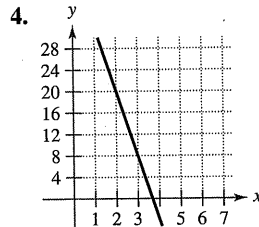
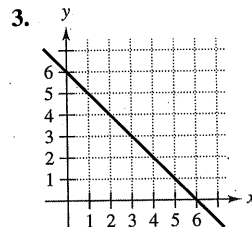
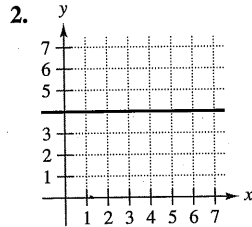
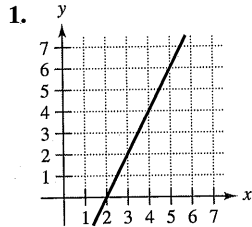


P.2 Exercises

See CalcChat.com for tutorial help and worked-out solutions to odd-numbered exercises.

Estimating Slope In Exercises 1–4, estimate the slope of the line from its graph. To print an enlarged copy of the graph, go to *MathGraphs.com*.



Finding the Slope of a Line In Exercises 5–10, plot the pair of points and find the slope of the line passing through them.

- 5. $(3, -4), (5, 2)$
- 6. $(1, 1), (-2, 7)$
- 7. $(4, 6), (4, 1)$
- 8. $(3, -5), (5, -5)$
- 9. $(-\frac{1}{2}, \frac{2}{3}), (-\frac{3}{4}, \frac{1}{6})$
- 10. $(\frac{7}{8}, \frac{3}{4}), (\frac{5}{4}, -\frac{1}{4})$

Sketching Lines In Exercises 11 and 12, sketch the lines through the point with the indicated slopes. Make the sketches on the same set of coordinate axes.

- | Point | Slopes |
|---------------|---|
| 11. $(3, 4)$ | (a) 1 (b) -2 (c) $-\frac{3}{2}$ (d) Undefined |
| 12. $(-2, 5)$ | (a) 3 (b) -3 (c) $\frac{1}{3}$ (d) 0 |

Finding Points on a Line In Exercises 13–16, use the point on the line and the slope of the line to find three additional points that the line passes through. (There is more than one correct answer.)

- | Point | Slope | Point | Slope |
|--------------|----------|----------------|-------------------|
| 13. $(6, 2)$ | $m = 0$ | 14. $(-4, 3)$ | m is undefined. |
| 15. $(1, 7)$ | $m = -3$ | 16. $(-2, -2)$ | $m = 2$ |

Finding an Equation of a Line In Exercises 17–22, find an equation of the line that passes through the point and has the indicated slope. Then sketch the line.

- | Point | Slope | Point | Slope |
|---------------|-------------------|----------------|--------------------|
| 17. $(0, 3)$ | $m = \frac{3}{4}$ | 18. $(-5, -2)$ | m is undefined. |
| 19. $(0, 0)$ | $m = \frac{2}{3}$ | 20. $(0, 4)$ | $m = 0$ |
| 21. $(3, -2)$ | $m = 3$ | 22. $(-2, 4)$ | $m = -\frac{3}{5}$ |

23. Conveyor Design A moving conveyor is built to rise 1 meter for each 3 meters of horizontal change.

- (a) Find the slope of the conveyor.
- (b) Suppose the conveyor runs between two floors in a factory. Find the length of the conveyor when the vertical distance between floors is 10 feet.



24. Modeling Data The table shows the populations y (in millions) of the United States for 2004 through 2009. The variable t represents the time in years, with $t = 4$ corresponding to 2004. (Source: U.S. Census Bureau)

t	4	5	6	7	8	9
y	293.0	295.8	298.6	301.6	304.4	307.0

- (a) Plot the data by hand and connect adjacent points with a line segment.
- (b) Use the slope of each line segment to determine the year when the population increased least rapidly.
- (c) Find the average rate of change of the population of the United States from 2004 through 2009.
- (d) Use the average rate of change of the population to predict the population of the United States in 2020.

Finding the Slope and y-Intercept In Exercises 25–30, find the slope and the y-intercept (if possible) of the line.

- 25. $y = 4x - 3$
- 26. $-x + y = 1$
- 27. $x + 5y = 20$
- 28. $6x - 5y = 15$
- 29. $x = 4$
- 30. $y = -1$

Sketching a Line in the Plane In Exercises 31–38, sketch a graph of the equation.

- 31. $y = -3$
- 32. $x = 4$
- 33. $y = -2x + 1$
- 34. $y = \frac{1}{3}x - 1$
- 35. $y - 2 = \frac{3}{2}(x - 1)$
- 36. $y - 1 = 3(x + 4)$
- 37. $2x - y - 3 = 0$
- 38. $x + 2y + 6 = 0$

Finding an Equation of a Line In Exercises 39–46, find an equation of the line that passes through the points. Then sketch the line.

