**1.)**

$$\frac{\partial T}{\partial t} \propto T - T_{in} \rightarrow \frac{\partial T}{\partial t} = k(T - t_{in})$$

$$\frac{\partial T}{\partial T} = K(T - 100)$$

$$\int \frac{dT}{T - 100} = k \partial t$$

$$\ln(T - 100) = kt + c_1$$

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

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

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

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

$$t = 82 \sec$$

✗ time taken to reach 900

$T_M = 100$
$T(0) = 20$
$T(1) = 22$

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

$$20 = 100 + c$$

$$c = -80$$

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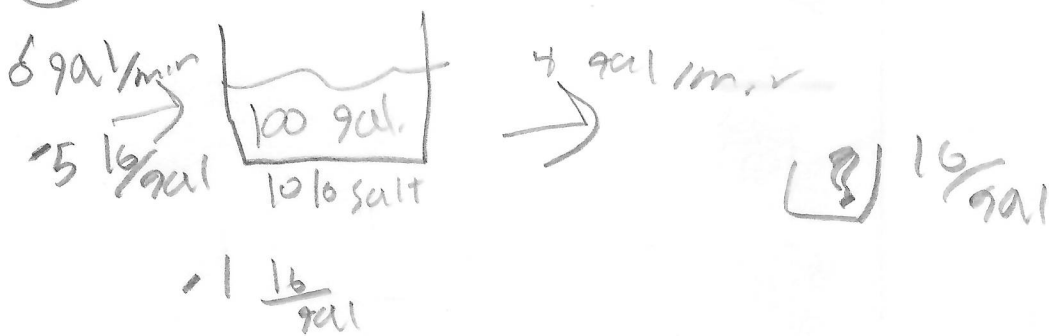
$$\frac{100 - 22}{80} = e^k$$

$$k = -0.025318$$

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

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

$$t = 145.7 \sec$$

✗ time taken to reach 900

2.

(Quz 4) Mixer mixture

6 gal/min → | 100 gal. |  → 4 gal/min
.5 lb/gal      | 100 salt |

[3] $\frac{lb}{gal}$

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

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

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

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

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

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

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

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

$$.1 = \frac{3}{4} + K$$

$$\boxed{K = -.65}$$

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

$$A = .75 - .65e^{-4(30)}$$
$$A = .75 \frac{lb}{gal}$$

$$100 + (6-4) \cdot t = gal \text{ total}$$
$$160 \, gal$$

#for
30 minutes

$\boxed{lb \text{ of salt} = 120 \, lb}$

$$100 + 2t = 200$$ ⟵ tank overflow

$$\boxed{t = 50 \text{ minutes}}$$

$$A = .75$$
$$\boxed{150 \, lbs \text{ of salt}}$$ ⟵ when tank overflows

2.

$t = 120$   $A = .75$

$\otimes$ After 2 hours

$$100 + 2t = 340 \text{ gal}$$

$$340 \times .75 = 255 \text{ lb of salt}$$

3

$$a(0) = 40$$
$$b(0) = 50$$

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

$$X(5) = 10$$
$$X(0) = 0$$

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

$$= K \left( \frac{2}{3} \right) \left( \frac{1}{3} \right) \left[ 60 - x \right] \left[ 150 - x \right.$$

$$\frac{dx}{dt} = K \left[ 60 - x \right] \left[ 150 - x \right]$$

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

$$K t + c_1$$

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

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

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

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

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

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

$$x(5)=10$$

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

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

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

$$k = .02267$$

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

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How much is formed in 20 minutes?

$$\frac{150-x}{60-x} = \boxed{N}$$

$$150 - 60N = X(1-N)$$

$$150 - X = 60N - Nx$$

$$X = \frac{150-60N}{1-N}$$

$$N = 3.934138705$$

$$X = \frac{150-60N}{1-N} \longrightarrow \boxed{29.33 \text{ grams}}$$
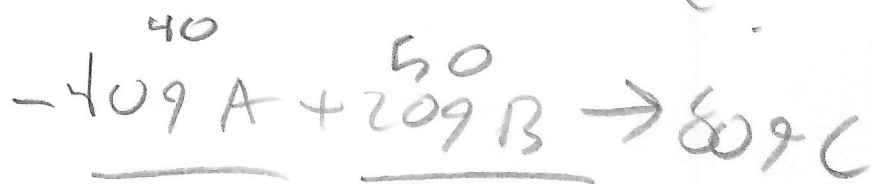
③ find limiting
amount

$$0 = K [60-x][150-x]$$

$$\boxed{x = 60, 150}$$

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

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How much of chemical A as to remain
after a long time?

$$\underline{\overset{40}{-40g} A + \overset{50}{20g} B} \rightarrow 60g C$$

$$\underline{0g A \quad\quad 30g B} \rightarrow \text{remaining}$$

~~$\underline{100g A + 50g B}$~~