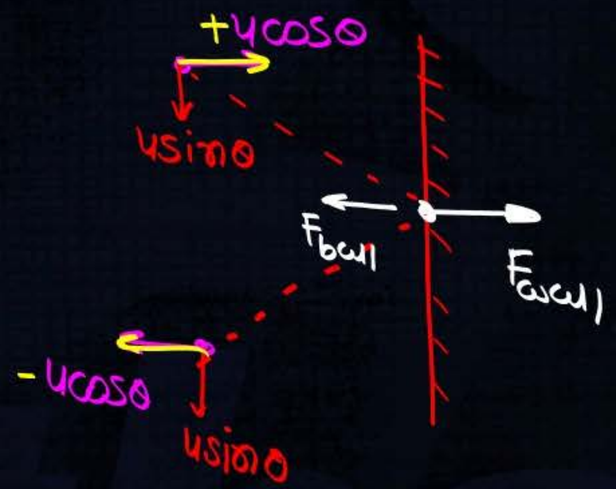


(a)

$\Delta P_{①} = |P_F - P_i| = 2mu$



(b)



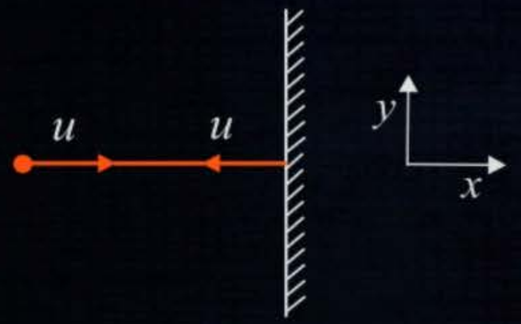
$\Delta P_{②} = 2mu\cos\theta$

BACKLOG MARATHON SERIES

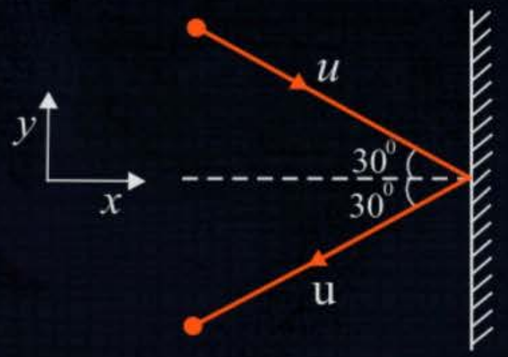
Next Toppers

Que.

(ii) What is the ratio of the magnitudes of impulses imparted to the balls by the wall ? [NCERT EX 5]



(a)



(b)

$$\frac{I_1}{I_2} = \frac{\Delta P_1}{\Delta P_2} = \frac{2mu}{2mu\cos 30^\circ}$$

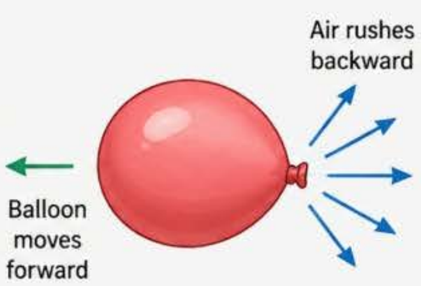
$$\text{Ans.} = \frac{2}{\sqrt{3}}$$

Marathon

Principle of Conservation of momentum

In an isolated system, total momentum remains constant.

1. AIR-FILLED BALLOONS

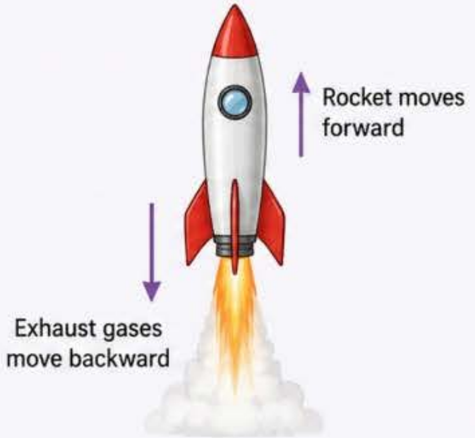


$p_{\text{balloon forward}} + p_{\text{air backward}} = 0$

2. SYSTEM OF GUN AND BULLET

$p_{\text{gun backward}} + p_{\text{bullet forward}} = 0$

3. MOTION OF ROCKETS



$p_{\text{rocket forward}} + p_{\text{gases backward}} = 0$

$$mv + M(-v_{Recoil}) = 0$$

$$v_{Recoil} = \frac{mv}{M}$$

$$F_{net} = \frac{dp}{dt}$$

$$0 = \frac{dp}{dt}$$

$$0 = dp$$

$$p = \text{constant}$$

$$F_x = 0 \Rightarrow (P_i = P_F)_{x\text{-direction}}$$

$$F_y = 0 \Rightarrow (P_i = P_F)_{y\text{-direction}}$$

BACKLOG MARATHON SERIES

Next Toppers

Que.

A body of mass 0.25 kg is projected with muzzle velocity 100 m/s from a tank of mass 100 kg. What is the recoil velocity of the tank

a. 5 m/s
b. 25 m/s
c. 0.5 m/s
d. 0.25 m/s

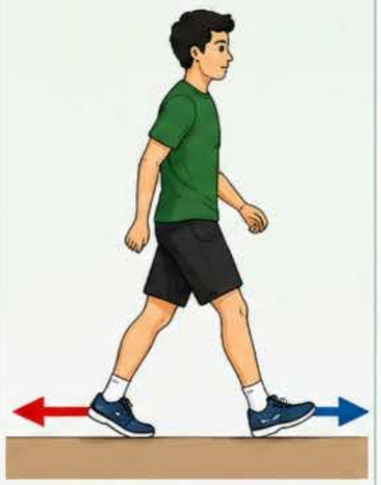
$$v_{Recoil} = \frac{mv}{M} = \frac{(\frac{1}{4})(100)}{100}$$

Marathon

3. Newton's Third Law of Motion

Every action , there is always an equal (in magnitude) & opposite (in direction) reaction.

1. WALKING



Action: Foot pushes the ground backward.

Reaction: Ground pushes the foot forward.

2. SWIMMING

Action: Swimmer pushes water backward.

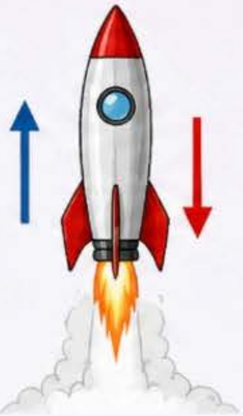
Reaction: Water pushes swimmer forward.

3. RECOILING OF GUN WHEN A BULLET IS FIRED FROM IT

Action: Gun pushes the bullet forward.

Reaction: Bullet pushes the gun backward.

