Kinematics

acceleration

Acceleration

- Acceleration, a = rate of change of velocity.
  - a = acceleration [m/s^2]
  - v = velocity [m/s]
  - v_0= initial velocity [m/s]
  - t = time [sec]

$$a = \frac{v - v_0}{t}$$

- Other units for a = [ft/sec^2], [mph/sec]
- Tool = accelerometer

Intuitions

- Cruise at constant velocity $a = 0$
- Increase velocity $a = (+)$
- Decrease velocity $a = (-)$
- Acceleration tells us the behavior of the dial on the speedometer.

  Ex: If a = 5 mph/sec, the speedometer dial is jumping up in chunks of 5 mph. If a = -15 mph/sec, the dial is dropping in chunks of -15 mph each second.

Signs: Position

- Only depend upon present location.
  Cartesian coordinate system:

X Axis:	Located right of origin	x = (+)
	Located left of origin	x = (-)
Y Axis:	Located above ground	y = (+)
	Located under ground	y = (-)

Signs: Velocity

- Only depends upon present direction of motion

X Axis:	Going right	$v_x = (+)$
	Going left	$v_x = (-)$
Y Axis:	Going up	$v_y = (+)$
	Going down	$v_y = (-)$

Signs: Acceleration

- If the velocity is (+),
  - Pick up speed: a = (+)
  - Lose speed: a = (-)

- If the velocity is (-),
  - Pick up speed: a = (-)
  - Lose speed: a = (+)

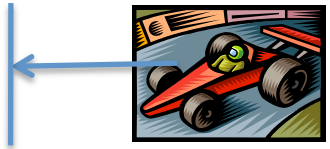
Examples

$$a = \frac{v - v_0}{t}$$

- Find a: Pick up speed, 0 to 60 mph in 4 sec

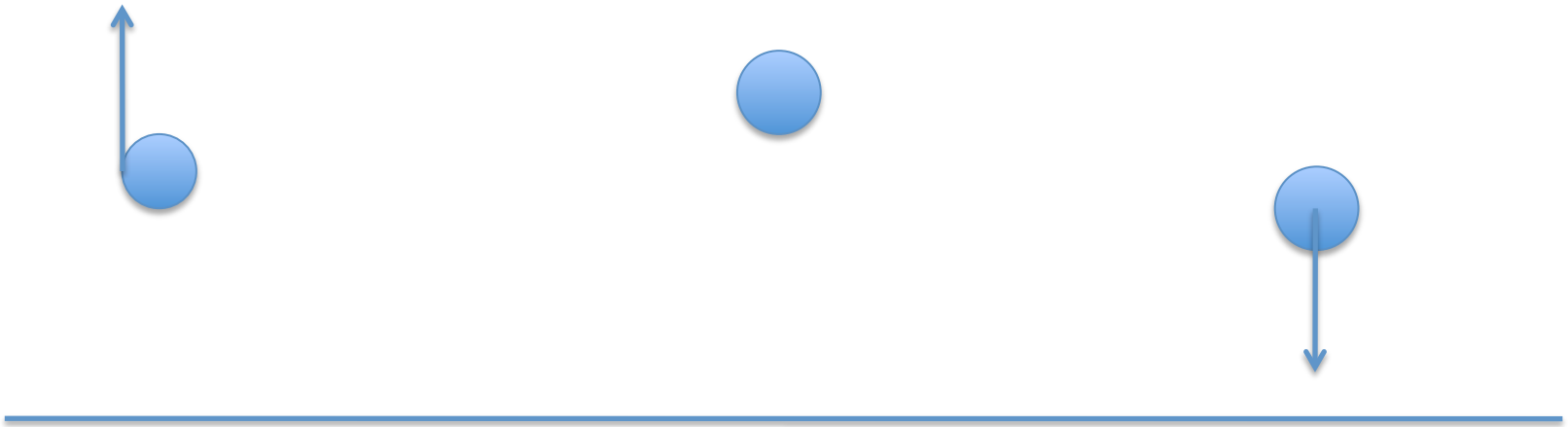
- Find a: Pick up speed, 0 to -60 mph in 4 sec

- Braking to stop



x = y = v_x= v_y= a_x= a_y=

After a ball leaves our hand, on its vertical path, it slows down, stops at the top, then picks up speed on the way down.



Going Up At Top Coming Down

Kinematics With Constant Acceleration

- Note = the speed changes smoothly
- Displacement, $S\text{-}S_0$, is the change in our position.
- Basic Formulas

$$a = \frac{v - v_0}{t} \qquad \bar{v} = \frac{v + v_0}{2}$$

$$s - s_0 = \bar{v}t$$

$$x - x_0 = \bar{v}_x t$$

$$y - y_0 = \bar{v}_y t$$

Ex: A biker is traveling E at 6 m/s. He accelerates at 2 m/s^2 for 10 s. What is his final velocity?

What is the area under the curve of an acceleration vs. time graph?

Elaine accelerates her F-16 jet from 0 to 120 m/s in 5 seconds. Find:

a) Her acceleration

b) The speed at each instant

c) Average velocity for the entire trip

d) Displacement for the entire trip

Elaine lands her jet at 120 m/s and accelerates at -20 m/s^2. Find:

a) Her speed at each instant

b) Time to stop:

c) Average velocity to stop

d) Displacement to stop

e) Average velocity for the first five seconds

f) Displacement in those five seconds