Name:_____

Check one: Section 1 (Mon-Wed. 10:30-noon):_____

Section 2 (Mon-Wed. 1:30-3:00):_____

Statistics 431 Practice Midterm
Spring 2004

This exam is closed book.
You may use a calculator.
You must write the exam using pen (not pencil).

Show all your work.

A formula Sheet and Statistical Tables are attached.
There are blank pages at the end of the exam if you need more room.

Question	Total Points	Points Received
1	16	
2	16	
3	8	
4	9	
5	7	
6	4	
7	6	
8	14	
Total	80	

1) The following is a list of some of the statistical methods that you have learned about so far in this course:

- One sample t/Z-test of a population mean.
- One sample z-test of a population proportion.
- Two sample t/Z-test of population means.
- Two sample z-test of population proportions.
- Matched pairs t/Z-test.
- One-way ANOVA

For each of the situations described below, state the technique (from the list above) that you believe is appropriate. **If none are appropriate, state "none of the above".**

No calculations are required.

a) **[2 points]** A random sample of 40 cars were clocked as they passed by a checkpoint. Their speeds were recorded in miles per hour. Officials are interested in knowing if drivers are, on average, driving in excess of the 45 mph speed limit on this stretch of road.

b) **[2 points]** Small white worms that reduce strawberry yield can be treated with fumigation. A new additive was developed to make the fumigation persist longer, but with unknown side effects on the strawberry plants themselves. To test its overall effect, 15 plots were randomly selected in a large experimental farm, planted with strawberries, then split in half, with one half randomly selected for treatment with the standard fumigation, and the other half with the new additive. The strawberry yields were recorded (in quarts) for each half-plot under the standard and new treatments. Researchers want to know if the new additive is more effective than the standard fumigation.

c) **[2 points]** A "Union Shop" clause in a contract requires every worker to join the union soon after starting to work for the company. In 1973 there were 32 states that permitted the Union Shop, and 19 states (mostly southern) that had earlier passed "Right-to-Work" laws that outlawed the Union Shop and certain other practices. A random sample of 5 states from each group was selected and the average hourly wage within the state was calculated. You are interested in using this data to investigate the claim that Right-to-Work laws are costing the average

worker $0.50 per hour. You may assume that average hourly wages are normally distributed.

d) [2 points] Researchers want to answer the question: Do seat belts help? To answer this, a study was undertaken of cars that had been equipped with seat belts (lap-and-shoulder belts) and that had subsequently been involved in accidents. A random sample of 10,000 occupants showed the following:

	Seat Belt Worn	**Seat Belt Not Worn**	**Total**
Severe or Fatal Injury	3	119	122
No injuries	829	9,049	9,878
Total	832	9,168	10,000

e) [2 points] A large corporation is interested in determining whether an association exists between the commuting time of their employees and the level of stress-related problems observed on the job. A study of 116 assembly line workers reveals the following:

	Stress			
Commuting Time	High	Moderate	Low	Total
Under 15 min.	9	5	18	32
15-45 min	17	8	28	53
Over 45 min	18	6	7	31
Total	44	19	53	116

