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$-48(t+1)^{-2}$
$96(t+1)^{-3}$

Applications of derivatives

Problems involving position, velocity and acceleration

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Consider each of the following situations and answer clearly. Remember to use the appropriate mathematical notation and to frame your final answer.

$80(40)-(40)^2$

1. An object is moving along a straight line, and its position (in meters) is given by the function $s(t)=80t-t^2$ Determine
   a) The velocity of the object when t = 2 sec $v'(t)=-2t+80$ $v(t)=76\,m/s$
   b) The acceleration when t = 3 sec $a'(t)=-2$
   c) The time when the velocity is zero and the position of the object at that time $0=-2t+80$ $-2t=-80$ $t=40s$ $S(t)=1,600$

2. An object is moving along a straight line, and its position (in meters) is given by the function $s(t)=3t+\frac{48}{t+1}$

Determine
   a) The velocity of the object when t = 2 sec $v'(t)=3-\frac{48}{(t+1)^2}=3-5.33=-2.33$
   b) The acceleration when t = 2 sec $a(t)=\frac{96}{(t+1)^3}=3.55$
   c) The time when the velocity is zero and the position of the object at that time

3. A dynamite charge blows a rock up with a velocity of 160 feet/sec. The height of the rock is given by $h(t)=160t-16t^2$ where "h" is measured in feet and "t" in seconds. Find
   a) The equation that gives the velocity of the rock at any time
   b) The time when the velocity is zero
   c) The height of the rock when the velocity is zero (maximum height)
   d) The times (on the way up and on the way down) when the height is 256 feet
   e) The velocities of the rock when the height is 256 feet
   f) The equation that gives the acceleration of the rock at any time
   g) How long does it take the rock to fall back down?

a) $V=160-32t$
b) $t=5sec$
c) 400 m
d) 2 times
e) $v=96$ $v=-96$
f) $a=-32$ g) 10 sec.

4. A baseball is thrown upward while being in the moon (hypothetically), with an initial velocity of 24 meters/second. The height of the ball is given by $s=24t-0.8t^2$
   a) Find the equations of velocity and acceleration at any time
   b) How long does it take the ball to reach its maximum height?
   c) Find the maximum height of the ball
   d) How long was the ball in the air?

a) $v=24-1.6t\ m/s$ $a=-1.6\,m/s^2$
b) $t=15s$
c) 180 m
d) 30s

5. The position of an object is given by $S(t)=t^3-6t^2+9t$ where "t" is measured in seconds and "s" in meters
   a) Find the equations of velocity and acceleration as a function of time
   b) Find the time when the velocity is zero
   c) Find the acceleration when the velocity is zero
   d) Find the time when the acceleration is zero and then give the velocity at that time.

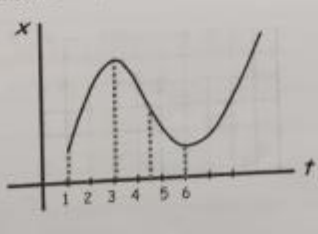
a: $v=3t^2-12t+9$ $a=6t-12$
b): $t=5$ $t=1$
c $=0$ 1/2

6. The height of a certain tree (starting from being 1 year old) is modeled by $H(t)=5\sqrt{t^3}+2t^2+10$, where height is measured in cm and time in years

Find:
   a) The height of the tree in its 5th year (hint t=4)
   b) The function that models the rate of change of its height
   c) The rate of change when t=4
   d) The rate of change when t=9
   e) When is the tree growing faster? at t=4 or t=9 years? Why?

a) 82
b) $\frac{15}{2}t^{1/2}+4t$
c) 31
d) 58.5

CHALLENGE: The following graph shows the position of a particle that moves along a straight line (author: Lic. Norma Patricia Salinas Martinez).



a) In which interval or intervals is the velocity of the particle positive?
b) In which interval or intervals is the velocity of the particle negative?
c) In which interval or intervals of time is the position increasing faster?
d) In which interval or intervals of time is the position increasing slower?
e) In which interval or intervals of time is the position decreasing faster?
f) In which interval or intervals of time is the position decreasing slower?
g) In which interval or intervals of time is the velocity increasing?
h) In which interval or intervals of time is the velocity decreasing?

1/2 a) 1-3, 6-∞
b) 3-6
c) ~~6-∞~~
d) 1-3
e) 3-4.5
f) 4.5-6
g) 4.5-+∞
h) 1-4.5

*answers in procedure sheet!!

① a) $v'(t) = -2t + 80$
$v'(t) = 76 m/s$

b) $a'(t) = -2$

c) $0 = -2t + 80$
$t = 40s$

$s(t) = 80(40) - (40)^2$
$s(t) = 1,600m$

② a) $v'(t) = 3 - \frac{48}{(t+1)^2}$
$v'(t) = -2.33 m/s$

b) $a(t) = \frac{96}{(t+1)^3}$
$a(t) = 3.55 m/s^2$

c) $0 = 3 - \frac{48}{(t+1)^2}$
$t =$

$s(t) = 3t + \frac{48}{t+1}$

③ a) $v(t) = -32t + 160$

b) $0 = -32t + 160$
$-160 = -32t$
$5_s = t$

c) $h'(t) = 160(5) - 16(5)^2$
$800 - 400$
$h'(t) = 400ft$

d) $256 = 160t - 16t^2$
$-16t^2 + 160t - 256$
$\frac{-160 \pm \sqrt{(160)^2 - 4(-16)(-256)}}{2(-16)}$
$\frac{-160 \pm \sqrt{25,600 - 16,384}}{-32}$
$\frac{-160 \pm \sqrt{9,216}}{-32}$
$\frac{-160 \pm 96}{-32}$
$h(t) = 2, 8$

④ a) $v = 24 - 1.6t$
$a = -1.6$

b) $0 = 24 - 1.6t$
$\frac{-24}{-1.6} = t$
$t = 15s$

c) $s = 24t - 0.8t^2$
$s = 24(15) - 0.8(15)^2$
$s = 360 - 180$
$s = 180m$
$t:$

d) 30s

Mead.