Example 3: Find the velocity and the acceleration of the displacement function $s(t) = -5t^3 + 2t^2 - 7t$ when $t = 3$. State whether the object is speeding up or slowing down at $t = 3$.

Feb 16-8:43 PM

Rate of Change

	Negative	0	Positive
s	if $s(t)<0$ position is to the LEFT (below)the origin	at origin	if $s(t)>0$ position is to the RIGHT (above) the origin
V	- slope of **s** is negative - **s** is decreasing - moving in neg. direction (left/down)	stopped v = 0	- slope of **s** is positive - **s** is increasing - moving in positive direction (moving right/up)
a	- slope of **v** is negative Case 1 $v(t) > 0$ $a(t) < 0$ - velocity is decreasing - slowing down Case 2 $v(t) < 0$ $a(t) < 0$ - velocity is increasing - speeding up	velocity is constant	- slope of **v** is positive - velocity is increasing - *acceleration* (if v(t)>0) (speeding up) - velocity if decreasing - *deceleration* (if v(t)<0) (slowing down)

Feb 20-10:23 PM

In General...

accelerating $\neq$ speeding up

a & v same sign $\Rightarrow$ speeding up

a & v opposite sign $\Rightarrow$ slowing down

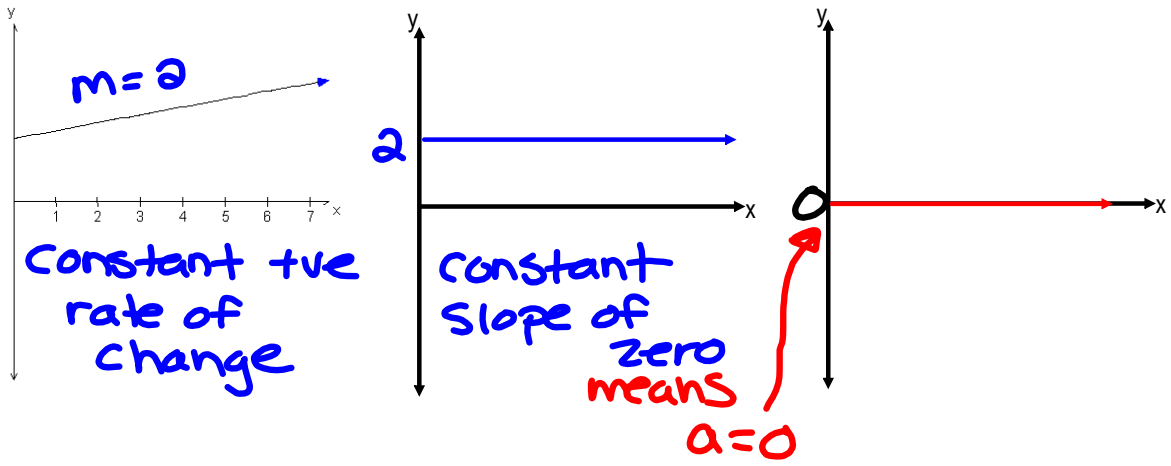
s & v same sign $\Rightarrow$ moving away from origin

s & v opposite sign $\Rightarrow$ moving towards origin

Feb 20-10:23 PM

Example 4

For each distance-time graph, sketch the velocity function and the acceleration function.



