Section 3.2

#3: $V(t)$ = volume in L of nitric acid in tank.

$$\frac{dV}{dt} = \left(6\ L/min\right)\left(.20\ L/L\right) - \left(8\ L/min\right)\left(\frac{V(t)}{200-2t}\ \frac{L}{L}\right)$$

↑ % is unitless

exactly because it is described by a portion of a whole - but both the portion and the whole have the same units!

$$\Rightarrow \frac{dV}{dt} = 1.2 - \frac{4V}{100-t}, \quad V(0) = (0.005)(200\ L) = 1\ L$$

$$\Rightarrow \frac{dV}{dt} + \left(\frac{4}{100-t}\right)V = 1.2, \quad \text{let } y(t) = e^{\int \frac{4}{100-t}dt} \quad -4\ln|100-t| = e$$

$$= (100-t)^{-4}$$

$$\Rightarrow \frac{d}{dt}\left((100-t)^{-4}V\right) = 1.2(100-t)^{-4}$$

$$(100-t)^{-4}V = +0.4(100-t)^{-3} + C$$

$$V = 0.4(100-t) + C(100-t)^4$$

since $V(0)=1 \Rightarrow 1 = 40 + C(100)^4 \Rightarrow C = \frac{-39}{(100)^4} = \frac{-39}{10^8} = -39\times10^{-8}$

So $V(t) = 0.4(100-t) + (-39\times10^{-8})(100-t)^4$

Find t so that $\frac{V(t)}{200-2t} = 0.1 \Rightarrow V(t) = 0.2(100-t)$

$$\Rightarrow -0.2(100-t) = (-39\times10^{-8})(100-t)^4 \Rightarrow \frac{0.2}{39\times10^{-8}} = (100-t)^3$$

$$\boxed{t = \sqrt[-3]{\frac{0.2}{39\times10^{-8}}} + 100}$$ ← time when % in tank is 10%.