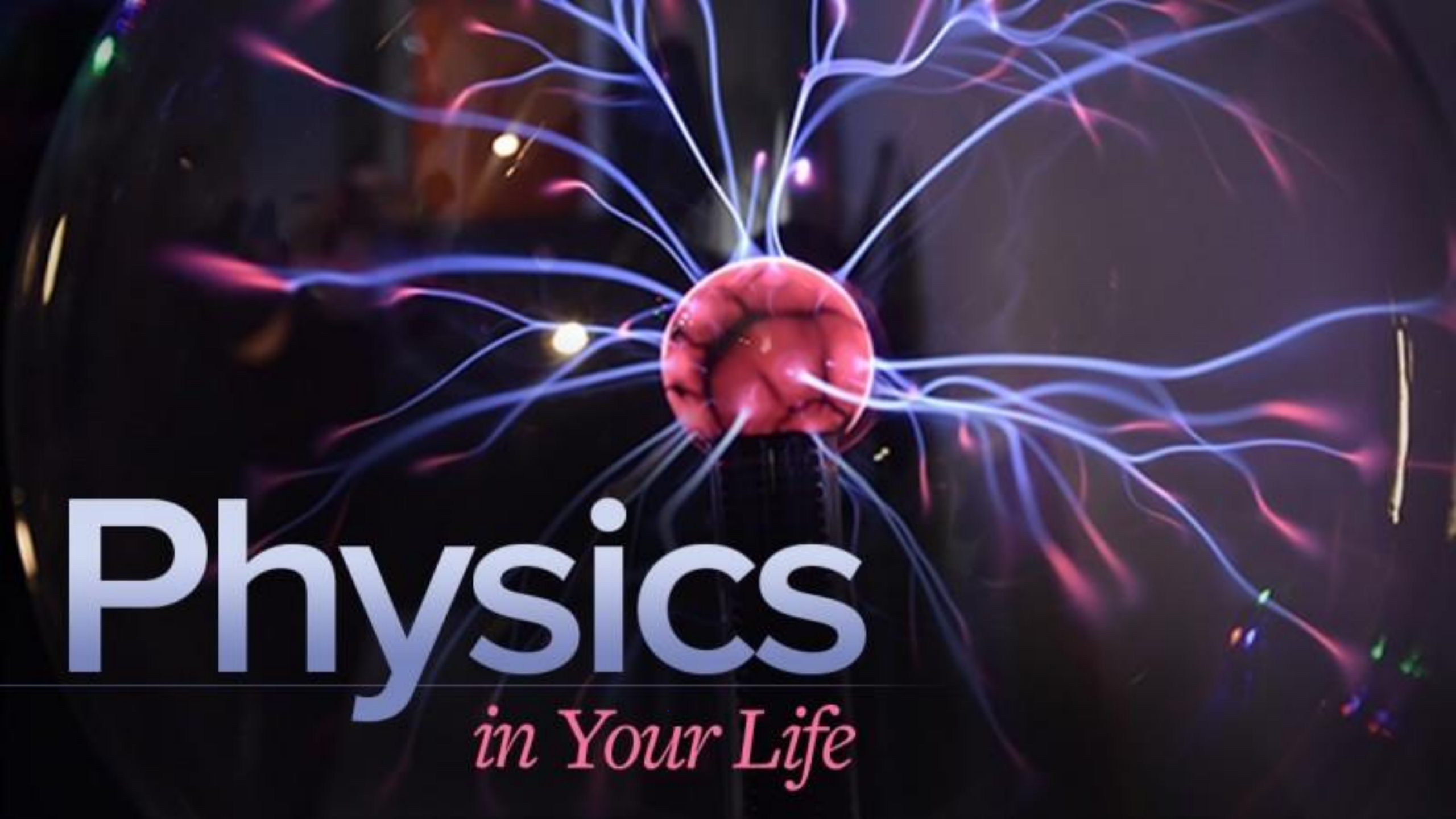
PHYSICS C-1


Physics
in Your Life

CLASS - 1

UNITS & DIMENSIONS

मात्रक

विमाएं

Fundamental and Derived Quantities
(मौलिक और व्युत्पन्न मात्राएँ)

- The quantities that are independent of other quantities are called **fundamental quantities**.

अन्य राशियों से स्वतंत्र होने वाली राशियों को मौलिक राशियाँ कहा जाता है।

- The units that are used to measure these fundamental quantities are called **fundamental units**.
- इन मूलभूत मात्राओं को मापने के लिए जिन इकाइयों का उपयोग किया जाता है, उन्हें मूलभूत इकाइयाँ कहा जाता है

- There are four systems of units namely C.G.S, M.K.S, F.P.S, and SI.

C.G.S, M.K.S, F.P.S, और SI जैसी इकाइयों की चार प्रणालियाँ हैं।

- The quantities that are derived using the fundamental quantities are called **derived quantities**.

मौलिक मात्राओं का उपयोग करके जो मात्राएँ प्राप्त की जाती हैं, उन्हें व्युत्पन्न मात्राएँ कहा जाता है।

- The units that are used to measure these derived quantities are called **derived units**.

इन व्युत्पन्न मात्राओं को मापने के लिए उपयोग की जाने वाली इकाइयों को व्युत्पन्न इकाइयाँ कहा जा

Fundamental Quantity	System of units		
	C.G.S.	M.K.S.	F.P.S.
Length	centimeter	Meter	foot
Mass	gram	Kilogram	pound
Time	second	Second	second

7 FUNDAMENTAL UNITS (SI)

Physical quantity	Unit	Symbol
Length	Meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Intensity of light	candela	cd
Quantity of substance	mole	mol

