SAS Output for Practice Exam Question 1, page 1 of 5

SAS Code:

```
proc glm data=pigs plots=diagnostics;
class litter;
model weight = litter / solution ss3;
lsmeans litter / stderr pdiff;
lsmeans litter / stderr pdiff adjust=tukey;
means litter / hovtest=bf;
run;
```

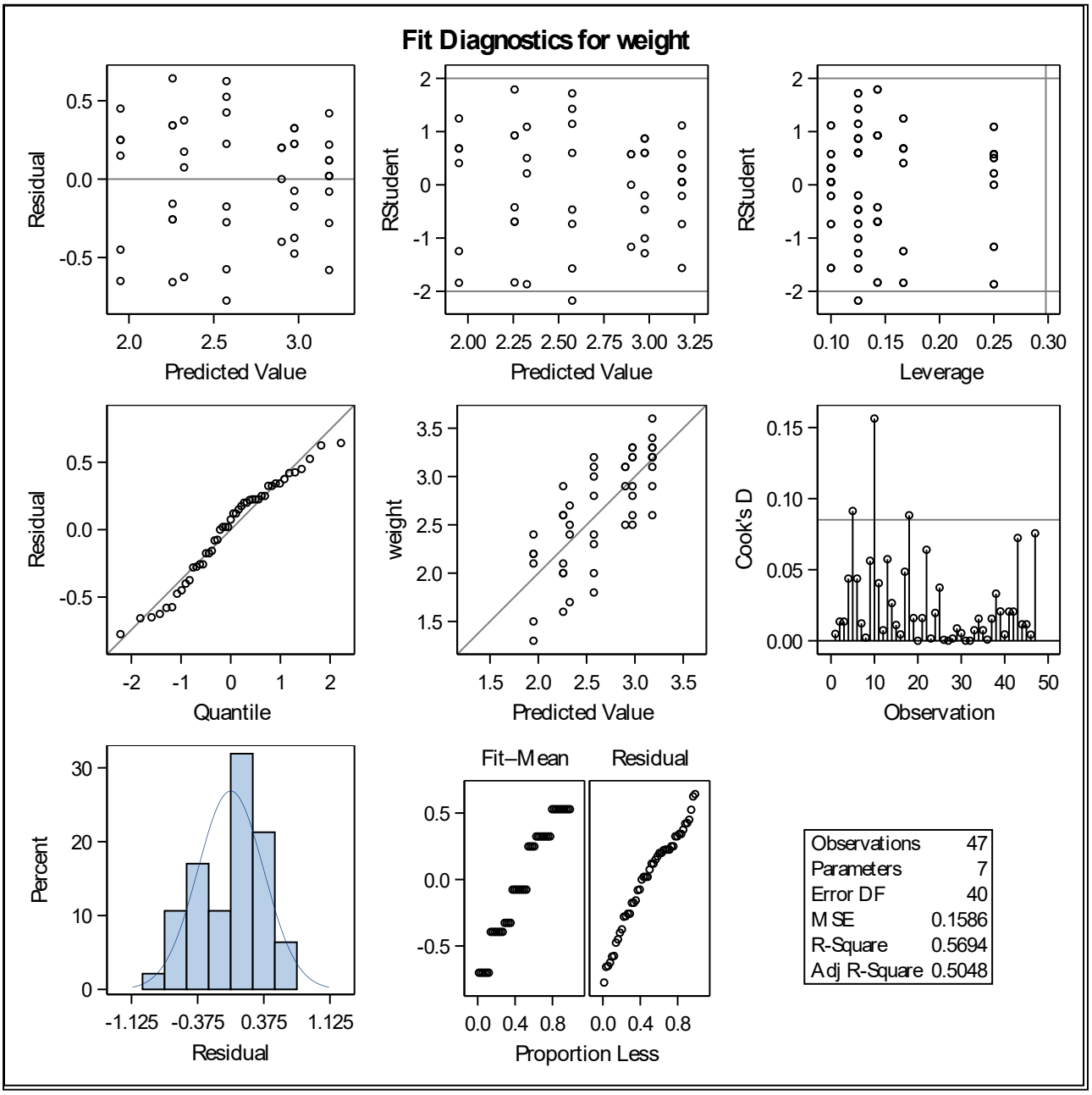
The GLM Procedure
Dependent Variable: Weight

