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UNDERSTANDING AND USING THE VOCABULARY

Choose the letter of the term that best matches each statement or phrase.

- for the function f , a value of x for which $f(x) = 0$
- a pairing of elements of one set with elements of a second set
- has the form $Ax + By + C = 0$, where A is positive and A and B are not both zero
- $y - y_1 = m(x - x_1)$, where (x_1, y_1) lies on a line having slope m
- $y = mx + b$, where m is the slope of the line and b is the y -intercept
- a relation in which each element of the domain is paired with exactly one element of the range
- the set of all abscissas of the ordered pairs of a relation
- the set of all ordinates of the ordered pairs of a relation
- a group of graphs that displays one or more similar characteristics
- lie in the same plane and have no points in common

- function
- parallel lines
- zero of a function
- linear equation
- family of graphs
- relation
- point-slope form
- domain
- slope-intercept form
- range



SKILLS AND CONCEPTS

OBJECTIVES AND EXAMPLES

Lesson 1-1 Evaluate a function.

Find $f(-2)$ if $f(x) = 3x^2 - 2x + 4$.
 Evaluate the expression $3x^2 - 2x + 4$ for $x = -2$.

$$\begin{aligned} f(-2) &= 3(-2)^2 - 2(-2) + 4 \\ &= 12 + 4 + 4 \\ &= 20 \end{aligned}$$

Lesson 1-2 Perform operations with functions.

Given $f(x) = 4x + 2$ and $g(x) = x^2 - 2x$,
 find $(f + g)(x)$ and $(f \cdot g)(x)$.

$$\begin{aligned} (f + g)(x) &= f(x) + g(x) \\ &= 4x + 2 + x^2 - 2x \\ &= x^2 + 2x + 2 \end{aligned}$$

$$\begin{aligned} (f \cdot g)(x) &= f(x) \cdot g(x) \\ &= (4x + 2)(x^2 - 2x) \\ &= 4x^3 - 6x^2 - 4x \end{aligned}$$

Lesson 1-2 Find composite functions.

Given $f(x) = 2x^2 + 4x$ and $g(x) = 2x - 1$,
 find $[f \circ g](x)$ and $[g \circ f](x)$.

$$\begin{aligned} [f \circ g](x) &= f(g(x)) \\ &= f(2x - 1) \\ &= 2(2x - 1)^2 + 4(2x - 1) \\ &= 2(4x^2 - 4x + 1) + 8x + 4 \\ &= 8x^2 + 6 \end{aligned}$$

$$\begin{aligned} [g \circ f](x) &= g(f(x)) \\ &= g(2x^2 + 4x) \\ &= 2(2x^2 + 4x) - 1 \\ &= 4x^2 + 8x - 1 \end{aligned}$$

REVIEW EXERCISES

Evaluate each function for the given value.

11. $f(4)$ if $f(x) = 5x - 10$

12. $g(2)$ if $g(x) = 7 - x^2$

13. $f(-3)$ if $g(x) = 4x^2 - 4x + 9$

14. $h(0.2)$ if $h(x) = 6 - 2x^3$

15. $g\left(\frac{1}{3}\right)$ if $g(x) = \frac{2}{5x}$

16. $k(4c)$ if $k(x) = x^2 + 2x - 4$

17. Find $f(m + 1)$ if $f(x) = |x^2 + 3x|$.

 Find $(f + g)(x)$, $(f - g)(x)$, $(f \cdot g)(x)$, and $\left(\frac{f}{g}\right)(x)$ for each $f(x)$ and $g(x)$.

18. $f(x) = 6x - 4$
 $g(x) = 2$

19. $f(x) = x^2 + 4x$
 $g(x) = x - 2$

20. $f(x) = 4 - x^2$
 $g(x) = 3x$

21. $f(x) = x^2 + 7x + 12$
 $g(x) = x + 4$

22. $f(x) = x^2 - 1$
 $g(x) = x + 1$

23. $f(x) = x^2 - 4x$
 $g(x) = \frac{4}{x - 4}$

 Find $[f \circ g](x)$ and $[g \circ f](x)$ for each $f(x)$ and $g(x)$.

