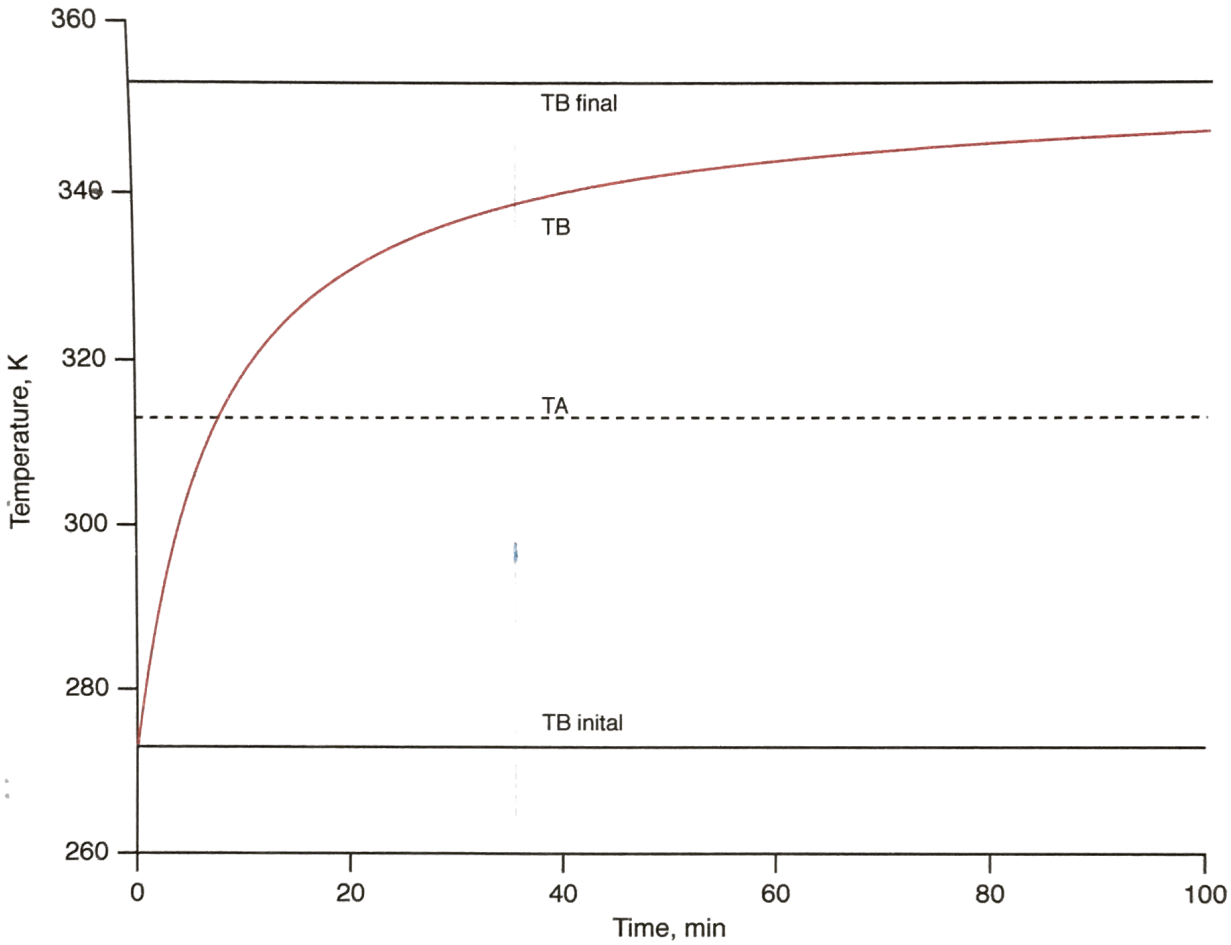
	Answer Sheet	
a)	P_f, MPa	0.794 MPa
	n_f^A, moles	8.18 moles
	n_f^B, moles	6.09 moles
b)	Excess Moles	0.47 moles 8.4% excess
c)	T_f^B, K	353 K
	P_f^B, MPa	1.38 MPa
	n_f^B, moles	8.19 moles
d)	Function: $T_f^B = A + \frac{B}{Ct+1}$	
	A, K	353 K
	B, K	80 K
	C, min^{-1}	0.130 min^{-1}
e)	Time $T_B = T_A$, min	7.69 min


360
340
320
300
280
260
Temperature, K
TB final
TB
TA
TB inital
0
20
40
60
80
100
Time, min

(a) $n_i = \frac{PV}{RT} = \frac{1.38\,MPa\ 2.69e4\,cm^3}{8.31\,\frac{MPa\,cm^3}{K\,mole}\ 313K} = 14.3\,moles$

$n_i = n_A^f + n_B^f$

$n_A = \frac{P_f\ 2.69e4\,cm^3}{8.31\,\frac{MPa\,cm^3}{K\,mole}\ T_A} \qquad n_B = \frac{P_f\ 1.74e4\,cm^3}{8.31\,\frac{MPa\,cm^3}{K\,mole}\ T_B}$