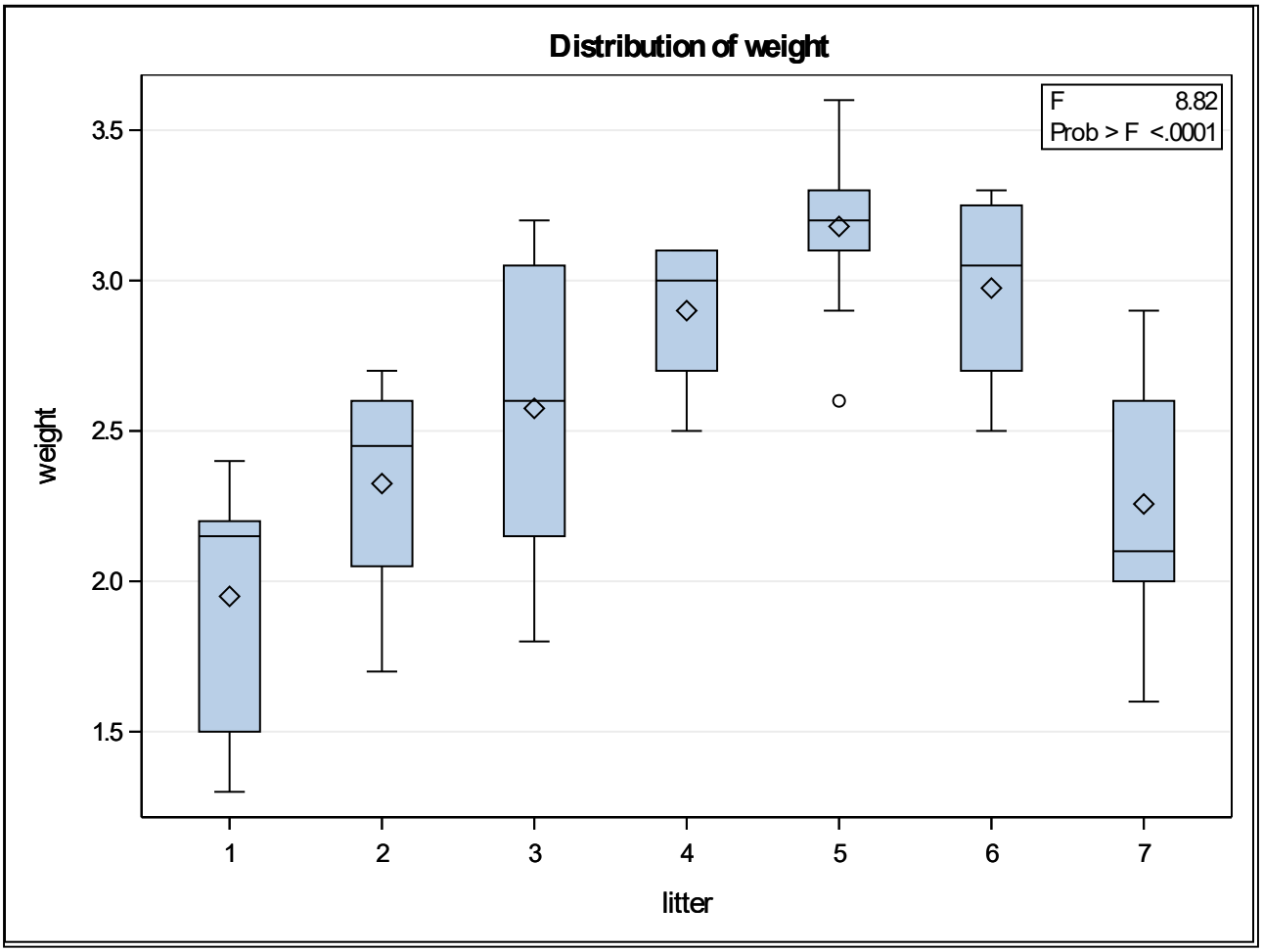
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	6	8.39180395	1.39863399	8.82	<.0001
Error	40	6.34564286	0.15864107		
Corrected Total	46	14.73744681			

R-Square	Coeff Var	Root MSE	weight Mean
0.569420	15.02407	0.398298	2.651064

Source	DF	Type III SS	Mean Square	F Value	Pr > F
litter	6	8.39180395	1.39863399	8.82	<.0001

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		2.257142857	B	0.15054239	14.99	<.0001
litter	1	-0.307142857	B	0.22159239	-1.39	0.1734
litter	2	0.067857143	B	0.24964631	0.27	0.7872
litter	3	0.317857143	B	0.20613865	1.54	0.1310
litter	4	0.642857143	B	0.24964631	2.58	0.0138
litter	5	0.922857143	B	0.19628326	4.70	<.0001
litter	6	0.717857143	B	0.20613865	3.48	0.0012
litter	7	0.000000000	B	.	.	.


Fit Diagnostics for weight
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
weight
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 47
Parameters 7
Error DF 40
MSE 0.1586
R-Square 0.5694
Adj R-Square 0.5048



Brown and Forsythe's Test for Homogeneity of weight Variance ANOVA of Absolute Deviations from Group Medians					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
litter	6	0.3952	0.0659	1.09	0.3829
Error	40	2.4090	0.0602		

The GLM Procedure
Least Squares Means

litter	weight LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
1	1.95000000	0.16260436	<.0001	1
2	2.32500000	0.19914886	<.0001	2
3	2.57500000	0.14081951	<.0001	3
4	2.90000000	0.19914886	<.0001	4
5	3.18000000	0.12595280	<.0001	5
6	2.97500000	0.14081951	<.0001	6
7	2.25714286	0.15054239	<.0001	7

Least Squares Means for effect litter
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: weight

i/j	1	2	3	4	5	6	7
1		0.1525	0.0059	0.0007	<.0001	<.0001	0.1734
2	0.1525		0.3115	0.0478	0.0008	0.0110	0.7872
3	0.0059	0.3115		0.1902	0.0027	0.0514	0.1310
4	0.0007	0.0478	0.1902		0.2417	0.7601	0.0138
5	<.0001	0.0008	0.0027	0.2417		0.2844	<.0001
6	<.0001	0.0110	0.0514	0.7601	0.2844		0.0012
7	0.1734	0.7872	0.1310	0.0138	<.0001	0.0012	

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

litter	weight LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
1	1.95000000	0.16260436	<.0001	1
2	2.32500000	0.19914886	<.0001	2
3	2.57500000	0.14081951	<.0001	3
4	2.90000000	0.19914886	<.0001	4
5	3.18000000	0.12595280	<.0001	5
6	2.97500000	0.14081951	<.0001	6
7	2.25714286	0.15054239	<.0001	7

Least Squares Means for effect litter
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: weight

i/j	1	2	3	4	5	6	7
1		0.7667	0.0794	0.0108	<.0001	0.0005	0.8058
2	0.7667		0.9451	0.4058	0.0129	0.1341	1.0000
3	0.0794	0.9451		0.8326	0.0392	0.4254	0.7184
4	0.0108	0.4058	0.8326		0.8945	0.9999	0.1611
5	<.0001	0.0129	0.0392	0.8945		0.9289	0.0006
6	0.0005	0.1341	0.4254	0.9999	0.9289		0.0191
7	0.8058	1.0000	0.7184	0.1611	0.0006	0.0191	

