THE FORTY SECOND W.J. BLUNDON MATHEMATICS CONTEST

Sponsored by
The Canadian Mathematical Society*
in cooperation with
The Department of Mathematics and Statistics
Memorial University of Newfoundland

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1. A bath can be filled with water running from two separate pipes controlled by two separate taps. One pipe supplies cold water and the other supplies hot water. If the drain plug is used, it takes 5 minutes to fill the bath with cold water when that tap is completely open, while it takes 10 minutes to fill the bath with hot water when its tap is completely open. If the bath is filled with water, it takes 6 minutes to drain the bath after taking out the plug. How much time does it take to fill the bath if both taps are completely open and the drain plug is not used? Express your answer in seconds.

2. In the grid shown, 15 cells contain X's and 10 cells are empty. Any X may be moved to any empty cell. What is the smallest number of X's that must be moved so that each row and each column contains exactly three X's? Show that your answer is correct by showing the moves of the X's.

X	X	X	X	
X	X	X		X
X	X	X		
X	X			
		X	X	

3. (a) Find the largest *6-digit* number in which each digit starting from the 3rd is equal to the sum of two previous digits.

   (b) Find the largest whole number in which each digit starting from the 3rd is equal to the sum of two previous digits.

4. A square was cut into six parts, each of which was a convex polygon. Five of these parts were lost and the one that remained had a shape of a regular octagon with side length 1 cm.

   (a) Is it possible to determine the exact side length (in cm) of the original square from the dimensions of the octagon? Is the answer unique?

   (b) Is it possible to determine the shape of the missing parts? Is the answer unique? Explain why.

5. Find whole numbers a, b, c, d with the smallest possible values for b and d such that
$$\frac{80+\sqrt{120}+\sqrt{360}+\sqrt{19200}}{\sqrt{10}+\sqrt{30}} = a\sqrt{b}+c\sqrt{d}.$$

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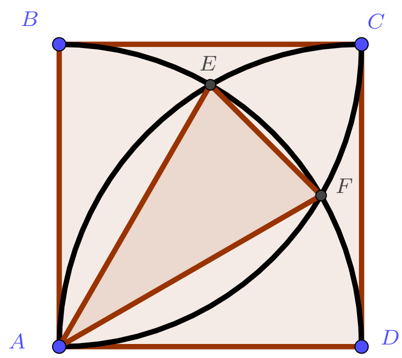
6. There are 500 lamps numbered from 1 to 500, each of which could be turned either ON or OFF. We say that the *state of a lamp is changed* if it is changed either from ON to OFF or from OFF to ON. Originally all lamps are turned OFF. The first person changes the state of all lamps (that is, turned all of them ON). Then the second person changes the state of each lamp with even number. Then the third person changes the state of each lamp whose number is a multiple of 3, etc.

   All in all, the k-th person changes the state of each lamp whose number is a multiple of k for all $1 \leq k \leq 500$. How many lamps are emitting light as the result of this procedure?

7. Let $ABCD$ be a square with side length a. Arcs of circles with radius a and centres at each vertex A, B, and D are drawn. The arcs intersect at points E and F. Find the ratio of areas of the square $ABCD$ and triangle AEF.



8. In some countries a postal code consists of 2 letters followed by 4 digits. In one of these countries there are 30 letters and 10 digits to choose from.

   (a) What is the probability that the postal code contains repeated letters and no repeated digits (e.g. AA1234)? Express your answers as a fraction in lowest terms.

   (b) Is it more likely or more unlikely that at least one symbol (letter or digit) in a postal code is repeated? Justify your answer.

9. Four numbers p, q, r, s satisfy $p < q < r < s$. Each of the six possible pairs of distinct numbers has a different sum. The four smallest sums are $a < b < c < d$. What is the sum of all possible values of s in terms of a, b, c, d?

10. Find all integer solutions, if any exist, to equation $15x^2 - 7y^2 = 9$.

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