

Question Group A

SAS code

```
DATA GroupA;
INPUT Formulation Hardness;
DATALINES;
. . . data goes here . . .
;

PROC GLM DATA=GroupA PLOTS=DIAGNOSTICS;
CLASS Formulation;
MODEL Hardness = Formulation / SS3;
MEANS Formulation/ HOVTEST=BF;
LSMEANS Formulation / PDIFF ADJUST=TUKEY LINES;
CONTRAST 'Contrast 1' Formulation 1 -1 1 -1 1 -1;
CONTRAST 'Contrast 2' Formulation 1 1 0 0 -1 -1;
CONTRAST 'Contrast 3' Formulation 1 -1 0 0 0 0;
CONTRAST 'Contrast 4' Formulation 0 1 0 -1 1 -1;
OUTPUT OUT=results R=resids;
RUN;
PROC UNIVARIATE DATA=results NORMAL;
VAR resids;
RUN;
```

The GLM Procedure ***Dependent Variable: Hardness***

Class Level Information						
Class	Levels	Values				
Formulation	6	F1	F2	F3	F4	F5 F6

Number of Observations Read	90
Number of Observations Used	90

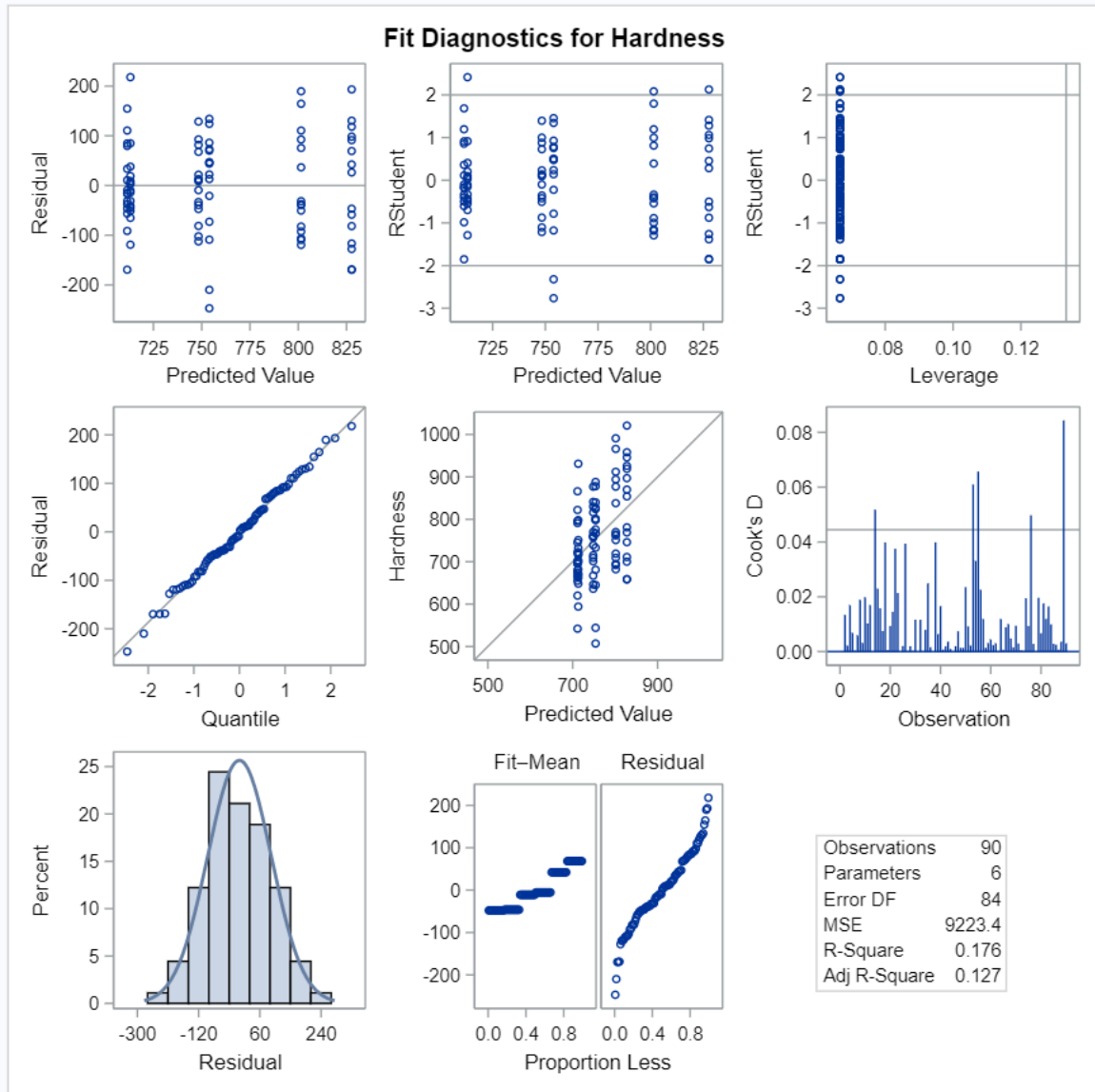
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	165495.4222	33099.0844	3.59	0.0054
Error	84	774763.8667	9223.3794		
Corrected Total	89	940259.2889			

