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Extreme Problems and Their Study in a Mathematics Course

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Abstract: In this article, the methods that can be used in solving problems that lead to finding the largest and smallest values of the function: the method of inequalities, the method of using quadratic triangle properties, the symmetry method and the essence of the differential calculus methods are explained with the help of problems.

Keywords: Maximum, minimum, extremum, largest value, smallest value, arithmetic mean, geometric mean, isoperimetric problem, critical point.

It is known that in recent years, great importance has been attached to the development of mathematical education in our republic. As a clear example of this , on May 7, 2020, the President of the Republic of Uzbekistan "Measures to improve the quality of education and develop scientific research in the field of mathematics PQ-4708, July 9, 2019 PQ-4387" State support in the further development of mathematics education and sciences, measures to fundamentally improve the activities of the Institute of Mathematics of the Academy of Sciences of the Republic of Uzbekistan named after VI Romanovisky" decisions can be made. The main goal of this decision is to develop mathematical sciences in our republic and to train qualified specialists who are not far behind the specialists trained in developed countries. Among the subjects taught in higher educational institutions, higher mathematics takes an important place in the training of such specialists. That is why teaching higher mathematics in higher educational institutions should be given great importance. Because today in the day each how expert own in the activity mathematics and mathematician to methods often appeal does.

It is known that there are many practical issues mathematics and mathematician methods using own the solution easy finds. Such to issues example as extreme issues to bring can extreme to issues people their own practical activity during often face they come extreme matters of quantities the most big and the most small values to find circle issues being such issues solve with ancient time mathematicians Euclid, Pythagoras, Archimedes, Apollonius, Zenodorus, Geron and others are also involved. Medium in Asia while such issues with Abu Rayhan Beruni engaged in Until the 17th century such matters basically geometric method solved. French math P. Farm English math and physical I. Newton and german math G. Leibniz works using later on such issues analytical method solve started.

Someone of the amount the most big and the most small values to find and such values there is to be conditions determination demand done issues usually to the extreme about issues called (Latin extremum - the edge). They are "maximum" and "minimum" (Latin maximum and minimum - corresponding without "eng big” and “most to small"), about are also called issues. To this similar to issues mathematics, physics, mechanics, technology, medicine, economy and etc in the sciences often face will come. For example, round from wood how by doing right rectangle sectional beam it's waste the most less will be Given from the material made of the box volume the most big to be for his dimensions how to be do you need. Two the city connector road the most short to be for the bridge of the river which to the place to build do you need and etc issues these are including. Such practical important have issues geometric to the view to bring difficulty does not give birth. Most simple and ancient from issues one: perimeter known right rectangles between which one's surface the most big that determination issue and it is called an isoperimetric problem. To the extreme about such issues in solving most of the time of quantities medium arithmetic and medium geometric values conjunction from the relationship is used. This is the following theorem with defined as:

Theorem. Minus didn't happen $n$of a natural number medium arithmetic value that's it of thighs medium from geometry small not, that is

$$\frac{x_1 + x_2 + \cdots + x_n}{n} \geq \sqrt[n]{x_1 \cdot x_2 \cdot \ldots x_n}.$$

Equality sign $x_1 = x_2 = \cdots = x_n$ will be executed when

Below this of the theorem private from consists of was

$$\frac{x_1 + x_2}{2} \geq \sqrt{x_1 x_2}$$

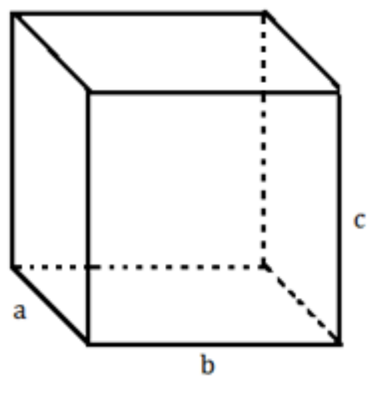
relationship using solvable extreme to the matter we will stop.

Issue 1. Surface surface when given volume the most big will be box (true rectangular parallelepiped). dimensions how selection do you need

Solution: Get rid of it edges a, b, c with s, his full the surface while S with and V we define the size with. In that case $S = 2(ab + ac + bc)$ and $V = abc$ will be (Fig. 1).