Supplementary Quantities: पूरक मात्रक :-

Plane angle ✓	radian ✓✓	rad
Solid angle ✓	steradian	sr

स्टेरेडियन

DERIVED UNITS: (व्युत्पन्न मात्रक): with the help of fundamental units

⇒ Speed = $\frac{\text{Dis}}{\text{Time}}$ = $\frac{m}{s}$ ✓

f → Newton

W → Joule

⋮ ⋮

MACRO Prefixes	MICRO Prefixes
Kilo (K) 10^3 ✓	Milli (m) 10^{-3} ✓
Mega (M) 10^6 ✓	(μ) 10^{-6} ✓
Giga (G) 10^9 ✓	nano (n) 10^{-9} ✓
Tera (T) 10^{12}	pico (p) 10^{-12} ✓
Peta (P) 10^{15}	femto (f) 10^{-15} ✓ (fermi)
Exa (E) 10^{18}	atto (a) 10^{-18}
Zetta (Z) 10^{21}	zepto (z) 10^{-21}
Yotta (y) 10^{24}	yocto (y) 10^{-24}

1 mm = 10^{-3} m

1 μm = 10^{-6} m

Important Small Units Of Length : लम्बाई

① 1 Fermi = 10^{-15} m ⇒ Radius of nucleous
✓ परिनाभक की त्रिज्या

② 1 pm = 10^{-12} m ⇒ Radius of Atom
✓ परमाणु की त्रिज्या

③ 1 $\mathring{A}$ = 10^{-10} m
1 nm = 10^{-9} m
⇒ Wavelength of Light
✓ प्रकाश की तरंगदैर्ध्य

Important Large Units of Length :

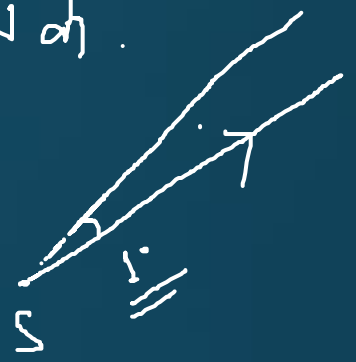
① 1 AU (Astronomical Unit) :- Average Distance b/w
(1 खगोलीय इकाई) ⇒ SUN & earth.

$$1\ AU = 1.496 \times 10^{11}\ m$$

② (दूरी का मात्रक)
Light Year :- Distance traveled by light in 1 year.

$$1\ LY = 9.46 \times 10^{15}\ m$$ (एक प्रकाश वर्ष)

(3) Parsec :- Largest unit of Distance.
दूरी का सबसे बड़ा मात्रक.



⇒ 1 Parsec = 3.26 LY

⇒ 1 Parsec = 3.08×10^{16} m

⇒ Parallactic Second

Is Parsec का Full form.

Some Important Conclusions:

- Angstrom is the unit of length used to measure the wavelength of light. 1 Å $= 10^{-10}$ m.
- Fermi is the unit of length used to measure nuclear distances. 1 Fermi = 10^{-15} meter.
- A light year is the unit of length for measuring astronomical distances.
- Light year = distance traveled by light in 1 year = 9.4605×10^{15} m.
- Astronomical unit = Mean distance between the sun and earth = 1.5×10^{11} m.

- कुछ महत्वपूर्ण निष्कर्ष:

- एंगस्ट्रॉम प्रकाश की तरंग दैर्ध्य को मापने के लिए उपयोग की जाने वाली लंबाई की इकाई है। 1 एंगस्ट्रॉम = 10^-10 मीटर।

- फर्मी परमाणु दूरी को मापने के लिए इस्तेमाल की जाने वाली लंबाई की इकाई है। 1 फर्मी = 10^-15 मीटर।

- खगोलीय दूरी मापने के लिए एक प्रकाश वर्ष लंबाई की इकाई है।

- प्रकाश वर्ष = 1 वर्ष में प्रकाश की दूरी = 9.4605 × 10^15 मीटर।

- खगोलीय इकाई = सूर्य और पृथ्वी के बीच की दूरी = 1.5 × 10^11 मीटर।

- Parsec = 3.26 light years = 3.084×10^{16} m

- Barn is the unit of area for measuring scattering cross-section of collisions.

  1 barn = 10^{-28} m^2.

- Chronometer and metronome are time measuring instruments. The quantity having the same unit in all the systems of units is time.

- पारसेक = 3.26 प्रकाश वर्ष = 3.084 × 10^16 मीटर

- क्रोनोमीटर और मेट्रोनोम समय मापने के उपकरण हैं। सभी इकाइयों के सिस्टम में एक ही इकाई होने वाली मात्रा समय है।

⇒ Mass (द्रव्यमान):

① ISL (Chandrashekhar Limit) ✓✓ = 1.5 × Mass of Sun

= चन्द्रशेखर सीमा ⇒

① White Dwarf = ✓

⇒ ② Black Hole = ✓

Dimensions

- **Dimensions** of a physical quantity are the powers to which the fundamental units are raised to obtain one unit of that quantity.
- भौतिक मात्रा के आयाम वे हैं, जिनके लिए मौलिक इकाइयों को उस मात्रा की एक इकाई प्राप्त करने के लिए उठाया जाता है|

⇓

⇒ F = ma ✓ [ ] capital letter A, B...

① Length → m → [L]

② Mass → Kg ⇒ [M]

③ Time → Sec ⇒ [T]

④ Temp. → K ⇒ [θ, K]

⑤ Current → Amp ⇒ [A]

⑥ Lum. Intensity → cd ⇒ [cd]

⑦ Am. of Subst. → mol ⇒ [mol]

X

e-g: Speed → विमा = ?

$$\text{Speed} = \frac{\text{dis}}{\text{Time}} = \frac{m}{s} = \frac{[L]}{[T]}$$

$$= [L\,T^{-1}]$$

- Area = $l \times b = m \times m = m^2$

  $= [L][L] = [L^2]$

- Volume = $m^3 = [L^3]$

* $\vec{a}$ ⇒ त्वरण निमा ⇒

$$\vec{a} = \frac{du}{dt} = \frac{[L T^{-1}]}{[T]} = [L T^{-2}]$$

⇒ Force :-

$$F = ma$$

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

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

⇒ Work $= f \cdot d = [M L T^{-2}][L]$

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

* Density (घनत्व):- $\rho = \frac{m}{V} = \frac{[M]}{[L^3]} = [ML^{-3}]$

* Energy ⇒ Work ⇒ $[ML^2T^{-2}]$

⇒ Energy = Work = Torque = $[ML^2T^{-2}]$

ऊर्जा = कार्य = बल-आघूर्ण

$G = ?$ $\quad F = G \frac{m_1 m_2}{r^2}$

$g = ? \rightarrow [L T^{-2}]$

$\varepsilon_0 = ? \quad \Rightarrow F = \frac{1}{4\pi\varepsilon_0} \frac{q_1 q_2}{r^2}$

