STAT-E 150
Practice Exam

Notes about the Final Exam:

It will take place in Science Center Hall D, as will the review session prior to the test (4:30-5:30). You will have the option of taking the exam on your computer or on paper. Regardless, you will receive the exam in paper format. If you do it on the computer, you will submit it via Canvas as a word or pdf document. You will have two hours to complete the exam.

Note on the practice: This is not an estimate of the length of the final – this is long!!! It's to give you a comprehensive review.

Use the SPSS output shown below to answer questions 1 - 5:

Model Summary

Model	R	R Square	Adjusted R Square
1	.787[a]	.619	.511

a. Predictors: (Constant), dollarsspent, hours, dollarsspentsq, hourssq, dollarsspenthours

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	595.948	2331.293		.160	.901
	dollarsspent	119.685	64.580	2.922	1.853	.097
	hours	139.795	491.635	.312	.284	.873
	dollarsspentsq	1.571	.691	3.172	2.273	.029
	hourssq	3.84	26.728	.409	.302	.579
	dollarsspenthours	3.662	3.420	.559	.778	.956

a. Dependent Variable: earnings

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6520244.617	5	1304048.923	5.594	.013[a]
	Residual	2098183.117	9	233131.457		
	Total	8618427.733	14			

1. What is the fitted regression equation derived from this output?

2. Assess the overall model.

3. Which relationships are statistically significant, using an alpha of 0.05?

4. Would R^2 or R^2_{adj} be a better tool to indicate how well the model accounts for variability in this sample's data? Why and what does it mean?

5. What predictors might you try taking out of the model?

6. Which is larger: the confidence interval or the prediction interval for a value of the predictor? Why? What do they represent?

7. What are the assumptions for simple linear regression? Very briefly explain each one.

8. Researchers investigated the relationship between job success upon graduation (a rating ranging from 1-100 representing job salary and prestige), grades, and extracurricular involvement. They found the following relationship:

   $\widehat{\text{job success}} = 10 + 2.3\text{Grade} + 4.5\text{Extra} - 3.1\text{GradeExtra}$

   How would job success change with a one unit increase in grades?

9. A researcher thinks that the price of electric cars is related to the cost of fuel. Write the model they are proposing, as well as the appropriate null and alternative hypotheses.

10. Researchers hypothesize that the number of hours someone sleeps can be predicted by their age and stress level, such that there is a linear relationship between sleep and age and stress. In addition, they hypothesize that when people are young, the amount of stress will have a large influence on the amount of time they sleep, while for older people stress will have less of an effect on the amount of sleep. Write the hypothesized regression equation and the hypotheses for testing whether stress has a different effect on the amount of sleep for young and old people.

11. Researchers want to investigate whether there is an interaction between coffee brand (Green Mountain, Dunkin Donuts, or Newman's Own) and the rating of the roast darkness (on a scale from 1-10) when predicting caffeine amount. Write the model equation to test this theory.

12. If researchers used number of hours of TV watched to predict life satisfaction and found a correlation of r = -.4, what would the R^2 value be, and how would you interpret it in context?

13. A linear regression model using cumulative advertising dollars (in thousands of dollars) was used to predict the number of new cases a lawyer's office received. The output is shown below:

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	7.767	3.385		2.295	.027
	CUM. ADV (thous)	.113	.028	.539	4.042	.000

a. Dependent Variable: Num of Cases

a. What is the fitted regression equation?

b. Interpret the value of β_1 in context.

14. Researchers used revolutions per minute (rpm) to predict the heat rate (how much an engine heats up over time in degrees per minute) of an engine. The output included the following:

HEATRATE	RPM	LMCI_1	UMCI_1	LICI_1	UICI_1
8714	3600	9906.37570	10414.60029	8420.28723	11900.68876
9469	3600	9906.37570	10414.60029	8420.28723	11900.68876
11948	16000	12224.37956	12849.95687	10787.43613	14286.90030
12414	14600	11985.88157	12551.78514	10524.18801	14013.47869

a. What would the predicted heat rate for an engine with an RPM of 14,600? And what is the interval for this value and what does it represent (in context)?

b. What is the confidence interval for RPM=16,000, and what does it represent (in context)?