R-Square	Coeff Var	Root MSE	Hardness Mean
0.176010	12.64810	96.03843	759.3111

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Formulation	5	165495.4222	33099.0844	3.59	0.0054

Question Group A

The GLM Procedure Dependent Variable: Hardness



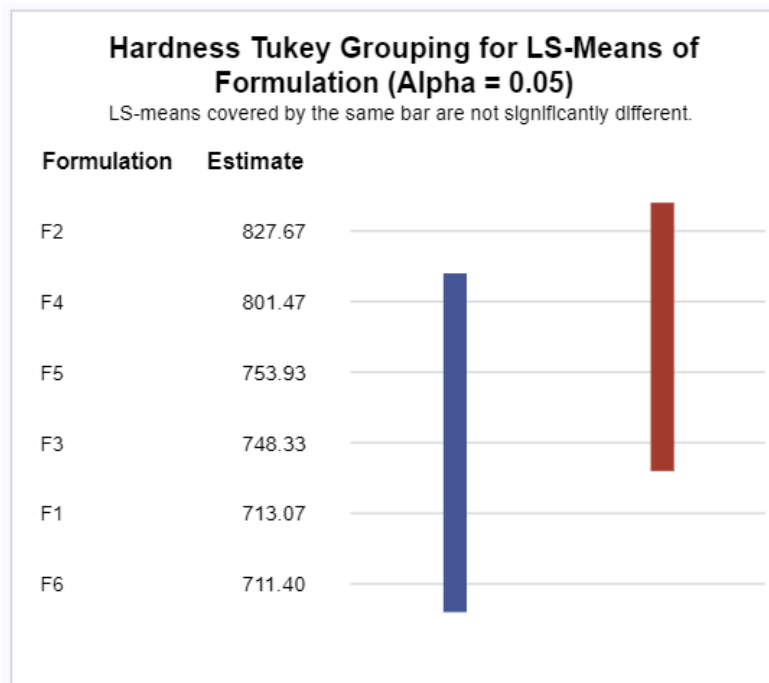
Brown and Forsythe's Test for Homogeneity of Hardness Variance					
ANOVA of Absolute Deviations from Group Medians					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Formulation	5	28404.5	5680.9	1.36	0.2468
Error	84	350326	4170.5		

Question Group A

The GLM Procedure Least Squares Means Adjustment for Multiple Comparisons: Tukey

Formulation	Hardness LSMEAN	LSMEAN Number
F1	713.066667	1
F2	827.666667	2
F3	748.333333	3
F4	801.466667	4
F5	753.933333	5
F6	711.400000	6

