

Name: _____
AP Calc AB: Motion Introduction

Date: _____
Ms. Loughran

A **position equation** is:

Notation:

By plugging in values of t ,

$x(0)$ or $s(0)$ is often called

Remember that the derivative describes the rate of change of a function. Therefore $s'(t)$ represents the _____ of the object in question at any given instant. Velocity combines an object's _____ with its _____. Therefore velocity can be negative but speed can not. Speed is the _____ of velocity.

(In a vertical motion problem, negative velocity means the object is _____.
In a horizontal motion problem, negative velocity means the object is moving to the _____.)

If you want an object's **average velocity**, (**average rate of change**) this value comes from:

Acceleration is the rate of change of _____. It is the second derivative of the _____ equation. The derivative of acceleration, rate of change of acceleration, is called the "_____."

Recap: $s(t)$ is _____
 $s'(t) =$ _____ is _____
 $s''(t) =$ _____ is _____
 $s'''(t) =$ _____ is _____

1. My dog, Molly, is pushing a ball along a straight wall according to the equation of motion

$$s(t) = 3t^2 - 12t + 9, \text{ where } s \text{ is in feet and } t \text{ is in seconds.}$$

(a) Find the average velocity on the interval $[1,3]$.

(b) Find the instantaneous velocity at $t = 1$ and at $t = 3$.

(c) When is the particle at rest?

2. Laura drops a stone off a cliff from a height of 256 feet. (When an object falls from rest, its equation of motion is $s = -16t^2$, with s in feet and t in seconds.)

(a) Find the velocity of the stone when $t = 1$ and $t = 2$.

(b) How long does it take for the stone to reach the ground?

(c) Find the velocity of the stone when it reaches the ground.

VELOCITY PROBLEMS

1. THE BALL IN THE AIR PROBLEM. A ball is thrown upward from the ground with initial velocity $v_0 = 64$ ft/sec so that $s = 64t - 16t^2$, with t in seconds.
- a) Find the velocity of the ball at the end of 1 second.
 - b) Find the average velocity of the ball during the first 2 seconds.
[Ans: 32 fps]
 - c) Find the velocity of the ball at the end of 3 seconds.
 - d) How long does it take the ball to reach its highest point?
 - e) Find the velocity and acceleration of the ball when it is 48 ft from ground level. (There are two answers to each part of this question.)
 - f) Find the maximum height the ball reaches?
 - g) Find the SPEED (which is the absolute value of velocity) of the ball at the end of 1 second and at the end of 3 seconds.
 - h) After how long will the ball return to the ground?
 - i) Find the ball's average vel. during the last 2 secs.
 - j) Find the ball's IMPACT VELOCITY (when it hits ground).
2. THE FALLING ROCK PROBLEM. A rock falls from a building, its height y in feet from the ground after t seconds being given by $y = 100 - 16t^2$.
- a) Find the INITIAL HEIGHT from which the rock fell.
 - b) Find the IMPACT TIME (the time it takes the rock to strike ground).
 - c) Find the IMPACT VELOCITY (at the impact time).