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

1. What is the minimum number of roots a polynomial, f(x), must have if the graph of y=f(x) contains the following points: (-4, 7), (-3, 5), (-2, 6), (-1, -4), (0,-2), (1, -3), and (2, 1)?

A. 0 B. 2 C. 5 D. 6 E. NOTA

2. The sum of the integers 1 through n inclusive can be modeled by a polynomial. What is the sum of the coefficients of that polynomial?

A. 0 B. ½ C. 1 D. 2 E. NOTA

3. How many times does the polar graph of $r(\theta) = \theta^2 - 7\theta + 1$ pass through the pole?

A. 0 B. 1 C. 2 D. 3 E. NOTA

4. What is the sum of the x-intercepts of $g(t) = e^{2t} + e^{t+ln5} - 14$

A. ln2 B. $\ln(\frac{2}{7})$ C. ln7 D. ln14 E. NOTA

5. Which of the following functions has y = x+2 as a slant asymptote?

A. $y = \frac{x^3+4x^2+6}{x^3+2x^2+3}$ B. $y = \frac{x^3}{x^2-2x}$ C. $y = \frac{4x^2+6}{2x^3+3}$ D. $All\ of\ the\ above$ E. NOTA

6. The function $f(x) = \frac{ax^2+x-7}{9x^2+bx+4}$ has a horizontal asymptote at y=c, exactly one vertical asymptote, and no removable discontinuities (holes). What is $\frac{a}{bc}$?

A. $\frac{1}{16}$ B. $\frac{3}{4}$ C. $\frac{4}{3}$ D. $\frac{3}{2}$ E. NOTA

7. What is the y-coordinate of the hole in the graph of $f(x) = \frac{x-5}{x^2-25}$?

A. 0 B. $\frac{1}{5}$ C. 1 D. 5 E. NOTA

8. If $f(x) = x^5 + 10x^4 + 40x^3 + 80x^2 + 80x + 32$, what is $f^{-1}(-32)$?

A. -4 B. -2 C. 0 D. 2 E. NOTA

9. On what interval(s) is f(x) > 1, if $f(x) = \frac{x-7}{x^2+3}$?

A. $(7, \infty)$ B. $(-\infty, 7)$ C. $\left(\frac{1-\sqrt{17}}{2}, \frac{1+\sqrt{17}}{2}\right)$ D. $\left(-\infty, \frac{1-\sqrt{17}}{2}\right) \cup \left(\frac{1+\sqrt{17}}{2}, \infty\right)$ E. NOTA

10. If the roots of $y = 3x^4 - 8x^3 + 9x - 17$ are a, b, c, and d, find $a + b + c + d$.

A. -3 B. $-\frac{8}{3}$ C. $\frac{8}{3}$ D. 8 E. NOTA

11. When $f(x) = x^7 - 4x^6 - 6x^5 + 7x^4 + x^3 - x - 5$, Descartes' Rule of Signs guarantees that the maximum number of positive zeroes is a, and b is the maximum number of negative zeroes. What is a-b?

A. -3 B. -1 C. 1 D. 3 E. NOTA

12. If $f(x) = (-3x + 2)(x - 5)^2(x - 11)$ on what interval(s) is f(x) strictly positive?

A. $\left(-\infty, \frac{2}{3}\right) U(11, \infty)$ B. $(\frac{2}{3}, 5)$ C. $(5, 11)$ D. $(\frac{2}{3}, 11)$ E. NOTA

13. What is the remainder when $x^4 + 3x^3 - 4x^2 + 5x - 6$ is divided by $x - 1$?

A. -17 B. -1 C. 1 D. 6 E. NOTA

14. The function $f(x) = \frac{ax^2+4x+c}{3x^2+5x-7}$ has a horizontal asymptote of $y = 3$ and a zero at $x = 1$. Find ac.

A. -117 B. -21 C. -5 D. -4 E. NOTA

15. For what value(s) of θ does the polar function $r(\theta) = \theta^3 - \pi\theta^2 - \frac{\pi^2}{4}\theta + \frac{\pi^3}{4}$ pass through the pole?

A. $-\pi$ B. $-\frac{\pi}{2}$ & $\frac{\pi}{2}$ C. π D. $-\frac{\pi}{2}, \frac{\pi}{2}, \& \pi$ E. NOTA

16. If $\cos^2(\theta) + \frac{64}{65}\cos(\theta) + \frac{3}{13} = 0$, what is the sum of all possible values of $\csc(\theta)$ if $0 \leq \theta \leq \pi$?

