

2002 National Mu Alpha Theta Convention  
Theta Division Ciphering

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2. Find  $x$  given that

$$\sqrt{\sqrt{x} + 4} = 12.$$

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3. How many distinct arrangements of the letters in  
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4. Given that

$$\frac{x+5}{2x^2+11x-21} = \frac{A}{2x-3} + \frac{B}{x+7}$$

for some pair of constants  $(A, B)$ , find  $A + B$ .

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5. Three fair six-sided dice are rolled. At least one die shows a 1. What is the probability that the sum of the three dice is 6?

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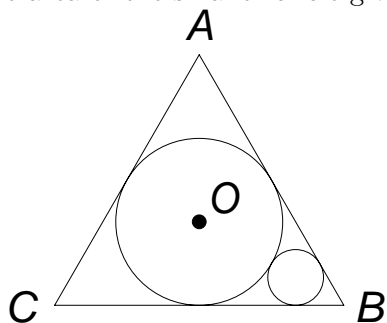
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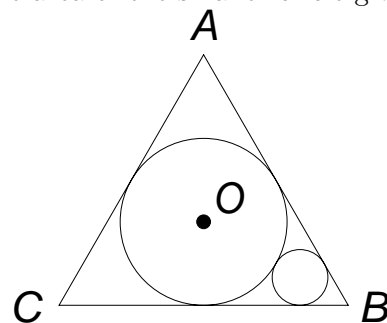
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6. Circle  $O$  is inscribed in equilateral triangle  $ABC$ . The smaller circle is tangent to circle  $O$ , to  $AB$ , and to  $BC$ . Find the area of the smaller circle given that  $BC = 6$ .



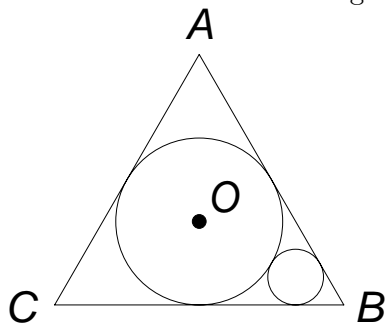
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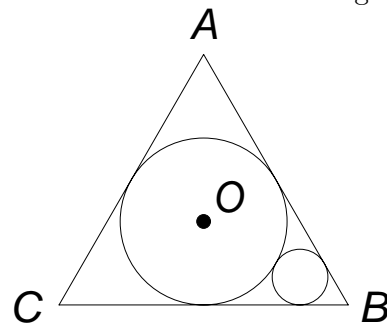
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7. For how many pairs of positive integers  $(a, b)$ , such that  $a, b < 6$ , is

$$\sum_{i=0}^{\infty} \left(\frac{a}{b}\right)^i = 2$$

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8. What is the area of the largest circle that can be inscribed in the ellipse

$$9x^2 + 4y^2 + 90x - 8y + 85 = 0?$$

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9. We write  $m \equiv r \pmod{n}$  (where  $m$  and  $r$  are integers and  $n$  is a positive integer) if  $m = qn + r$  for some integer  $q$ . You can also think of this as  $m$  divided by  $n$  leaves a remainder of  $r$ . How many integers  $k$  such that  $0 \leq k \leq 500$  satisfy

$$3k \equiv 4 \pmod{7}?$$

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10. Find the determinant of  $AB$  if

$$A = \begin{bmatrix} 1 & 3 \\ -7 & 2 \end{bmatrix} \text{ and } B = \begin{bmatrix} 0 & 1 \\ -4 & 6 \end{bmatrix}.$$

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11. Find all values of  $z$  such that

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12. Given that  $\triangle ABC \sim \triangle ADB$ ,  $AD = 6$ , and  $AC = 8$ ,  
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