15. Researchers investigated the relationship between revolutions per minute (rpm) and heat rate of an engine. They found the following output:

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.844[a]	.712	.703	868.673

a. Predictors: (Constant), RPM_sq, RPM
b. Dependent Variable: HEATRATE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.196E8	2	59801660.914	79.250	.000[a]
	Residual	48293886.620	64	754591.978		
	Total	1.679E8	66			

a. Predictors: (Constant), RPM_sq, RPM
b. Dependent Variable: HEATRATE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	9485.978	255.225		37.167	.000
	RPM	.188	.050	.827	3.770	.000
	RPM_sq	1.356E-7	.000	.017	.080	.937

a. Dependent Variable: HEATRATE

a. Is there a significant quadratic relationship between rpm and heat rate? Use a .05 level of significance to justify your answer

b. If these were your results, would you use this model to predict heat rate or would you try another model? If so, why? What model would you try?

16. A study was conducted to see if students' grades on an exam in their statistics course could be predicted by their amount of studying and their SAT score. "Studying" was a categorical variable with 3 levels: no studying, reviewing notes, and attending a review section. "No studying" was treated as the base level, while "reviewing notes" was represented by x_1 (1 = notes, 0 = everything else), and "review section" by x_2 (1 = review section, 0 = everything else). The regression equation that was found was: $\hat{g}\text{rade} = 50 + 15X_1 + 30X_2 + 2X_{satscore}$.

a. What does 30 represent in context?

b. How many points higher would the average grade be for someone in the "review notes" group versus the "no study" group, after accounting for their SAT score?

17. A study was conducted to investigate whether the amount that wine collectors spent per month could be predicted by the average price they spent on each bottle of wine in their collection and how high they rated their expertise. The output from a stepwise regression analysis is shown below.

a. Assess which model better predicts the amount of money spent by wine experts.

b. What model would you use to predict the amount spent by wine experts? Write the equation.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.764[a]	.584	.577	72.993
2	.855[b]	.731	.721	59.310

a. Predictors: (Constant), AvgPrice

b. Predictors: (Constant), AvgPrice, Rating

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	404529.316	1	404529.316	75.925	.000[b]
	Residual	287714.113	54	5328.039		
	Total	692243.429	55			
2	Regression	505806.031	2	252903.015	71.895	.000[c]
	Residual	186437.398	53	3517.687		
	Total	692243.429	55			

a. Dependent Variable: AmountSpent

b. Predictors: (Constant), AvgPrice

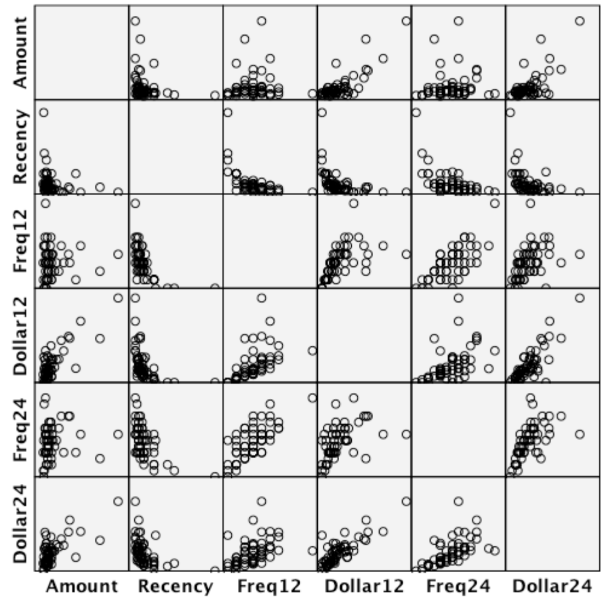
c. Predictors: (Constant), AvgPrice, Rating

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	-8.359	16.563		-.505	.616
	AvgPrice	1.352	.155	.764	8.713	.000
2	(Constant)	37.218	15.915		2.339	.023
	AvgPrice	1.743	.146	.986	11.969	.000
	Rating	-26.602	4.958	-.442	-5.366	.000

a. Dependent Variable: AmountSpent

Use the data below to answer the next three questions.



