Please Note:

(1) **(E)** NOTA denotes none of the above (answers are correct); (2) $\lfloor k \rfloor$ represents the greatest integer less than or equal to k; and (3) the approximations $e \approx 2.71$, $\sqrt{10} \approx 3.16$ and $\log 2 \approx .301$ might be of some use.

1. Compute, in terms of a and c, $\log 2012$ where $\log 503 = a$ and $\log 5 = c$.

(A) $a + 2c - 2$ **(B)** $a + 2c + 2$ **(C)** $a - 2c + 2$ **(D)** $a - 2c - 2$ **(E)** NOTA

2. Find the units digit of $3^{2012} + 4^{2012}$.

(A) 5 **(B)** 7 **(C)** 9 **(D)** 13 **(E)** NOTA

3. For positive x and $n > 1$ which are both $\in \mathbb{Z}$ find the sum of all possibles values of x if

$$\log_{\sqrt[n]{2}} \sqrt[n]{x} + \log_{\sqrt[n-1]{2}} \sqrt[n-1]{x} + \cdots + \log_2 x = 8.$$

(A) 278 **(B)** 256 **(C)** 22 **(D)** 20 **(E)** NOTA

4. Let $x > 0$ be an element of the real numbers, and let: $f(x) = x\sqrt{x\sqrt{x\sqrt{\cdots}}}$. Compute $\displaystyle\sum_{k=1}^{2012} \frac{f(k)}{2012}$.

Hint: $1^2 + 2^2 + 3^2 + \cdots + k^2 = \frac{k(k+1)(2k+1)}{6}$; For example: $1^2 + 2^2 + \cdots + 5^2 = \frac{5 \cdot 6 \cdot 11}{6} = 55$

(A) $\dfrac{2700775}{6}$ **(B)** $\dfrac{2700775}{2}$ **(C)** $\dfrac{2012^3}{6}$ **(D)** $\dfrac{2012^3}{2}$ **(E)** NOTA

5. Which of the following **best** approximates $\log 5$?

(A) .666 **(B)** .677 **(C)** .688 **(D)** .699 **(E)** .709

6. Given that the value of $k = \log_{\log_{\log_{\cdots} 27} 27} 27$ is real, find k.

(A) $\sqrt{3}$ **(B)** 3 **(C)** $3\sqrt{3}$ **(D)** 9 **(E)** NOTA

7. How many distinguishable permutations of the word "logarithms" are there?

(A) $10!$ **(B)** $10!/2$ **(C)** $(10 - 1)!$ **(D)** $\frac{(10-1!)}{2}$ **(E)** NOTA

8. Let $f(x) = e^x + 2012$ and $g(x) = x + 2012$. At how many points do f and g concur?

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

9. Let $x^{17} - x + 1 = 0$. What is $r_1^{16} + r_2^{16} + r_3^{16} + \cdots + r_{17}^{16}$ where the set $\{r_1^{16}, r_2^{16}, r_3^{16}, \cdots r_{17}^{16}\}$ contains the 17 roots of $x^{17} + x - 1 = 0$, raised individually to the 16th power.

(A) 18 **(B)** 17 **(C)** 16 **(D)** $\frac{1}{16}$ **(E)** NOTA

10. Compute the product:

$$\log_3 2 \cdot \log_4 3 \cdot \log_5 4 \cdots \log_{256} 255.$$

(A) 8 **(B)** $\frac{1}{8}$ **(C)** 16 **(D)** $\frac{1}{16}$ **(E)** NOTA

11. Let $k = \sqrt{\sqrt{\sqrt{\sqrt{10000}}}}$. What is $\lfloor k \rfloor$?

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

12. Which of the following expressions gives the number of digits in the expansion of: 125^{2012}?

(A) $\lfloor 125\log(2012) - 1\rfloor$ **(B)** $\lfloor 125\log(2012 - 1)\rfloor$ **(C)** $\lfloor 125\log(2012) + 1\rfloor$

(D) $125\log(2012 + 1)\rfloor$ **(E)** NOTA

13. Solve for all real z:

$$\log(\log_2(\log_7(\log_3 z^{49}))) = 0.$$

(A) 3 **(B)** 9 **(C)** 7 **(D)** 49 **(E)** NOTA

14. By definition, the base of the natural logarithm is:

(A) π **(B)** 10 **(C)** 2 **(D)** e **(E)** NOTA

15. Suppose the function $x^4 - 3x^3 + 12x^2 - 11x + 7 = 0$ has roots α, β, γ, and δ. Compute:

$$\log(\alpha\beta\gamma) + \log(\alpha\gamma\delta) + \log(\beta\gamma\delta) + \log(\beta\alpha\delta).$$

(A) $\log 7$ **(B)** $2\log 7$ **(C)** $3\log 7$ **(D)** $4\log 7$ **(E)** NOTA

16. Let $11^b = a^c$. Which of the following, if any, values of a makes the $\log\left(\frac{b}{c}\right)$ have a characteristic of 3?

