PHY 113 A General Physics I
9-9:50 AM MWF Olin 101

Plan for Lecture 3:

Some announcements

Chapter 2 – Motion in one dimension

1. **Acceleration**
2. **Relationships between position, velocity, and acceleration**

Some updates/announcements

No.	Lecture Date	Topic	Text Sections	Problem Assignments	Assignment Due Date
1	08/29/2012	Units & measurement	1.1-1.6	1.2,1.6,1.13,1.20	
2	08/31/2012	Motion in 1d -- constant velocity	2.1-2.3	2.1,2.8	09/07/2012
3	09/03/2012	Motion in 1d -- constant acceleration	2.4-2.8	2.13,2.16	09/07/2012
4	09/05/2012	Vectors	3.1-3.4		09/07/2012
5	09/07/2012	Motion in 2d	4.1-4.3		09/10/2012
6	09/10/2012	Circular motion	4.4-4.6		09/12/2012
7	09/12/2012	Newton's laws	5.1-5.6		09/14/2012
8	09/14/2012	Newton's laws applied	5.7-5.8		09/17/2012
	09/17/2012	Review	1-5		
	09/19/2012	Exam	1-5		
9	09/21/2012	More applications of Newton's laws	6.1-6.4		09/24/2012
10	09/24/2012	Work	7.1-7.4		09/26/2012

Starting September 3, 2012

Schedule for Physics 113 Tutorials
5-7 PM in Olin 101

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
Loah Stevens	Jiajie Xiao	Jiajie Xiao	Stephen Baker	Stephen Baker	Loah Stevens

First Webassign sets "due" on Friday, Sept. 7th

PHY 113 Labs start September 3, 2012
(Please see Eric Chapman in Olin 110
chapmaek@wfu.edu for all of your
laboratory concerns)

Velocity

Instanteous velocity:

$$v(t) = \frac{dx}{dt}$$

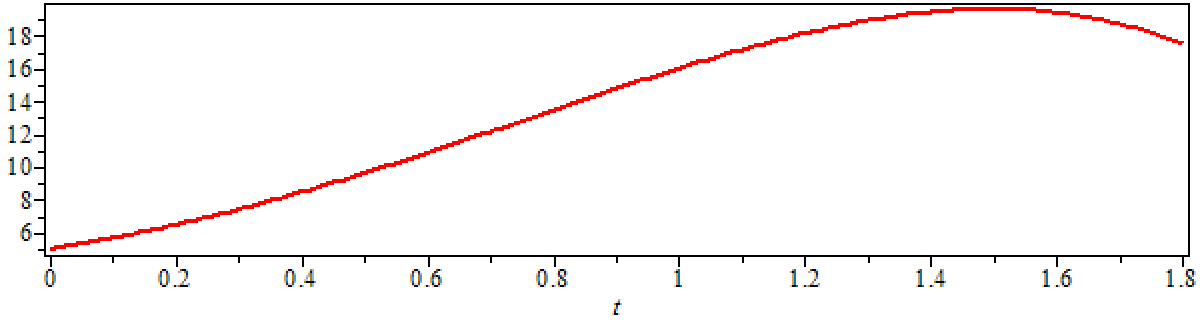
Average velocity:

$$\langle v \rangle_A^B = \frac{x(t_B) - x(t_A)}{t_B - t_A}$$

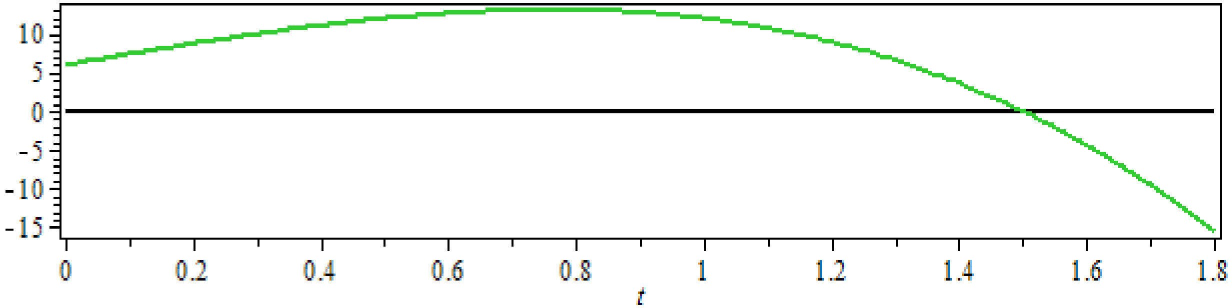
Instantaneous velocity using calculus

Suppose:

$$x(t) = 5 + 6t + 7t^2 - 2t^4$$



$$v(t) = \frac{dx}{dt} = 6 + 14t - 8t^3$$



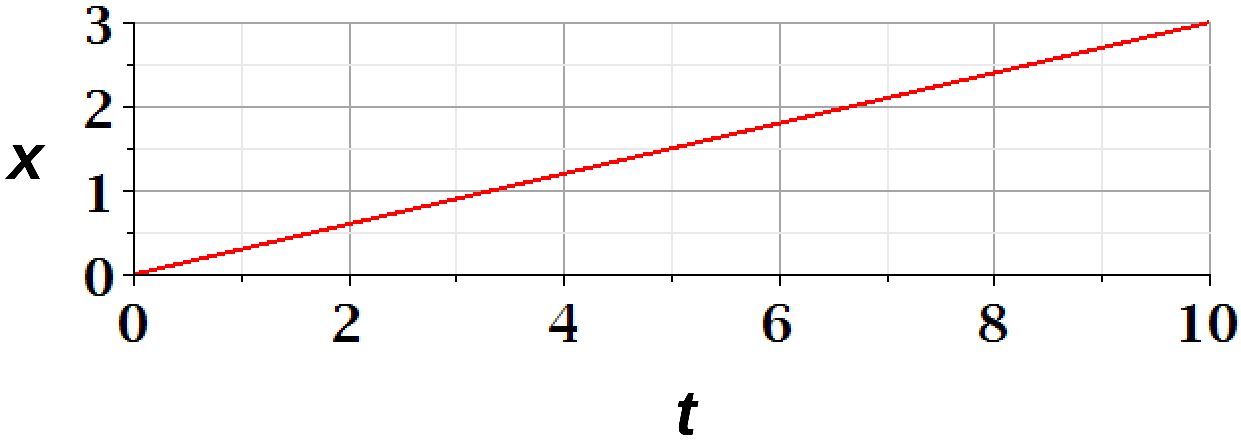
Anti-derivative relationship

Constant velocity motion

Suppose: $\frac{dx}{dt} = v_0$

Then: $x(t) = x_0 + v_0 t$

Example -- suppose $x_0 \equiv 0$ and $v_0 \equiv 0.3$ m/s:



Acceleration

Instanteous acceleration :

$$a(t) = \frac{dv}{dt} = \frac{d}{dt}\frac{dx}{dt} \equiv \frac{d^2x}{dt^2}$$

Average acceleration :

$$\left\langle a \right\rangle_A^B = \frac{v(t_B) - v(t_A)}{t_B - t_A}$$

Rate of acceleration

Instanteous rate of acceleration :

$$\frac{da}{dt} = \frac{d}{dt}\frac{dv}{dt} = \frac{d^2v}{dt^2} = \frac{d}{dt}\frac{d}{dt}\frac{dx}{dt} \equiv \frac{d^3x}{dt^3}$$

Instanteous rate of rate of acceleration :

$$\frac{d}{dt}\frac{da}{dt} = \frac{d^2a}{dt^2} = \frac{d^2}{dt^2}\frac{dv}{dt} = \frac{d^3v}{dt^3} = \frac{d^3}{dt^3}\frac{dx}{dt} \equiv \frac{d^4x}{dt^4}$$

iclicker exercise

How many derivatives of position are useful for describing motion:

A. 1 *(dx/dt)*
B. 2 *(d^2x/dt^2)*
C. 3 *(dx^3/dt^3)*
D. 4 *(dx^4/dt^4)*
E. ∞

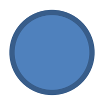
Anti-derivative relationship

Constant acceleration motion

Suppose: $\frac{dv}{dt} = a_0$ and $v(0) = v_0, \quad x(0) = x_0$

Then: $v(t) = v_0 + a_0 t$

$$x(t) = x_0 + v_0 t + \tfrac{1}{2} a_0 t^2$$

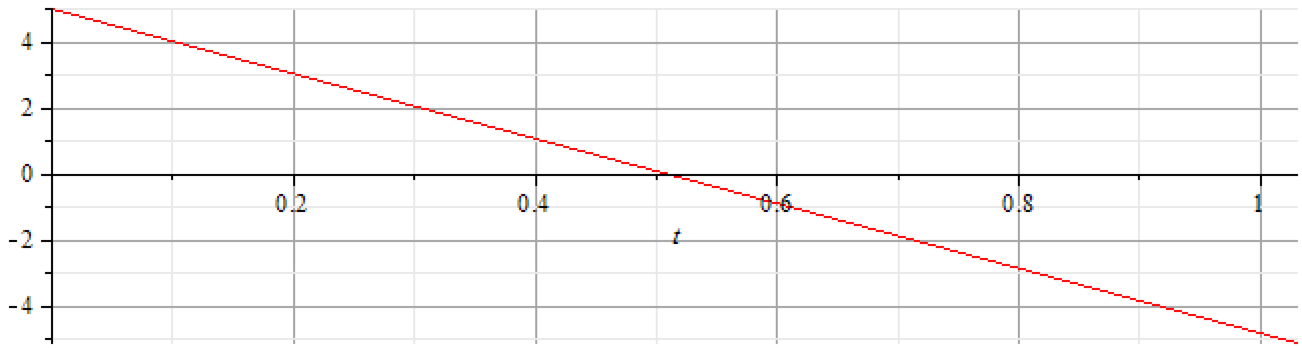


Examples

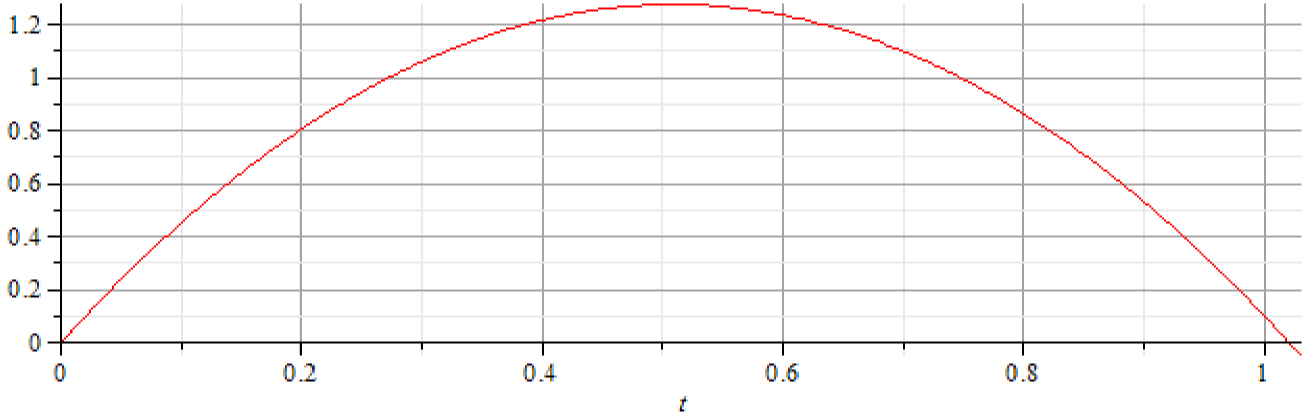
$$v(t) = v_0 + a_0 t \qquad x(t) = x_0 + v_0 t + \tfrac{1}{2} a_0 t^2$$

$$x_0 = 0 \qquad v_0 = 5\text{m/s} \qquad a_0 = -9.8\,\text{m/s}^2$$

v(t)



x(t)