Correlations

		Amount	Recency	Freq12	Dollar12	Freq24	Dollar24
Amount	Pearson Correlation	1	-.221	.052	.804**	.102	.677**
	Sig. (2-tailed)		.102	.706	.000	.456	.000
	N	56	56	56	56	56	56
Recency	Pearson Correlation	-.221	1	-.584**	-.454**	-.549**	-.432**
	Sig. (2-tailed)	.102		.000	.000	.000	.001
	N	56	56	56	56	56	56
Freq12	Pearson Correlation	.052	-.584**	1	.556**	.710**	.421**
	Sig. (2-tailed)	.706	.000		.000	.000	.001
	N	56	56	56	56	56	56
Dollar12	Pearson Correlation	.804**	-.454**	.556**	1	.485**	.827**
	Sig. (2-tailed)	.000	.000	.000		.000	.000
	N	56	56	56	56	56	56
Freq24	Pearson Correlation	.102	-.549**	.710**	.485**	1	.596**
	Sig. (2-tailed)	.456	.000	.000	.000		.000
	N	56	56	56	56	56	56
Dollar24	Pearson Correlation	.677**	-.432**	.421**	.827**	.596**	1
	Sig. (2-tailed)	.000	.001	.001	.000	.000	
	N	56	56	56	56	56	56

**. Correlation is significant at the 0.01 level (2-tailed).

18. According to this correlation matrix, which predictor variable would you use for a simple linear regression analysis with Amount as the dependent variable? Why?

19. According to this correlation matrix, which set of predictor variables are most likely have some collinearity? How can you tell?

20. Write the hypotheses to asses the following model:

$$Amount = \beta_0 + \beta_1 \text{Dollar12} + \beta_2 \text{Freq12} + \beta_3 \text{Dollar24} + \beta_4 \text{Freq24} + \beta_5 \text{Recency} + \beta_6 \text{Card} + \varepsilon$$

21. Use the SPSS output shown below to answer all parts of this question:

Researchers investigated whether the number of eggs laid by birds were affected by the nest type or location. The nests were chosen from following types: saucer, cup, or pendant. The location was either on the ground or on a bridge.

a. Does the data satisfy the assumptions of ANOVA?

b. Are there any significant main effects?

c. Is there interaction? How might this change the interpretation of the results?

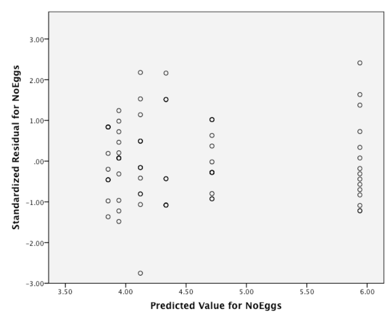
Levene's Test of Equality of Error Variances[a]

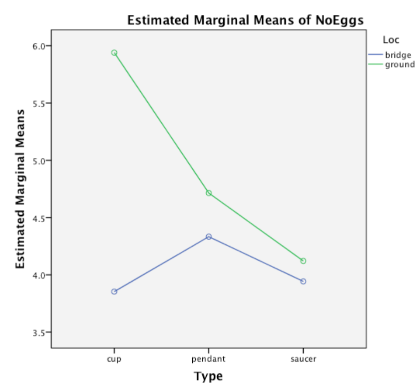
Dependent Variable: NoEggs

F	df1	df2	Sig.
2.010	5	76	.087

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

a. Design: Intercept + Loc + Type + Loc * Type



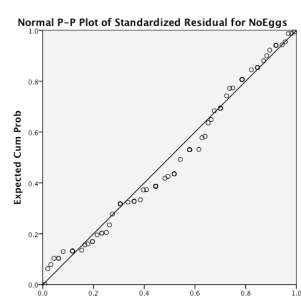


Tests of Between-Subjects Effects

Dependent Variable: NoEggs

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	43.845[a]	5	8.769	14.754	.000
Intercept	1640.764	1	1640.764	2760.640	.000
Loc	15.865	1	15.865	26.693	.000
Type	10.507	2	5.254	8.840	.000
Loc * Type	15.181	2	7.591	12.772	.000
Error	45.170	76	.594		
Total	1759.430	82			
Corrected Total	89.015	81			

a. R Squared = .493 (Adjusted R Squared = .459)