24. $f(x) = x^2 - 4$
 $g(x) = 2x$

25. $f(x) = 0.5x + 5$
 $g(x) = 3x^2$

26. $f(x) = 2x^2 + 6$
 $g(x) = 3x$

27. $f(x) = 6 + x$
 $g(x) = x^2 - x + 1$

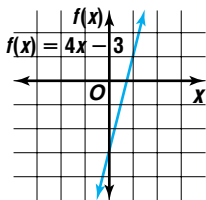
28. $f(x) = x^2 - 5$
 $g(x) = x + 1$

29. $f(x) = 3 - x$
 $g(x) = 2x^2 + 10$

 30. State the domain of $[f \circ g](x)$ for $f(x) = \sqrt{x - 16}$ and $g(x) = 5 - x$.


OBJECTIVES AND EXAMPLES

Lesson 1-3 Graph linear equations.

 Graph $f(x) = 4x - 3$.

Lesson 1-4 Write linear equations using the slope-intercept, point-slope, and standard forms of the equation.

Write the slope-intercept form of the equation of the line that has a slope of 24 and passes through the point at (1, 2).

$$y = mx + b \quad \text{Slope-intercept form}$$

$$2 = -4(1) + b \quad y = 2, x = 1, m = -4$$

$$6 = b \quad \text{Solve for } b.$$

 The equation for the line is $y = -4x + 6$.

Lesson 1-5 Write equations of parallel and perpendicular lines.

 Write the standard form of the equation of the line that is parallel to the graph of $y = 2x - 3$ and passes through the point at (1, -1).

$$y - y_1 = m(x - x_1) \quad \text{Point-slope form}$$

$$y - (-1) = 2(x - 1) \quad y_1 = -1, m = 2, x = 1$$

$$2x - y - 3 = 0$$

 Write the standard form of the equation of the line that is perpendicular to the graph of $y = 2x - 3$ and passes through the point at (6, -1).

$$y - y_1 = m(x - x_1) \quad y_1 = -1, m = -\frac{1}{2}, x = 6$$

$$y - (-1) = -\frac{1}{2}(x - 6) \quad m = -\frac{1}{2}, x = 6$$

$$x + 2y - 2 = 0$$

REVIEW EXERCISES

Graph each equation.

31. $y = 3x + 6$

32. $y = 8 - 5x$

33. $y - 15 = 0$

34. $0 = 2x - y - 7$

35. $y = 2x$

36. $y = -8x - 2$

37. $7x + 2y = -5$

38. $y = \frac{1}{4}x - 6$

Write an equation in slope-intercept form for each line described.

39. slope = 2, y-intercept = -3

40. slope = -1, y-intercept = 1

41. slope = $\frac{1}{2}$, passes through the point at (-5, 2)

42. passes through A(-4, 2) and B(2, 5)

43. x-intercept = 1, y-intercept = -4

44. horizontal and passes through the point at (3, -1)

45. the x-axis

46. slope = 0.1, x-intercept = 1

Write the standard form of the equation of the line that is parallel to the graph of the given equation and passes through the point with the given coordinates.

47. $y = x + 1$; (1, 1)

48. $y = \frac{1}{3}x - 2$; (-1, 6)

49. $2x + y = 1$; (-3, 2)

Write the standard form of the equation of the line that is perpendicular to the graph of the given equation and passes through the point with the given coordinates.

