



SAT® MATHEMATICS • DIAGNOSTIC

# Self-Study Diagnostic

| QUESTIONS | TIME             | CALCULATOR      |
|-----------|------------------|-----------------|
| 50 Q      | 2 parts × 40 min | Desmos graphing |

**Anyone who decides to reach 800 can get there.**

*Don't memorize problems — understand why they work.*

Fifty questions on the ideas SAT Math is built on. This is not a score predictor. It shows whether the core ideas are in place, so the next step is clear: studying on your own, studying with some guidance, or working with a teacher. Take it alone, without notes, in two 40-minute parts with a real break between them. If you have no idea how to begin a question, leave it blank rather than guess. A blank tells us more than a lucky guess.

## SAT MATH DIAGNOSTIC

50 QUESTIONS · 2 PARTS · 40 MINUTES EACH

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Part 1: start \_\_\_\_\_ end \_\_\_\_\_ Part 2: start \_\_\_\_\_ end \_\_\_\_\_

## DIRECTIONS

This test has 50 questions in two parts: Part 1 (questions 1–25) and Part 2 (questions 26–50), 40 minutes each. Take a real break between the parts; you may finish Part 2 later. For multiple-choice questions, select the best answer. For student-produced response (SPR) questions, write your answer in the box. Fractions such as  $\frac{7}{2}$  and negative answers are allowed; for a repeating decimal, write a fraction or fill the box with digits (for example,  $\frac{2}{3}$  or .6667). Figures are drawn to scale unless a note says otherwise. The formulas below may be used. The **Desmos graphing calculator** may be used on every question. If you do not know how to begin a question, leave it blank instead of guessing. (This is for the diagnostic only. On the real SAT, never leave a question blank: there is no penalty for guessing.)

## REFERENCE

Circle:  $A = \pi r^2$ ,  $C = 2\pi r$ Rectangle:  $A = \ell w$ Triangle:  $A = \frac{1}{2}bh$ Pythagorean theorem:  $c^2 = a^2 + b^2$ 30°-60°-90° triangle: sides  $x$ ,  $x\sqrt{3}$ ,  $2x$ 45°-45°-90° triangle: sides  $s$ ,  $s$ ,  $s\sqrt{2}$ Rectangular prism:  $V = \ell wh$ Cylinder:  $V = \pi r^2 h$ Sphere:  $V = \frac{4}{3}\pi r^3$ Cone:  $V = \frac{1}{3}\pi r^2 h$ Pyramid:  $V = \frac{1}{3}\ell wh$ A circle has 360 degrees of arc, or  $2\pi$  radians of arc. The angles of a triangle add up to  $180^\circ$ .

## PART 1 Questions 1–25

40 minutes

1 \_\_\_\_\_

A sphere has a diameter of 18 centimeters. The volume of the sphere is  $k\pi$  cubic centimeters. What is the value of  $k$ ?

- ☐ A 324
- ☐ B 972
- ☐ C 2,916
- ☐ D 7,776

2 \_\_\_\_\_

A theater sells tickets online for \$12 each. Each online order also has a one-time service fee of \$5, no matter how many tickets are in the order. Ana placed one online order for  $t$  tickets and paid a total of \$77. Which equation represents this situation?

- ☐ A  $12t + 5 = 77$
- ☐ B  $(12 + 5)t = 77$
- ☐ C  $5t + 12 = 77$
- ☐ D  $12t = 77 + 5$

3 \_\_\_\_\_

What are the solutions to  $2x^2 - 6x + 1 = 0$ ?

- ☐ A  $\frac{-3 \pm \sqrt{7}}{2}$
- ☐ B  $\frac{3 \pm \sqrt{7}}{4}$
- ☐ C  $\frac{3 \pm \sqrt{7}}{2}$
- ☐ D  $\frac{3 \pm \sqrt{11}}{2}$

4 \_\_\_\_\_

A linear model estimates the value of a used car, in dollars. According to the model, the car was worth \$16,400 in 2021 and \$12,800 in 2023. Which equation gives the estimated value  $v$ , in dollars, of the car  $x$  years after 2018?

- ☐ A  $v = 16,400 - 1,800x$
- ☐ B  $v = 21,800 - 1,800x$
- ☐ C  $v = 21,800 - 3,600x$
- ☐ D  $v = 11,000 - 1,800x$

**5**

At the start of a study, a lake had 5,000 fish. The number of fish in the lake decreased by 8% each year. Which function gives the number of fish,  $f(t)$ ,  $t$  years after the start of the study?