SAS Output for Practice Exam Question 2, page 1 of 5

SAS Code:

```
proc glm data=pigs plots=diagnostics;
class litter;
model weight = litter / solution ss3;
lsmeans litter / stderr pdiff;
lsmeans litter / stderr pdiff adjust=tukey;
means litter / hovtest=bf;
run;
```

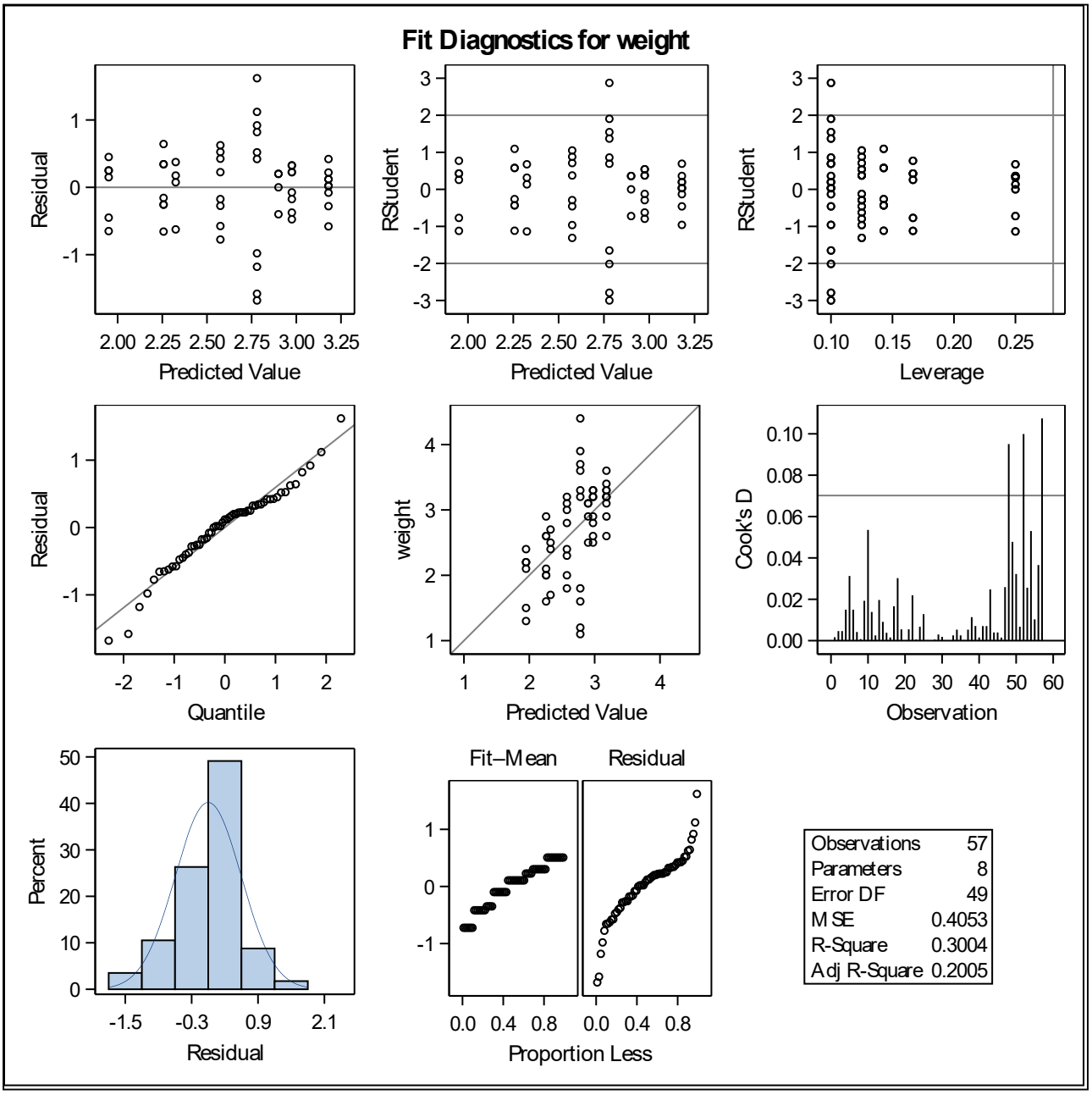
The GLM Procedure
Dependent Variable: Weight

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	7	8.52888346	1.21841192	3.01	0.0104
Error	49	19.86164286	0.40533965		
Corrected Total	56	28.39052632			