50. $y = -2x + \frac{1}{4}$; (4, -8)

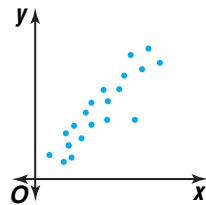
51. $4x - 2y + 2 = 0$; (1, 4)

52. $x = -8$; (4, -6)

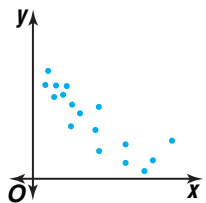
OBJECTIVES AND EXAMPLES

Lesson 1-6 Draw and analyze scatter plots.

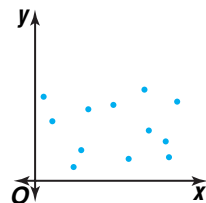
This scatter plot implies a linear relationship. Since data closely fits a line with a positive slope, the scatter plot shows a strong, positive correlation.



This scatter plot implies a linear relationship with a negative slope.



The points in this scatter plot are dispersed and do not form a linear pattern.

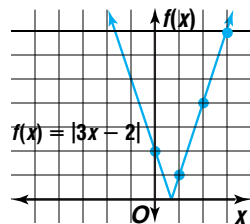


Lesson 1-7 Identify and graph piecewise functions including greatest integer, step, and absolute value functions.

Graph $f(x) = |3x - 2|$.

This is an absolute value function. Use a table of values to find points to graph.

x	$(x, f(x))$
0	(0, 2)
1	(1, 1)
2	(2, 4)
3	(3, 7)
4	(4, 10)



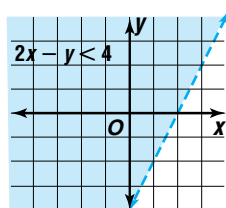
Lesson 1-8 Graph linear inequalities.

Graph the inequality $2x - y < 4$.

$$2x - y < 4$$

$$y > 2x - 4$$

The boundary is dashed. Testing $(0, 0)$ yields a true inequality, so shade the region that includes $(0, 0)$.



REVIEW EXERCISES

53. a. Graph the data below on a scatter plot.
- b. Use two ordered pairs to write the equation of a best-fit line.
- c. Use a graphing calculator to find an equation of the regression line for the data. What is the correlation value?
- d. If the equation of the regression line shows a moderate or strong relationship, predict the number of visitors in 2005. Explain whether you think the prediction is reliable.

Overseas Visitors to the United States (thousands)					
Year	1987	1988	1989	1990	1991
Visitors	10,434	12,763	12,184	12,252	12,003
Year	1992	1993	1994	1995	1996
Visitors	11,819	12,024	12,542	12,933	12,909

Source: U.S Dept. of Commerce

Graph each function.

54. $f(x) = \begin{cases} x & \text{if } 0 \leq x \leq 5 \\ 2 & \text{if } 5 < x \leq 8 \end{cases}$
55. $h(x) = \begin{cases} -1 & \text{if } -2 \leq x \leq 0 \\ -3x & \text{if } 0 < x \leq 2 \\ 2x & \text{if } 2 < x \leq 4 \end{cases}$
56. $f(x) = \llbracket x \rrbracket + 1$
57. $g(x) = |4x|$
58. $k(x) = 2|x| + 2$

Graph each inequality.

59. $y > 4$
60. $x \leq 5$
61. $x + y \leq 1$
62. $2y - x < 4$
63. $y \leq |x|$
64. $y - 3x > 2$
65. $y > |x| - 2$
66. $y < |x - 2|$

APPLICATIONS AND PROBLEM SOLVING

- 67. Aviation** A jet plane starts from rest on a runway. It accelerates uniformly at a rate of 20 m/s^2 . The equation for computing the distance traveled is $d = \frac{1}{2}at^2$. (*Lesson 1-1*)
- Find the distance traveled at the end of each second for 5 seconds.
 - Is this relation a function? Explain.

- 68. Finance** In 1994, outstanding consumer credit held by commercial banks was about \$463 billion. By 1996, this amount had grown to about \$529 billion. (*Lesson 1-4*)
- If x represents the year and y represents the amount of credit, find the average annual increase in the amount of outstanding consumer credit.
 - Write an equation to model the annual change in credit.