Least Squares Means for effect Formulation Pr > t for H0: LSMean(i)=LSMean(j)						
Dependent Variable: Hardness						
i/j	1	2	3	4	5	6
1		0.0189	0.9148	0.1298	0.8519	1.0000
2	0.0189		0.2213	0.9753	0.2960	0.0165
3	0.9148	0.2213		0.6556	1.0000	0.8982
4	0.1298	0.9753	0.6556		0.7531	0.1167
5	0.8519	0.2960	1.0000	0.7531		0.8294
6	1.0000	0.0165	0.8982	0.1167	0.8294	



Question Group A

The GLM Procedure Dependent Variable: Hardness

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
Contrast 1	1	39187.60000	39187.60000	4.25	0.0424
Contrast 2	1	21319.35000	21319.35000	2.31	0.1322
Contrast 3	1	98498.70000	98498.70000	10.68	0.0016
Contrast 4	1	17716.01667	17716.01667	1.92	0.1694

The UNIVARIATE Procedure Variable: resids

Moments			
N	90	Sum Weights	90
Mean	0	Sum Observations	0
Std Deviation	93.3017255	Variance	8705.21199
Skewness	-0.0485988	Kurtosis	-0.1500927
Uncorrected SS	774763.867	Corrected SS	774763.867
Coeff Variation	.	Std Error Mean	9.83486541

Basic Statistical Measures			
Location		Variability	
Mean	0.00000	Std Deviation	93.30173
Median	-3.20000	Variance	8705
Mode	.	Range	464.86667
		Interquartile Range	129.46667

Tests for Location: Mu0=0				
Test	Statistic		p Value	
Student's t	t	0	Pr > t	1.0000
Sign	M	0	Pr >= M	1.0000
Signed Rank	S	-5	Pr >= S	0.9841

Tests for Normality				
Test	Statistic		p Value	
Shapiro-Wilk	W	0.994093	Pr < W	0.9622
Kolmogorov-Smirnov	D	0.054738	Pr > D	>0.1500
Cramer-von Mises	W-Sq	0.029882	Pr > W-Sq	>0.2500
Anderson-Darling	A-Sq	0.186769	Pr > A-Sq	>0.2500

Question Group B

SAS code

```
DATA GroupB;
  INPUT Alloy $ Temp Hardness;
  DATALINES;
  . . . data goes here . . .
;
PROC GLM DATA=GroupB;
  CLASS Temp Alloy;
  MODEL Hardness = Temp Alloy Temp*Alloy / SS3;
  LSMEANS Temp Alloy Temp*Alloy / PDIFF ADJUST=TUKEY;
RUN;
```

The GLM Procedure Dependent Variable: Hardness

Class Level Information		
Class	Levels	Values
Temp	3	1500 1600 1700
Alloy	2	A1 A2

Number of Observations Read	90
Number of Observations Used	90

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	165495.4222	33099.0844	3.59	0.0054
Error	84	774763.8667	9223.3794		
Corrected Total	89	940259.2889			

R-Square	Coeff Var	Root MSE	Hardness Mean
0.176010	12.64810	96.03843	759.3111

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Temp	2	32254.95556	16127.47778	1.75	0.1803
Alloy	1	39187.60000	39187.60000	4.25	0.0424
Temp*Alloy	2	94052.86667	47026.43333	5.10	0.0081

Question Group B

***The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey***

Temp	Hardness LSMEAN	LSMEAN Number
1500	770.366667	1
1600	774.900000	2
1700	732.666667	3

Least Squares Means for effect Temp Pr > t for H0: LSMean(i)=LSMean(j)			
Dependent Variable: Hardness			
i/j	1	2	3
1		0.9817	0.2866
2	0.9817		0.2100
3	0.2866	0.2100	

***The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey***

Alloy	Hardness LSMEAN	H0:LSMean1=LSMean2
		Pr > t
A1	738.444444	0.0424
A2	780.177778	

Question Group B

The GLM Procedure Least Squares Means Adjustment for Multiple Comparisons: Tukey

Temp	Alloy	Hardness LSMEAN	LSMEAN Number
1500	A1	713.066667	1
1500	A2	827.666667	2
1600	A1	748.333333	3
1600	A2	801.466667	4
1700	A1	753.933333	5
1700	A2	711.400000	6

