Q1

→ 3 reactors are available
→ each can be run on one of 3 settings
→ 359 million lb of chemical total prodⁿ req'd / yr
→ same setting for entire yr for any given reactor.
→ IP to be setup for minimum-cost method for company meeting annual prodⁿ demand.

∴ x_{ij} = reactor i used with setting j

∴ $x_{ij} = 0$, if reactor not being used for prodⁿ with setting
$= 1$, if " " being used " "

a_{ij} = reactor i cost in setting j

p_{ij} = prodⁿ of reactor i in setting j.

here, $\forall i, j = 1, 2, 3$.

and x_{ij} is binary variable

whereas a_{ij} and p_{ij} are known values which we will mention below.

$$\therefore \min z = \sum_{j=1}^{3} \sum_{i=1}^{3} a_{ij} x_{ij}$$

$$\therefore \min z = 50x_{11} + 80x_{12} + 100x_{13} + 65x_{21} + 90x_{22} + 120x_{23} + 70x_{31} + 90x_{32} + 110x_{33}$$

and constraints will be:

$$x_{11} + x_{12} + x_{13} \leq 1$$
$$x_{21} + x_{22} + x_{23} \leq 1$$
$$x_{31} + x_{32} + x_{32} \leq 1$$

∴ any reactor can work in one of three settings only.

$$\text{and } \sum_{i=1}^{3} \sum_{i=1}^{3} p_{ij} x_{ij} \geq 359$$

i.e. $80x_{11} + 140x_{12} + 170x_{13} + 100x_{21} + 140x_{22} + 215x_{23} + 112x_{31} + 153x_{32} + 195x_{33} \geq 359$

for $x_{ij} \in \{0, 1\}$, $\forall i, j = 1, 2, 3$.

note : If suppose question would have also added that all reactor shall be used and operate for the prodⁿ then our first 3 constraints of ≤1 would have changed to =1 and our answer would be different in that case. This case is termed as [B].

* → So, for normal case [A] and above case [B] we can solve this problem in Excel solver for our curiosity and learn that in case (A) our answer would be min z = 210 whereas in case [B] our answer of min z = 225.

[A]

	x11	x12	x13	x21	x22	x23	x31	x32	x33	LHS		RHS
Variable values	0	0	1	0	0	0	0	0	1			
Obj. Fun Coeff	50	80	100	65	90	120	70	90	110	z	=	210
const1 Coeff	1	1	1							1	<=	1
const2 Coeff				1	1	1				0	<=	1
const3 Coeff							1	1	1	1	<=	1
const4 Coeff	80	140	170	100	140	215	112	153	195	365	>=	359

[B]

	x11	x12	x13	x21	x22	x23	x31	x32	x33	LHS		RHS
Variable values	1	0	0	1	0	0	0	0	1			
Obj. Fun Coeff	50	80	100	65	90	120	70	90	110	z	=	225
const1 Coeff	1	1	1							1	=	1
const2 Coeff				1	1	1				1	=	1
const3 Coeff							1	1	1	1	=	1
const4 Coeff	80	140	170	100	140	215	112	153	195	375	>=	359