PHYSICS (Kinematics)

↳ (1) Unit & Dimension

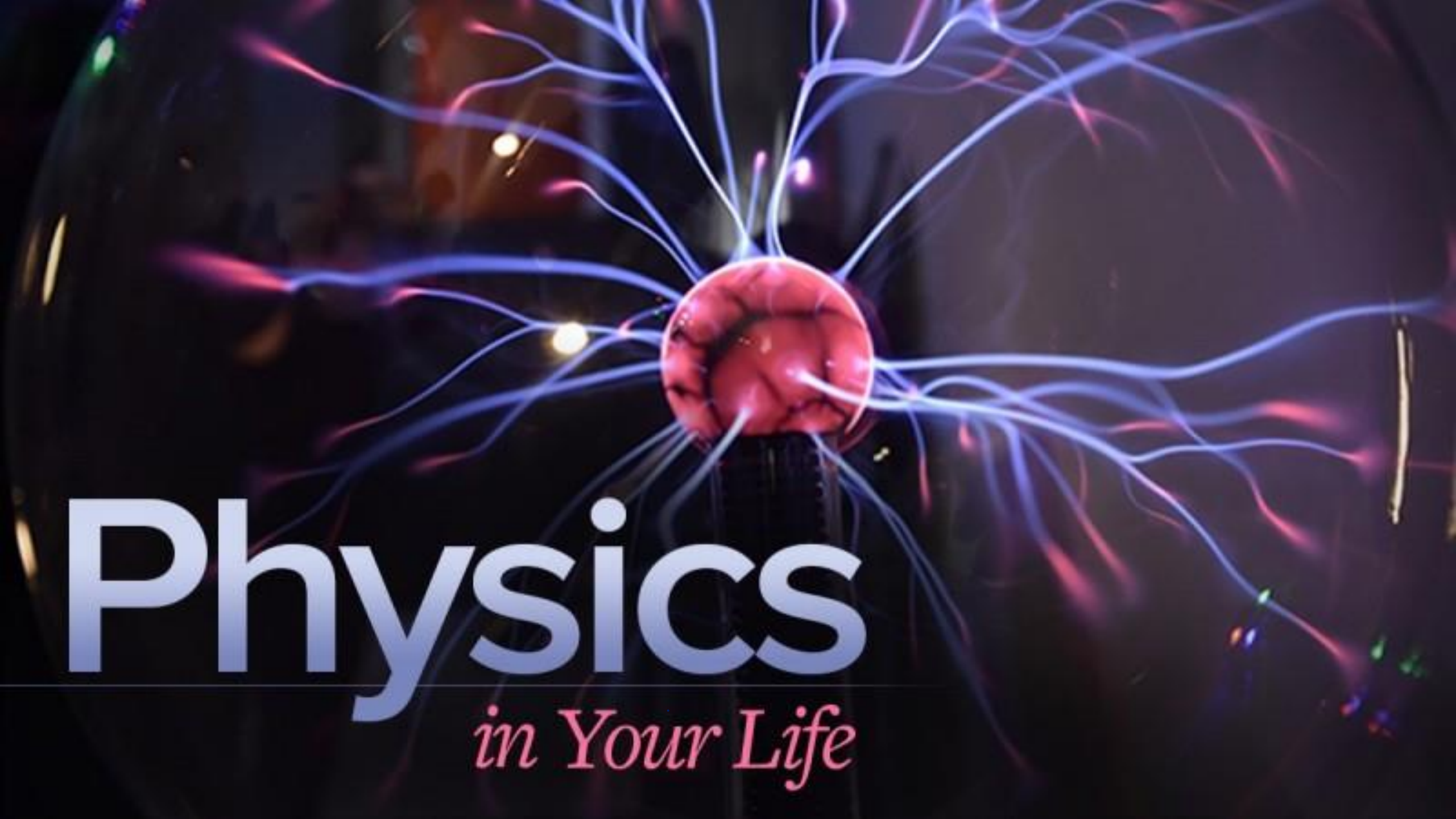
(1)