- 69. Recreation** Juan wants to know the relationship between the number of hours students spend watching TV each week and the number of hours students spend reading each week. A sample of 10 students reveals the following data.

Watching TV	Reading
20	8.5
32	3.0
42	1.0
12	4.0
5	14.0
28	4.5
33	7.0
18	12.0
30	3.0
25	3.0

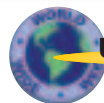
Find the equation of a regression line for the data. Then make a statement about how representative the line is of the data. (*Lesson 1-6*)

ALTERNATIVE ASSESSMENT

OPEN-ENDED ASSESSMENT

- If $[f \circ g](x) = 4x^2 - 4$, find $f(x)$ and $g(x)$. Explain why your answer is correct.
- Suppose two distinct lines have the same x -intercept.
 - Can the lines be parallel? Explain your answer.
 - Can the lines be perpendicular? Explain your answer.
- Write a piecewise function whose graph is the same as each function. The function should not involve absolute value.
 - $y = x + |4 - x|$
 - $y = 2x + |x + 1|$

Additional Assessment See p. A56 for Chapter 1 Practice Test.


 Unit 1 *inter*NET Project

TELECOMMUNICATION

Is Anybody Listening?

- Research several telephone long-distance services. Write and graph equations to compare the monthly fee and the rate per minute for each service.
- Which service would best meet your needs? Write a paragraph to explain your choice. Use the graphs to support your choice.


PORTFOLIO

Select one of the functions you graphed in this chapter. Write about a real-world situation this type of function can be used to model. Explain what the function shows about the situation that is difficult to show by other means.

Multiple-Choice and Grid-In Questions

At the end of each chapter in this textbook, you will find practice for the SAT and ACT tests. Each group of 10 questions contains nine multiple-choice questions, and one grid-in question.

MULTIPLE CHOICE

The majority of questions on the SAT are multiple-choice questions. As the name implies, these questions offer five choices from which to choose the correct answer.

The multiple choice sections are arranged in order of difficulty, with the easier questions at the beginning, average difficulty questions in the middle, and more difficult questions at the end.

Every correct answer earns one raw point, while an incorrect answer results in a loss of one fourth of a raw point. Leaving an answer blank results in no penalty.

The test covers topics from numbers and operations (arithmetic), algebra 1, algebra 2, functions, geometry, statistics, probability, and data analysis. Each end-of-chapter practice section in this textbook will cover one of these areas.

Arithmetic

Six percent of 4800 is equal to 12 percent of what number?

- A 600
- B 800
- C 1200
- D 2400
- E 3000

Write and solve an equation.

$$\begin{aligned} 0.06(4800) &= 0.12x \\ 288 &= 0.12x \\ \frac{288}{0.12} &= x \\ 2400 &= x \end{aligned}$$

Choice **D** is correct.



THE
PRINCETON
REVIEW

TEST-TAKING TIP

When you take the SAT, bring a calculator that you are used to using. Keep in mind that a calculator is not necessary to solve every question on the test. Also, a graphing calculator may provide an advantage over a scientific calculator on some questions.

Algebra

If $(p + 2)(p^2 - 4) = (p + 2)^q(p - 2)$ for all values of p , what is the value of q ?

- A 1
- B 2
- C 3
- D 4
- E It cannot be determined from the given information.

Factor the left side.

$$(p + 2)(p^2 - 4) = (p + 2)^q(p - 2)$$

$$(p + 2)(p + 2)(p - 2) = (p + 2)^q(p - 2)$$

$$(p + 2)^2(p - 2) = (p + 2)^q(p - 2)$$

$$(p + 2)^2 = (p + 2)^q$$

If $a^m = a^n$, then $m = n$.