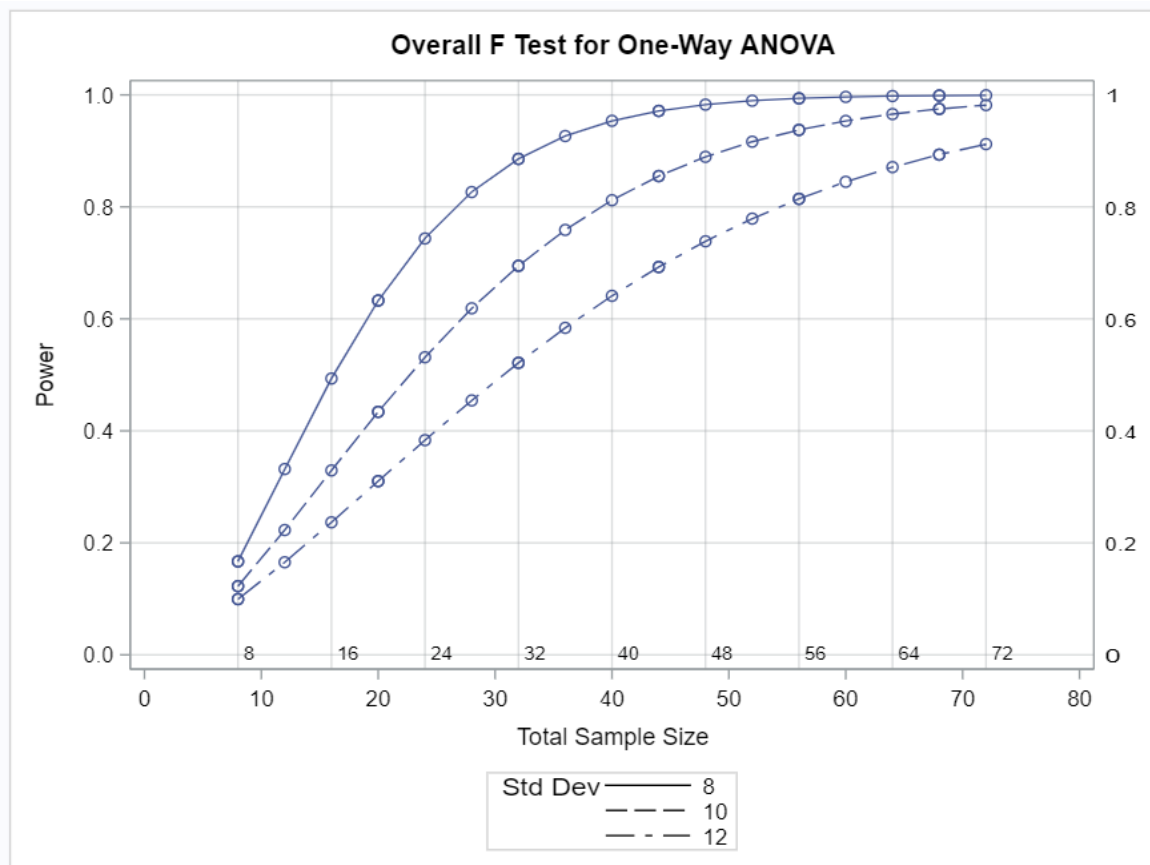
Least Squares Means for effect Temp*Alloy Pr > t for H0: LSMean(i)=LSMean(j)						
Dependent Variable: Hardness						
i/j	1	2	3	4	5	6
1		0.0189	0.9148	0.1298	0.8519	1.0000
2	0.0189		0.2213	0.9753	0.2960	0.0165
3	0.9148	0.2213		0.6556	1.0000	0.8982
4	0.1298	0.9753	0.6556		0.7531	0.1167
5	0.8519	0.2960	1.0000	0.7531		0.8294
6	1.0000	0.0165	0.8982	0.1167	0.8294	