A. -7 B. -2 C. 2 D. 7 E. NOTA

17. How many asymptotes (of any kind) are on the graph of $(x) = \frac{x-2}{x^3-7x}$?

A. 0 B. 1 C. 2 D. 3 E. NOTA

18. How many zeroes does the function $f(x) = \cos\left(\frac{1}{x}\right)$ have on the open interval $(0,1)$?

A. 0 B. 1 C. 2 D. infinitely many E. NOTA

19. What is the largest x value for which $f(x) = \cos\left(\frac{1}{x}\right)$ has a zero?

A. $\frac{1}{\pi}$ B. $\frac{2}{\pi}$ C. $\frac{5}{2\pi}$ D. $\frac{\pi}{2}$ E. NOTA

20. What happens to the distance between consecutive zeroes of $f(x) = \sin(x^2)$ as x increases over the interval $(-100, -50)$?

A. it always decreases B. it remains constant C. it always increases
D. it decreases then increases E. NOTA

21. What is the sum of the coefficients of the expansion of $(x-5)^9$?

A. -5^9 B. -2^9 C. 0 D. 2^9 E. NOTA

22. $f(x)$ and $g(x)$ are both polynomial functions such that $f\big(g(x)\big) = g\big(f(x)\big) = x$. If a is the degree of $f(x)$ and b is the degree $g(x)$ what is $a + b$?

A. 0 B. 1 C. 2 D. 3 E. NOTA

23. $f(x)$ and $g(x)$ are both polynomial functions of degree greater than 2 such that the degree of g is one more than the degree of f. If the leading coefficient of f is positive and odd and the leading coefficient of g is negative and odd, what is the end behavior of $g\big(f(-x)\big)$?

A. As $x \to \infty, y \to \infty$ and as $x \to -\infty, y \to \infty$
B. As $x \to \infty, y \to -\infty$ and as $x \to -\infty, y \to -\infty$
C. As $x \to \infty, y \to \infty$ and as $x \to -\infty, y \to -\infty$
D. Not enough information
E. NOTA

24. $f(x)$ and $g(x)$ are both polynomial functions of degree greater than 2 such that they both have a leading coefficient of 1 and the degree of f is n and the degree of g is $2n$. The function $h(x) = \frac{g(x)}{f(f(x))}$ approaches an asymptote as $x \to \infty$. What is this asymptote and from which side does it approach?

A. y = 0 from the bottom B. y = 0 from the top
C. y = 1 from the bottom D. y = 1 from the top E. NOTA

25. Let s be the sum of the terms in the 28th row of Pascal's triangle. Find $\sqrt[3]{s}$. The 1st row of Pascal's triangle consists of a single 1, obviously.

A. 512 B. $512\sqrt[3]{2}$ C. 1024 D. $1024\sqrt[3]{4}$ E. NOTA

26. Which of the following represents the function $f(x) = x^2$ with holes at 2 and -2?

A. $g(x) = \frac{x^4-4x^2}{x^2}$ B. $g(x) = \frac{x^2(x-2)^2}{x^2}$ C. $g(x) = \frac{x^2}{x^2(x-2)^2}$
D. $g(x) = \frac{x^2}{x^4-4x^2}$ E. NOTA

27.Find $\sum_{n=0}^{\infty} \frac{n^2-3n+3}{2^n}$

A. 1 B. $\frac{3}{2}$ C. 3 D. 6 E. NOTA

28. The function $g(x) = \frac{1}{f(x)}$ has three vertical asymptotes at x = a, b, and c. $f(x)$ is a cubic polynomial with leading coefficient 1. What is the y-coordinate of the y-intercept of $g(x)$?

A. abc B. $\frac{1}{abc}$ C. $a + b + c$ D. $\frac{1}{a+b+c}$ E. NOTA

29. According to the Rational Zeroes Theorem, how many *possible* rational zeroes are there for $f(x) = 4x^7 + 2x^6 - 9x^4 + x^3 - 72$?

A. 7 B. 18 C. 36 D. 72 E. NOTA

30. Find the sum of all distinct solutions for x in the following equation: $\frac{x^2+3x+2}{x^2+2x+1} = \frac{x+2}{x^2+4x+3}$

A. -4 B. -2 C. 2 D. 4 E. NOTA