$T_A = 313K \qquad T_B = 273K$

$n_i = 14.3\,moles = P_f\left(10.3\,\frac{mole}{MPa} + 7.67\,\frac{mole}{MPa}\right)$

$P_f = 0.794\,MPa$

$n_A = 0.794\,MPa\ \ 10.3\,\frac{mole}{MPa} = 8.18\,moles$

$n_B = 0.794\,MPa\ \ 7.67\,\frac{mole}{MPa} = 6.09\,moles$

(b) $n_A = n_i \frac{V_A}{V_T} = \frac{14.3\,moles\ 2.69e4\,cm^3}{4.43e4\,cm^3} = 8.68\,moles$

$n_B = n_i \frac{V_B}{V_T} = 14.3\,moles\ \frac{1.74e4\,cm^3}{4.43e4\,cm^3} = 5.62\,moles$

$Excess\ Moles = 6.09\,moles - 5.62\,moles = 0.47\,moles$

8.4% excess

(c) For Tank B $d(nU) = n_f^B U_f^B = H^A\,dn = H^A n_f^B = n_f^B(U^A + PV^A) = n_f^B(U^A + RT^A)$

$(U_f^B - U^A) = C_v(T_f^B - T^A) = RT^A$

$C_p = 8.31R$, $C_v = 7.31R$ i.g.

$T_f^B = \frac{RT^A}{C_v} + T^A = T^A\left(\frac{R}{C_v} + \frac{C_v}{C_v}\right) = T^A\left(\frac{C_p}{C_v}\right)$

$T_f^B = 313K\left(\frac{8.31R}{7.31R}\right) = 353K$

$P_f = 1.38\,MPa$

$n_f^B = \frac{P_f V^B}{R\,T_f^B} = \frac{1.38\,MPa\ 1.74e4\,cm^3}{8.31\,\frac{MPa\,cm^3}{K\,mole}\ 353K} = 8.19\,moles$

(d) $d(nU)^B = H^A dn = n^B dU^B + U^B dn^B$

$dn = \left(\frac{dn}{dt}\right) dt \qquad \left(\frac{dn}{dt}\right) = 0.1 \frac{mole}{min} = \dot{n}$

$= \dot{n}\, dt$

$(H^A - U^B)\, dn = n^B dU^B$

$(H^A - H^B + (PV)^B)\, dn = n^B C_V\, dT^B$

$(C_p(T^A - T^B) + RT^B)\, dn = n^B C_V\, dT^B$

$n^B = n_i^B + \left(\frac{dn}{dt}\right) t$

both dn^B & n^B are functions of time

$$\frac{\dot{n}\, dt}{(n_i^B + \dot{n}\, t)} = \frac{C_V\, dT^B}{C_p T^A + T^B(R - C_p)}$$

$y = n_i^B + \dot{n}\, t$

$dy = \dot{n}\, dt$

$x = C_p T^A + T^B(R - C_p)$

$dx = (R - C_p)\, dT^B$

$$\ln \frac{\dot{n} t_f + n_i^B}{\dot{n} t_i + n_i^B} = \frac{C_V}{(R - C_p)} \ln \frac{C_p T^A + T_f^B (R - C_p)}{C_p T^A + T_i^B (R - C_p)}$$

$t_i = 0 \qquad C_p = C_V + R$

$$\frac{\dot{n} t_f + n_i^B}{n_i^B} = \left(\frac{C_p T^A + T_f^B (R - C_p)}{C_p T^A + T_i^B (R - C_p)}\right)^{-1}$$

$$\frac{\dot{n} t_f}{n_i^B} + 1 = \frac{C_p T^A - T_i^B (C_V)}{C_p T^A - T_f^B C_V}$$

$$\boxed{T_f^B = \frac{C_p}{C_V} T^A + \frac{T_i^B - (C_p/C_V) T^A}{\left(\frac{\dot{n}}{n_i^B}\right) t + 1}}$$

$$T_f^B = \left(\frac{8.85R}{7.85R}\right)313K + \frac{333K - \left(\frac{8.85R}{7.85R}\right)313K}{\left(\frac{0.1\ mole/min}{0.767\ moles}\right)t + 1}$$

$$n_i^B = \frac{PV}{RT} = \frac{0.1\ atm \cdot 1.74\ cm^3}{8.31\ \frac{atm\ cm^3}{mole\ K} \cdot 273K} = 0.767\ moles$$

$$T_f^B = 353K + \frac{273K - 353K}{\left(0.130\frac{1}{min}\right)t + 1}$$

$$T_f^B = 353K - \frac{80K}{\left(0.130\frac{1}{min}\right)t + 1}$$

$T_f^B = 313K$ at $7.69\ min$

(using solver in excel)

or

$$\frac{\left(\frac{80K}{353K - 313K}\right) - 1}{\left(0.130\ 1/min\right)} = 7.69\ min$$