2022 MU ALPHA THETA NATIONAL CONVENTION
THETA CIPHERING CONDENSED VERSION

0) Let x and y be two positive integers such that $5x - y = 10$ and $2x + 3y = 3$. What is the value of $10x^2 + 13xy - 3y^2$?

1) What is the maximum possible value of the determinant of the matrix $\begin{bmatrix} 1 & 0 & 2x \\ 2 & x & 4 \\ 2 & 4 & 0 \end{bmatrix}$?

2) How far, in terms of pi, does the tip of the hour hand of a clock travel from 2:13 p.m. to 6:53 p.m. on the same day if the hour hand is 6 cm. long?

3) The rational expression $\frac{8x-9}{2x^2+x-15}$ can be written as $\frac{A}{x+3}+\frac{B}{2x-5}$. Find $A + B$.

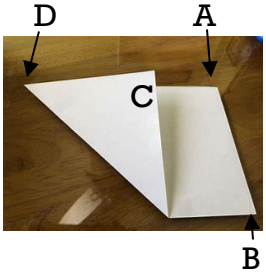
4) Andrew and Brandon are running toward each other from their respective starting points, which are 300 meters apart. Andrew runs at 2 m/s and Brandon runs at 5 m/s. If Andrew started running 3 seconds before Brandon started running, then how many seconds will Andrew run before they meet?

5) There is a 0.3 probability that it will rain today at Shreeyan's house. There is a 0.4 probability that it will rain tomorrow at Shreeyan's house. What is the probability that it will rain on exactly ONE of the two days (today or tomorrow) at Shreeyan's house?

6) ABCDEFGH is a regular octagon with side length 2. The midpoints of sides AB, CD, EF, and GH are connected to form a square inside the octagon. What is the area of the square? Answer in the form $\mathbf{a+b\sqrt{c}}$ for prime number **c**.

7) What is the <u>product</u> of the solutions for $\log(x^{\log(x)}) - \log(x^3) = 4$?

8) An 8 inch by 12 inch piece of paper ABCD is folded as shown, making a triangular region and a rectangular region. (vertex C is folded onto side DA.) What is the area of the trapezoid, in square inches of the region on the table covered by the new shape?



9) What is the sum of the x-coordinates of the solutions to these equations?

$y = x - 5$
$y = 5x^3 - 12x - 5$

10) Ben the Frog falls into a 120 foot well. During the day, Ben can crawl up 6 feet, but he slides down 3 feet at night while sleeping. On what day does Ben finally crawl out of the well? Note : There is food and water along the way up. So, don't dispute that! Assume that he starts climbing upon waking, on the morning of the 1st day.

11) Given the graph of the equation $9x^2 + 25y^2 - 18x + 100y - 116 = 0$. Find the following information :

The center (x, y)
a = the length of the major axis
b = the length of the minor axis
c = the length of the focal radius

Find $\frac{x}{y} \cdot a + (b \cdot c)$

12) x represents any Real Number. Solve $\frac{(x^2 - 121)(2x^2 + x)}{x^2 + 1} < 0$. Write your answer in interval notation.