

HW 3.9

3.9.20: $V = \frac{1}{3} \pi h (a^2 + ab + b^2)$ $a = 20$ $b = \frac{h}{4} + 20$

$$V = \frac{1}{3} \pi h \left(400 + 5h + 400 + \frac{h^2}{16} + 10h + 400 \right)$$

$$= \frac{1}{3} \pi \left(1200h + 15h^2 + \frac{h^3}{16} \right) \quad \text{When } h=30, \frac{dV}{dt} = 2000$$

$$\frac{dV}{dt} = \frac{1}{3} \pi \left(1200 \frac{dh}{dt} + 30h \frac{dh}{dt} + \frac{3h^2}{16} \left(\frac{dh}{dt} \right) \right) = 2000$$

$$\frac{1}{3} \pi \left(1200 \frac{dh}{dt} + 900 \frac{dh}{dt} + \frac{2700}{16} \frac{dh}{dt} \right) = 2000$$

(Solving this) $\Rightarrow \frac{dh}{dt} = \frac{320}{121\pi}$ cm/min

3.9.24: $V = \pi h^2 \left(r - \frac{h}{3} \right)$ $r = 20$
 $= \pi h^2 \left(20 - \frac{h}{3} \right) = 20\pi h^2 - \frac{\pi}{3} h^3$

$$\frac{dV}{dt} = 40\pi h \cdot \frac{dh}{dt} - \frac{3\pi}{3} h^2 \frac{dh}{dt}$$

At 7:00 am, $h = 15$, $\frac{dh}{dt} \approx -3 \Rightarrow \frac{dV}{dt} = 40\pi(15)(-3) - \pi(225)(-3)$
 $\frac{dV}{dt} \approx -1125\pi \approx -3534$

Webster City residents used water at the rate of $2400 + 3534 = 5934 \text{ ft}^3/\text{h}$