Lines of Best Fit and Predictions

Name: _____	Date: _____	Score: _____ / 30

Quick Review

A **line of best fit** (regression line) is the straight line that comes closest to all the points in a scatter plot. Its equation, $y = mx+b$, lets you make predictions: substitute an x value and read out a predicted y. **Interpolation** = predicting within the range of your data (usually reliable). **Extrapolation** = predicting outside the data range (risky — the relationship might not hold). The slope m represents the rate of change (y per unit of x); the y-intercept b represents the predicted value when $x = 0$. **Residuals** are the differences between actual and predicted y-values; a good fit has small residuals scattered randomly around zero.

PRACTICE

Use the line of best fit.

1. A line of fit for study time and quiz score is $y = 2x + 5$. Predict the score when $x = 10$ study sessions. _____

2. A used-bike value model is $y = -3x + 50$, where x is age in years and y is value in dollars. Predict the value at $x = 8$. _____

3. A plant-height line of fit is $y = 5x + 12$, where x is weeks and y is centimeters. What does the slope mean?

_____

4. A club-balance model is $y = \frac{1}{2}x + 20$. What is the predicted starting balance? _____

5. A scatter plot used data for ages 12 to 18. Predicting for age 25 is called what? _____

6. A line predicts 78, but the actual data value is 83. What is the residual? _____

7. What residual pattern suggests that a straight line is a reasonable fit? _____

8. A fundraiser's best-fit line is $y = 3x$, where x is days and y is dollars donated. Predict y on day 4. _____

9. A tank model is $y = -x + 10$, where x is hours after draining begins. What is the predicted amount at $x = 0$?

_____

10. A line of fit is $y = 2x + 1$. For what x-value does the model predict $y = 11$? _____

11. In a line of fit, the slope is 2. Explain what that means in context. _____

12. Why is interpolation usually more reliable than extrapolation? _____

13. A calibration line is $y = 4x+10$. What does the model predict when $x = -2$? _____

14. A battery model is $y = -5x + 100$. After how many hours does the model predict $y = 0$? _____

15. What quantity does a least-squares line make as small as possible? _____

16. A line of fit for cost is $y = 0.5x + 30$. Predict the cost when $x = 40$. _____

17. For the line of fit $y = 6x-1$, identify the slope and the y-intercept. _____

18. A best-fit model has slope 3 and y-intercept 7. Write it in $y = mx + b$ form. _____

19. A point has a positive residual. Where is the actual point compared with the line of fit? _____

20. A remaining-supplies model is $y = 10 - 2x$. When does the model predict $y = 0$? _____

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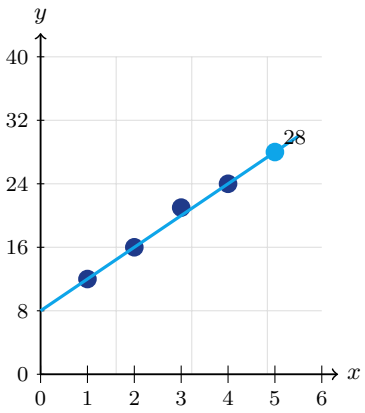
VISUAL PRACTICE

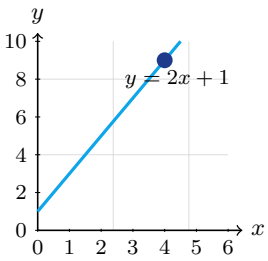
Use the graph, table, chart, or diagram to answer the question.

21. Use the line of fit to predict y when $x = 5$.



Answer: _____

22. Use the line of fit to predict y when $x = 4$.



Answer: _____

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Word Problems

23. A line of best fit for study hours vs. score is $y = 4x + 60$. Predict the score for 5 hours.

Model: _____ **Answer:** _____

24. A plant-height scatter plot has a line of best fit $y = 0.8x+5$, where x is days of growth and y is height in centimeters. Estimate the height on day 30.

Model: _____ **Answer:** _____

25. A sales model uses $y = 2.5x+10$, where x is advertising budget in thousands of dollars and y is sales in thousands of dollars. Predict sales for a $\$20{,}000$ budget.

Model: _____ **Answer:** _____

26. A teacher's line is $y = 5x + 40$ (study hours vs. score). A student studied 0 hours and got 50. What's the residual?

Model: _____ **Answer:** _____

27. A best-fit line for minutes of practice and free throws made is $y = 1.8x + 12$. Predict the result after 15 minutes.

Model: _____ **Answer:** _____

28. A line of fit for temperature vs. ice cream sales is $y = 14x - 620$. Interpret the slope.

Model: _____ **Answer:** _____

29. A model predicts 72 for a data point, but the actual value is 68. Find the residual.

Model: _____ **Answer:** _____

30. A scatter plot used data from ages 10 to 16. A line of fit is used to predict at age 14 and age 22. Which prediction is extrapolation?