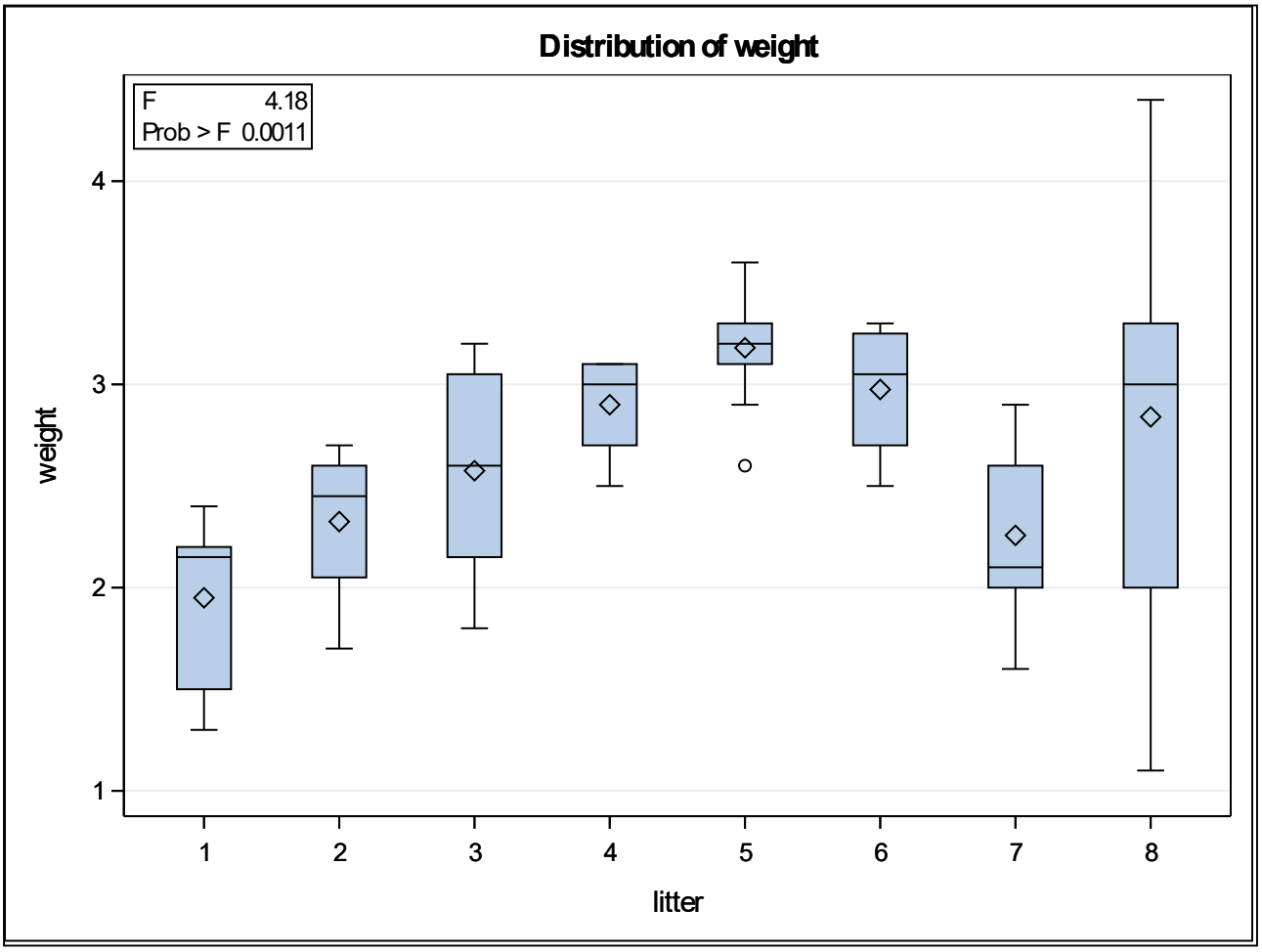
R-Square	Coeff Var	Root MSE	weight Mean
0.300413	23.81220	0.636663	2.673684

Source	DF	Type III SS	Mean Square	F Value	Pr > F
litter	7	8.52888346	1.21841192	3.01	0.0104

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		2.780000000	B	0.20133049	13.81	<.0001
litter	1	-0.830000000	B	0.32877131	-2.52	0.0149
litter	2	-0.455000000	B	0.37665485	-1.21	0.2328
litter	3	-0.205000000	B	0.30199573	-0.68	0.5004
litter	4	0.120000000	B	0.37665485	0.32	0.7514
litter	5	0.400000000	B	0.28472431	1.40	0.1664
litter	6	0.195000000	B	0.30199573	0.65	0.5215
litter	7	-0.522857143	B	0.31375090	-1.67	0.1020
litter	8	0.000000000	B	.	.	.


Fit Diagnostics for weight
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
weight
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 57
Parameters 8
Error DF 49
MSE 0.4053
R-Square 0.3004
Adj R-Square 0.2005

SAS Output for Practice Exam Question 2, page 3 of 5



Brown and Forsythe's Test for Homogeneity of weight Variance ANOVA of Absolute Deviations from Group Medians					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
litter	7	4.4848	0.6407	3.86	0.0020
Error	49	8.1340	0.1660		

The GLM Procedure
Least Squares Means

litter	weight LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
1	1.95000000	0.25991654	<.0001	1
2	2.32500000	0.31833145	<.0001	2
3	2.57500000	0.22509433	<.0001	3
4	2.90000000	0.31833145	<.0001	4
5	3.18000000	0.20133049	<.0001	5
6	2.97500000	0.22509433	<.0001	6
7	2.25714286	0.24063596	<.0001	7
8	2.78000000	0.20133049	<.0001	8

Least Squares Means for effect litter
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: weight

i/j	1	2	3	4	5	6	7	8
1		0.3660	0.0752	0.0250	0.0005	0.0045	0.3901	0.0149
2	0.3660		0.5244	0.2075	0.0276	0.1019	0.8657	0.2328
3	0.0752	0.5244		0.4086	0.0507	0.2149	0.3395	0.5004
4	0.0250	0.2075	0.4086		0.4608	0.8482	0.1136	0.7514
5	0.0005	0.0276	0.0507	0.4608		0.5004	0.0050	0.1664
6	0.0045	0.1019	0.2149	0.8482	0.5004		0.0342	0.5215
7	0.3901	0.8657	0.3395	0.1136	0.0050	0.0342		0.1020
8	0.0149	0.2328	0.5004	0.7514	0.1664	0.5215	0.1020	

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

litter	weight LSMEAN	Standard Error	Pr > |t|	LSMEAN Number
1	1.95000000	0.25991654	<.0001	1
2	2.32500000	0.31833145	<.0001	2
3	2.57500000	0.22509433	<.0001	3
4	2.90000000	0.31833145	<.0001	4
5	3.18000000	0.20133049	<.0001	5
6	2.97500000	0.22509433	<.0001	6
7	2.25714286	0.24063596	<.0001	7
8	2.78000000	0.20133049	<.0001	8

