

Mu Alpha Theta National Convention: Denver, 2001
Equations and Inequalities Topic Test – Theta Division

1. What is the equation in standard form of the line through the points (1, 3) and (5, 7)?

(A) $x - y = 2$ (B) $x^2 - 6x + y = 2$
 (C) $x - y = -2$ (D) $x + y = 4$ (E) NOTA

2. For what value of x does $3(3x - 3) - (3x - 1) = 8 + 3(3 - 3x)$?

(A) $\frac{5}{9}$ (B) $\frac{5}{3}$ (C) $\frac{5}{2}$ (D) $\frac{7}{2}$ (E) NOTA

3. What are the roots of the equation $x^2 - x - 12 = 0$?

(A) 3, 4 (B) 3, -4 (C) 4, 3 (D) 4, -3 (E) NOTA

4. The profit at a company is given by the formula $p(x) = -100x^2 + 700x + 15000$. Find the value of x at which profit is maximized.

(A) $\frac{7}{15}$ (B) $\frac{3}{2}$ (C) $\frac{5}{2}$ (D) $\frac{7}{2}$ (E) NOTA

5. Solve for x : $\ln x + \ln(2x) = 2$

(A) $\frac{e^2\sqrt{2}}{8}$ (B) $\frac{e\sqrt{2}}{2}$ (C) 2 (D) $\frac{e^2}{2}$ (E) NOTA

6. Solve for $a + b + c + d + e$: $a + b = 10$, $b + c = -7$, $c + d = 3$, $d + e = 11$, $e + a = 1$

(A) 3 (B) 6 (C) 9 (D) 12 (E) NOTA

7. Given that $3^x = 8$, evaluate $9^x - 5 \cdot 3^{2x} + 4$.

(A) -260 (B) -256 (C) -252 (D) -320 (E) NOTA

8. Solve for x : $\sqrt{x^2 - 4x - 38} = \sqrt{7}$

(A) -5 (B) 9 (C) -5 or 9 (D) 25 (E) NOTA

9. Solve for q : $\sqrt{5 - \sqrt{7 + q}} = 1$

(A) 4 (B) 9 (C) 16 (D) 25 (E) NOTA

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10. Given the set $A = \{-10, -9, -8, \dots, 8, 9, 10\}$, how many elements x , of A , satisfy $x^2 - 5x - 11 \leq 0$?
- (A) 8 (B) 9 (C) 10 (D) 11 (E) NOTA
11. Arthur buys a piece of land. Bart buys the same land from Arthur for at least two hundred percent more than what Arthur paid for it. Carl buys the same land from Bart for at least four hundred percent more than what Bart paid for it. Dan buys the same land from Carl for at least forty percent more than what Carl paid for it. If Dan paid 4.2 million dollars for the land, what is the largest amount that Arthur could have paid for the land?
- (A) \$200,000 (B) \$250,000 (C) \$375,000 (D) \$1,312,500 (E) NOTA
12. For what values of x is $x^2 + 5x + 9 > 5$?
- (A) $x > -4$ (B) $x < -1$ or $x > 4$
(C) $x < -1$ and $x > -4$ (D) $x > -1$ or $x < -4$ (E) NOTA
13. How many of the following are roots of $x^3 + 6 = -2$?
- I: 2
II: -2
III: $1 + i\sqrt{3}$
IV: $1 - i\sqrt{3}$
- (A) 1 (B) 2 (C) 3 (D) 4 (E) NOTA
14. What is the domain of the function $f(x) = \frac{\sqrt{4-x}}{x-3}$, assuming both the domain and range are subsets of the real numbers?
- (A) $x < 4$ (B) $x \neq 3$ (C) $x \geq 4$ (D) $x \leq 4$ and $x \neq 3$ (E) NOTA
15. How many integer values of x satisfy $\frac{x-3}{2x+1} > 4$?
- (A) 0 (B) 1 (C) 3 (D) infinitely many (E) NOTA
16. Given that $f(x) = \frac{6}{6-3x}$, determine $f^{-1}(x)$.
- (A) $\frac{2x-2}{x}$ (B) $\frac{6-3x}{6}$ (C) $\frac{-6}{6-3x}$ (D) $\frac{2-3x}{2}$ (E) NOTA

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17. Given $g(d) = 9d + 4$ and $f(d) = \frac{d^2}{9}$, evaluate $g(f(14))$.
- (A) 188 (B) 192 (C) 196 (D) 200 (E) NOTA
18. Solve for f : $2^{f-1}32^{f+1} = 8^{3f-3}$
- (A) $\frac{-10}{3}$ (B) $\frac{7}{3}$ (C) $\frac{10}{3}$ (D) $\frac{13}{3}$ (E) NOTA
19. Solve for y given that x and y are both integers: $6^{x-2}18^{y+2} = 3,779,136$
- (A) -2 (B) 1 (C) 2 (D) 2 or -2 (E) NOTA
20. What is the sum of the non-real roots of $x^3 - 2x^2 + 4x - 8 = 0$?
- (A) 0 (B) 1 (C) 2 (D) 3 (E) NOTA
21. What is the sum of the reciprocals of the roots of $f(x) = 4x^5 + 2x^4 - 5x^3 + 4x + 3$?
- (A) -2 (B) $-\frac{3}{2}$ (C) $-\frac{4}{3}$ (D) -1 (E) NOTA
22. Given that $f(x-3) = x^2 + 6x - 11$, what is the constant term of $\frac{f(x)}{5}$?
- (A) $-\frac{11}{5}$ (B) $\frac{16}{5}$ (C) $\frac{41}{5}$ (D) $\frac{66}{7}$ (E) NOTA
23. Given that $\frac{4x}{x^2 - 4x - 5} = \frac{A}{x+1} + \frac{B}{x-5}$ Find $A + B$, where A and B are real numbers.
- (A) $\frac{5}{6}$ (B) 1 (C) 4 (D) 6 (E) NOTA
24. Given that $\frac{32x-9}{x^2 + 2x+1} = \frac{A}{x+1} + \frac{B}{(x+1)^2}$ Find $A + B$, where A and B are real numbers.
- (A)-11 (B) -10 (C) -9 (D) -8 (E) NOTA