- 39. $(0, 0), (4, 8)$
- 40. $(-2, -2), (1, 7)$

41. (2, 8), (5, 0) 42. (-3, 6), (1, 2)
 43. (6, 3), (6, 8) 44. (1, -2), (3, -2)
 45. $(\frac{1}{2}, \frac{7}{2}), (0, \frac{3}{4})$ 46. $(\frac{7}{8}, \frac{3}{4}), (\frac{5}{4}, -\frac{1}{4})$
47. Find an equation of the vertical line with x -intercept at 3.
 48. Show that the line with intercepts $(a, 0)$ and $(0, b)$ has the following equation.

$$\frac{x}{a} + \frac{y}{b} = 1, \quad a \neq 0, b \neq 0$$

Writing an Equation in General Form In Exercises 49–54, use the result of Exercise 48 to write an equation of the line in general form.

49. x -intercept: (2, 0) 50. x -intercept: $(-\frac{2}{3}, 0)$
 y -intercept: (0, 3) y -intercept: (0, -2)
 51. Point on line: (1, 2) 52. Point on line: (-3, 4)
 x -intercept: $(a, 0)$ x -intercept: $(a, 0)$
 y -intercept: (0, a) y -intercept: (0, a)
 ($a \neq 0$) ($a \neq 0$)
 53. Point on line: (9, -2) 54. Point on line: $(-\frac{2}{3}, -2)$
 x -intercept: $(2a, 0)$ x -intercept: $(a, 0)$
 y -intercept: (0, a) y -intercept: (0, $-a$)
 ($a \neq 0$) ($a \neq 0$)

Finding Parallel and Perpendicular Lines In Exercises 55–62, write the general forms of the equations of the lines through the point (a) parallel to the given line and (b) perpendicular to the given line.

Point	Line	Point	Line
55. (-7, -2)	$x = 1$	56. (-1, 0)	$y = -3$
57. (2, 5)	$x - y = -2$	58. (-3, 2)	$x + y = 7$
59. (2, 1)	$4x - 2y = 3$	60. $(\frac{5}{6}, -\frac{1}{2})$	$7x + 4y = 8$
61. $(\frac{3}{4}, \frac{7}{8})$	$5x - 3y = 0$	62. (4, -5)	$3x + 4y = 7$

Rate of Change In Exercises 63–66, you are given the dollar value of a product in 2012 and the rate at which the value of the product is expected to change during the next 5 years. Write a linear equation that gives the dollar value V of the product in terms of the year t . (Let $t = 0$ represent 2010.)

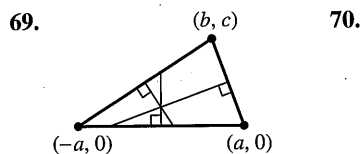
2012 Value	Rate
63. \$1850	\$250 increase per year
64. \$156	\$4.50 increase per year
65. \$17,200	\$1600 decrease per year
66. \$245,000	\$5600 decrease per year

Collinear Points In Exercises 67 and 68, determine whether the points are collinear. (Three points are *collinear* if they lie on the same line.)

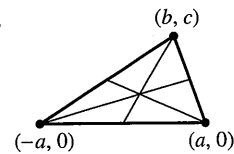
67. (-2, 1), (-1, 0), (2, -2)
 68. (0, 4), (7, -6), (-5, 11)

WRITING ABOUT CONCEPTS

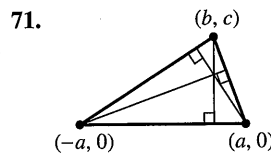
Finding Points of Intersection In Exercises 69–71, find the coordinates of the point of intersection of the given segments. Explain your reasoning.



Perpendicular bisectors



Medians



Altitudes

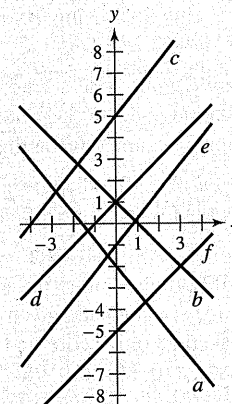
72. Show that the points of intersection in Exercises 69, 70, and 71 are collinear.

73. Analyzing a Line A line is represented by the equation $ax + by = 4$.

- (a) When is the line parallel to the x -axis?
 (b) When is the line parallel to the y -axis?
 (c) Give values for a and b such that the line has a slope of $\frac{5}{8}$.
 (d) Give values for a and b such that the line is perpendicular to $y = \frac{2}{5}x + 3$.
 (e) Give values for a and b such that the line coincides with the graph of $5x + 6y = 8$.



74. HOW DO YOU SEE IT? Use the graphs of the equations to answer the questions below.




- (a) Which lines have a positive slope?
 (b) Which lines have a negative slope?
 (c) Which lines appear parallel?
 (d) Which lines appear perpendicular?

75. Temperature Conversion Find a linear equation that expresses the relationship between the temperature in degrees Celsius C and degrees Fahrenheit F . Use the fact that water freezes at 0°C (32°F) and boils at 100°C (212°F). Use the equation to convert 72°F to degrees Celsius.