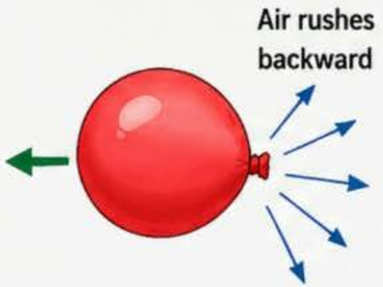
4. ROCKET PROPULSION



Reaction: Exhaust gases push rocket upward.

Action: Rocket pushes exhaust gases downward.

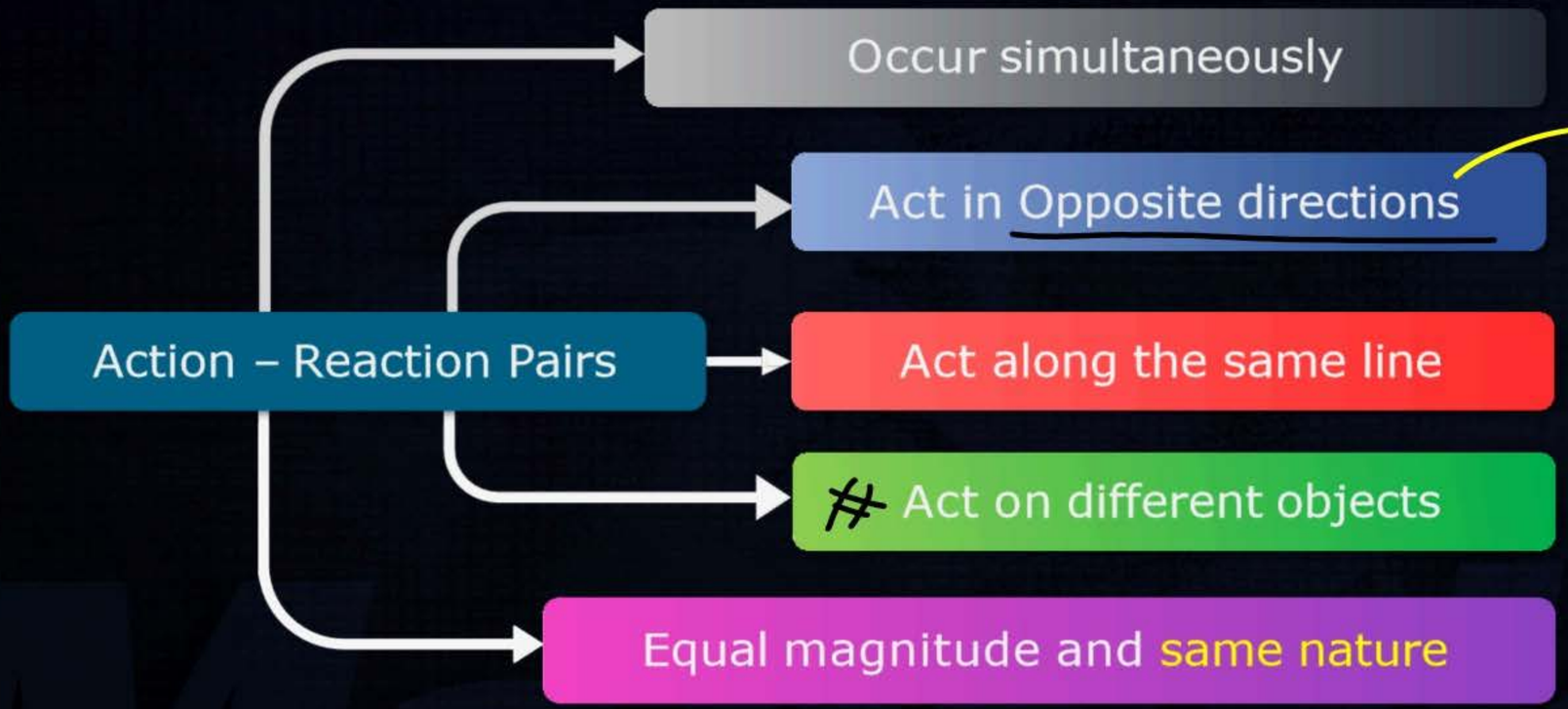
5. AIR-FILLED BALLOONS



Action: Air rushes backward.

Reaction: Balloon moves forward.

- Conditions for Action - Reaction pair.

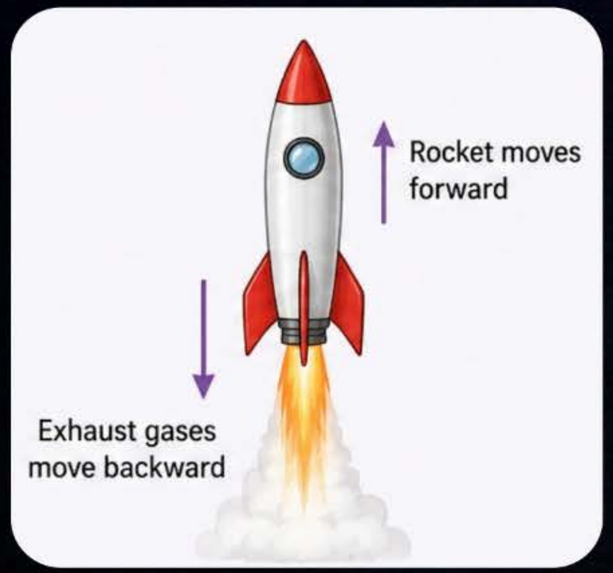


$\vec{F}_{12} = -\vec{F}_{21}$

$F_{21} = F_{12}$ & $|\vec{F}_{21}| = |\vec{F}_{12}|$

Marathon

Variable Mass System (Rocket Propulsion)



$F_{thrust} = V_{rel}\left(\frac{dm}{dt}\right)$

$a \uparrow$

mg

Marathon

BACKLOG MARATHON SERIES

Next Toppers

Que.

A 5000 kg rocket is set for vertical firing. The exhaust speed is 800 ms^{-1} . To give an inertial upward acceleration of 20 ms^{-2} the amount of gas ejected per second to supply the needed thrust will be.

$F_{thrust} = v_{rel} \cdot \frac{dm}{dt}$

$a = 20\ m/s^2$

mg

$= (5000)(10)$

$= 5000011$

$F_{net} = F_{\text{le Jane wala}} - F_{\text{Rokane wala}}$

$ma = v_{rel}\left(\frac{dm}{dt}\right) - mg$

$(5000)(20) = 800\left(\frac{dm}{dt}\right) - 50000$

$100000 + 50000 = 800\left(\frac{dm}{dt}\right)$

$\frac{dm}{dt} = \_\_\_ \frac{kg}{s}$

BACKLOG MARATHON SERIES

Next Toppers

Que.

A 5000 kg rocket is set for vertical firing. The exhaust speed is 800 ms^{-1} . To give an inertial upward acceleration of 20 ms^{-2} the amount of gas ejected per second to supply the needed thrust will be.

