

For all questions, answer E) NOTA means none of the above answers is correct. Good luck and have fun!

1. Consider the functions $f(x) = 3ax + 4$ and $g(x) = -4x + 2$. If $(f \circ g)(x) = (g \circ f)(x)$, find the value of a .

A) -3 B) -1 C) 1/3 D) 1 E) NOTA

2. A function is defined by $A(x) = 5x^2 - 13$, while another function is defined by $J(x) = 3x^2 + 11x - 28$. What is the smallest integer x in which both functions give the same value?

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

3. What is the sum of the reciprocal of the roots of $y = -x^2 - 2x + x^3 - 12x + 24$?

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

4. Find the domain of the function $\frac{\sqrt{16-x^2}}{x^2-9}$.

A) $[-4, -3) \cup (-3, 0) \cup (0, 3) \cup (3, 4]$ B) $[-4, -3) \cup (-3, 3) \cup (3, 4]$
 C) $(-4, -3) \cup (-3, 3) \cup (3, 4)$ D) $(-\infty, -4) \cup (-4, -3) \cup (-3, 4) \cup (4, \infty)$
 E) NOTA

5. Given the function $e(z) = \sqrt{z + \sqrt{z + \sqrt{z + \dots}}}$, what value of z makes $e(z) = 5$ true?

A) 5 B) 10 C) 15 D) 20 E) NOTA

6. Use the following table for questions 6-8. Assume that all functions are one-to-one with domains over all real numbers.

x	f(x)	g(x)	h(x)
1	3	6	-1
2	10	4	5
3	5	2	4
4	2	1	2

Find $f^{-1}(h(g^{-1}(h(3))))$.

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

7. Given that $p(x) = 3f(x) - 6g(x) + 9h(x) + 12$, among the given values of x , which value results in the highest value of $p(x)$?
- A) 1 B) 2 C) 3 D) 4 E) NOTA
8. If $f(N) + g(N) + h(N) = 21 - N$, which of the following is a possible value of N ?
- A) 1 B) 2 C) 3 D) 4 E) NOTA
9. Suppose f is an even function and g is an odd function, both defined for all real numbers. Let $h(x) = \frac{f(x)}{g(x)} * g^3(x)$. If $f(4) = 5$ and $g(4) = -2$, find $h(-4)$.
- A) -40 B) -20 C) 20 D) 40 E) NOTA
10. Function $A(x) = x - 5$. Function $L(x) = x^2 - 3$. What value of d makes $A(L(d)) = L(A(d))$?
- A) -5 B) -3 C) 3 D) 5 E) NOTA
11. What is the sum of the coefficients of the terms in the expansion of $(3x + 1)^5$?
- A) 1024 B) 512 C) 128 D) 42 E) NOTA
12. Suppose f is a linear function passing through points $(2, -5)$ and $(-5, 2)$. Determine $f(2) + f(-2)$.
- A) 2 B) -2 C) 6 D) -6 E) NOTA
13. Joy and Jade are practicing how to factor equations. Joy writes down the equation $x^3 - 14x^2 + 49x - 36 = 0$ but Jade copies the equation wrong, writing $x^3 - 16x^2 + 69x - 54 = 0$. After solving the problem, Joy noticed that one of the roots they got was different. If Joy got the roots a, b, c , and Jade got the roots a, b, d , what is $c+d$?
- A) 4 B) 6 C) 8 D) 10 E) NOTA
14. Given that $f\left(\frac{3x+2}{4x} + 1\right) = 2x$ for all real numbers of x except 0, what is $f(x)$ equal to?
- A) $\frac{1}{2x-7}$ B) $\frac{2}{2x-7}$ C) $\frac{2}{4x-7}$ D) $\frac{4}{4x-7}$ E) NOTA

