Motion in One Dimension: Falling Objects
Section 2.3

Relationship of Displacement, Velocity, and Acceleration to the Slopes and Areas

--The <u>slope of a position vs. time graph gives the velocity</u> of an object.

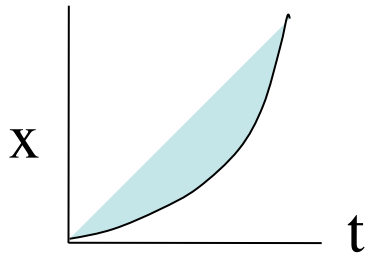
--The <u>slope of a velocity vs. time graph gives the acceleration</u> of the object.

--The <u>area under the curve of an acceleration vs. time graph gives the velocity</u> of the object.

--The <u>area under the curve of a velocity vs. time graph gives the displacement</u> of the object.

Graph of:

Position
(x)



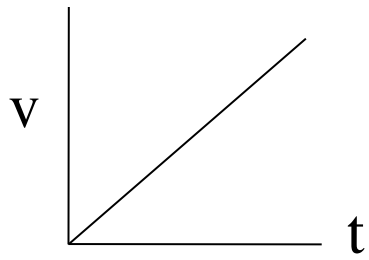
slope =
velocity

$$V = \frac{\Delta x}{\Delta t}$$

area under line =
displacement

$$\Delta x = v\Delta t$$

Velocity
(v)



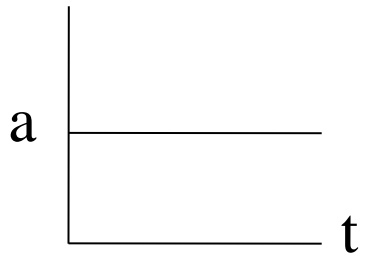
slope =
acceleration

$$a = \frac{\Delta v}{\Delta t}$$

area under line =
velocity

$$\Delta v = a\Delta t$$

Acceleration
(a)



Free Fall

--In the absence of air resistance a hammer and a feather will fall (accelerate) at the same rate and hit the ground at the same time.

--August 2, 1971; Apollo 15 landing on the moon as performed by Astronaut David Scott.

--<u>Free fall</u> is the <u>constant acceleration</u> of all objects near the surface of the Earth in the absence of air resistance.

--Air resistance may be ignored for objects of relatively large mass and small surface area.

Acceleration of Gravity

--The acceleration of gravity (g) for objects in free fall near the surface of the Earth is 9.81 m/s^2. (See transparency T7 modified)

--Since the acceleration of gravity is directed toward the center of the Earth, and since the coordinate system usually used by physicists defines the <u>downward</u> direction as <u>negative</u>, $g = -9.81\ m/s^2$.

Flight of a Ball Thrown Straight Up

--If a ball is thrown straight up in the air, it will have a constant acceleration of -9.81 m/s^2 on the way up, at the top of its motion, and on the way down.

--Show transparency of Figures 2-14 and 2-15, pages 60-61; identify the direction of the acceleration and velocity vectors for the ball moving up, at the top of its motion, and on the way back down. (Sketch acceleration and velocity vectors on the transparency; demonstrate with a tennis ball.)