

1. If $x \in \mathbb{R}$, solve for the sum of the values of 3^x in the following equation:

$$3^x + 3^{2x+2} - 10 = 0$$

- A. $\frac{10}{9}$ B. $\frac{1}{9}$ C. $\log_3 10 - 2$ D. 1 E. NOTA

2. A 5th degree monomial with real, rational coefficients is written as such, with a, b, c, d, and e all greater than 0:

$$x^5 - ax^4 + bx^3 - cx^2 - dx + e$$

What is the maximum number of real roots it could have?

- A. 5 B. 4 C. 1 D. 0 E. NOTA

3. Find the product of the real solutions of this equation:

$$2x^5 - 8x^4 + 10x^3 - 20x^2 + 8x + 48 = 0$$

- A. 24 B. 4 C. -24 D. -6 E. NOTA

4. Venti is concocting a new type of Dandelion Juice. He is making 30 liters of the juice, and he wants 30% of it to be dandelion extract. The other 70% will be water. After preparing it, he distributes 10 liters to Diluc, 10 liters to Kaeya, and 10 liters to Rosaria. Kaeya adds x liters of dandelion extract to his share for extra flavor. The water percentage decreases to 40 after this addition. Find x (yes, all of them are 21+ age wise).

- A. $\frac{5}{3}$ B. $\frac{15}{2}$ C. 20 D. $\frac{10}{3}$ E. NOTA

5. Refer to previous problem: Rosaria hasn't drunk any of her juice yet. After drinking 5 liters of his juice, Kaeya gives the remainder of his juice to Rosaria. Diluc then gives Rosaria 5 liters of his juice. What is the fraction of dandelion extract in Rosaria's juice after these additions?

- A. $\frac{4}{5}$ B. $\frac{34}{55}$ C. $\frac{24}{55}$ D. $\frac{55}{48}$ E. NOTA

6. Yanfei is standing on top of the Skyfrost Nail, which is 15 units directly above the ground. Ningguang is standing on the top of Qingyun Peak, which is 10 units directly above the ground. The distance from Yanfei to Ningguang is 13 units. Yanfei fires an attack to the base of Qingyun Peak, and it leaves a red trail. Ningguang fires an attack to the base of the Skyfrost Nail, and it leaves a yellow trail. How high above the ground do these trails intersect? The attacks aren't obstructed by anything or each other. Both trails are linear.

A. 6 B. 25 C. 4 D. $5\sqrt{3}$ E. NOTA

7. The equation $x^3 - 25x^2 - 10x + 40 = 0$ has roots a, b, c . Find the value of

$$\frac{1}{a+b} + \frac{1}{a+c} + \frac{1}{b+c}.$$

A. $-\frac{127}{52}$ B. $-\frac{41}{14}$ C. $\frac{127}{42}$ D. $-\frac{123}{52}$ E. NOTA

8. Solve for x if the following 3×3 matrix is singular:

$$\begin{bmatrix} x-3 & 1 & 0 \\ x+2 & 2 & 1 \\ -3 & -x & 1-x \end{bmatrix}$$

A. $\frac{1}{6}$ B. $\frac{11}{4}$ C. $\frac{11}{6}$ D. $-\frac{1}{6}$ E. NOTA

9. The Geo Hypostasis spawns 3 pillars (for our purposes, these are points), such that when connected, they form an equilateral triangle. Standing in the center of this triangle, Kazuha uses his Kazuha Slash attack to form a circle that circumscribes the triangle. What is the equation of this circle if the vertices of the triangle are $(1,0)$, $(-1,0)$, and $(0,\sqrt{3})$?

A. $x^2 + \left(y - \frac{\sqrt{3}}{3}\right)^2 = \frac{4}{3}$ B. $\left(x - \frac{\sqrt{3}}{2}\right)^2 + y^2 = 4$
 C. $x^2 + \left(y - \frac{\sqrt{3}}{3}\right)^2 = \frac{2\sqrt{3}}{3}$ D. $x^2 + \left(y + \frac{\sqrt{3}}{2}\right)^2 = \frac{5}{3}$ E. NOTA

