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**SECTION 2. Applied mathematics. Mathematical modeling.**

## GEOMETRIC SOLUTION OF NON-GEOMETRIC PROBLEMS

**Abstract:** In this article we indicate with geometric methods some algebraic problems are solved. In each sketch, geometric methods for solving problems are given. They, as a rule, do not have a habit for students, but experience shows that they are easily perceived by them. Thanks to the integration of the "non-geometric" conditions of the problem and its geometric solution, mathematical knowledge appears to the students as a living, dynamic system capable of solving problems from other sciences and practices. In essence, there is a bilateral process: teaching mathematics and teaching mathematics.

**Key words:** Theorem, triangle, circle, radius, semi perimeter, function, graph, equation, inequality, system equation.

**Language:** English

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### Introduction

As you know, algebra and geometry are one of the major branches of mathematics. They always come to fill one another. It's hard to imagine the other one. In geometry, there are such problems that it is very difficult to calculate in geometric methods we know them. For example, perimeters can help to solve geometry algebra in the solution of such issues as finding the largest polygonal polygons among the same polygons, finding large geometrical objects, finding nonstandard rotating objects. Now, it can be said that some algebraic equations and equations are much easier to solve than the usual algebraic solutions by using the properties of geometric shapes. In this work, we have tried to point out that in this work, the interdisciplinary integration of algebra and geometry, more precisely, the geometric solution of some algebraic types and examples is more understandable to the majority of students than algebraic solution.

### Materials and Methods

Non-traditional examples of solving problems allow us to more fully reveal the potential of schoolchildren, to introduce them to creativity and research activities. Some tasks, dear colleagues, may seem difficult for you to choose them as exercises in the lesson, then you can consider them in group or elective classes like.

**Example №1.** 
$$\begin{cases} x^2 + xy + y^2 = 4 \\ x^2 + xz + z^2 = 9 \\ y^2 + yz + z^2 = 36 \end{cases}$$

Does the system of equations have solutions for  $x > 0, y > 0, z > 0$ ?

**Solution:** Assume that there is a triple of positive numbers  $x, y, z$  satisfying each equation of the given system. Then a geometric interpretation is possible in the figure (1).



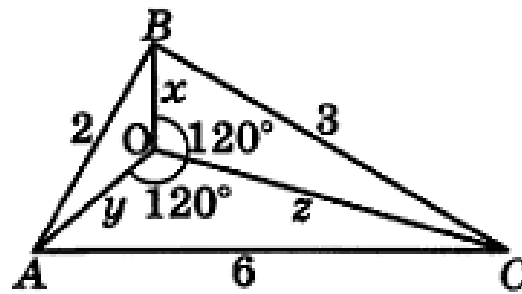


Fig-1. Figure on the subject of the task.

But the triangle ABC does not exist, because the triangle inequality is not satisfied. So the system has no solutions. [2]

**Example №2.** Find the least value of expression

$$f(x; y) = |x - y| + \sqrt{(x - 4)^2 + (y + 2)^2}$$

**Solution:** Consider the point A (4; -2) and the straight line  $y = x$  on the coordinate plane (see Fig. 2). Let  $M(x; y)$ , then

$$MA = \sqrt{(x - 4)^2 + (y + 2)^2}$$

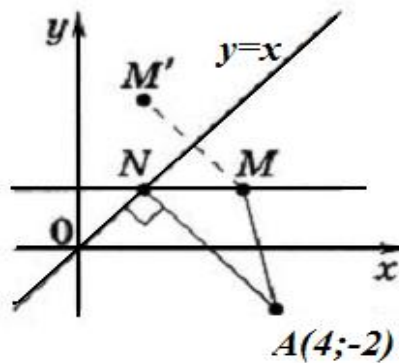


Fig-2. Figure on the subject of the task.

Note that if the point  $M'$  is symmetric to the point  $M$  relative to the line  $y=x$ , then  $(y; x)$ . Thus, for these two points the meaning of the expression is the same  $|x - y|$ . Therefore, the smaller distance from the point A will be to the one of them that lies with the point A in one half-plane with respect to the straight line  $y=x$ . Thus, the desired point M lies below this line, and then  $|x - y|$ , where N is the point of intersection of  $y = x$  with the horizontal line passing through the point M. By the triangle inequality  $MA + MN \geq AN$ , therefore, the point M must lie on the segment AN, and the smallest value of the length AN is reached if N is the base of

the perpendicular dropped from the point A to the line  $y = x$ .

