Mathematics Level 1 and Level 2

Questions cover topics emphasized in most high school courses. Because of course differences, most students will find there are some questions on topics that aren't familiar to them. You may not be able to complete all the questions in the time given, but it isn't necessary to get every question correct to get a high score or even the highest score on the test.

Recommended Preparation

Mathematics Level 1

- Three years of college-preparatory mathematics, including 2 years of algebra and 1 year of geometry.

Mathematics Level 2

- More than 3 years of college-preparatory mathematics, including 2 years of algebra, 1 year of geometry, and elementary functions (precalculus) and/or trigonometry.
- If you have had preparation in trigonometry and elementary functions and have attained grades of B or better in these courses, select Level 2. If you are sufficiently prepared to take Level 2 but take Level 1 in hopes of receiving a higher score, you may not do as well as you expect.

Scores

The content of the 2 tests is different enough that you can't use results on 1 test to predict how you'll do on the other test. You also shouldn't compare scores between the 2 math tests.

Calculators

Be sure to bring a calculator to use on the Mathematics tests. If you take these tests without a calculator, you will be at a disadvantage. In fact, some questions can't be solved without a scientific or a graphing calculator. Check page 71 for Acceptable and Unacceptable Calculators.

- Verify that your calculator is in good working condition before you take the test.
- If possible, bring batteries and a backup calculator to the test center. No substitute calculators or batteries will be available. Students may not share calculators.
- If your calculator malfunctions during the test and you don't have a backup calculator, you can cancel scores on just the Mathematics Test. You must tell the proctor when the malfunction occurs in order to cancel scores on these tests only.

FORMAT/CONTENT	Approximate % Level 1 Test	Approximate % Level 2 Test
50 multiple-choice questions each		
Topics Covered* *(topics in italics are tested on Level 2 Test only)*	Level 1	Level 2
Number and Operations Operations, ratio and proportion, complex numbers, counting, elementary number theory, matrices, sequences, *series, vectors*	**10%–14%**	**10%–14%**
Algebra and Functions Expressions, equations, inequalities, representation and modeling, properties of functions (linear, polynomial, rational, exponential, *logarithmic, trigonometric, inverse trigonometric, periodic, piecewise, recursive, parametric*)	**38%–42%**	**48%–52%**
Geometry and Measurement	**38%–42%**	**28%–32%**
Plane Euclidean/Measurement	**18%–22%**	-
Coordinate Lines, parabolas, circles, *ellipses, hyperbolas,* symmetry, transformations, *polar coordinates*	8%–12%	10%–14%
Three-dimensional Solids, surface area and volume (cylinders, cones, pyramids, spheres, prisms), *coordinates in three dimensions*	4%–6%	4%–6%
Trigonometry Right triangles, identities, *radian measure, law of cosines, law of sines, equations, double angle formulas*	6%–8%	12%–16%
Data Analysis, Statistics and Probability Mean, median, mode, range, interquartile range, *standard deviation,* graphs and plots, least-squares regression (linear, *quadratic, exponential*), probability	**8%–12%**	**8%–12%**

**The content of Level 1 overlaps somewhat with that on Level 2, but the emphasis on Level 2 is on more advanced content. Plane Euclidean geometry is not tested directly on Level 2.*

Using the Calculator

You don't need to use a calculator to solve every question, and it's important to know when and how to use one. First decide how you will solve a problem; then determine whether the calculator is needed.

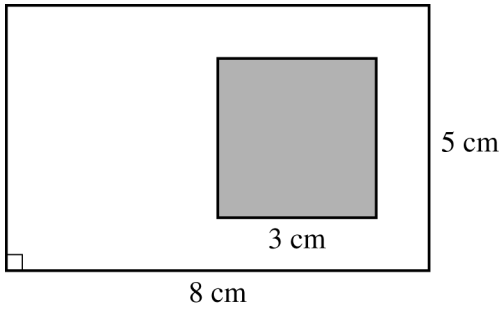
- You'll need a calculator for 40 to 50 percent of the questions on Level 1 and for 55 to 65 percent of the questions on Level 2. For the rest of the questions, there's no advantage, perhaps even a disadvantage, to using a calculator.
- **Don't round any intermediate calculations.** When you get a result from the calculator for the first step of a solution, keep the result in the calculator and use it for the second step. If you round the result from the first step, your answer may not be one of the choices.