- A**  $f(t) = 5,000(0.08)^t$
- B**  $f(t) = 5,000(0.92)^t$
- C**  $f(t) = 5,000(1.08)^t$
- D**  $f(t) = 5,000 - 400t$

**6**

$$\frac{x+5}{3} - \frac{x-1}{4} = 3$$

What value of  $x$  is the solution to the given equation?

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**7**

Triangles  $ABC$  and  $DEF$  are right triangles with right angles at  $C$  and  $F$ , respectively. The measure of angle  $A$  is equal to the measure of angle  $E$ . If  $\sin A = \frac{5}{13}$ , what is the value of  $\cos D$ ?

- A**  $\frac{5}{13}$
- B**  $\frac{5}{12}$
- C**  $\frac{12}{13}$
- D**  $\frac{12}{5}$

**8**

The table shows the numbers of 10th-grade and 11th-grade students in a club who chose art or music as their elective.

|            | Art | Music | Total |
|------------|-----|-------|-------|
| 10th grade | 18  | 24    | 42    |
| 11th grade | 22  | 36    | 58    |
| Total      | 40  | 60    | 100   |

If one of the students who chose music is selected at random, what is the probability that the student is in the 11th grade?

- A**  $\frac{9}{25}$
- B**  $\frac{29}{50}$
- C**  $\frac{3}{5}$
- D**  $\frac{18}{29}$

**9**

The quadratic function  $f$  has a minimum value, and  $a$ ,  $c$ ,  $h$ ,  $k$ ,  $p$ , and  $q$  are constants. Which of the following forms of  $f(x)$  displays the minimum value of  $f(x)$  as a constant or coefficient?

- A**  $f(x) = (x - p)(x - q)$
- B**  $f(x) = (x - h)^2 + k$
- C**  $f(x) = x(x - 2h) + c$
- D**  $f(x) = x^2 + ax + c$

**10**

In the  $xy$ -plane, the line  $y = 4x + k$ , where  $k$  is a constant, intersects the parabola  $y = x^2 - 2x + 7$  at exactly one point. What is the value of  $k$ ?

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11

A delivery van uses 0.12 gallon of fuel for each mile driven on the highway and 0.2 gallon for each mile driven in the city. On one trip, the van used 18 gallons of fuel. The equation  $0.12h + 0.2c = 18$  represents this situation, where  $h$  is the number of highway miles and  $c$  is the number of city miles. If the van was driven 30 miles in the city, how many miles was it driven on the highway?

- ☐ A 60
- ☐ B 72
- ☐ C 100
- ☐ D 150

12

A bike rental shop uses the equation  $C = 45 + 12h$  to find the total cost  $C$ , in dollars, of renting a bike for  $h$  hours. What is the best interpretation of 12 in this context?

- ☐ A The total cost, in dollars, of renting a bike for 1 hour
- ☐ B The cost, in dollars, for each hour a bike is rented
- ☐ C The fixed fee, in dollars, charged for every rental
- ☐ D The number of hours a bike is rented

13

Points  $A$  and  $B$  lie on a circle with center  $O$  and radius 12. The length of minor arc  $AB$  is  $10\pi$ . The measure of central angle  $AOB$  is  $k\pi$  radians. What is the value of  $k$ ?

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14

Data set  $P$  consists of 25 values. The mean of data set  $P$  is 40, and the median is 38. Data set  $Q$  is created by adding the two values 10 and 70 to data set  $P$ . Which statement must be true?

- ☐ A The mean of data set  $Q$  is equal to the mean of data set  $P$ , and the median of data set  $Q$  is equal to the median of data set  $P$ .
- ☐ B The mean of data set  $Q$  is greater than the mean of data set  $P$ , and the median of data set  $Q$  is equal to the median of data set  $P$ .
- ☐ C The mean of data set  $Q$  is equal to the mean of data set  $P$ , and the median of data set  $Q$  is greater than the median of data set  $P$ .
- ☐ D The mean of data set  $Q$  is greater than the mean of data set  $P$ , and the median of data set  $Q$  is greater than the median of data set  $P$ .

15

The edge length of cube  $B$  is 3 times the edge length of cube  $A$ . The volume of cube  $B$  is how many times the volume of cube  $A$ ?