Least Squares Means for effect litter
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: weight

i/j	1	2	3	4	5	6	7	8
1		0.9834	0.6115	0.3083	0.0105	0.0784	0.9877	0.2096
2	0.9834		0.9981	0.9029	0.3305	0.7076	1.0000	0.9257
3	0.6115	0.9981		0.9902	0.4902	0.9101	0.9773	0.9972
4	0.3083	0.9029	0.9902		0.9951	1.0000	0.7415	1.0000
5	0.0105	0.3305	0.4902	0.9951		0.9972	0.0861	0.8507
6	0.0784	0.7076	0.9101	1.0000	0.9972		0.3820	0.9980
7	0.9877	1.0000	0.9773	0.7415	0.0861	0.3820		0.7080
8	0.2096	0.9257	0.9972	1.0000	0.8507	0.9980	0.7080	

SAS Output for Practice Exam Question 3, page 1 of 5

SAS Code:

```
proc glm data=factory plots=diagnostics;
class Day Music;
model productivity = Day|Music / solution ss3;
lsmeans Day Music Day*Music / pdiff adjust=tukey;
run;
```

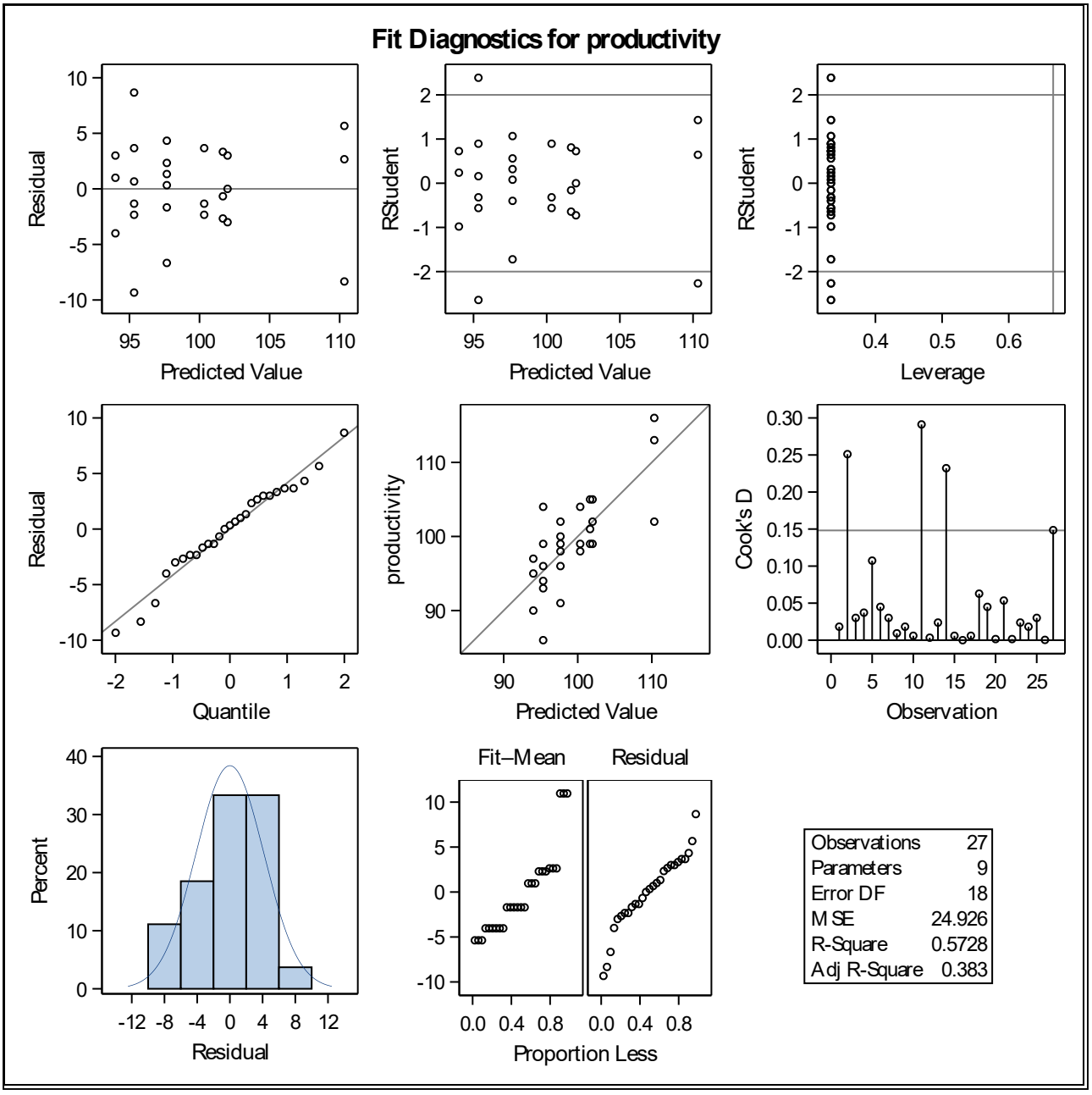
The GLM Procedure
Dependent Variable: productivity