22. An owner of a trucking company was interested in investigating the amount of money it costs to transport a load depending on which company the truck was from (Carrier) and the market size it was being delivered to (Market). He randomly selected several trucks from 4 different carriers and two different market sizes (large and small). Use the results below to answer the following questions.
    a. Are there any significant main effects?

    b. Is there a significant interaction? How does this affect the interpretation of the results?

    c. Would you run any posthoc tests? Why or why not?

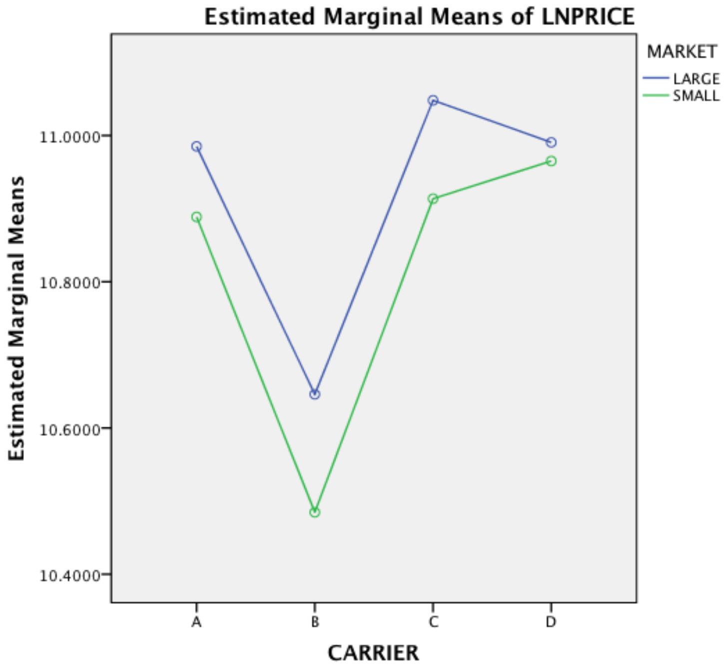
    d. Use the posthoc test of carrier below to follow up the main effect of carrier.

Tests of Between-Subjects Effects

Dependent Variable: LNPRICE

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	16.483[a]	7	2.355	5.170	.000
Intercept	47145.999	1	47145.999	103508.119	.000
MARKET	1.090	1	1.090	2.393	.123
CARRIER	14.314	3	4.771	10.476	.000
MARKET * CARRIER	.240	3	.080	.175	.913
Error	200.412	440	.455		
Total	53000.507	448			
Corrected Total	216.895	447			

a. R Squared = .076 (Adjusted R Squared = .061)



Multiple Comparisons

Dependent Variable: LNPRICE

Tukey HSD

(I) CARRIER	(J) CARRIER	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
A	B	.376073*	.0827631	.000	.162637	.589509
	C	-.041789	.0902568	.967	-.274550	.190972
	D	-.029906	.0938574	.989	-.271953	.212140
B	A	-.376073*	.0827631	.000	-.589509	-.162637
	C	-.417862*	.0899711	.000	-.649886	-.185838
	D	-.405979*	.0935827	.000	-.647317	-.164641
C	A	.041789	.0902568	.967	-.190972	.274550
	B	.417862*	.0899711	.000	.185838	.649886
	D	.011883	.1002711	.999	-.246704	.270469
D	A	.029906	.0938574	.989	-.212140	.271953
	B	.405979*	.0935827	.000	.164641	.647317
	C	-.011883	.1002711	.999	-.270469	.246704

Based on observed means.
The error term is Mean Square(Error) = .455.

