

**#0 Theta Ciphering**  
**MAΘ National Convention 2018**

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How many even numbers between 611 and 901 can be formed using only the digits 3, 4, 5, 6, 7, and 8 with repetition allowed?

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The minute hand on Big Ben in London is 8 feet long. What is the arc length, in feet, traversed by the end of the minute hand in 38 minutes?

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**#2 Theta Ciphering**  
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Find the x-intercept of the line that is perpendicular to  $3x - 4y = 12$  and passes through the midpoint of the segment whose endpoints are  $(-2, -1)$  and  $(-4, 5)$ .

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**#2 Theta Ciphering**  
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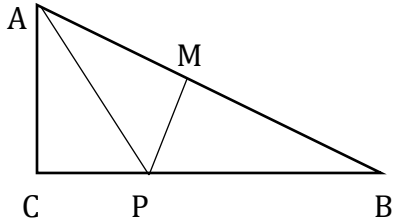
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**#3 Theta Ciphering**  
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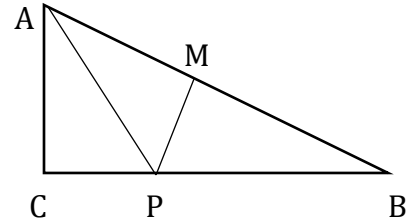
In the diagram below,  $AC=5$ ,  $CB=12$ , and  $AB=13$ . The perpendicular bisector of  $AB$  intersects  $BC$  at  $P$  and  $AB$  at  $M$ . Find the length of  $AP$ .



**#3 Theta Ciphering**  
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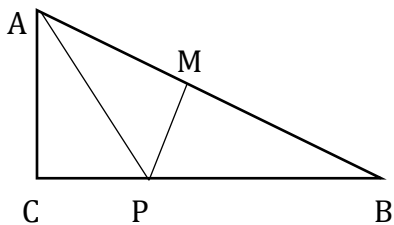
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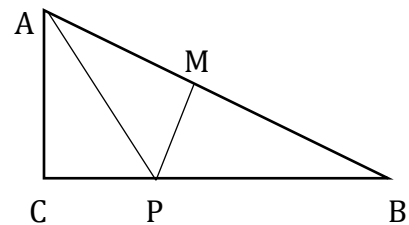
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**#4 Theta Ciphering**  
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An ellipse with equation  $\frac{(x-h)^2}{b^2} + \frac{(y-k)^2}{a^2} = 1$  has foci at (0, 0) and (0, -8) and passes through (0, 1). Given that a and b are positive, what is  $a + b + h + k$ ?

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$$\text{If } A = \begin{bmatrix} 4 & 2 \\ 1 & -4 \end{bmatrix} \text{ and } B = \begin{bmatrix} 0 & -1 \\ 3 & 2 \end{bmatrix},$$

find  $AB - B^{-1}A$ .

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A regular hexagon is circumscribed about a circle whose diameter is 12. What is the area of the region that is inside the hexagon but outside the circle?

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**#7 Theta Ciphering**  
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Evaluate:  $4 \log_3 \frac{1}{3} + 2 \log_9 27 + 6 \log_{27} 3$

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**#8 Theta Ciphering**  
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Find all solutions to the equation below:

$$x^3 + 2x^2 - 19x - 20 = 0$$

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What is the exact value of

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**#10 Theta Ciphering**  
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Find the domain of the function, written in interval notation:

$$y = \log_{3x-2} \left( \frac{x-2}{x^2-9} \right)$$

**#10 Theta Ciphering**  
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Express in simplest form:

$$[x + (x + x^{-1})^{-1}]^{-1}$$

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**#12 Theta Ciphering**  
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Let  $X$  be the smallest prime factor of 2016  
and let  $Y$  be the largest prime factor of 2016.  
What is  $X^Y$  ?

**#12 Theta Ciphering**  
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How many different integers satisfy both

$$|3x - 4| \leq 10 \text{ and } |3x + 2| > 4 ?$$

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**#14 Theta Ciphering**  
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Determine the sum of the real values of  $x$  that satisfy the equation  $3(2^{2x+3}) - 4^{2x} = 128$ .

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