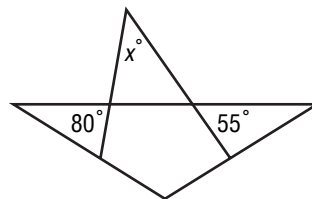
$$2 = q$$

Answer choice **B** is correct.

Geometry

In the figure, what is the value of x ?

- A 25
- B 30
- C 45
- D 90
- E 135



This is a multi-step problem. Use vertical angle relationships to determine that the two angles in the triangle with x are 80° and 55° . Then use the fact that the sum of the measures of the angles of a triangle is 180 to determine that x equals 45. The correct answer is choice **C**.

GRID IN

Another section on the SAT includes questions in which you must mark your answer on a grid printed on the answer sheet. These are called *Student Produced Response* questions (or Grid-Ins), because you must create the answer yourself, not just choose from five possible answers.

Every correct answer earns one raw point, but there is no penalty for a wrong answer; it is scored the same as no answer.

These questions are *not* more difficult than the multiple-choice questions, but you'll want to be extra careful when you fill in your answers on the grid, so that you don't make careless errors. Grid-in questions are arranged in order of difficulty.

The instructions for using the grid are printed in the SAT test booklet. *Memorize* these instructions before you take the test.

○	/	/	○
○	○	○	○
①	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦
⑧	⑧	⑧	⑧
⑨	⑨	⑨	⑨

The grid contains a row of four boxes at the top, two rows of ovals with decimal and fraction symbols, and four columns of numbered ovals.

After you solve the problem, always write your answer in the boxes at the top of the grid.

Start with the left column. Write one numeral, decimal point, or fraction line in each box. Shade the oval in each column that corresponds to the numeral or symbol written in the box. Only the shaded ovals will be scored, so work carefully. Don't make any extra marks on the grid.

Suppose the answer is $\frac{2}{3}$ or 0.666 You can record the answer as a fraction or a decimal. For the fraction, write $\frac{2}{3}$. For a decimal answer, you must enter the most accurate value that will fit the grid. That is, you must enter as many decimal place digits as space allows. An entry of .66 would not be acceptable.

	2	/	3
○	/	○	○
○	○	○	○
①	①	①	①
②	○	②	②
③	③	③	○
④	④	④	④
⑤	⑤	⑤	⑤
⑥	⑥	⑥	⑥
⑦	⑦	⑦	⑦

.	6	6	6
○	/	/	○
○	○	○	○
①	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
⑥	○	○	○
⑦	⑦	⑦	⑦

.	6	6	7
○	/	/	○
○	○	○	○
①	①	①	①
②	②	②	②
③	③	③	③
④	④	④	④
⑤	⑤	⑤	⑤
⑥	○	○	○
⑦	⑦	⑦	○

There is no 0 in bubble column 1. This means that you do *not* enter a zero to the left of the decimal point. For example, enter .25 and not 0.25.

Here are some other helpful hints for successfully completing grid-in questions.

- You don't have to write fractions in simplest form. Any equivalent fraction that fits the grid is counted as correct. If your fraction does not fit (like 15/25), then either write it in simplest form or change it to a decimal before you grid it.
- There is no negative symbol. Grid-in answers are never negative, so if you get a negative answer, you've made an error.
- If a problem has more than one correct answer, enter just one of the answers.
- Do not grid mixed numbers. Change the mixed number to an equivalent fraction or decimal. If you enter 11/2 for $1\frac{1}{2}$, it will be read as $\frac{11}{2}$. Enter it as 3/2 or 1.5.



Arithmetic Problems

All SAT and ACT tests contain arithmetic problems. Some are easy and some are difficult. You'll need to understand and apply the following concepts.

odd and even	factors	divisibility
positive, negative	integers	fractions
scientific notation	exponents	roots
prime numbers	decimals	inequalities

TEST-TAKING TIP

Know the properties of zero and one. For example, 0 is even, neither positive nor negative, and not prime. 1 is the only integer with only one divisor. 1 is not prime.

