Questions on Homework

Oct 11-8:39 AM

3-4 Derivave and Rates of Change

Learning Objecves:

I can calculate the position, velocity, acceleration, and speed for motion along a line.

I can calculate the position, velocity, acceleration, and speed for vertical motion.

I can interpret the position, velocity, acceleration, and speed using appropriate units.

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Moon Along a Line

Suppose that an object is moving along a coordinate line so that we know its posion on that line as a funcon of me p = f(t) (t is in seconds and p is in feet)

$\frac{dp}{dt} = f'(t) = p' = v$ (↘ position)

The change in the object's posion over me would be $\frac{dp}{dt}$. The rate of change of the object's posion would be the object's velocity and the units for $\frac{dp}{dt}$ would be feet per second.

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??? Quesons for Discussion ???

- What does the +/- on the posion indicate?
- What does the +/- on the velocity indicate? (→ direction)
- How would you find the speed of the object? |velocity|

What would be an expression for speed?

$\frac{dv}{dt} = p'$

- What would be the meaning of $\frac{dv}{dt}$?

derivative of velocity = acceleration ft/sec^2

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Derivaves of a Posion Funcon

p(t) = posion of the object at me t

v(t) = p'(t)= $\frac{dp}{dt}$ = the velocity of the object at me t

a(t) = p''(t) = v'(t)= $\frac{dv}{dt} = \frac{d^2p}{dt^2}$ = the acceleraon of the object at me t.

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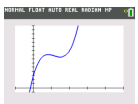
Ex1. An object is moving back and forth on the number line and its posion is given by the equaon $x(t) = t^3 - 7t^2 + 15t + 6$ (p)

Where x(t) is measured in and t is measured in sec

a.) Find the posion of the object at me t = 1 sec, t = 2 sec t= 2.5 sec, and t = 5 sec.

15 ft 16 ft 15.375 31

b.) Graph x(t).



c.) What does the +/- on the posion mean?

moving away from 0 (to the right)

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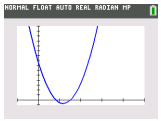
d.) Find the object's velocity as a funcon of me. $p = t^3 - 7t^2 + 15t + 6$

$v = 3t^2 - 14t + 15$

e.) Find the object's velocity at me t = 1 sec, t = 2 sec, t= 2.5 sec, and t = 5 sec. 4 ft/sec

-1 ft/sec -1.25 ft/sec 20



f.) Graph v(t)

g.) What does the +/- on the velocity mean?

\+ positive direction (forward)

\− negative " (backward)

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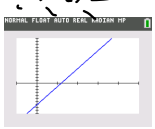
h.) Find the object's acceleraon as a funcon of me. $p = t^3 - 7t^2 + 15t + 6$

$v = 3t^2 - 14t + 15$

$a = 6t - 14$

i.) Find the object's acceleraon at me t = 1 sec, t = 2 sec, t= 2.5 sec, and t = 5 sec. -8 ft/s²

-2 ft/s² 1 ft/s² 16 ft/s²



j.) Graph a(t)

k.) What does the +/- on the acceleraon mean?

gaining or losing velocity

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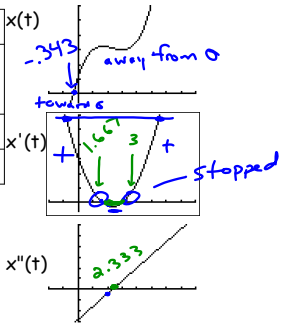
l.) Completely describe the moon of the object at me t = 1 sec, t = 2 sec, t= 2.5 sec, and t = 5 sec.

x	1	2	2.5	5
x(t) p	15	16	15.375	31
x'(t) v	4	-1	-1.25	20
x"(t) a	-8	-2	1	16



15 away from starting point moving in a positive direction at 4 ft/sec. and slowing down at 8 ft/sec²

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m.) When is the object's posion to the right of 0? To the le of 0? At 0?

$t > -.34$ → away from 0

$t = -.34$ → at 0

$t < -.34$ → toward 0

n.) When is the object moving to the right? Moving to the le? Stopped?

right $t > 3$, $t < 1.667$

left $1.667 < t < 3$

Stopped at $t = 3$, $t = 1.667$

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o.) When is the object speeding up, slowing down, moving at a constant velocity?

slowing down $t < 1.667$, $2.333 < t < 3$

↘ $a = 0$ $t = 2.333$

speeding up $t > 3$, $1.667 < t < 2.333$

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p.) When is the velocity of the object 7 /sec?

$7 = 3t^2 - 14t + 15$

$0 = 3t^2 - 14t + 8$

$0 = (3t - 2)(t - 4)$

$t = \frac{2}{3}$, 4

$t = 4$ sec and $\frac{2}{3}$ sec

q.) When is the acceleraon of the object 22 /sec²?

$22 = 6t - 14$

$36 = 6t$

$t = 6$ sec

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Object Moving Vercally under the Influence of Gravity

Free Fall

$$d(t) = -\frac{1}{2}gt^2$$

$$p(t) = -\frac{1}{2}gt^2 + h_0$$

t = me (seconds)
h_0 = Inial height
d(t) = displacement at me t
p(t) = posion at me t

Object Launched Vercally

$$d(t) = -\frac{1}{2}gt^2 + v_0 t$$

$$p(t) = -\frac{1}{2}gt^2 + v_0 t + h_0$$

t = me (seconds)
h_0 = inial height
v_0 = inial velocity
d(t) = displacement at me t
p(t) = posion at me t

Gravity = 9.8 m/sec² or 32 /sec²

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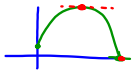
Ex2. A model rocket is shot vercally from 10 above the ground with an inial velocity of 120 /sec

$y = -\frac{1}{2}gt^2 + v_0 t + h_0$

$y = -\frac{1}{2}(32)t^2 + 120t + 10$

a.) Write the equaon that models the rocket's posion at me t.

$y = -16t^2 + 120t + 10$



b.) At what me does the rocket reach its maximum height? What is the maximum height?

$y' = -32t + 120 = 0$

$t = 3.75$ sec $\quad (3.75, 235)$

c.) When does the rocket land on the ground?

$t = 7.582$ sec

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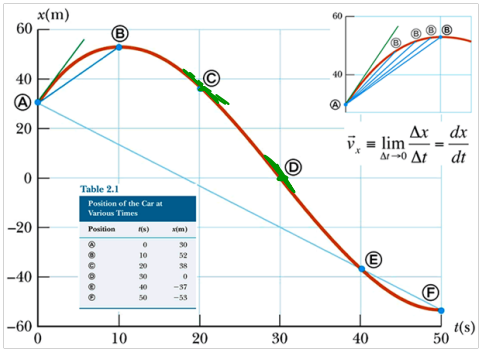
Average vs Instantaneous Velocity



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Instantaneous Velocity

The derivave of the posion funcon at me t=c.

posion = f(t)

instantaneous velocity at me t = c would be f'(c)

Average Velocity

The slope of the secant line over the me interval from t = a to me t=b.

posion = f(t)

posion at me me t=a (a,f(a)) and the posion at me t=b is (b,f(b))

average velocity from me t=a to me t=b would be

$$\frac{f(b) - f(a)}{b - a}$$

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Homework

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