PHYS 2010 LECTURE 3

Some administrative notes:

- My email address is edz@colorado.edu.
  Contact me for lecture/exam/CAPA issues.
  Contact Prof. DeWolfe for homework/lab/recitation issues.
- Recitations: a few sections have waitlist.. risky!

If you send me email, please put "2010" in Subject.
If time passes with no response, send again. I get huge amounts of spam, and sometimes ignore important mail if it's from an unfamiliar sender.

Where was I last week? See the photo on p. 805 of textbook: Super-Kamiokande neutrino detector.
We're planning a major new experiment there.

Important: READ THE TEXT. Not everything is covered in lecture!

Last week, covered concepts of displacement, speed, velocity, graphical expressions:

instantaneous velocity = slope of tangent to x vs. t curve

$$\text{average velocity} = \frac{\Delta x}{\Delta t} \quad \begin{array}{l}\leftarrow \text{displacement} \\ \leftarrow \text{time interval.}\end{array}$$

Now, decide how to handle non-constant velocity, similar to non-constant position:

velocity = rate of change of position vs. time
acceleration = rate of change of velocity vs. time

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

over finite time, average acceleration $\bar{a} = \frac{\Delta v}{\Delta t}$

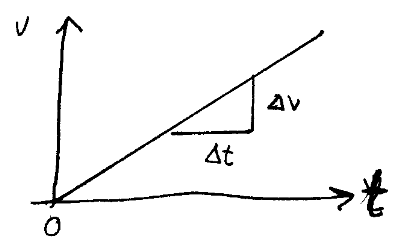
$$= \frac{v_f - v_i}{t_f - t_i}$$

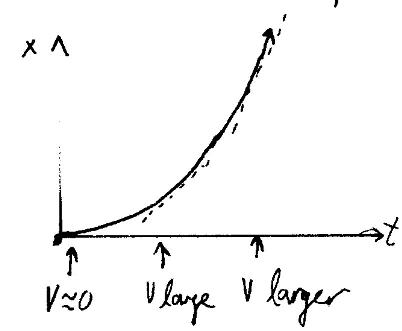
units of a are $\frac{\text{velocity}}{\text{time}} = \frac{\text{length/time}}{\text{time}} = \frac{m/s}{s} = \frac{m}{s^2}$

Constant velocity: $a = 0$
v growing more positive: $a > 0$
" " " negative: $a < 0$

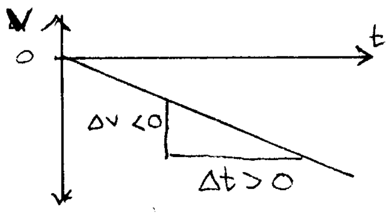
a = slope of v vs. t, just like v = slope of x vs. t

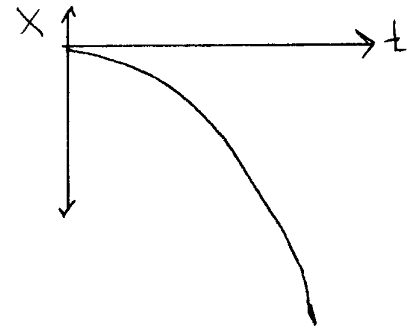
Scenario I: $v = 0$ at first, a is constant, positive.



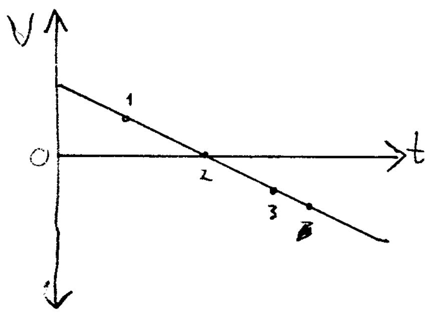


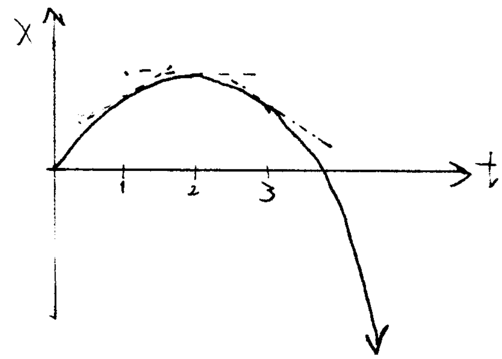
Scenario II: $v = 0$ at start, a is constant, negative.





Scenario III $v > 0$ at start, $a < 0$





Gravity: it's experimentally observed that all objects in free-fall at the earth's surface have an acceleration of $-9.8\ \frac{m}{s^2}$ in the vertical direction. Define magnitude as $g = 9.8\ \frac{m}{s^2}$

This is a common constant acceleration scenario. The following apply only if acceleration is constant: "o" ↔ value at $t=0$

1)	$v = v_0 + at$	relates (v, t)
2)	$x = x_0 + v_0 t + \frac{1}{2} a t^2$	(x, t)
3)	$v^2 = v_0^2 + 2a(x - x_0)$	(v, x)

Also: $\bar{v} = \frac{v_0 + v_f}{2}$

Proof of 1) $a = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1}$ definition!

Proof of 2): start from 1), 3):

$$v = v_0 + at$$
$$v^2 = (v_0 + at)^2$$
$$v_0^2 + 2a(x - x_0) = (v_0 + at)^2$$
$$v_0^2 + 2a(x - x_0) = v_0^2 + 2atv_0 + a^2t^2$$
$$2(x - x_0) = 2v_0t + at^2$$
$$x - x_0 = v_0t + \frac{1}{2}at^2$$
$$x = x_0 + v_0t + \frac{1}{2}at^2$$

Also: $\bar{v} = \frac{v_0 + v_f}{2}$

Proof of 1) $a = \frac{\Delta v}{\Delta t} = \frac{v_2 - v_1}{t_2 - t_1}$ definition!

Proof of 2): start from 1), 3):

$$v = v_0 + at$$
$$v^2 = (v_0 + at)^2$$
$$v_0^2 + 2a(x - x_0) = (v_0 + at)^2$$
$$\cancel{v_0^2} + 2\cancel{a}(x - x_0) = \cancel{v_0^2} + 2\cancel{a}tv_0 + a^{\cancel{2}}t^2$$
$$2(x - x_0) = 2v_0t + at^2$$
$$x - x_0 = v_0t + \frac{1}{2}at^2$$
$$x = v_0 + v_0t + \frac{1}{2}at^2$$