

MATH TEST KEY POINTS

TEST 1

 The Key Points section reviews many of the concepts you will encounter on the SAT Math Practice Tests. Each Key Point corresponds to one or more test questions. Key Points with a **nc** next to them correspond to "no calculator" questions, while Key Points with a **c** next to them correspond to "calculator" questions. The numbers next to the **nc** and **c** labels tell you which question each Key Point relates to.

1. Slope of a Straight Line (nc14)

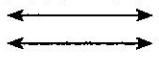
The slope of a non-vertical line that contains points $A(x_1, y_1)$ and $B(x_2, y_2)$ is given by the formula:

Remember :

$$\text{Slope}(m) = \frac{\text{Change in } y}{\text{Change in } x} = \frac{y_2 - y_1}{x_2 - x_1}$$

- Slope-Intercept Form: $y = mx + b$
A line in this form has slope m and includes y -intercept b (the point $(0, b)$).

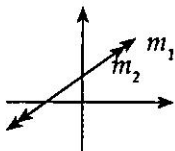
2. Parallel and Perpendicular Lines(c10)

- Two lines are parallel if their slopes, m , are identical. 
- Two lines are perpendicular if their slopes, m_1 and m_2 are negative reciprocals.

$$m_1 \cdot m_2 = -1$$

$$\text{so } m_1 = -\frac{1}{m_2}$$

- Two lines are identical if their slopes, m_1 and m_2 and the y -intercepts, b_1 and b_2 are identical.



3. Complex Numbers (c30)

The symbol $\sqrt{\quad}$ is called a **radical** and is used to indicate a square root. A number or expression under a radical is referred to as a **radicand**.

Radical $\rightarrow \sqrt{\quad} \leftarrow$ Radicand

- For any real number a , $\sqrt{a^2} = |a|$

Using similar logic, the square root of any negative number can be defined as follows: For any real number a ,

- $\sqrt{a^2} = |a| i$ where $i^2 = -1$.

A **complex number** is any number of the form $a + bi$, where a and b are real numbers, $b \neq 0$, and i is the imaginary unit.

4. Factors of a Polynomial Function (nc18)

Let $f(x)$ be a polynomial function. If the function has a factor $x - a$, then $f(a) = 0$. 

5. Operations with Exponents (c21)

The operations of exponents are summarized below. Assume all bases and denominators are nonzero.

$(a^m)(a^n) = a^{m+n}$	$(a^m)^n = a^{m \cdot n}$
$(ab)^n = a^n b^n$	$\left(\frac{a}{b}\right)^0 = \frac{a^0}{b^0} = 1$
$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$	$\left(\frac{a}{b}\right)^{-n} = \frac{a^{-n}}{b^{-n}} = \frac{b^n}{a^n}$
$\frac{a^m}{a^n} = a^{m-n}$	$a^{\frac{m}{n}} = \sqrt[n]{a^m} = (\sqrt[n]{a})^m$

6. Factorization of Cubes (c27)

$$a^3 + b^3 = (a + b)(a^2 - ab + b^2)$$

$$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$$

$$(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3 \quad \text{* two minus sign}$$

$$(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3 \quad \text{* signs are all plus}$$

7. Defining of a Function (c22)

- A **function** is a set of ordered pairs with a one to one relation between the two values of each pair. Often times, a function is denoted as $y = f(x)$, where each input, x , has a single output, y .
- The **domain** of a function is the set of all the first coordinates of the ordered pairs. The domain of $y = f(x)$ is the set of x-coordinates★ on the graph of the function.
- The **range** of a function is the set of all the second coordinates of the ordered pairs. The range of $y = f(x)$ is the set of y-coordinates★ on the graph of the function.

8. Quadratic Formula (nc11)

For the binomial function $f(x) = ax^2 + bx + c$, the roots of $f(x) = 0$ are as follows:

Remember ★:

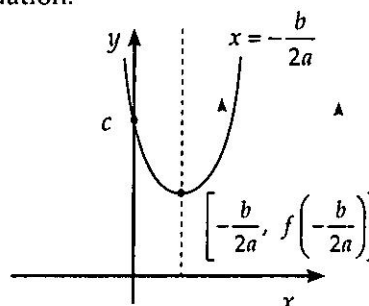
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

If $D = b^2 - 4ac$, then the following holds:

- If $D > 0$, there exist two real number roots.
- If $D = 0$, there exists one real number root.
- If $D < 0$, there does not exist a real number root, only complex number roots.

