1. A varies directly with the square of B, B varies inversely with the cube of C, and C varies inversely with D. When $D = 1$, $A = 2$. Find A when $D = 2$.

   a. $\frac{1}{32}$ b. $\frac{\sqrt{2}}{4}$ c. $\sqrt[3]{4}$ d. 128 e. NOTA

2. Andrea picks a point on the parabola $y = x^2$. Let this point be (a, b). She then graphs the parabola $y = bx^2 + ax + 4$. Let the vertex of this new parabola be (c, d). If $c + d = 4$, find the value of $|a + b|$.

   a. 0 b. 6 c. 12 d. 20 e. NOTA

3. Five cats and five dogs would like to play a game of basketball. League rules dictate that there must be at least one dog and at least one cat on each team. In how many distinct ways can these ten animals be divided into two teams of five? Treat the teams to be indistinct; that is, picking 5 specific animals to be on team A is not a different arrangement than picking those same 5 animals to be on team B.

   a. 125 b. 252 c. 700 d. 1400 e. NOTA

4. Find the sum of the real zeros of $f(x) = \Big|\big||x-2|-2\big|-2\Big|-2$

   a. 0 b. 2 c. 4 d. 6 e. NOTA

5. Let $f(x) = x^{10} - x^9 + x^8 - x^7 + \cdots + x^2 - x + 1$. Find the remainder when $f(x)$ is divided by $(2x - 1)$.

   a. $\frac{683}{1024}$ b. $\frac{683}{2048}$ c. $\frac{1023}{1024}$ d. $\frac{2049}{1024}$ e. NOTA

6. Georgina inscribes a circle inside a square. She then inscribes an equilateral triangle inside that circle. If the square has area S and the triangle has area T, find $\frac{T}{S}$.

   a. $\frac{\pi}{12}$ b. $\frac{27\sqrt{3}}{16}$ c. $\frac{\sqrt{3}}{4}$ d. $\frac{3\sqrt{3}}{4\pi}$ e. NOTA

7. At what x-value does $f(x) = \frac{3x^3-2x^2-4x}{x^2-1}$ cross its oblique asymptote?

   a. -2 b. -1 c. $\frac{2}{3}$ d. 1 e. NOTA

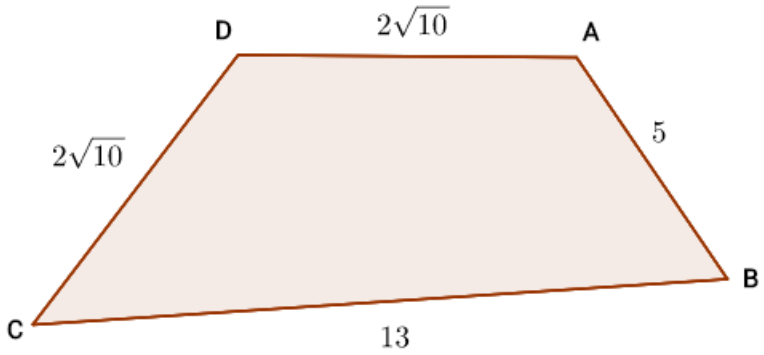
8. How many integers are not in the domain of $f(x) = \frac{\log(x^2)}{\sqrt{|x-6|-2}}$?

   a. 2 b. 4 c. 6 d. Infinitely many e. NOTA

9. Simplify $\left(1+\frac{1}{1+\frac{1}{1+\cdots}}\right)^2$.

a. $\frac{1+\sqrt{5}}{2}$ b. $\frac{3+\sqrt{5}}{2}$ c. $\frac{10+\sqrt{5}}{2}$ d. $\frac{15+\sqrt{5}}{2}$ e. NOTA

10. Quadrilateral ABCD has an area of 44 and has side lengths given in the figure below. If the midpoint of each side is joined to form a new convex quadrilateral, what will be the area of the new quadrilateral?



a. 11 b. 22 c. $18\sqrt{2}$ d. 36 e. NOTA

11. $f(x) = 2x^3 + 3x^2 - 8x - 12$ has distinct zeros r_1, r_2, and r_3. Find $|r_1| + |r_2| + |r_3|$.

a. $\frac{3}{2}$ b. $\frac{5}{2}$ c. $\frac{11}{2}$ d. 6 e. NOTA

12. Buckley rolls six standard six-sided dice. What is the probability that the dice result in three distinct pairs of numbers?

a. $\frac{25}{648}$ b. $\frac{25}{108}$ c. $\frac{75}{108}$ d. $\frac{1}{216}$ e. NOTA

13. Marissa has 40 feet of fencing with which she plans to build an enclosure for her tortoises in the shape of a triangle. One side of the enclosure will be along the river and will require no fencing. The other two sides will be made using the 40 feet of fencing. What is the largest area in square feet that Marissa will be able to enclose? Assume the 40 feet can be divided into any pieces of any arbitrary length less than 40.

a. $100\sqrt{3}$ b. 200 c. $250\sqrt{2}$ d. 400 e. NOTA

14. The graphs of $y = \ln x$ and $y = \frac{1}{x}$ intersect at the point (A, B). Find A^A.

a. $\frac{1}{e}$ b. $\ln 2$ c. e^e d. e e. NOTA

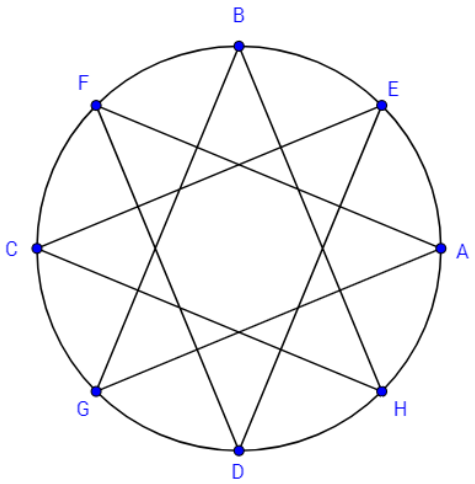
15. Find $\sum_{i=5}^{24} \ln\left(1+\frac{1}{i+5}\right)$