Question Group C

SAS code

```
PROC POWER PLOTONLY;
  onewayanova
    test=overall
    groupmeans = 50 | 55 | 60 | 65
    stddev= 8 to 12 by 2
    alpha = 0.05
    ntotal = 8 to 76 by 4
    power=.;
  plot x=n min=8 max=76
       yopts=(ref=0 0.2 0.4 0.6 0.8 1.0)
       xopts=(ref=8 16 24 32 40 48 56 64 72);
RUN;
```

The POWER Procedure Overall F Test for One-Way ANOVA



Question Group D

SAS code

```
DATA GroupD;
INPUT Age $ Gender $ Color $ Words;
DATAPOINTS;
. . . data goes here . . .
;

PROC GLM DATA=GroupD PLOTS=NONE;
CLASS Color Age Gender;
MODEL Words = Age | Color | Gender / SS3;
LSMEANS Age | Color | Gender / PDIF ADJUST=TUKEY;
RUN;
```

The GLM Procedure

Class Level Information		
Class	Levels	Values
Color	4	Blue Green Red Yellow
Age	2	Adult Senior
Gender	2	Female Male

Number of Observations Read	64
Number of Observations Used	64

The GLM Procedure *Dependent Variable: Words*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	15	8380.43750	558.69583	3.87	0.0002
Error	48	6934.00000	144.45833		
Corrected Total	63	15314.43750			

R-Square	Coeff Var	Root MSE	Words Mean
0.547225	6.467305	12.01908	185.8438

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Age	1	126.562500	126.562500	0.88	0.3540
Color	3	4250.187500	1416.729167	9.81	<.0001
Color*Age	3	917.187500	305.729167	2.12	0.1105
Gender	1	1350.562500	1350.562500	9.35	0.0036
Age*Gender	1	1072.562500	1072.562500	7.42	0.0089
Color*Gender	3	463.687500	154.562500	1.07	0.3707
Color*Age*Gender	3	199.687500	66.562500	0.46	0.7110

Question Group D

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey

Age	Words LSMEAN	H0:LSMean1=LSMean2
		Pr > t
Adult	184.437500	0.3540
Senior	187.250000	

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey

Color	Words LSMEAN	LSMEAN Number
Blue	195.125000	1
Green	192.750000	2
Red	178.375000	3
Yellow	177.125000	4

Least Squares Means for effect Color Pr > t for H0: LSMean(i)=LSMean(j)				
Dependent Variable: Words				
i/j	1	2	3	4
1		0.9437	0.0015	0.0006
2	0.9437		0.0076	0.0032
3	0.0015	0.0076		0.9910
4	0.0006	0.0032	0.9910	

Question Group D

The GLM Procedure Least Squares Means Adjustment for Multiple Comparisons: Tukey

Color	Age	Words LSMEAN	LSMEAN Number
Blue	Adult	190.250000	1
Blue	Senior	200.000000	2
Green	Adult	187.500000	3
Green	Senior	198.000000	4
Red	Adult	182.000000	5
Red	Senior	174.750000	6
Yellow	Adult	178.000000	7
Yellow	Senior	176.250000	8

Least Squares Means for effect Color*Age Pr > t for H0: LSMean(i)=LSMean(j)								
Dependent Variable: Words								
i/j	1	2	3	4	5	6	7	8
1		0.7347	0.9998	0.8983	0.8649	0.1889	0.4680	0.2994
2	0.7347		0.4419	1.0000	0.0762	0.0027	0.0134	0.0057
3	0.9998	0.4419		0.6572	0.9831	0.4163	0.7590	0.5760
4	0.8983	1.0000	0.6572		0.1596	0.0073	0.0332	0.0151
5	0.8649	0.0762	0.9831	0.1596		0.9261	0.9975	0.9783
6	0.1889	0.0027	0.4163	0.0073	0.9261		0.9993	1.0000
7	0.4680	0.0134	0.7590	0.0332	0.9975	0.9993		1.0000
8	0.2994	0.0057	0.5760	0.0151	0.9783	1.0000	1.0000	

Question Group D

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey

Gender	Words LSMEAN	H0:LSMean1=LSMean2
		Pr > t
Female	181.250000	0.0036
Male	190.437500	

