Chapter 2: Describing Motion in One Dimension

Lecture 1B

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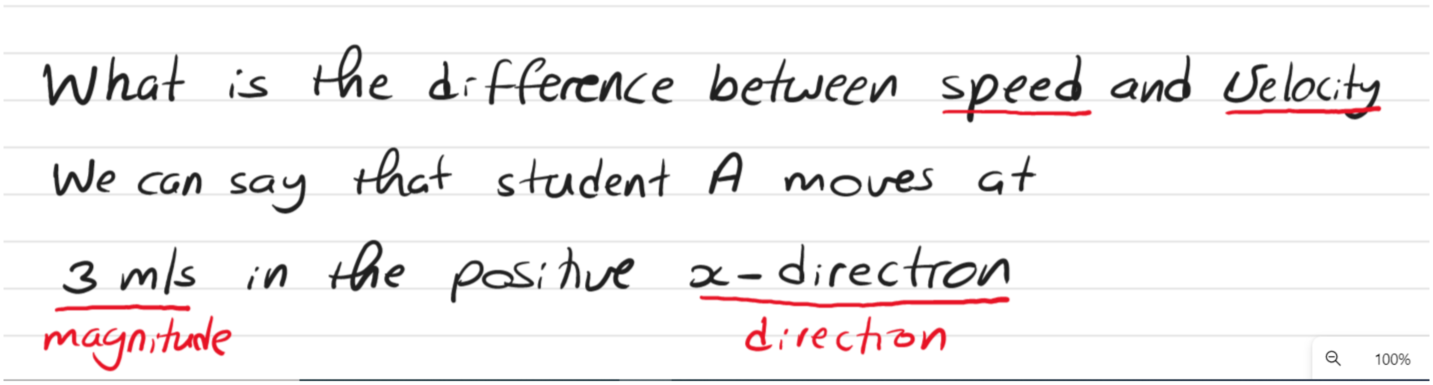


What is the difference between speed and Velocity

We can say that student A moves at 3 m/s in the positive x-direction

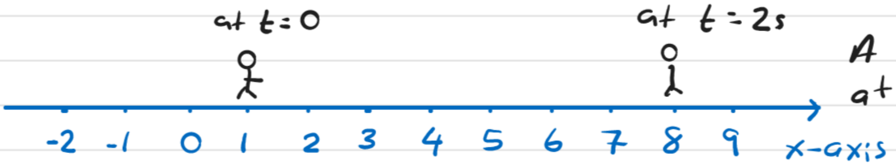
magnitude — direction

$v_A = +3$ m/s

↳ direction to the right (along positive x-direction)

$v_B = -3$ m/s

↳ direction to the left (along negative x-direction)



A student was at x=1 m at t=0 and moved to x=8 at t=2s

Define average velocity as :

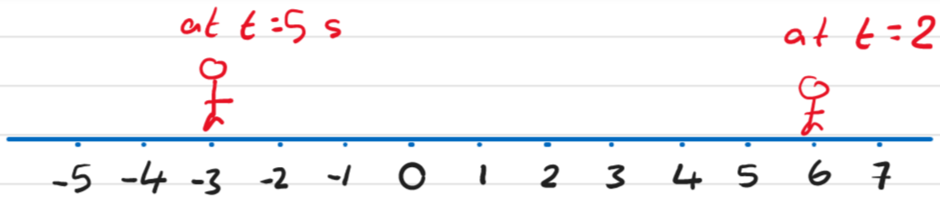
final position at t_f

means average → $$\bar{v} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$ initial position at t_i

final time

initial time

$$\bar{v}_{0-2} = \frac{8-1}{2-0} = \frac{7}{2} = 3.5 \text{ m/s}.$$



Find the average velocity of the student over the time interval $t = 2s \rightarrow t = 5s$.

$$\bar{v}_{2-5} = \frac{x_f - x_i}{t_f - t_i} = \frac{-3-6}{5-2} = -\frac{9}{3} = -3 \text{ m/s}$$

$$\bar{v}_{2-5} = -3 \text{ m/s}$$

↳ means the average velocity is along the negative x-direction.

NOTE: Average velocity is given over a time interval.

2-3] Instantaneous velocity

When you drive your car, you look at the odometer (عداد السرعة) you may read 50 km/h.

This is the velocity at a given instant. We call this Instantaneous velocity. Which is given at a particular instant of time.

$v = 60$ km/h direction in positive x-axis.

$v = -40$ km/h " " negative x-axis.

2-4] Acceleration

When the velocity of an object changes with time then this object accelerates.

Acceleration is CHANGE in velocity with time.

Example: At $t = 2s$, the velocity of a train is 4 m/s.
After 3s, its velocity is 12 m/s.

Is the train accelerating? Why?

Yes it is accelerating, because the velocity changed with time.

Average acceleration $\bar{a}$

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

Defined over a time interval $\Delta t = t_f - t_i$

Example: Find the average acceleration of the car

$t_i = 2s$, $t_f = 2+3 = 5s$.

$v_i = 4 m/s$, $v_f = 12 \ m/s$

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{12 - 4}{5 - 2} = \frac{8}{3} \ m/s^2 .$$

Example: A car accelerates on a straight road from rest to in 5.0 s, What is the magnitude of its average acceleration?

$$\bar{a} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}.$$

Since Δt is given in seconds, we need to convert the magnitudes of the velocities to m/s.

$$75\,\frac{km}{h} = 75\,\frac{\cancel{km}}{\cancel{h}} \times \frac{1000\,m}{\cancel{km}} \times \frac{\cancel{h}}{3600\,s} \approx 21\ m/s.$$

$$\therefore\ \bar{a} = \frac{21-0}{5-0} = 4.2\ m/s^2.$$

Question: If the velocity of an object is zero, does it mean that the acceleration is zero?

If $v = 0$ it does NOT necessarily mean that

the the acceleration is zero. Because the acceleration depends on CHANGE of v NOT v itself.

Note $$\bar{a} = \frac{v_f - v_i}{t_f - t_i}$$