H_0: The effects of the 5 ingredients will have no significant difference
H_1: $\beta_1 = \beta_2 = \beta_3$
H_2:
H_3:

4.24)

	1	2	3	4	5	
1	A=8	B=7	D=1	C=7	E=3	26
2	C=11	E=2	A=7	D=3	B=8	31
3	B=4	A=9	C=10	E=1	D=5	29
4	D=6	C=8	E=6	B=6	A=10	36
5	E=4	D=2	B=3	A=8	C=8	25
	33	28	27	25	34	147

$CF = \frac{147^2}{25} = 864.36$

$SS_{Total} = (8^2 + 7^2 + 1^2 + 7^2 \ldots + 8^2) - 864.36$
$= 1071 - 864.36 = \boxed{206.64}$

$SS_{Row} = \frac{1}{5}[26^2 + 31^2 + 29^2 + 36^2 + 25^2] - 864.36$
$= 879.8 - 864.36 = \boxed{15.44}$

$SS_{Colms} = \frac{1}{5}[33^2 + 28^2 + 27^2 + 25^2 + 34^2] - 864.36$
$\frac{1}{5}(4383) - 864 = \boxed{12.24}$

$SS_{Treatmen} = \frac{1}{5}[42^2 + 28^2 + 44^2 + 17^2 + 16^2] - 864.36$
$\frac{1}{5}(5029) - 864.36 = \boxed{141.44}$

$SS_{Error} = 206.64 - 15.44 - 12.24 - 141.44 = \boxed{37.52}$

Source	df	SS	MS	F
Rows	4	15.44	3.86	1.2345
Colums	4	12.24	3.06	.9787
Treatment	4	141.44	35.36	11.309
Error	12	37.52	3.1267	
Total	24	206.64		

$F_{4,6}(.05) = 4.5337$

$H_1: \alpha_1 \ldots = \alpha_t$
$H_2: \beta_1 \ldots = \beta_t$
$H_3: \tau_1 = \ldots = \tau_t$

Since 11.309 > 4.5337, the variation due to ~~treatments~~ has a significant effect on the yield. The variation due to rows and columns is not significant to the yield, thus we reject the null hypothesis for rows and colums.

4.25)

	1	2	3	4	
1	C=10	D=14	A=7	C=8	39
2	B=7	C=18	D=11	A=8	44
3	A=5	B=10	C=11	D=9	35
4	D=10	A=10	B=12	C=14	46
	32	52	41	39	164

$CF = \frac{(164)^2}{16} = 1681$

$SS_{Total} = (10^2 + 14^2 + 7^2 + 8^2 \dots 14^2) - 1681$

$1834 - 1681 = \boxed{153}$

$SS_{Rows} = \frac{1}{4}((39^2) + (44)^2 + 35^2 + (48^2)) - 1681$

$1899.5 - 1681 = \boxed{18.5}$

$SS_{Col.} = \frac{1}{4}(32^2 + 52^2 + 41^2 + 39^2) - 1681$

$= 1732.5 - 1681 = \boxed{51.5}$

$SS_{R\ (Treatment)} = \frac{1}{4}(30^2 + 37^2 + 53^2 + 44^2) - 1681$

$= 1753.5 - 1681 = \boxed{72.5}$

$SS_{Error} = 153 - 72.5 - 18.5 - 51.5 = \boxed{10.5}$

$H_1: \alpha_1 \dots = \alpha_t$

$H_2: \beta_1 \dots = \beta_t$

$H_3: \tau_1 \dots = \tau_t$

Source	df	SS	MS	F
Treatment	3	72.5	24.167	13.80
Row	3	18.5	6.167	3.52
Column	3	51.5	17.167	9.80
Error	6	10.5	1.75	
Total	15	153		

$F_{3,6,.05} = 4.76$

We fail to reject the null hypothesis for Row data.

Because $13.80 > 4.76$, we reject the null hypothesis. Thus, at least two assembly methods are significantly different (due to treatment being significant diff)

Because $9.80 > 4.76$, we reject the null hypothesis as the assembly methods are different (due to column data being significant different)

$H_1: \alpha_1 = \alpha_2 = \dots = \alpha_t$
$H_2: \beta_1 = \beta_2 = \dots = \beta_t$
$H_3: \tau_1 = \tau_2 = \tau_3 \dots = \tau_t$
H_4: Replication Effects

2 Replicates

$2(4^2) = 32$

4.38)

	1	2	3	4	
1	C=11	B=10	D=14	A=8	43
2	B=8	C=12	A=10	D=12	42
3	A=9	D=11	B=7	C=15	42
4	D=9	A=8	C=18	B=6	41
	37	41	49	41	168

$CF = \frac{(164+168)^2}{32} = 3444.5$

$SS_{Total}: [10^2 + 7^2 + 5^2 \dots 8^2 + 12^2 + 15^2 + 6^2] - 3444.5$

$= 3748 - 3444.5 = \boxed{303.5}$

$SS_{Rows}: [\frac{1}{8}(82^2 + 86^2 + 77^2 + 87^2)] - 3444.5$

$= \boxed{7.75}$

$SS_{Cols}: [\frac{1}{8}(69^2 + 93^2 + 90^2 + 80^2)] - 3444.5$

$= \boxed{44.25}$

$SS_{Treatment}: [\frac{1}{8}(65^2 + 68^2 + 109^2 + 90^2)] - 3444.5$

$= \boxed{159.25}$

$SS_{Replicates}: [\frac{1}{42}(164^2 + 168^2)] - 3444.5 = \boxed{.5}$

$SS_{Error}: 303.5 - 7.75 - 44.25 - 159.25 - .5 = \boxed{91.5}$

Source	df	SS	MS	F
Rows	3	7.75	2.58	.59
Cols	3	44.25	14.75	3.38
Treatment	3	159.25	53.08	12.15
Replicates	1	.5	.5	.11
Error	21	91.75	4.37	
Total	31	303.5		

$\boxed{F_{.05,3,21} = 3.07}$

F_2 & $F_3 > 3.07$, thus we fail to reject null hypotheses H_1 & H_4, & reject H_2 & H_3. Replication & order of assembly have no effect. Operator & Assembly method have an effect on assembly time.