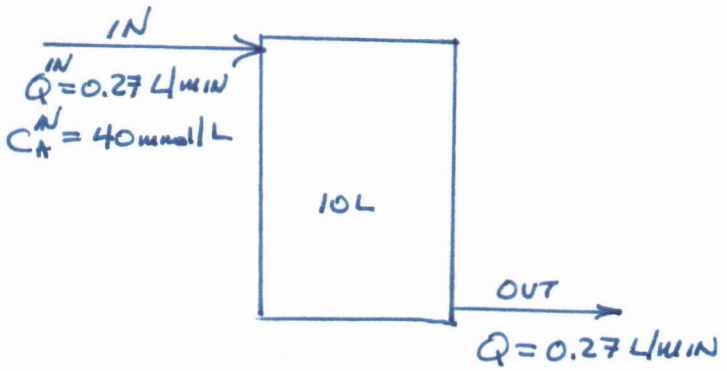
(33)



$R_A = -kC_A \quad k = 0.070\ min^{-1} \quad A \rightarrow B$

i) "A" BALANCE

$ACC = IN - OUT + GEN$

$0 = QC_A^{IN} - QC_A - kC_A V$

$0 = (0.27)(40) - 0.27C_A - (0.070)C_A(10)$

$C_A = 11.13\ mmol/L$

"B" BALANCE

$ACC = IN - OUT + GEN$

$0 = 0 - QC_B + kC_A V$

$0 = -0.27C_B + (0.07)(11.13)(10)$

$C_B = 28.86\ mmol/L$

ii) $k' = 0.035\ min^{-1}$

"A" BALANCE

$ACC = IN - OUT + GEN$

"A" 50% INCREASE

$C_A^{final} = 1.5(11.13)$

$= 16.70$

$V\frac{dC_A}{dt} = QC_A^{IN} - QC_A - k'C_A V$

$\frac{dC_A}{dt} = \frac{Q}{V}C_A^{IN} - \frac{Q}{V}C_A - k'C_A$

$\frac{dC_A}{dt} = \left(\frac{0.27}{10}\right)(40) - \left(\frac{0.27}{10}\right)C_A - 0.035C_A$

$\frac{dC_A}{dt} = 1.08 - 0.062C_A$

$$\int_{11.13}^{16.70} \frac{dC_A}{1.08 - 0.062C_A} = \int_0^t dt$$

$$-\frac{1}{0.062}\ln\left[\frac{1.08-0.062(16.695)}{1.08-0.062(11.13)}\right]=t$$

$$t = 34.9 \text{ min}$$

ii) "A" BALANCE

$$ACC = IN - OUT + GEN$$

$$0 = Q C_A^{IN} - Q C_A - k C_A V$$

$$0 = (0.27)(40) - 0.27 C_A - 0.035 C_A (10)$$

$$C_A = 17.42 \text{ mmol/L}$$

iv) $A \rightarrow B \rightarrow C$

$$R_A = -k C_A$$

$$R_B = +k C_A - k_2 C_B$$

$C_B = 11.00$ mmol/L (EXPECTED 28.86 mmol/L)

NOTE: CONCENTRATION OF "A" IN EFFLUENT DOES NOT CHANGE

"B" BALANCE

$$ACC = IN - OUT + GEN$$

$$0 = 0 - Q C_B + k C_A V - k_2 C_B V$$

$$C_B = \frac{k C_A V}{Q + k_2 V}$$

$$11.0 = \frac{(0.070)(11.13)(10)}{0.27 + k_2 (10)}$$

$$k_2 = 0.0438 \text{ min}^{-1}$$

v) "A" BALANCE

ACC = IN - OUT + GEN

$$0 = Q C_A^{IN} - Q C_A - k C_A V$$

$$C_A = \frac{Q C_A^{IN}}{Q + kV}$$

$$C_A = \frac{(0.27)(40)}{0.27 + (0.07)(5)} = 17.42 \text{ mmol/L}$$

"B" BALANCE

ACC = IN - OUT + GEN

$$0 = 0 - Q C_B + k C_A V - k_2 C_B V$$

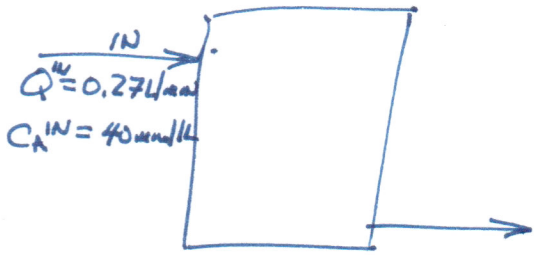
$$C_B = \frac{k C_A V}{Q + k_2 V}$$

$$C_B = \frac{(0.070)(17.42)(5)}{0.27 + (0.0438)(5)}$$

$C_B = 12.47$ mmol/L

YES C_B INCREASED SLIGHTLY FROM 11.0 mmol/L

vi)



a) "A" BALANCE

ACC = IN - OUT + GEN

$$V \frac{dC_A}{dt} = Q C_A^{IN} - Q C_A - k C_A V$$

$$\frac{dC_A}{dt} = \frac{Q}{V} C_A^{IN} - \frac{Q}{V} C_A - k C_A$$

$$\frac{dC_A}{dt} = 2.16 - 0.054 C_A - 0.070 C_A$$

$$\frac{dC_A}{dt} = 2.16 - 0.124 C_A$$

$$\int_{11.13}^{C_A} \frac{dC_A}{2.16 - 0.124 C_A} = \int_0^t dt$$

$$-\frac{1}{0.124}\ln\left[\frac{2.16-0.124\,C_A}{2.16-0.124\,(11.13)}\right] = t$$

@ $t = 10$ min

$$-\frac{1}{0.124}\ln\left[\frac{2.16-0.124 C_A}{0.7799}\right] = 10$$

$$\underline{\underline{C_A = 15.60 \text{ mmol/L}}}$$

b) "B" BALANCE

$$ACC = IN - OUT + GEN$$

$$V\frac{dC_B}{dt} = -QC_B + kC_A V - k_2 C_B V$$

FROM ABOVE $\quad C_A = \dfrac{0.7799e^{-0.124t} - 2.16}{-0.124}$

$$C_A = 17.42 - 6.29\,e^{-0.124t}$$

so $\quad \dfrac{dC_B}{dt} = -\dfrac{Q}{V}C_B + k\left(17.42 - 6.29e^{-0.124t}\right) - k_2 C_B$

$$\boxed{\frac{dC_B}{dt} = -0.0978 C_B + 1.219 - 0.4403e^{-0.124t}}$$

INITIAL CONDITIONS @ $t = 0$

$C_B = 11.0$ mmol/L