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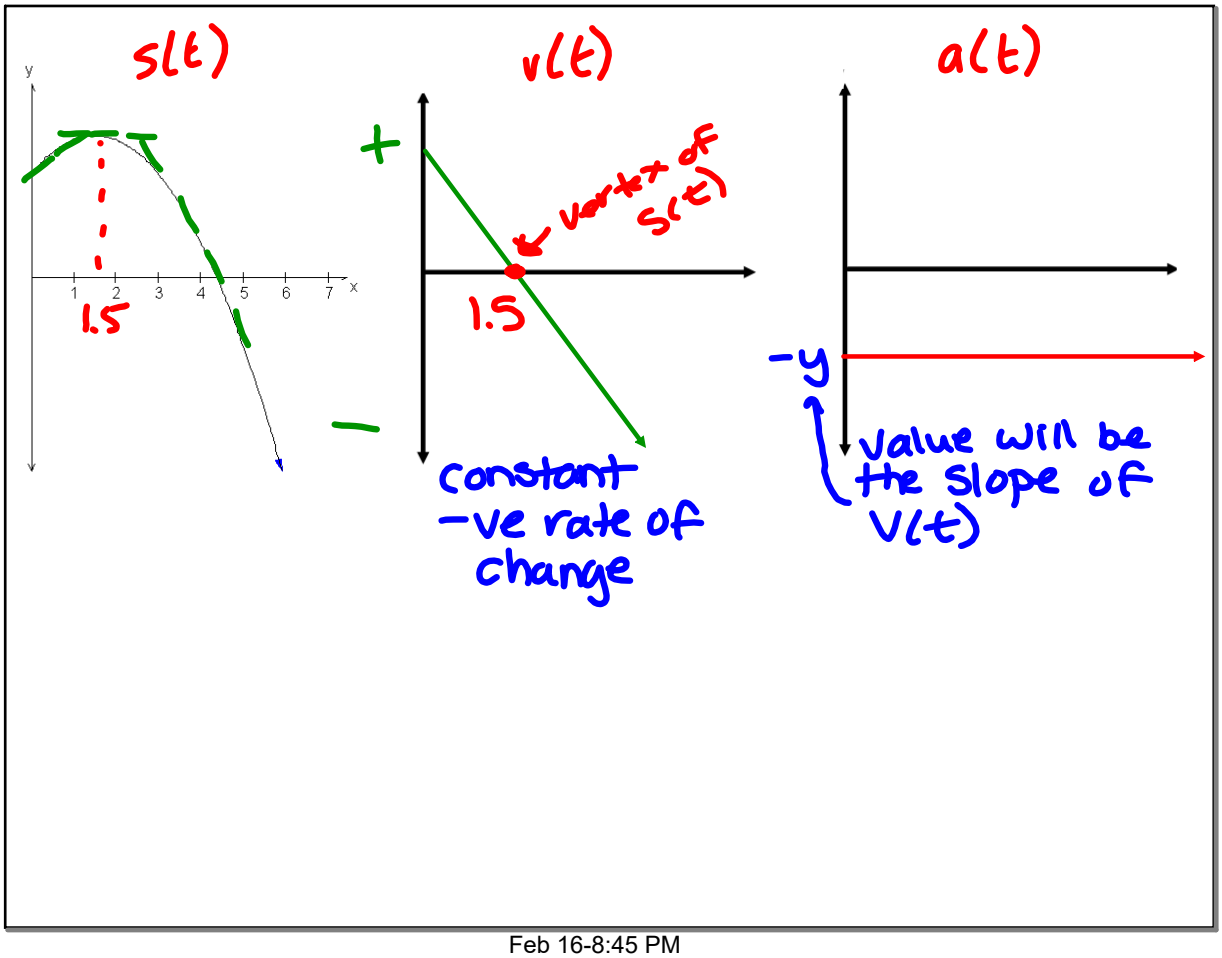