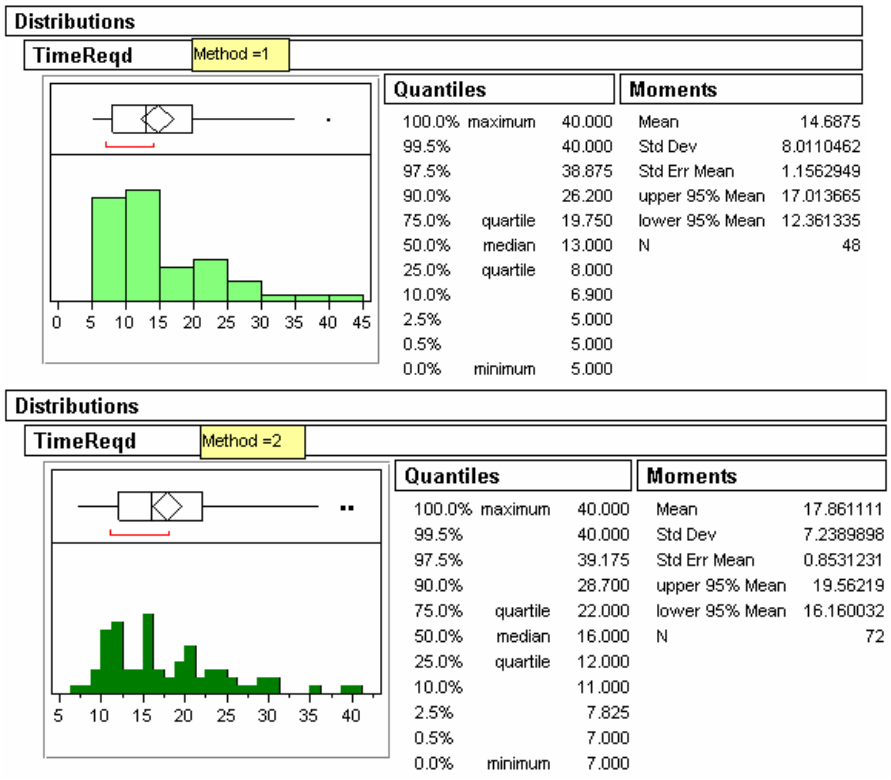
f) [2 points] A snack foods company that supplies stores in a metropolitan area with "healthy" snack products was interested in improving the shelf life of its tortilla chip product. Six batches (each batch containing 1 pound) of the product were made under each of four different formulations. The batches were then kept under the same conditions of storage. Product condition was checked each day for freshness. The shelf life in days until the product was deemed to be lacking in freshness was recorded. The company wants to know whether there is a difference in the average shelf life among the formulations.

g) **[2 points]** A student wants to investigate the prices of new textbooks in the campus bookstore and the competing off-campus store, which is a branch of a national chain. The student randomly chooses the required texts for 12 business school courses and compares the prices in the two stores. She wants to determine if there is a difference in average prices of required business textbooks between the two stores.

h) **[2 points]** An industrial psychologist wants to study the effects of motivation on sales in a particular firm. Of 24 new salespeople, 12 are randomly assigned to be paid an hourly rate, and the other 12 are paid a commission. The sales volume (in thousands of dollars) of each of the salespeople is measuring during the first two months on the job. The psychologist wants to know if there is a difference in average sales in the two groups.

2. A large food processing center needs to be able to switch from one type of package to another quickly to react to changes in order patterns. Consultants recommended and helped implement an alternative method for changing the production line. Data was gathered for both methods. The time (in minutes) required to change the production on a food processing line was measured over several days using both methods. A summary of the data is shown below.

   a) [11 points] Is one of these changeover methods faster than the other? Conduct the appropriate hypothesis test (and check the necessary assumptions). Use $\alpha = 0.05$. Report the P-value of your test.
   b) [5 points] If the cost per minute of lost production is $1000 and if 20 changeovers are made per day, calculate a 90% confidence interval for the savings (or extra cost) per day of using Method #2 instead of Method #1.



More room for answer to question #1…..

3) [8 points] A recent survey by Screenvision Cinema Promotions (a New York marketing company that specializes in movie houses) asked 400 filmgoers around the country questions to find the differences between regular popcorn-eaters and people who rarely consume it (reported on NPR Saturday, Sept 29, 2001). According to the report, 66 percent of the people who regularly eat popcorn say they're likely to cry during a movie, while only 22 percent of the non-popcorn crowd said so. Assume that 25% of filmgoers are regular popcorn-eaters (that statistic wasn't included in the report). Also assume that this is a simple random sample of filmgoers.

   Is there sufficient evidence at the 1% level to conclude that there is a difference in propensity-to-cry between popcorn-eaters and non-eaters? Remember to check the necessary assumptions.

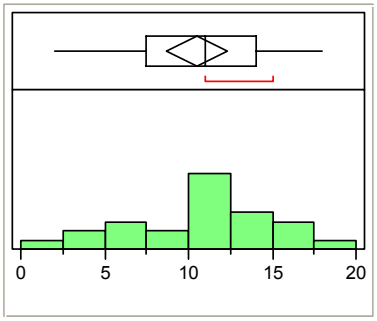
4) The local manager of a weight-loss organization wants to advertise about how effective their diet plan is. She samples 20 customers, at random, who have graduated from the program in the last 3 months. She records their total weight loss. This data is shown below.