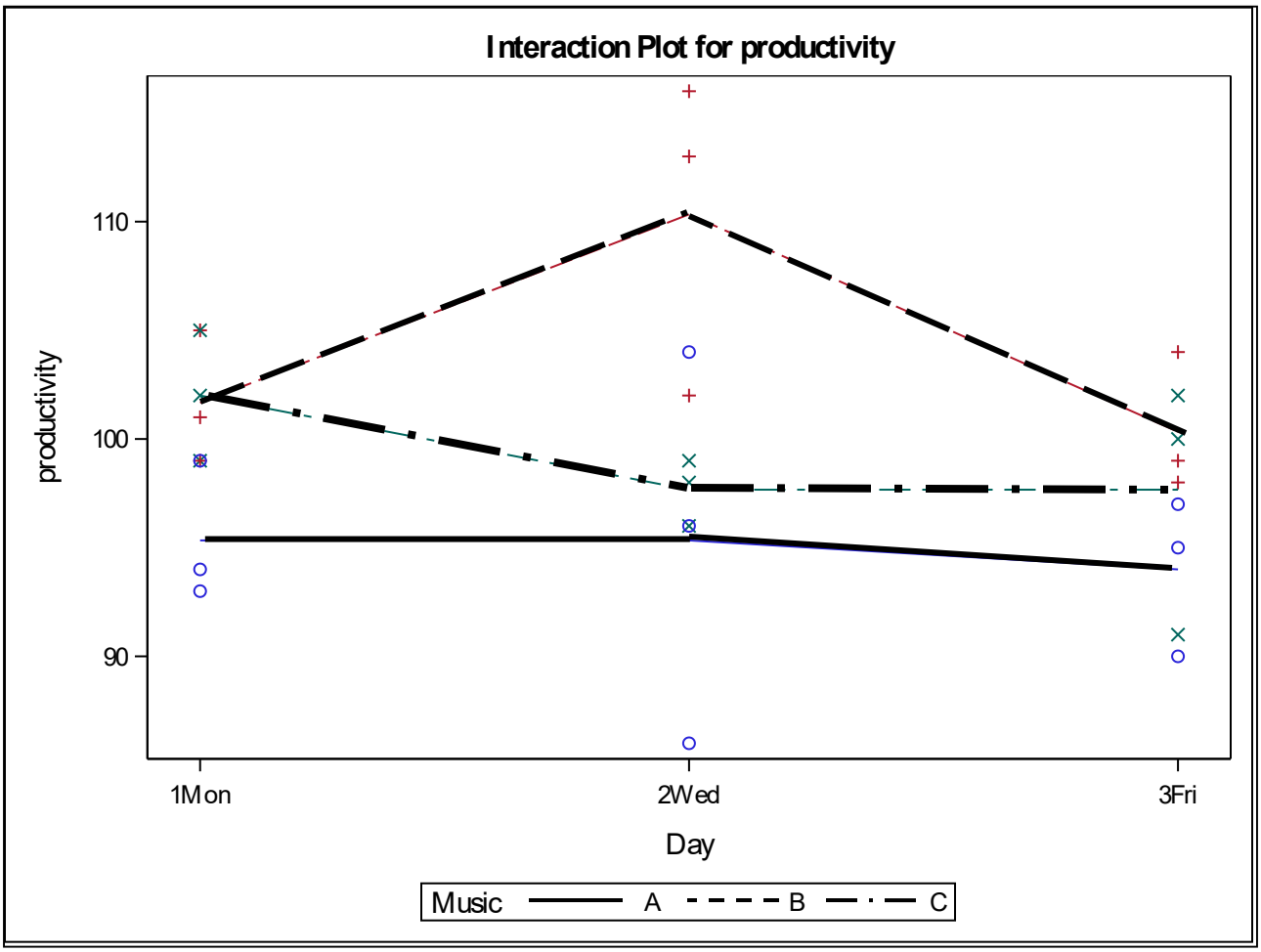
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	601.629630	75.203704	3.02	0.0246
Error	18	448.666667	24.925926		
Corrected Total	26	1050.296296			

R-Square	Coeff Var	Root MSE	productivity Mean
0.572819	5.024221	4.992587	99.37037

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Day	2	65.4074074	32.7037037	1.31	0.2938
Music	2	383.6296296	191.8148148	7.70	0.0038
Day*Music	4	152.5925926	38.1481481	1.53	0.2356

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		97.66666667	B	2.88247150	33.88	<.0001
Day	1Mon	4.33333333	B	4.07643030	1.06	0.3018
Day	2Wed	0.00000000	B	4.07643030	0.00	1.0000
Day	3Fri	0.00000000	B	.	.	.
Music	A	-3.66666667	B	4.07643030	-0.90	0.3803
Music	B	2.66666667	B	4.07643030	0.65	0.5213
Music	C	0.00000000	B	.	.	.
Day*Music	1Mon A	-3.00000000	B	5.76494301	-0.52	0.6091
Day*Music	1Mon B	-3.00000000	B	5.76494301	-0.52	0.6091
Day*Music	1Mon C	0.00000000	B	.	.	.
Day*Music	2Wed A	1.33333333	B	5.76494301	0.23	0.8197
Day*Music	2Wed B	10.00000000	B	5.76494301	1.73	0.0999
Day*Music	2Wed C	0.00000000	B	.	.	.
Day*Music	3Fri A	0.00000000	B	.	.	.
Day*Music	3Fri B	0.00000000	B	.	.	.
Day*Music	3Fri C	0.00000000	B	.	.	.