Geometric Figures

Figures shown with problems provide information useful in solving the problems. They are drawn as accurately as possible EXCEPT if you see the text "Note: Figure not drawn to scale." This means that degree measures may not be accurately shown and specific lengths may not be drawn in the correct proportions. In such cases, the relative positions of points and angles will still be in the correct order. You can also assume that line segments that extend through points and appear to lie on the same line are on the same line.

Geometric Probability

In any problem involving geometric probability, the assumption is the feasible region is a part of the sample space. Example:



The figure above is a rectangular game board. What is the probability of randomly throwing a dart at the board such that it lands within the shaded square, assuming that the dart always lands within the boundary of the game board? (Answer: $\frac{9}{40}$)

The assumption is that the point inside the shaded square can be located anywhere in the region with the same probability.

Measures of Center

- The **mean** of a list of n numbers is equal to the sum of the numbers divided by n.
- The **median** of a list of numbers is the number in the middle when the numbers are ordered from least to greatest or from greatest to least. When there is an even number of values, the median is equal to the mean of the two middle numbers.
- A **mode** of a list of numbers is a number that occurs most often in the list. For example, 7 is the mode of 2, 7, 5, 8, 7, and 12. The list 2, 4, 2, 8, 2, 4, 7, 4, 9, and 11 has two modes, 2 and 4.

Calculating Quartiles

1. Arrange the data in order from least to greatest. The median of the data is the **second quartile**, Q2.
2. Now consider the lower half of the data. The median of these data is the **first (lower) quartile**, Q1.*
3. Next, consider the upper half of the data. The median of these data is the **third (upper) quartile**, Q3.*
4. Finally, the **interquartile range** (IQR) is equal to Q3 – Q1.

*Note: If the number of data points is odd, exclude Q2, the median of the entire data set, before separating it into halves to calculate Q1 or Q3.

Example: Consider the list 1, 2, 4, 5, 5, 5, 5, 7, and 9. The mean is $\frac{43}{9}$. The mode is 5. Q1 is 3. Q2, the median, is 5. Q3 is 6. The IQR is 3.

Sample Questions

All questions in the Mathematics Level 1 and Mathematics Level 2 Subject Tests are multiple-choice questions. For each question, choose the BEST response from the 5 choices offered. The directions for the tests are below:

Directions

For each of the following problems, decide which is the **BEST** of the choices given. If the exact numerical value is not one of the choices, select the choice that best approximates this value. Then fill in the corresponding bubble on the answer sheet.

Notes: (1) A scientific or graphing calculator will be necessary for answering some (but not all) of the questions in this test. For each question you will have to decide whether or not you should use a calculator.

(2) Level 1: The only angle measure used on this test is degree measure. Make sure your calculator is in the degree mode.

Level 2: For some questions in this test you may have to decide whether your calculator should be in the radian mode or the degree mode.

(3) Figures that accompany problems in this test are intended to provide information useful in solving the problems. They are drawn as accurately as possible EXCEPT when it is stated in a specific problem that its figure is not drawn to scale. All figures lie in a plane unless otherwise indicated.

(4) Unless otherwise specified, the domain of any function f is assumed to be the set of all real numbers x for which $f(x)$ is a real number. The range of f is assumed to be the set of all real numbers $f(x)$, where x is in the domain of f.

(5) Reference information that may be useful in answering the questions in this test can be found before Question 1.

Reference Information. The following information is for your reference in answering some of the questions in this test.