Data: (total weight loss for each person, in pounds)

19	14	20	11	8	7	14	15	12	4	12	4
12	12	10	7	11	19	7	10	17	17	5	2

Distributions

loss



Quantiles		
100.0%	maximum	18.000
99.5%		18.000
97.5%		18.000
90.0%		15.000
75.0%	quartile	14.000
50.0%	median	11.000
25.0%	quartile	7.500
10.0%		4.000
2.5%		2.000
0.5%		2.000
0.0%	minimum	2.000

Moments	
Mean	10.50000
Std Dev	4.20145
Std Err Mean	0.85762
upper 95% Mean	12.27410
lower 95% Mean	8.72590
N	24.00000

a) [5 points] Calculate a 99% confidence interval for the percentage of graduates who have lost more than 10 pounds on the program.

b) [2 points] Show that you checked the necessary conditions in order to use the interval in (a).

c) [2 points] Notice that the manager sampled customers who have "graduated" (ie., successfully completed the program). Do you see any problem with this sampling strategy, in terms of representing the amount of weight people can expect to lose on the program?

More room for answer to #3…..

5) A recent Gallup poll (May 9, 2001) surveyed people about traffic. Three things they measured were:

I. The proportion of people who said that traffic was a major problem in their area every day.
II. The proportion of people who have a daily of commute of over 30 minutes.
III. The proportion of people who said they have made some sort of change in their life or schedule in order to account for traffic.

a) [5 points] Suppose pilot data suggests that 20% of Americans say that traffic is a major problem in their area everyday, 10% of Americans have a daily commute of over 30 minutes, and 40% of Americans said they had made some sort of change in their life in order to account for traffic.

Using this pilot data, what is the smallest sample size necessary so that all three estimates have a margin of error of +/- 5 percentage points (or less) on a 95% confidence interval? (i.e., each person in the sample gets asked these three questions)

b) [1 point] How would you modify your calculations in (a) if you had no pilot data. Don't redo your calculations….just tell me what you'd do differently.

c) [1 point] Would you expect to get a larger sample size in (a) or (b) ?

6) A new DSL (fast internet connection) provider is experimenting with two marketing strategies. They would like to offer customers free installation and some free service (with no future obligation) as an incentive to try their service, and hopefully subscribe. They are trying to decide if offering three free months of service would be more successful than offering one free month of service.

Suppose installation and service costs are such that, as part of this pilot experiment, they can afford to offer 50 customers one free month and 50 customers three free months, **or**, they can offer 90 customers one free month and 10 customers three free months.

Their objective is to decide if the proportion of customers who ultimately subscribe after receiving the free trial is different for the two strategies (one free month versus three free months).

a) [1 point] Write down the null and alternative hypotheses that would be appropriate for this analysis.
b) [1 point] Write down the formula for the test statistic that you would use to conduct this test (if you had data).
c) [2 points] Assume that the estimates of interest would be roughly similar under both study designs (e.g. assume $\bar{x}_1 - \bar{x}_2$, and/or s^2_{pooled}, and/or $\hat{p}_1 - \hat{p}_2$, and/or $\hat{p}_{pooled}$ would be basically the same under either scheme). Assuming both schemes **cost the same** (e.g. the only real costs to the company are installation costs), which scheme would you recommend? Why?

7)

a) [1 point] What is a Type I error?

b) [1 point] What is a Type II error?

c) [2 points] What is the formal definition of a P-value?

d) [1 point] What is α ? (in terms of probability)

e) [1 point] What theorem tells us that the sampling distribution of the sample mean is normal for large enough samples?

8) Data on the nutritional content of 76 (randomly selected) breakfast cereals sold at one particular grocery store was gathered. Besides nutritional information such as grams of sugar per serving, grams of dietary fiber per serving, and calories per serving, the shelf on which the cereal appeared in the grocery store was recorded (1=bottom shelf, 2=middle shelf, 3=top shelf).

Descriptive statistics and some data analysis results are shown below.

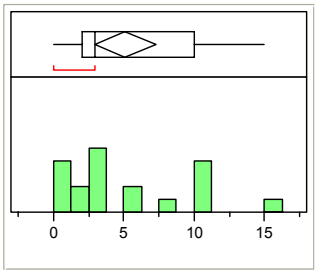
[20 points] What conclusions can you make about the differences of the cereals by shelf? Give a complete answer (state null hypotheses, test statistics, conclusions, check as sumptions, interpretations in words, etc).

Note that some of these tests don't satisfy the necessary assumptions. For the purposes of this practice midterm, interpret all the tests anyways.

