Lecture 1

Friday, July 8, 2022 21:49

Scalars and Vectors

segue into this

Basic Physical Quantities

Q: Identify:

- weight (scalar)
- position
- speed
- velocity
- time (scalar)

Def. position $\vec{d}$: relative location wrt reference point

Ask: what type of quantity is position

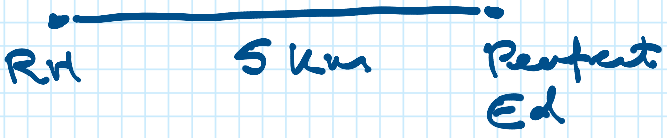
Vector

Note: we need to specify both direction and magnitude

Example: Perfect Education is 5 km [East] of RH station

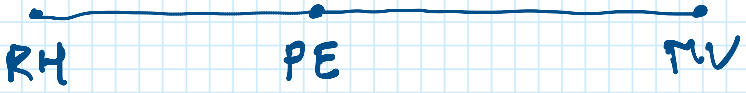
Here, RH station is the observation point (reference)

we can find Perfect Ed at 5 km east



Positin can also add up vectorially

Now if we introduce Markville Mall which is 8 km [East] of Perfect Ed



$\vec{d}$ = 5 [east] + 8 [east]

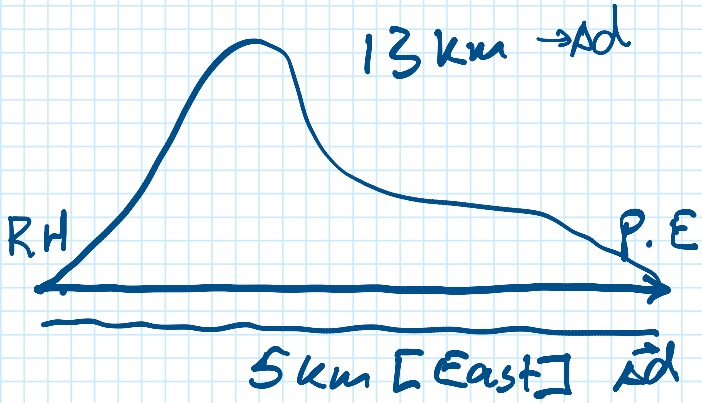
= 13 [east]

A total of 13 km east.

Def: Δd distance: the total length of path an object traveled in motin

Δ : change

$\Delta \vec{d}$ displacement: change of positin.



Bus - car analogy

Def: Speed (Average): total dist. traveled divided by time

$$v_{av} = \frac{\Delta d}{\Delta t}$$

Ex: Usain Bolt runs 100 m in 9.58 s

What is his average speed?

$$v_{av} = \frac{\Delta d}{\Delta t} = \frac{100\ m}{9.58\ s} = 10.44\ m/s$$

Ex: A ball is rolling at a const. 3.8 m/s

How far will it roll in 15 s?

$v_{av} = 3.8\ m/s$, $\Delta t = 15\ s$

$$\Delta t \cdot v_{av} = \frac{\Delta d}{\Delta t} \Delta t$$

$$\Delta d = v_{av} \Delta t$$

$$= 15 \times 3.8$$

$$= 57\ m$$

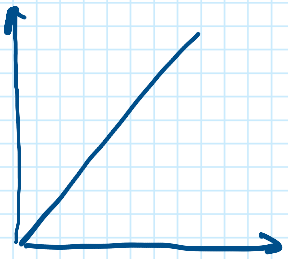
Def: Average Velocity: Time rate of change of displacement

Velocity: Time rate of change of displacement

$$\vec{V}_{av} = \frac{\vec{\Delta d}}{\Delta t}$$

→ Slope on position-time graph

Note: We only think of linear case, when determining velocity graphically



Ex. Position of balloon blown 82 m [N] away on a windy day in 15 s

→ what is the average velocity of balloon?

$$\vec{V}_{av} = \frac{\vec{\Delta d}}{\Delta t} = \frac{82\,m\,[N]}{15\,s} = 5.5\,m/s\,[N]$$

Acceleration: velocity can also change!

