Phys 131 2025

Lecture 4

Mon: Warm Up 2 By 9am D2L

Tues: Discussion quiz

Ex

* Bring completed problems to class – not collected
  - not graded

* Discuss with students
* 10 min in class quiz at end

Velocity and position conceptual scheme

CONCEPT / IDEA

Velocity describes rate of change of position

DEFINITION (MATHEMATICAL)

Observe the motion of object from time $t \to t+\Delta t$

Record displacement Δx.

Velocity is

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

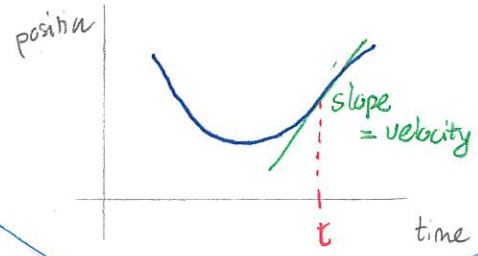
→ Speed = magnitude of velocity

$s = |v|$

Calculation / computation

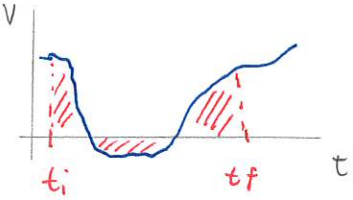
Given position versus time get velocity via

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



Given velocity versus time get change in position via

1) integration (calculus)
2) from graph of v vs t



Δx = area between graph and axis

$x_f = x_i + \Delta x$

Acceleration

In physics, the interesting situations involve changes in velocity

DEMO: Cheerios Effect video - Thumbtacks.

The video illustrates two floating thumbtacks that interact via the water. As they interact they speed up and their velocities change. To describe such situations we use

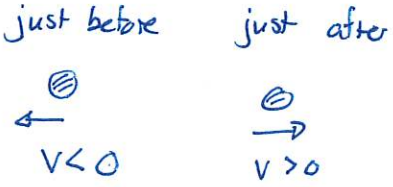
acceleration ⇝ rate of change of velocity

DEMO: PhET Moving Man → Charts

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

Observe - apparent motion
- graph of v vs t

We observe that the man's velocity changes constantly. Consider the period just before the turn (3.0s). The man slows down during this period and the velocity changes. Just after the turn the man speeds up and the velocity changes. From just before to just after, the velocity changes since direction changes.



So velocity can change because

speed changes AND/OR direction changes

We can account for all of these with a single (preliminary) definition of

average acceleration

Observe an object at two instants t_i and t_f. Then the average acceleration over this interval is

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

units: m/s^2

Fundamental Mechanics: Group Exercise 1

22 August 2025

Names: _____ _____ _____

_____ _____

1 Rotating object

The instructor will describe a demonstration, that each group can do. Follow the instructions and do the demonstration. *No written response is needed.*

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 change 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 change 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) If the speed of an object is larger, does this automatically mean that the acceleration is larger? Explain your answer.

Answer: a) increases by 3.0 m/s every second

b) increases " 3.0 m/s " "

c) non-zero, velocity changes.

d) $t_i = 0.0\,s$ $v_i = -6.0\,m/s$

$t_f = 2.0\,s$ $v_f = 0.0\,m/s$

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

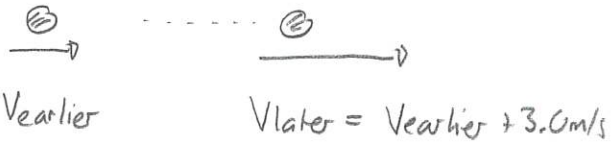
e) $$a_{avg} = \frac{6.0\,m/s - 0\,m/s}{4.0\,s - 2.0\,s} = 3.0\,m/s^2$$

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

g) no. In this example accel is always $3.0\,m/s^2$ but speed varies.

In the example, the acceleration is $3.0\,m/s^2$

This means that every second the velocity increases by $3.0\,m/s$.



Important points

1) acceleration does not describe velocity → in the exercise, accel $= 3.0\,m/s^2$ when $v = -3.0\,m/s$, $0\,m/s$ and $3.0\,m/s$

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

Quiz 1 50% → 80% & 30% → 60%

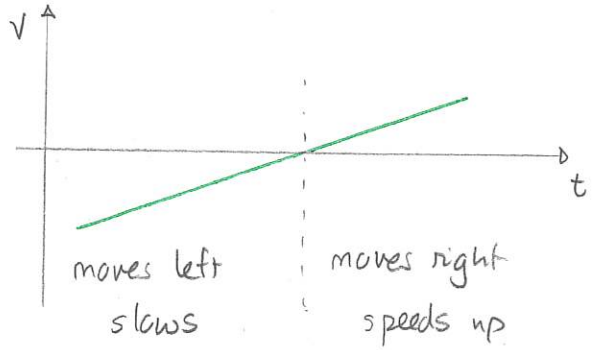
3) it is possible that acceleration is non-zero but the speed does not change

no change in speed but velocity changes ⇒ $a \neq 0$.

4) acceleration has a sign

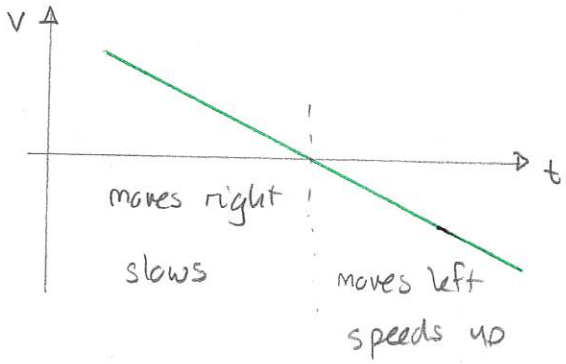
Positive acceleration

⇒ velocity (number) increases



Negative acceleration

⇒ velocity (number) decreases



Quiz 2

Quiz 3