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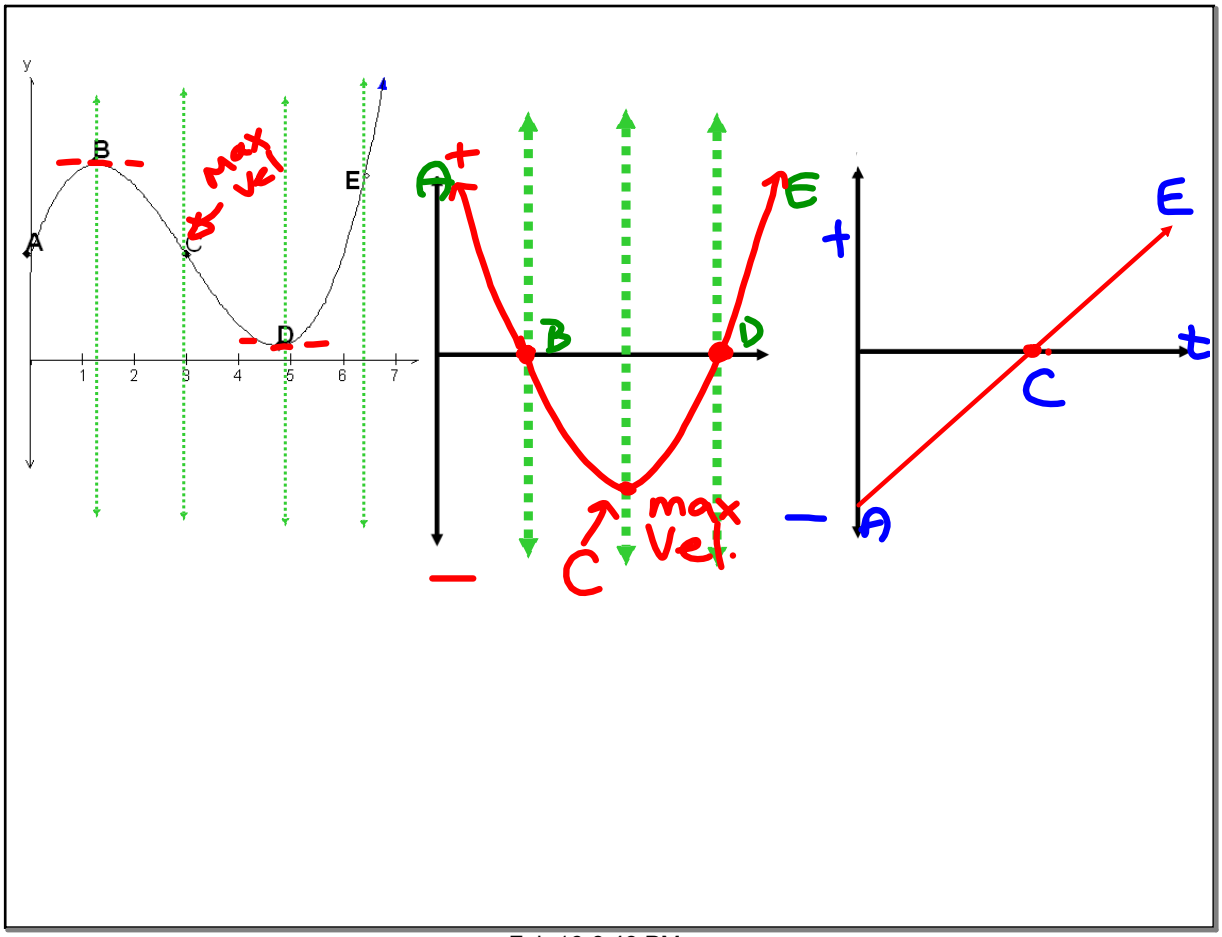
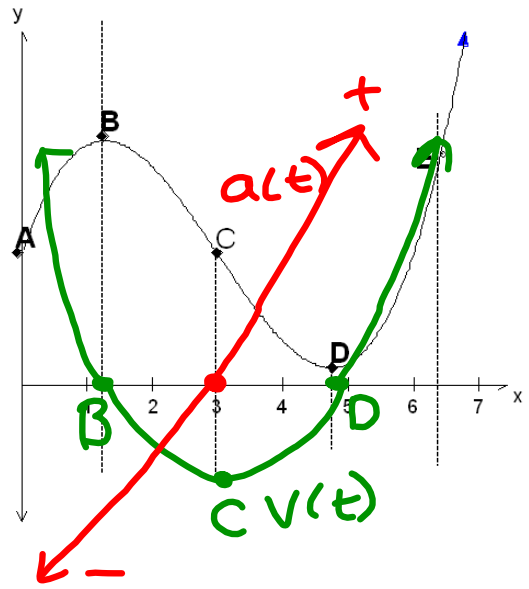


Feb 16-8:48 PM

Example 5: The graph shows the position function of an object.



a) At what point(s) on the graph is the velocity 0?

B and D

b) During which intervals is the velocity positive?

AB, DE

c) During which intervals is the velocity negative?

BC, CD or BD

d) During which intervals is the acceleration positive?

