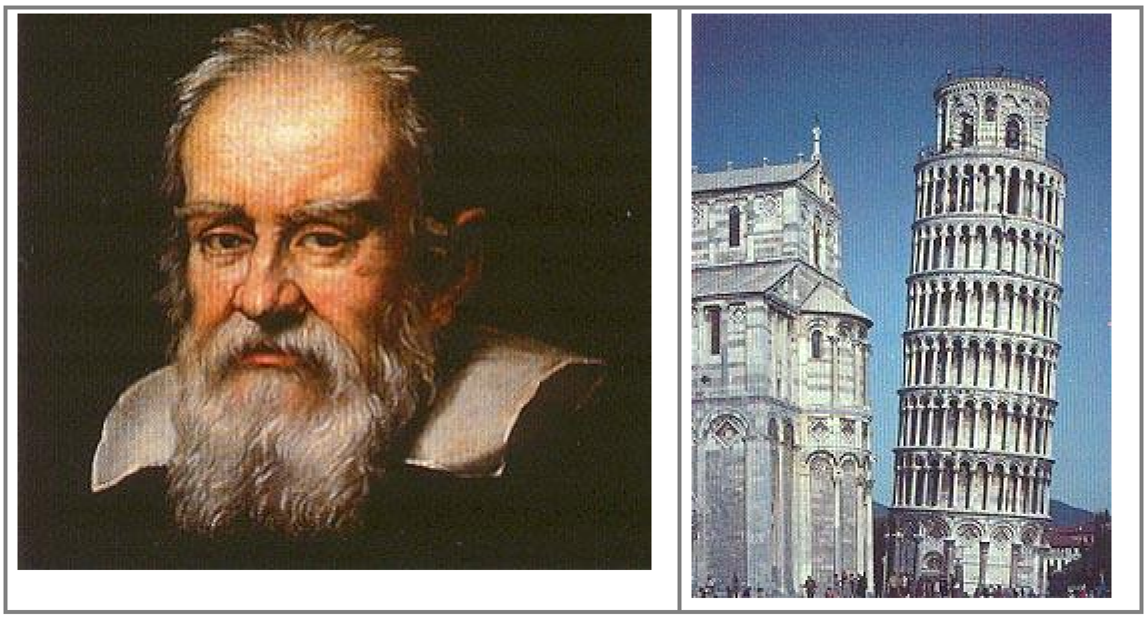
Falling objects
Another case of uniformly accelerated motion

1. At a given location on the Earth and in the absence of air resistance all objects fall with the same constant acceleration. The acceleration due to gravity is g and has a value of $9.80 m/s^2$.

Galileo Galilei and Acceleration Due to Gravity



2. Since falling objects move in the “y” dimension, the kinematic formulas need to be altered to replace the x and x_o with y and y_o respectively.

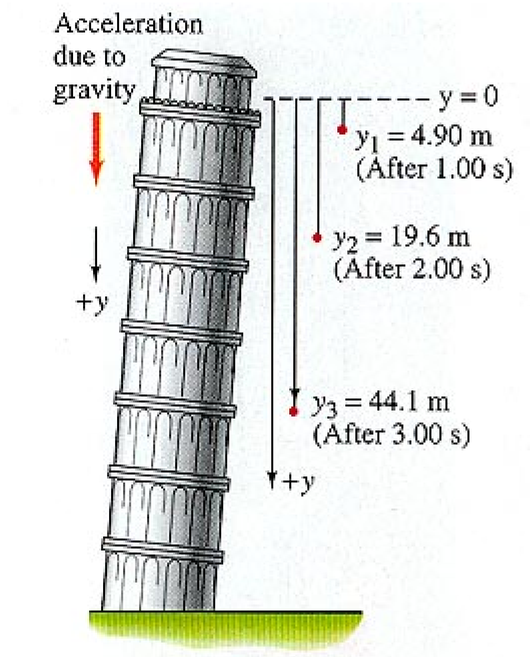
$$v = v_o + at$$

$$y = y_o + v_o t + 1/2 a t^2$$

$$v^2 = v_o^2 + 2a(y - y_o)$$

$$v_{ave} = (v + v_o)/2$$

Example 2-11 p34: Suppose that a ball is dropped from a tower 70.0m high. How far will it have fallen after 1.00s, 2.00s and 3.00s? Assume y is positive downward. Neglect air resistance



$$y = y_0 + v_0t + ½at^2$$

$$y = ½\ at^2 \text{ since } y_o \text{ and } v_o = 0$$

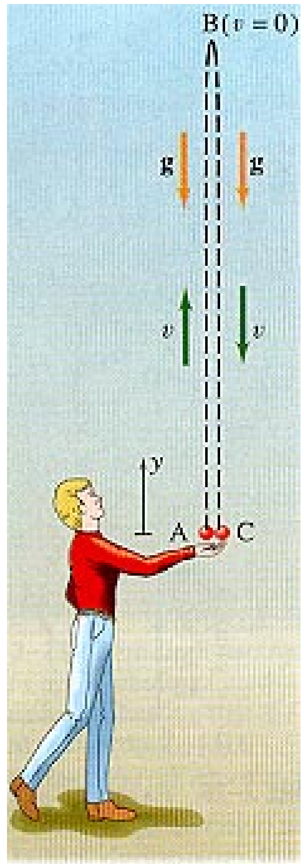
$$y = ½ \times -9.80\text{m/s}^2 \times (1.00\text{s})^2$$

$$y = -4.90\text{m}$$

3. If a ball is thrown down then the previous equation would be :

$$y = v_0t + ½\ at^2$$

4. If a ball is thrown up and then falls down note the acceleration and the velocity are in opposite directions on the way up and that at the highest point the acceleration remains constant at 9.8m/s^2



Example 2-13 page 35: A person throws a ball upward into the air with an initial velocity of 15.0m/s. Calculate a) how high it goes and b) how long is the ball in the air.

a) Choose the positive “y” direction as up.

Decide on a formula:

$$v^2 = v_o^2 + 2ay$$

Solve for y:

$$y = (v^2 - v_o^2)/2a$$

$$y = \frac{0 - (15.0\text{m/s})^2}{2(-9.8\text{m/s}^2)} = 11.5\text{m}$$

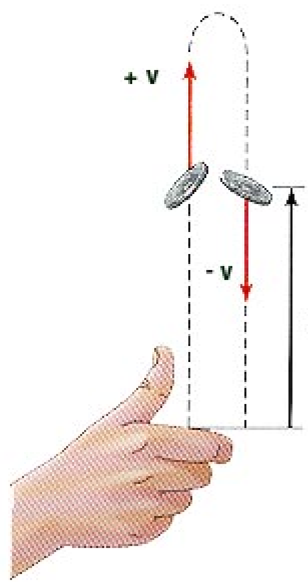
b) $y = v_o t + \frac{1}{2} a t^2$

$$0 = (15.0 m/s)t + \frac{1}{2}(-9.8 m/s^2)t^2$$

$$(15.0 m/s - 4.90 m/s^2 t)t = 0$$

Solving for t we have t = 0 or $t = (15.0 m/s)/(4.90 m/s^2) = 3.06 s$

Symmetry of motion:



The right side of the motion has the same magnitude as the left at displacement “y” The object will reach the hand with the same velocity as it left the hand but in the opposite direction.

$$v^2 = v_o^2 + 2ay$$

$$v^2 = v_o^2 - 2gy$$