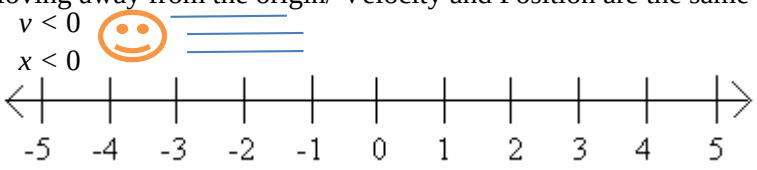
Particle Motion Cheat Sheet:

1. Position
   a. Particles are moving on the x axis, $x(t)$, or may be disguised are real world problems.
   b. If p is the position of the particle at time t, then $p(t) - p(a) = \int_a^t v(s)ds$, where v is the velocity.
2. Velocity
   a. A particle is moving to the left/backwards when $v(t) < 0$.
   b. A particle is moving to the right/forwards when $v(t) > 0$.
   c. Units: distance/time
   d. Derivative of position function: $\frac{d}{dt} p(t)$
   e. Anti-derivative of acceleration function: $v(t) - v(a) = \int_a^t a(s)ds$
   f. Movement with respect to the origin
      i. Moving away from the origin/ Velocity and Position are the same sign.



      ii. Moving towards the origin/ Velocity and Position are different signs

3. Speed
   a. The absolute value of the velocity function: $|v(t)|$
   b. Units: distance/time
   c. Increasing
      i. the acceleration and the velocity are the same sign.
   d. Decreasing
      i. the acceleration and the velocity are different sign.
   e. distance a particle travels from $t = a$ to $t = b$ is given by $\int_a^b |v(t)|\,dt$ (the integral of speed)

-50 mph (t = 2 sec) -20 mph (t= 1 sec)

velocity and acceleration are negative, but car's speed is increasing.

4. Acceleration
    a. The second derivative of the position function, $\frac{d^2p}{dt^2} = a(t)$
    b. The derivative of velocity, $\frac{dv}{dt} = a(t)$

- Changing Direction = Velocity changes sign
- Farthest to the Left = Absolute minimum of position (check endpoints and local min values)
- Farthest to the Right = Absolute maximum of position (check endpoints and local max values)
- Particle at rest = Velocity is zero
- Particle is moving fastest = Absolute maximum of speed (not velocity)

Function	Derivative	Integral
$x(t)$	N/A	$x(t) = x(a) + \int_a^t v(u)du$
$v(t)$	$x'(t)$	$v(t) = v(a) + \int_a^t a(u)du$
$a(t)$	$v'(t)$	N/A