15. Let $A(x) = 4^x + 4^x + 4^x + 4^x$. Which function is equivalent to $A(x)$ multiplied by itself?
- A) $a(x) = 16^x$ C) $c(x) = 16^{3x}$ E) NOTA
- B) $b(x) = 16^{x+1}$ D) $d(x) = 64^{\frac{x}{4}}$
16. Given that $f(x) = -x^2$, $g(x) = -x - 1$, $h(x) = \frac{1}{x} + x^3$, which of the following is not an even nor an odd function?
- A) $f(x)$ B) $h(x)$ C) $f(g(x))$ D) $h(f(x))$ E) NOTA
17. Function $p(x)$ is a polynomial function with degree 6 and rational coefficients. It has several roots including $2 - i$, i , and $1 - i$. Given $p(1)$ is 4, what is $p(2)$?
- A) 0 B) 10 C) 50 D) 100 E) NOTA
18. Define the operation \blacksquare as follows: $x \blacksquare y = x^y - y^x$. Determine the value of $(2 \blacksquare 3) \blacksquare (5 \blacksquare 2)$.
- A) 6 B) $\frac{6}{7}$ C) $-\frac{8}{7}$ D) $-\frac{1}{7}$ E) NOTA
19. Let $f(x) = 1 - \frac{1}{x}$. Which expression is equivalent to $f(f(f(x)))$ for $x \neq 0, 1$ & $f(x) \neq 0, 1$?
- A) x B) $-x$ C) $\frac{1}{1-x}$ D) x^2 E) NOTA
20. What is a possible real value of $x + \frac{1}{x}$, given that $x^4 + \frac{1}{x^4} = 34$ and $x > 0$?
- A) 2 B) 4 C) 6 D) 8 E) NOTA
21. Which of the following statements is true regarding $w(x) = -2x^4 + 8x^3 - 11x^2 + kx - 9$, with $k > 0$ and rational?
- I) w could have at least one negative root
- II) If w has at least one positive root, then it also has at least one non-real root
- III) w could have all non-real roots
- A) II only B) III only C) I & II only D) II & III only E) NOTA

22. If the complete solution to the inequality $|15 - 4x| > 3$ is $x < a$ or $x > b$, find $a + b$.
A) 7.5 B) 10.5 C) 15 D) 22 E) NOTA
23. Which of the following describes the graph of $3x^2 - 24x - 16y^2 - 64y - 16 = 0$?
A) circle B) ellipse C) hyperbola D) parabola E) NOTA
24. Let $C(x)$ = the number of circular permutations of a set with x elements, and let $P(x)$ = the number of 2-element groups that can be formed from a set of x elements (x is a positive integer). Evaluate $C(P(5))$.
A) 12! B) 11! C) 10! D) 9! E) NOTA
25. What is $P(C(5))$ as defined in question 24?
A) 15 B) 138 C) 276 D) 7140 E) NOTA
26. Find all values of a such that the quadratic equation $x^2 + (a - 3)x + a = 0$ has two distinct positive real solutions.
A) $a > 0$ B) $0 < a < 1$ C) $a < 1$ D) $a > 9$ E) NOTA
27. If $f(x) = 2x^3 + 4$ and $g(x) = 3x^3 + 1$, find the horizontal asymptote of the graph $y = \frac{f(x)}{g(x)}$.
A) $y = 0$ B) $y = \frac{2}{3}$ C) $y = \frac{3}{2}$ D) $y = 3$ E) NOTA
28. Let the function $A(x)$ represent the maximum possible area of a rectangle with perimeter x . What is $A(12)$?
A) 6 B) 9 C) 12 D) 24 E) NOTA
29. What is the sum of the solutions of the equation $(x + 4)^3 + 4(x + 4)^2 - 12(x + 4) = 0$?
A) -16 B) -8 C) -4 D) -2 E) NOTA

30. Let $f(x) = \lfloor x \rfloor$, or the function that produces the greatest integer less than or equal to the x . Find $f^{\lfloor 2020.1 \rfloor}(1) + f^{\lfloor 2020.6 \rfloor}\left(-\frac{1}{2}\right)$. Here $f^n(x)$ denotes the composition of f with itself n times.

A) -2019

B) -1

C) 0

D) 1

E) NOTA