RECTILINEAR MOTION

— Motion in a straight line

position
$$\longrightarrow \quad s(t) = 8t - t^2$$

$\uparrow$ position at time t

t	s
0	0
1	7
2	12

Find velocity at $t = 2$.

$$V = \frac{\Delta s}{\Delta t} = \frac{12}{2} = 6 \frac{ft}{s}$$

$$= \frac{s(2) - s(0)}{2 - 0}$$

$$\lim_{t \to 2^-} \frac{s(t) - s(2)}{t - 2}$$

$t=0 \qquad t=1 \quad t=2$
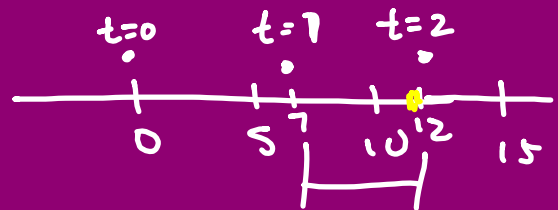
$$\frac{s(2) - s(1)}{2 - 1} = \frac{12 - 7}{1}$$
$$= 5$$

$$v(t) = s'(t)$$

$$v(t) = 8 - 2t$$

$$a = \frac{\Delta v}{\Delta t} = \frac{v(2) - v(0)}{2 - 0}$$

$$\lim_{t \to 2} \frac{v(t) - v(2)}{t - 2}$$

instantaneous velocity

$$s(t)$$
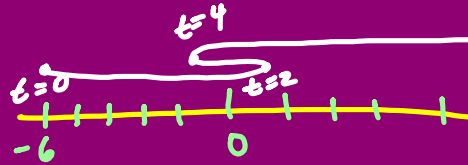$$v(t) = s'(t)$$
$$a(t) = v'(t) = s''(t)$$

$$S(t) = \frac{1}{3}t^3 - 3t^2 + 8t - 6$$

$$v(t) = t^2 - 6t + 8$$

$$a(t) = 2t - 6$$
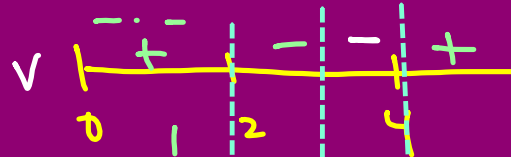
t=4 t=0 t=2
-6   0

1) When does the Polar Express stop?

$$v = 0$$

$$0 = t^2 - 6t + 8$$

$$v(t) \rightarrow 0 = (t - 4)(t - 2)$$

$$t = 2, 4$$

t	S
0	-6
2	2/3
4	-2/3

v $+$ $-$ $-$ $+$
     0   1   2   4

a $-$ $-$ $+$ $+$
     0   1   3

2) When does it
   Speed up/slow down?

	S.d.	S.u.	s.d.	S.u.
0		2	3	4

$$a(t) = 0 = 2t - 6$$

$$6 = 2t$$

$$3 = t$$

Slow down $(0, 2)$ $(3, 4)$
Speed up $(2, 3)$ $(4, \infty)$

How far did the train travel between
0 & 5 seconds?

-6 -2/3 0 2/3

t	S
0	-6
2	2/3
4	-2/3
5	2/3

$$6\frac{2}{3} = \frac{20}{3}$$

$$4/3$$

$$4/3$$

$$\frac{28}{3} = 9\frac{1}{3} \text{ ft.}$$
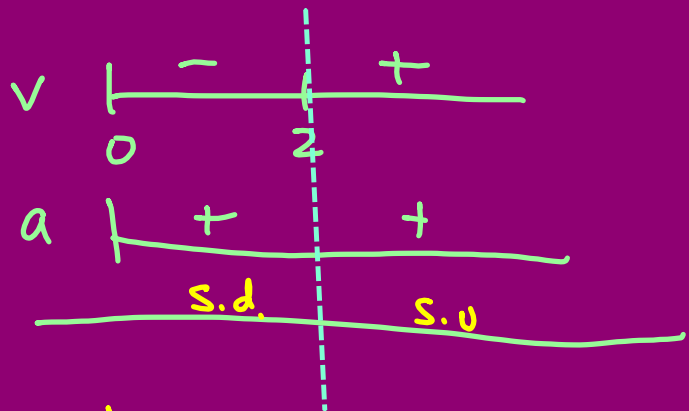
$$S(t) = 5t^2 - 20t$$
$$V(t) = 10t - 20$$
$$a(t) = 10$$

(Hint for Problems 1 & 3 on next page.)

$V = 0 \qquad 0 = 10t - 20$

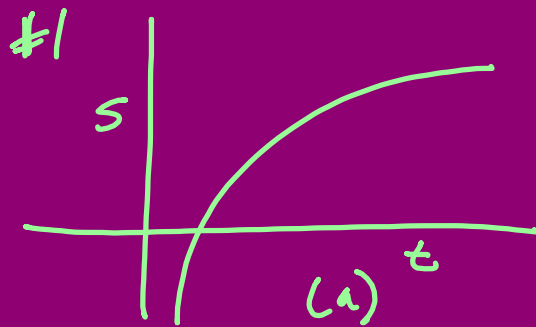$\qquad\qquad 20 = 10t$

$\qquad\qquad 2 = t$

$a = 0 \qquad$ solve for

V

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   -        |        +
|——————————+——————————
0          2
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a

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|     +    |     +
|——————————+——————————
     s.d.  |     s.u
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Slow down $(0, 2)$

Speed up $(2, \infty)$

How far did it travel
from $t = 1$ to $t = 4$

t	s
1	-15
2	-20
4	0

$\left.\begin{array}{c} -15 \\ -20 \end{array}\right\rangle 5$

$\left.\begin{array}{c} -20 \\ 0 \end{array}\right\rangle \dfrac{20}{25 \text{ units}}$

#1

s

(a) t

$V = inc/dec = +$

$a = concavity = -$

slowing down