Model: _____ **Answer:** _____

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Answer Keys

1. 25
2. 26
3. 5 cm per week
4. 20
5. extrapolation
6. 5
7. small and random residuals
8. 12
9. 10
10. $x = 5$
11. y rises 2 per unit of x
12. it stays inside the data range
13. 2
14. 20
15. sum of squared residuals
16. 50
17. $m = 6, b = -1$
18. $y = 3x + 7$
19. above the line
20. $x = 5$
21. 28
22. 9
23. 80
24. 29 cm
25. \$60,000
26. $+10$
27. 39
28. sales rise by 14 units per degree
29. -4
30. age 22

Step-by-Step Tutor Notes

1. Put the given value into the expression first, then simplify from the inside out. Substitute $x = 10$ into the model: $y = 2(10) + 5 = 25$. That confirms the final answer is 25.
2. This is a good place to slow down, check the notation, and simplify cleanly. Use $x = 8$: $y = -3(8) + 50 = -24 + 50 = 26$. The model predicts \$26. So the answer is 26.
3. The slope is the coefficient of x. Here 5 means the plant is predicted to grow about 5 cm each week.
4. The starting value is the y-intercept, the value when $x = 0$. In this model, it is 20.
5. Age 25 is outside the data range, so the prediction is extrapolation and should be treated carefully.
6. Start with the definition the problem is testing, then apply it directly. Residual means actual minus predicted. Here $83 - 78 = 5$. So the answer is 5.
7. A good linear fit has residuals that stay fairly small and do not form a clear curve or pattern.
8. Put the given value into the expression first, then simplify from the inside out. Substitute $x = 4$: $y = 3(4) = 12$. That confirms the final answer is 12.
9. This is a good place to slow down, check the notation, and simplify cleanly. At $x = 0$, the model gives the starting amount: $y = -(0) + 10 = 10$. So the answer is 10.
10. Set $11 = 2x + 1$. Subtract 1 to get $10 = 2x$, then divide by 2 to get $x = 5$.
11. For every 1-unit increase in x, the model predicts a 2-unit increase in y.
12. This is a good place to slow down, check the notation, and simplify cleanly. Interpolation uses values inside the observed data range, where the trend has actually been seen. So the answer is it stays inside the data range.
13. Start by substituting the given value or values carefully, using parentheses when a value is negative. Substitute $x = -2$: $y = 4(-2) + 10 = -8 + 10 = 2$. That confirms the final answer is 2.
14. Focus on the main idea of the problem, then simplify carefully. Set $0 = -5x + 100$. Then $5x = 100$, so $x = 20$ hours. So the answer is 20.
15. This is a good place to slow down, check the notation, and simplify cleanly. Least squares chooses the line that minimizes the total of the squared vertical prediction errors. So the answer is sum of squared residuals.
16. Take it one clear step at a time and keep the original question in mind. Use $x = 40$: $y = 0.5(40) + 30 = 20 + 30 = 50$. So the answer is 50.
17. The coefficient of x is the slope, so $m = 6$. The constant term is the intercept, so $b = -1$.
18. In $y = mx + b$, use $m = 3$ for the slope and $b = 7$ for the starting value. The model is $y = 3x + 7$.
19. A positive residual means actual minus predicted is positive, so the actual point is above the line.
20. Start with the definition the problem is testing, then apply it directly. Set $0 = 10 - 2x$. Then $2x = 10$, so $x = 5$. So the answer is $x = 5$.
21. This is a good place to slow down, check the notation, and simplify cleanly. Use the line of fit: $y = 4(5) + 8 = 28$. So the answer is 28.
22. Use the line of fit $y = 2x + 1$. When $x = 4$, $y = 2(4) + 1 = 9$.
23. Set up the model from the story, then calculate carefully. $y = 4(5) + 60 = 80$.
24. Set up the model from the story, then calculate carefully. $y = 0.8(30) + 5 = 24 + 5 = 29$ cm.
25. Name the quantities first so the model is easy to read. $y = 2.5(20) + 10 = 60$ (thousand). Sales \$60K.
26. Name the quantities first so the model is easy to read. Predicted: $y = 5(0) + 40 = 40$. Actual: 50. Residual: $50 - 40 = +10$.
27. Start by substituting the given value or values carefully, using parentheses when a value is negative. Substitute $x = 15$: $y = 1.8(15) + 12 = 27 + 12 = 39$. That confirms the final answer is 39.
28. The slope is 14, so the model predicts 14 more sales for each 1° increase in temperature.
29. Residual is actual minus predicted: $68 - 72 = -4$. The actual value is 4 below the line.
30. Age 14 is inside the data range, so that is interpolation. Age 22 is outside the range, so it is extrapolation.

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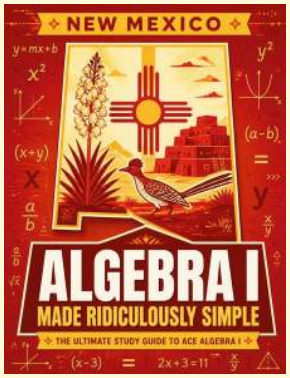

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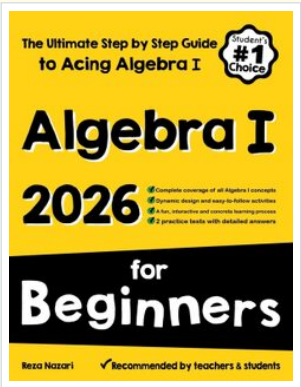

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