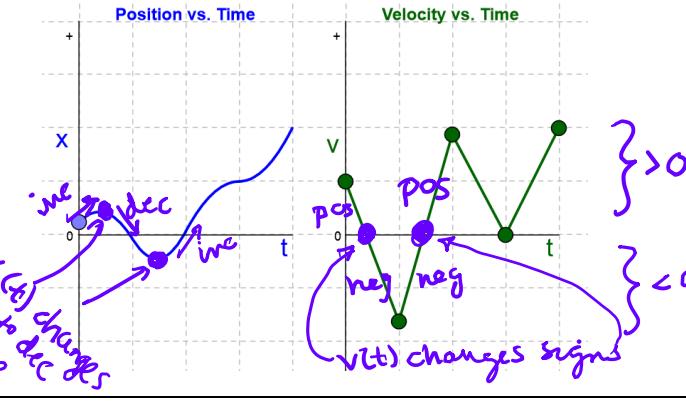
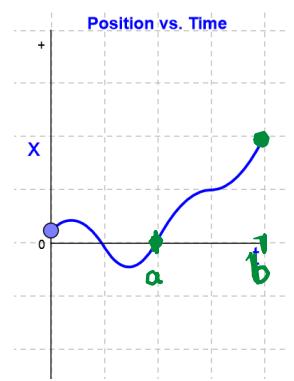
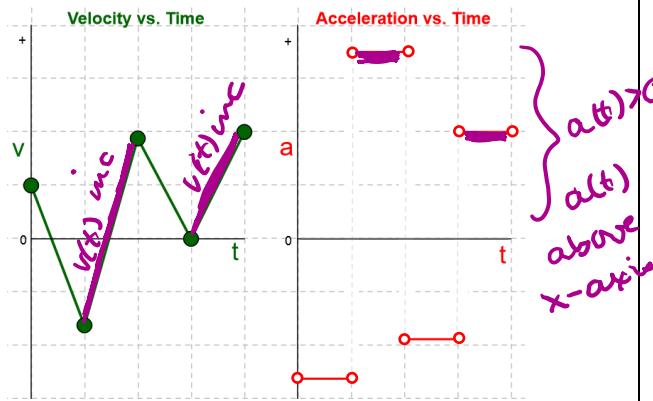
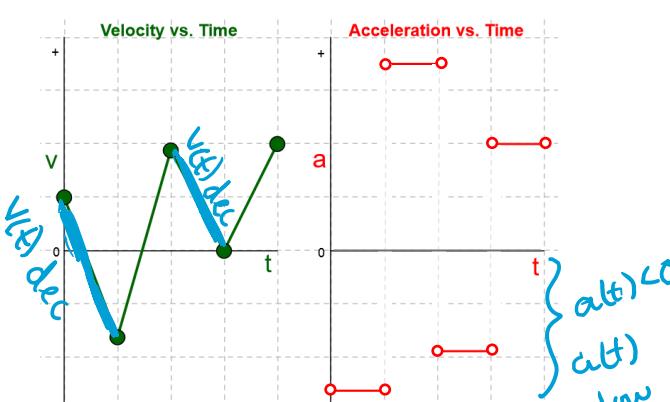


Particle Motion (along  $x$ -axis or  $y$ -axis)

When you read...	Think...	See...
Initially	$t=0$	
Particle is at rest OR Particle is not moving	$v(t) = 0$ $x'(t) = 0$ slope of tangent lines on $x(t)$ are zero	
Particle is moving right (forward)	$v(t) > 0$ $x'(t) > 0$ $x(t)$ inc	
Particle is moving left (backward)	$v(t) < 0$ $x'(t) < 0$ $x(t)$ dec	

When you read...	Think...	See...
Particle changes direction	$v(t)$ changes signs ( $\text{pos to neg}$ or $\text{neg to pos}$ ) $x'(t)$ changes signs or $x(t)$ changes from $\text{inc to dec}$ or $\text{dec to inc}$	 <p>The Position vs. Time graph shows a curve with points labeled 'pos' (positive) and 'neg' (negative). The Velocity vs. Time graph shows a curve with points labeled 'pos' (positive), 'neg' (negative), and 'neg' (negative). Handwritten notes indicate where <math>v(t)</math> changes signs.</p>
Velocity at $t = a$	$v(a) = x'(a)$	
Average Velocity on $[a, b]$	$v_{\text{avg}} = \frac{\Delta x}{\Delta t}$ $= \frac{x(b) - x(a)}{b - a}$	 <p>The Position vs. Time graph shows a curve with points labeled 'a' and 'b'. A horizontal line segment connects the points <math>x(a)</math> and <math>x(b)</math>. Handwritten notes show the formula for average velocity and calculate <math>v_{\text{avg}} = \frac{2-0}{4-2} = \frac{1}{2}</math>.</p>
Velocity is increasing	$v'(t) > 0$ $a(t) > 0$	 <p>The Velocity vs. Time graph shows a curve with points labeled 'inc' (increasing) and 'dec' (decreasing). The Acceleration vs. Time graph shows a series of open circles above the x-axis, indicating <math>a(t) &gt; 0</math>.</p>
Velocity is decreasing	$v'(t) < 0$ $a(t) < 0$	 <p>The Velocity vs. Time graph shows a curve with points labeled 'dec' (decreasing) and 'inc' (increasing). The Acceleration vs. Time graph shows a series of open circles below the x-axis, indicating <math>a(t) &lt; 0</math>.</p>

When you read...	Think...	See...
Acceleration at $t = c$	$a(c) = v'(c)$	
Average acceleration on $[c, d]$	$a_{\text{avg}} = \frac{\Delta v}{\Delta t}$ $= \frac{v(d) - v(c)}{d - c}$	<p>on <math>[2, 3]</math>  <math>a_{\text{avg}} = \frac{0-2}{3-2} = -2</math></p>
Speed	$ v(t) $ <i>magnitude of velocity → length</i>	
Speed is increasing (particle is speeding up)	$v(t)$ and $a(t)$ have same signs. $v(t) > 0$ and $a(t) > 0$ or $v(t) < 0$ and $a(t) < 0$ <b>OR</b> $v(t) > 0$ and $v(t)$ inc or $v(t) < 0$ and $v(t)$ dec	
Speed is decreasing (particle is slowing down)	$v(t)$ and $a(t)$ have different signs $v(t) > 0$ and $a(t) < 0$ or $v(t) < 0$ and $a(t) > 0$ <b>OR</b> $v(t) > 0$ and $v(t)$ dec or $v(t) < 0$ and $v(t)$ inc	