Quiz #4 Newton's Law

$T_m = 100$

$T(0) = 20$ ←

$T(1) = 22$ ←

1.

$$\frac{dT}{dt} \propto T - T_{in} \rightarrow \frac{dT}{dt} = k(T - T_{in})$$

$$\frac{dT}{dT} = k(T-100)$$

$$\int \frac{dT}{T-100} = \int k\,dt$$

$$\ln(T-100) = kt + C_1$$

$$T = 100 + Ce^{kt}$$

$$T = 100 - 80e^{kt}$$

$20 = 100 + Ce^{k(0)}$

$20 = 100 + C$

$C = -80$

$22 = 100 - 80e^{k(1)}$

$\frac{100-22}{80} = e^{k}$

$k = -0.025318$

$90 = 100 - 80e^{-.025318t}$

$\frac{100-90}{80} = e^{-.025318t}$

$t = 82$ sec

* time take on to reach 90

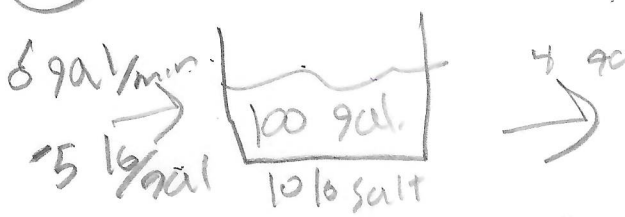
$98 = 100 - 80e^{-.025318t}$

$\frac{100-98}{80} = e^{-.025318t}$

$t = 145.7$ sec

* + time taken to reach 90

2. (Quiz 4) Noor Mojtaba



$\cdot 1 \frac{lb}{gal}$

$$\frac{dA}{dt} = R_{in} - R_{out} \qquad A(0) = .1$$

$$\frac{dA}{dt} = 6(.5) - 4(A) = 3 - 4A$$

$$\int \frac{dA}{3-4A} = \int dt$$

$$\frac{\ln(3-4A)}{-4} = t + C$$

$$\ln(3-4A) = -4t + C$$

$$3 - 4A = Ke^{-4t}$$

$$A = \frac{3}{4} + Ke^{-4t}$$

$$.1 = 3/4 + K$$

$$K = -.65$$

$$A = 3/4 + .65e^{-4t}$$

$$A = .75 - .65e^{-4(30)}$$

$$A = .75 \text{ lb/gal}$$

$100 + (6-4)\cdot t = \text{gal}_{\text{total}}$

160 gal

* for 30 minutes: 1 lb of salt = 120 lb

$100 + 2t = 200$ * tank overflow

$t = 50$ minutes

$A = .75$

150 lb of salt * when tank overflow

(continues on next page)

Quiz 4 | poor mixture

2.

After 2 hours

$t = 120 \quad A = .75$

$100 + 2t = 340$ gal

$340 \times .75 =$ 255 lb of salt

Quiz 4 Nour Mutlaq

(3)

$a(0) = 40$

$b(0) = 50$

$$\frac{dx}{dt} \propto \left[40 - \frac{2}{1+2}x\right]\left[50 - \frac{1}{1+2}x\right]$$

$x(5) = 10$

$x(0) = 0$

$$\frac{dx}{dt} = k\left[40 - \tfrac{2}{3}x\right)\left[50 - \frac{1}{3}x\right)$$

$$= k\left(\tfrac{2}{3}\right)\left(\tfrac{1}{3}\right)[60 - x][150 - x$$

$$\frac{dx}{dt} = k[60 - x][150 - x)$$

$$\int \frac{dx}{(60-x)(150-x)} = \int k\,dt$$

$$kt + C_1$$

$$\int \left(\frac{A}{60-x} + \frac{B}{150-x}\right)dx = \int k\,dt$$

continued

Quiz 4 Nour Mustafa

#3

$$-\frac{1}{90}\ln(60-x)+\frac{1}{90}\ln(150-x)=kt+C$$

$$-\ln(60-x)+\ln(150-x)=kt+C$$

$$\ln\left[\frac{150-x}{60-x}\right]=kt+C$$

$$\frac{150-x}{60-x}=Ce^{kt} \rightarrow x(0)=0$$

$$\rightarrow \frac{150}{60}=C \rightarrow 5/2=C$$

$x(5)=10$

$$\frac{150-10}{60-10}=\frac{5}{2}e^{k(5)}$$

$$\frac{140}{50}\cdot\frac{2}{5}=e^{k(5)}$$

$$\frac{\ln(1.12)}{5}=k$$

$$k=.02267$$

(Quiz 4) No or mistakes

#3

$$\frac{150 - x}{60 - x} = \frac{5}{2} e^{.02267t}$$

How much is formed in 20 minutes?

$$\frac{150 - x}{60 - x} = N \qquad 150 - 60N = x(1 - N)$$

$$150 - x = 60N - Nx \qquad x = \frac{150 - 60N}{1 - N}$$

$$N = 3.934133805$$

$$x = \frac{150 - 60N}{1 - N} \rightarrow \text{29-33 grams}$$

$N = \frac{5}{2} e^{.02267 \cdot 20}$

Quiz 4 (near misfire)

(3) find limiting amount

setting $\frac{dQ}{dt} = 0$

setting derivative equal to zero

$Q = k[60-x][150-x]$

$x = 60, 150$

only 60 g of C because you can only use up to 60 g for C.

How much of chemical A or B remain after a long time?

$$-40\text{ g A} + 20\text{ g B} \rightarrow 60\text{ g C}$$

40 A, 50 A

-40 A, -20 b

0 A, $+30$ b $= 60$

0 g A 30 g B → remaining

~~100 g A + 50 g B~~

Not possible to get 100 g of A because the most grams of A we can have is 40 grams when B has only 50 grams.