

⇒ Kinematics (गतिविधि)



SAFALTA CLASSTM

An Initiative by **अमर उजाला**

KINEMATICS

(गति की)

Scalar Quantity (अदिश राशियाँ)

Scalar quantity is defined as the physical quantity with magnitude and no direction.

वैसी भौतिक राशि, जिनमें केवल परिमाण होता है. दिशा नहीं, उसे अदिश राशि कहा जाता है:.

नोट: विद्युत धारा (current), ताप (temperature), दाब (pressure) ये सभी अदिश राशियाँ हैं।

Examples : Mass, Speed, Distance, Time, Volume, Density, Temperature etc.....

जैसे - द्रव्यमान, चाल, आयतन, कार्य, समय, ऊर्जा आदि

Vector Quantity (संदिश राशि)



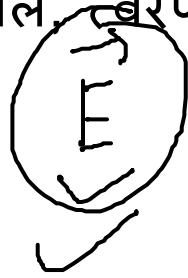
A vector quantity is defined as the physical quantity that has both direction as well as magnitude.

वैसी भौतिक राशि जिनमें परिमाण के साथ-साथ दिशा भी रहती है और जो योग के निश्चित नियमों के अनुसार जोड़ी जाती हैं,

उन्हें संदिश राशि कहते हैं:

Examples: Linear momentum, Acceleration, Displacement, Momentum, Angular velocity, Force, Electric field, Polarization

जैसे- वेग, विस्थापन, बल, त्वरण आदि.



* Distance

* Displacement

* Speed

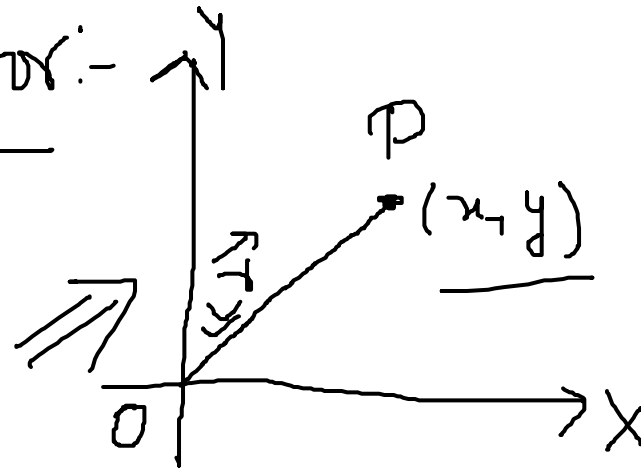
* Velocity

* Acceleration

* Rest: - Depends on observer.

* motion: - everything is in motion

* Position Vector: -



Kinematics definitions (cause of motion x)

