

Alpha Equations and Inequalities Test
2015 Mu Alpha Theta National Convention

1. If $f(3x - 3) = x^3 + 6x^2 + 12x + 7$, what is $f(3)$?
- A) -145 B) 63 C) 250 D) 124 E) NOTA
2. How many solutions are there to the equation $|x + 1 + |2x + 4|| = 6$?
- A) 2 B) 1 C) 0 D) 4 E) NOTA
3. Solve for x: $\sin^3(x) + 3\sin^2(x) + 3\sin(x) + 1 = 0$ where $x \in [0, 2\pi)$
- A) $\pi/2$ B) π C) $3\pi/2$ D) 0 E) NOTA
4. Given that $x - y = 8$ and $xy = 6$, find the real value of $x^3 - y^3$.
- A) 0 B) 212 C) -155 D) 656 E) NOTA
5. How many integer pair solutions are there to the equation: $\frac{x^2}{4} + \frac{y^2}{9} = 1$?
- A) Infinite B) 2 C) 4 D) 1 E) NOTA
6. What is the domain of the function $(x) = \sqrt{|\ln(3x + 2)|}$?
- A) $[\frac{2}{3}, \infty)$ B) $[e, \infty)$ C) $(-\frac{2}{3}, \infty)$ D) $(0, \infty)$ E) NOTA
7. Solve for x: $\frac{2}{x-6} + \frac{5}{2x-3} \geq 0$
- A) 6 B) $x > 6, x < 4$ C) $x > 6, -\frac{2}{3} < x \leq 3$
D) $x > 6, \frac{3}{2} < x \leq 4$ E) NOTA
8. Solve for x: $4 - \frac{4}{\frac{4}{x-4}} = 10$
- A) 2 B) 4 C) -4 D) -2 E) NOTA
9. If y is varied from $(-\infty, \infty)$, what is the difference between the maximum number of solutions and the minimum number of solutions to the equation: $\frac{|6|x-3|}{|10|x-1|} = y$
- A) 6 B) 4 C) 2 D) 0 E) NOTA
10. If $f(x) = 6x^2 + 1$ and $g(x) = -x + 6$, what is $f(g(2x))$ if $x = 4$?
- A) 10 B) 25 C) 126 D) 50 E) NOTA

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11. Solve for x: $\sqrt{x + \sqrt{x + \sqrt{x \dots}}} = 6$

- A) 6 B) $36/3$ C) 30 D) $\sqrt{6}$ E) NOTA

12. John saves \$100 each month in his mattress. Jim invests \$50 each month in a bank that pays 10% interest at the end of each month on the total amount in the account. Jim takes the interest gained each month and puts it in his mattress. How many deposits must Jim make until he has more money in his mattress than John?

- A) 40 B) 30 C) 20 D) 50 E) NOTA

13. What is the area of the region enclosed by $|x - 5| + 2|y + 3| = 8$?

- A) 8 B) 16 C) 32 D) 64 E) NOTA

14. James decides to spend the same amount of time (in a positive integer number of minutes) on each problem but not necessarily work every problem on this 30-question, 60-minute test. How many different numbers of problems is it possible for James to work on this test?

- A) 8 B) 10 C) 11 D) 12 E) NOTA

15. Bob is half as old as Alice will be in 12 years. 7 years ago, Chris was half Alice's current age. Bob's age is divisible by 7. Alice is 1 year older than Chris. What is the sum of Bob's, Alice's, and Chris's current ages?

- A) 26 B) 41 C) 45 D) 78 E) NOTA

16. What are the real solutions to: $\frac{x^5+x^4+x^3+x^2+x+1}{x^5-x^4+x^3-x^2+x-1} = 0$?

- A) 0, 1 B) $1 - \sqrt{2}$ C) $1 + \sqrt{2}$ D) -1 E) NOTA

17. How many times do the graphs of $y = x^2 + 5x + 17$ and $y = x$ intersect?

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

18. $x^5 - 650x^3 + 104329x = 0$ has 5 real roots. What is the median of those roots?

- A) 0 B) -7 C) $2 + \sqrt{2}$ D) -3 E) NOTA

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19. Find the product of the solutions of x given $\begin{vmatrix} x & 1 & 2 \\ 3 & x & 4 \\ 5 & 6 & 7 \end{vmatrix} = 0$.
- A) $34/7$ B) 5 C) 0 D) 34 E) NOTA
20. If a and b are real, find $a + b$ given: $\frac{4-i}{2-i} + \frac{2+i}{4+i} = a + bi$
- A) 6 B) $44/85$ C) $242/85$ D) $148/85$ E) NOTA
21. Find the real solution for x given: $4^3 - 4^{x-6} * 4^{2x} = 0$
- A) 1 B) 3 C) -1 D) 6 E) NOTA
22. For what values of x where $x \in [0, \pi)$ does $\sqrt{3} \cos(x) \geq \sin(x)$?
- A) $x \leq \frac{\pi}{2}$ B) $\frac{\pi}{3} \leq x < \frac{\pi}{2}$ C) $x \leq \frac{2\pi}{3}$ D) $\frac{\pi}{4} \leq x \leq \frac{\pi}{2}$ E) NOTA
23. Solve for y : $y^2 < |6|$
- A) $y > \sqrt{6}$ B) $y < -\sqrt{6}$ C) $-\sqrt{6} < y < \sqrt{6}$
D) \emptyset E) NOTA
24. $f(x)$ is quadratic and $f(2) = 17, f(3) = 24, f(4) = 33, f(5) = 44$. What is the product of the roots of $f(x)$?
- A) 9 B) -24 C) 24 D) 18 E) NOTA
25. If a, b, c are the roots of $x^3 + 6x^2 + 11x + 6$, what is $\frac{ab+bc+ac}{a+b+c}$?
- A) $-6/11$ B) $6/11$ C) $11/6$ D) $-11/6$ E) NOTA
26. If $f(x) = \sqrt{x+1}$, what is $f^{-1}(-2)$?
- A) 3 B) -3 C) 5 D) -5 E) NOTA
27. For the quadratic $x^2 - 10x + 23$, what is the sum of the sum of the roots and the product of the roots?
- A) 33 B) 13 C) -33 D) -13 E) NOTA

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28. How many positive integer pair solutions are there to the equation $6x + 7y = 71$?

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

29. Find $A + B$ if : $\frac{A}{x+2} + \frac{B}{x-5} = \frac{6x+7}{x^2-3x-10}$

- A) -10 B) -5 C) 6 D) -6 E) NOTA

30. What value of a makes the vectors $\langle a + 1, a + 2, a + 3 \rangle$ and $\langle 4, 5, 6 \rangle$ perpendicular?

- A) -32/15 B) -2 C) -5/3 D) -15/2 E) NOTA