Volume of a right circular cone with radius r and height h: $V = \frac{1}{3}\pi r^2 h$

Volume of a sphere with radius r: $V = \frac{4}{3}\pi r^3$

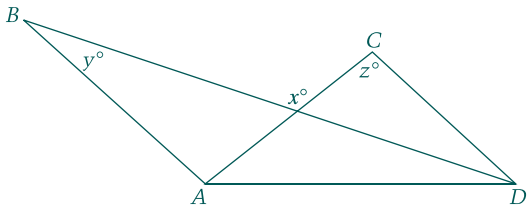
Volume of a pyramid with base area B and height h: $V = \frac{1}{3}Bh$

Surface Area of a sphere with radius r: $S = 4\pi r^2$

Mathematics Level 1

1. A band wants to distribute its music on compact discs (CDs). The equipment to produce the CDs costs $250, and blank CDs cost $5.90 for a package of 10. Which of the following represents the total cost, in dollars, to produce n CDs, where n is a multiple of 10?

   (A) $(250 + 0.59)n$ (B) $250 + 0.59n$
   (C) $(250 + 5.90)n$ (D) $250 + 5.90n$
   (E) $250n + 5.90$



2. In the figure above, $\overline{AB}$ and $\overline{CD}$ are parallel. What is x in terms of y and z?

   (A) $y + z$
   (B) $2y + z$
   (C) $2y - z$
   (D) $180 - y - z$
   (E) $180 + y - z$

3. A number n is increased by 8. If the cube root of that result equals −0.5, what is the value of n?

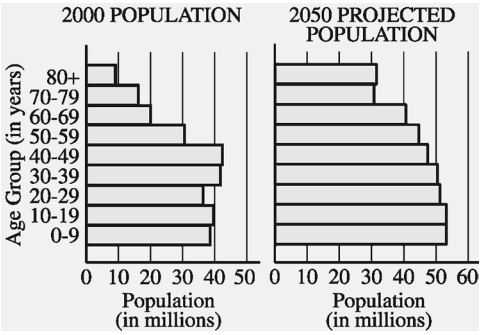
   (A) −15.625
   (B) −8.794
   (C) −8.125
   (D) −7.875
   (E) 421.875

4. If a and b are real numbers, $i^2 = -1$, and $(a + b) + 5i = 9 + ai$, what is the value of b?

   (A) 4 (B) 5 (C) 9
   (D) $4 + 5i$ (E) $5 + 4i$

5. What are all values of x for which $4 - x^2 \geq x - 2$?

   (A) $x \geq -3$ (B) $-5 \leq x \leq 0$
   (C) $-3 \leq x \leq 2$ (D) $x \leq -3$ or $x \geq 2$
   (E) $-2 \leq x \leq 3$



6. The graphs above show United States Census Bureau population figures for the year 2000 for various age groups, together with projections for the year 2050. Of the following age groups, for which is the projected percent increase in population from 2000 to 2050 greatest?

   (A) 30–39 (B) 40–49 (C) 50–59
   (D) 60–69 (E) 70–79

7. If $\log_c a = x$, which of the following must be true?

   (A) $a^c = x$ (B) $a^x = c$ (C) $c^a = x$
   (D) $c^x = a$ (E) $x^c = a$

8. If $f(x) = x + 3$ and $g(x) = \frac{x^2 - 9}{x - 3}$, which of the following statements are true about the graphs of f and g in the xy-plane?

   I. The graphs are exactly the same.
   II. The graphs are the same except when $x = 3$.
   III. The graphs have an infinite number of points in common.

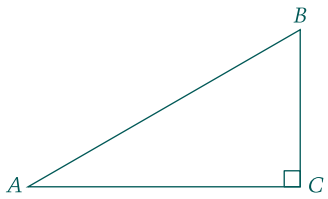
   (A) I only (B) II only (C) III only
   (D) I and III (E) II and III

9. If line ℓ is the perpendicular bisector of the line segment with endpoints $(2, 0)$ and $(0, -2)$, what is the slope of line ℓ?