SAFALTA CLASS™

An Initiative by अमर उजाला

(2) Kinematics

(3) Vector


Physics
in Your Life

CLASS - 1

UNITS (मात्रक)

&

DIMENSIONS (विमा)

Some Physics Quantities

Vector - quantity with both magnitude (size) and direction

Scalar - quantity with magnitude only

Vectors:

- Displacement
- Velocity
- Acceleration
- Momentum
- Force

Scalars:

- Distance
- Speed
- Time
- Mass
- Energy

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 लम्बाई	centimeter	Meter	foot
Mass द्रव्यमान	gram	Kilogram	pound
Time समय	second	Second	second

7 FUNDAMENTAL UNITS (૭ મૂળ માત્રક)

Physical quantity (લંબાઈ)	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

DERIVED UNITS: (व्युत्पन्न मात्रक)

$A = l \times b$

$= m^2$

Area $= m^2$

⇒ m , kg , Amp , Newton

* kg/m^3 → घनत्व (Density)

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}
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 km = 10^3 m

1 kg => 10^3 gm

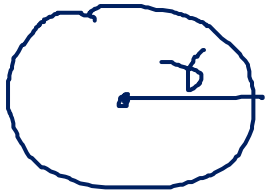
1 mm = 10^{-3} m

1 μm = 10^{-6} m

(Fermi)

Important Small Units Of Length :

* (1) 1 Fermi $= 10^{-15}$ m → (1) Radius of Nucleus (नाभिक की त्रिज्या)



$= 1$ Fermi $= 10^{-15}$ m

(2) $1\,\text{Å} = 10^{-10}$ m ✓ → Radius of atom ($10^{-10} - 10^{-12}$) ✓

↳ Wavelength of light

(3) $1\,nm = 10^{-9}$ m ⇒ (400 — 700) nm

(4) $1\,\mu m = 10^{-6}$ m

Important Large Units of Length :

① खगोलीय मानक (AU) :- Average Distance b/w earth & Sun.

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

② Light Year (प्रकाश वर्ष) :- (Distance travels by light in 1 year).

$c = 3 \times 10^{8}\ m/s$, $1\ LY = 9.46 \times 10^{15}\ m$.

③ Parsec (परसेक) :- (Largest unit) :- $1\ Parsec = 3.08 \times 10^{16}\ m$

↳ Parallactic second

$1\ parsec = 3.26\ LY$.

* Mass :- (द्रव्यमान) :-

(Largest unit)

1 चंद्रशेखर सीमा :- 1.4 × सूर्य का द्रव्यमान

1 CSL = 1.4 × Mass of Sun

• 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।

Dimensions (विमा) ⇒ Varification of formulas.

- **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 |

* Square Bracket: [ ]

* Capital Letter: A, B, - - - -

	Unit	Dimension
* Length →	m	→ [L] ✓
* Mass →	kg	→ [M]
* Time →	sec	→ [T]
* Temp →	Kelvin	→ [θ, K]
* Current →	Amp	→ [A]
* I I →	cd	→ [cd]
* Am of S. →	mol	→ [mol]

✓✓

X

Area $= l \times b$

$= m \times m = [L][L] = [L^2]$

Volume $= l \times b \times h = m \times m \times m = m^3$

$= [L][L][L] = [L^3]$

$$\text{Density} = \frac{m}{V} = \frac{[M]}{[L^3]} = [ML^{-3}]$$

$$\Rightarrow \text{Speed} = \frac{D}{T} = \frac{[L]}{[T]} = [LT^{-1}]$$

$$a = \frac{dv}{dt} = \frac{[LT^{-1}]}{[T]}$$

$$a = [LT^{-2}]$$

$$F = ma = [M][LT^{-2}] = [MLT^{-2}]$$

$$W = F \cdot d = [MLT^{-2}]\,[L] = [ML^2T^{-2}]$$

$$E = [ML^2T^{-2}] \Rightarrow K.E. = \left(\frac{1}{2}\right)mv^2$$

$$= [M][LT^{-1}]^2$$

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

(कार्य ऊर्जा)