9. Graphing Quadratic Functions (nc19)

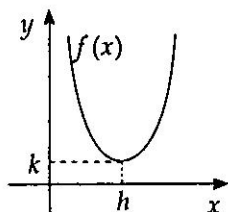
The graph of a quadratic function is a parabola. It is either the standard form or the vertex form of the equation:



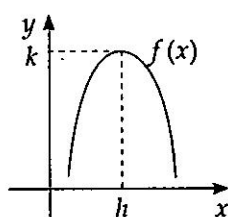
- Standard Form:** $y = ax^2 + bx + c$
The vertex is $\left(-\frac{b}{2a}, f\left(-\frac{b}{2a}\right)\right)$
The axis of symmetry is $x = -\frac{b}{2a}$
The y-intercept is $(0, c)$
The x-intercepts are $\left(\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}, 0\right)$
- Vertex Form:** $y = a(x - h)^2 + k$
The vertex is (h, k) .
If the x-intercepts are $(p, 0)$ and $(q, 0)$, then $h = \frac{p+q}{2}$.

10. Interpreting Quadratic Functions (nc4)

The graph of a quadratic function $y = a(x - h)^2 + k$ has its minimum value k at the vertex (h, k) if $a > 0$ (the parabola opens upward).



$y = a(x - h)^2 + k$ has its maximum value k at the vertex (h, k) if $a < 0$ (the parabola opens downward).



11. Roots of a Quadratic Function

Let r and β be the two roots of a quadratic function $f(x) = ax^2 + bx + c$, ($a \neq 0$). Then, $f(x)$ can be represented as follows:

$$\begin{aligned} f(x) &= a(x - r)(x - \beta) \\ &= a\{x^2 - (r + \beta)x + r\beta\} \\ &= ax^2 - a(r + \beta)x + ar\beta \end{aligned}$$

Therefore, it follows that $r + \beta = -\frac{b}{a}$, $r\beta = \frac{c}{a}$.[★]

Note that the roots of the quadratic function

$$f(x) \text{ have the following form: } x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

If $D = b^2 - 4ac$, then the following holds:

- If $D > 0$, there exist two real number roots.
- If $D = 0$, there exists one real number root.
- If $D < 0$, there does not exist a real number root.

If $D = b^2 - 4ac \geq 0$, then the function has real number solutions.

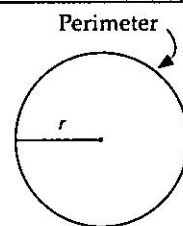
12. Circles (c34)

Let r be the radius of the circle.

$\pi \approx 3.14$, Diameter $= 2r$

Area of circle $A = \pi r^2$

Circumference of circle $C = 2\pi r$



Remember ✱:

$$\text{Equation of circle: } (x - h)^2 + (y - k)^2 = r^2$$

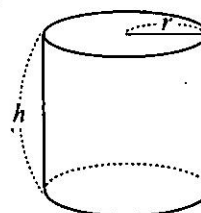
* where (h, k) is the coordinate of the center and r is the radius.

13. Cylinders (c28)

Let r be the radius of the circular base of the cylinder and h be the cylinder's height. Note that the top circle and bottom circle are the same size.

Volume of Cylinder (V) = (area of bottom circle) $\times$ height.

That is, $V = \pi r^2 h$

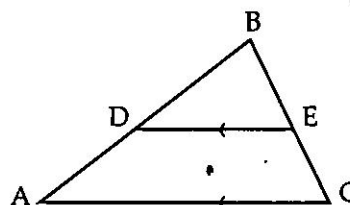


$$\text{Volume} = \pi r^2 h$$

14. Triangle Side-Splitter Theorem (nc15)

The side splitter theorem states that if a line is parallel to a side of a triangle and intersects the other two sides, then this line divides those two sides proportionally. In the example below where the bases of the conjoined triangles are parallel,

$$\frac{AD}{DB} = \frac{CE}{EB}$$

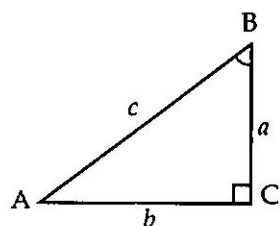


Remember ✱:

$$\text{If } \frac{BE}{BC} = \frac{1}{k}, \text{ then } \frac{S(\triangle DBE)}{S(\triangle ABC)} = \frac{1}{k^2}$$