10. Find the sum of all possible values of x :

$$\log(19x^2 + 21) - \log(x - 1) = \log(2x) + \log(10)$$

A. -1 B. 1 C. 20 D. 21 E. NOTA

11. Give the sum of all possible values of x given the following equation:

$$x = \frac{3}{2 + \frac{3}{2 + \frac{3}{2 + \frac{3}{2 + \dots}}}}$$

- A. $\frac{3}{2}$ B. -2 C. -3 D. 1 E. NOTA
12. For the equation $x^2 + (k - 4)x - 4k = 0$, what is the value of k such that this equation has a double root?
- A. $2i$ B. -4 C. 0 D. $-2i$ E. NOTA
13. Real numbers x, y satisfy
- $$\lfloor x \rfloor + 2y = 9.6$$
- $$3x + \lfloor y \rfloor = 14.1$$
- Find the sum of the values of $\lfloor x + y \rfloor$ over all possible pairs of x, y . ($\lfloor x \rfloor$ is the greater integer less than or equal to x .)
- A. 7 B. 13 C. 14 D. 21 E. NOTA
14. When Beidou uses her skills Tidecaller and Storm Breaker simultaneously, it forms an ellipse which its minor axis is part of the y -axis. The length of a latus rectum of the ellipse is $\frac{16}{3}$, and the area of the ellipse 24π . Which of the following is a directrix of this ellipse?
- A. $x = \frac{18\sqrt{5}}{5}$ B. $y = \frac{18\sqrt{5}}{5}$ C. $x = -\frac{2}{3}$ D. $y = 2\sqrt{5}$ E. NOTA
15. Link fires an arrow which travels along the path of the parabola $y = -\frac{x^2}{20} + \frac{4}{5}x + \frac{9}{5}$. What is the maximum height of this parabola minus the x -coordinate of its greater x -intercept?
- A. -5 B. -13 C. 7 D. ∞ E. NOTA

16. What is the area of the enclosed region that is bound by the equations $|x + y| = 2$ and $|x - y| = 2$?

A. 8 B. 4 C. 1 D. No bounded region E. NOTA

17. Evaluate the following summation:

$$\sum_{x=3}^{\infty} \frac{10}{(x-2)(x+3)}$$

A. 0 B. $\frac{137}{60}$ C. $\frac{137}{30}$ D. 3 E. NOTA

18. Albedo currently is half as old as Aether will be in 50 years and 30 times as old as Sucrose was 10 years ago. In 20 years, Aether's age will be divisible by Sucrose's current age. Aether is older than 1000 years. Which of the following could be Sucrose's age 10 years ago? (All ages are integers.)

A. 28 B. 30 C. 25 D. 18 E. NOTA

19. The largest possible value of $\log(x) + \log(y) + \log(z)$ given

$$\begin{cases} \log(x) \log(y) - \log(xy) + \frac{1}{3} = 0 \\ \log(y) \log(z) - \log(yz) + \frac{5}{8} = 0 \\ \log(z) \log(x) - \log(zx) - 3 = 0 \end{cases}$$

can be written as $\frac{m}{n}$ in simplest form. Find $m + n$.

A. 99 B. 100 C. 101 D. 102 E. NOTA

20. Yoon Se-ri and Ri Jeong Hyeok are trying to meet at a mountaintop in Switzerland, but neither knows when the other will be there. Se-ri will wait for 30 minutes and Ri Jeong Hyeok can only wait for 15 minutes, and both arrive in the same window of time (12 pm to 2 pm). What is the probability they meet?

A. $\frac{43}{128}$ B. $\frac{23}{32}$ C. $\frac{79}{128}$ D. $\frac{85}{128}$ E. NOTA

26. Evaluate:

$$\sqrt{72 + \sqrt{72 + \sqrt{72 + \dots}}}$$

- A. -9 B. 8 C. $6\sqrt{2}$ D. 9 E. NOTA

27. Simplify $\left| \frac{3-i}{2-3i} \right| - 4 \left| \frac{4+3i}{1+2i} \right|$

- A. 13 B. 20 C. $\frac{20-\sqrt{10}}{5}$ D. $\frac{3-2\sqrt{13}}{5}$ E. NOTA

28. Find the area of the region defined by

$$4x^2 + 24x + 4y^2 - 32y \geq 96$$

- A. 49π B. 25π C. 24π D. 8π E. NOTA

29. In Genshin Impact, the amount of money a player spends on the game is jointly proportional to the amount of characters they have and the amount of Mora they have. When a player spends \$5, they have 12 characters and 3000000 Mora. How much money will a player have spent if they have 45000000 Mora and 36 characters?

- A. \$200 B. \$225 C. \$120 D. \$150 E. NOTA

30. Find the surface area of a sphere with volume 36π .

- A. 36π B. 20π C. 6π D. 18π E. NOTA