

2018 Four-by-Four Competition
Thursday, February 1st, 2018

Round 1

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1. Simplify by rationalizing the denominator: $\frac{24}{8+\sqrt{61}}$

2. What is the value of the missing term in the sequence
60, 80, 132, 120, 204, 180, 276, 270, ____, 405, 420, ...

3. If $s \blacksquare t = -7s^2t - \frac{5s}{t} + 6t^2$, evaluate $6 \blacksquare 2$.

4. A right triangle has an angle measuring 60° and a perimeter of $3\sqrt{6} + 3\sqrt{2}$ m. What is the area, in square meters, of the triangle?

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5. What are the coordinates, in the form (x, y) , of the vertex of the parabola with equation $y = 5x^2 + 4x - 1$?
6. What is the measure, in degrees, of the smaller angle between the hour and minute hands of a standard 12-hour analog clock at 3:50 AM?
7. How many subsets of the nine smallest counting numbers contain exactly two prime numbers and exactly three even numbers?
8. What is the largest number less than 1000 that leaves a remainder of 6 when divided by 70 and 1 when divided by 45?

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9. What is the slope of the line through the point $(-1,1)$ and perpendicular to the line $6x - 3y = 2$?
10. What is the sum of the first 14 terms of the arithmetic sequence with first term 4 and common difference 7?
11. A math club's membership consists of 6 boys and 7 girls. Their bylaws state that they must have a President, a Vice-President, and two Representatives to the ASB, and that these four people must include at least one boy and at least one girl. In how many ways could these offices be filled according to these rules?
12. A dodecagon has U interior angles measuring 120° , and all the other interior angles measure V° . What value of V corresponds to the largest possible value of U ?

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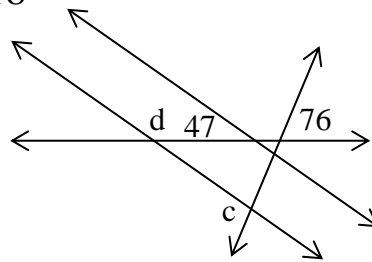
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13. The figure to the right shows four lines, two of which are parallel, with some angle measures given in degrees. What is the value of $c + d$?



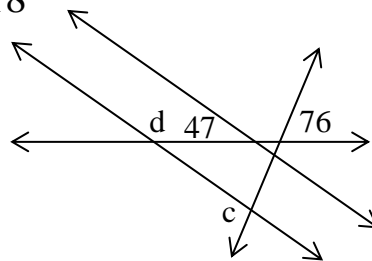
14. Evaluate: $\frac{9! \cdot 11! \cdot 7!}{8! \cdot 14! \cdot 5!}$

15. What is the sum of the factors of 975?

16. My pocket contains 21 coins, each of which is either a quarter, dime, nickel, or penny. If the total value of these coins is \$3.04, what is the largest possible number of dimes in my pocket?

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17. Two concentric circles are drawn so that the area of the annular region between them is 75π m². What is the length, in meters, of a chord of the larger circle that is tangent to the smaller circle?
18. If $w(x) = 4x - 1$, $y(z) = -2z + 6$, and $b(c) = -5c - 4$, evaluate $y(w(b(-5)))$.
19. An **unfair** coin has a $\frac{25}{49}$ probability of coming up heads. When it is flipped seven times, what is the ratio, expressed as a fraction, between the probability of getting exactly three heads and the probability of getting exactly three tails?
20. What is the volume of the solid generated when the area between $y = x^2$ and $y = 13 - (x - 1)^2$ is rotated about the line $x = 5$?

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Round 6

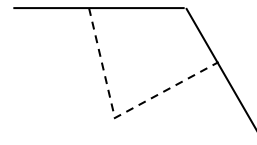
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21. Moldessa and Napstablook see one another at the same moment when they are 2400 meters apart and immediately rush towards one another. If Napstablook floats at a speed of 2 meters per second (mps) and Moldessa oozes at a speed of 1 mps, how many **minutes** will it take them to reach one another?

22. Express the base-10 numeral 539_{10} as a base-4 numeral.



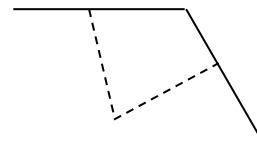
23. A folding screen has two sections that are each four feet wide. If this screen is placed in the corner of a (regular) hexagonal room (see figure to the upper right), what is the largest area, in square feet, that it can separate from the rest of the room?

24. What is the area of the ellipse with equation $5x^2 + y^2 - 8x + 7y = 8$?

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25. When the centers of the faces of a regular dodecahedron are used as the vertices of a new regular polyhedron, what is the name for that polyhedron?

26. How many prime numbers are there between 70 and 100?

27. Last night at charity Casino Night, I saw the new game Rollow. Players pay \$5 to roll two dice. They win \$2 for each 1 they roll, \$1 for each 2 they roll, and an additional bonus of \$40 if they roll two 1s. What is a player's expected **loss**, in dollars rounded to the nearest hundredth (cent), when they play this game?

28. Evaluate: $\lim_{n \rightarrow 0} \frac{7\sin^2 5n \cos 9n}{6n^2}$

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29. What are the coordinates, in the form (x, y) , of the rightmost x-intercept of the parabola with equation $y = x^2 + 2x$?

30. A circle has both an inscribed equilateral triangle and a circumscribed equilateral triangle. What is the ratio, as a fraction, of the area of the smaller triangle to the area of the larger triangle?

31. In the Radical Rectangle to the right, six distinct positive integers must be placed in the cells (one number per cell, in any order) so that the sums of the three numbers in each row are equal, and the sums of the two numbers in each column are equal. What is the smallest possible sum of all six numbers?

32. Express $\frac{9.4 \times 10^6 + 6.224 \times 10^9}{9 \times 10^4}$ in scientific notation rounded to four significant figures.

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33. What is the period, in radians, of $2 \sin^3 8k + 9 \cos^2 6k$?
34. What is the remainder when 3975 is divided by 74?
35. What is the sum of the first ten terms of the Fibonacci Sequence, the first two terms of which are 1 and 1?
36. If $\log_5 2 = d$, express $\log \frac{5}{4}$ in terms of d and without logarithms.

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Round 10

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37. What number is 253 more than twice 984?
38. What is the average value of $9m^2 - 4$ on the interval $[-2,1]$?
39. If seven Octopuses are equivalent to one Peacock, nine Quetzals are equivalent to six Rats, and one Octopus is equivalent to eight Rats, how many Peacocks are equivalent to 504 Quetzals?
40. What is the equation, in the form $x = f(y) = g(z)$, of the line through the points $(-7,3,-8)$ and $(3,-2,-2)$?

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