Questions (1) through (11) apply to the gamma radiation data below.

- The article “Effects of Gamma Radiation on Juvenile and Mature Cuttings of Quaking Aspen” (Forest Science (1967): 240-245) reported data on the effect of exposure to radiation (kR per 16 hours) on the dry weight of roots (milligrams). (A kiloroentgen, abbreviated kR, is a unit of gamma radiation.)

- The dataset analyzed here has 20 observations; 4 measured dry weights at each of 5 levels of radiation exposure.

- Summary statistics for the variables radiation and weight:

<table>
<thead>
<tr>
<th>Variable</th>
<th>25%</th>
<th>Median</th>
<th>Mean</th>
<th>75%</th>
<th>90%</th>
<th>s</th>
</tr>
</thead>
<tbody>
<tr>
<td>radiation</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>2.9</td>
</tr>
<tr>
<td>weight</td>
<td>82.5</td>
<td>100.6</td>
<td>98.7</td>
<td>120.2</td>
<td>123.3</td>
<td>22.7</td>
</tr>
</tbody>
</table>

- Partial Splus output and a plot are given below for the simple linear regression model: weight ~ radiation. In the Splus output, dashes indicate omitted information.

Call: lm(formula = weight ~ radiation)

Residuals:
  Min 1Q Median 3Q Max
  -15.21 -5.437 0.3482 5.931 15.5

Coefficients:

|            | Value | Std. Error | t value | Pr(>|t|) |
|-------------|-------|------------|---------|---------|
| (Intercept) | --    | 3.1466     | 40.7031 | --      |
| radiation   | -7.3387| 0.6423     | 11.5966 | --      |

Residual standard error: 8.125 on 18 degrees of freedom
Multiple R-Squared: 0.8788
F-statistic: 130.5 on 1 and 18 degrees of freedom, the p-value is 1.107e-09

Correlation of Coefficients:

  (Intercept)
  radiation -0.8165

<table>
<thead>
<tr>
<th>Df</th>
<th>Sum of Sq</th>
<th>Mean Sq</th>
<th>F Value</th>
<th>Pr(F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>radiation</td>
<td>1</td>
<td>8617.000</td>
<td>8617.00</td>
<td>--</td>
</tr>
<tr>
<td>Residuals</td>
<td>18</td>
<td>1188.138</td>
<td>66.01</td>
<td></td>
</tr>
</tbody>
</table>
1. Write out in precise statistical notation the fitted model for the simple linear regression. [5 points]

2. Explain in a sentence what the slope term means as applied to this problem. [5 points]

3. Give the value of the linear correlation coefficient between radiation and height. [5 points]

4. True or False. Circle one. A correlation coefficient near -1 always implies a large negative slope. [5 points]

5. What percent of variation remains unexplained by the regression of weight on radiation? [5 points]
6. At what value of radiation will we get our most precise prediction of weight? (Hint: You do not need to do any calculations here.) [5 points]

7. Determine whether there is evidence of a linear association between radiation exposure and dry weight. Give hypotheses, test statistic, a p-value for your test and a conclusion. [15 points]

8. Determine whether there is evidence of a negative association between radiation exposure and dry weight. Give hypotheses, test statistic, a p-value for your test and a conclusion. [10 points]
9. The partial Splus output for the model states:

F-statistic: 130.5 on -- and -- degrees of freedom, the p-value is 1.107e-09

(a) [5 points] Give the null and alternative hypotheses associated with this F-statistic in formal statistical terms.

(b) What is the rejection region for a test of the hypotheses in part (9a) at $\alpha = 0.05$? [5 points]

10. We wish to perform an F-test for lack of fit to the simple linear regression model,

(a) Why can we perform a lack of fit test in this example? [5 points]

(b) What are the hypotheses being tested? Give the hypotheses in formal statistical notation. [5 points]

(c) Give the degrees of freedom associated with the Sum of Squares for Lack of Fit in this case. [5 points]

(d) Imagine that the null hypothesis in (10b) is rejected; give an example of a model you might investigate next. [5 points]
11. Imagine that we need to rescale our radiation exposure measurements to units of \( kR \ per \ hour \) (rather than \( kR \ per \ 16 \ hours \)) and then refit the simple linear regression model. Which of the following would change? \textbf{Circle all that apply.} [5 points]

(a) the estimated coefficient for radiation in the regression, \( \hat{\beta}_{\text{radiation}} \)
(b) the overall conclusion of a hypothesis test of \( H_o : \beta_{\text{radiation}} = 0 \) vs. \( H_a : \beta_{\text{radiation}} \neq 0 \)
(c) the residual sum of squares for the regression
(d) the degrees of freedom for \( \hat{\sigma}^2 \)
(e) \( R^2 \)