Phys 131 2023

Lecture 2

Diagnostic - Pre Test Grades on D2L

Fri: Warm Up Exercise (D2L) due by 9am

- Show on D2L
- Reading exercise
- Each worth 2pts (eventual total 600pts)

~~Mon * Reading for class~~

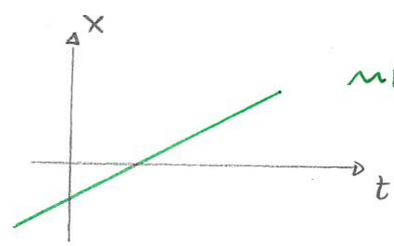
Group Exercise in class.

Mon: * Read before

- HW by 5pm - show on course website.

Recall that when describing the motion of an object we aim to provide the position at all times.
However, this does not immediately connect to the physics of the interactions of the object and we need to work through intermediate quantities:

- speed, velocity, acceleration.



e.g.
MD $x = \frac{1}{2}t - \frac{1}{2}$

Speed

Sometimes one can almost completely describe motion via the rate at which an object moves

Demo: PhET Moving Man

- Charts Tab
- Initial $x_0 = -8$ → observe + describe motion
  $v_0 = 3$

In the animation the man covers distance at a constant rate. If we know the man's initial position then we can determine his position at any later time. We could describe the rate via the concept

Speed ~ rate at which distance is covered

A more precise definition would be:

Consider an object moving during an interval of time. Then

$$\text{average speed over interval} = \bar{s} = \frac{\text{total distance traveled}}{\text{time elapsed during interval}}$$

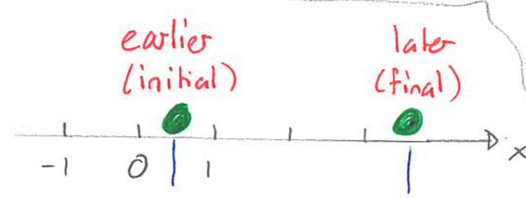
units: m/s

Displacement, velocity

The concept of speed is inadequate for capturing information about direction of motion or changes in direction of motion. Both of these will be important when we eventually describe the dynamics of an object. So we need to modify speed. We first provide a preliminary modification:

FRAMEWORK FOR DEFINING AVERAGE VELOCITY

Observe an object over an interval of time. Consider the moments at the beginning and end of this interval



	earlier	later
position	x_1	x_2
time	t_1	t_2

Displacement of the object during interval → change in position

$$\text{displacement} := \Delta x = x_2 - x_1$$

units: meters [m]

Average velocity over interval

velocity ~ rate of change of position

$$\text{average velocity from } t_1 \text{ to } t_2 \equiv \bar{v} := \frac{\Delta x}{\Delta t} = \frac{x_2 - x_1}{t_2 - t_1}$$

units: m/s

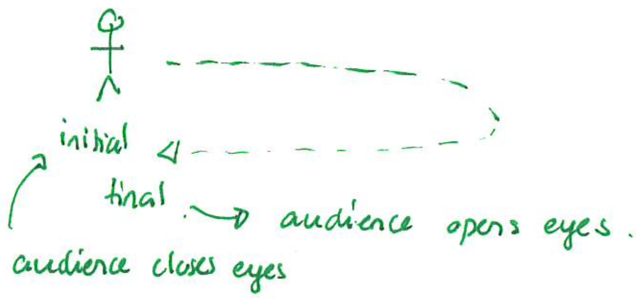
Quiz 1 95% } 70% → 95%

Quiz 2 20% → 60% } 40% → 70%

Note :

1) average velocity and average speed are different. Consider the motion:

Demo:

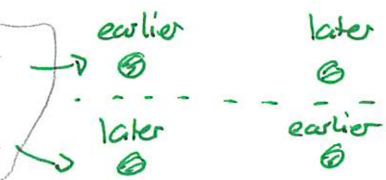


Here $\bar{v} = 0 m/s$ $\bar{s} > 0 m/s$.

2) velocity has a sign

$\bar{v}$ positive ⇒ displacement to right

$\bar{v}$ negative ⇒ displacement to left.



3) the word "average" is part of the terminology. It does not mean "take an average".

Uniform motion

A special type of motion is that where, at all times,

* the object moves in the same direction
* the object moves at a constant rate.

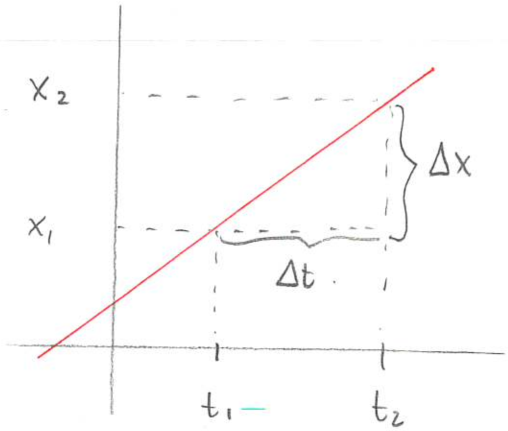
This is called uniform motion

Then, for <u>uniform motion</u>

a) the average velocity is the same regardless of the interval over which one calculates it.

Quiz3 95% & 90%

b) a graph of position versus time is a straight line.



c) the slope of of the straight line is

$$\frac{\text{rise}}{\text{run}} = \frac{\Delta x}{\Delta t}$$

Thus

average velocity = slope of position versus time

d) It is exactly true that

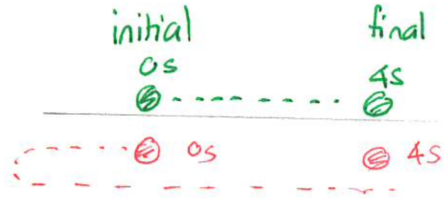
$$\bar{v} = \frac{\Delta x}{\Delta t} \Rightarrow \boxed{\Delta x = \bar{v}\,\Delta t.}$$

UNIFORM MOTION ONLY

Sometimes the motion is uniform over an interval with one particular average velocity and it then changes to a different uniform motion with a different velocity.

Instantaneous velocity

Average velocity often does not capture the details of the motion adequately. The diagram illustrates two distinct motions



for which the average velocity will be the same. We refine this via a concept of velocity. Consider the moving man

Demo: PhET Moving Man

Charts: $x_0 = 0m$ → show position

$v_0 = -2.0 m/s$

$a = 1.0 m/s^2$

We aim to get an idea of the velocity at 3.0s We can extract data from various later points

t_1	t_2	x_1	x_2	Δt	Δx	$\bar{v}$
3.0s	4.0s	−1.5m	−0.0m	1.0 s	1.5m	1.5m/s
3.0s	3.5s	−1.5m	−0.875m	0.5s	0.625m	1.25m/s

Show table

We see that

As Δt decreases → Δx also decreases

→ Ratio

$$\bar{v} = \frac{\Delta x}{\Delta t}$$

approaches a fixed non-zero value.

So this will give the key idea:

Instantaneous velocity ~ average velocity over a vanishingly small interval