   (A) 2 (B) 1 (C) 0
   (D) −1 (E) −2

10. Twenty students have each sampled one or more of three kinds of candy bars that a school store sells. If 3 students have sampled all three kinds, and 5 have sampled exactly two kinds, how many of these students have sampled only one kind?

(A) 8 (B) 12 (C) 15
(D) 17 (E) 18



Note: Figure not drawn to scale.

11. In the figure above, $\triangle ABC$ has a right angle at C. If the length of side $\overline{AC}$ is 10 and the measure of $\angle BAC$ is 22°, what is the length of side $\overline{BC}$?

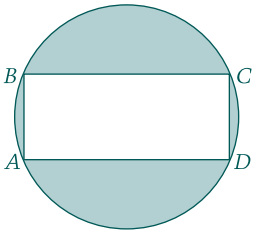
(A) 3.7 (B) 4.0 (C) 5.8
(D) 6.8 (E) 9.3

12. The function h given by $h(t) = -16t^2 + 46t + 5$ represents the height of a ball, in feet, t seconds after it is thrown. To the nearest foot, what is the maximum height the ball reaches?

(A) 5 (B) 23 (C) 35
(D) 38 (E) 46

13. The front, side, and bottom faces of a rectangular solid have areas of 24 square centimeters, 8 square centimeters, and 3 square centimeters, respectively. What is the volume of the solid, in cubic centimeters?

(A) 24 (B) 96 (C) 192
(D) 288 (E) 576



14. Rectangle $ABCD$ is inscribed in the circle shown above. If the length of side $\overline{AB}$ is 5 and the length of side $\overline{BC}$ is 12, what is the area of the shaded region?

(A) 40.8 (B) 53.1 (C) 72.7
(D) 78.5 (E) 81.7

15. If $f(x) = x^4 - 3x^3 - 9x^2 + 4$, for how many real numbers k does $f(k) = 2$?

(A) None (B) One (C) Two
(D) Three (E) Four

Time t (years)	0	1	2	5
Value $v(t)$ (dollars)	15,000	13,000	10,900	3,000

16. When purchased, an automobile is valued at $15,000. Its value depreciates at the rate shown in the table above. Based on a least-squares linear regression, what is the value, to the nearest hundred dollars, of the automobile when $t = 4$?

(A) $5,400 (B) $5,500 (C) $5,600
(D) $6,400 (E) $7,000

Mathematics Level 2

17. What is the distance in space between the points with coordinates $(-3, 6, 7)$ and $(2, -1, 4)$?

(A) 4.36 (B) 5.92 (C) 7.91
(D) 9.11 (E) 22.25

18. If $f(x) = \dfrac{3x + 12}{2x - 12}$, what value does $f(x)$ approach as x gets infinitely larger?

(A) -6 (B) $-\dfrac{3}{2}$ (C) -1
(D) $\dfrac{2}{3}$ (E) $\dfrac{3}{2}$

19. In January 1990 the world's population was 5.3 billion. Assuming a growth rate of 2 percent per year, the world's population, in billions, for t years after 1990 can be modeled by the equation $P = 5.3(1.02)^t$. According to the model, the population growth from January 1995 to January 1996 was

(A) 106,000,000
(B) 114,700,000
(C) 117,000,000
(D) 445,600,000
(E) 562,700,000

20. What is the measure of one of the larger angles of a parallelogram in the xy-plane that has vertices with coordinates $(2, 1)$, $(5, 1)$, $(3, 5)$, and $(6, 5)$?

(A) 93.4° (B) 96.8° (C) 104.0°
(D) 108.3° (E) 119.0°

21. For some real number t, the first three terms of an arithmetic sequence are $2t, 5t-1$, and $6t+2$. What is the numerical value of the fourth term?

(A) 4 (B) 8 (C) 10
(D) 16 (E) 19

22. The diameter and height of a right circular cylinder are equal. If the volume of the cylinder is 2, what is the height of the cylinder?