$\mu_0 = ? \quad \Rightarrow F = \frac{\mu_0}{2\pi} \frac{I}{r}$

Distance दूरी

Displacement विस्थापन

Speed चाल

Velocity वेग

Acceleration त्वरण

KINEMATICS

(गतिकी)

Kinematics definitions

- Kinematics – branch of physics; study of motion
- Position (***x***) – where you are located
- Distance (*d*) – how far you have traveled, regardless of direction
- Displacement ($\Delta \boldsymbol{x}$) – where you are in relation to where you started

गतिकी परिभाषा

- गतिकी - भौतिकी की एक शाखा; गति का अध्ययन
- स्थिति (x) - जहां आप स्थित हैं
- दूरी (d) - दिशा की परवाह किए बिना आपने कितनी दूर की यात्रा की है
- विस्थापन (Δx) - जहां आप शुरू किए , संबंध में हैं

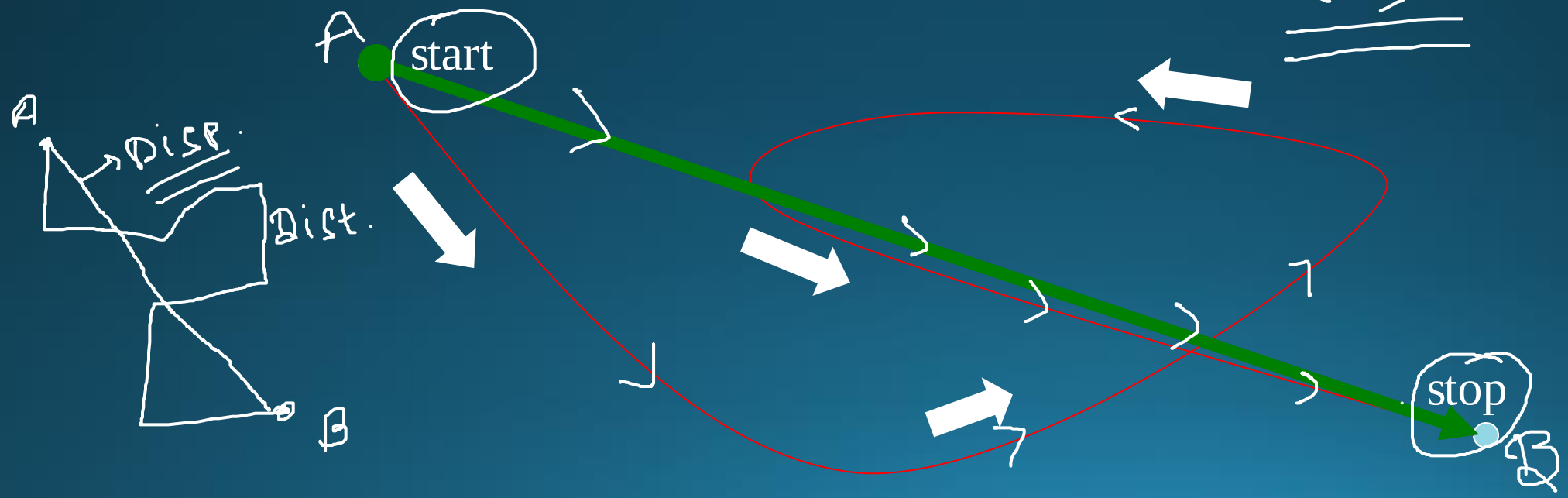
Distance vs. Displacement (दूरी व विस्थापन)

- You drive the path, and your odometer goes up by 8 miles (your distance).
- Your displacement is the shorter directed distance from start to stop (green arrow).
- What if you drove in a circle?

सदिश राशि (Vector)