- ☐ A 3
- ☐ B 6
- ☐ C 9
- ☐ D 27

16

A car is traveling at a constant speed of 54 kilometers per hour. What is this speed in meters per second? (1 kilometer = 1,000 meters)

- ☐ A 0.9
- ☐ B 15
- ☐ C 194.4
- ☐ D 900

17

$$7x + 3y = 23$$

$$3x + 7y = 7$$

If  $(x, y)$  is the solution to the given system of equations, what is the value of  $x^2 - y^2$ ?

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18

Which expression is equivalent to  $(2x - 3)^2 - (x + 1)(x - 4)$ ?

☐ A  $3x^2 - 9x + 13$

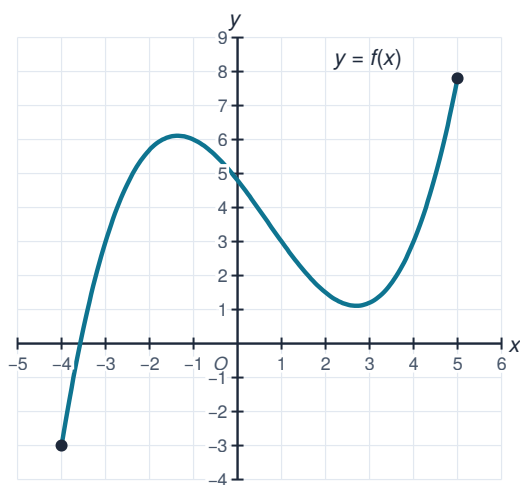
☐ B  $3x^2 - 9x + 5$

☐ C  $3x^2 - 15x + 13$

☐ D  $3x^2 + 3x + 13$

19

The graph of  $y = f(x)$  is shown for  $-4 \leq x \leq 5$ .



For how many values of  $x$  in this interval does  $f(x) = 3$ ?

☐ A 0

☐ B 1

☐ C 2

☐ D 3

20

The polynomial  $p(x) = (x^2 - 3x + 4)(2x + 1)^2 - 5x$  can be written in the form  $ax^4 + bx^3 + cx^2 + dx + e$ , where  $a, b, c, d$ , and  $e$  are constants. What is the value of  $a + b + c + d + e$ ?

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21

For a group of students, the line of best fit for test score  $y$  versus hours of practice  $x$  in a week is  $y = 2.4x + 31$ . Maria practiced for 15 hours that week and scored 70 on the test. Which statement is true?

☐ A Maria's actual score is 3 points greater than the score predicted by the line of best fit.

☐ B Maria's actual score is 3 points less than the score predicted by the line of best fit.

☐ C Maria's actual score is 34 points greater than the score predicted by the line of best fit.

☐ D Maria's actual score is 39 points greater than the score predicted by the line of best fit.

22

$$a(2x + b) = 9x + 12$$

In the given equation,  $a$  and  $b$  are constants. If the equation has infinitely many solutions, what is the value of  $ab$ ?

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**23**

The number of bacteria in a sample  $t$  hours after the start of an experiment is modeled by the function  $f(t) = 250(2)^{t/6}$ . According to the model, how many hours does it take for the number of bacteria to double?

- ☐ A  $\frac{1}{6}$
- ☐ B 2
- ☐ C 6
- ☐ D 12

**24**

The expression  $\frac{3x-4}{x+2}$  is equivalent to  $3 - \frac{a}{x+2}$  for all  $x \neq -2$ , where  $a$  is a constant. What is the value of  $a$ ?

- ☐ A -2
- ☐ B 4
- ☐ C 6
- ☐ D 10

**25**

The value  $V$ , in dollars, of a laptop  $t$  years after it was purchased is modeled by the function  $V(t) = 1,500(0.9)^t$ . What is the best interpretation of 0.9 in this context?

- ☐ A Each year, the value of the laptop decreases by \$0.90.
- ☐ B Each year, the value of the laptop decreases by 90%.
- ☐ C Each year, the value of the laptop is 90% of its value the year before.
- ☐ D Each year, the value of the laptop decreases by 10% of its purchase price.

**STOP.** This is the end of Part 1. Take a real break before you turn the page: stand up, stretch, drink some water. You may also finish Part 2 later.

**PART 2** Questions 26–50**40 minutes****26**

In the  $xy$ -plane, a line passes through the points  $(-2, 7)$  and  $(4, -5)$ . What is the  $y$ -coordinate of the  $y$ -intercept of the line?

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**27**

The equation  $x^2 + y^2 - 6x + 10y + 18 = 0$  represents a circle in the  $xy$ -plane. Which of the following statements is true?