a. $\ln 2$ b. $\ln 3$ c. $\ln 5$ d. $\ln 6$ e. NOTA

16. How many distinct three letter words can be made by choosing letters from the word WINDIGO? (include words that are not real)

a. 85 b. 125 c. 135 d. 210 e. NOTA

17. Consider the following 8-pointed star inscribed in a circle.



Given that $\angle A = \angle B = \angle C = \cdots = \angle G = \angle H$, find the sum $\angle A + \angle B + \angle C + \cdots + \angle G + \angle H$.

a. $180°$ b. $360°$ c. $540°$ d. $720°$ e. NOTA

18. Consider the sequence defined recursively by:

$$a_n = 2 \times (a_{n-1} + 1) \text{ for } n > 1, \text{ and } a_1 = 1$$

Find $a_{2019} - a_{2018}$.

a. 3×2^{2018} b. $3 \times (2018)^2$ c. $3^{2018} - 2^{2017}$ d. 2×3^{2019} e. NOTA

19. The area enclosed between the graphs of $f(x) = x^2$ and $g(x) = -2x^2 + 3$ is 4.
If $f^*(x) = \frac{1}{2}f(2x+3)$ and $g^*(x) = \frac{1}{2}g(2x+3)$, find the area enclosed between the graphs of $f^*(x)$ and $g^*(x)$.

a. 17 b. 13 c. 4 d. 1 e. NOTA

20. Given $f(x)$ is an odd function and $g(x) + 1 = f(x+1)$, find

$$g(1) + g(-3) + g(2) + f(-3) + 7$$

a. -1 b. 3 c. 7 d. 9 e. NOTA

21. Round to the nearest integer

$$\frac{3}{\log 5} - \frac{(\log_5 4)(\log_5 8)(\log_6 5)}{(\log_{10} 9)(\log_3 10)(\log_6 2)}$$

a. 0 b. 1 c. 2 d. 3 e. NOTA

22. Richard picks a random number between -4 and 4. Zonshen picks a random number between -2 and 2. What is the probability that Richard and Zonshen's numbers differ by less than 1? Note: their numbers may be irrational.

a. $\frac{1}{8}$ b. $\frac{1}{4}$ c. $\frac{1}{3}$ d. $\frac{1}{2}$ e. NOTA

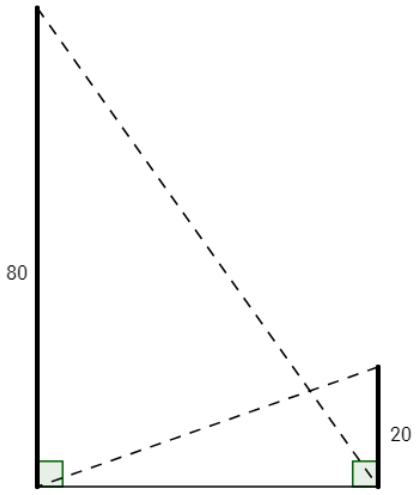
23. $f(x) = \frac{|x-3|-1}{|2x-12|-4}$ has a removable discontinuity at the point (A, B). Find $A + B$.

a. -2 b. 2 c. $\frac{7}{2}$ d. 10 e. NOTA

24. Written in the standard form of a polynomial, how many terms are in the expansion of $(x^8 + x^7 + x^6)^5$?

a. 10 b. 11 c. 15 d. 21 e. NOTA

25. As pictured to the right, a 20 foot pole and an 80 foot pole are perpendicular to the ground (which is flat). The tip of each pole is connected by a thin cable to the base of the other pole. What is the height above the ground of the point at which the two cables meet?



a. 10 b. 13.5 c. 15

d. 16 e. NOTA

26. The hyperbola $-x^2 + 4y^2 - 4x - 40y + 92 = 0$ has two asymptotes. These asymptotes have y-intercepts $(0, A)$ and $(0, B)$. Find $|A - B|$.

a. $\frac{1}{2}$ b. 1 c. 2 d. 4 e. NOTA

27. Adam can paint 4 houses in 3 days. Alex can paint 3 houses in 4 days. Combining efforts, how long will it take Adam and Alex to paint 60 houses? Assume they don't get tired and their combined efficiency is the sum of their individual efficiencies.

a. 18.8 days b. 28.8 days c. 60 days d. 125 days e. NOTA

28. Which of the following functions are invertible (meaning their inverses are also functions) over their given domains?

$$f(x) = \sqrt{x^2 - 6x + 9}, \quad \{x | x \in \mathbb{R}\}$$
$$g(x) = \log_2 x + \log_3 x, \quad \{x | x > 0\}$$
$$h(x) = \frac{1}{x^2 - 1}, \quad \{x | x \neq -1 \; and \; x \neq 1\}$$

a. g only b. h only c. f and g only d. f and h only e. NOTA

29. Solve the inequality. Express the solution in interval notation:

$$\frac{1}{\ln x + 1} \leq 1$$

a. $[1, \infty)$ b. $(-\infty, 1) \cup [e, \infty)$ c. $\left(0, \frac{1}{e}\right) \cup [1, \infty)$
d. $(-\infty, 0) \cup \left(\frac{1}{e}, \infty\right)$ e. NOTA

30. Simplify $\left(\frac{1+i}{2}\right)^{10}$.

a. $\frac{-i}{32}$ b. 0 c. $\frac{1-i}{1024}$ d. $\frac{i}{1024}$ e. NOTA