Def. acceleration: Time rate of change of speed / velocity

$$a,\ \vec{a} = \frac{\Delta V}{\Delta t},\ \frac{\vec{\Delta V}}{\Delta t}$$

→ Slope of velocity - time graph

What is the unit of accelerating?

$$\frac{\Delta v}{\Delta t} \Rightarrow \frac{m/s}{s} \rightarrow m/s^2$$

Ex: what is acceleration of skateboard

$\vec{v}_i = 0$ m/s $\vec{v}_f = 30$ m/s [S]

$t_i = 0$ s $t_f = 10$ s

Tutorial: **Write Out All Variables**

① School: 500 m [E]

Library: 1200 m [W]

From your house

What is your displacement if you walk from Library to School?

2 min

1700 m [E]

② A car goes 32 km [S] for Costco
then goes north 59 km To cinema

Determine its 3 min

(a) Distance Traveled

(b) Total Displacement

③ Use vector scale determine total disp

(a) $\Delta\vec{d}_1 = 10\,m\,[W]$ $\Delta\vec{d}_2 = 8\,m\,[E]$

(Example)

(b) $\Delta\vec{d}_1 = 10\,m\,[W]$ $\Delta\vec{d}_2 = 3\,m\,[W]$

(c) $\Delta\vec{d}_1 = 7\,km\,[W]$

$\Delta\vec{d}_2 = 12\,km\,[E]$

$\Delta\vec{d}_3 = 5\,km\,[W]$

① Coordinate System

[N] [E] positive $\longrightarrow E$

② Draw Vectors up To scale

keep track of the origin

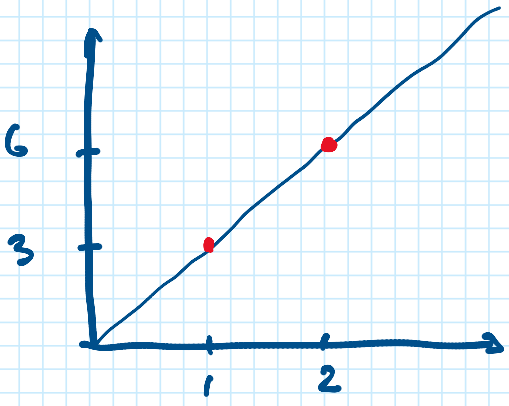
↑

beginning point

beginning point

③ Add & subtract

④ Determine velocity for the motion described below:



⑤ Complete the table:

$\frac{\Delta \vec{d}}{\Delta t} = \vec{v}$

$\vec{v}_{av}$	$\Delta \vec{d}$	Δt
$\frac{126}{163}$ m/s, [S] 0.773 m/s	12.6 m [S]	16.3 s
2.0×10^3 m/s [E]	25 m [E]	$\pm$ 80 s
M = 5.88 Hypersonic	40 m/s [N]	10 m [N]
		0.25 s

⑥ What is the velocity of F-18 fighter jet 8.864 km [S] in 0.297 min?

What is the velocity in m/s

What is the velocity in m/s

$$\frac{8.864\ \text{km}}{0.297\ \text{min}} = 29.845\ \text{km/min}$$

match sig fig

1 km = 1000 m,

1 min = 60 s

$$\Rightarrow = 29.845\ \frac{1000\ \text{m}}{60\ \text{s}}$$

$$= 497.42\ \text{m/s}$$

M 1.46

(7) How long does it take for a car to accelerate from 3.2 m/s [W] to 5.8 m/s [W] if it experience avg. accel. of 1.23 m/s² [W] ?

$v_i = 3.2\ \text{m/s}\ [W]$ $\vec{a}_{av} = 1.23\ \text{m/s}^2\ [W]$

$v_f = 5.8\ \text{m/s}\ [W]$

$\Delta t = ?$

$$\vec{a} = \frac{\Delta \vec{v}}{\Delta t} = \frac{\vec{v}_f - \vec{v}_i}{\Delta t}$$

$$\Delta t = \frac{\vec{v}_f - \vec{v}_i}{\vec{a}} = \frac{5.8 - 3.2}{1.23} = 2.11 \text{ s}$$

(8) speedboat experience average acceleration 2.4 m/s^2 [W]

$v_f = 17 \text{ m/s}$ [W], accelerated for 6.2 s

What is v_i?

2.1 m/s [W].