* k is a constant

15. Pythagorean Theorem (nc14)



If a , b , c are the sides of a right triangle and a and b are adjacent to the right angle, then the following equation holds:

$$c^2 = a^2 + b^2$$

16. Measure of Center and Spread (c16-19)

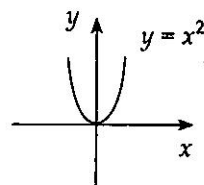
- **Mean:** The mean of a set of a data (commonly called the "average") is the sum of the numbers in the set divided by the number of members of the set. If n numbers are given, each number denoted by a_i (where $i = 1, 2, \dots, n$), the arithmetic mean is given as following.

$$\text{Mean} = \frac{1}{n} \sum_{i=1}^n a_i = \frac{1}{n} (a_1 + a_2 + \dots + a_n)$$

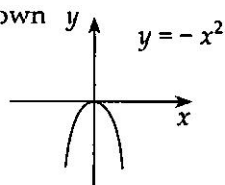
- **Median:** The median of a data set is the *middle value* when the set is arranged in order of increasing value. If there are an even number of values in the set, the median is the average of the two middle values.
- **Mode:** The mode is the *most occurring number* in the set.
- **Range:** The range is the *difference between the greatest and least values* of the set.

17. Graph Transformations (c24)

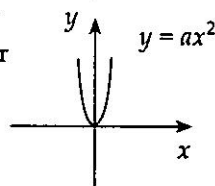
Original



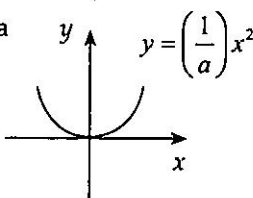
Upside-down



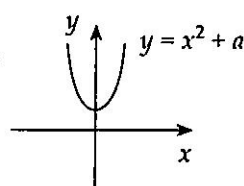
Narrower by a factor of a



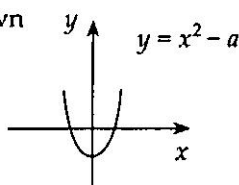
Wider by a factor of a



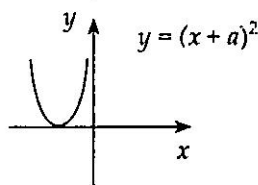
Move up by a units



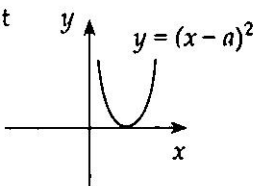
Move down by a units



Move left by a units



Move right by a units



18. Sequences (nc20)

An arithmetic sequence is a list of terms where the difference between consecutive numbers is identical:

$$a_n = a_1 + (n - 1)d$$

* a_1 is the first number

d is the difference

A geometric sequence is a list of numbers where each consecutive number have a common ratio. To find the n^{th} term of a sequence:

$$a_n = a_1 r^{(n-1)}$$

* a_1 is the first number

* r is the common ratio

19. Proportionality (c20)

Remember *

When x and y are directly proportional,

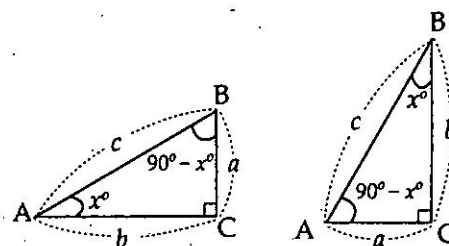
$$\frac{x_1}{y_1} = \frac{x_2}{y_2}$$

When x and y are inversely proportional,

$$x_1 y_1 = x_2 y_2$$

20. Trigonometric Relations (c15)

The sine and cosine of complementary angles in a right triangle are equal.



$$\sin x^\circ = \cos(90^\circ - x^\circ) = \frac{a}{c}$$

$$\cos x^\circ = \sin(90^\circ - x^\circ) = \frac{b}{c}$$

Given an angle in radians, we have the following results:

$$\sin \theta = \cos\left(\frac{\pi}{2} - \theta\right)$$

$$\sin \theta = \sin(\pi - \theta),$$

$$\cos \theta = -\cos(\pi - \theta)$$

$$\cos \theta = \sin\left(\frac{\pi}{2} - \theta\right)$$

$$\tan\left(\frac{\pi}{2} - \theta\right) = \frac{\sin\left(\frac{\pi}{2} - \theta\right)}{\cos\left(\frac{\pi}{2} - \theta\right)} = \frac{\sin(\theta)}{\cos(\theta)}$$

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