Several concepts are often combined in a single problem.

SAT EXAMPLE

1. What is the sum of the positive even factors of 12?

HINT Look for words like *positive*, *even*, and *factor*.

Solution First find all the factors of 12.

1 2 3 4 6 12

Re-read the question. It asks for the sum of *even* factors. Circle the factors that are even numbers.

1 (2) 3 (4) (6) (12)

Now add these even factors to find the sum.

$$2 + 4 + 6 + 12 = 24 \quad \text{The answer is 24.}$$

This is a grid-in problem. Record your answer on the grid.

2	4		
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<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
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ACT EXAMPLE

2. $(-2)^3 + (3)^{-2} + \frac{8}{9}$
- A -7 B $-1\frac{7}{9}$ C $\frac{8}{9}$
- D $1\frac{7}{9}$ E 12

HINT Analyze what the $-$ (negative) symbol represents each time it is used.

Solution Use the properties of exponents to simplify each term.

$$(-2)^3 = (-2)(-2)(-2) \text{ or } -8$$

$$(3)^{-2} = \frac{1}{3^2} \text{ or } \frac{1}{9}$$

Add the terms.

$$\begin{aligned} (-2)^3 + (3)^{-2} + \frac{8}{9} &= -8 + \frac{1}{9} + \frac{8}{9} \\ &= -8 + 1 \text{ or } -7 \end{aligned}$$

The answer is choice **A**.

Always look at the answer choices before you start to calculate. In this problem, three (incorrect) answer choices include fractions with denominators of 9. This may be a clue that your calculations may involve ninths.

Never assume that because three answer choices involve ninths and two are integers, that the correct answer is more likely to involve ninths. Also don't conclude that because the expression contains a fraction that the answer will necessarily have a fraction in it.

After you work each problem, record your answer on the answer sheet provided or on a piece of paper.

Multiple Choice

- Which of the following expresses the prime factorization of 54?
 - 9×6
 - $3 \times 3 \times 6$
 - $3 \times 3 \times 2$
 - $3 \times 3 \times 3 \times 2$
 - 5.4×10
- If 8 and 12 each divide K without a remainder, what is the value of K ?
 - 16
 - 24
 - 48
 - 96
 - It cannot be determined from the information given.
- After $\frac{4\frac{1}{3}}{2\frac{3}{5}}$ has been simplified to a single fraction in lowest terms, what is the denominator?
 - 2
 - 3
 - 5
 - 9
 - 13
- For a class play, student tickets cost \$2 and adult tickets cost \$5. A total of 30 tickets were sold. If the total sales must exceed \$90, what is the minimum number of adult tickets that must be sold?
 - 7
 - 8
 - 9
 - 10
 - 11
- $-|-7| - |-5| - 3|-4| = ?$
 - 24
 - 11
 - 0
 - 13
 - 24
- $(-4)^2 + (2)^{-4} + \frac{3}{4}$
 - $16\frac{13}{16}$
 - $16\frac{3}{4}$
 - $-15\frac{7}{32}$
 - $15\frac{7}{32}$
 - 16
- Kerri subscribed to four publications that cost \$12.90, \$16.00, \$18.00, and \$21.90 per year. If she made an initial down payment of one half of the total amount and paid the rest in 4 equal monthly payments, how much was each of the 4 monthly payments?
 - \$8.60
 - \$9.20
 - \$9.45
 - \$17.20
 - \$34.40
- $\sqrt{64 + 36} = ?$
 - 10
 - 14
 - 28
 - 48
 - 100
- What is the number of distinct prime factors of 60?
 - 12
 - 4
 - 3
 - 2
 - 1
- Grid-In** There are 24 fish in an aquarium. If $\frac{1}{8}$ of them are tetras and $\frac{2}{3}$ of the remaining fish are guppies, how many guppies are in the aquarium?

interNET
CONNECTION

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