Distance ⇒ (+ve) Always

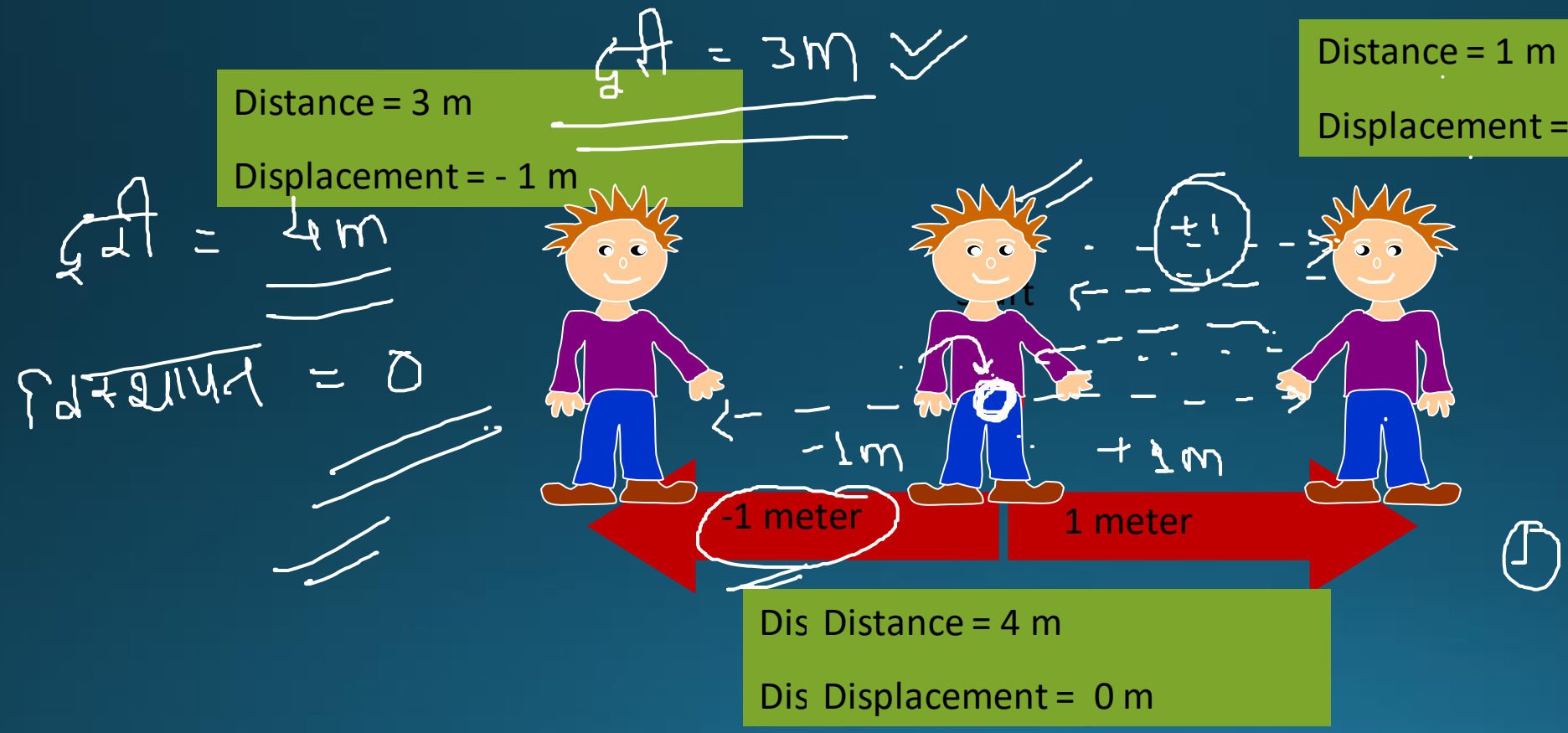
Displacement ⇒ (+ve) (-ve) (0)



Let's Practice!

REMEMBER:

- "Distance" is how far you have gone. "दूरी आप कितनी दूर चले गए हैं
- "Displacement" is how far you are from the starting point. "विस्थापन" आप शुरुआती बिंदु से कितनी दूर हैं



दूरी ⇒ (+Ve) ⇒ Scalar (अदिश)

विस्थापन ⇒ (+Ve) (-Ve) (0) (सदिश) ✓
Vector

Speed vs. Velocity (चाल तथा वेग)

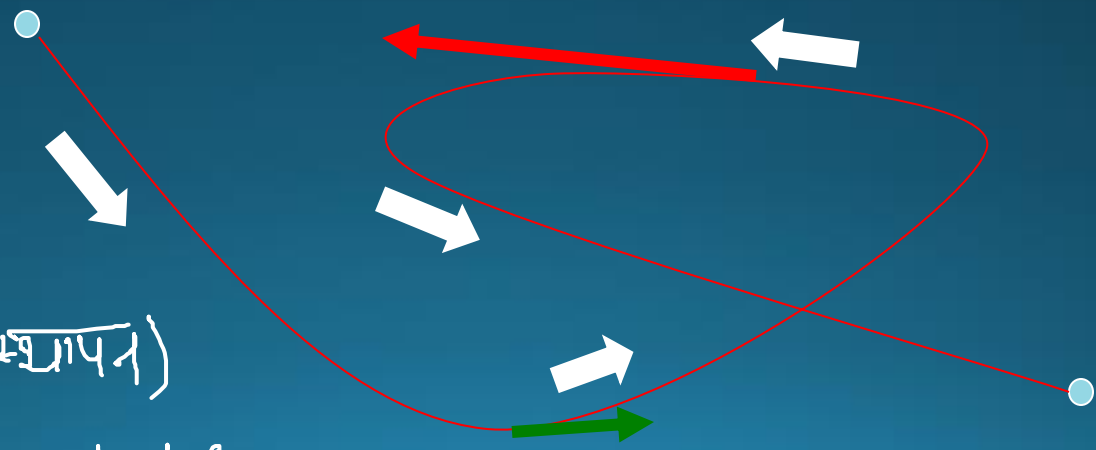
- Speed is a scalar (how fast something is moving regardless of its direction).
  Ex: v = 20 mph
- Speed is the magnitude of velocity.
- Velocity is a combination of speed and direction. Ex: $\boldsymbol{v}$ = 20 mph at 15° south of west
- The symbol for speed is v.
- The symbol for velocity is type written in bold: $\boldsymbol{v}$ or hand written with an arrow: $\vec{v}$

Speed vs. Velocity

- During your 8 mi. trip, which took 15 min., your speedometer displays your instantaneous speed, which varies throughout the trip.
- Your average speed is 32 mi/hr.
- Your average velocity is 32 mi/hr in a SE direction.
- At any point in time, your velocity vector points tangent to your path.
- The faster you go, the longer your velocity vector.

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$ दूरी m/s

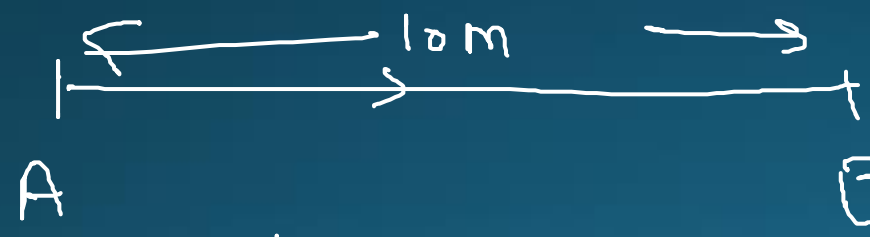
$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$ (विस्थापन) m/s



Speed = 60 km/h (+ve)

Velocity = 60 km/h in north

= (+ve) (-ve)



