Phys 131 2025

Lecture 2

Weds: - Warm Up 1

* on D2L - show access
- refer to email.

2pts out of 600

- Turn in Intro Survey

Fri: - Read according to Course Materials page

- HW by 5pm

Ex: 10, 13, 18, 20, 24, 26, 30, 34, 35

FCI average - 46%

- will take again at end of semester
- knowledge, skills learned in this class should give improvement,

In general classical physics deals with the motion of objects. We need to develop a language for describing how objects move and then find a system of laws that describes why they move as they do.

DEMO: Hawk-eye in cricket video approx ~1:20 in

We will end up with

1) kinematics - a language of mathematics that describes how objects move

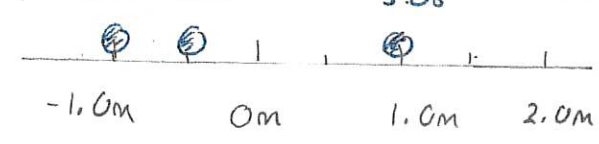
2) dynamics - a set of rules that describes why objects move as they do.

One dimensional kinematics

We start by considering objects that move along one straight line, for convenience oriented horizontally. Such objects can move left or right. We can imagine setting up an axis to record the position and also recording time using some timing device. We can create a motion diagram consisting of snapshots of the object's location at various moments.

We eventually turn this into data.

Motion diagram



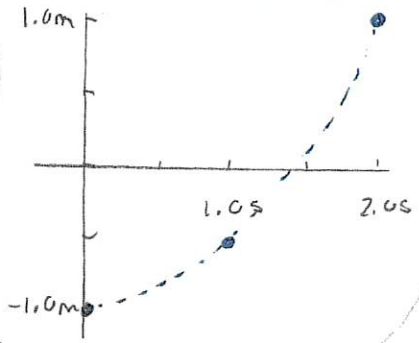
record times in standard units of seconds [s]

measure positions in standard units of meters [m]

Data

time t	position x
0.0s	-1.0m
1.0s	-0.5m
2.0s	1.0m

→ Graph of x vs t



→ Function of position vs time

$x = \frac{1}{2}t^2 - 1$

or

$x(t) = \frac{1}{2}t^2 - 1$

This is the goal. However, it will not be the most natural way in which physics delivers the information. That will be provided by other quantities that describe motion: velocity and acceleration.

Speed and velocity

Speed quantifies the rate at which an object covers distance

Conceptual idea

Speed ≈ rate at which distance is covered

→ **Definition**

If an object covers distance d in time t the (average) speed is

$s = d/t$

→ **Units**

m/s

In physics the direction of motion will also be important and we add this information to speed to give velocity.

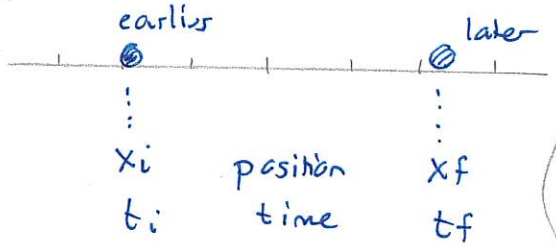
Conceptual Idea

velocity ~ rate of change of position

Definition (preliminary here)

AVERAGE VELOCITY

Observe an object and record positions and times at two instants



The displacement of the object over the interval is

$\Delta x = x_f - x_i$ units: meters m

The average velocity over the time interval is

$$v_{avg} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i}$$

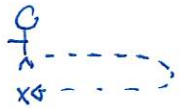
units: m/s

Quiz 1 90% // 90%

Quiz 2 90-80% //

Quiz 3

Important points: 1) average velocity and average speed are different. In the demonstration

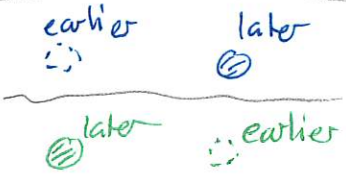


$v_{avg} = 0$ $s > 0$

2) velocity has a sign

v_{avg} positive $\Rightarrow$ displacement to right

v_{avg} negative $\Rightarrow$ " to left



3) "average" is part of the terminology and it doesn't mean "take the average."

Uniform motion

The simplest non-trivial type of motion is that where:

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

This is called uniform motion. Then the following are true for uniform motion

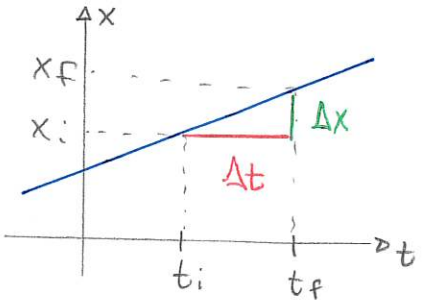
1) regardless of which interval of observation one uses, the average velocity is the same

- Quiz 4 100% ξ 90%

2) a graph of position versus time for uniform motion is

a) a straight line

b) has slope $\frac{\text{rise}}{\text{run}} = \frac{\Delta x}{\Delta t} = v_{avg}$



uniform motion only

slope of x vs t = average velocity

c) the displacement during an interval of time Δt is

$\Delta x = v_{avg} \Delta t$ uniform motion only

since $v_{avg} = \frac{\Delta x}{\Delta t}$

$\Delta t \, v_{avg} = \frac{\Delta x}{\Delta t} \Delta t = \Delta x$

d) the speed of the object is the magnitude of the velocity (ignores sign)

Piecewise uniform motion

Sometimes an object will move so that the motion is uniform over an interval but then changes to a different uniform motion at a later interval. We can use the rules for uniform motion in a piecewise fashion