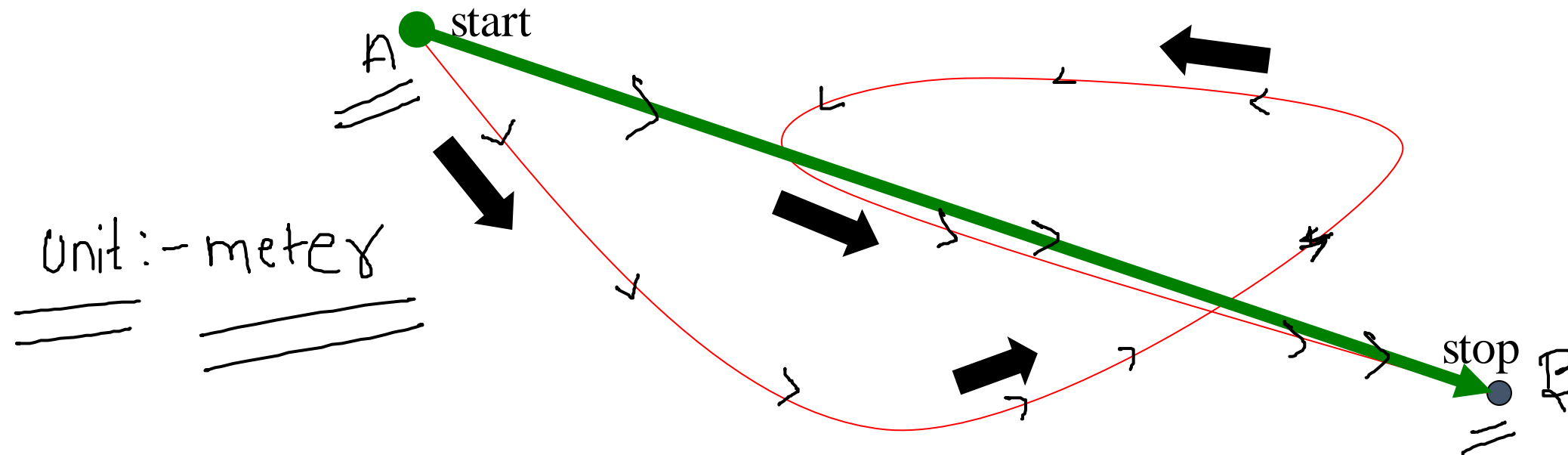
- Kinematics – branch of physics; study of motion
- Position (\mathbf{x}) – where you are located
- Distance (d) – how far you have traveled, regardless of direction
- Displacement ($\Delta\mathbf{x}$) – where you are in relation to where you started

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 ✓
- विस्थापन (Δx) - जहां आप शुरू किए , संबंध में हैं ✓

Distance vs. Displacement

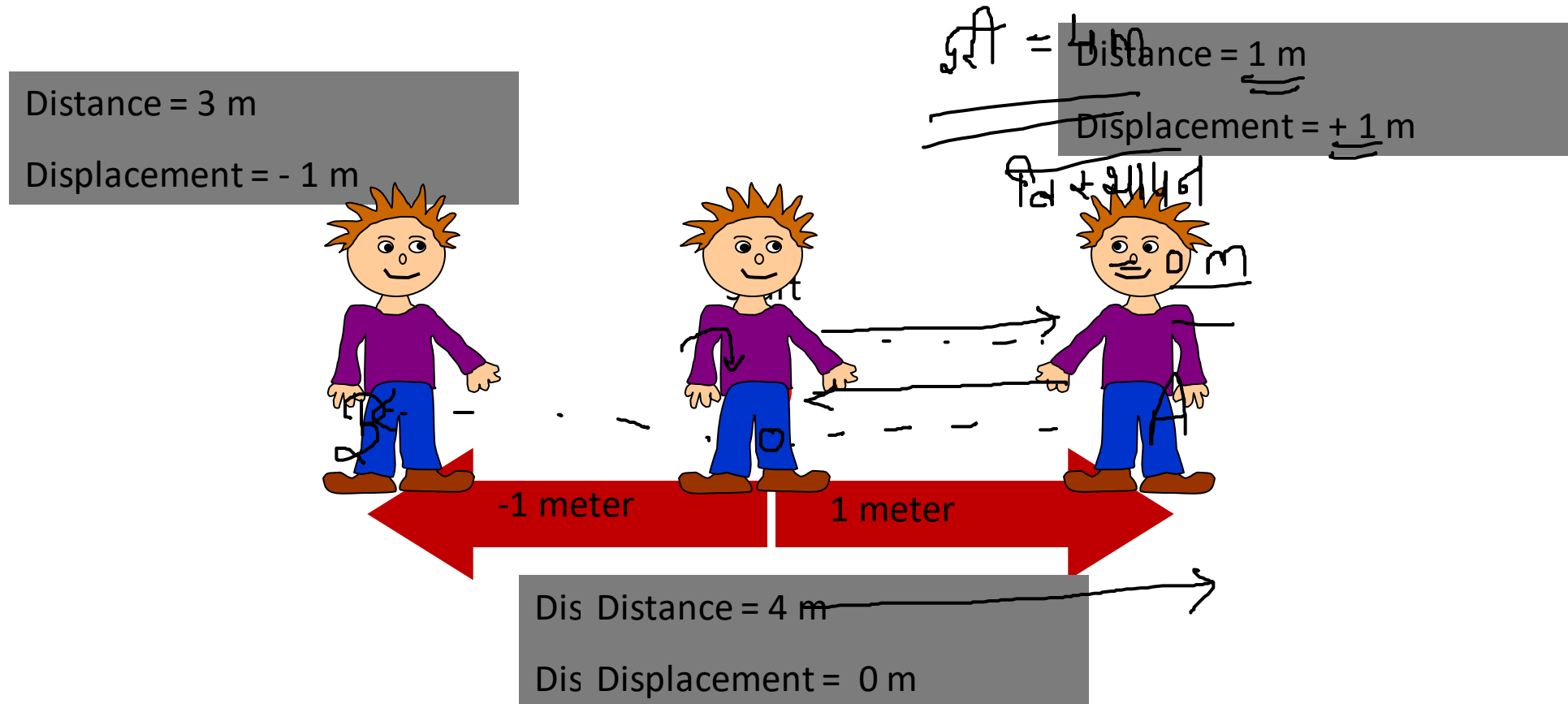
- Distance is the total movement of an object without any regard to direction.
- किसी दिए गए समयान्तराल में वस्तु द्वारा तय किए गए मार्ग की लंबाई को दूरी कहते हैं। यह एक अदिश राशि है। यह सदैव धनात्मक(+ve) होती है।
- Displacement is defined as the change in position of an object. It is a [vector quantity](#) and has a direction and magnitude.
- एक निश्चित दिशा में दो बिन्दुओं के बीच की लंबवत दूरी को विस्थापन कहते हैं। यह सदिश राशि है। इसका S.I. मात्रक मीटर है। विस्थापन धनात्मक, ऋणात्मक और शून्य कुछ भी हो सकता है।