1

Distributions

sugars

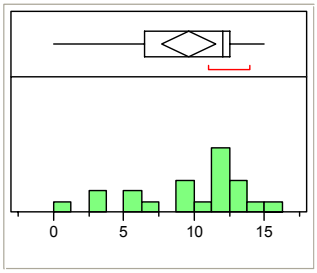


Quantiles			Moments	
100.0%	maximum	15.000	Mean	5.105263
99.5%		15.000	Std Dev	4.483237
97.5%		15.000	Std Err Mean	1.028525
90.0%		11.000	upper 95% Mean	7.266100
75.0%	quartile	10.000	lower 95% Mean	2.944426
50.0%	median	3.000	N	19.000000
25.0%	quartile	2.000		
10.0%		0.000		
2.5%		0.000		
0.5%		0.000		
0.0%	minimum	0.000		

2

Distributions

sugars

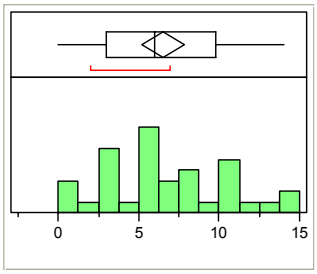


Quantiles			Moments	
100.0%	maximum	15.000	Mean	9.619048
99.5%		15.000	Std Dev	4.128876
97.5%		15.000	Std Err Mean	0.900995
90.0%		13.800	upper 95% Mean	11.498475
75.0%	quartile	12.500	lower 95% Mean	7.739620
50.0%	median	12.000	N	21.000000
25.0%	quartile	6.500		
10.0%		3.000		
2.5%		0.000		
0.5%		0.000		
0.0%	minimum	0.000		

3

Distributions

sugars

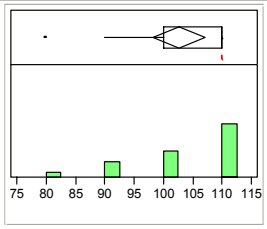


Quantiles			Moments	
100.0%	maximum	14.000	Mean	6.527778
99.5%		14.000	Std Dev	3.835817
97.5%		14.000	Std Err Mean	0.639303
90.0%		12.300	upper 95% Mean	7.825624
75.0%	quartile	9.750	lower 95% Mean	5.229932
50.0%	median	6.000	N	36.000000
25.0%	quartile	3.000		
10.0%		1.400		
2.5%		0.000		
0.5%		0.000		
0.0%	minimum	0.000		

1

Distributions

calories

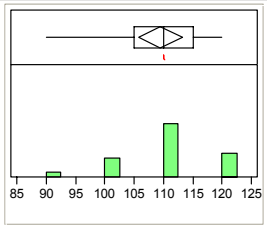


Quantiles			Moments	
100.0%	maximum	110.00	Mean	102.6316
99.5%		110.00	Std Dev	9.3346
97.5%		110.00	Std Err Mean	2.1415
90.0%		110.00	upper 95% Mean	107.1307
75.0%	quartile	110.00	lower 95% Mean	98.1325
50.0%	median	110.00	N	19.0000
25.0%	quartile	100.00		
10.0%		90.00		
2.5%		80.00		
0.5%		80.00		
0.0%	minimum	80.00		

2

Distributions

calories

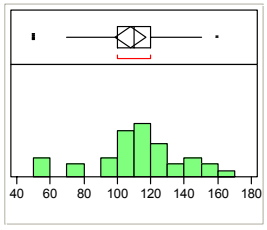


Quantiles			Moments	
100.0%	maximum	120.00	Mean	109.5238
99.5%		120.00	Std Dev	8.0475
97.5%		120.00	Std Err Mean	1.7561
90.0%		120.00	upper 95% Mean	113.1870
75.0%	quartile	115.00	lower 95% Mean	105.8607
50.0%	median	110.00	N	21.0000
25.0%	quartile	105.00		
10.0%		100.00		
2.5%		90.00		
0.5%		90.00		
0.0%	minimum	90.00		

3

Distributions

calories

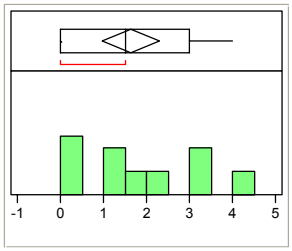


Quantiles			Moments	
100.0%	maximum	160.00	Mean	107.7778
99.5%		160.00	Std Dev	26.9509
97.5%		160.00	Std Err Mean	4.4918
90.0%		143.00	upper 95% Mean	116.8966
75.0%	quartile	120.00	lower 95% Mean	98.6590
50.0%	median	110.00	N	36.0000
25.0%	quartile	100.00		
10.0%		64.00		
2.5%		50.00		
0.5%		50.00		
0.0%	minimum	50.00		