(A) 1.37 (B) 1.08 (C) 0.86
(D) 0.80 (E) 0.68

23. If $\sin\theta = 0.57$, then $\sin(\pi - \theta) =$

(A) −0.57 (B) −0.43 (C) 0
(D) 0.43 (E) 0.57

24. In a group of 10 people, 60 percent have brown eyes. Two people are to be selected at random from the group. What is the probability that <u>neither</u> person selected will have brown eyes?

(A) 0.13 (B) 0.16 (C) 0.25
(D) 0.36 (E) 0.64

25. If $x-2$ is a factor of $x^3 + kx^2 + 12x - 8$, then $k =$

(A) −6 (B) −3 (C) 2
(D) 3 (E) 6

26. If $f(x) = \sqrt[3]{x^3+1}$, what is $f^{-1}(1.5)$?

(A) 3.4 (B) 2.4 (C) 1.6
(D) 1.5 (E) 1.3

x	−9.8	−0.9	5.2	8.8
y	0.12	2.43	18.46	68.4

27. Which of the following equations best models the data in the table above?

(A) $y = -3.3(1.4)^x$ (B) $y = -1.4(3.3)^x$
(C) $y = 1.4(3.3)^x$ (D) $y = 3.3(1.4)^x$
(E) $y = 1.4x^{3.3}$

$$C = -1.02F + 93.63$$

28. The linear regression model above is based on an analysis of nutritional data from 14 varieties of cereal bars to relate the percent of calories from fat (F) to the percent of calories from carbohydrates (C). Based on this model, which of the following statements must be true?

I. There is a positive correlation between C and F.
II. When 20 percent of calories are from fat, the predicted percent of calories from carbohydrates is approximately 73.
III. The slope indicates that as F increases by 1, C decreases by 1.02.

(A) II only (B) I and II only
(C) I and III only (D) II and III only
(E) I, II, and III

29. A line has parametric equations $x = 5 + t$ and $y = 7 + t$, where t is the parameter. The slope of the line is

(A) $\frac{5}{7}$ (B) 1 (C) $\frac{7+t}{5+t}$
(D) $\frac{7}{5}$ (E) 7

30. What is the range of the function defined by

$f(x) = \frac{1}{x} + 2$?

(A) All real numbers
(B) All real numbers except $-\frac{1}{2}$
(C) All real numbers except 0
(D) All real numbers except 2
(E) All real numbers between 2 and 3

31. The number of hours of daylight, d, in Hartsville can be modeled by $d = \frac{35}{3} + \frac{7}{3}\sin\left(\frac{2\pi}{365}t\right)$, where t is the number of days after March 21. The day with the greatest number of hours of daylight has how many <u>more</u> daylight hours than May 1? (March and May have 31 days each. April and June have 30 days each.)

(A) 0.8 hr (B) 1.5 hr (C) 2.3 hr
(D) 3.0 hr (E) 4.7 hr

Model X	20	18	3
Model Y	16	5	8
Model Z	19	11	10

32. The table above shows the number of digital cameras that were sold during a three-day sale. The prices of models X, Y, and Z were \$99, \$199, and \$299, respectively. Which of the following matrix representations gives the total income, in dollars, received from the sale of the cameras for each of the three days?

(A) $\begin{bmatrix} 20 & 18 & 3 \\ 16 & 5 & 8 \\ 19 & 11 & 10 \end{bmatrix} [99 \quad 199 \quad 299]$

(B) $\begin{bmatrix} 20 & 18 & 3 \\ 16 & 5 & 8 \\ 19 & 11 & 10 \end{bmatrix} \begin{bmatrix} 99 \\ 199 \\ 299 \end{bmatrix}$

(C) $[99 \quad 199 \quad 299] \begin{bmatrix} 20 & 18 & 3 \\ 16 & 5 & 8 \\ 19 & 11 & 10 \end{bmatrix}$