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey

Age	Gender	Words LSMEAN	LSMEAN Number
Adult	Female	183.937500	1
Adult	Male	184.937500	2
Senior	Female	178.562500	3
Senior	Male	195.937500	4

Least Squares Means for effect Age*Gender Pr > t for H0: LSMean(i)=LSMean(j)				
Dependent Variable: Words				
i/j	1	2	3	4
1		0.9953	0.5894	0.0337
2	0.9953		0.4453	0.0593
3	0.5894	0.4453		0.0009
4	0.0337	0.0593	0.0009	

Question Group D

The GLM Procedure Least Squares Means Adjustment for Multiple Comparisons: Tukey

Color	Gender	Words LSMEAN	LSMEAN Number
Blue	Female	190.875000	1
Blue	Male	199.375000	2
Green	Female	192.250000	3
Green	Male	193.250000	4
Red	Female	172.625000	5
Red	Male	184.125000	6
Yellow	Female	169.250000	7
Yellow	Male	185.000000	8

Least Squares Means for effect Color*Gender Pr > t for H0: LSMean(i)=LSMean(j)								
Dependent Variable: Words								
i/j	1	2	3	4	5	6	7	8
1		0.8461	1.0000	0.9999	0.0690	0.9484	0.0160	0.9755
2	0.8461		0.9322	0.9692	0.0012	0.2049	0.0002	0.2686
3	1.0000	0.9322		1.0000	0.0390	0.8737	0.0083	0.9261
4	0.9999	0.9692	1.0000		0.0252	0.7938	0.0051	0.8649
5	0.0690	0.0012	0.0390	0.0252		0.5487	0.9992	0.4549
6	0.9484	0.2049	0.8737	0.7938	0.5487		0.2307	1.0000
7	0.0160	0.0002	0.0083	0.0051	0.9992	0.2307		0.1738
8	0.9755	0.2686	0.9261	0.8649	0.4549	1.0000	0.1738	

Question Group D

The GLM Procedure
Least Squares Means
Adjustment for Multiple Comparisons: Tukey

Color	Age	Gender	Words LSMEAN	LSMEAN Number
Blue	Adult	Female	188.000000	1
Blue	Adult	Male	192.500000	2
Blue	Senior	Female	193.750000	3
Blue	Senior	Male	206.250000	4
Green	Adult	Female	193.500000	5
Green	Adult	Male	181.500000	6
Green	Senior	Female	191.000000	7
Green	Senior	Male	205.000000	8
Red	Adult	Female	181.250000	9
Red	Adult	Male	182.750000	10
Red	Senior	Female	164.000000	11
Red	Senior	Male	185.500000	12
Yellow	Adult	Female	173.000000	13
Yellow	Adult	Male	183.000000	14
Yellow	Senior	Female	165.500000	15
Yellow	Senior	Male	187.000000	16

