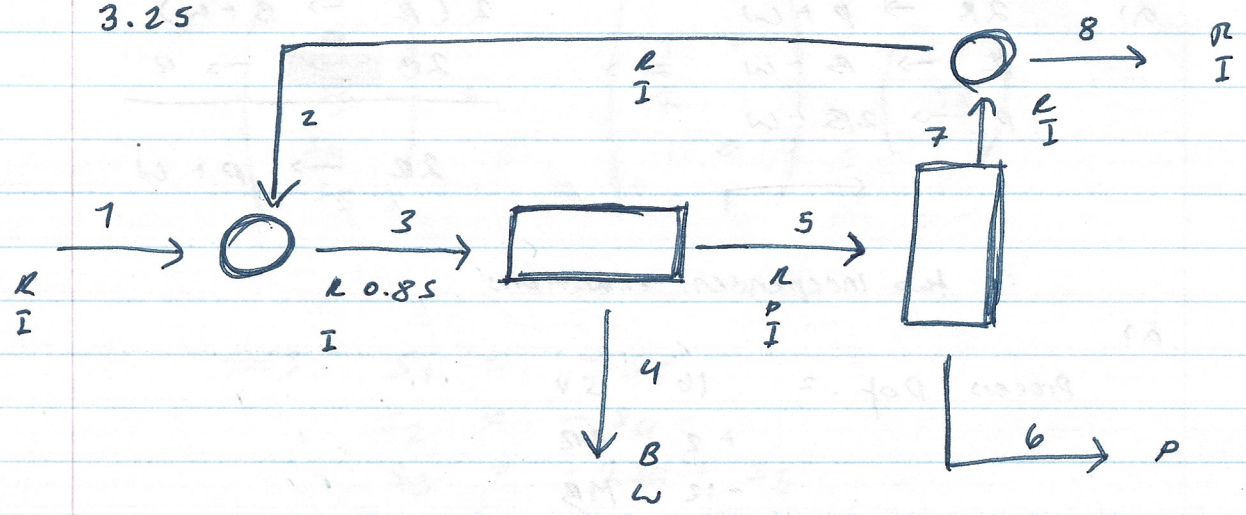
3.25



(SR1) $\frac{n_1'}{n_2'} = \frac{1}{11}$

(SR2) 50% conversion

$$n_R^8 = 0.5\, n_R^1$$

(SR3) 80% yield

$$0.8 = \frac{n_P^6}{R_{PR}^{max}}$$

→ when all reacted R is allocated to P

→ amount converted = 50%

2R for 1 P

$$0.8 = \frac{n_P^6}{\frac{1}{4} n_R^1}$$

(SR4) splitter ratio, $w_R^8 = w_R^7$

a) $2R \rightarrow P + W$

$R \rightarrow B + W$ $\Rightarrow$ $2(R \rightarrow B + W)$

$P \rightarrow 2B + W$ $\quad 2B + W \rightarrow P$

$2R \rightarrow P + W$

$\therefore$ two independent reactions

a)

Process Dof = 16 SV

+ 2 RR

- 12 MB

- 1 SSU

- 4 SR

1

- 1 (basis)

0

$\rightarrow$ process is correctly specified if we prescribe a basis

- let $N' = 100$ mol/h

b) · does not change Dof of process

$\rightarrow$ only two independent reactions so the absence of the third reaction would not have given more information

c)

	Mixer	Reactor	Seperater	Splitter	OB
SV	6	7	6	6	7
RR	—	+2	—	—	+2
MB	-2	-5	-3	-2	-5
SSV	-1	-1	-0	-0	-0
SR	-1	-0	-0	-1	-3
DoF	2	3	3	3	1
				(massive)	-1
					0

• solving the OB

• we get n_W^4 ; n_B^4, $N^8(r_1, r_2, N^4, N^6)$

• can solve reactor

Mixer	Reactor	Seperator	Splitter	OB
2	1	2	1	0

• can combine reactor + seperator + splitter into one CV

	Reactor + Seperator + Splitter
SV	9
RR	+2
MB	-5
SSV	-4
SR	-2
DoF	0

• solve reactor + seperator + splitter

• get N^3, N^2

Mixer	Reactor	Seperator	Splitter	OB
0	0	0	0	0

• solve for N^7, N^5

d) • let $N^1 = 100$ mol/h

(SR 7) $$\frac{n_1^1}{n_R^1} = \frac{1}{11}$$

$$N^1 = n_R^1 + n_1^1$$

$$100 = 12\, n_1^1$$

$$n_1^1 = 8.33 \text{ mol/h} = n_1^8$$

(SR 2) $$n_R^1 = 91.67 \text{ mol/h} = \frac{1}{2} n_R^8$$

$$\Rightarrow n_R^8 = 45.83$$

(SR 3) $$0.80 = \frac{n_P^6}{\frac{1}{4} n_R^1}$$

$$n_P^6 = 18.33 \text{ mol/h} = r_1$$

$$= N^6$$

• total balances:

$$n_W^4 = r_1 + r_2 \quad \Rightarrow \quad r_2 = n_W^4 - r_1$$

$$n_B^4 = r_2$$

$$n_R^1 - n_R^8 - 2r_1 - r_2 = 0$$

$$45.833 = 2r_1 + r_2$$

$$45.833 = 2r_1 + n_W^4 - r_1$$

$$n_W^4 = 27.503$$

$$r_2 = 9.17 \text{ mol/h} = n_B^4$$

$$N^4 = n_W^4 + n_B^4$$

$$= 36.676 \text{ mol/h}$$

Reactor + Seperator + Splitter

· stream 8

$$\omega_R^8 = \frac{n_R^8}{n_R^8 + n_I^8}$$

$$= 0.846 = \omega_R^7 = \omega_R^2$$

$$\omega_I^8 = 0.154 = \omega_I^7 = \omega_I^2$$

· total balance

$$0.85N^3 - 0.846N^2 = n_R^8 + 2r_1 + r_2$$

$$0.15N^3 - 0.156N^2 = n_I^8$$

$\Vert$ MATLAB

$$N^2 = 1733.33 \text{ mol/h}$$

$$N^3 = 1833.33 \text{ mol/h}$$

$$\Rightarrow 0.15N^3 = 0.156N^7$$

$$N^7 = 1787.50 \text{ mol/h}$$

$$= N^5 + N^6$$

$$\Rightarrow N^5 = 1769.17 \text{ mol/h}$$

4.25

$$A = \begin{array}{c} \\ e_1 \\ e_2 \\ e_3 \\ e_4 \end{array} \begin{array}{c} \begin{array}{ccccc} s_1 & s_2 & s_3 & s_4 & s_5 \end{array} \\ \begin{pmatrix} 1 & 0 & 1 & 2 & 0 \\ 1 & 0 & 0 & 0 & 1 \\ 3 & 2 & 1 & 4 & 2 \\ 0 & 1 & 0 & 1 & 0 \end{pmatrix} \end{array}$$

$$\rightarrow \begin{array}{r} \\ -R_1 \\ -3R_1 \\ \\ \end{array} \begin{array}{c} \begin{array}{ccccc} & & & & \end{array} \\ \begin{pmatrix} 1 & 0 & 1 & 2 & 0 \\ 0 & 0 & -1 & -2 & 1 \\ 0 & 2 & -2 & -2 & 2 \\ 0 & 1 & 0 & 1 & 0 \end{pmatrix} \end{array} \begin{array}{l} e_1 \\ e_2 \\ e_3 \\ e_4 \end{array}$$

$$\rightarrow \begin{array}{r} \\ \\ -2R_4 \\ \\ \end{array} \begin{array}{c} \begin{array}{ccccc} & & & & \end{array} \\ \begin{pmatrix} 1 & 0 & 1 & 2 & 0 \\ 0 & 0 & -1 & -2 & 1 \\ 0 & 0 & -2 & -4 & 2 \\ 0 & 1 & 0 & 1 & 0 \end{pmatrix} \end{array} \begin{array}{l} e_1 \\ e_2 \\ e_3 \\ e_4 \end{array}$$

$$\rightarrow \begin{array}{r} \\ \\ \div 2 \\ \\ \end{array} \begin{array}{c} \begin{array}{ccccc} & & & & \end{array} \\ \begin{pmatrix} 1 & 0 & 1 & 2 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & -1 & -2 & 1 \\ 0 & 0 & -1 & -2 & 1 \end{pmatrix} \end{array} \begin{array}{l} e_1 \\ e_4 \\ e_3 \\ e_2 \end{array}$$

$$\rightarrow \begin{array}{r} \\ \\ \times -1 \\ -R_3 \end{array} \begin{array}{c} \begin{array}{ccccc} & & & & \end{array} \\ \begin{pmatrix} 1 & 0 & 1 & 2 & 0 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 2 & -1 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \end{array} \begin{array}{l} e_1 \\ e_4 \\ e_3 \\ e_2 \end{array}$$

$$\rightarrow \begin{array}{r} -R_3 \\ \\ \\ \end{array} \begin{pmatrix} 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 & 0 \\ 0 & 0 & 1 & 2 & -1 \\ 0 & 0 & 0 & 0 & 0 \end{pmatrix} \begin{pmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \\ s_5 \end{pmatrix}$$

rank 3

$\therefore$ Max # rxns $= 5 - 3 = 2$

$$\begin{pmatrix} s_1 \\ s_2 \\ s_3 \\ s_4 \\ s_5 \end{pmatrix} = - \begin{pmatrix} 0 & 1 \\ 1 & 0 \\ 2 & -1 \\ 1 & 0 \\ 0 & 1 \end{pmatrix} \begin{pmatrix} s_4 \\ s_5 \end{pmatrix}$$

$$\Rightarrow \quad \begin{aligned} s_1 &= -s_5 \\ s_2 &= -s_4 \\ s_3 &= -2s_4 + s_5 \\ s_4 &= s_4 \quad \Rightarrow r_1 \\ s_5 &= s_5 \quad \Rightarrow r_2 \end{aligned}$$

$$\Rightarrow \quad s_2 + 2s_3 \longrightarrow s_4$$

$$s_1 \longrightarrow s_3 + s_5$$