#19 $h(t) = 1000 - 16t^2$

$h'(t) = -32t$ $\quad \Delta t = 5.7 - 5 = .7$

$\Delta h \approx h'(5)\Delta t = -32(5)(.7)$

$= -112 ft$

#20 $E(M) = 25{,}000 \cdot 10^{1.5t}$ $\quad 7 \to 7.5$

$\Delta M = 7.5 - 7 = .5$, $t = 7$

$\Delta E \approx E'(7)\Delta M = 25 \cdot 10^3 (1.5) 10^{1.5(7)} \ln 10 (.5)$

$\approx 1.365 \times 10^{15} J.$

#21 $P(t) = \dfrac{100t}{t+1}$

a) $t \in [0, 8]$

average rate of change of $P(t)$

$= \dfrac{P(8) - P(0)}{8 - 0}$

$= \dfrac{800/9 - 0}{8}$

$= \dfrac{100}{9}$ cells/wk

b) $P' = \dfrac{100t + 100 - 100t}{(t+1)^2} = \dfrac{100}{(t+1)^2} = \dfrac{100}{9}$

$\Rightarrow (t+1)^2 = 9$

$t + 1 = 3$

$t = 2$ weeks

#22 a) 500 → 515 cm. 10 AM → 3 PM

average rate of change = $\frac{515-500}{5} = \underline{3 \text{ cm/hr}}$

b) $3 \frac{\text{cm}}{\text{hr}} \cdot \frac{10 \text{ mm}}{1 \text{ cm}} \cdot \frac{1 \text{ hr}}{3600 \text{ sec}} = \frac{1}{120}$ mm/sec

The mean Value Theorem tells us that sometimes between 10:00 AM & 3:00 PM, there will be a time when the instantaneous growth rate is exactly $\frac{1}{120}$ mm/sec

#23 $f(x) = 3x^3 - 4x^2 + 1$

$$\begin{array}{r|rrrr} & 3 & -4 & 0 & 1 \\ 1 & & 3 & -1 & -1 \\ \hline & 3 & -1 & -1 & 0 \end{array}$$

by inspection, $x = 1$ (root)

$f(x) = (x-1)(3x^2 - x - 1)$

we apply Newton's method to $g(x) = 3x^2 - x - 1$

$g(0) = -1$ $\quad g'(x) = 6x - 1$
$g(1) = 1$

n	x_n	$f(x_n)$	$f'(x_n)$	$x_{(n+1)}$
0	0	-1	-1	-1
1	$-1.$	3	-7	$-.57$
2	$-.5714287$	.5510204	-4.428571	$-.4470046083$
3	$-.44700$			
4	$-.434390$			
5	$-.434258$			
6	$-.43425 85459$			

$\underline{x = -.4342585459}$

$x_n = 1 \rightarrow \underline{x = .7675918792}$