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



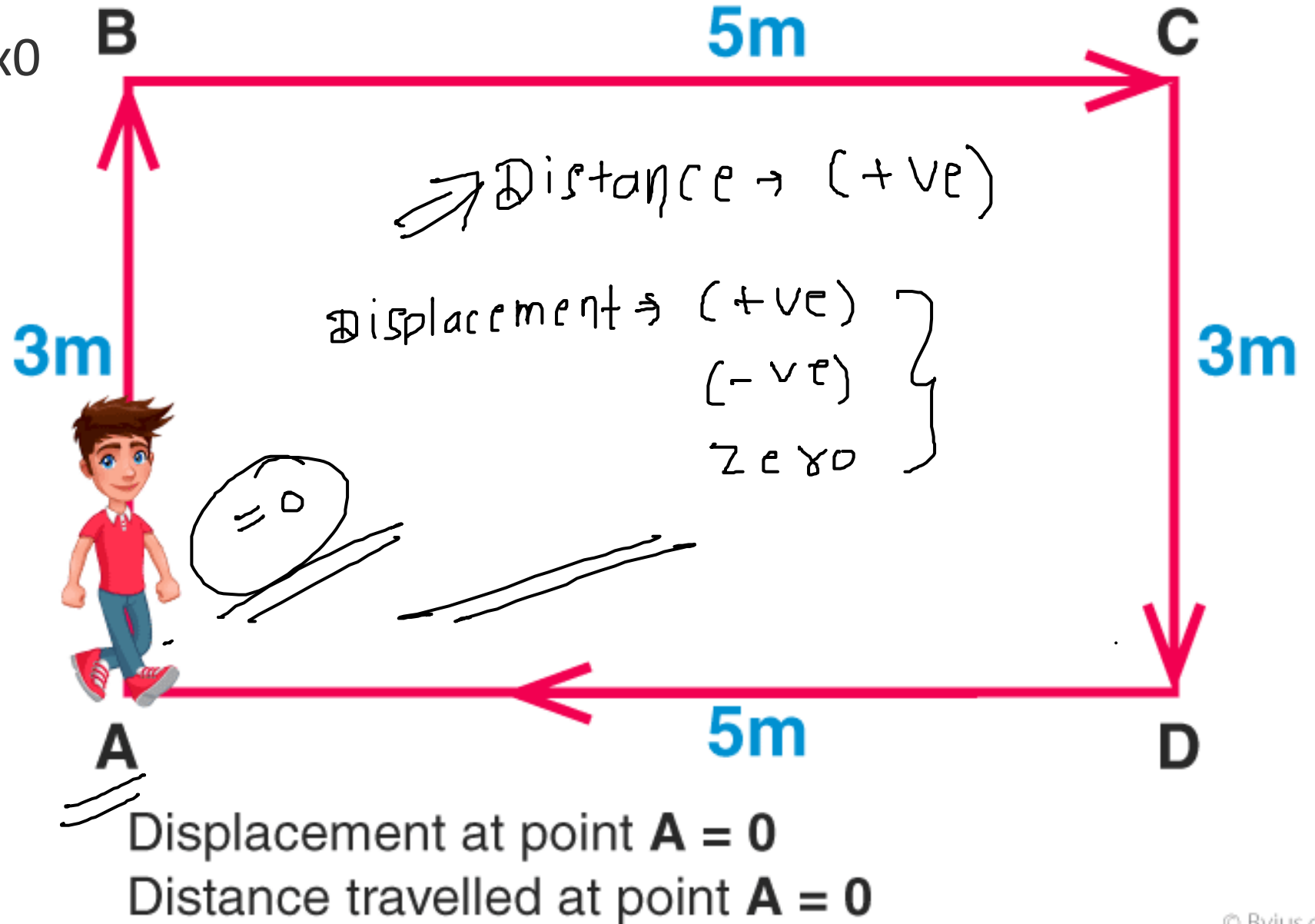
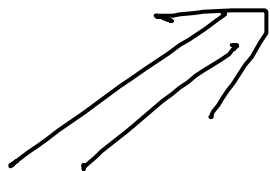
Displacement = $\Delta x = x_f - x_0$

x_f = Final Position

x_0 = Initial Position

Δx = Displacement

$$\Delta x = x_f - x_i$$



Speed vs. Velocity (चाल और वेग)

- Velocity can be defined as the rate at which an object changes position in a certain direction. किसी वस्तु के विस्थापन की दर को या एक निश्चित दिशा में प्रति सेकंड वस्तु द्वारा तय की दूरी को वेग कहते हैं।
$$\text{वेग} = \frac{\text{दूरी}}{\text{समय}}$$

$$\text{वेग} = \frac{\text{विस्थापन}}{\text{समय}}$$
- Vector quantity. यह एक सदिश राशि है।
$$\text{m/s} \Rightarrow \underline{\underline{SI}}$$
- Velocity can be zero, negative, or positive.
- An object may possess different velocities but the same speed.
- Velocity is measured in m/s. इसका S.I. मात्रक मीटर/सेकंड है।

Speed vs. Velocity

- The rate at which an object covers a certain distance is known as speed.

किसी वस्तु के विस्थापन की दर को चाल कहते हैं। Scalar quantity. यह एक अदिश राशि है।

- Speed can never be negative or zero.
- Speed may or may not be equal to velocity.

