

2. (a) $x(t) = \frac{t}{1+t^2} \Rightarrow v(t) = x'(t) = \frac{(1+t^2)(1) - t(2t)}{(1+t^2)^2} = \frac{1-t^2}{(1+t^2)^2}$

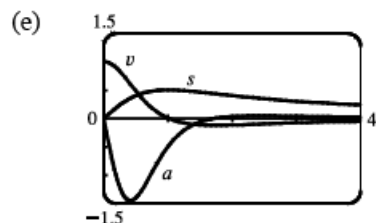
(b) Right: $v(t) > 0 \Rightarrow 1-t^2 > 0 \Rightarrow t^2 < 1 \Rightarrow |t| < 1 \Rightarrow 0 \leq t < 1$

Left: $v(t) < 0 \Rightarrow 1-t^2 < 0 \Rightarrow t > 1$

(c) $|x(1) - x(0)| + |x(4) - x(1)| = |\frac{1}{2} - 0| + |\frac{4}{17} - \frac{1}{2}| = \frac{1}{2} + \frac{9}{34} = \frac{13}{17}$

(d) $x(t) = \frac{t}{1+t^2} \Rightarrow v(t) = x'(t) = \frac{(1+t^2)(1) - t(2t)}{(1+t^2)^2} = \frac{1-t^2}{(1+t^2)^2}$. $a(t) = v'(t) = \frac{2t(t^2-3)}{(1+t^2)^3}$.

$a(t) = 0 \Rightarrow 2t(t^2-3) = 0 \Rightarrow t = 0$ or $\sqrt{3}$



(f) v and a have the same sign and the particle is speeding up when $1 < t < \sqrt{3}$. The particle is slowing down and v and a have opposite signs when $0 < t < 1$ and when $t > \sqrt{3}$.

4. (a) The velocity v is positive when s is increasing, that is, on the intervals $(0, 1)$ and $(3, 4)$; and it is negative when s is decreasing, that is, on the interval $(1, 3)$. The acceleration a is positive when the graph of s is concave upward (v is increasing), that is, on the interval $(2, 4)$; and it is negative when the graph of s is concave downward (v is decreasing), that is, on the interval $(0, 2)$. The particle is speeding up on the interval $(1, 2)$ [$v < 0, a > 0$] and on $(3, 4)$ [$v > 0, a > 0$]. The particle is slowing down on the interval $(0, 1)$ [$v > 0, a < 0$] and on $(2, 3)$ [$v < 0, a > 0$].

(b) The velocity v is positive on $(3, 4)$ and negative on $(0, 3)$. The acceleration a is positive on $(0, 1)$ and $(2, 4)$ and negative on $(1, 2)$. The particle is speeding up on the interval $(1, 2)$ [$v < 0, a < 0$] and on $(3, 4)$ [$v > 0, a > 0$]. The particle is slowing down on the interval $(0, 1)$ [$v < 0, a > 0$] and on $(2, 3)$ [$v < 0, a > 0$].

6. (a) $s = 5t + 3t^2 \Rightarrow v(t) = \frac{ds}{dt} = 5 + 6t$, so $v(2) = 5 + 6(2) = 17$ m/s.

(b) $v(t) = 35 \Rightarrow 5 + 6t = 35 \Rightarrow 6t = 30 \Rightarrow t = 5$ s.