(A) $(1 - .5064)^{11}$ **(B)** $\left(\frac{1}{1+.5064}\right)^{11}$ **(C)** $(1 + .5064)^{11}$ **(D)** $\left(\frac{1}{1-.5064}\right)^{11}$ **(E)** NOTA

17. Simplify: $\ln e^{2\ln e^{2\ln e^2}}$.

(A) 2 **(B)** 4 **(C)** 8 **(D)** 16 **(E)** NOTA

18. What is: $\log_8\left(\sqrt{2} \cdot \sqrt[4]{2} \cdot \sqrt[8]{2} \cdots\right)$?

(A) $-\frac{1}{2}$ **(B)** 1 **(C)** $\frac{1}{3}$ **(D)** $\frac{1}{2}$ **(E)** NOTA

19. How many of the following statements are always true?

1. If $\log(ab)$ exists, then $\log(ab) = \log a + \log b$ for a and b in $\mathbb{R}$ (the set of real numbers)
2. If $\log(a^2)$ exists, then $\log(a^2) = 2\log a$ where a is in $\mathbb{R}$
3. If $\ln a$ exists then $e^{\ln a} = a$
4. If $\log\left(\frac{b}{c}\right)$ exists, then $\log\left(\frac{b}{c}\right) = \log b - \log c$

(A) 4 **(B)** 3 **(C)** 2 **(D)** 1 **(E)** NOTA

20. Let the solution to the equation: $\left(3^{\log x}\right)^2 - 2x^{\log 3} = 8$ be written in the form $a^{\log_b c}$ where a is as large as possible, c is as small as possible, and b is prime. What is $a + b + c$?

(A) 11 **(B)** 15 **(C)** 57 **(D)** 105 **(E)** NOTA

21. If a, b, and c (the largest of the three numbers) are the sides of a right triangle, then

(A) $\log_{c^2}(a^2 + b^2) = 0$ **(B)** $\log_{a^2}(c^2 - b^2) = 0$ **(C)** $\log_c(a^2 + b^2) = 2$

(D) $\log_a(b^2 - c^2) = 2$ **(E)** NOTA

22. Let $\log(A^2 + B^2) = \log(A^2) + \log(B^2)$. Solve for B in terms of A.

(A) $\sqrt{\dfrac{A}{A^2 - 1}}$ **(B)** $\dfrac{A}{\sqrt{A^2 - 1}}$ **(C)** $\sqrt{\dfrac{A}{1 - A^2}}$ **(D)** $\dfrac{A}{\sqrt{1 - A^2}}$ **(E)** NOTA

23. Let $k = e + \pi + e^2 + \pi^2$. Find $\lfloor k \rfloor$.

(A) 23 **(B)** 24 **(C)** 25 **(D)** 26 **(E)** NOTA

24. What is the sum of the solutions to the equation $7^{3x^2} \cdot 5^x = 11$?

(A) $\log 5$ **(B)** $\log 7$ **(C)** $\log_5 7$ **(D)** $\frac{\log(1/5)}{\log 7}$ **(E)** NOTA

25. A triangle has side lengths $\log_2 5$ and $\log_4 9$. Let k be the smallest number such that, if c is the third side of the triangle, $c < k$ for all c. Find $\lfloor k \rfloor$.

(A) 2 **(B)** 3 **(C)** 4 **(D)** 5 **(E)** NOTA

26. For how many integers x is $f(x) = \log(2012 - x^3)$ defined?

(A) 12 **(B)** 13 **(C)** 24 **(D)** 26 **(E)** NOTA

27. Which of the following numbers is the largest?

(A) $\sqrt[30]{2}$ **(B)** $\sqrt[35]{3}$ **(C)** $\sqrt[40]{4}$ **(D)** $\sqrt[50]{5}$ **(E)** $\sqrt[60]{6}$

28 The sum $\log\frac{1}{2}+\log\frac{2}{3}+\log\frac{3}{4}+\cdots+\log\frac{2011}{2012}$ can be written as $\log\left(\frac{m}{n}\right)$ where m and n are relatively prime positive integers. Find $m+n$.

(A) 2010 **(B)** 2011 **(C)** 2013 **(D)** 2014 **(E)** NOTA

29 The set of all numbers x for which

$$\log_{2012}\left(\log_{2011}\left(\log_{2010}\left(\log_{2009}x\right)\right)\right)$$

is defined is $\{x>n\}$. What is that number n?

(A) $2012^{2011^{2010^{2009}}}$ **(B)** $2011^{2010^{2009}}$ **(C)** $2009^{2010^{2011}}$ **(D)** 2009^{2010} **(E)** NOTA

30 What is the inverse of $y(x)=\ln(2x)$?

(A) $y^{-1}(x)=e^{2x}$ **(B)** $y^{-1}(x)=e^{x/2}$ **(C)** $y^{-1}(x)=e^{x}/2$

(D) $y^{-1}(x)=e^{2x}/2$ **(E)** NOTA