1

Distributions

fiber

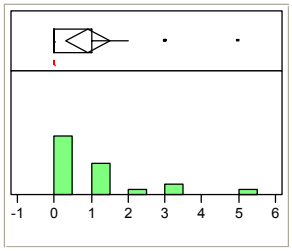


Quantiles			Moments	
100.0%	maximum	4.0000	Mean	1.631579
99.5%		4.0000	Std Dev	1.372772
97.5%		4.0000	Std Err Mean	0.314935
90.0%		4.0000	upper 95% Mean	2.293229
75.0%	quartile	3.0000	lower 95% Mean	0.969928
50.0%	median	1.5000	N	19.000000
25.0%	quartile	0.0000		
10.0%		0.0000		
2.5%		0.0000		
0.5%		0.0000		
0.0%	minimum	0.0000		

2

Distributions

fiber

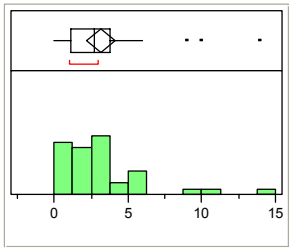


Quantiles			Moments	
100.0%	maximum	5.0000	Mean	0.9047619
99.5%		5.0000	Std Dev	1.3380868
97.5%		5.0000	Std Err Mean	0.2919945
90.0%		3.0000	upper 95% Mean	1.5138471
75.0%	quartile	1.0000	lower 95% Mean	0.2956767
50.0%	median	0.0000	N	21
25.0%	quartile	0.0000		
10.0%		0.0000		
2.5%		0.0000		
0.5%		0.0000		
0.0%	minimum	0.0000		

3

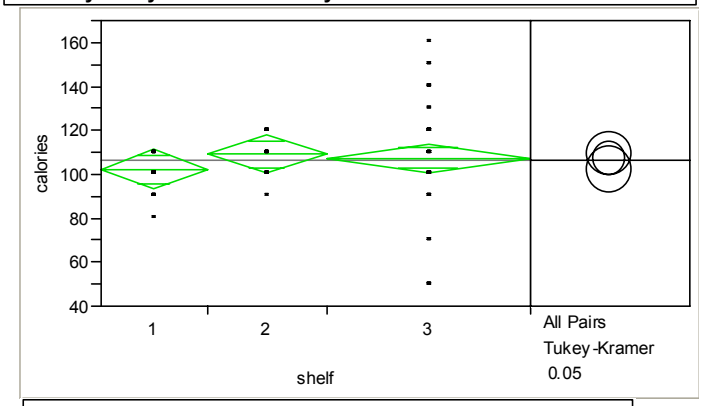
Distributions

fiber



Quantiles			Moments	
100.0%	maximum	14.000	Mean	3.138889
99.5%		14.000	Std Dev	2.872558
97.5%		14.000	Std Err Mean	0.478760
90.0%		6.900	upper 95% Mean	4.110817
75.0%	quartile	3.750	lower 95% Mean	2.166961
50.0%	median	2.750	N	36.000000
25.0%	quartile	1.125		
10.0%		0.700		
2.5%		0.000		
0.5%		0.000		
0.0%	minimum	0.000		

Oneway Analysis of calories By shelf



Oneway Anova

Summary of Fit

Rsquare	0.017986
Adj Rsquare	-0.00892
Root Mean Square Error	19.68446
Mean of Response	106.9737
Observations (or Sum Wgts)	76

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
shelf	2	518.066	259.033	0.6685	0.5156
Error	73	28285.881	387.478		
C. Total	75	28803.947			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	19	102.632	4.5159	93.63	111.63
2	21	109.524	4.2955	100.96	118.08
3	36	107.778	3.2807	101.24	114.32

Std Error uses a pooled estimate of error variance

Means Comparisons

Dif=Mean[i]-Mean[j]

	2	3	1
2	0.00000	1.74603	6.89223
3	-1.74603	0.00000	5.14620
1	-6.89223	-5.14620	0.00000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q*