Fit Diagnostics for productivity
Residual
Predicted Value
RStudent
Predicted Value
RStudent
Leverage
Residual
Quantile
productivity
Predicted Value
Cook's D
Observation
Percent
Residual
Fit–Mean
Residual
Proportion Less
Observations 27
Parameters 9
Error DF 18
MSE 24.926
R-Square 0.5728
Adj R-Square 0.383



Brown and Forsythe's Test for Homogeneity of productivity Variance ANOVA of Absolute Deviations from Group Medians					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
treatment	8	61.4074	7.6759	0.62	0.7485
Error	18	222.0	12.3333		

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

Day	productivity LSMEAN	LSMEAN Number
1Mon	99.666667	1
2Wed	101.111111	2
3Fri	97.333333	3

Least Squares Means for effect Day
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: productivity

i/j	1	2	3
1		0.8145	0.5915
2	0.8145		0.2691
3	0.5915	0.2691	

Music	productivity LSMEAN	LSMEAN Number
A	94.888889	1
B	104.111111	2
C	99.111111	3

Least Squares Means for effect Music
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: productivity

i/j	1	2	3
1		0.0028	0.1998
2	0.0028		0.1129
3	0.1998	0.1129	

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

Day	Music	productivity LSMEAN	LSMEAN Number
1Mon	A	95.333333	1
1Mon	B	101.666667	2
1Mon	C	102.000000	3
2Wed	A	95.333333	4
2Wed	B	110.333333	5
2Wed	C	97.666667	6
3Fri	A	94.000000	7
3Fri	B	100.333333	8
3Fri	C	97.666667	9

Least Squares Means for effect Day*Music
Pr > |t| for H0: LSMean(i)=LSMean(j)

Dependent Variable: productivity

i/j	1	2	3	4	5	6	7	8	9
1		0.8164	0.7747	1.0000	0.0353	0.9996	1.0000	0.9397	0.9996
2	0.8164		1.0000	0.8164	0.4871	0.9831	0.6337	1.0000	0.9831
3	0.7747	1.0000		0.7747	0.5352	0.9727	0.5843	1.0000	0.9727
4	1.0000	0.8164	0.7747		0.0353	0.9996	1.0000	0.9397	0.9996
5	0.0353	0.4871	0.5352	0.0353		0.1060	0.0183	0.3150	0.1060
6	0.9996	0.9831	0.9727	0.9996	0.1060		0.9901	0.9988	1.0000
7	1.0000	0.6337	0.5843	1.0000	0.0183	0.9901		0.8164	0.9901
8	0.9397	1.0000	1.0000	0.9397	0.3150	0.9988	0.8164		0.9988
9	0.9996	0.9831	0.9727	0.9996	0.1060	1.0000	0.9901	0.9988	

SAS Code:

```
proc glm data=reaction plots=diagnostics;
class age alcohol;
model time = age|alcohol / ss3;
lsmeans age alcohol age*alcohol;
run;
```

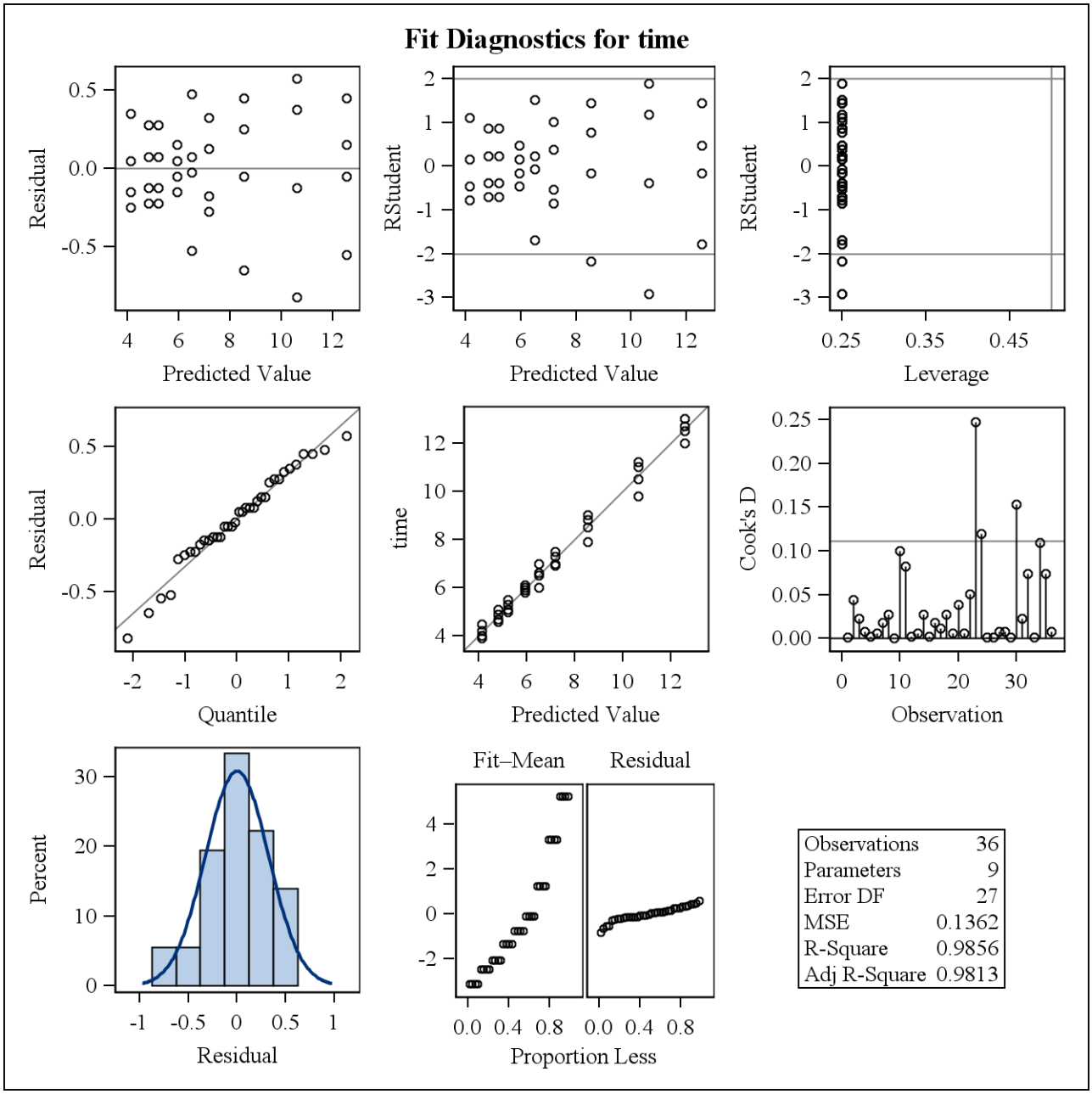
The SAS System
The GLM Procedure
Dependent Variable: time

