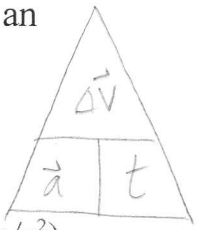
Mechanics Unit | Acceleration | gpb video: | Phys Std:

11a

- What is acceleration?
  - The rate of change of velocity (how quickly an object's velocity changes)
  - It is a vector quantity and has direction
    $\vec{a} = \Delta\vec{v}/t$ ($\Delta\vec{v} = \vec{v}_f - \vec{v}_i$)
    acceleration triangle:



  - It has units of velocity per time: m/s/s (or m/s^2)
  - Objects can accelerate at a constant rate (i.e. increase by 10 m/s every second) **or** objects can accelerate at different rates (more complicated)
    *We will only focus on constant accelerations in this course.
  - Important Note: If direction changes, velocity changes so there is acceleration (i.e. traveling in a circle at a constant speed)
  - If an object speeds up, it covers more ground in a given amount of time and vice versa

- How do you figure out the direction for acceleration?
  - It depends on 2 things:
    1. The direction of the object's velocity (the direction in which the object is traveling)
    --we will designate "left", "west", or "down" to be the negative (-) direction;
    --we will designate "right", "east", or "up" to be the positive (+) direction.
    2. If the object is speeding up or slowing down
    --speeding up would be (+)
    --slowing down would be (-)

6 Scenarios:

a. Object is not moving → acceleration is 0
b. Object is moving at a constant speed → acceleration is 0
c. Object is slowing down in the positive direction → acceleration is negative (negative times positive equals negative)
d. Object is slowing down in the negative direction → acceleration is positive (negative times negative equals positive)
e. Object is speeding up in the positive direction → acceleration is positive (positive times positive equals positive)
f. Object is speeding up in the negative direction → acceleration is negative (positive times negative equals negative)

**<u>Think of it this way: if acceleration opposes the motion, it slows down and vice versa. (upward velocity and downward acceleration → slows down)</u>

11b

Practice:

1. As the bus comes to a stop to avoid hitting a dog, it accelerates uniformly at -4.1 m/s/s as it slows from +9.0 m/s to 0.0 m/s. How long did it take to stop the bus?
2. Look at the following position versus time data and determine if the object is: at rest, at a constant speed, or accelerating

a)

t (s)	d (m)
0	5
1	5
2	5
3	5

Answer: at rest

b)

t(s)	d(m)
0	50
1	45
2	40
3	35

Answer: constant ~~speed~~ velocity (- 5 m/s)

c)

t(s)	d(m)
0	0
1	1
2	4
3	8.5

Answer: accelerating (nonuniform)

11C

3. Look at the following velocity versus time data for a uniformly accelerating object and determine the magnitude and direction of the acceleration:

a)

t(s)	v(m/s)
0	50
1	40
2	30
3	20

Hint: it's moving in the positive direction (since v has positive values) and it's slowing down.

Answer: negative acceleration (-10 m/s/s)

b)

t(s)	v(m/s)
0	5
1	10
2	15
3	20

Answer: +5 m/s/s

(gaining speed of 5 m/s every second in the positive direction)

c)

t(s)	v(m/s)
0	-2
0.5	-4
1.0	-6
1.5	-8

Answer: -4 m/s/s

(gaining speed of 2 m/s every half second in the negative direction) ⇒ gaining 4 m/s every second in the negative direction

4. What is the acceleration of an object who slows down from $10\frac{m}{s}$ to $2\frac{m}{s}$ in a 4.0 second time interval?

$\vec{a} = \frac{\Delta \vec{v}}{t} = \frac{2\,m/s - 10\,m/s}{4} = \boxed{-2\,m/s/s}$