- ☐ **A** The circle intersects the  $x$ -axis at two points and does not intersect the  $y$ -axis.
- ☐ **B** The circle does not intersect either axis.
- ☐ **C** The circle intersects both the  $x$ -axis and the  $y$ -axis.
- ☐ **D** The circle intersects the  $y$ -axis at two points and does not intersect the  $x$ -axis.

**28**

In the  $xy$ -plane, line  $\ell$  has a slope of 3 and passes through the point  $(2, 5)$ . What is the  $y$ -coordinate of the point on line  $\ell$  whose  $x$ -coordinate is 6 ?

- ☐ **A** 9
- ☐ **B** 11
- ☐ **C** 17
- ☐ **D** 23

**29**

To estimate how many of the 1,800 students at a high school walk to school, a teacher surveyed 150 students selected at random from all the students at the school. Of the students surveyed, 36 said they walk to school. Which conclusion is most appropriate?

- ☐ **A** About 24% of the students at the school walk to school.
- ☐ **B** Exactly 432 students at the school walk to school.
- ☐ **C** About 24% of all high school students in the country walk to school.
- ☐ **D** No conclusion can be made about the school, because only 150 of its 1,800 students were surveyed.

**30**

A delivery van can carry at most 1,600 pounds of packages and at most 40 packages in all. Large packages weigh 50 pounds each, and small packages weigh 20 pounds each. On one trip, the van carries 14 large packages. What is the greatest number of small packages the van can also carry on this trip?

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**31**

For the linear function  $f$ ,  $f(3) = 14$  and  $f(7) = 30$ . What is the value of  $f(-2)$  ?

- ☐ **A** -10
- ☐ **B** -6
- ☐ **C** 2
- ☐ **D** 6

**32**

A student solves equations of the form  $(x + a)(x + b) = r$ , where  $a$ ,  $b$ , and  $r$  are constants, by writing  $x + a = r$  or  $x + b = r$ . The student's method is guaranteed to give the correct solutions for which value of  $r$ ?

- ☐ **A** Every value of  $r$
- ☐ **B**  $r = 1$
- ☐ **C**  $r = ab$
- ☐ **D**  $r = 0$

**33**

$$y = 3x - 7$$

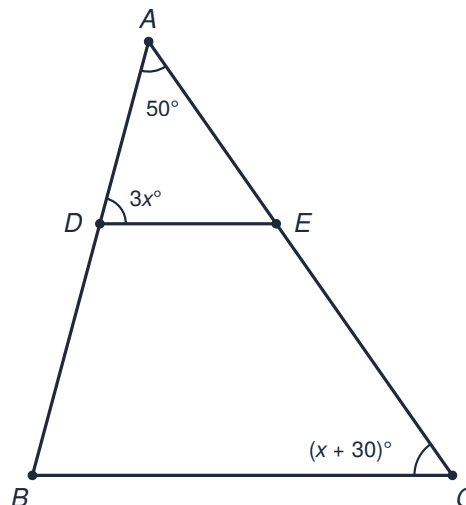
$$2x + 5y = 33$$

The solution to the given system of equations is  $(x, y)$ . What is the value of  $x$ ?

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**34**

In the figure, point  $D$  lies on  $\overline{AB}$ , point  $E$  lies on  $\overline{AC}$ , and  $\overline{DE}$  is parallel to  $\overline{BC}$ .



*Note: Figure not drawn to scale.*

What is the measure, in degrees, of angle  $DEC$ ?

- ☐ **A** 55
- ☐ **B** 75
- ☐ **C** 105
- ☐ **D** 125

**35**

Jae can spend at most \$60 in all at a fair. Admission costs \$18, and each ride ticket costs \$7. Which inequality represents the possible numbers of ride tickets,  $n$ , that Jae can buy?

- ☐ **A**  $18 + 7n \leq 60$
- ☐ **B**  $18 + 7n \geq 60$
- ☐ **C**  $7n \leq 60$
- ☐ **D**  $18n + 7 \leq 60$

**36**

The graph of  $y = f(x)$  in the  $xy$ -plane passes through the point  $(2, 5)$ . Which point must lie on the graph of  $y = f(x - 3) + 1$ ?

- ☐ A  $(-1, 6)$
- ☐ B  $(-1, 4)$
- ☐ C  $(5, 6)$
- ☐ D  $(5, 4)$

**37**

The price of a stock increased by 25% in January. In February, the price decreased by  $p\%$ . At the end of February, the price was 10% less than it was at the start of January. What is the value of  $p$ ?

