Begin your response to **QUESTION 1** on this page.

STATISTICS

SECTION II

Total Time—1 hour and 30 minutes

6 Questions

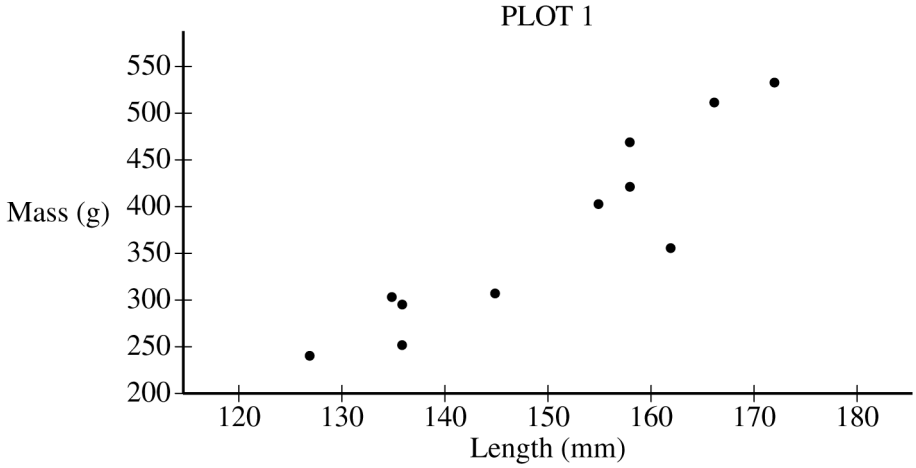
Part A

Suggested Time—1 hour and 5 minutes

5 Questions

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

1. A biologist gathered data on the length, in millimeters (mm), and the mass, in grams (g), for 11 bullfrogs. The data are shown in Plot 1.



(a) Based on the scatterplot, describe the relationship between mass and length, in context.

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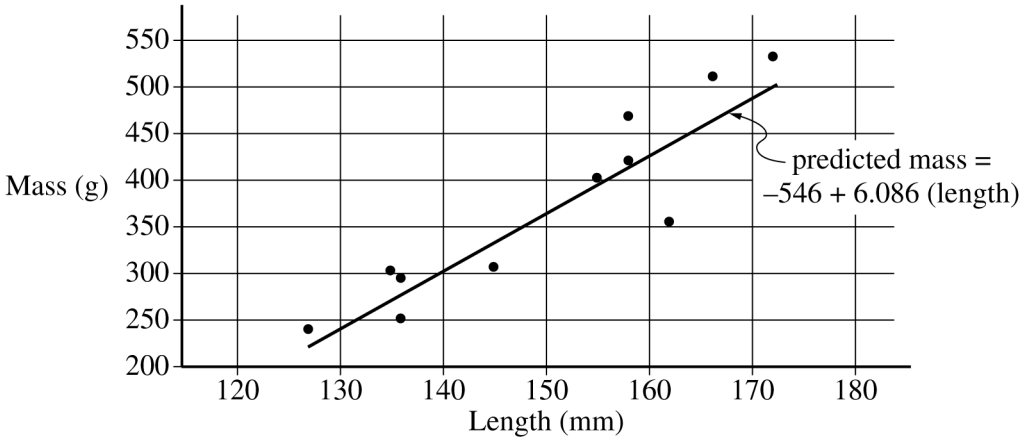
Continue your response to **QUESTION 1** on this page.

From the data, the biologist calculated the least-squares regression line for predicting mass from length. The least-squares regression line is shown in Plot 2.

PLOT 2



(b) Identify and interpret the slope of the least-squares regression line in context.

(c) Interpret the coefficient of determination of the least-squares regression line, $r^2 \approx 0.819$, in context.

(d) From Plot 2, consider the residuals of the 11 bullfrogs.

(i) Based on the plot, approximately what is the length and mass of the bullfrog with the largest absolute value residual?

(ii) Does the least-squares regression line overestimate or underestimate the mass of the bullfrog identified in part (d-i)? Explain your answer.