Ans.

185.5 kg ms^{-1}

Marathon

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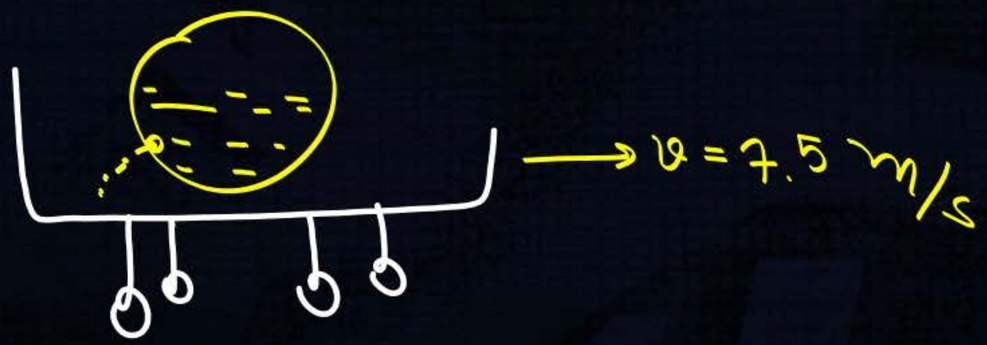
Next Toppers

Que.

A trolley of mass 300 kg carrying a sandbag of 25 kg is moving uniformly with a speed of 7.5 m/s on a frictionless track. After a while, sand starts leaking out of a hole on the floor of the trolley at the rate of 0.05 kg s^{-1}. What is the speed of the trolley after the entire sand bag is empty ? [NCERT]

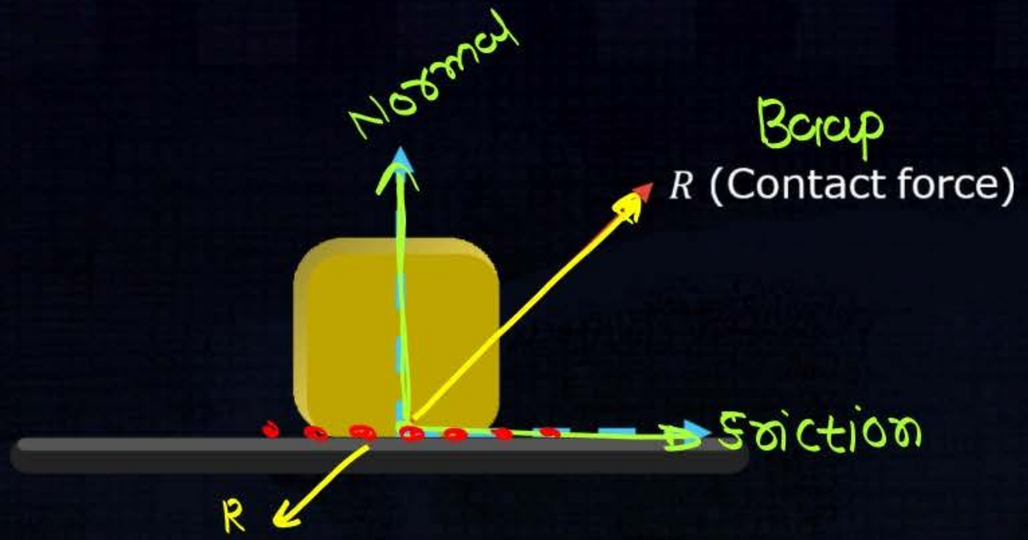
a. 7.5 m/s
b. 10 m/s
c. 5 m/s
d. Jai Baba ki...



Marathon

Marathon

Normal Reaction



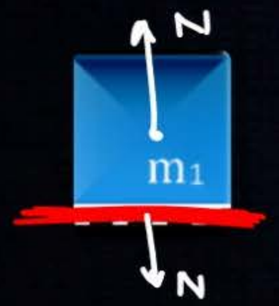
- Normal Reaction is always Normal to the contact surface or Interface.
- Normal Reaction is always pushing in nature.
- Electromagnetic in nature
- Only act when bodies physical contact & pushing each other

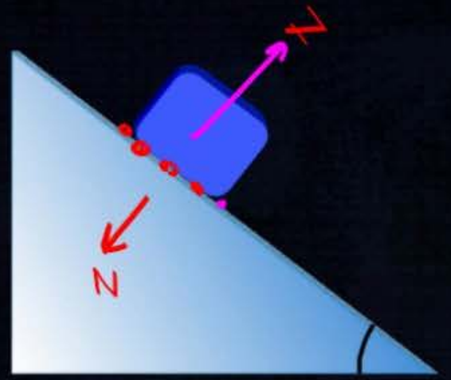
BACKLOG MARATHON SERIES

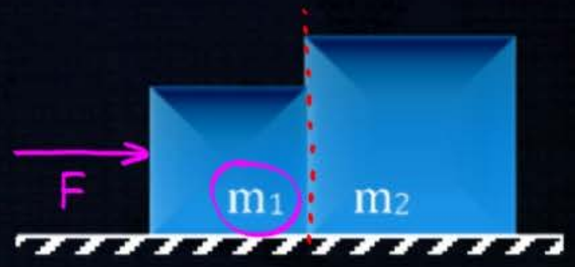
Next Toppers

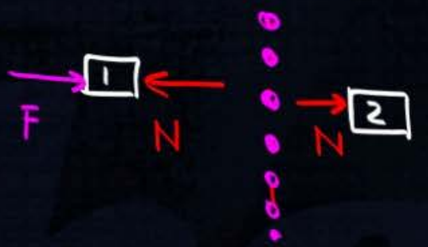
Que.

Show the normal reaction forces in following figure ?





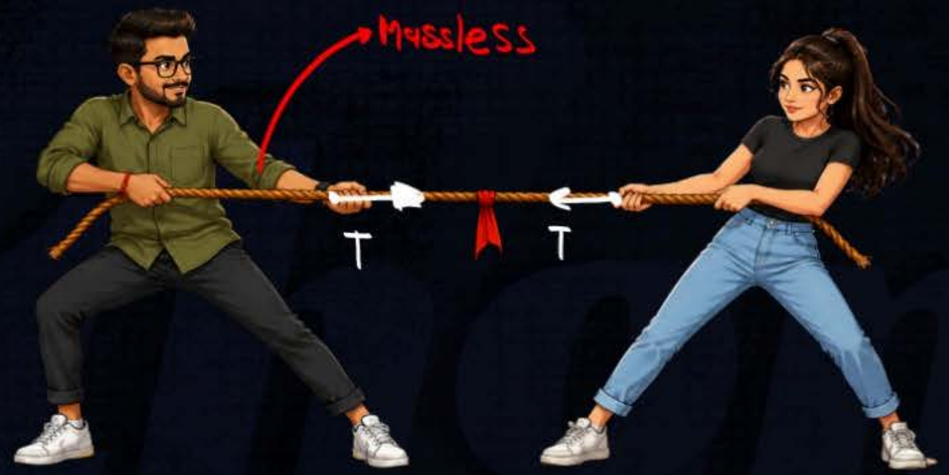




Marathon

Tension Force

- Tension force is always along the string.
- Tension force is always pulling in nature.
- direction away from the poitied end of the string.
- Electromagnetic in nature
- Only act when string is stretched.
- Tension in slack string is always zero

