Part 1: Multiple Choice. *Circle the letter corresponding to the best answer.*

1. Other things being equal, larger automobile engines consume more fuel. You are planning an experiment to study the effect of engine size (in liters) on the gas mileage (in miles per gallon) of sport utility vehicles. In this study,
(a) gas mileage is a response variable, and you expect to find a negative association.
(b) gas mileage is a response variable, and you expect to find a positive association.
(c) gas mileage is an explanatory variable, and you expect to find a strong negative association.
(d) gas mileage is an explanatory variable, and you expect to find a strong positive association.
(e) gas mileage is an explanatory variable, and you expect to find very little association.

2. In a statistics course, a linear regression equation was computed to predict the final-exam score from the score on the first test. The equation was $\hat{y} = 10 + 0.9x$ where y is the final-exam score and x is the score on the first test. Carla scored 95 on the first test. What is the predicted value of her score on the final exam?
(a) 85.5 (b) 90 (c) 95 (d) 95.5 (e) none of these

3. In the course described in #2, Bill scored a 90 on the first test and a 93 on the final exam. What is the value of his residual?
(a) –2.0 (b) 2.0 (c) 3.0 (d) 93 (e) none of these

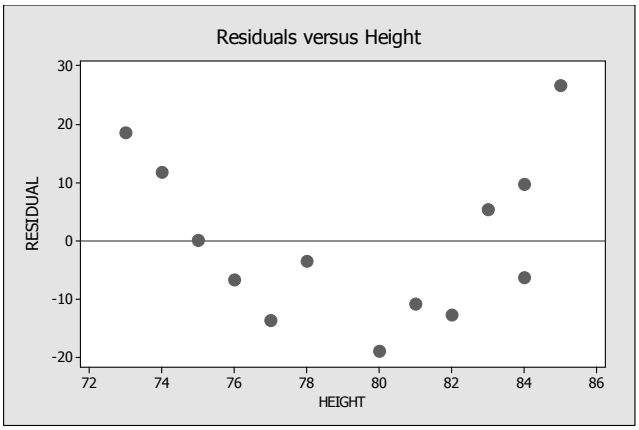
4. The correlation between the heights of fathers and the heights of their (fully grown) sons is $r = 0.52$. This value was based on both variables being measured in inches. If fathers' heights were measured in feet (one foot equals 12 inches), and sons' heights were measured in furlongs (one furlong equals 7920 inches), the correlation between heights of fathers and heights of sons would be
(a) much smaller than 0.52
(b) slightly smaller than 0.52
(c) unchanged: equal to 0.52
(d) slightly larger than 0.52
(e) much larger than 0.52

5. All but one of the following statements contains an error. Which statement could be correct?
(a) There is a correlation of 0.54 between the position a football player plays and his weight.
(b) We found a correlation of $r = –0.63$ between gender and political party preference.
(c) The correlation between the distance travelled by a hiker and the time spent hiking is $r = 0.9$ meters per second.
(d) We found a high correlation between the height and age of children: $r = 1.12$.
(e) The correlation between mid-August soil moisture and the per-acre yield of tomatoes is $r = 0.53$.

6. A set of data describes the relationship between the size of annual salary raises and the performance ratings for employees of a certain company. The least squares regression equation is $\hat{y} = 1400 + 2000x$ where y is the raise amount (in dollars) and x is the performance rating. Which of the following statements is *not necessarily* true?

(a) For each one-point increase in performance rating, the raise will increase on average by $2000.
(b) The actual relationship between salary raises and performance rating is linear.
(c) A rating of 0 will yield a predicted raise of $1400.
(d) The correlation between salary raise and performance rating is positive.
(e) If the average performance rating is 1.2, then the average raise is $3800.

7. A least-squares regression line for predicting weights of basketball players on the basis of their heights produced the residual plot below.



What does the residual plot tell you about the linear model?

(a) A residual plot is not an appropriate means for evaluating a linear model.
(b) The curved pattern in the residual plot suggests that there is no association between the weight and height of basketball players.
(c) The curved pattern in the residual plot suggests that the linear model is not appropriate.
(d) There are not enough data points to draw any conclusions from the residual plot.
(e) The linear model is appropriate, because there are approximately the same number of points above and below the horizontal line in the residual plot.

Use the following to answer questions **8** and **9**.

One concern about the depletion of the ozone layer is that the increase in ultraviolet (UV) light will decrease crop yields. An experiment was conducted in a green house where soybean plants were exposed to varying levels of UV, measured in Dobson units. At the end of the experiment the yield (kg) was measured. A regression analysis was performed with the following results:

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|	Lower 95%	Upper 95%
Intercept	3.9800118	0.053774	74.01	<.0001	3.8638398	4.0961838
uv	-0.046285	0.010741	* hidden *	0.0008	**** hidden ****	

8. The least-squares regression line is the line that
(a) minimizes the sum of the distances between the actual UV values and the predicted UV values.
(b) minimizes the sum of the squared residuals between the actual yield and the predicted yield.
(c) minimizes the sum of the distances between the actual yield and the predicted UV.
(d) minimizes the sum of the squared residuals between the actual UV reading and the predicted UV values.
(e) minimizes the perpendicular distance between the regression line and each data point.

