Warm-Up:

Solve for f'(x).

1. $f(x) = x^4 + \sin x$

$f'(x) = 4x^3 + \cos x$

2. $f(x) = \cos x - \frac{2}{\sqrt{x^3}}$

$-\frac{3}{2} \cdot -2x^{-3/2-\frac{2}{2}}$

$f'(x) = -\sin x + 3x^{-5/2}$

Particle Motion

Position(t)= original function

Velocity(t) = 1st derivative

Acceleration(t)=2nd derivative

Lucky drops an acorn off the top of a 100 foot tree. What is the position of the acorn at time 1 sec, 2 sec, 3 sec with respect to the ground?

$s(t) = -16t^2 + 100$ position function

$S(1) = -16(1)^2 + 100 = 84$ ft

$S(2) = -16(2)^2 + 100 = 36$ ft

$S(3) = -16(3)^2 + 100 = -44$ ft

at 3 seconds the acorn is on the ground.

What is the instantaneous velocity at t = 1 and t=2 seconds for the acorn in the previous problem?

$s(t) = -16t^2 + 100$

$v(t) = -32t$

$v(1) = -32(1) = -32 \text{ ft/sec}$

$v(2) = -32(2) = -64 \text{ ft/sec}$

What is the instantaneous acceleration of the acorn at t = 1 sec. and t=2 sec.?

$v(t) = -32t$

$a(t) = -32$

$a(1) = -32 \text{ ft/sec}^2$

$a(2)$

At what time does Lucky's acorn hit the ground?

Set the position equal to zero and solve for t.

$$-16t^2 + 100 = 0$$

$$-100 \quad -100$$

$$-16t^2 = -100$$

$$\frac{-16t^2}{-16} = \frac{-100}{-16}$$

$$\sqrt{t^2} = \sqrt{\frac{25}{4}}$$

$$t = \frac{5}{2} = 2.5 \text{ seconds}$$

General equation for Position/Acceleration/Velocity

$$s(t) = at^2 + v_0 t + s_0$$

a = given
v_0 = initial velocity
s_0 = initial height

For a free falling object....

a = -16 when the height is in feet

a = -4.9 when the height is in meters

A coin is dropped from the top of each of the buildings listed below. Find

a. the position function
b. the velocity function
c. the acceleration function

CN Tower	1815 ft.
Sears Tower	1700 ft.
Empire State Building	1454 ft.
Eiffel Tower	324 m

a) $s(t) = -16t^2 + 1815$

b) $v(t) = -32t$

c) $a(t) = -32$

a) $s(t) = -4.9t^2 + 324$

b) $v(t) = -9.8t$

c) $a(t) = -9.8$

For his next trick, Lucky is being launched out of a cannon that rests ontop of a diving board 150 feet in the air! If he follows

$$s(t) = -75t^2 + 75t + 150$$

at what time will Lucky hit the safety net below?

$0 = -75t^2 + 75t + 150$

$0 = -75(t^2 - t - 2)$

$0 = -75(t+1)(t-2)$

$t+1=0$ $\quad t-2=0$ $\quad t=2$ seconds

$-1 \quad -1 \quad +2 \quad +2$

What is Lucky's velocity when he hits the net?

$v(t) = -150t + 75$

$v(2) = -150(2) + 75$

$= -225$ ft/sec

A rock is dropped into the Chatahoochee river from atop a bridge that is 54 meters above the surface of the water. What is the instantaneous velocities at t = 1 and t =2 seconds? How long does it take the rock to hit the water? Find the velocity of the rock just before it hits the water.

$s(t) = -4.9t^2 + 54$

$v(t) = -9.8t$

$v(1) = -9.8(1) = -9.8$ m/sec

$v(2) = -9.8(2) = -19.6$ m/sec

$0 = -4.9t^2 + 54$

$-54 \qquad -54$

$\frac{-54}{-4.9} = \frac{-4.9t^2}{-4.9}$

$\sqrt{t^2} = \sqrt{\frac{54}{4.9}}$

$t = 3.32$ seconds

$v(3.32) = -9.8(3.32)$

$= -32.53$ m/sec