

Theta Algebra
2007 Mu Alpha Theta National Convention

For all questions, answer E. "NOTA" means none of the above answers is correct.

1. If $f(x) = e^x$ and $g(x) = \ln(x)$, find $f^{-1}(g^{-1}(4))$.
A) 4 B) $\ln(4)$
C) e^2 D) e^4 E) NOTA
2. The number of freshmen at Math Central High School varies directly with the number of sophomores and inversely with the number of juniors. Also, the number of seniors always equals the total number of students in the three other grades. If there are 380 seniors when there are 200 freshmen and 30 juniors, how many sophomores will there be when there are 50 juniors and 230 seniors?
A) 100 B) 120
C) 150 D) 160 E) NOTA
3. $\sum_{n=1}^{\infty} \frac{25}{5^n} = ?$
A) $\frac{25}{4}$ B) $\frac{25}{3}$
C) $\frac{25}{2}$ D) 25 E) NOTA
4. Given: $f(x) = x^2 - 2x - 4$, $g(x) = f(x+2)$. Find $f(g(2))$.
A) 2 B) 4
C) 6 D) 8 E) NOTA
5. $|2x + y + 6| + |2x - y - 14| = 0$. What is the value of $|x + y|$?
A) 0 B) 2
C) 8 D) 12 E) NOTA
6. Five consecutive integers add up to 1000. Find the largest prime factor of the largest of these integers.
A) 5 B) 11
C) 101 D) 199 E) NOTA
7. The graph of $x = y^2 - 4y$ never passes through which quadrant?
A) Quadrant I B) Quadrant II
C) Quadrant III D) Quadrant IV E) NOTA
8. Let $K = \log_2 3 * \log_3 4 * \log_4 5 * \log_5 6 * \log_6 7 * \log_7 8 * \log_8 9$. What is $\log_3 4^K$?
A) 2 B) 4
C) 9 D) 12 E) NOTA

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9. There are twenty-seven students in Mrs. Hiller's algebra class. If 18 of them like Chinese food, 14 of them like Japanese food, and six like neither Chinese nor Japanese food, how many in the class like both?
- A) 3 B) 7
C) 10 D) 14 E) NOTA
10. For $x \neq 1$ and $x \neq -1$, simplify the following expression: $\frac{(x^3 + 1)(x^3 - 1)}{(x^2 - 1)}$
- A) $x^4 + x^2 + 1$ B) $x^4 + x^3 + x + 1$
C) $x^6 - 1$ D) $x^6 + 1$ E) NOTA
11. Barbara is twice as old as her sister, Darla. Five years ago, Barbara was three times Darla's age. How many years ago was Barbara six times as old as Darla?
- A) 3 B) 5
C) 8 D) 12 E) NOTA
12. $\frac{A}{(x+3)} + \frac{B}{(x-4)} = \frac{(6x-3)}{(x^2-x-12)}$
- Given that $x \neq -3$ and $x \neq 4$, find the average of A and B.
- A) -1.5 B) 0
C) 1.5 D) 3 E) NOTA
13. If $i = \sqrt{-1}$, find the conjugate of $(1+i)(2-3i)$.
- A) $1-5i$ B) $1+5i$
C) $5-i$ D) $5+i$ E) NOTA
14. The Wynn family starts their annual family trip at Point A. From there, Mr. Wynn drives 300 miles east to Point B, at a constant speed of 50 mph. Upon arriving at Point B, Mrs. Wynn gets in the driver's seat and drives 400 miles north to Point C, at an average speed of 100 mph. At Point C, Bill Wynn gets behind the wheel of the van and drives the family straight home to Point A. If Bill drives constantly at 125 mph, and no time is lost when drivers change, how many hours did the entire trip take?
- A) 12 B) 14
C) 18 D) 24 E) NOTA