9. Which of the following is correct?
(a) If the UV value increases by 1 Dobson unit, the yield is expected to increase by 0.0463 kg.
(b) If the yield increases by 1 kg, the UV value is expected to decrease by 0.0463 Dobson units.
(c) If the UV value increases by 1 Dobson unit, the yield is expected to decrease by 0.0463 kg.
(d) The predicted yield is 4.3 kg when the UV value is 20 Dobson units.
(e) None of the above is correct.

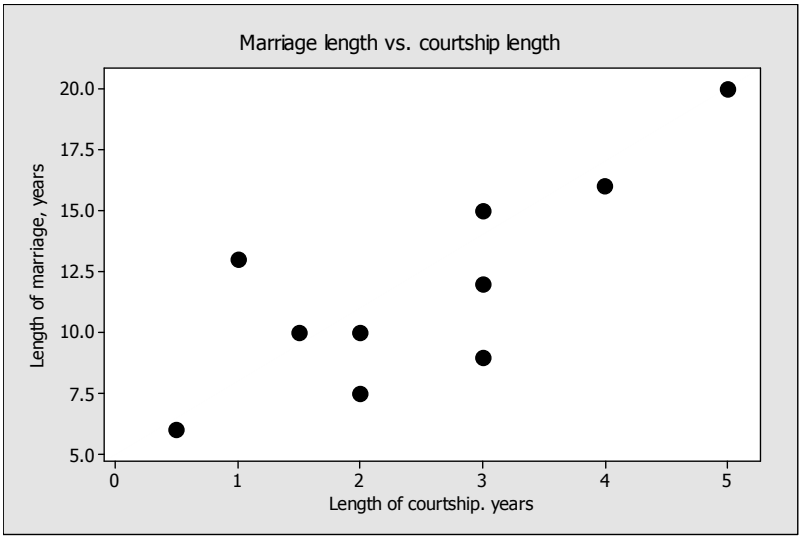
10. Which statements below about least-squares regression are correct?
I. Switching the explanatory and response variables will not change the least-squares regression line.
II. The slope of the line is very sensitive to outliers with large residuals.
III. A value of r^2 close to 1 does <u>not</u> guarantee that the relationship between the variables is linear.
(a) Only I is correct.
(b) Only II is correct.
(c) Only III is correct.
(d) Both II and III are correct.
(e) All three statements—I, II, and III—are correct.

Part 2: Free Response

Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

Questions 11-15 relate to the following.

A certain psychologist counsels people who are getting divorced. A random sample of ten of her patients provided the data in the following scatterplot, where x = number of years of courtship before marriage, and y = number of years of marriage before divorce.



11. Describe what the scatterplot reveals about the relationship between length of courtship and length of marriage.

12. Suppose a new point at (4.5, 8), that is, years of courtship = 4.5 and years of marriage = 8, were added to the plot. What effect, if any, will this new point have on the correlation between courtship duration and marriage duration? Explain.

Below is the computer output for the regression of length of marriage *versus* length of courtship.

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Predictor     Coef  SE Coef      T      P
Constant     5.710    1.880   3.04  0.016
courtship   2.4559   0.6669   3.68  0.006

S = 2.74982   R-Sq = 62.9%   R-Sq(adj) = 58.3%
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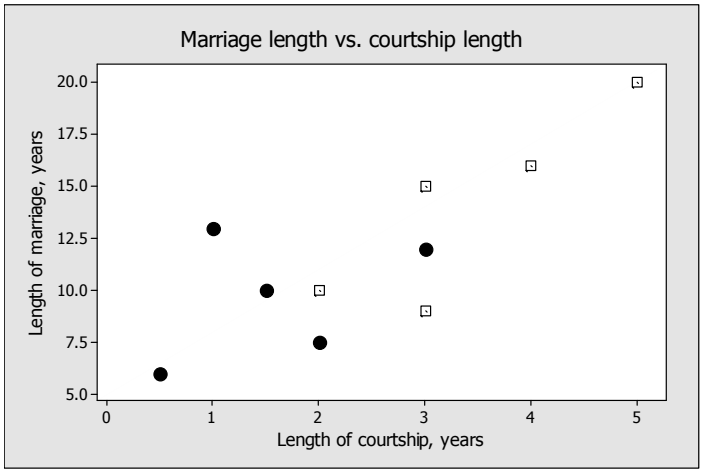
13. What is the slope of the regression line? Interpret the slope in the context of this problem.

14. Explain what the quantity S = 2.74982 measures in the context of this problem.

15. The psychologist is curious about whether having children has an impact on this relationship. She draws a second scatterplot, with those couples who have children as open squares and couples without children as closed circles.



Comment on the impact that having children has on the relationship between length of courtship and length of marriage for these patients.

One weekend, a statistician notices that some of the cars in his neighborhood are very clean and others are quite dirty. He decides to explore this phenomenon, and asks 15 of his neighbors how many times they wash their cars each year and how much they paid in car repair costs last year. His results are in the table below:

	Mean	Standard deviation
x = number of car washes per year	6.4	3.78
y = repairs costs for last year	$955.30	$323.50

The correlation for these to two variables is $r = -0.71$

16. Find the equation of the least-squares regression line (with y as the response variable).

17. What percentage of the variation in repair costs can be explained by the number of times per year a car is washed?

18. Based on these data, can we conclude that washing your car frequently will reduce repair costs? Explain.