Torque

$$\Rightarrow W = E = \tau \Rightarrow \text{Dimensions are Same } [ML^2T^{-2}]$$

$$\hookrightarrow \tau = F \times d$$

* $g \Rightarrow ?$ Gravitational acceleration $\Rightarrow [LT^{-2}]$

* $G = ?$ $\rightarrow$ "

Charge :- $q \Rightarrow [AT]$

$\Rightarrow \varepsilon_0 = ?$ $\mu_0 = ?$

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

$$\varepsilon_0 = \frac{q_1 q_2}{F r^2}$$

$$\varepsilon_0 = \frac{[AT][AT]}{[MLT^{-2}][L^2]} = [M^{-1} L^{-3} T^4 A^2]$$

$$*$$

$$\Rightarrow \begin{cases} V = \dfrac{1}{4\pi\varepsilon_0} \dfrac{q}{r} \\ V = IR \\ V = E \end{cases}$$

(effect of motion)

KINEMATICS

(गतिकी)

Position change

Distance

Displacement

Speed

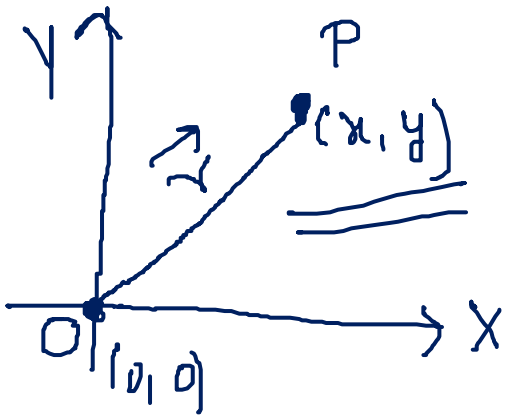
Velocity

Acceleration

Kinematics definitions

(cause of motion) X

- Kinematics – branch of physics; study of motion



- Position (***x***) – where you are located

- Distance (*d*) – how far you have traveled, regardless of direction

Actual Length

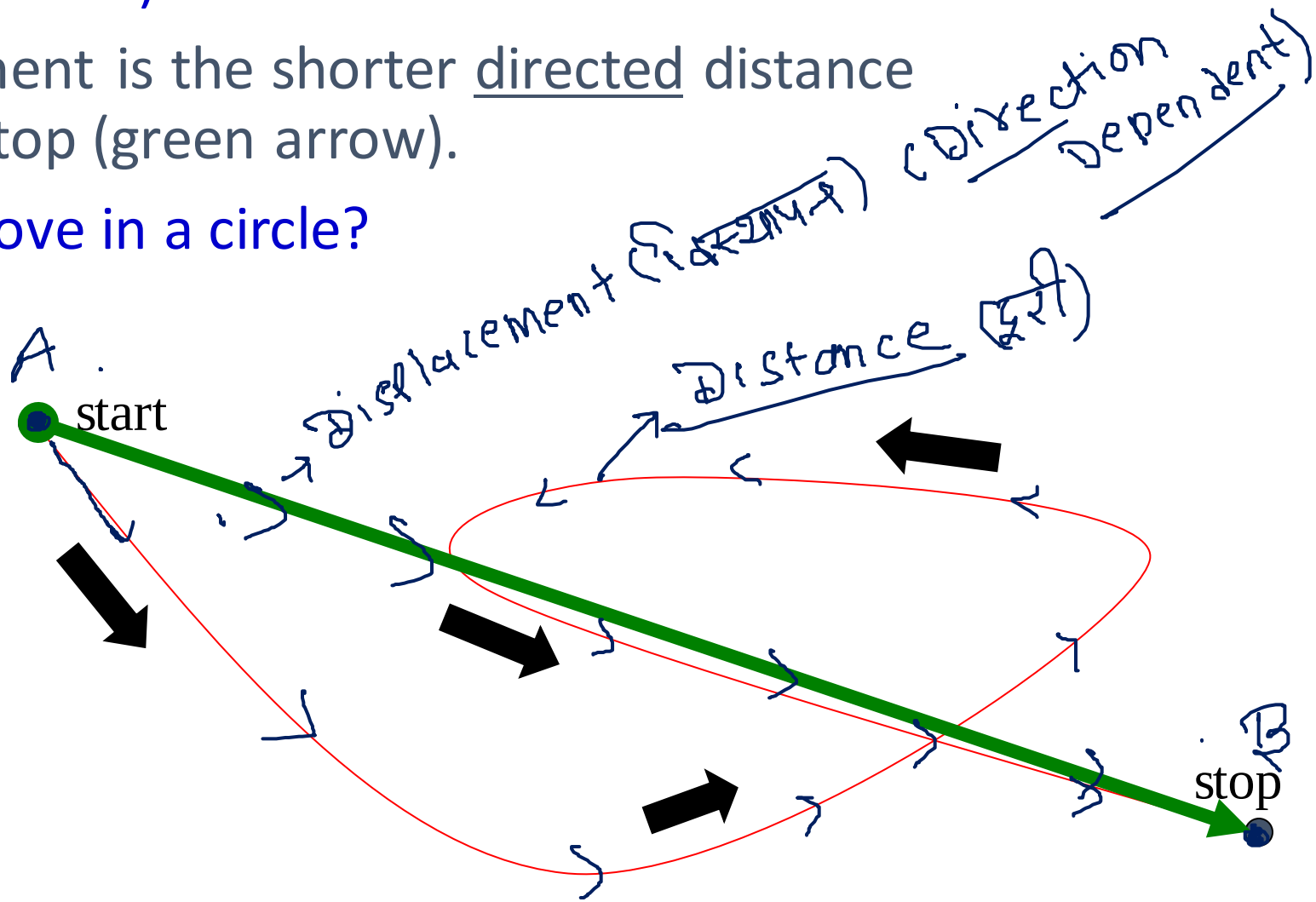
- Displacement ($\Delta \boldsymbol{x}$) – where you are in relation to where you started

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

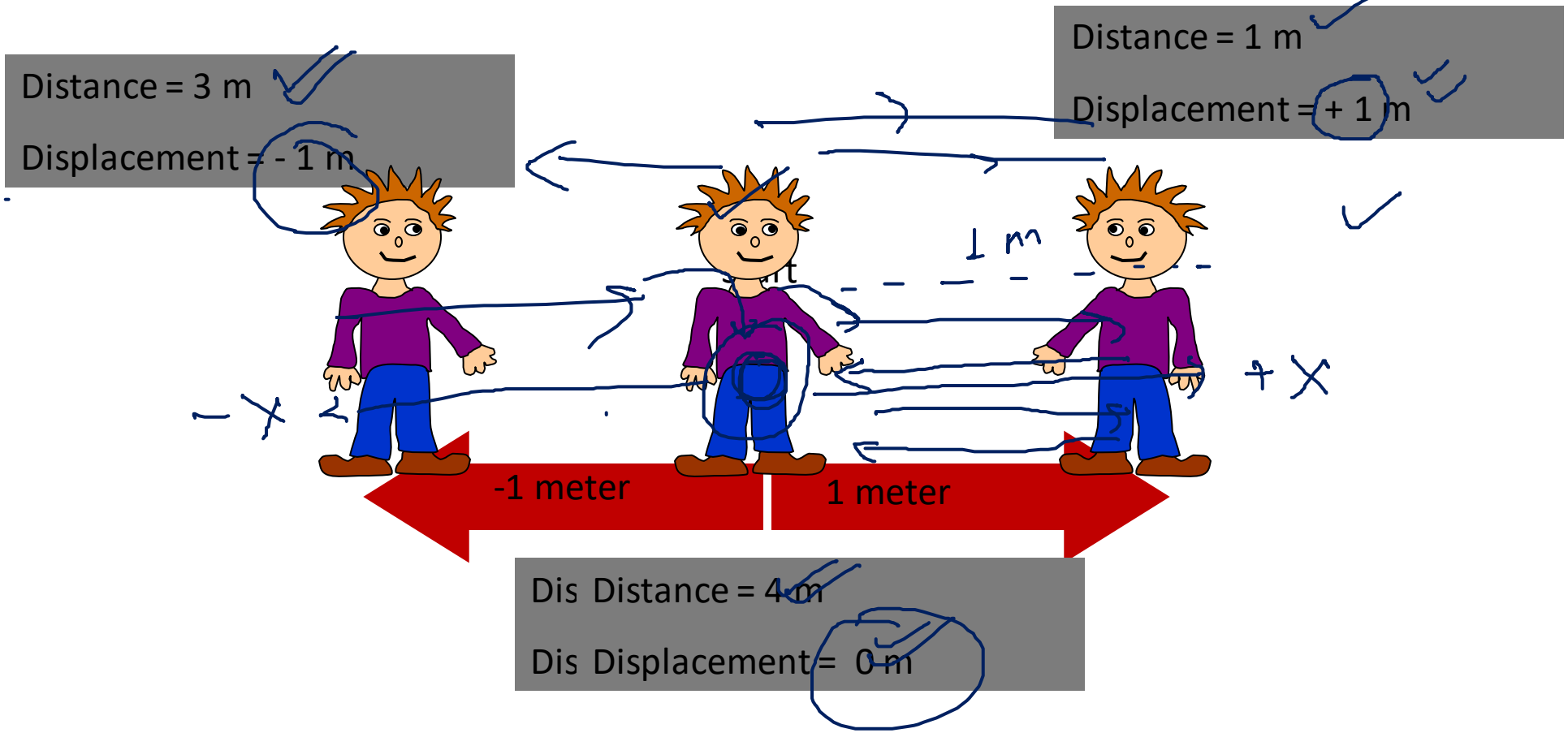
- You drive the path, and your odometer goes up by 8 miles (your distance).
- Your displacement is the shorter directed distance from start to stop (green arrow).
- What if you drove in a circle?