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15. Simplify the following expression, given that all expressions in parentheses are nonzero:

$$\frac{\frac{(2x^2 - 2x - 12)}{(x + 4)}}{\frac{(2x - 6)}{(x^2 - 16)}}$$

- A) $2x + 4$ B) $x^2 - 2x - 8$
C) $x^2 - x - 6$ D) $x^2 + 6x + 8$ E) NOTA
16. For all nonnegative numbers x , $f(x) = x!$ and $g(x) = (x - 2)$. Assuming $x > 3$, what is $f(x)$ divided by $f(g(x))$?
- A) $x - 1$ B) $x + 1$
C) $x^2 - x$ D) $x^2 - 1$ E) NOTA
17. The evil Murdoc is trying to blow up the ocean! Frantically, our hero MacGyver searches his pockets to find a bent paperclip, half of a dollar bill, a glow-in-the-dark yoyo, a roll of duct tape (of course), and a dog-eared copy of Dante's *Inferno*. In how many different ways can MacGyver choose any two of these items to combine to defuse Murdoc's bomb? Hurry!
- A) 10 B) 20
C) 60 D) 120 E) NOTA
18. In what base, n , is 567_n written if it equals 1234_7 ? **NOTE:** n is a whole number.
- A) 8 B) 9
C) 10 D) 11 E) NOTA
19. A ball dropped from a height of 3 meters bounces back to a height of 2 meters on its first bounce. It then drops from the height of 2 meters, and it continues to bounce and drop in this fashion, with the heights after each bounce forming an infinite geometric sequence of common ratio r . When the ball finally comes to a rest, what is the total distance in meters it has traveled? Ignore any horizontal motion of the ball.
- A) 6 B) 9
C) 12 D) 15 E) NOTA

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20. $z(x) = \frac{(x^5 - 2x^4 + 3x^3 + 4x^2 - 6x - 180)}{(x - 3)}$ Find the integral remainder when $z(2)$ is divided by $z(1)$.

A) 28 B) 56
C) 62 D) 90 E) NOTA

21. $X = 3Y, Z = Y^2 + 4, W = \frac{X}{5} + 1$ Express $9Z$ in terms of W .

A) $W^2 + 36$ B) $9W^2 + 36$
C) $25W^2 - 50W + 29$ D) $25W^2 - 50W + 61$ E) NOTA

22. Which of the following is included in the domain of the given function?

$$f(x) = \frac{\sqrt{x^2 - 5x + 4}}{x^2 - 4x}$$

A) 0 B) 2
C) 3 D) 4 E) NOTA

23. $x + 2y + z = 30$
 $x + 3y - 2z = 14$
 $2x + 5y + 21z = 0$

Find the value of $x + y + z$.

A) 8 B) 24
C) 30 D) 52 E) NOTA

24. Tim weighs twice as much as Betty. If the sum of their weights is 372 pounds, what is the geometric mean of their weights, in pounds?

A) $2\sqrt{93}$ B) $93\sqrt{2}$
C) $124\sqrt{2}$ D) 186 E) NOTA

25. Let $a, b,$ and c be positive real numbers. If $abc = 48, bcd = 96, ad = 72,$ and $c - b = 7,$ find the sum of $a, b, c,$ and d .

A) 27 B) 32
C) 64 D) 96 E) NOTA

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26. How many ounces of a smoothie that is 40% banana should Sreya add to a 16-ounce smoothie that is 75% banana if she wants to end up with a smoothie that is 60% banana? Assume uniform mixtures in each smoothie.
- A) 4.8 B) 12
C) 16 D) 28 E) NOTA
27. $3x + By = 7$, $Ax + 11y = 4$
Given that $A \neq \frac{12}{7}$, what value for A, in terms of B, will make the above system of equations have no solution?
- A) $\frac{12B}{7}$ B) $\frac{B}{33}$
C) $\frac{11}{3B}$ D) $\frac{33}{B}$ E) NOTA
28. Five friends are comparing their heights. Tommy is twice as tall as Steve, and Steve is half of Jordan's height. If Rachel is the shortest one there, and Eddie is only taller than two of the others, in what range does Eddie's height fall?
- A) Between Jordan and Steve B) Between Jordan and Tommy
C) Between Rachel and Steve D) Taller than Tommy
E) NOTA
29. When $1.797979797979\dots$ is expressed as a simplified fraction in lowest terms, what is the sum of its numerator and denominator?
- A) 277 B) 278
C) 279 D) 280 E) NOTA
30. For all $G \neq 0$, $H \neq 0$, and $G \neq H$, the expression $\frac{H - G}{G^{-1} - H^{-1}}$ is equivalent to which of the following?
- A) $G + H$ B) $G - H$
C) GH D) $-GH$ E) NOTA