Distance = Displacement = 10m

दूरी = विस्थापन = 10m

More About Velocity

- **Average Velocity**: the overall displacement covered in a given time period

$$v_{avg} = \frac{displacement}{time} = \frac{\Delta d}{t}$$

$$v_{avg} = \frac{\text{Total Distance}}{\text{Total time}}$$

- Units = $^{m}/_{s}$ = $m \cdot s^{-1}$

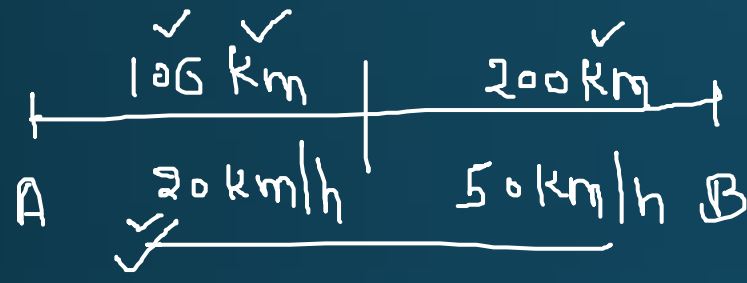
*Note: average speed = total ***distance*** per unit time

- **Instantaneous Velocity**: The speed and direction of a moving object at a particular instant in time
  - Initial velocity → v_1 (or v_i or v_o)
  - Final velocity → v_2 (or v_f or v)

$$v_{avg} = \frac{\text{Total Dist}}{\text{Total time}}$$

$$\frac{400\,km}{5\,hr} = 80\,km/h$$

(1)



$$\Rightarrow \frac{300\,km}{9\,hr}$$

$$t_1 = \frac{100}{30} = 5\,hr$$

$$t_2 = \frac{200}{50} = 4\,hr$$

$$T = t_1 + t_2$$

$$= 9\,hr$$

$$v_{avg} = \frac{100}{3}\,km/h$$

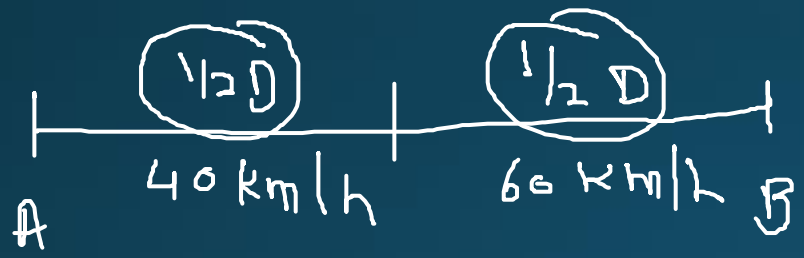
(1)

$\Rightarrow$ समान दूरी में विक्षालित

$S_1 = S_2$

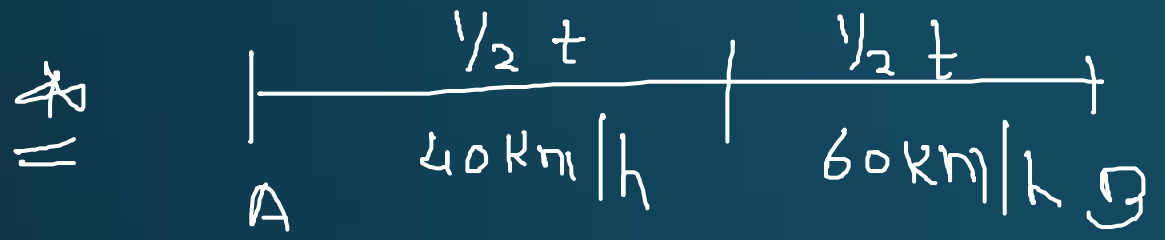
$$v_{avg} = \frac{2v_1v_2}{v_1+v_2}$$

$\Rightarrow$



$$v_{avg} = \frac{2 \times 40 \times 60}{(40+60)} = \frac{2 \times 4 \times 6 \times \cancel{100}}{\cancel{100}}$$

$$= 48 \text{ km/h}$$



समय समान भाग में है।

$$v_{avg} = \frac{v_1 + v_2}{2} = \frac{60+40}{2} = 50 \text{ km/h}$$

Acceleration

- **Acceleration** (Vector): ANY change in velocity
  - Speeding up (final velocity is a larger magnitude than the initial velocity)
  - Slowing down (final velocity is a smaller magnitude than the initial velocity)
  - Changing directions (the direction of the vector is changing)
- **Average Acceleration**: the rate at which velocity is changing

final vel - initial vel / Time.

$$a = \frac{\Delta v}{t} = \frac{v_2 - v_1}{t}$$

- Units = $^{m}/_{s^2}$ = $m \cdot s^{-2}$

* $u_1 = 10\ m/s$, $t = 15\ sec$, $u_2 = 40\ m/s$, a = ? सदिश Vector

$$\vec{a} = \frac{u_2 - u_1}{t} = \frac{40 - 10}{15} = \frac{30}{15}$$

$$\Rightarrow \boxed{\vec{a} = 2\ m/s^2} \Rightarrow \text{Acceleration}$$

* $u_1 = 40\ m/s$, $t = 15\ sec$, $u_2 = 10\ m/s$

$$\vec{a} = \frac{u_2 - u_1}{t} = \frac{10 - 40}{15} = -2\ m/s^2$$

$\vec{a} \Rightarrow$ Negative Acceleration = Retardation (मंदन)