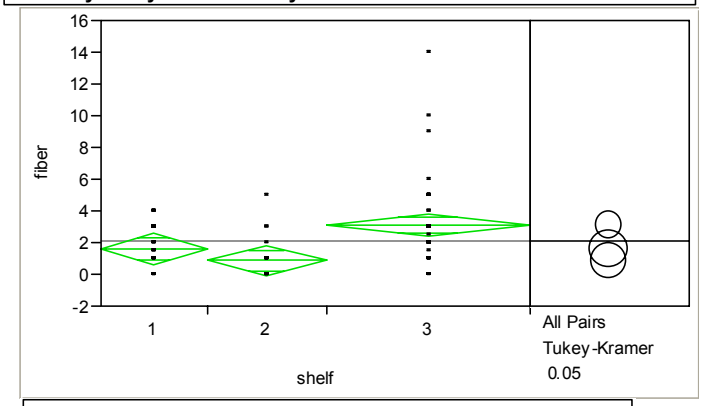
2.39245

Abs(Dif)-LSD

	2	3	1
2	-14.5335	-11.1853	-8.0189
3	-11.1853	-11.1002	-8.2080
1	-8.0189	-8.2080	-15.2793

Positive values show pairs of means that are significantly different.

Oneway Analysis of fiber By shelf



Oneway Anova

Summary of Fit

Rsquare	0.168916
Adj Rsquare	0.146147
Root Mean Square Error	2.21618
Mean of Response	2.144737
Observations (or Sum Wgts)	76

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
shelf	2	72.87176	36.4359	7.4186	0.0012
Error	73	358.53613	4.9115		
C. Total	75	431.40789			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	19	1.63158	0.50843	0.6183	2.6449
2	21	0.90476	0.48361	-0.0591	1.8686
3	36	3.13889	0.36936	2.4027	3.8750

Std Error uses a pooled estimate of error variance

Means Comparisons

Dif=Mean[i]-Mean[j]

	3	1	2
3	0.00000	1.50731	2.23413
1	-1.50731	0.00000	0.72682
2	-2.23413	-0.72682	0.00000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q*

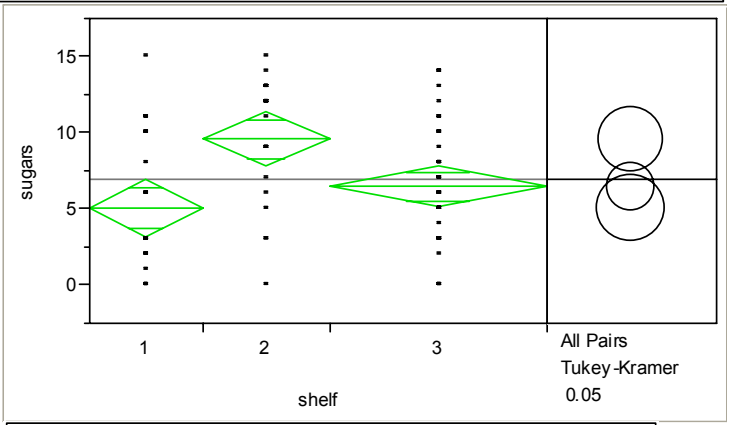
2.39245

Abs(Dif)-LSD

	3	1	2
3	-1.24972	0.00382	0.77825
1	0.00382	-1.72023	-0.95195
2	0.77825	-0.95195	-1.63626

Positive values show pairs of means that are significantly different.

Oneway Analysis of sugars By shelf



Oneway Anova

Summary of Fit

Rsquare	0.153158
Adj Rsquare	0.129957
Root Mean Square Error	4.08424
Mean of Response	7.026316
Observations (or Sum Wgts)	76

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
shelf	2	220.2333	110.117	6.6013	0.0023
Error	73	1217.7141	16.681		
C. Total	75	1437.9474			

Means for Oneway Anova

Level	Number	Mean	Std Error	Lower 95%	Upper 95%
1	19	5.10526	0.93699	3.2378	6.973
2	21	9.61905	0.89125	7.8428	11.395
3	36	6.52778	0.68071	5.1711	7.884

Std Error uses a pooled estimate of error variance

Means Comparisons

Dif=Mean[i]-Mean[j]

	2	3	1
2	0.00000	3.09127	4.51378
3	-3.09127	0.00000	1.42251
1	-4.51378	-1.42251	0.00000

Alpha= 0.05

Comparisons for all pairs using Tukey-Kramer HSD

q*

2.39245

Abs(Dif)-LSD

	2	3	1
2	-3.01550	0.40821	1.41995
3	0.40821	-2.30312	-1.34830
1	1.41995	-1.34830	-3.17024

Positive values show pairs of means that are significantly different.