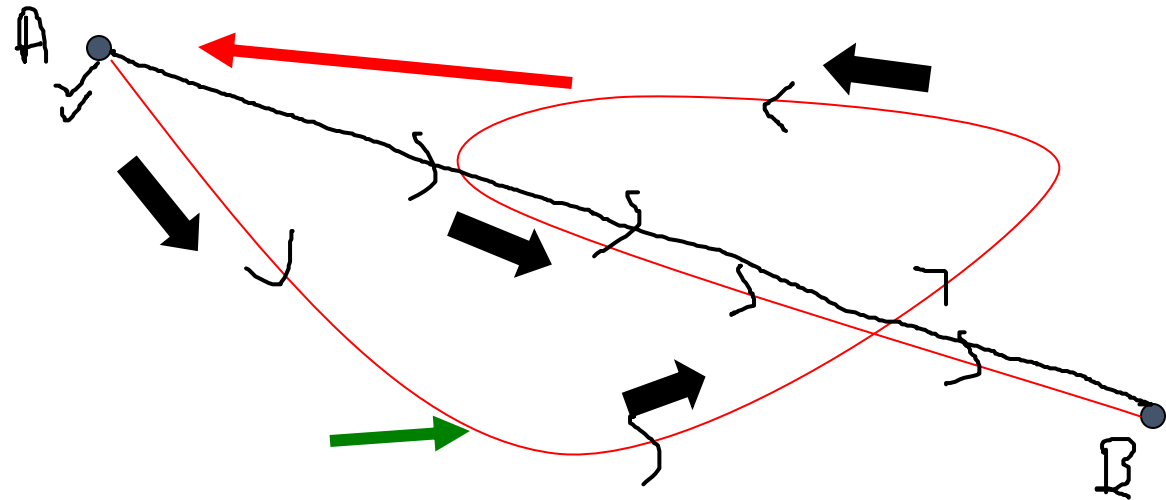
- इसका S.I. मात्रक मीटर/सेकंड है।

वेग $\rightarrow \vec{v}$

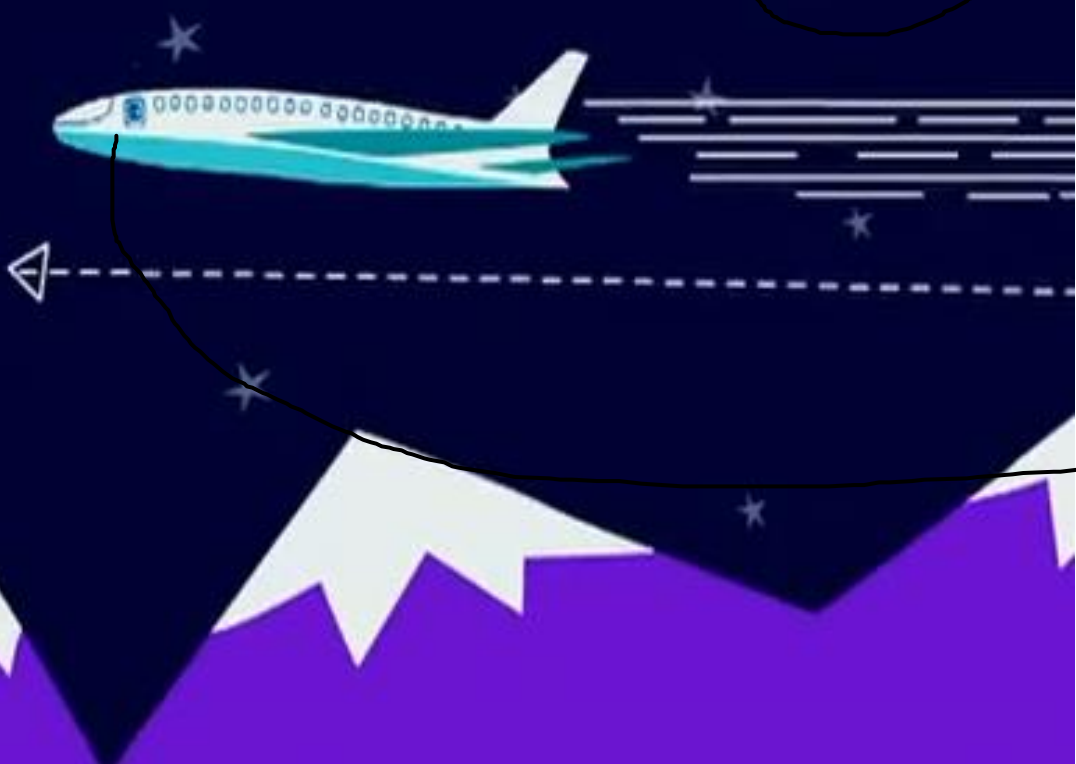
- चाल = दूरी / समय

Speed $\rightarrow \frac{d \text{ or } |\vec{v}|}{t}$

* Speed = Velocity
 \Rightarrow uniform linear motion

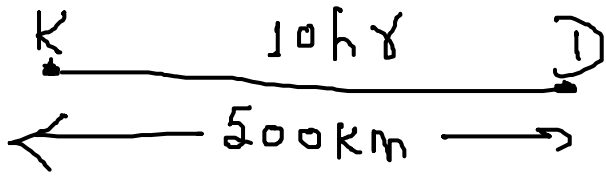


VELOCITY: 500 MILES PER HOUR WEST



Speedometer





More About Velocity

$$\text{औसत वेग} = \frac{\text{कुल विस्थापन}}{\text{कुल समय}}$$

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

$$\Rightarrow SP = \frac{500}{10}$$

$$SP = 50 \text{ km/h}$$

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

$$S = \frac{D}{t}$$

$$t = \frac{D}{S}$$

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

*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 $\rightarrow v_1$ (or v_i or v_o)