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Begin your response to **QUESTION 2** on this page.

2. A dermatologist will conduct an experiment to investigate the effectiveness of a new drug to treat acne. The dermatologist has recruited 36 pairs of identical twins. Each person in the experiment has acne and each person in the experiment will receive either the new drug or a placebo. After each person in the experiment uses either the new drug or the placebo for 2 weeks, the dermatologist will evaluate the improvement in acne severity for each person on a scale from 0 (no improvement) to 100 (complete cure).

   (a) Identify the treatments, experimental units, and response variable of the experiment.

   - Treatments:
   - Experimental units:
   - Response variable:

   Each twin in the experiment has a severity of acne similar to that of the other twin. However, the severity of acne differs from one twin pair to another.

   (b) For the dermatologist's experiment, describe a statistical advantage of using a matched-pairs design where twins are paired rather than using a completely randomized design.

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Question 1: Focus on Exploring Data — 4 points

General Scoring Notes

- Each part of the question (indicated by a letter) is initially scored by determining if it meets the criteria for essentially correct (E), partially correct (P), or incorrect (I). The response is then categorized based on the scores assigned to each letter part and awarded an integer score between 0 and 4 (see the table at the end of the question).
- The model solution represents an ideal response to each part of the question, and the scoring criteria identify the specific components of the model solution that are used to determine the score.

	Model Solution	Scoring
(a)	The scatterplot reveals a strong, positive, roughly linear association between the mass and length of bullfrogs. There are no points that seriously deviate from the straight-line pattern of the points in the plot.	**Essentially correct (E)** if the response provides a description that includes at least three of components 1-4 and component 5: 1. Direction of association (positive or increasing) 2. Strength of association (strong) 3. Form of association (linear or approximately linear) 4. Unusual features (no points with large discrepancies from the pattern (straight line) exhibited by most of the points on the plot) 5. Context (association between length and mass of bullfrogs) **Partially correct (P)** if the response satisfies only one or two components out of components 1-4 and component 5 *OR* if the response satisfies at least three out of components 1-4 but does not satisfy component 5. **Incorrect (I)** if the response does not meet the criteria for E or P.

Additional Notes:

- To satisfy component 4, it is sufficient to simply indicate that there are no unusual features.
- To satisfy component 5, it is minimally sufficient for the response to refer to the association or relationship between mass and length without explicitly mentioning bullfrogs.
- The strength of the response in part (a) may be considered if holistic scoring is needed.

	Model Solution	Scoring
(b)	The value of the slope of the least-squares regression line is 6.086. This value indicates that the predicted mass of a bullfrog increases by 6.086 grams for each additional millimeter of length.	**Essentially correct (E)** if the response satisfies the following three components: 1. Identifies the value of the slope as 6.086 2. Provides an interpretation that references an increase of a number of grams of mass for each one-millimeter increase in length 3. Indicates that the slope represents a change in a prediction using non-deterministic language such as "predicted," "estimated," "expected," or "average" **Partially correct (P)** if the response satisfies only two of the three components. **Incorrect (I)** if the response does not meet the criteria for E or P.

Additional Notes:

- The value of the slope, 6.086, may be rounded to 6.09 or 6.1, but not to 6, to satisfy the numerical requirement in component 1.
- A response that only contains 6.086 in the interpretation satisfies component 1.
- A calculation of slope may satisfy component 1, provided that two points from the line are used in the calculation.
- Units of measurements must be correctly specified for both mass and length to satisfy component 2.
- It is not required to refer specifically to the "least-squares regression line."

Scoring for Question 1
Each essentially correct (E) part counts as 1 point, and each partially correct (P) part counts as ½ point.

	Score
Complete Response	**4**
Substantial Response	**3**
Developing Response	**2**
Minimal Response	**1**

If a response is between two scores (for example, 2 ½ points), use a holistic approach to decide whether to score up or down, depending on the strength of the response and quality of the communication.