

Question #0  
Theta Ciphering  
MAΘ National Convention 2007

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### Question #1

Theta Ciphering

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The function  $f(x) = x^3 + 15x^2 + 39x - 55$  has roots  $r, s$ , and  $t$ , and  $r > s > t$ .

Find the value of  $3r + s - 5t$ .

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## Question #2

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Given that  $5x \log(5x \log(5x \log(\dots))) = 100$ ,  
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### Question #3

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Given that  $i = \sqrt{-1}$ ,  $\frac{31-5i}{2-5i} = a + bi$ ,

and that  $a$  and  $b$  are elements of the set of real numbers, what is the

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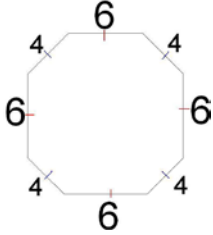
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What is the area of an equiangular octagon with side lengths that alternate between 4 and 6 as shown in the diagram?

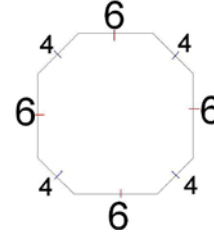


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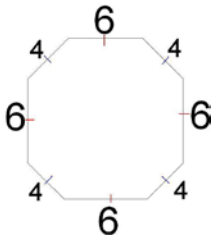


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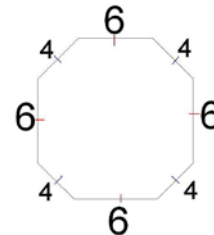


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How many distinct positive integers are factors of 1512?

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### Question #6

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Given that  $p$  is a prime number,  $p > 3$ ,

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Given that  $f(x) = \frac{ax^2 + b}{x^4 + c}$  and that

$(1,2)$ ,  $\left(2, \frac{5}{16}\right)$ , and  $\left(3, \frac{10}{81}\right)$  all lie on

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What is the determinant of the matrix  $A^2$

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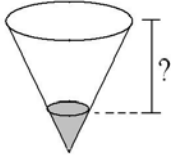
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A cup is in the shape of inverted (point-down) right circular cone whose height is 10 cm and has a base radius equal to 5 cm. The cup is partially full of water and the water takes up 2.7% of the volume of the cup. What is the distance from the top of the water to the top of the cup (in cm)?

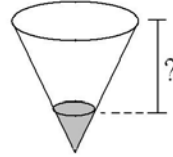


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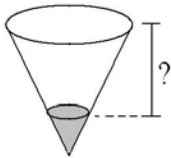


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