Lecture 2

Fri: HW by 5pm

Exercises: 4, 10, 13, 17, 18, 19, 22, 23

* write complete solutions on sheet paper - explain your answers
* turn in to my office by 5pm.
* can use my office hrs, TLC, discussion with each other.

Counts 14pts (grand total 600 pts)

Fri: Intro survey - will reflect on this later.

Mon: Warm Up 2 (D2L)

NOTE: The two sections of Phys 131 are taught differently.

Motion: Kinematics

The key question in classical physics is to predict how an object will move and to find the fundamental rules that govern the motion of objects.

DEMO: Hawk-Eye in Cricket video

There are two aspects to this

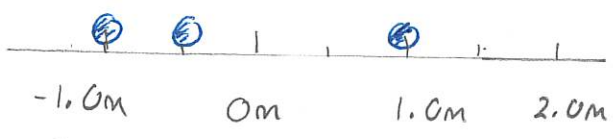
1) kinematics: providing a language and system to describe how motion occurs

2) dynamics: providing a system to describe and understand why particular motions occur

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.

Motion diagram



record times in standard units of seconds [s]

measure positions in standard units of meters [m]

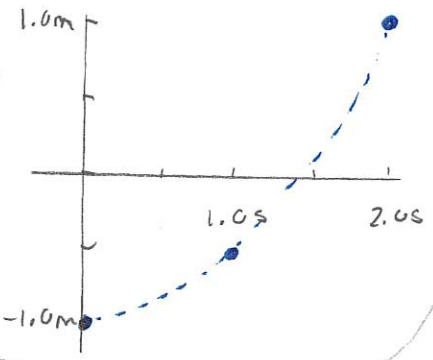
We eventually turn this into data.

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 subsequent physics the direction of motion will be important and the basic idea of speed is extended to velocity which includes information about direction.

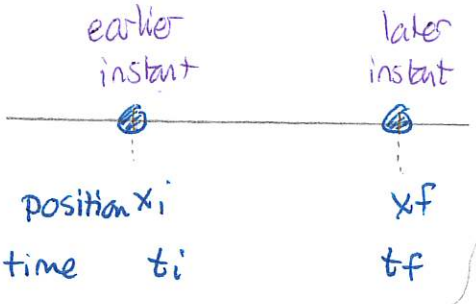
Conceptual idea

velocity ~ rate of change of position.

(Preliminary) definition

Average velocity

Observe an object over a time interval. Record positions and times at two instants.



The displacement of the object during the interval is the change in position

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

→ The average velocity during this interval from t_i to t_f is

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

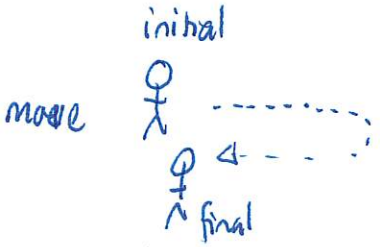
units m/s

Quiz 1

Quiz 2

Quiz 3

Warm Up 1



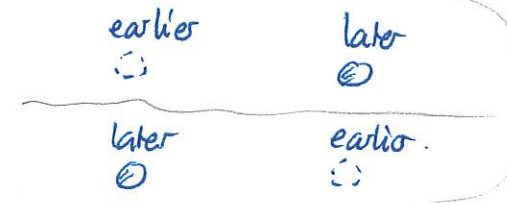
Notes: 1) Average velocity and average speeds are different. In the demonstration

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

2) velocity has a sign

v_{avg} positive ⇒ displacement to right

v_{avg} negative ⇒ displacement to left.



3) the term "average" is part of the terminology and does not mean "take an average."

Uniform motion

The simplest 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, and, in this case,

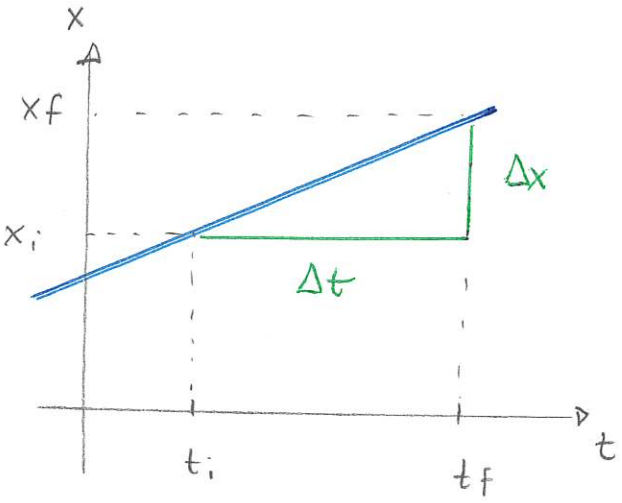
1) the average velocity is the same regardless of the interval used to calculate it.

Warm Up 2

2) a graph of position versus time:

* is a straight line
* has slope

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



⇒ for uniform motion
average velocity = slope of position versus time graph

3) displacement over a time interval can always be determined using

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

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

4) speed is the magnitude (no ± sign) of velocity

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