3) x, $S-x$ $\quad \left[\frac{S}{2}, \frac{S}{2}\right]$ $\quad \frac{2S}{2} - \frac{S}{2} = \frac{1S}{2}$

$P(x) = x(S-x)$

$= Sx - x^2$

$P'(x) = S - 2x$

$0 = S - 2x$

$2x = S$

$x = \frac{S}{2}$

$P''(x) = -2$ max by 2nd deriv test

5) x, $\frac{147}{x}$

21 | 7

$S(x) = x + 3\left(\frac{147}{x}\right)$

$S(x) = x + \frac{441}{x} = x + 441x^{-1}$

$S'(x) = 1 - \frac{441}{x^2}$

$\frac{441}{x^2} = 1$

$441 = x^2$

$21 = |x|$

min

1st deriv test

$F'(20) = -$

$F'(21) = 0$

$F'(22) = +$

19) Q_0

$\frac{dQ_0}{dx} = kx(Q_0 - x) = Q_0kx - kx^2$

$0 = kx$

$x = 0$

$0 = Q_0 - x$

$x = Q_0$ max

2nd deriv test

$\frac{d^2Q_0}{dx^2} = Q_0k - 2kx \Big|_{x=0} = Q_0k$ or $\Big|_{Q_0} Q_0k - 2Q_0k = -Q_0k$

min $\quad$ max

23) $V = lwh$

$V = x^2\left(\frac{150 - 2x^2}{4x}\right)$

$V = \frac{75x - x^3}{2}$

$\frac{dV}{dx} = \frac{75 - 3x^2}{2}$

$0 = \frac{75 - 3x^2}{2}$

$3x^2 = 75$

$x^2 = 25 \quad |x| = 5$

$SA = 2xy + 2yz + 2xz$

but $x = y$

$SA = 2x^2 + 2xz + 2xz$

$150 = 2x^2 + 4xz$

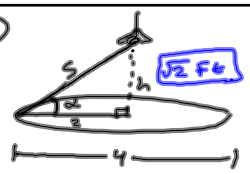
$\frac{150 - 2x^2}{4x} = z$

$\frac{150 - 2(25)}{20} = z$

$\frac{100}{20} = z$

$5 = z$

47)



$\sqrt{2}$ ft

$I = \frac{k\sin\alpha}{s^2} = \frac{k\sin\alpha}{h^2+4}$

$I = \frac{k}{h^2+4} \cdot \frac{h}{s}$

$s^2 = h^2 + 2^2$

$s = \sqrt{h^2+4}$

$I = \frac{hk}{(h^2+4)\sqrt{h^2+4}}$

$\frac{dI}{dh} = \frac{k\sqrt{(h^2+4)} - hk\frac{2}{2}(h^2+4)^{-\frac{1}{2}}(2h)}{\sqrt{(h^2+4)}^5}$

$I = \frac{hk}{\sqrt{(h^2+4)^3}} = \frac{hk}{(h^2+4)^{\frac{3}{2}}}$

$0 = k(h^2+4) - 3h^2k$

$0 = h^2k + 4k - 3h^2k$

$0 = k(-2h^2+4)$

$2h^2 = 4$

$h^2 = 2$

$h = \pm\sqrt{2}$

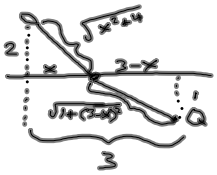
1st deriv Test

$F'(1) = \frac{k(5)-3k}{\sqrt{5}^5} = +$

$F'(\sqrt{2}) = 0$

$F'(2) = \frac{8k-12k}{\sqrt{8^5}} = -$

49)



row 2mph
walk 4mph

$d = rt$

$\frac{d}{r} = t$

$t = \frac{\sqrt{x^2+4}}{2} + \frac{\sqrt{1+(3-x)^2}}{4}$

$4t = 2\sqrt{x^2+4} + \sqrt{10-6x+x^2}$

$\frac{4}{4}\frac{dt}{dx} = \frac{2(2x)}{4\sqrt{x^2+4}} + \frac{2x-3}{4\sqrt{10-6x+x^2}}$

$\frac{dt}{dx} = \frac{2x}{4\sqrt{x^2+4}} + \frac{x-3}{4\sqrt{10-6x+x^2}}$

$0 = \frac{2x\sqrt{10-6x+x^2} + (x-3)\sqrt{x^2+4}}{4\sqrt{x^2+4}\sqrt{10-6x+x^2}}$

$[(3-x)\sqrt{x^2+4}]^2 = [2x\sqrt{10-6x+x^2}]^2$

$(3-x)^2(x^2+4) = 4x^2(10-6x+x^2)$

$(9-6x+x^2)(x^2+4) = 40x^2-24x^3+4x^4$

$9x^2-6x^3+x^4+36-24x+4x^2 = 40x^2-24x^3+4x^4$

$0 = 3x^4-18x^3+27x^2+24x-36$

$0 = x^4-6x^3+9x^2+8x-12$

From Graph: $x = 1, -1.112$

Since domain $[0,3]$, $\boxed{x=1}$