*. The mean difference is significant at the 0

23. Researchers were interested in whether dynamic stretching was superior to static stretching for professional dancers. They randomly selected 10 dancers from New York City, and had them on four separate days either not stretch at all, perform static stretching, perform dynamic stretching, or perform a combination of static and dynamic. They then recorded their vertical jump height. Here are the results of their analysis.

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b]		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
stretching	.541	4.740	5	.452	.702	.921	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: stretching

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
stretching	Sphericity Assumed	113.601	3	37.867	24.353	.000
	Greenhouse-Geisser	113.601	2.105	53.962	24.353	.000
	Huynh-Feldt	113.601	2.763	41.111	24.353	.000
	Lower-bound	113.601	1.000	113.601	24.353	.001
Error(stretching)	Sphericity Assumed	41.983	27	1.555		
	Greenhouse-Geisser	41.983	18.947	2.216		
	Huynh-Feldt	41.983	24.870	1.688		
	Lower-bound	41.983	9.000	4.665		

Pairwise Comparisons

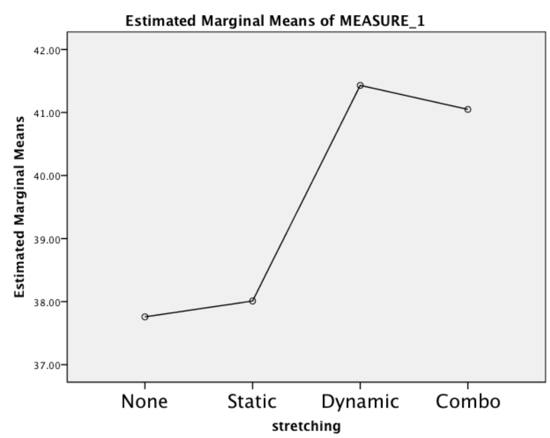
Measure: MEASURE_1

(I) stretching	(J) stretching	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b] Lower Bound	Upper Bound
1	2	-.251	.460	.996	-1.794	1.292
	3	-3.671*	.735	.004	-6.133	-1.209
	4	-3.290*	.475	.000	-4.881	-1.699
2	1	.251	.460	.996	-1.292	1.794
	3	-3.420*	.665	.004	-5.650	-1.190
	4	-3.039*	.434	.000	-4.494	-1.584
3	1	3.671*	.735	.004	1.209	6.133
	2	3.420*	.665	.004	1.190	5.650
	4	.381	.507	.978	-1.318	2.080
4	1	3.290*	.475	.000	1.699	4.881
	2	3.039*	.434	.000	1.584	4.494
	3	-.381	.507	.978	-2.080	1.318

Based on estimated marginal means

*. The mean difference is significant at the

b. Adjustment for multiple comparisons: Sidak.



a. Is there a significant main effect of stretching type?

b. What can you conclude from the study via the pairwise comparisons?

Answers:

1. The complete second-order model is
$\widehat{\text{Earnings}}$= 595.95 + 119.69Dollarsspent + 139.80Hours + 1.57Dollarsspent^2 +3.84Hours^2 +3.66DollarsspentHours

2. H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$
H_a: the betas are not all zero

   Since p is small (.013), we reject the null hypothesis. The data suggests that the model is useful in predicting average earnings. [list betas]

3. H_0: $\beta_3 = 0$
H_a: $\beta_3 \neq 0$
Because p is equal to .029, which is less than .05, we can reject the null hypothesis that there is no relationship between dollarspent^2 and earnings. The data suggests that there is a curvilinear relationship between the average dollars spent and earnings.

4. R^2_{adj} represents the variation in the dependent variable that is explained by its association with the predictor variables, adjusting for the number of predictor variables and sample size. Adjusted R^2 would be a better tool because we have more than one predictor variable.

5. I might suggest taking out the interaction of dollarsspent and hours, and hours^2 as they are higher order terms and nonsignificant. I might also consider taking out hours, as the p-value is high (.873), but I might want to leave it in and see how much it accounts for after the higher order terms are removed. I cannot remove dollarsspent, even though the pvalue is greater then .05, as the higher order term dollarsspent^2 is significant.