76. Reimbursed Expenses A company reimburses its sales representatives \$200 per day for lodging and meals plus \$0.51 per mile driven. Write a linear equation giving the daily cost C to the company in terms of x , the number of miles driven. How much does it cost the company if a sales representative drives 137 miles on a given day?

77. Choosing a Job As a salesperson, you receive a monthly salary of \$2000, plus a commission of 7% of sales. You are offered a new job at \$2300 per month, plus a commission of 5% of sales.

(a) Write linear equations for your monthly wage W in terms of your monthly sales s for your current job and your job offer.

 (b) Use a graphing utility to graph each equation and find the point of intersection. What does it signify?

(c) You think you can sell \$20,000 worth of a product per month. Should you change jobs? Explain.

78. Straight-Line Depreciation A small business purchases a piece of equipment for \$875. After 5 years, the equipment will be outdated, having no value.


(a) Write a linear equation giving the value y of the equipment in terms of the time x (in years), $0 \leq x \leq 5$.

(b) Find the value of the equipment when $x = 2$.


(c) Estimate (to two-decimal-place accuracy) the time when the value of the equipment is \$200.

79. Apartment Rental A real estate office manages an apartment complex with 50 units. When the rent is \$780 per month, all 50 units are occupied. However, when the rent is \$825, the average number of occupied units drops to 47. Assume that the relationship between the monthly rent p and the demand x is linear. (Note: The term *demand* refers to the number of occupied units.)

(a) Write a linear equation giving the demand x in terms of the rent p .

 (b) *Linear extrapolation* Use a graphing utility to graph the demand equation and use the *trace* feature to predict the number of units occupied when the rent is raised to \$855.

(c) *Linear interpolation* Predict the number of units occupied when the rent is lowered to \$795. Verify graphically.

 **80. Modeling Data** An instructor gives regular 20-point quizzes and 100-point exams in a mathematics course. Average scores for six students, given as ordered pairs (x, y) , where x is the average quiz score and y is the average exam score, are $(18, 87)$, $(10, 55)$, $(19, 96)$, $(16, 79)$, $(13, 76)$, and $(15, 82)$.

(a) Use the regression capabilities of a graphing utility to find the least squares regression line for the data.

(b) Use a graphing utility to plot the points and graph the regression line in the same viewing window.

(c) Use the regression line to predict the average exam score for a student with an average quiz score of 17.

(d) Interpret the meaning of the slope of the regression line.

(e) The instructor adds 4 points to the average exam score of everyone in the class. Describe the changes in the positions of the plotted points and the change in the equation of the line.

81. Tangent Line Find an equation of the line tangent to the circle $x^2 + y^2 = 169$ at the point $(5, 12)$.

82. Tangent Line Find an equation of the line tangent to the circle $(x - 1)^2 + (y - 1)^2 = 25$ at the point $(4, -3)$.

Distance In Exercises 83–86, find the distance between the point and line, or between the lines, using the formula for the distance between the point (x_1, y_1) and the line $Ax + By + C = 0$.

$$\text{Distance} = \frac{|Ax_1 + By_1 + C|}{\sqrt{A^2 + B^2}}$$

83. Point: $(-2, 1)$

Line: $x - y - 2 = 0$

84. Point: $(2, 3)$

Line: $4x + 3y = 10$

85. Line: $x + y = 1$


Line: $x + y = 5$

86. Line: $3x - 4y = 1$

Line: $3x - 4y = 10$

87. Distance Show that the distance between the point (x_1, y_1) and the line $Ax + By + C = 0$ is

$$\text{Distance} = \frac{|Ax_1 + By_1 + C|}{\sqrt{A^2 + B^2}}$$

 **88. Distance** Write the distance d between the point $(3, 1)$ and the line $y = mx + 4$ in terms of m . Use a graphing utility to graph the equation. When is the distance 0? Explain the result geometrically.

89. Proof Prove that the diagonals of a rhombus intersect at right angles. (A rhombus is a quadrilateral with sides of equal lengths.)

90. Proof Prove that the figure formed by connecting consecutive midpoints of the sides of any quadrilateral is a parallelogram.

91. Proof Prove that if the points (x_1, y_1) and (x_2, y_2) lie on the same line as (x_1^*, y_1^*) and (x_2^*, y_2^*) , then

$$\frac{y_2^* - y_1^*}{x_2^* - x_1^*} = \frac{y_2 - y_1}{x_2 - x_1}$$

Assume $x_1 \neq x_2$ and $x_1^* \neq x_2^*$.

92. Proof Prove that if the slopes of two nonvertical lines are negative reciprocals of each other, then the lines are perpendicular.

True or False? In Exercises 93–96, determine whether the statement is true or false. If it is false, explain why or give an example that shows it is false.

93. The lines represented by $ax + by = c_1$ and $bx - ay = c_2$ are perpendicular. Assume $a \neq 0$ and $b \neq 0$.

94. It is possible for two lines with positive slopes to be perpendicular to each other.

95. If a line contains points in both the first and third quadrants, then its slope must be positive.

96. The equation of any line can be written in general form.