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



Distance

* Length
  (meter)
* Direction Indep. ✓
* Scalar (अदिश)
* Negativ (नहीं हो सकती)
* if motion Done,
  Dist. can't be zero.

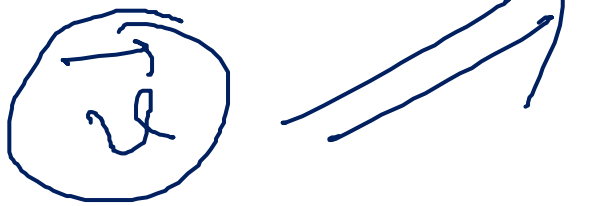
Displacement

Length
(meter)

* Dir. Depend.
* Vector (सदिश)
* Disp:- (+ve)
  (-ve)
  (Zero)

Speed vs. Velocity

- 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: $\vec{v}$

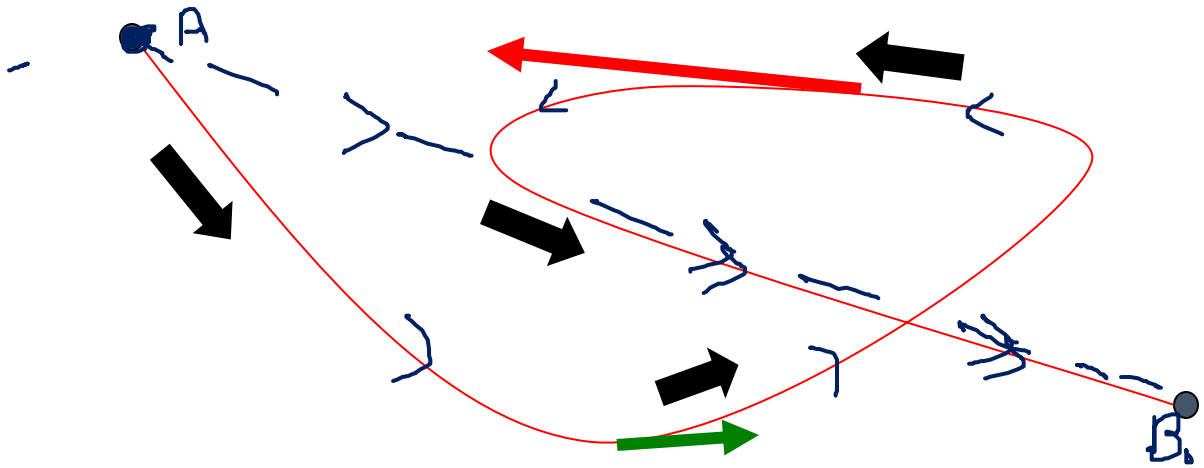


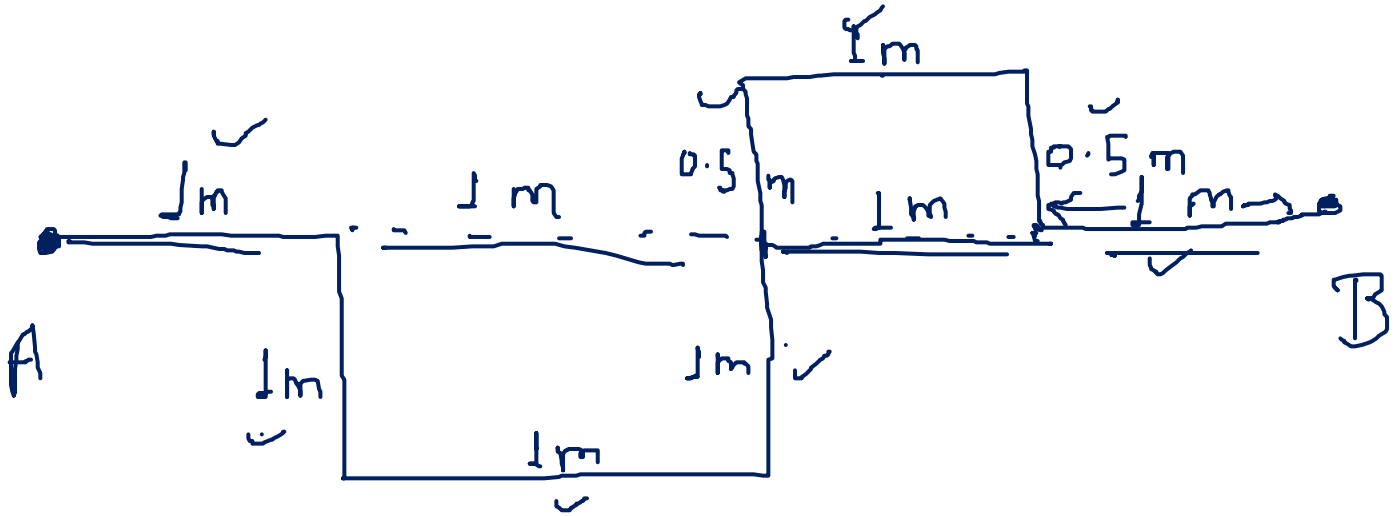