We use the formula the distance from the point to the straight lines (from the point A (4; -2) to the lines  $x - y = 0$ ),

$$d = \frac{|ax_0 + by_0 + c|}{\sqrt{a^2 + b^2}} = \frac{|4 - (-2)|}{\sqrt{1^2 + (-1)^2}} = 3\sqrt{2} \cdot [1, 2]$$

**Example №3.** Prove that if  $\alpha + \beta + \gamma = \pi$  ( $\alpha > 0, \beta > 0, \gamma > 0$ ), then

$$\operatorname{tg} \frac{\alpha}{2} \cdot \operatorname{tg} \frac{\beta}{2} + \operatorname{tg} \frac{\beta}{2} \cdot \operatorname{tg} \frac{\gamma}{2} + \operatorname{tg} \frac{\gamma}{2} \cdot \operatorname{tg} \frac{\alpha}{2} = 1. [3]$$

**Solution:** Consider a triangle ABC with corners  $\alpha, \beta$  and  $\gamma$ .

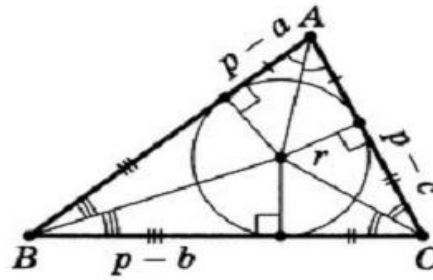


Fig-3. Figure on the subject of the task.

Let the lengths of its opposite sides be equal to a, b and c, respectively; p, S and r are the half-meter, the area and radius of the inscribed circle of this triangle. Then

$$r = (p-a) \cdot \operatorname{tg} \frac{\alpha}{2} = (p-b) \cdot \operatorname{tg} \frac{\beta}{2} = (p-c) \cdot \operatorname{tg} \frac{\gamma}{2}$$

Consequently,

$$\begin{aligned} & \operatorname{tg} \frac{\alpha}{2} \cdot \operatorname{tg} \frac{\beta}{2} + \operatorname{tg} \frac{\beta}{2} \cdot \operatorname{tg} \frac{\gamma}{2} + \operatorname{tg} \frac{\gamma}{2} \cdot \operatorname{tg} \frac{\alpha}{2} = \\ & = r^2 \left( \frac{1}{p-a} \cdot \frac{1}{p-b} + \frac{1}{p-b} \cdot \frac{1}{p-c} + \frac{1}{p-c} \cdot \frac{1}{p-a} \right) = \\ & = \frac{r^2 p}{(p-a)(p-b)(p-c)} = \frac{r^2 p^2}{S^2} = 1 \end{aligned}$$

**Example №4.** . Prove that if  $0 < x < 1$ ,  $0 < y < 1$  and  $0 < z < 1$ , then

$$x(1-y) + y(1-z) + z(1-x) < 1. \quad [3]$$

**Solution:** Consider a cube with an edge 1. Choose three edges that emanate from the same vertex and lay out on them segments with the lengths x, y and z (see Fig. 4).

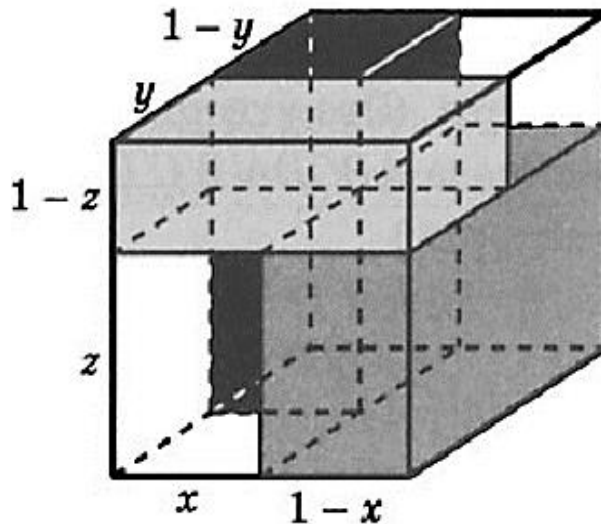


Fig-4. Figure on the subject of the task.

We construct three rectangular parallelepipeds with dimensions (x; 1-y; 1), (y; 1-z; 1), (z; 1-x; 1). Since these parallelepipeds do not have common internal points, the sum of their volumes is less than the volume of the cube, equal to 1.

Thus, the analysis of the work done has taught us new and simplest ways of solving problems. This will help you to explore various mathematical topics, and, in truth, receive answers from the most complex equations. Using the geometric solutions of geometrical problems, using controversy and

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theorem method, we have come to the conviction that the equation and expression solution is a good way to achieve faster and more accurate results.

Nonstandard issues have always attracted scientists' attention. There are very interesting issues among them. These issues develop theoretical and logical thinking and cognitive abilities. An unusual method of problem solving can make the schoolchildren more aware of their potential. That is why most of the tasks at various levels of the Olympiad test the ability of the child to see non-standard issues. During the preparation for the Olympics, it is a good idea to teach students to solve complex algebraic problems that are solved by geometrical methods. The beauty of the solution, with its clarity and simplicity, makes the person laugh.

We often encounter geometrical problems that are solved by algebra (different equations, equation systems, and so on). Less known algebraic and algebraic problems can be solved in a convenient geometric language, but there are rarely cases where these tactics are used in school lyceum math lesson. The non-traditional method of solving problems provides students with a better understanding of their potential, introduces them to creativity, and provides intramathematic communication.

### Conclusion

In conclusion, we can say that when the same conditions are reasonable, it is more convenient to geometricalize than to solve some non-uniform equation and algebraic solution.

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