First from equality $ab + ac + bc = \frac{S}{2}$ the fact that known. Secondly $ab \cdot ac \cdot bc = V^2$ the to write can now these are for medium arithmetic and medium geometric about inequality if we apply, to the following have we will be:

$$\frac{ab + ac + bc}{3} \geq \sqrt[3]{ab \cdot ac \cdot bc}, \frac{S}{6} \geq V^{\frac{2}{3}} \, yoki \, V \leq \left(\frac{S}{6}\right)^{\frac{3}{2}}$$



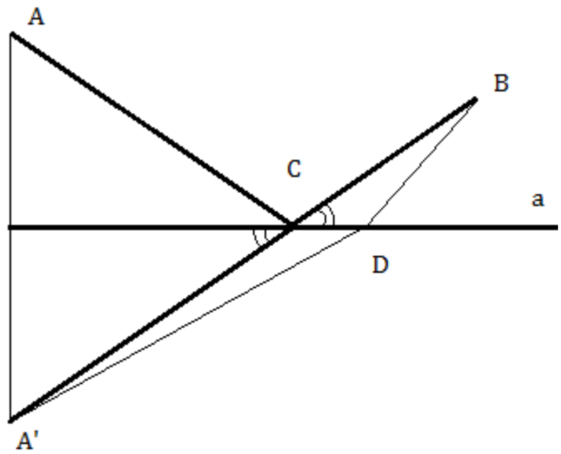
Medium values about from the theorem only $= ac = bc$, i.e. when $a = b = c$b dies inequality it follows that the sign becomes equal, and in this case the volume V assumes the largest value.

To the extreme about some geometric issues in solving symmetry using the method can below to him Let's look at the issue:

Issue 2.a given a $a$straight line and points B on one side of it. A find a point on the A straight line such C that B to the points distances sum the most small to value let it reach (Fig. 2).

Solution: Let A' the point $a$be point-to-point symmetric C with respect to the straight line, A and the point and $A'B$ and $a$be the point of intersection of straight lines. In that case C the wanted point will be Indeed too $CA + CB = CA' + CB = A'B$. If we $a$choose another option of a straight line D the point if we get, $AD + DB = A'D + DB > A'B$ the inequality will be valid.

Extreme issues in solving most of the time don't multiply maximum and get together minimum about theorems are also used. Below them without proof we bring.



Theorem $1.n$ if the sum of positive numbers is constant, then the product of these numbers is the largest value of these numbers mutually equal to when achieves.

Theorem $2.n$ if the product of a positive number is constant, then the sum of these numbers reaches its smallest value when these numbers are equal to each other.

Below this theorems to apply let's see the issue:

Issue 3. Side $a$there was an awning square shaped tin given tin off four from the tip one different square will play cut off taken and left from the part over open box made cut off received squares side how when box volume the most big will be.

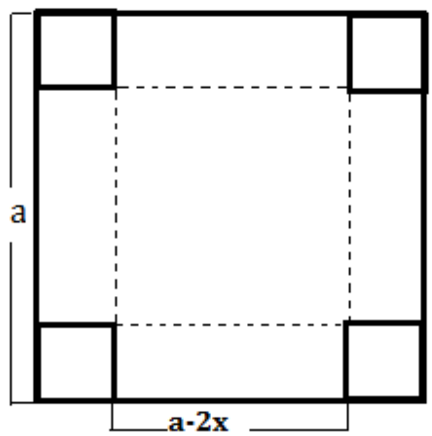
Solution: Cut received squares let the side be x (Fig. 3). In that case of the box $V = (a-2x)^2x$ volume will be Of this the most big value to find for as follows form change we do:

$$4V = 4x(a-2x)(a-2x).$$

Multipliers sum $4x + a - 2x + a - 2x = 2a$ immutable that it was for $4x = a - 2x$reaches its maximum value when $4V$

$$4x = a - 2x;\ 6x = a;\ x = \frac{a}{6};\ V_{max}\left(\frac{a}{6}\right) = \frac{2}{27}a^3.$$

So, cut received square side given square side of $\frac{1}{6}$ when forming the part box the most big to volume have will be.



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Some one extreme issues in solving square of the triangle properties are also used. In this the following from the theorem is used.

Theorem. $y = ax^2 + bx + c$ kvadrat triple $a > 0$ when $x = -\frac{b}{2a}$ at the point $\frac{4ac-b^2}{4a}$ is equal to the most small to $a < 0$ value when $x = -\frac{b}{2a}$ at the point $\frac{4ac-b^2}{4a}$ is equal to the most big to value have will be.

Below this the theorem to apply let's see the issue:

Issue 4. $y = -2x^2 - 3x - 1$ of the function extremum be found.