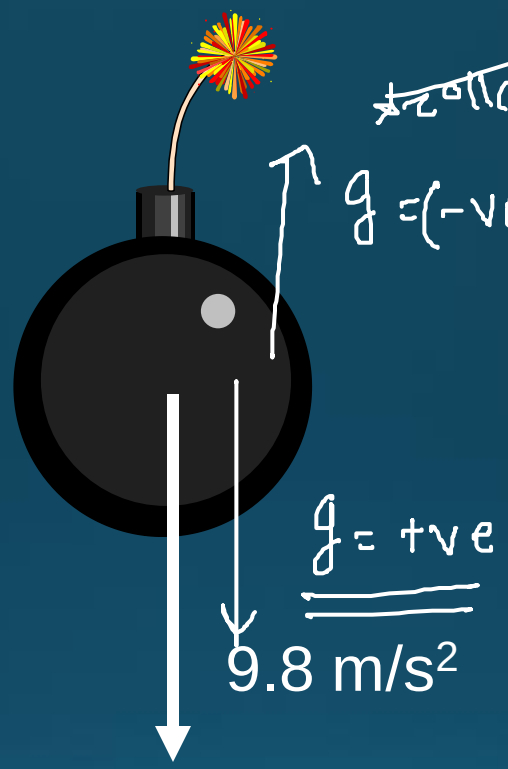
Velocity & Acceleration Sign Chart

		VELOCITY +	VELOCITY −
ACCELERATION	+	Moving forward; Speeding up	Moving backward; Slowing down
ACCELERATION	−	Moving forward; Slowing down	Moving backward; Speeding up

Acceleration due to Gravity

Near the surface of the Earth, all objects accelerate at the same rate (ignoring air resistance).

$$a = -g = -9.8 \text{ m/s}^2$$



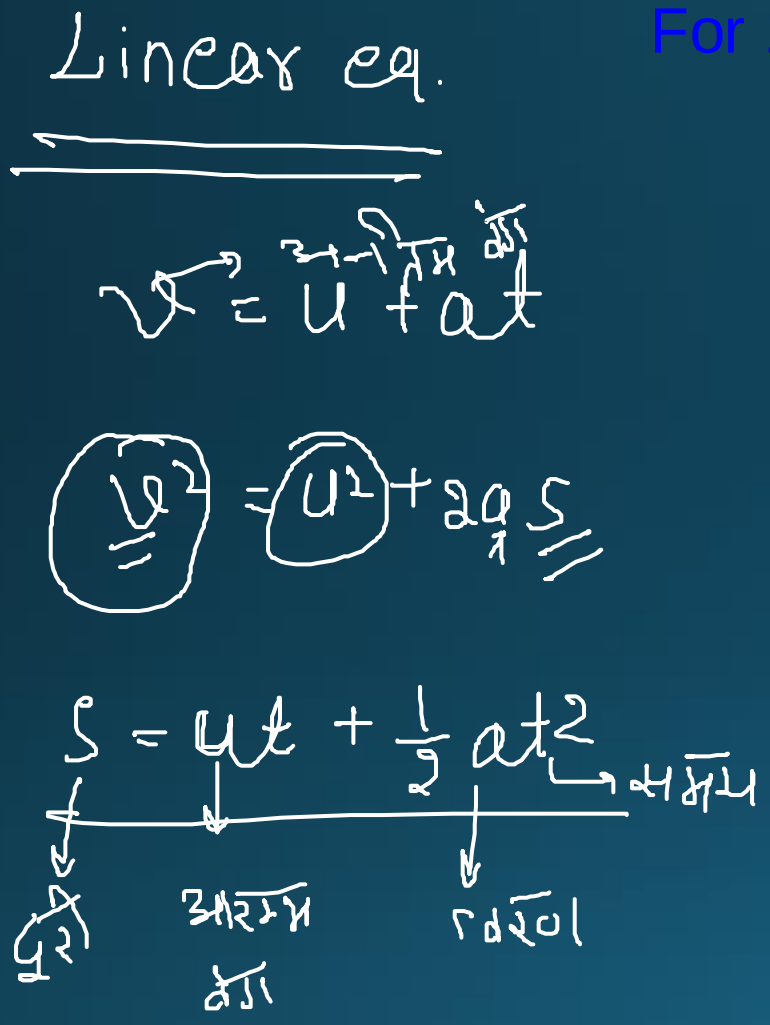
This acceleration vector is the same on the way up, at the top, and on the way down!

Interpretation: Velocity decreases by 9.8 m/s each second, meaning velocity is becoming less positive or more negative. Less positive means slowing down while going up. More negative means speeding up while going down.

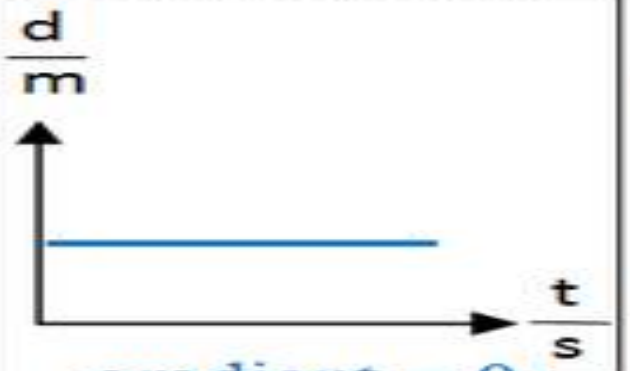
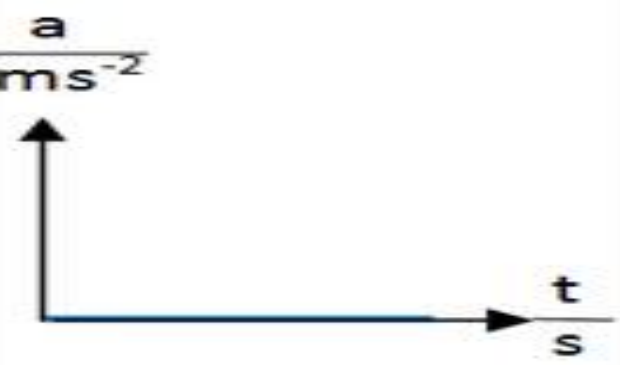
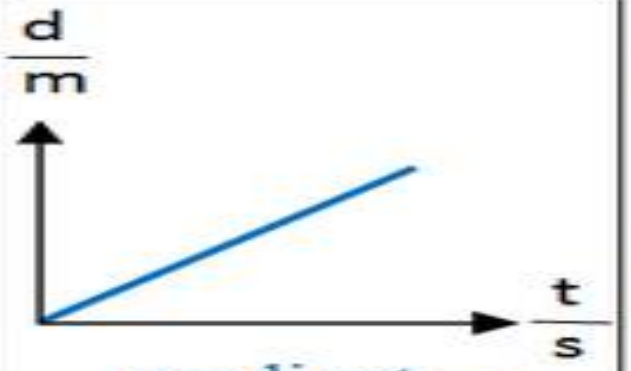
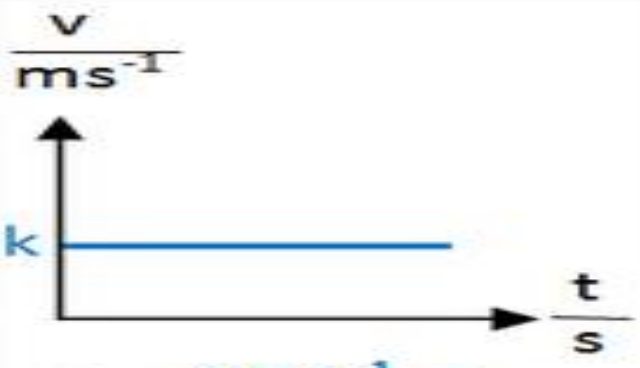
Kinematics Formula Summary