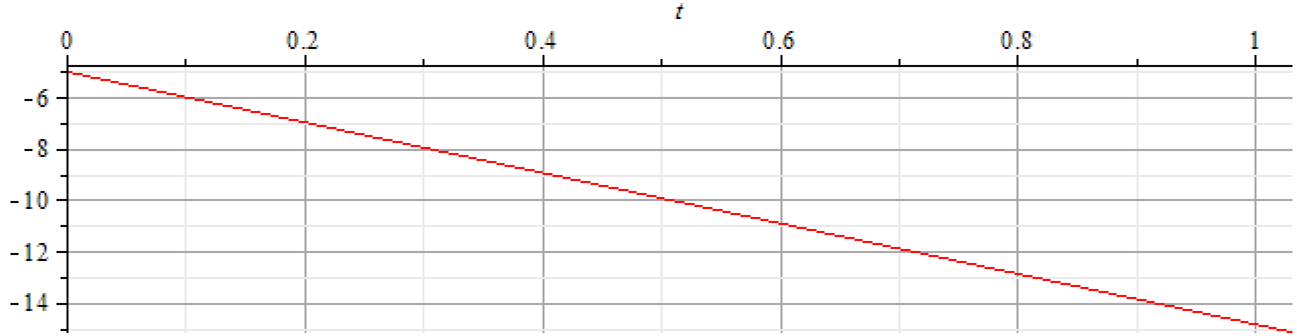


Examples

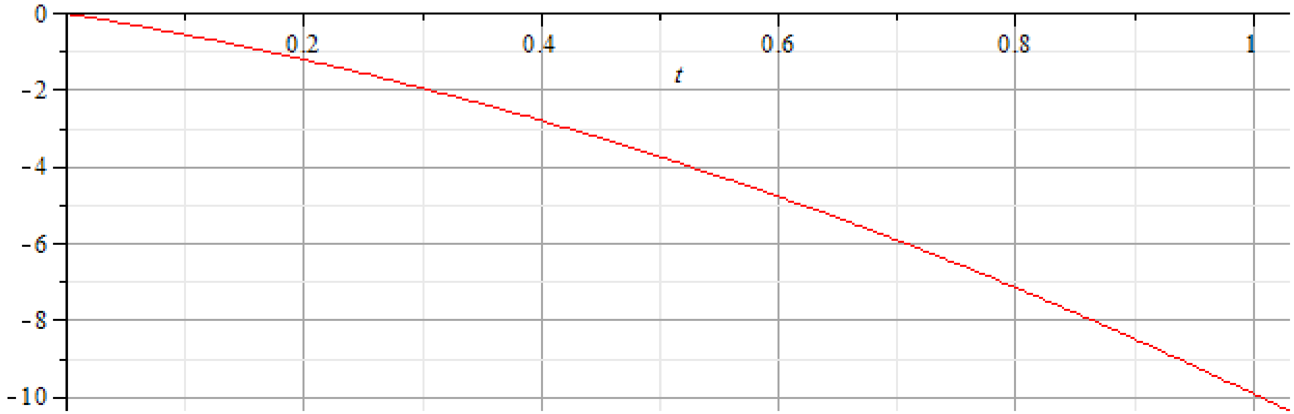
$$v(t) = v_0 + a_0 t \qquad x(t) = x_0 + v_0 t + \tfrac{1}{2} a_0 t^2$$

$$x_0 = 0 \qquad v_0 = -5\text{m/s} \qquad a_0 = -9.8\,\text{m/s}^2$$

v(t)



x(t)



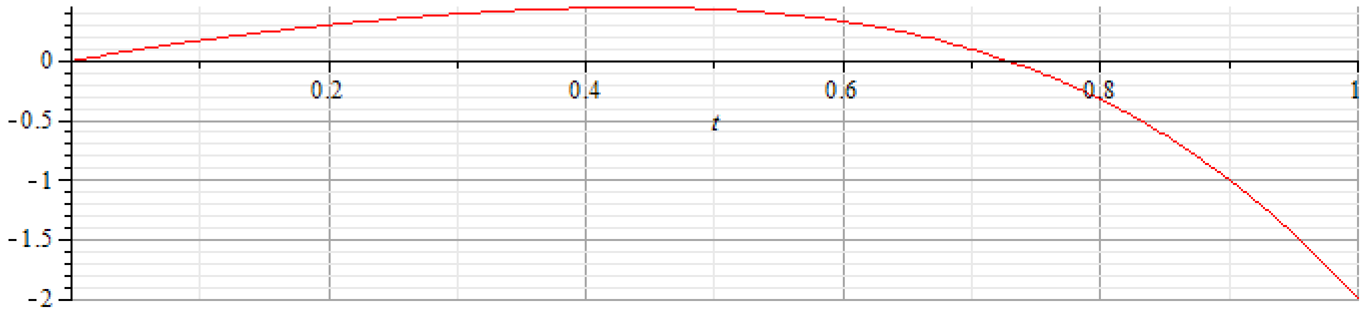
Summary

$$v(t) = \frac{dx}{dt} \qquad \Leftrightarrow \qquad x(t) = \int_{t_0}^{t} v(t')dt'$$

