## Particle Motion

**What you need to know about motion along the x-axis:**

| When you see... | Think... |
|---|---|
| Initially | $t = 0$ |
| At rest | $v(t) = 0$ |
| Particle moving right (forward or up) | $v(t) > 0$ |
| Particle moving left (backward or down) | $v(t) < 0$ |
| Average velocity on [a,b] [1] | $\frac{1}{b-a}\int_a^b v(t)dt = \frac{1}{b-a}x(t)\Big\|_a^b = \frac{x(b)-x(a)}{b-a}$ |
| Instantaneous velocity at time $t = a$ | $v(a) = x'(a)$ |
| Acceleration at time $t = c$ | $a(c) = v'(c) = x''(c)$ |
| Velocity is increasing | $a(t) = v'(a) > 0$ |
| Velocity is decreasing | $a(t) = v'(a) < 0$ |
| Speed | $\lvert v(t)\rvert$ |
| Speed is increasing | $v(t)$ and $a(t)$ have same sign (both + or both -) |
| Speed is decreasing | $v(t)$ and $a(t)$ have different signs |
| Total distance traveled on $[a, b]$ | $\int_a^b \lvert v(t)\rvert dt$ Absolute value is important! |
| Net distance traveled | $\int_a^b v(t)dt$ |
| Position of object at time $t = b$ | $x(b) = x(a) + \int_a^b v(t)dt$ |
| Particle is farthest left (right) | Compare positions ($x$-values) at endpoints & at local minima (maxima). |

[1] Do NOT think $\frac{v(a)+v(b)}{2}$