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25. Given that $x + y + z = 1$ and $3x - 2y + 3z = 5$, solve for x in terms of z .

- (A) $-z + \frac{7}{5}$ (B) $-z - \frac{7}{5}$ (C) $z + \frac{7}{5}$ (D) $-z - \frac{7}{5}$ (E) NOTA

26. Given that $-3x + 4y + 2z = -15$, $-3x + 4y + 4z = -13$, and $-4x + y + 4z = -10$, evaluate $x + y + z$.

- (A) 0 (B) 1 (C) 2 (D) 3 (E) NOTA

27. Solve the equation for x : $\log_2(5x) + \log_8(8x^3) = 1$

- (A) $\frac{\sqrt{2}}{5}$ (B) $\frac{\sqrt{5}}{5}$ (C) $\frac{\sqrt{10}}{10}$ (D) $\frac{\sqrt[3]{10}}{20}$ (E) NOTA

28. Solve the equation for x : $\log_3(x) = \log_x(27)$

- (A) $3\sqrt{3}$ (B) $3^{\sqrt{3}}$ (C) $3^{\pm\sqrt{3}}$ (D) 9 (E) NOTA

29. Assuming that N is a natural number less than or equal to 1000, what is the lowest possible value of the expression $\lfloor \log_2 N \rfloor - \log_2 N$? Note: $\lfloor x \rfloor$ stands for the greatest integer less than or equal to x .

- (A) $\log_2 1000 - 9$ (B) $\log_2 511 - 7$
(C) $8 - \log_2 511$ (D) $9 - \log_2 1000$ (E) NOTA

30. Solve for x : $\frac{x-2}{-4x+5} \leq -3$

- A) $\left[\frac{-13}{11}, \infty \right)$ B) $\left[\frac{13}{11}, \infty \right)$ C) $\left(\frac{13}{11}, \frac{5}{4} \right)$ D) $\left[\frac{13}{11}, \frac{5}{4} \right)$ E) NOTA

31. Bill is nine years older than Mary, and in five years he will be twice Mary's age three years ago. How old is Bill now?

- (A) 11 (B) 17 (C) 20 (D) 29 (E) NOTA

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32. If $r = -3$ is a solution to $3r - qr^3 + 11 = 5$, what is the value of q ?
- (A) $\frac{5}{9}$ (B) $\frac{-5}{9}$ (C) $\frac{1}{9}$ (D) $\frac{-1}{9}$ (E) NOTA
33. One of the roots of $3x^2 + 18x + c = 0$ is twice the other. What is the value of c ?
- (A) 6 (B) 12 (C) 18 (D) 24 (E) NOTA
34. In the Mu Alpha Theta Survivor Contest, five contestants named A, B, C, D, and E are placed in a room. They cast one vote each. A and B receive a total of 2 votes. D and E receive a total of 3 votes. A and D receive a total of 2 votes. A and E receive a total of 3 votes. Who received the most votes?
- (A) E (B) D (C) C (D) B (E) NOTA
35. Given that $k(m) = 7m - 3$, what is $k^{-1}(m)$?
- (A) $\frac{m-3}{7}$ (B) $\frac{m+3}{7}$ (C) $\frac{7m-7}{3}$ (D) $\frac{7m-3}{7}$ (E) NOTA
36. What is the minimal set of quadrants which contains the entire set of points satisfying $-4y - 3x < 3$ and $x + y < -5$?
- (A) I (B) II (C) I, II (D) I, II, IV (E) NOTA
37. The equation $\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1$ is the general form for what shape centered at the origin and aligned with the coordinate axes?
- (A) circle (B) ellipse (C) parabola (D) hyperbola (E) NOTA
38. Given that $g(d) = 2d - 7$ and $f(d) = \frac{d}{d-2}$, evaluate $g(f(7))$?
- (A) $\frac{-49}{5}$ (B) $\frac{-21}{5}$ (C) $\frac{21}{5}$ (D) $\frac{49}{5}$ (E) NOTA
39. How many natural numbers are solutions of $3w - 44 < 35$?
- (A) 0 (B) 23 (C) 25 (D) 26 (E) NOTA

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40. How many integers satisfy: $t - 1 < -t + 4 < 2t + 17$

- (A) 1 (B) 3 (C) 5 (D) 7 (E) NOTA