Announcements

1. Homework answers are available on WebAssign after the "due" date. Please check any solutions that you missed.

2. Possible change in assignment schedule ??

   Vote:

   a. Leave as is (assignment for each lecture due before next lecture).

   b. Group ~3 assignments together to be due once a week

      i. Monday

      ii. Tuesday

      iii. Wednesday

      iv. Thursday

      v. Friday

On line quiz for lecture 5

A small airplane is traveling horizontally in the East direction at a constant velocity of 200000 m/s at a height of 600 m, when it passes over your head. At the same time, a ball (which had been stuck to the plane) falls from the bottom of the plane. Suppose you are watching all of this happen and the air friction is negligible (not really a good approximation, but this makes the problem easier to analyze). Also assume that the ground to the east of you is completely flat (no hills, etc.).

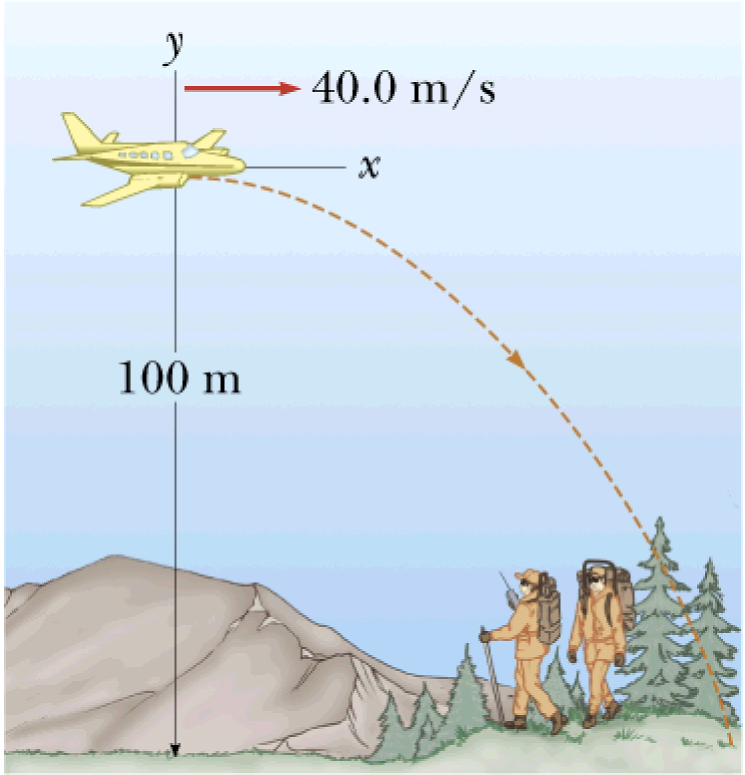
1. Is the ball likely to hit you?

2. What is the magnitude of the horizontal velocity (in m/s) when the ball hits the ground?

3. What is the magnitude of the vertical velocity when the ball hits the ground? (a) 0 m/s (b) 77 m/s (c) 108 m/s (d) 11760 m/s

4. Where will the ball land on the ground? (a) On your head? (b) Several hundred meters to the East of you? (c) Several thousand meters to the East of you? (d) Several million meters to the East of you?

Serway, Physics for Scientists and Engineers, 5/e
Figure 4.13



Two-dimensional motion

Displacement: $\mathbf{r}(t) = \mathrm{x}(t)\,\mathbf{i} + \mathrm{y}(t)\,\mathbf{j}$

Velocity: $\mathbf{v}(t) = \mathbf{v_x}(t)\,\mathbf{i} + \mathbf{v_y}(t)\,\mathbf{j}$ $\quad \mathbf{v}_x = \dfrac{dx}{dt} \quad \mathbf{v}_y = \dfrac{dy}{dt}$

Acceleration: $\mathbf{a}(t) = \mathbf{a_x}(t)\,\mathbf{i} + \mathbf{a_y}(t)\,\mathbf{j}$ $\quad \mathbf{a}_x = \dfrac{dv_x}{dt} \quad \mathbf{a}_y = \dfrac{dv_y}{dt}$

Special case – Projectile motion

a = -g $\hat{\mathbf{y}}$ (constant; g~9.8 m/s^2)

$$v_x(t) = v_{xi}$$

$$x(t) = x_i + v_{xi}\, t$$

$$v_y(t) = v_{yi} - g\, t$$

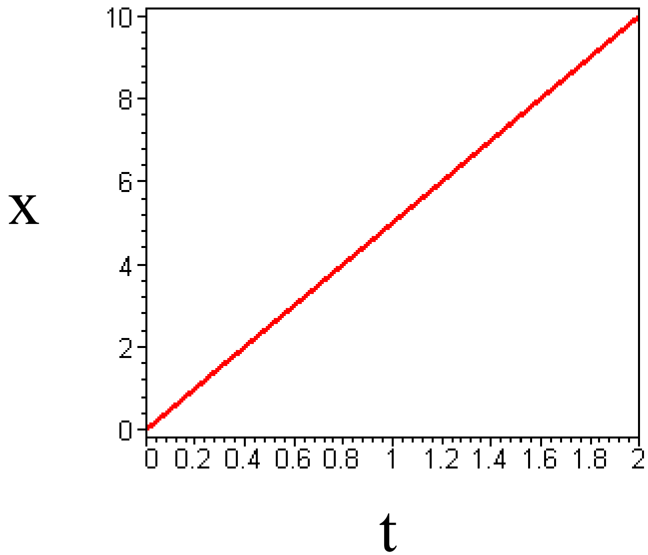
$$y(t) = y_i + v_{yi}\, t - \tfrac{1}{2} g\, t^2$$

