Tues: Discussion / quiz

Ex: 25, 29, 30, 33, 34, 35, 38

Thurs -

Fri: HW 5pm

LABS : Meet this week

Velocity

The flow of ideas about velocity is:

CONCEPTUAL IDEA

Velocity ~ rate of change of position

MATHEMATICAL DEFINITION

Observe motion from $t \to t+\Delta t$ and determine change in position, Δx

Then velocity is

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$$

→ Speed = magnitude of velocity

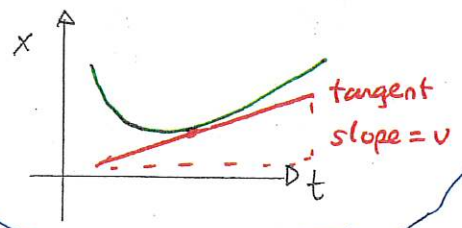
$$s = |v|$$

CALCULATION / COMPUTATION

Given position versus time

Get velocity via

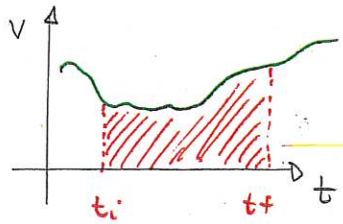
1) calculus ~ differentiation
2) from graph of x vs t



Given velocity versus time

Get change in position via

1) calculus ~ integration.
2) from graph of v vs t



Δx = area between graph and t-axis

$x_f = x_i + \Delta x$

Acceleration

The interesting situations in physics involve interacting objects

DEMO: Cheerios Effect videos – two thumbtacks

In this situation the thumbtacks and water interact and they attract.

But they move together with increasing speed as time passes. So what matters is how the velocity changes. To quantify this we introduce:

Acceleration ⇝ rate of change of velocity

DEMO: PhET Moving Man → Charts

* Set $x_0 = 0$
  $v_0 = -6$
  $a = 2$

* Observe – apparent motion. → Three phases
  – graph of v vs t
  1) start to turn
  2) just before turn → just after
  3) just after turn → later

We observe that the man's velocity changes constantly. It does this in two ways:

1) speed changes
2) direction of motion changes.

Since the velocity always changes the acceleration is always non-zero. We make a preliminary definition:

Observe the object at two instants. Then the average acceleration over the interval from t_i to t_f is

$$a_{avg} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

	~~earlier~~	later
		
time	t_i	t_f
velocity	v_i	v_f

Units: m/s^2

Fundamental Mechanics: Group Exercise 1

27 January 2025

Names: _____ _____ _____

_____ _____

1 Rotating object

Take a rectangular object with three sides of different lengths: a phone is a good example. Try to flip the phone in such a way that it rotates and does not "tumble." Try this for three distinct axes. Is it easier to to this about some axes rather than others? Have you ever noticed this before? Where? *The instructor will provide some assistance.*

2 Moving man animation

An animation shows a man moving horizontally. The table provides data for the positions and velocities of the man at various times.

Time	Position	Velocity
0.0 s	4.0 m	−6.0 m/s
1.0 s	−0.5 m	−3.0 m/s
2.0 s	−2.0 m	0.0 m/s
3.0 s	−0.5 m	3.0 m/s
4.0 s	4.0 m	6.0 m/s

a) Does the velocity of the man stay constant, increase or decrease during the period from 2.0 s to 4.0 s? By how much does the man's velocity increase every second?

b) Does the velocity of the man stay constant, increase or decrease during the period from 0.0 s to 2.0 s? By how much does the man's velocity increase every second?

c) Does the man have zero or non-zero acceleration from 1.0 s to 3.0 s?

d) Determine the average acceleration of the man from 0.0 s to 2.0 s.

e) Determine the average acceleration of the man from 2.0 s to 4.0 s.

f) Determine the average acceleration of the man from 1.0 s to 3.0 s.

g) Is there any clear correlation between acceleration and position?

h) If the speed of an object is larger, does this automatically mean that the acceleration is larger?

a) increases by 3.0 m/s each second

b) increases by 3.0 m/s each second

c) non-zero since velocity changes

d) $a_{avg} = \frac{v_f - v_i}{t_f - t_i} = \frac{0.0\,m/s - (-6.0\,m/s)}{2.0\,s} = 3.0\,m/s^2$

e) $a_{avg} = \frac{6.0\,m/s - 0\,m/s}{2s} = 3.0\,m/s^2$

f) $a_{avg} = \frac{3.0\,m/s - (-3.0\,m/s)}{2.0\,s} = 3.0\,m/s^2$

g) No

h) No, here $a = 3.0\,m/s^2$ and there are many different speeds.

In this example the acceleration is $3.0 m/s^2$. What this means is one must add 3.0 m/s to the velocity each second.

Warm Up 1

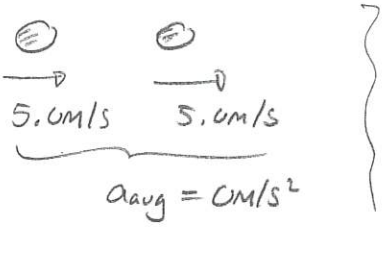
Notes:

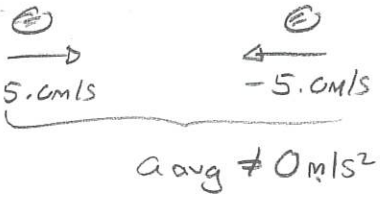
1) acceleration does not describe velocity. → In exercise accel $= 3.0 m/s^2$ when $v = 0 m/s$, $v = 3.0 m/s$, $v = 6.0 m/s$

2) having a larger acceleration does not automatically imply having a larger velocity

Warm Up 2

3) acceleration is not immediately connected to speed. The object's speed could be the same at the beginning and end of an interval, and have zero or non-zero acceleration

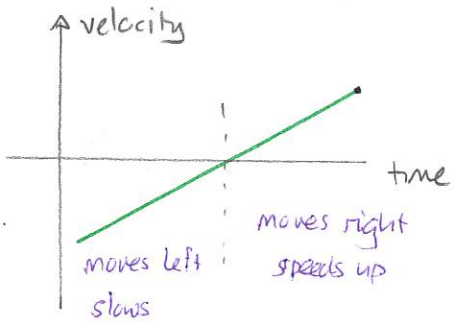




4) acceleration has a sign

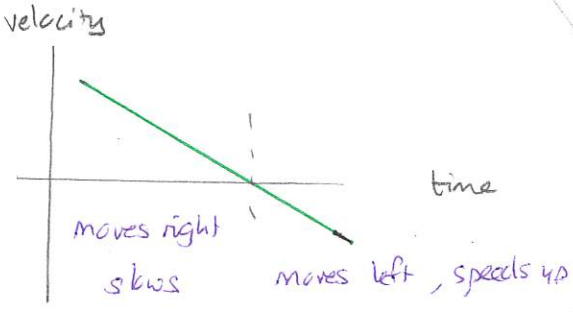
Positive acceleration

⇒ velocity number increases



Negative acceleration

⇒ velocity number decreases.



Quiz 1

Quiz 2