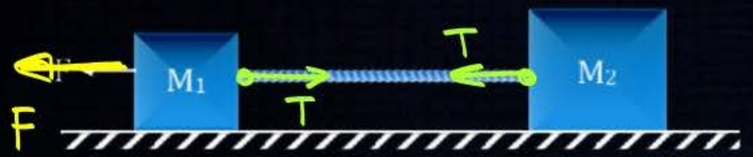


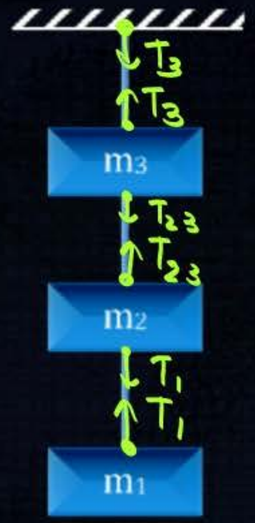
BACKLOG MARATHON SERIES

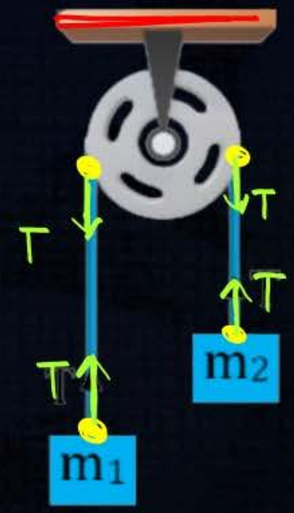
Next Toppers

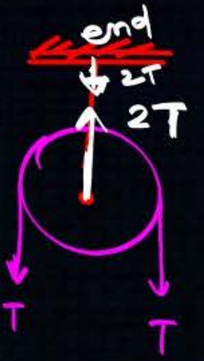
Que.

Show the Tension force in following figure ?









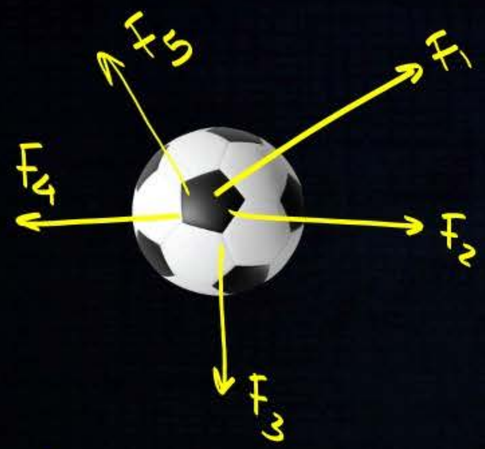
- String is inextensible ---- accelerations of the blocks are same
- String is massless & frictionless------- tension throughout the string remains same

BACKLOG MARATHON SERIES

Next Toppers

Translational Equilibrium

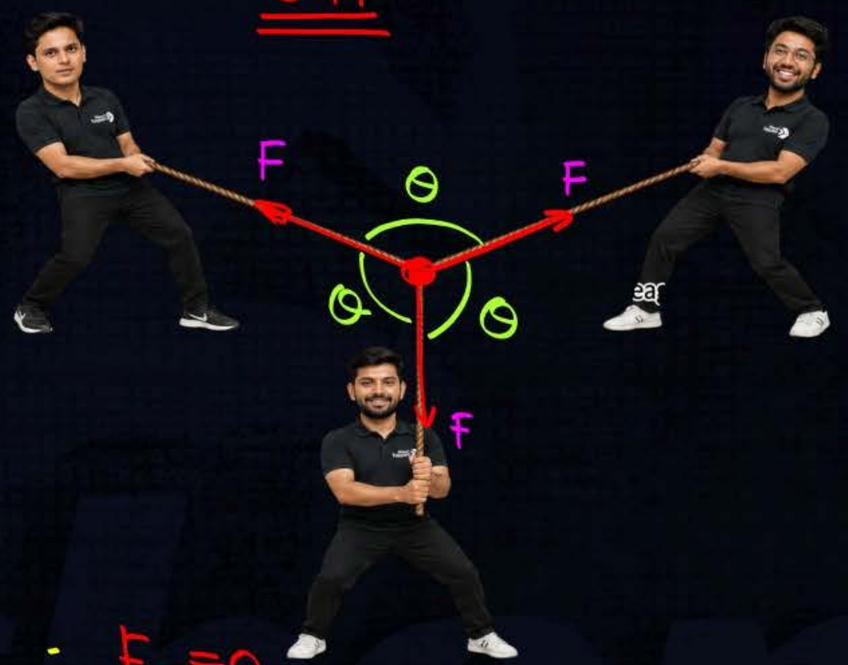
vector sum of all the forces acting on it must be zero



$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 + \ldots = 0$$

$F_{net} = 0$

SMT



$F_{net} = 0$

Marathon

BACKLOG MARATHON SERIES

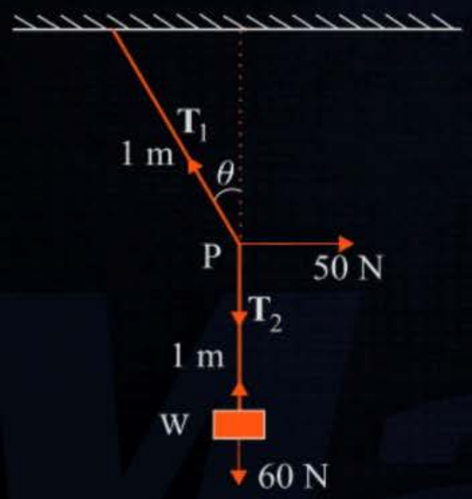
Next Toppers

Que. (3)

LOM → One Shot (YT)

A mass of 6 kg is suspended by a rope of length 2 m from the ceiling. A force of 50 N in the horizontal direction is applied at the mid point P of the rope, as shown. What is the angle the rope makes with the vertical in equilibrium ? (Take g = 10 m s^{-2}). Neglect the mass of the rope