(D) $\begin{bmatrix} 99 \\ 199 \\ 299 \end{bmatrix} \begin{bmatrix} 20 & 18 & 3 \\ 16 & 5 & 8 \\ 19 & 11 & 10 \end{bmatrix}$

(E) $99 \begin{bmatrix} 20 & 18 & 3 \\ 16 & 5 & 8 \\ 19 & 11 & 10 \end{bmatrix} + 199 \begin{bmatrix} 20 & 18 & 3 \\ 16 & 5 & 8 \\ 19 & 11 & 10 \end{bmatrix} + 299 \begin{bmatrix} 20 & 18 & 3 \\ 16 & 5 & 8 \\ 19 & 11 & 10 \end{bmatrix}$

ANSWERS

The estimated difficulty level, on a scale of 1 to 5, with 1 the easiest and 5 the most difficult, is in parentheses.

Mathematics Level 1

1.	B (2)	5.	C (3)	9.	D (4)	13.	A (4)
2.	A (2)	6.	D (4)	10.	B (3)	14.	C (4)
3.	C (2)	7.	D (3)	11.	B (3)	15.	E (3)
4.	A (3)	8.	E (3)	12.	D (4)	16.	C (5)

Mathematics Level 2

17.	D (2)	21.	E (4)	25.	A (2)	29.	B (3)
18.	E (2)	22.	A (3)	26.	E (4)	30.	D (3)
19.	C (4)	23.	E (3)	27.	D (4)	31.	A (4)
20.	C (4)	24.	A (4)	28.	D (4)	32.	C (3)

Answer explanations for these practice questions are available online. Visit **SATSubjectTests.org/mathanswers** to view and download the complete document.

The SAT® and SAT Subject Tests™

Calendar 2020-21

Deadlines expire at 11:59 p.m. U.S. ET.

	2020				2021		
Test Dates*	**AUG 29**	**OCT 3**	**NOV 7**	**DEC 5**	**MAR 13**	**MAY 8**	**JUN 5**
Domestic Registration Deadline	**July 31**	**Sep 4**	**Oct 9**	**Nov 5**	**Feb 12**	**Apr 8**	**May 6**
Domestic Late Registration Deadline							
Paper	Aug 11	Sep 15	Oct 20	Nov 17	Feb 23	Apr 20	May 18
Online and Phone	Aug 18	Sep 22	Oct 27	Nov 24	Mar 2	Apr 27	May 26
International Registration Deadline**	**July 31**	**Sep 4**	*Not Available*	**Nov 5**	**Feb 12**	**Apr 8**	**May 6**
International Early Registration Deadline**	July 15	Aug 19		Oct 21	Jan 27	Mar 24	Apr 21
The SAT	●	●	●	●	●	●	●
The SAT Subject Tests					*SAT Subject Tests are not offered on this date.*		
Biology E/M, Chemistry, Physics	●	●	●	●		●	●
Literature	●	●	●	●		●	●
Mathematics Levels I and II	●	●	●	●		●	●
United States (U.S.) History	●	●	●	●		●	●
World History	●			●			●
Languages: Reading Only							
French, Spanish	●	●		●			
German, Italian, and Modern Hebrew							●
Latin				●			●
Languages with Listening *You may take only one listening test on this date.*							
Chinese, French, German, Japanese, Korean, and Spanish			● (U.S. only)			●	

Domestic Registration: **sat.org/register**
Domestic Fees: **sat.org/us-fees**
Fee Waivers: **sat.org/fee-waivers**

International Registration: **sat.org/international**
International Fees: **sat.org/intl-fees**

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* Sunday tests are given the day after the Saturday test except for October 18 (moved later to avoid conflict with a religious holiday).
**If registering through a service provider, you'll need to submit by the early international deadline. Be sure to review the test calendar carefully because not all subjects are offered on every test date. The SAT is offered internationally in August, October, December, March, and May. The SAT Subject Tests are offered internationally in August, October, December, May, and June. Language with Listening Tests are offered internationally in May.

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