Rectilinear Motion

- Motion along a line
- Three needed things:
  1. Zero
  2. Positive
  3. Units
- This is our coordinate system.
- Motion variables are vectors since they have magnitude and direction.

The Kinematics Ladder

Down the ladder:  
\[ s(t) = s_0 + \int_0^t v(t)dt \]
\[ v(t) = \frac{ds}{dt} \]
\[ a(t) = \frac{dv}{dt} \]

Up the ladder:  
\[ s(t) = s_0 + \int_0^t v(t)dt \]
\[ v(t) = v_0 + \int_0^t a(t)dt \]
\[ a(t) \]

Constant Acceleration: Ladder

Up the ladder:

Constant Acceleration: Results

Up the ladder:
Constant Acceleration: Bonus

Eliminate time between the position and velocity equations to get

which simplifies to

Caution: This equation is not independent of the two results from which it is derived.

Constant Acceleration: Summary

\[ s = s_0 + v_0 t + \frac{1}{2} at^2 \]

\[ v = v_0 + at \]

\[ s = s_0 + \frac{v^2 - v_0^2}{2a} \]

Caution: A frequent mistake is to use constant acceleration equations for variable acceleration, FOR WHICH THE EQUATIONS DO NOT APPLY.

Given: Ball thrown vertically upward from 40. ft level of an elevator shaft with an initial velocity of 50. ft/sec. At the same instant, an open elevator passes the 10. ft level moving upward with a constant velocity of 5.0 ft/sec.

Required: When and where the ball hits the floor of the elevator.

Subway train leaves station A
Accelerates at 4.0 ft/s² for 6.0 sec
Maintains same speed until approaches station B
Accelerates at constant rate stopping in 6.0 sec
Total running time from A to B is 40. sec

Determine distance between stations A and B.