Speed vs. Velocity

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

$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

- 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.





Time = 10 min

Speed = ?

Velocity = ?

$$\text{Speed} = \frac{7}{10} = 0.7 \text{ m/s}$$

$$\text{Velocity} = \frac{4}{10} = 0.4 \text{ m/s}$$

More About Velocity

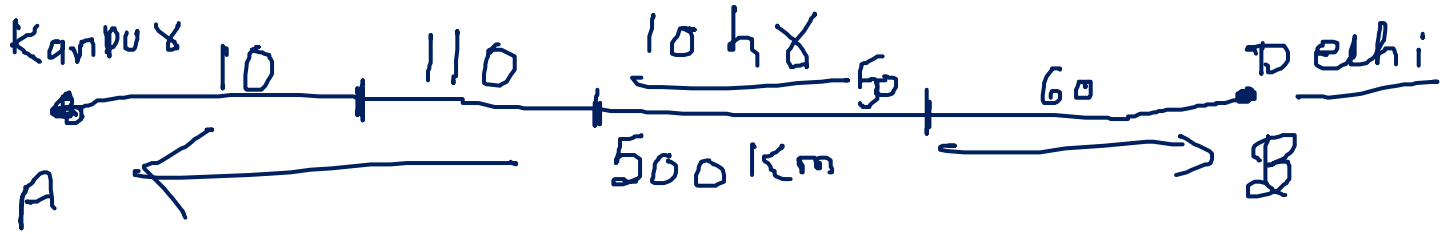
- **Average Velocity**: the overall displacement covered in a given time period