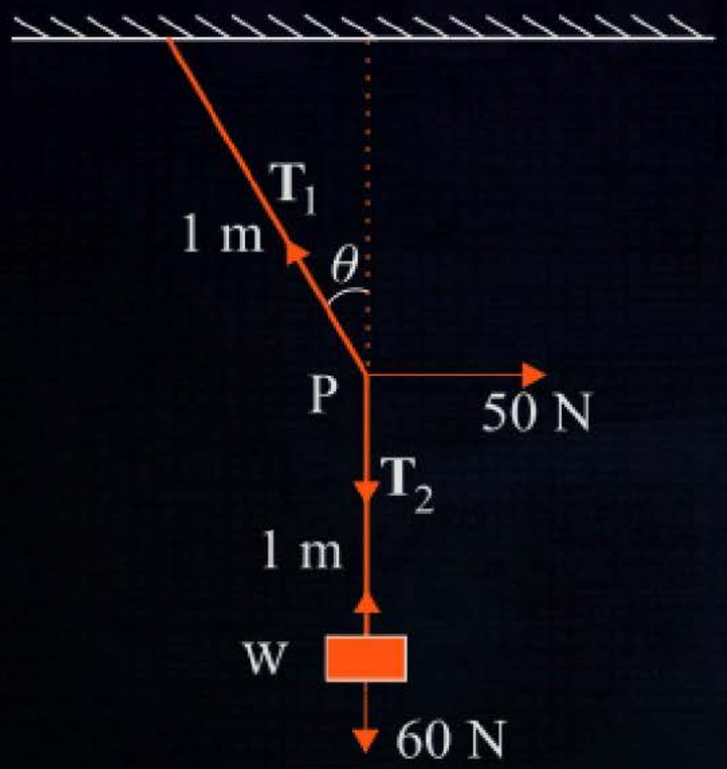
[NCERT EX 6]



Comment

BACKLOG MARATHON SERIES

Next Toppers



Marathon

BACKLOG MARATHON SERIES

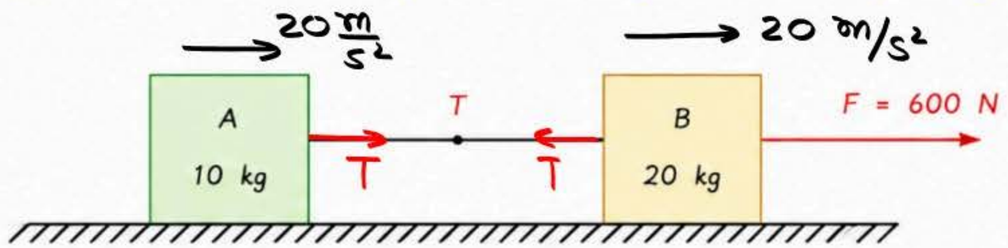
Next Toppers

Que.

What is the tension in the string ?

Method ① a_{system}

(ii) Force F = 600 N applied to B along the direction of string



$10 + 20 \rightarrow 600\ N$

$a_{system} = \frac{F_{net}}{M} = \frac{60\phi}{3\phi}$

$\Rightarrow a = 20\ m/s^2$

A

$a = 20\ m/s^2$

10 kg → T

$T = (m)(a)$

$= (10)(20)$

$= 200\ N$

BACKLOG MARATHON SERIES

Que.

Next Toppers

What is the tension in the string ?

Given (Data) :

Mass of A, $m_A = 10$ kg

Mass of B, $m_B = 20$ kg

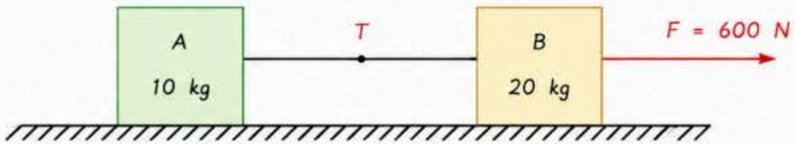
Applied force, $F = 600$ N

Surface : smooth ($\mu = 0$)

Direction : along the string

To find : $T = ?$

(ii) Force $F = 600$ N applied to B along the direction of string



Since surface is smooth, friction = 0

Both blocks will move together with the same acceleration a.

Solution :

Step 1 : Consider the system (A + B)

Net external force on system = $F = 600$ N

Total mass = $m_A + m_B = 10 + 20 = 30$ kg

$$\text{Acceleration, } a = \frac{F}{m_A + m_B} = \frac{600}{30} = 20 \text{ m/s}^2$$

Step 2 : Consider block A (10 kg)

The only horizontal force acting on A is the tension T (towards right).

Applying Newton's Second Law on block A :

$$T = m_A a = 10 \times 20 = 200 \text{ N}$$

Tension in the string, $T = 200$ N

Answer : The tension in the string is $T = 200$ N .

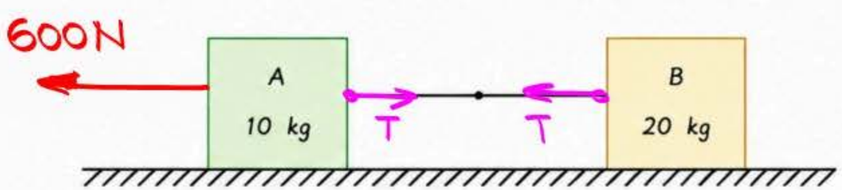
BACKLOG MARATHON SERIES

Next Toppers

Que.

What is the tension in the string ?

(i) Force F = 600 N applied to A along the direction of string



T = ?

HW

Mathlon

BACKLOG MARATHON SERIES

Que.

Next Toppers

What is the tension in the string ?

Given (Data) :

Mass of A, $m_A = 10\ kg$

Mass of B, $m_B = 20\ kg$

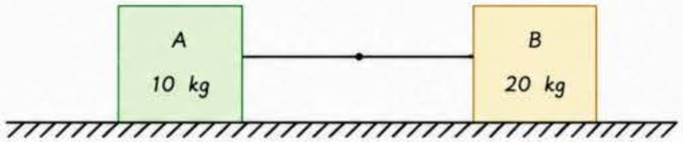
Applied force, $F = 600\ N$

Surface : smooth ($\mu = 0$)

Direction : along the string

To find : $T = ?$

(i) Force $F = 600\ N$ applied to A along the direction of string



Since surface is smooth, friction = 0

Both blocks will move together with the same acceleration a.

Solution :

Step 1 : Consider the system (A + B)

Net external force on system = $F = 600\ N$

Total mass = $m_A + m_B = 10 + 20 = 30\ kg$

$$\text{Acceleration, } a = \frac{F}{m_A + m_B} = \frac{600}{30} = 20\ m/s^2$$

Step 2 : Consider block B (20 kg)

The only horizontal force acting on B is the tension T (towards right).