6. The Prediction Interval, which is the interval you can be 95% confident will contain a predicted individual value of the response variable. It is larger because it is the prediction for an individual, as opposed to the confidence interval, which is used when predicting the mean value. Individual values vary more than means do.

7. Linearity: There is a linear relationship between the response and predictor variables. Can be checked by looking at your data and the residual plot.
Independence assumption: The errors must be mutually independent.
Equal variance assumption: The residuals should be constant for all values of the response variable. Can be checked with a residual plot.
Normality: Residuals should be normally distributed. Can be checked with a normal probability plot.
Randomization Condition: Data should be randomly selected.

8. It would change by 2.3 - 3.1Extra

9. A linear model, $Y = \beta_0 + \beta_1\text{Fuelcost} + \varepsilon$
   H_0: $\beta_1 = 0$; H_a: $\beta_1 \neq 0$.

10. $Y = \beta_0 + \beta_1 X_{age} + \beta_2 X_{stress} + \beta_3 X_{age} X_{stress} + \varepsilon$
    H_0: $\beta_3 = 0$; H_a: $\beta_3 \neq 0$

11. IsDD: 1 when coffee brand is dunkin donuts, 0 otherwise
    IsGreen: 1 when coffee brand is green mountain, 0 otherwise
    $Y_{caffeine} = \beta_0 + \beta_1\text{IsDD} + \beta_2\text{IsGreen} + \beta_3\text{Roast} + \beta_4\text{IsDDRoast} + \beta_5\text{IsGreenRoast} + \varepsilon$

12. $R^2 = .16$ It means that 16% of the variability in life satisfaction scores can be accounted for by the number of hours of TV watched.

13. a. $\widehat{\text{New}}$ cases = 7.77 + .113 Cum_Adv
    b. H_0: $\beta_1 = 0$
       H_a: $\beta_1 \neq 0$

    Because p is small ($p<.001$) we can reject the null hypothesis that there is no relationship between average cumulative advertising dollars and number of new cases. The data indicates that there is a linear relationship between the average amount of advertising dollars spent and personal injury cases, such that for every thousand of dollars spend on advertising, the number of cases will increase by .113 on average.

14. a. PI = 10,524,19 to 14,013.48. This means that we are 95% confident that the heat rate for an individual engine that has a rpm of 14,600 will fall within that range.
    b. CI = 12,224.38 to 12,849.96. This means that we are 95 % confident that the average heat rate for engines with a rpm of 16,000 will be somewhere within that range.

15. a. H_0: $\beta_2 = 0$
       H_a: $\beta_2 \neq 0$
    Since the p-value of .94 is large, we fail to reject the null hypothesis that there is no quadratic relationship between rpms and heat rate. The data suggests that there is not a curvilinear relationship between RPM and heat rate.
    b. No, I would try dropping the non-significant second order term from the model because it does not explain a significant amount of the variance in heat rate. I would try Heat rate = $\beta_0 + \beta_1 X_{RPM} + \varepsilon$

16. a. 30 represents how much higher the average score would be for students who attended a review section compared to those who did not study, after accounting for their SAT score.
    b. 15

17. a. When we compare the two models, we find that the R^2_{adj} value for model A is smaller at 57.7% compared to model B at 72%. This suggests that model B does a better job of predicting amount spent.
    Consistent with this, the standard error of the estimate is smaller for model B (59.31) compared to model A (72.99), again suggesting model B would do a better job of predicting amount spent. Taken together, this suggests that model B would be more accurate at predicting amount spent.

    b. $\widehat{\text{amount\_spent}} = 37.22 + 1.74X_{AvgPrice} - 26.60X_{rating}$

18. I would use dollar12 because it has the largest correlation with amount.

19. Dollar12 and Dollar24 are most likely to be collinear because these two variables have the highest

correlation value of r=.827. However, they are all significantly correlated ($p<.05$) with each other, so I would have concerns about all of them being collinear.

