Mu Alpha Theta National Convention: Denver, 2001

Ciphering – Theta Division

0. Simplify: $\dfrac{2-4i}{3-i}$

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1. A casino in Las Vegas offers a unique game: You can pay $5 to roll a fair six-sided die. If you roll a 6, you get $20, otherwise you get nothing. What is the probability that you have exactly $25 more than you started with after playing this game three times?

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2. A dartboard consists of three concentric circles. The radii of the circles are 2, 4, and 6 centimeters. If a dart falls in the inner region (within two centimeters of the center), the thrower gets 50 points. If it falls in the middle region (between two and four centimeters from the center), they receive 25 points, and if it falls in the outer region (between four and six centimeters from the center), they receive 11 points. What is the expected number of points a single throw of the dart will produce, assuming the dart has an equal probability of landing anywhere on the face of the dartboard?

3. What is the least common multiple of 360 and 84?

4. Let A be an arithmetic sequence with first term 5. Let B be an arithmetic sequence with second term –12. Let C be an arithmetic sequence with third term 12. If the nth term of sequence C is equal to the sum of the nth terms of sequences A and B, and sequence C has a common difference of 4, what is the value of the fifth term of sequence A?

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5. If Sam can paint a house in twenty hours, and Sally can paint a house in twelve hours, how many hours will it take them to paint a house if they work together?

6. For what value(s) of x is $\ln(3x) - \ln(x^2) = \log_4 32$?

7. A sphere with radius 3 has the same volume as a right circular cone with radius 3. What is the height of the cone?

8. Express 4320_5 in base ten.

9. In a certain game, a player has a $\frac{1}{3}$ chance of winning on any given turn. If Tom and Bill play this game, alternating turns with Tom going first, what is the probability that Bill wins?

10. What is the sum of the first thirty terms of an arithmetic sequence with first term 14 and common difference –3?

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11. Evaluate: $\dfrac{(1+i)^7}{(1-i)^3}$

12. If a and b are rational and $12^a 6^b = 432$, what is the value of b?

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13. What is the determinant of the matrix $\begin{bmatrix} -1 & 1 & 4 \\ 2 & 5 & -3 \\ -4 & -2 & 1 \end{bmatrix}$?

14. Evaluate: $\sum_{n=1}^{10}\left(\log_2\left(4^{n-3}\right)\right)$

15. Determine the equation of the parabola with vertex $(5, 3)$ which passes through the point $(1, 2)$ and whose axis of symmetry is parallel to the y-axis.

16. On a given test, scores may be integers from 0 to 100, inclusive. A set of five test scores has a mode of 37, a median of 56, and a mean of 55. What is the largest possible value for an element of this set?

17. What is the minimum value of $f(x) = 3x^2 - 4x + 5$?