Applying Newton's Second Law on block B :

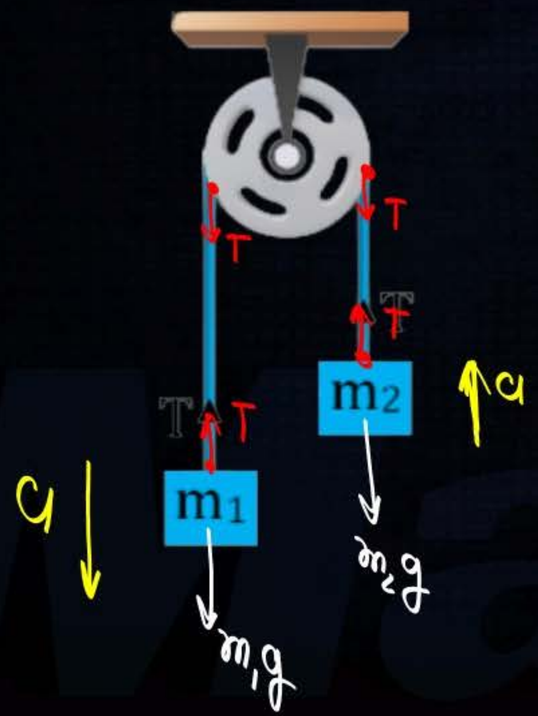
$$T = m_B\, a = 20 \times 20 = 400\ N$$

Tension in the string, $T = 400\ N$

Answer : The tension in the string is $T = 400\ N$.

Pulley block systems

- Ideal pulley is considered massless and frictionless. (No Rotate)
- Ideal string is massless and inextensible.
- The only function of Ideal pulley is to change the direction of force.



$F_{net} = ma$

Block-1 $\Rightarrow$ $m_1g - T = m_1a$

Block-2 $\Rightarrow$ $T - m_2g = m_2a$

$m_1g - m_2g = (m_1+m_2)a$

$$a = \frac{m_1g - m_2g}{m_1+m_2}$$

$$\Rightarrow T = \frac{2m_1m_2}{(m_1+m_2)}g$$

$$\Rightarrow a = \frac{F_{\text{Le Jane wala}} - F_{\text{Rokane wala}}}{M_{\text{total}}}$$

BACKLOG MARATHON SERIES

Next Toppers

Que.

Two masses 6 kg and 4 kg are connected by a light string passing over a frictionless pulley. The acceleration of the system is ($g=10\ m/s^2$)

(School, NEET & JEE)

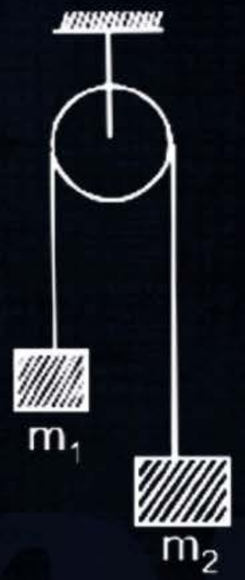
a. $1\ m/s^2$

b. $2\ m/s^2$

c. $3\ m/s^2$

d. $4\ m/s^2$

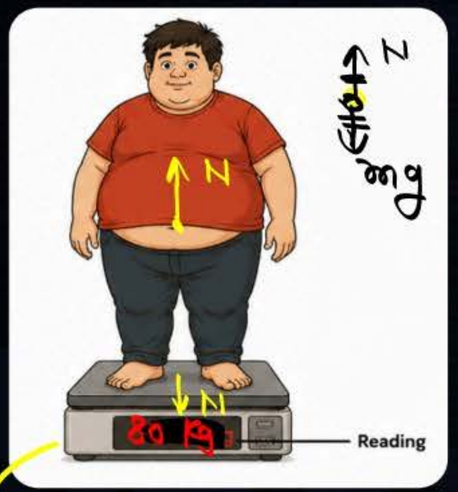
$$a = \frac{60-40}{10} = \frac{20}{10} = 2\ m/s^2$$



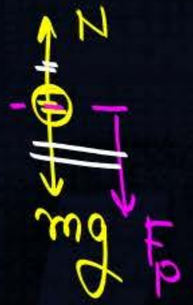
Marathon

Pseudo force

- It is a fictitious (imaginary) force. ($a_{frame} \neq 0$)
- It is used in a non-inertial reference frame to apply Newton's laws of motion.
- It helps us explain the motion of objects as seen by an accelerating observer



$$\text{Reading} = \frac{N}{g} = \frac{mg}{g} = m$$



$$F_p = m_{object} \cdot a_{Frame}$$

$$N = F_p + mg$$

$$N = ma + mg$$

$$N = m(a+g) \uparrow$$

$$\text{Reading} = \frac{N}{m} \uparrow$$

Magnitude

$$F_{\text{pseudo}} = m \times a_{\text{frame}}$$

where,

m = mass of the body

a_{frame} = acceleration of non-inertial frame (with respect to an inertial frame)

Direction

- Opposite to the direction of acceleration of the non-inertial frame (observer).

$$\vec{F}_{\text{pseudo}} = -m\,\vec{a}_{\text{frame}}$$

Important Note

- Pseudo force does not follow action–reaction law.
- It exists only in non-inertial reference frames.

BACKLOG MARATHON SERIES

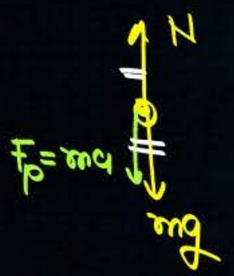
Next Toppers

Que.

$N = mg$ & Reading $= \frac{N}{g} = m = 70\ kg$

A man of mass 70 kg stands on a weighing scale in a lift which is moving (a) upwards with a uniform speed of 10 m s^{-1}, || $a_{Frame} = 0$

What would be the readings on the scale ? [NCERT EXERCISES 13]



$N = F_p + mg$

$N = ma + mg$

$N = m(a+g)$

$= (70)(10+10)$

$N = (70)(20)$

Reading $= \frac{N}{g} = \frac{70(20)}{10}$

$= 140\ kg$

BACKLOG MARATHON SERIES

Next Toppers

Que.

A man of mass 70 kg stands on a weighing scale in a lift which is moving
(a) upwards with a uniform speed of 10 m s^{-1},
What would be the readings on the scale ? [NCERT EXERCISES 13]

Ans.

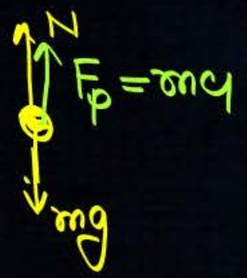
70 kg

BACKLOG MARATHON SERIES

Next Toppers

Que.

A man of mass 70 kg stands on a weighing scale in a lift which is moving (b) downwards with a uniform acceleration of 5 m s^{-2} , What would be the readings on the scale ? [NCERT EXERCISES 13]



$$N + ma = mg$$

$$N = mg - ma$$

$$N = m(g - a)$$

$$\text{Reading} = \frac{N}{g} = \frac{m(g-a)}{g}$$

$$= \frac{70(10-5)}{10} = 35 \text{ kg}$$

$\downarrow a = 5 m/s^2$

BACKLOG MARATHON SERIES

Next Toppers

Que.