20. H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$
    H_a: the betas are not all zero
21. a.
    Equal variances condition:

    H_0: $\sigma^2_{gc} = \sigma^2_{gp} = \sigma^2_{gs} = \sigma^2_{bc} = \sigma^2_{bp} = \sigma^2_{bs}$; H_a: the variances are not all equal.
    Since the p-value for Levene's test is greater than .05, we fail to reject the null hypothesis that the variances are all equal. In addition, the residual plot looks to have similar spread for all the groups. We are not given the standard deviations to perform the rule of thumb test. Taken together, this suggests that the assumption of equal variance is satisfied.

    Independence: The description does not say how the nests were chosen.

    Normality: The normal probability plot roughly follows the line.

    Since the assumptions of equal variance and normality are met, we can continue with the ANOVA. We need to be careful when interpreting the results as we don't know if the nests or locations studied were randomly selected from a larger population.

    b. H_0: $\mu_{saucer} = \mu_{cup} = \mu_{pendant}$
    H_a: at least one of the means is different
    For the main effect of nest type the p-value is small, ($p<.001$), so we can reject the null hypothesis. This suggests that there are differences in the average number of bird's eggs laid among the different nests types. However, there is a significant interaction ($p<.001$), so we should be careful in interpreting the main effects.

    H_0: $\mu_{bridge} = \mu_{ground}$
    H_a: $\mu_{bridge} \neq \mu_{ground}$

    For the main effect of location, the p-value is small ($p<.001$), so we can reject the null hypothesis. This suggests that the average number of eggs laid is larger for nests on the ground than on a bridge. However, there is a significant interaction ($p<.001$), so we should be careful in interpreting the main effects.

    c. H_0: the main effect of each factor is the same for each level of the other factor
    H_a: the two factors interact
    For the interaction, the p-value is small ($p<.001$), so we can reject the null hypothesis. This suggests that the effect of nest type on the number of eggs laid is different depending on the location of the nest. Given this significant interaction, we cannot interpret the main effects or run any posthoc tests to follow them up, as it no longer makes sense to average across factors. We would need to follow this ANOVA up with further analysis that pulls apart the two factors.

22. a. To test the main effect of market size:

    H_0: $\mu_{large} = \mu_{small}$
    H_a: $\mu_{large} \neq \mu_{small}$
    Since the p-value is large ($p=.123$), we fail to reject the null hypothesis. This suggests that the average cost to transport a load is similar for different market sizes.

H_0: $\mu_A = \mu_B = \mu_C = \mu_D$
H_a: the means are not all equal

Since the p-value is small ($p<.001$), we can reject the null hypothesis. This suggests that the average price of a load differs for at least one of the carriers. We would need a posthoc tests to figure out which.

b. To test the interaction:

H_0: the main effect of each factor is the same for each level of the other factor
H_a: the two factors interact

Since the p-value is large ($p=.913$), we fail to reject the null hypothesis. This suggests that the effect of carrier on the cost of a load is similar for large and small markets. Because there is no significant interaction, we can interpret the main effects and run any needed posthoc tests.

c. I would run posthoc tests on carrier, as there is a significant main effect and there are more than two levels. I would not run it on market size, as it is not significant. In addition, even if it was significant, there are only two levels so it is not necessary.

d.
H_0: $\mu_i = \mu_j$
H_a: $\mu_i \neq \mu_j$
From looking at Tukey's posthoc tests, we can see that the average cost of a load is significantly less from CarrierB than all the other carriers (all $p<.001$).

23. a.

H_0: $\mu_{none} = \mu_{static} = \mu_{dynamic} = \mu_{combo}$
H_a: the means are not all equal

Since $p<.001$, we can reject the null hypothesis. This suggests the average vertical jump height differs across the four stretching types.

b.
H_0: $\mu_i = \mu_j$
H_a: $\mu_i \neq \mu_j$
From the pairwise comparisons and the graph of the data, we can see that average vertical height is similar for dynamic and the combination of dynamic and static stretching ($p=.978$), but significantly greater than no stretching (none vs dynamic $p<.01$, none vs combination $p<.001$) and static stretching (static vs dynamic $p<.01$, static versus combination $p<.001$) which are similar (p=996). This suggests that dancers should incorporate some amount of dynamic stretching if they want to generally increase their vertical jump height.