CE

e) During which intervals is the acceleration negative?

AC

Feb 16-8:48 PM

Example 6: The position function of an object moving along a straight line is represented by the function $s(t) = 2t^3 - 2t^2 - 40t$, where t is in seconds and s is in metres.

a) What is the position of the object after 2 s and after 5 s?

$s(2) = 2(2)^3 - 2(2)^2 - 40(2)$

$s(2) = 2(8) - 2(4) - 80$

$= 16 - 8 - 80$

$= -72$ m

$s(5) = 2(5)^3 - 2(5)^2 - 40(5)$

$= 250 - 50 - 200$

$= 0$ m

b) What is the velocity of the object after 2 s and after 5 s?

$v(t) = 6t^2 - 4t - 40$

$v(2) = 6(2)^2 - 4(2) - 40$

$= 24 - 8 - 40$

$= -24$ m/s

$v(5) = 6(5)^2 - 4(5) - 40$

$= 150 - 20 - 40$

$= 90$ m/s

Feb 16-8:49 PM

c) When is the object stopped? What is its position at this time?

$v=0$

$0=6t^2-4t-40$

Q.F. $t_1=-2.2$ s ← reject

$t_2=2.94$ s

$s(2.94)=2(2.94)^3-2(2.94)^2-40(2.94)$

$=50.8-17.3-117.6$

$=-84$ m

d) When is the object moving in a positive direction?

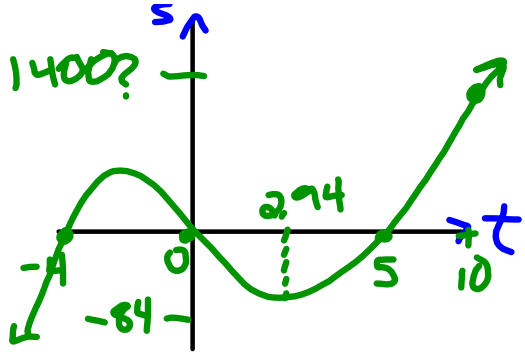
$0=2t^3-2t^2-40t$

$0=2t(t^2-t-20)$

$0=2t(t-5)(t+4)$

$t=0 \quad t=-4$

$t=5$



Feb 16-8:51 PM

e) Determine the total distance travelled by the object during the first 10 s.

$s(10)=2(10)^3-2(10)^2-40(10)$

$=2(1000)-2(100)-400$

$=2000-200-400$

$=1400$ m

total distance $=84+84+1400$

$=1568$ m

Feb 16-8:51 PM

Example 7: Starting at time $t = 0$, Johnny "The Speed Demon" accelerates down the local drag strip in his 1996 Porsche 911 Twin Turbo, and then brakes and comes to a stop. The position function for Johnny's car is given by $s(t) = 6t^2 - \frac{1}{5}t^3$, where s is in metres, and t is in seconds.

a) After how many seconds does "The Speed Demon" stop?

$v(t) = 12t - \frac{3}{5}t^2$

$0 = 12t - \frac{3}{5}t^2$ $\times 5$

$0 = 60t - 3t^2$

$0 = 3t(20 - t)$

$t = 0$

$t = 20$ seconds

b) What distance does Johnny's Porsche travel?

$s(20) = 6(20)^2 - \frac{1}{5}(20)^3$

$= 2400 - 1600$

$= 800$ m

c) Is Johnny speeding up or slowing down at $t = 5$ seconds?

$v(5) = 12(5) - \frac{3}{5}(5)^2$

$= 60 - 15$

$= 45$ m/s

$a(t) = 12 - \frac{6}{5}t$

$a(5) = 12 - \frac{6(5)}{5}$

$= 6$ m/s^2

$\because a(t) \times v(t) > 0$

$\therefore$ The car is speeding up.

d) At what time does Johnny begin to apply the brakes? $a = 0$

$0 = 12 - \frac{6}{5}t$

$\frac{6}{5}t = 12$

$6t = 60$

$\frac{6t}{6} = \frac{60}{6}$

$t = 10$

$\therefore$ He applies the brakes at 10 seconds

Mar 6-7:42 AM