A man of mass 70 kg stands on a weighing scale in a lift which is moving
(b) downwards with a uniform acceleration of 5 m s^{-2} ,
What would be the readings on the scale ? [NCERT EXERCISES 13]

Ans.

35 kg

Marathon

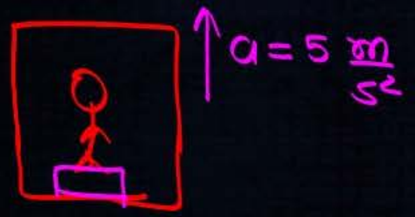
BACKLOG MARATHON SERIES

Next Toppers

Que.

A man of mass 70 kg stands on a weighing scale in a lift which is moving
(d) What would be the reading if the lift mechanism failed and it hurtled down freely under gravity ? [NCERT EXERCISES 13]

(c)



$$\text{Reading} = \frac{N}{g} = m(g+a)$$

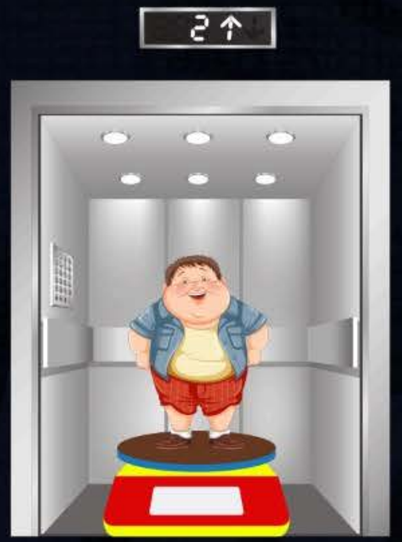
$$= \frac{(70)(10+5)}{10}$$

$$= 105 \text{ kg}$$

$$\text{Reading} = \frac{N}{g} = \frac{m(g-a)}{g}$$

$$= m(g-a)$$

$$\text{Reading} = 0$$



$a = g$

BACKLOG MARATHON SERIES

Next Toppers

Friction Force

Walking

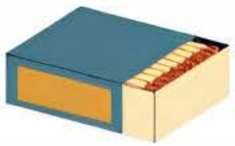
Driving a Car

Wriiting

Braking a Bicycle

Rubbing Hands

Climbing a Hill



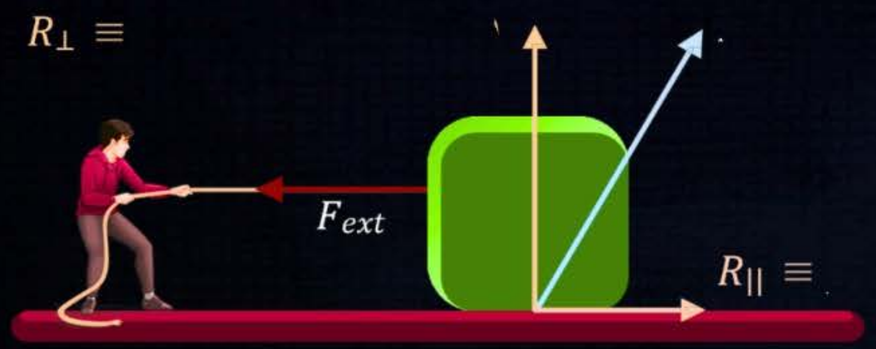
Lighting a Match

Playing Sports

Skiing

Opening a Jar

Marathon



f (Frictional force)

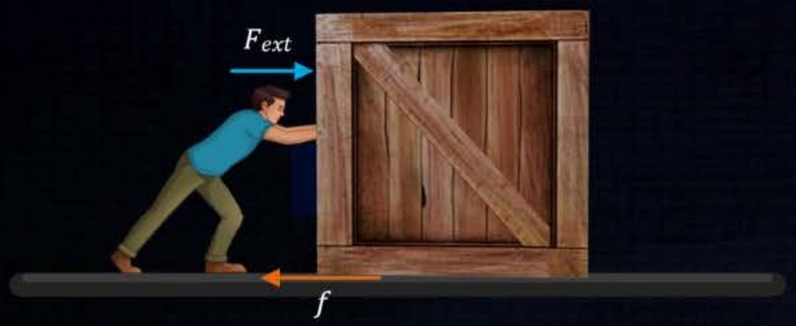
- Friction acts along the contact surface.
- Direction : always opposes the relative motion or tendency of motion between two surfaces.

- Friction is a self-adjusting force and can vary from zero to maximum value

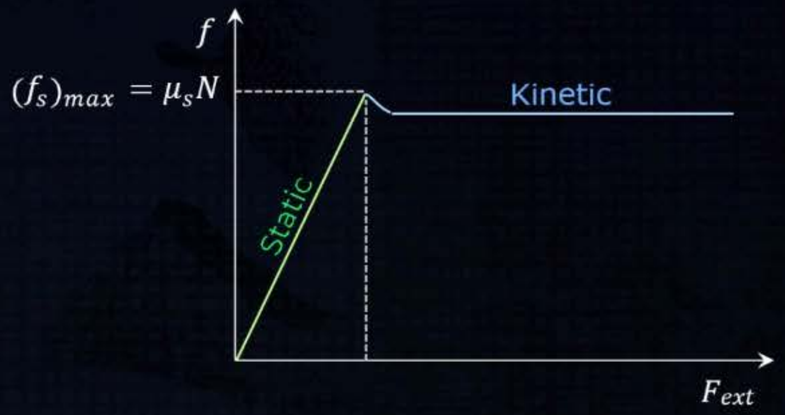
BACKLOG MARATHON SERIES

Next Toppers

Feel



F_{ext}	Friction force	Relative Motion ?
1 N		
2 N		
3 N		
4 N		
5 N		
6 N		



Marathon

Types of Friction

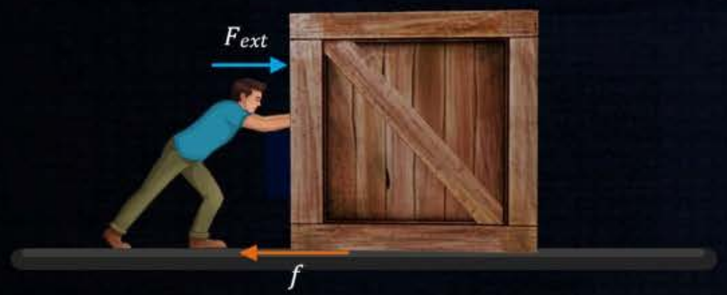
Type of Friction	When Does It Act?	Key Characteristics
1 Static Friction (Self-adjusting)	When the object is at rest	• Adjusts itself equal to applied force • Prevents motion • Exists up to a maximum limit
2 Limiting Static Friction (f_{lim})	When object is just about to move	• Maximum value of static friction • Transition point between rest and motion • In your example: occurs at 4 N
3 Kinetic Friction (f_k)	When the object is in motion	• Acts during sliding • Always less than limiting friction • Constant for given surfaces

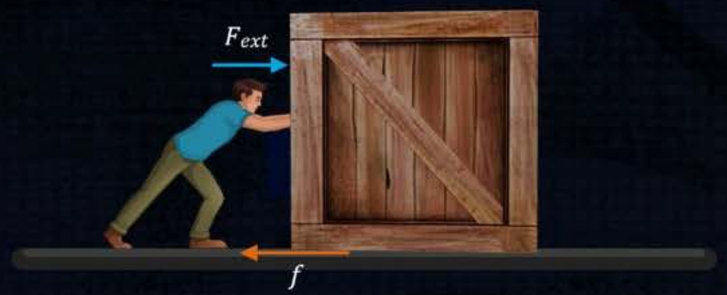
BACKLOG MARATHON SERIES

Next Toppers

Que.