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

- 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 → $\boldsymbol{v}_1$ (or $\boldsymbol{v}_i$ or $\boldsymbol{v}_o$)
  - Final velocity → $\boldsymbol{v}_2$ (or $\boldsymbol{v}_f$ or $\boldsymbol{v}$)

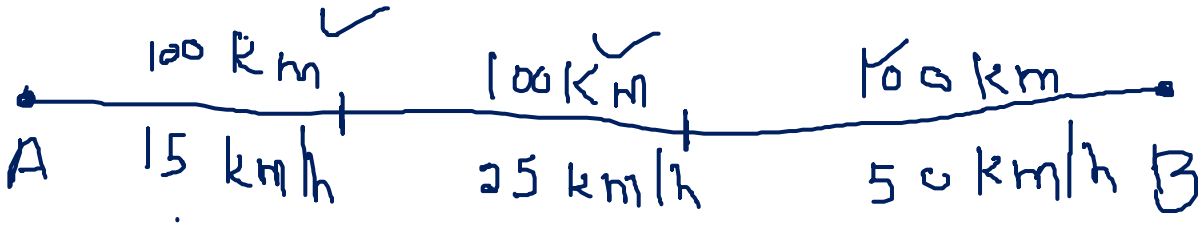


$$\text{Speed/velocity} = \frac{500}{10} = 50 \text{ km/h}$$

$$\left\{ v_{avg} = \frac{\text{Total Distance}}{\text{Total Time}} \right\}$$

$$\left\{ \vec{v}_{avg} = \frac{\text{Total Disp.}}{\text{Total time}} \right\}$$

*



$V_{avg} = ?$

$$\text{Total Dist} \over \text{Total Time}$$

T. D. = 300 km

① $Time_1 = \frac{100}{15} = \frac{20}{3}$ hr

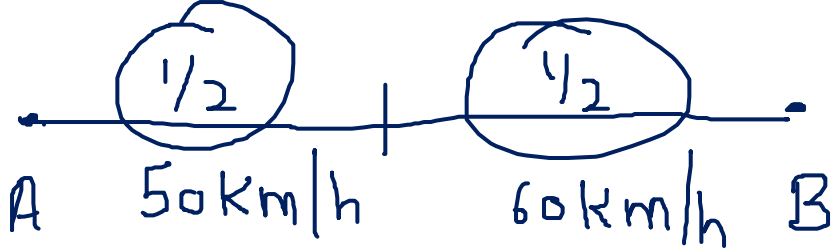
② $T_2 = \frac{100}{25} = 4$ hr

③ $T_3 = \frac{100}{50} = 2$ hr

$T. = T_1 + T_2 + T_3 = \frac{20}{3} + 6 = \frac{38}{3}$ hr

$V_{av} = \frac{300 \times 3}{38}$

$= \frac{450}{19}$ km/hr



$\Rightarrow S_1 = S_2$

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

$$v_{avg} = \frac{3 v_1 v_2 v_3}{v_1 v_2 + v_2 v_3 + v_3 v_1}$$

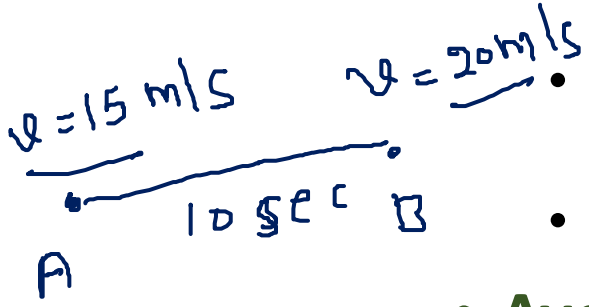
$$v_{avrg} = \frac{v_1 + v_2}{2}$$] when time interval is constant

