

```

data one;
  input temp density salinity wg;
  cards;
25 80 10 86
25 80 10 52
25 80 10 73
25 80 25 544
25 80 25 371
25 80 25 482
25 80 40 390
25 80 40 290
25 80 40 397
25 160 10 53
25 160 10 73
25 160 10 86
25 160 25 393
25 160 25 398
25 160 25 208
25 160 40 249
25 160 40 265
25 160 40 243
35 80 10 439
35 80 10 436
35 80 10 349
35 80 25 249
35 80 25 245
35 80 25 330
35 80 40 247
35 80 40 277
35 80 40 205
35 160 10 324
35 160 10 305
35 160 10 364
35 160 25 352
35 160 25 267
35 160 25 316
35 160 40 188
35 160 40 223
35 160 40 281
;

```

```

proc glm;
  class temp density salinity;
  model wg=temp density salinity temp*density temp*salinity density*salinity
        temp*density*salinity;
  lsmeans temp / stderr;
  lsmeans density / stderr;
  lsmeans salinity / stderr;
  lsmeans temp*density / stderr;
  lsmeans temp*salinity / stderr;
  lsmeans density*salinity / stderr;
  lsmeans temp*density*salinity / stderr;
  lsmeans temp*density*salinity / slice=density*salinity;
  lsmeans temp*density*salinity / slice=temp*salinity;
  lsmeans temp*density*salinity / slice=temp*density;
run;

```

The GLM Procedure

Class Level Information

Class	Levels	Values
temp	2	25 35
density	2	80 160
salinity	3	10 25 40
Number of observations		36

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	467636.3333	42512.3939	14.64	<.0001
Error	24	69690.6667	2903.7778		
Corrected Total	35	537327.0000			

Source	DF	Type I SS	Mean Square	F Value	Pr > F
temp	1	15376.0000	15376.0000	5.30	0.0304
density	1	21218.7778	21218.7778	7.31	0.0124
salinity	2	96762.5000	48381.2500	16.66	<.0001
temp*density	1	8711.1111	8711.1111	3.00	0.0961
temp*salinity	2	300855.1667	150427.5833	51.80	<.0001
density*salinity	2	674.3889	337.1944	0.12	0.8909
temp*density*salinity	2	24038.3889	12019.1944	4.14	0.0285

Source	DF	Type III SS	Mean Square	F Value	Pr > F
temp	1	15376.0000	15376.0000	5.30	0.0304
density	1	21218.7778	21218.7778	7.31	0.0124
salinity	2	96762.5000	48381.2500	16.66	<.0001
temp*density	1	8711.1111	8711.1111	3.00	0.0961
temp*salinity	2	300855.1667	150427.5833	51.80	<.0001
density*salinity	2	674.3889	337.1944	0.12	0.8909
temp*density*salinity	2	24038.3889	12019.1944	4.14	0.0285

Least Squares Means

temp	wg LSMEAN	Standard Error	Pr > t
25	258.500000	12.701220	<.0001
35	299.833333	12.701220	<.0001

density	wg LSMEAN	Standard Error	Pr > t
80	303.444444	12.701220	<.0001
160	254.888889	12.701220	<.0001

salinity	wg LSMEAN	Standard Error	Pr > t
10	220.000000	15.555754	<.0001
25	346.250000	15.555754	<.0001
40	271.250000	15.555754	<.0001

temp	density	wg LSMEAN	Standard Error	Pr > t
25	80	298.333333	17.962237	<.0001
25	160	218.666667	17.962237	<.0001
35	80	308.555556	17.962237	<.0001
35	160	291.111111	17.962237	<.0001

temp	salinity	wg LSMEAN	Standard Error	Pr > t
25	10	70.500000	21.999158	0.0038
25	25	399.333333	21.999158	<.0001
25	40	305.666667	21.999158	<.0001
35	10	369.500000	21.999158	<.0001
35	25	293.166667	21.999158	<.0001
35	40	236.833333	21.999158	<.0001

density	salinity	wg LSMEAN	Standard Error	Pr > t
80	10	239.166667	21.999158	<.0001
80	25	370.166667	21.999158	<.0001
80	40	301.000000	21.999158	<.0001
160	10	200.833333	21.999158	<.0001
160	25	322.333333	21.999158	<.0001
160	40	241.500000	21.999158	<.0001

temp	density	salinity	wg LSMEAN	Standard Error	Pr > t
25	80	10	70.333333	31.111508	0.0331
25	80	25	465.666667	31.111508	<.0001
25	80	40	359.000000	31.111508	<.0001
25	160	10	70.666667	31.111508	0.0324
25	160	25	333.000000	31.111508	<.0001
25	160	40	252.333333	31.111508	<.0001
35	80	10	408.000000	31.111508	<.0001
35	80	25	274.666667	31.111508	<.0001
35	80	40	243.000000	31.111508	<.0001
35	160	10	331.000000	31.111508	<.0001
35	160	25	311.666667	31.111508	<.0001
35	160	40	230.666667	31.111508	<.0001

temp*density*salinit Effect Sliced by density*salinity for wg

density	salinity	DF	Sum of Squares	Mean Square	F Value	Pr > F
80	10	1	171028	171028	58.90	<.0001
80	25	1	54722	54722	18.84	0.0002
80	40	1	20184	20184	6.95	0.0145
160	10	1	101660	101660	35.01	<.0001
160	25	1	682.666667	682.666667	0.24	0.6322
160	40	1	704.166667	704.166667	0.24	0.6269

temp*density*salinit Effect Sliced by temp*salinity for wg

temp	salinity	DF	Sum of Squares	Mean Square	F Value	Pr > F
25	10	1	0.166667	0.166667	0.00	0.9940
25	25	1	26401	26401	9.09	0.0060
25	40	1	17067	17067	5.88	0.0232
35	10	1	8893.500000	8893.500000	3.06	0.0929
35	25	1	2053.500000	2053.500000	0.71	0.4087
35	40	1	228.166667	228.166667	0.08	0.7816

temp*density*salinit Effect Sliced by temp*density for wg

temp	density	DF	Sum of Squares	Mean Square	F Value	Pr > F
25	80	2	250995	125497	43.22	<.0001
25	160	2	108329	54164	18.65	<.0001
35	80	2	46006	23003	7.92	0.0023
35	160	2	17002	8500.777778	2.93	0.0728

1. If you were to add all the numbers under the column Type I Sum of Squares, what would you get?
2. Is there significant 3-factor interaction in this case? Give a test statistic and p -value to support your answer.
3. What was the average of the treatment means associated with a water temperature of 25C?
4. What was the average of the treatment means associated with a water temperature of 25C and a salinity of 40%?
5. Was there a significant temperature effect on the per-shrimp weight gains among aquaria with density=80 and salinity=40%? Give the relevant mean values to compare and a p -value for testing whether the observed means are significantly different from each other.