In which case friction force is more ?





Marathon

Coefficient of Friction

- μ is known as the coefficient of friction.
- It does not have any unit
- depends only on the nature of surfaces of the materials in contact.

BACKLOG MARATHON SERIES

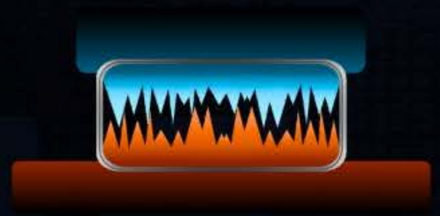
Que.

Next Toppers

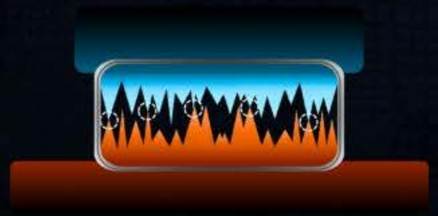
Why Kinetic Friction value is smaller than Limitng Friction ?

At rest

- Strong interlocking
- Higher friction



Interlocking



Cold - welding

Once motion begins

- Interlocking breaks
- Weaker friction

Interlocking

Que.

Why Kinetic Friction value is smaller than Limitng Friction ?

If the objects are at rest, then there is an interlocking between the micro particles of the surfaces along with the cold welding.

When the objects start to move relative to each other, the cold welding breaks, leaving only the interlocking that is left between the particles.

Hence, the coefficient of static friction is greater than the coefficient of kinetic friction,
i.e., $\mu_s > \mu_k$

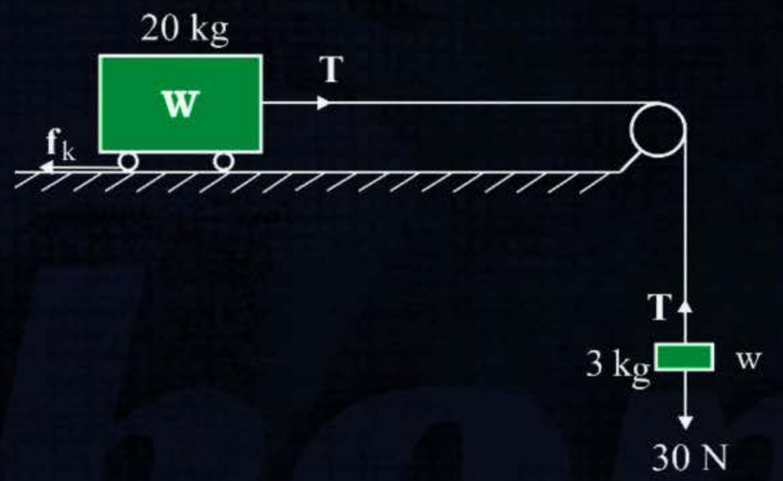
BACKLOG MARATHON SERIES

Next Toppers

Que.

What is the acceleration of the block and trolley system shown.If the coefficient of kinetic friction between the trolley and the surface is 0.04 ? What is the tension in the string? (Take g = 10 m s^{-2}). Neglect the mass of the string.

[NCERT Example 10]



Marathon

BACKLOG MARATHON SERIES

Next Toppers

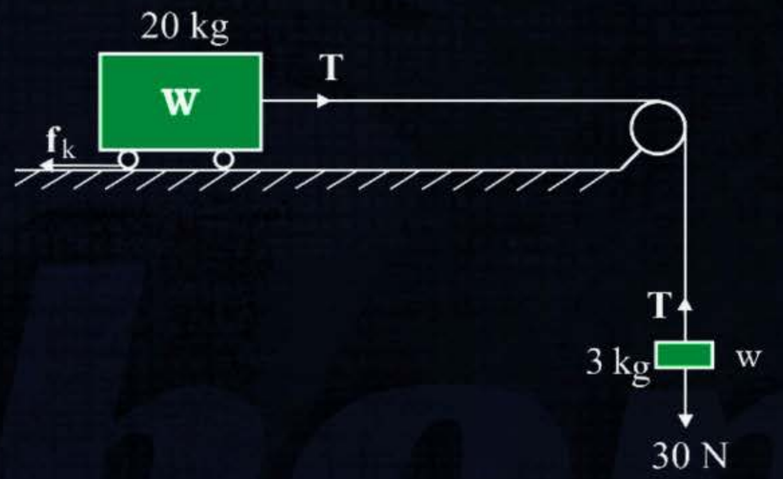
Que.

What is the acceleration of the block and trolley system shown.If the coefficient of kinetic friction between the trolley and the surface is 0.04 ? What is the tension in the string? (Take g = 10 m s^{-2}). Neglect the mass of the string.

[NCERT Example 10]

Ans.

T = 27.1 N & a = 22/23 m/s^2



Marathon

BACKLOG MARATHON SERIES

Next Toppers

Que.

A body of mass 0.1 kg is pressed against a wall with a horizontal force 5 N. If coefficient of friction is 0.5 then find force of friction.

Marathon

BACKLOG MARATHON SERIES

Next Toppers

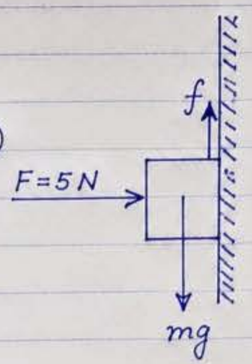
Given :

$m = 0.1$ kg

$F = 5$ N (horizontal force)

$\mu = 0.5$

$g = 10\ m/s^2$



Solution :

The body is pressed against the wall by horizontal force F.

Normal reaction (N) = F = 5 N

Maximum friction (f_{max}) = μN

= 0.5×5

= 2.5 N

Weight of the body, $mg = 0.1 \times 10 = 1$ N

Since mg (1 N) < f_{max} (2.5 N),
the body will not slide down.
So, friction will adjust itself and equal to mg.

Force of friction, $f = mg = \underline{1\ N}$

प्रारंभ BATCH

Backlog

Swahaa

(PRARAMBH 2.0)

2026-27

THANK YOU