Solution: Here $a = -2 < 0$, that is function to the maximum have will be Here $b = -3, c = -1$ that b is dead for $x = -\frac{b}{2a} = -\frac{3}{4}$ function at the point to the maximum have will be We will find it.

$$y_{max}\left(-\frac{3}{4}\right) = \frac{4ac-b^2}{4a} = \frac{4\cdot(-2)\cdot(-1)-(-3)^2}{4\cdot(-2)} = \frac{8-9}{-8} = \frac{1}{8}.$$

Some one extreme issues in solving above seeing passed methods supporting it didn't happen. Such cases derivative from the concept use comfortable will be In this initially given issue mathematical model has been function is made and the following confirmations attention is taken.

1. If $f(x)$ the function is something $[a,b]$ in cross section continuously being, then only one to the extreme have if, then this extremum when the maximum (minimum) is, it is a function that's it in cross section the most big (eng small) value will be.
2. If $f(x)$ the function is something $[a,b]$ in cross section continuously being, then to the extreme have if not, then of the function the most big and the most small values don't cut at the ends will be.
3. If $f(x)$ the function is something $[a,b]$ in cross section continuously is the following conditions if satisfied:
   a) $a < x < b$at$f(x) > 0$ $(f(x) < 0)$,
   b) $f(a) = f(b) = 0$,
   c) only one $a < x_0 < b$there is a critical point, then $f(x_0)$ the function is the largest (max small) value will be.
4. If given $f(x)$ function $x = x_0$ at the point to zero equal to didn't happen to the maximum (minimum). have if, then $\frac{1}{f(x)}$ the function $x = x_0$ to the minimum (maximum) at the point have will be.

Derivative using of the function the most big and the most small value to find circle the following issue let's see:

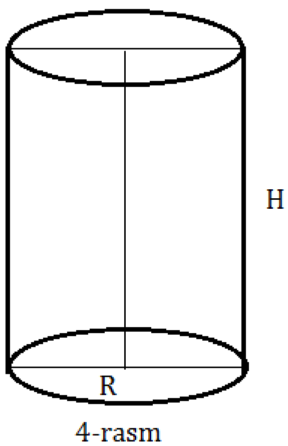
Issue 5. Size $125m^3$ has been cylinder shaped it is necessary to prepare a water container without a lid. Water of the vessel measurements how when him preparation for the most less material is used?

Solution: Water dish to prepare expendable of the material quantity dish of the surface face measure with is (in this to the seams taking into account consumables not available). So, a cylinder of the basis radius R and the height H should be chosen such that $125m^3$ capacity dish the surface the most small surface have let it be.

Cylinder of the basis radius R the manly we consider it a variable. Then the volume of the cylinder $V = \pi R^2 H$ or $\pi R^2 H = 125$ died from this $H = \frac{125}{\pi R^2}$ will be. The surface of the cylinder surface (top basis not added without).

$$S = \pi R^2 + 2\pi RH = \pi R^2 + \frac{250}{R}.$$

will be here $0 < R < \infty$. Thus, the surface area of the cylinder S is a function of the radius of the base. R So the question R is what is the value of $S(R)$ the most small to be from detection consists of will be.



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1) $S'(R)$ we find: $S'(R) = \left(\pi R^2 + \frac{250}{R}\right)' = 2\pi R - \frac{250}{R^2}$;

2) $S'(R)$ we solve for:

$2\pi R - \frac{250}{R^2} = 0, \frac{2\pi R^3 - 250}{R^2} = 0, 2\pi R^3 - 250 = 0, R = \frac{5}{\sqrt[3]{\pi}} \approx 3{,}42$;

3) $S'(R) = 2\pi R - \frac{250}{R^2} = \frac{2}{R^2}(\pi R^3 - 125)$ of $R = \frac{5}{\sqrt[3]{\pi}}$ we define the pointer around the point. $\frac{2}{R^2} > 0$ that b is dead for $f(R) = \pi R^3 - 125$ we limit ourselves to checking.

$0 < R < \frac{5}{\sqrt[3]{\pi}}$ when $f'(R) < 0$ and when $R > \frac{5}{\sqrt[3]{\pi}}$ dies $f'(R) > 0$.

So, $S(R)$ the function $R = \frac{5}{\sqrt[3]{\pi}}$ has a minimum at the point. This is the only one extremum that it was for the smallest value of u $S(R)$ will be b, i.e $R = H = \frac{5}{\sqrt[3]{\pi}}$ when $S_{min} = 3\pi R^3 = 75\sqrt[3]{\pi}$ will die .

This issue is practical being a matter of character to this similar issues many to bring can. Such issues solve in the process of students creative thinking abilities more develops and education process efficient will be So so we do this in the article extreme issues of solving one how many method with we met and this methods inside from the derivation use much comfortable and common method that trust harvest we did.

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