- Final velocity $\rightarrow v_2$ (or v_f or v)

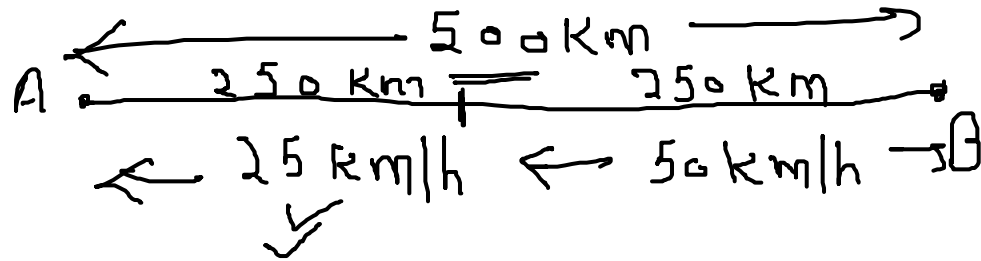
औसत वेग

||

कुल दूरी

कुल समय

$$\text{Avg Speed} = \frac{\text{Total Dist}}{\text{Total time}}$$



$$T_1 = \frac{250}{25} = 10 \text{ hr}$$

$$T_2 = \frac{250}{50} = 5 \text{ hr}$$

$$T = 10 + 5 = 15 \text{ hr}$$

$$S_{av} = \frac{500}{15}$$

$$v_{av} = 33.33 \frac{\text{km}}{\text{h}}$$

* दूरी समान भाग में →



$$v_{av} = \frac{2v_1v_2}{v_1 + v_2}$$
$$v_{av} = \frac{3v_1v_2v_3}{v_1v_2 + v_2v_3 + v_3v_1}$$

$$v_{av} = \frac{2 \times 50 \times 60}{110} \Rightarrow \frac{60}{1.1} = \underline{\underline{54.5}}$$

* समय समान भाग में:-



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

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

वेग परिवर्तन की दर

\Rightarrow

Acceleration (त्वरण) (Positive 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)

