Defn. Let \( s(t) \) measure distance at time \( t \).

1) \( s'(t) \) is \underline{instantaneous velocity} at time \( t \), usually denoted \( v(t) = s'(t) \) with units \( \frac{\text{distance}}{\text{time}} \).

2) \( s''(t) \) is \underline{instantaneous acceleration} at time \( t \), usually denoted \( a(t) = s''(t) \) with units \( \frac{\text{distance}}{\text{time}^2} \).

For free-falling and projectiles on earth, assuming acceleration is only due to gravity \( (g = -32 \text{ ft/sec}^2) \), we have the following formulas:

1) \( a(t) = s''(t) = -32 \text{ ft/sec}^2 \)

2) \( v(t) = s'(t) = -32t + v_0 \) \( \text{initial velocity (i.e. } v_0 = v(0)) \)

3) \( s(t) = -16t^2 + v_0 t + s_0 \) \( \text{initial position (i.e. } s_0 = s(0)) \)

Ex. A ball is projected upward at 96 ft/sec from the top of a 256 ft high building.

1) How high does the ball go?

2) How long is ball in the air?

3) What is ball’s velocity when:

   a) \( t = 1 \text{ sec} \)
   b) it strikes ground