

Worksheet #14: Linear Motion

If an object moves in along a straight line path, then the motion of the object is *linear*. The *position*, *velocity*, and *acceleration* (written as functions of time with $s(t)$ being the position, $v(t)$ being the velocity, and $a(t)$ being the acceleration) describing the motion of the object are related in the following manner:

$$v(t) = s'(t) \quad \text{and} \quad a(t) = v'(t) = s''(t)$$

These quantities may take on either positive or negative values, which indicate the *direction* of the quantities described. A positive direction is usually interpreted to mean *right* or *upward* and the negative means *left* or *downward*, depending on how the motion is oriented.

The *displacement* of the object is the difference in its ending and starting positions.

and may be either positive or negative: Displacement = $s(t_{\text{end}}) - s(t_{\text{start}})$

The *total distance* travelled by the object is always positive: Total Distance = $| \text{Pos Disp} | + | \text{Neg Disp} |$

The object is *speeding up* when the $+/-$ signs of $v(t)$ and $a(t)$ are the same, and *slowing down* when they are opposite.

An object thrown into the air and falling due to gravity obeys the following equation: $s(t) = -16t^2 + v_0t + s_0$

where the constants v_0 represents the *initial velocity* of the object (in units of $\frac{\text{ft}}{\text{sec}}$)

and s_0 represents its *initial height* (in units of ft).

1. A toy car moves along a straight track during time $0 \leq t \leq 4$. It's position at any time from a fixed point along the track is given by $s(t) = 2t^3 - 3t^2$. Answer the following about the motion of the car.

(Note: The time t is measured in minutes and distance s in inches.)

(a) What is the position, velocity, and acceleration of the car at the time $t = 3$ minutes?

(b) At what time does the car come to a stop?

(c) When is the car speeding up? When is it slowing down?

(d) What is the displacement of the car at the end of 4 minutes? What is the total distance it has traveled?

2. An object is thrown upward with a velocity of $16 \frac{\text{ft}}{\text{sec}}$ from the top of a building which 32 ft high. Answer the following about the motion of the object.

(a) Find the position, velocity, and acceleration equations of the object:

(b) At what time does the object reach its highest point?

(c) What is the highest height that it reaches?

(d) When does the object hit the ground?

(e) With is its velocity on impact with the ground?

(f) What is the total distance travelled by the by the object?