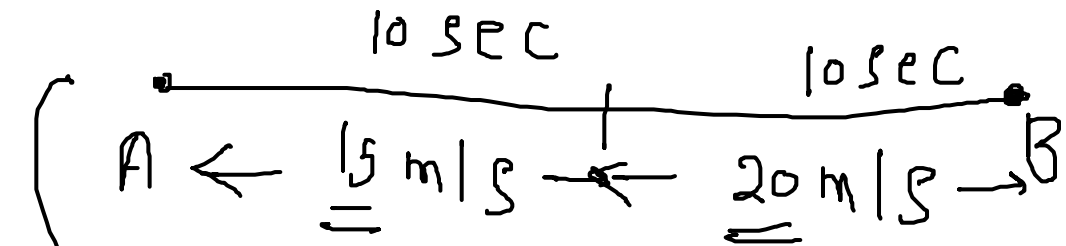
Negative
Acceleration
(Retardation)
(मंदन)

- **Average Acceleration:** the rate at which velocity is changing

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

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

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



$$v_f - v_i = 20 - 15 = \underline{5 \text{ m/s}}$$

$$t = \underline{\underline{10 \text{ SEC}}}$$

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{5}{10} = \underline{\underline{0.5 \text{ m/s}^2}}$$

Velocity & Acceleration Sign Chart



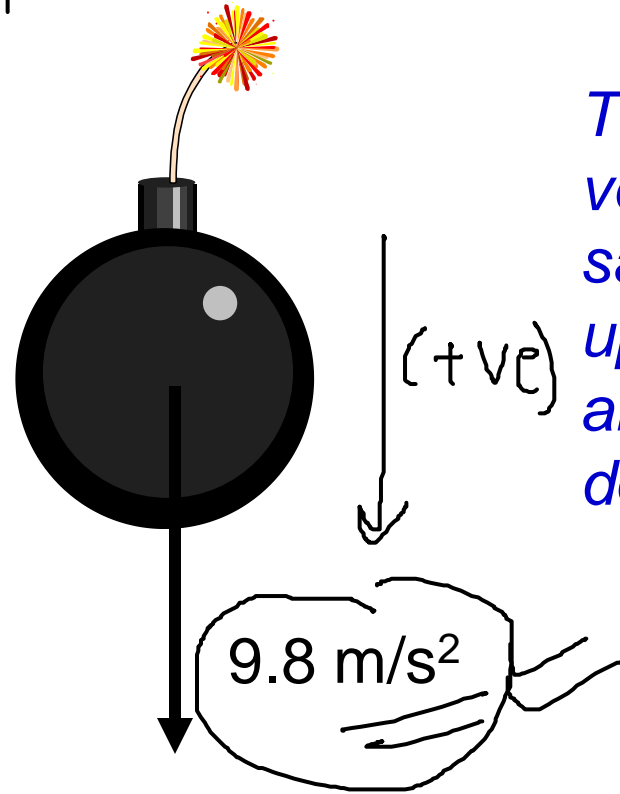
		<i>VELOCITY</i>	
<i>A C C E L E R A T I O N</i>		+ =	- =
	+ =	Moving forward; Speeding up	Moving backward; Slowing down
	- =	Moving forward; Slowing down	Moving backward; Speeding up

Acceleration due to Gravity

ସ୍ଵତନ୍ତ୍ରତା ଓ ଚରଣ

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

Final velocity
↑
initial vel. →

For 1-D motion with constant acceleration:

$$v = u + at \quad \checkmark$$

↓
acceleration

$$v^2 = u^2 + 2as \quad \checkmark$$

↓
Dist ✓

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

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

*

Rest $\longrightarrow v \rightarrow \underline{\underline{20 \text{ km/h}}}$

$\vec{a} = ?$

$t = \underline{\underline{15 \text{ sec}}}$

$$\vec{a} = \frac{v_f - v_i}{t} = \frac{20 \times \frac{5}{18} - 0}{15}$$

$$= \frac{50}{15 \times 9} = \frac{10}{27}$$

$$\rightarrow \frac{20 \times 1000}{60 \times 60} \times \frac{1}{36} = \frac{5}{18}$$

$$\frac{\text{km}}{\text{h}} \rightarrow \frac{5}{18} \frac{\text{km}}{\text{h}}$$

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