Question Group D

The GLM Procedure Least Squares Means Adjustment for Multiple Comparisons: Tukey

Least Squares Means for effect Color*Age*Gender Pr > t for H0: LSMean(i)=LSMean(j)																
Dependent Variable: Words																
i/j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1		1.0000	1.0000	0.7266	1.0000	1.0000	1.0000	0.8132	1.0000	1.0000	0.2907	1.0000	0.9167	1.0000	0.3923	1.0000
2	1.0000		1.0000	0.9569	1.0000	0.9943	1.0000	0.9808	0.9929	0.9984	0.0953	1.0000	0.6293	0.9988	0.1427	1.0000
3	1.0000	1.0000		0.9808	1.0000	0.9840	1.0000	0.9929	0.9808	0.9943	0.0665	0.9998	0.5280	0.9955	0.1021	1.0000
4	0.7266	0.9569	0.9808		0.9771	0.2466	0.9064	1.0000	0.2330	0.3227	0.0009	0.5280	0.0223	0.3394	0.0015	0.6493
5	1.0000	1.0000	1.0000	0.9771		0.9868	1.0000	0.9912	0.9840	0.9955	0.0716	0.9998	0.5483	0.9965	0.1094	1.0000
6	1.0000	0.9943	0.9840	0.2466	0.9868		0.9988	0.3227	1.0000	1.0000	0.7802	1.0000	0.9997	1.0000	0.8709	1.0000
7	1.0000	1.0000	1.0000	0.9064	1.0000	0.9988		0.9503	0.9984	0.9998	0.1427	1.0000	0.7450	0.9998	0.2073	1.0000
8	0.8132	0.9808	0.9929	1.0000	0.9912	0.3227	0.9503		0.3064	0.4108	0.0014	0.6293	0.0334	0.4296	0.0025	0.7450
9	1.0000	0.9929	0.9808	0.2330	0.9840	1.0000	0.9984	0.3064		1.0000	0.7970	1.0000	0.9998	1.0000	0.8835	1.0000
10	1.0000	0.9984	0.9943	0.3227	0.9955	1.0000	0.9998	0.4108	1.0000		0.6886	1.0000	0.9984	1.0000	0.7970	1.0000
11	0.2907	0.0953	0.0665	0.0009	0.0716	0.7802	0.1427	0.0014	0.7970	0.6886		0.4683	0.9993	0.6690	1.0000	0.3566
12	1.0000	1.0000	0.9998	0.5280	0.9998	1.0000	1.0000	0.6293	1.0000	1.0000	0.4683		0.9808	1.0000	0.5888	1.0000
13	0.9167	0.6293	0.5280	0.0223	0.5483	0.9997	0.7450	0.0334	0.9998	0.9984	0.9993	0.9808		0.9979	0.9999	0.9503
14	1.0000	0.9988	0.9955	0.3394	0.9965	1.0000	0.9998	0.4296	1.0000	1.0000	0.6690	1.0000	0.9979		0.7802	1.0000
15	0.3923	0.1427	0.1021	0.0015	0.1094	0.8709	0.2073	0.0025	0.8835	0.7970	1.0000	0.5888	0.9999	0.7802		0.4683
16	1.0000	1.0000	1.0000	0.6493	1.0000	1.0000	1.0000	0.7450	1.0000	1.0000	0.3566	1.0000	0.9503	1.0000	0.4683	

Question Group E

SAS code

```
DATA groupe;  
INPUT A $ B $ Y;  
DATALINES;  
... data goes here ...+  
;  
  
PROC GLM DATA=groupe PLOTS=NONE;  
CLASS A B;  
MODEL Y = A | B / SS3;  
RUN;
```

The GLM Procedure Dependent Variable: Y

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	211.1	30.2	???	<.0001
Error	40	156.1	3.9		
Corrected Total	47	367.2			

R-Square	Coeff Var	Root MSE	Response Mean
0.574977	19.46702	1.975287	10.14684

Source	DF	Type III SS	Mean Square	F Value	Pr > F
A	1	5.4	5.4	1.4	0.2463
B	3	???	64.9	16.6	<.0001
A*B	3	11.0	???	0.9	0.4278

Question Group F

SAS code

```
DATA GroupF;
INPUT Breed $ Gain;
DATALINES;
. . . data goes here . . .
;
PROC GLM DATA=GroupF;
CLASS Breed;
MODEL Gain = Breed / SS3 SOLUTION;
RUN;
```

The GLM Procedure *Dependent Variable: Gain*

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	18162.7	4540.7	9.19	<.0001
Error	45	22225.1	493.9		
Corrected Total	49	40387.8			

R-Square	Coeff Var	Root MSE	Gain Mean
0.449707	10.46304	22.22368	212.4017

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Breed	4	18162.68233	4540.67058	9.19	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > t
Intercept	223.8	B	7.03	31.85	<.0001
Breed Angus	9.6	B	9.94	0.97	0.3383
Breed Hereford	-45.7	B	9.94	-4.59	<.0001
Breed Highland	-16.3	B	9.94	-1.64	0.1070
Breed Holstein	-4.6	B	9.94	-0.47	0.6432
Breed Longhorn	0.0	B	.	.	.