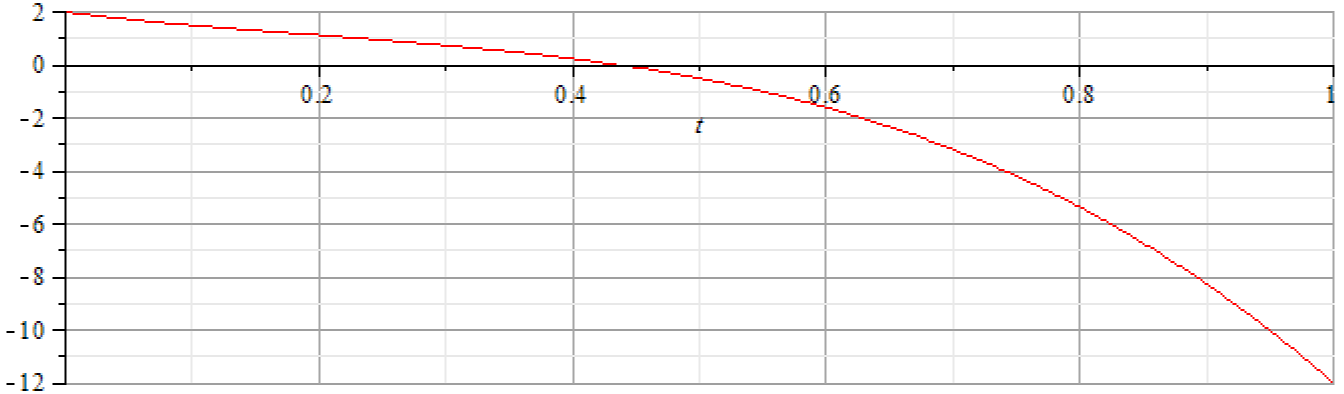
$$a(t) = \frac{dv}{dt} \qquad \Leftrightarrow \qquad v(t) = \int_{t_0}^{t} a(t')dt'$$

Another example

x(t)



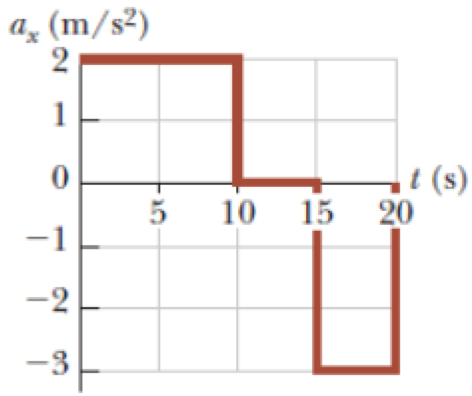
v(t)



From webassign:

3. –/0.5 points   My Notes | Se

A particle starts from rest and accelerates as shown in the figure below.



(a) Determine the particle's speed at t = 10.0 s.

m/s

Determine the particle's speed at t = 20.0 s?

m/s

$$\text{velocity at } t = 5s: \quad v(5s) = 2m/s^2 \cdot 5s = 10m/s$$

$$\text{position at } t = 5s: \quad x(5s) = \frac{1}{2} 2m/s^2 \cdot (5s)^2 = 25m$$

Special case: constant velocity due to earth's gravity

In this case, the "one" dimension is the vertical direction with "up" chosen as positive:

$a = -g = -9.8\ m/s^2$

$y(t) = y_0 + v_0 t - \frac{1}{2} g t^2$

$y_0 = 0 \qquad v_0 = 20\ m/s$

At what time t_m will the ball hit the ground $y_m = -50m$?

Solve: $y_m = y_0 + v_0 t_m - \frac{1}{2} g t_m^2$

quadratic equation

physical solution: $t_m = 5.83\ s$