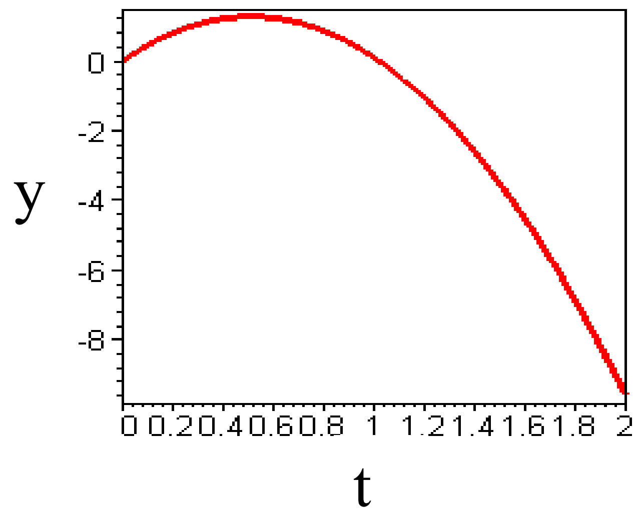
} "parametric equations"

Trajectory:

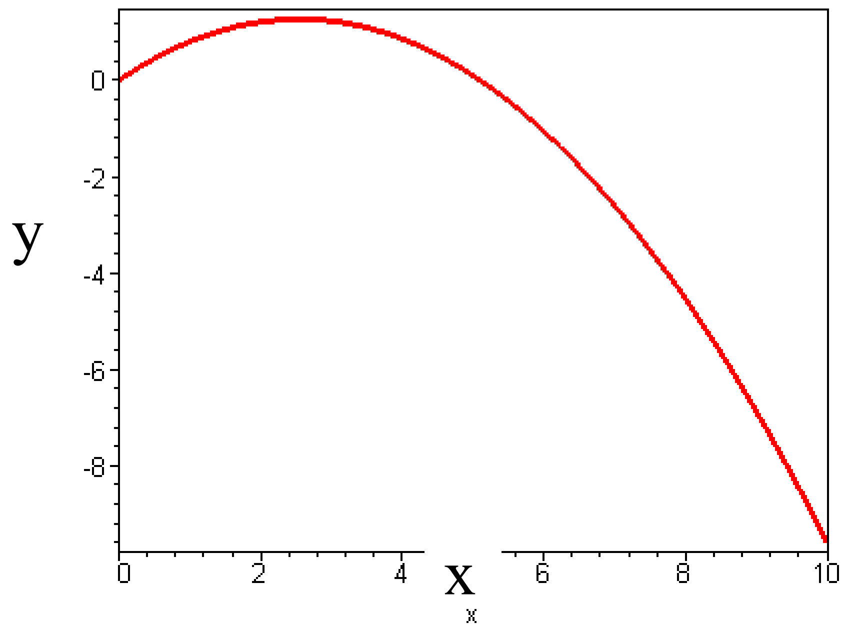
$$y(t) = y_i + v_{yi}\left(\frac{x(t) - x_i}{v_{xi}}\right) - \frac{1}{2} g \left(\frac{x(t) - x_i}{v_{xi}}\right)^2$$

Graphs of parametric equations:

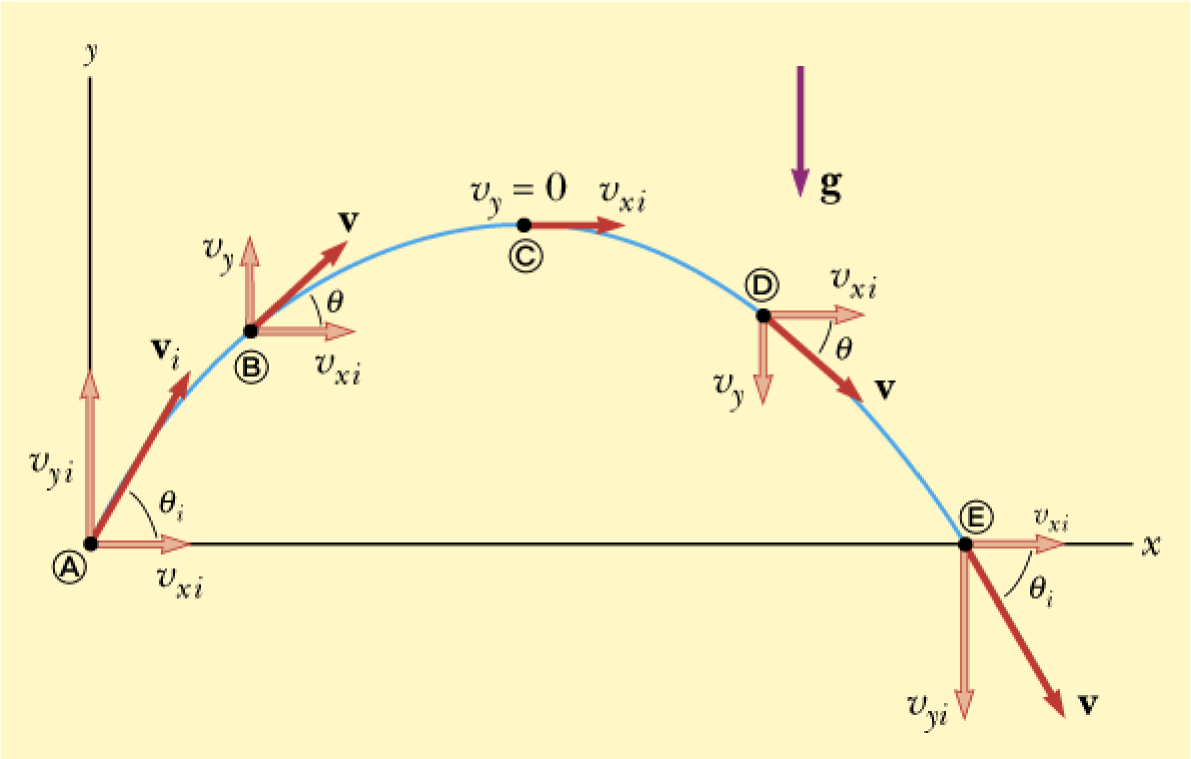




Graph of trajectory:



Serway, Physics for Scientists and Engineers, 5/e
Figure 4.6



$$y(t) = y_i + \tan\theta_i\left(x(t) - x_i\right) - \frac{1}{2}g\left(\frac{x(t) - x_i}{\underbrace{|\mathbf{v}_i|\cos\theta_i}_{(v_{xi})}}\right)^2$$

Other results derived from projectile equations

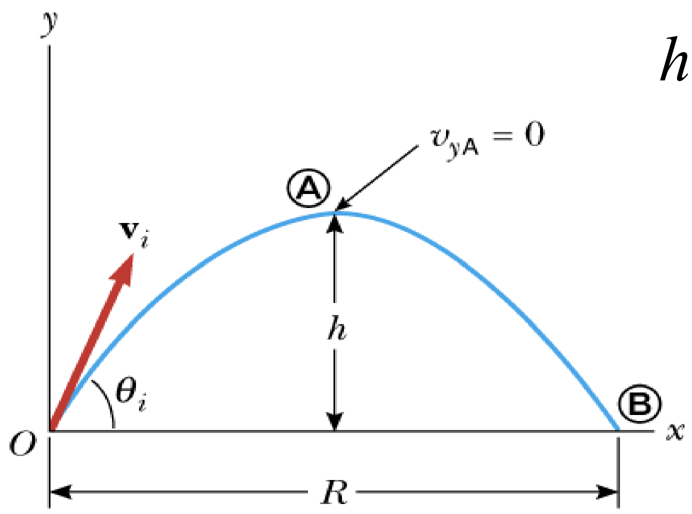
$v_x(t) = v_{xi}$

$x(t) = x_i + v_{xi}\, t$

$v_y(t) = v_{yi} - g\, t$

$y(t) = y_i + v_{yi}\, t - \frac{1}{2} g\, t^2$

$$y(t) = y_i + \tan\theta_i \left(x(t) - x_i\right) - \frac{1}{2} g \left(\frac{x(t) - x_i}{|\mathbf{v}_i| \cos\theta_i}\right)^2$$



$h = y(t_{top});\quad t_{top} = v_{yi}/g$

$\Rightarrow h = y_i + \frac{1}{2} v_{yi}^2/g$

$\Rightarrow R = x(2t_{top}) - x_i = 2 v_{xi} v_{yi}/g = v_i^2 \sin(2\theta)/g$

Peer instruction questions

1. Suppose you hit a golf ball on earth at an initial speed of 50m/s at a 45^o angle on Earth so that it travels a distance R_E before hitting the (level) ground. If you were to do the same thing on the moon which has a gravitational acceleration g/6 what distance R_M would it travel? (a) $R_E/36$ (b)$R_E/6$ (c) $6R_E$ (d) 36 R_E

2. Suppose that you drop a ball from a height of 100 m above the surface of the earth and it takes a time t_E to fall to the earth's ground. If you were to do the same thing 100 m above the surface of the moon, what is the time t_M that it takes to fall to moon's ground? (a) $t_E/6$ (b) $t_E/\sqrt{6}$ (c) $\sqrt{6}\ t_E$ (d) $6t_E$