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	8	251.8855556	31.4856944	231.17	<.0001
Error	27	3.6775000	0.1362037		
Corrected Total	35	255.5630556			

R-Square	Coeff Var	Root MSE	time Mean
0.985610	5.065224	0.369058	7.286111

Source	DF	Type III SS	Mean Square	F Value	Pr > F
age	2	91.6572222	45.8286111	336.47	<.0001
alcohol	2	141.1838889	70.5919444	518.28	<.0001
age*alcohol	4	19.0444444	4.7611111	34.96	<.0001

The SAS System
The GLM Procedure



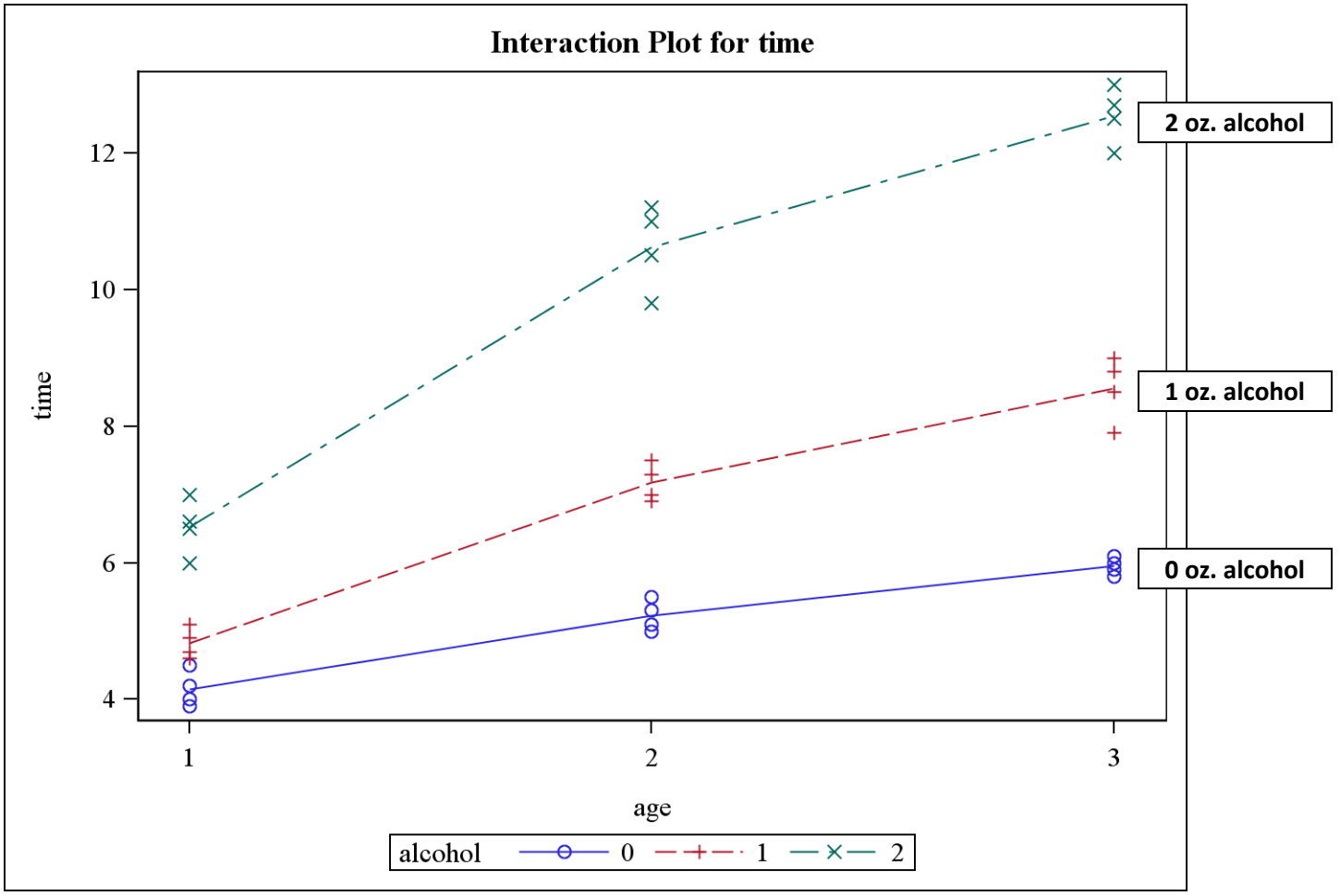
The SAS System
The GLM Procedure
Least Squares Means

age	time LSMEAN	LSMEAN Number
1	5.16666667	1
2	7.67500000	2
3	9.01666667	3

alcohol	time LSMEAN	LSMEAN Number
0	5.10833333	1
1	6.85000000	2
2	9.90000000	3

age	alcohol	time LSMEAN	LSMEAN Number
1	0	4.1500000	1
1	1	4.8250000	2
1	2	6.5250000	3
2	0	5.2250000	4
2	1	7.1750000	5
2	2	10.6250000	6
3	0	5.9500000	7
3	1	8.5500000	8
3	2	12.5500000	9

The SAS System
The GLM Procedure



Brown and Forsythe's Test for Homogeneity of time Variance ANOVA of Absolute Deviations from Group Medians					
Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
trt	8	0.4022	0.0503	1.23	0.3221
Error	27	1.1075	0.0410		