- ☐ A 15
- ☐ B 28
- ☐ C 35
- ☐ D 72

**38**

$$\frac{x+1}{4} = \frac{5}{x+2}$$

What is the positive solution to the given equation?

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**39**

A first print shop's one-time setup fee is \$15 greater than a second print shop's setup fee, and the two shops charge the same price per poster. For how many numbers of posters do the two shops charge the same total amount?

- ☐ A None
- ☐ B Exactly one
- ☐ C Exactly two
- ☐ D Infinitely many

**40**

$$\sqrt{3x+10} - x = 2$$

What are all the solutions to the given equation?

- ☐ A  $-3$  and  $2$
- ☐ B  $2$  only
- ☐ C  $-3$  only
- ☐ D There are no real solutions.

**41**

A survey of 400 voters selected at random from a city found that 52% of those surveyed support a new proposal. The margin of error for this estimate is 4 percentage points. Which conclusion is most appropriate?

- ☐ A It is plausible that between 48% and 56% of all voters in the city support the proposal.
- ☐ B Exactly 52% of all voters in the city support the proposal.
- ☐ C The proposal will definitely be supported by more than half of the city's voters.
- ☐ D The margin of error shows that 4% of the voters surveyed gave inaccurate answers.

**42**

Triangle  $ABC$  is similar to triangle  $DEF$ , where angle  $A$  corresponds to angle  $D$ . Each side of triangle  $DEF$  is 3 times the length of the corresponding side of triangle  $ABC$ . If the measure of angle  $A$  is  $54^\circ$ , what is the measure of angle  $D$ ?

- ☐ A  $18^\circ$
- ☐ B It cannot be determined from the given information.
- ☐ C  $162^\circ$
- ☐ D  $54^\circ$

**43**

Triangle  $PQR$  is a right triangle with its right angle at  $R$ . The measure of angle  $P$  is  $30^\circ$ , and  $PR = 9$ . What is the length of  $PQ$ ?

- A**  $3\sqrt{3}$
- B**  $6\sqrt{3}$
- C**  $9\sqrt{2}$
- D** 18

**44**

The function  $h(t) = -16t^2 + 96t + 20$  gives the height, in feet, of a ball  $t$  seconds after it is thrown upward. For how many seconds is the height of the ball at least 100 feet?

- A** 1
- B** 3
- C** 4
- D** 5

**45**

The equation  $F = 60 - 4t$  gives the amount of fuel  $F$ , in liters, left in a generator's tank  $t$  hours after the generator is turned on. The graph of this equation in the  $tF$ -plane crosses the  $t$ -axis at the point  $(15, 0)$ . What is the best interpretation of this point in this context?

- A** The tank holds 15 liters of fuel when the generator is turned on.
- B** The generator uses 15 liters of fuel each hour.
- C** The tank is empty 15 hours after the generator is turned on.
- D** After 15 hours, 15 liters of fuel are left in the tank.

**46**

What is the greatest integer value of  $x$  that satisfies the inequality  $3 - 2(x + 4) > -17$ ?

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**47**

A bakery sells muffins for \$3 each and scones for \$5 each. Yesterday, the bakery sold muffins and scones for a total of \$410. Which of the following additional pieces of information, together with the given information, is NOT enough to determine the number of muffins the bakery sold yesterday?

- A** The bakery sold 110 muffins and scones in all.
- B** The bakery sold 30 more muffins than scones.
- C** The money from muffins was \$10 more than the money from scones.
- D** If each price had been twice as much, the total would have been \$820.

**48**

$$y = x^2 - 4x + 1$$

$$y = 2x - 7$$

Which point  $(x, y)$  is a solution to the given system of equations?

- A**  $(-2, -11)$
- B**  $(0, 1)$
- C**  $(2, -3)$
- D**  $(3, -2)$

**49**

$$(x + c)^2 = 19$$

In the given equation,  $c$  is a constant. The sum of the solutions of the equation is  $-7$ . What is the value of  $c$ ?

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**50**

The function  $g$  is defined by  $g(x) = k(x - 3)(x + 5)$ , where  $k$  is a nonzero constant. Which of the following can be determined from this information alone?

- ☐ **A** The  $y$ -intercept of the graph of  $y = g(x)$
- ☐ **B** The maximum or minimum value of  $g(x)$
- ☐ **C** Whether the graph of  $y = g(x)$  opens upward or downward
- ☐ **D** The  $x$ -coordinate of the vertex of the graph of  $y = g(x)$

**STOP.** This is the end of the test.