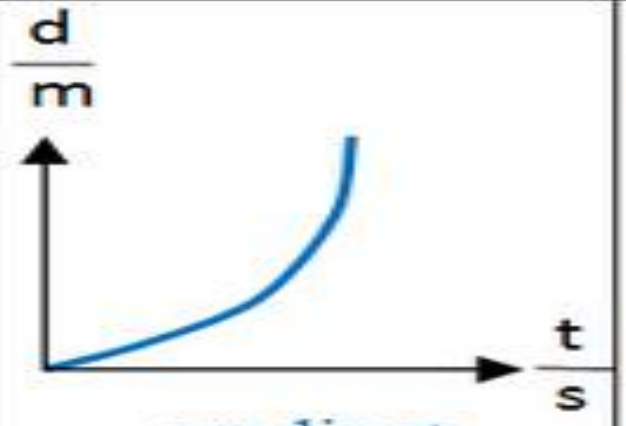
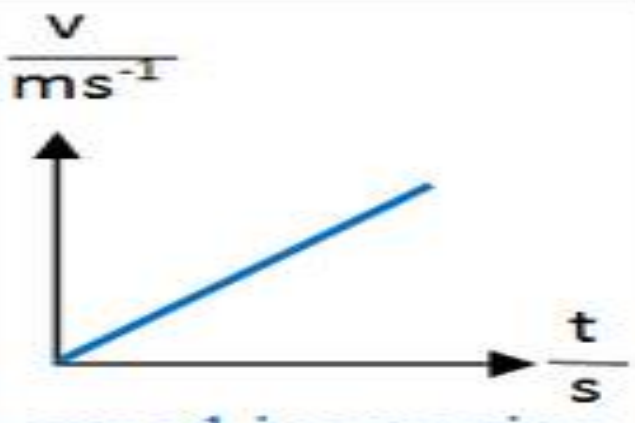
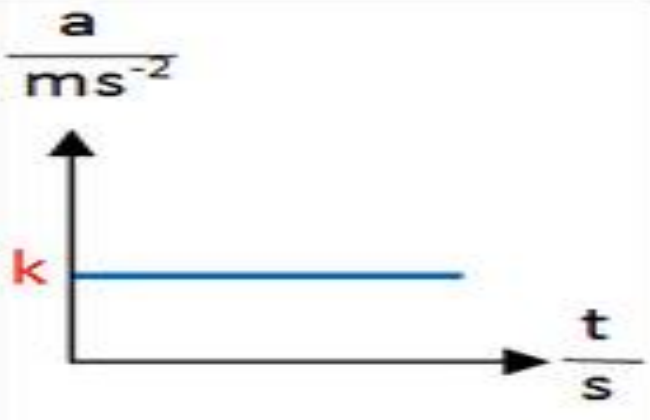
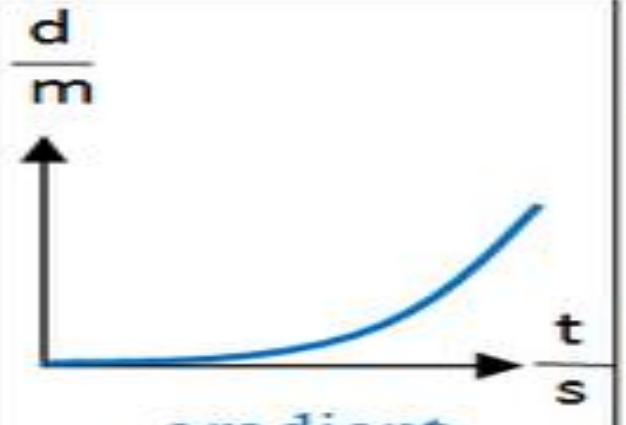
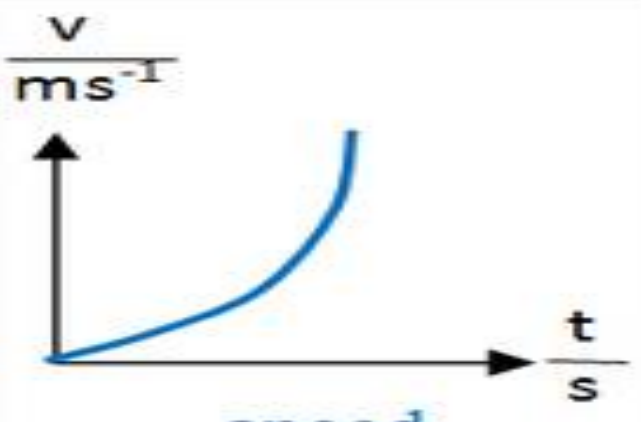
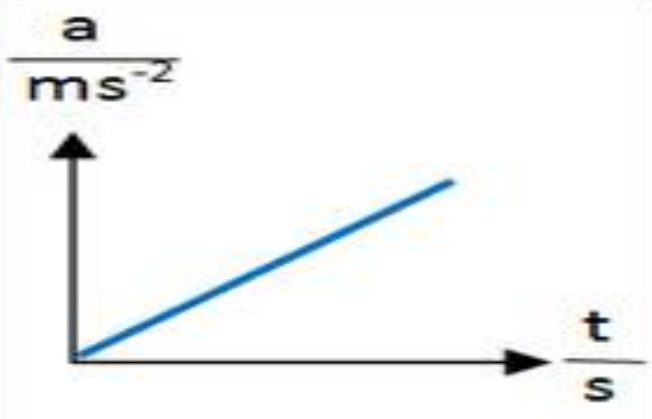
For 1-D motion with *constant* acceleration:

- $v_f = v_0 + at$
- $\overline{v} = (v_0 + v_f)/2$
- $\Delta x = v_0 t + \frac{1}{2} a t^2$
- $v_f^2 - v_0^2 = 2a\Delta x$

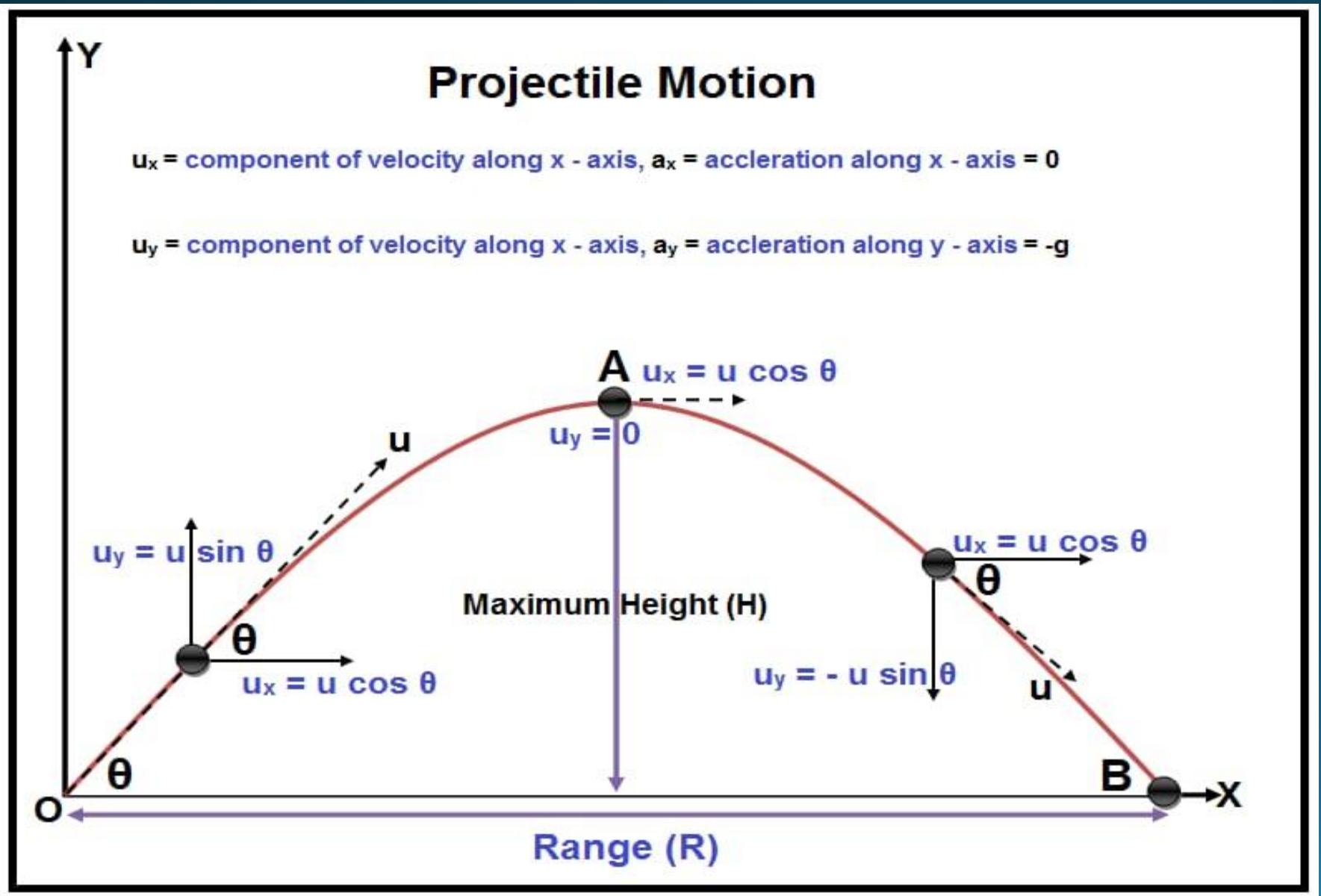


KINEMATICS GRAPH

Motion of object	Distance-Time graph	Speed-Time graph	Acceleration-Time graph
At rest	 gradient = 0	 speed = 0 gradient = 0	 acceleration = 0
At constant speed or uniform speed	 gradient = constant, k	 speed = constant, k gradient = 0	 acceleration = 0

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

PROJECTILE MOTION



Motion in a Plane - Part I

SALIL

Motion in a plane

Examples of motion in two dimensions.

Circular motion

Projectile motion

Equations of motion in a straight line

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

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

Equations of motion in a plane

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

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

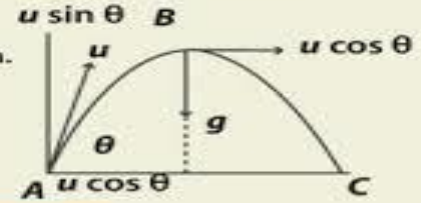
$s_x = u_x t + \frac{1}{2}a_x t^2$ $\quad$ $s_y = u_y t + \frac{1}{2}a_y t^2$

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

Projectile motion

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

$$y = ax + bx^2$$



Formulas for projectile motion

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

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