$$v_{av} = \frac{v_1 + v_2 + v_3 + \cdots}{3}$$

$\vec{a} = \frac{v_f - v_i}{time}$

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

$\vec{a} = \frac{20 - 15}{10} = \frac{5}{10}$

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

$0.5\ m/s^2$

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

$v_f = 15 m/s$ $\quad v_i = 30 m/s$

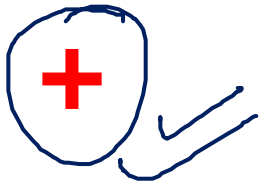
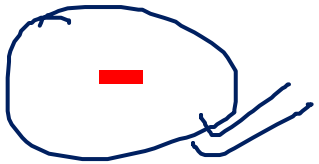
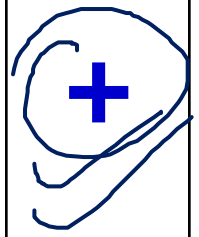
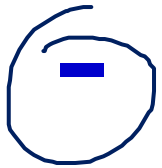
Time = 15 sec

$$\vec{a} = \frac{v_f - v_i}{T} = \frac{15 - 30}{15} = -1 m/s^2$$

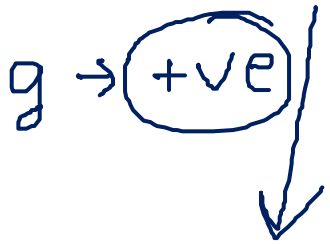
Retardation (Negative Acceleration)

Deacceleration

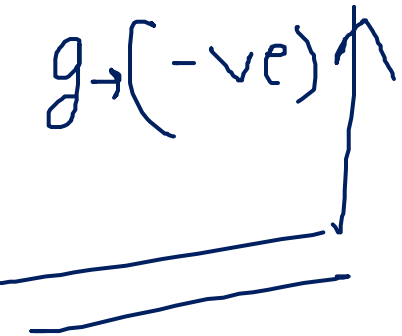
Velocity & Acceleration Sign Chart

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

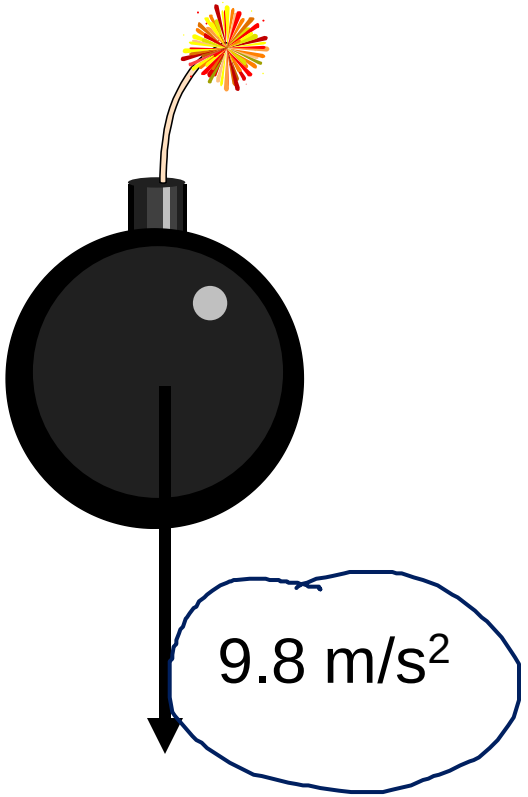
Acceleration due to Gravity



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



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



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:

$v = u + at$

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

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

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

Don’t Forget to Like / Comment & Share this video

www.Youtube.com/safaltaclass

www.Facebook.com/safaltaclass

www.Instagram.com/safaltaclass

Google Play Store

SAFALTACLASS