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Solving Problems with Different Methods Using Parallel Transfer

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Abstract: Many of our teachers complain that their students cannot solve problems independently in geometry, especially in its stereometry part.

Let's not constantly put the blame on the students, but let's look at ourselves and see if we didn't get them used to independently solve the problems of the planimetry part of the manuals other than the textbook.

Key words: parallel, parallelogram, plane, point, straight line, path, section, cosine, sine.

Parallel transfer in our tutorial advantage pointer issues little in consideration take the following issues another from manuals we got it with of students planimetry issues different methods with independent to solve we teach.

Main theoretical information: 1. In the plane each one point one different to the distance moving parallel migration to switching is called 2. Parallel transfer is action. 3.F the figure Fformed by parallel displacement $F^1$of the figure is equal to the figure. 4. One done in a row how many parallel transfers parallel transfer again gives 5. Directed is called a cross section vector, u$\vec{a}, \overrightarrow{AB}$ such as is determined.

Issue 1. of the channel one on the side Aplace the bridge on the canal so that $MN$the path from $AMB$the village to the village on the other side $B$is the shortest to build do you need (of the channel shores are parallel to each other lines in the form of a bridge while to the shores perpendicular by doing take it.)

Solution. Method 1. A method of moving point parallel. Suppose, to an arbitrary place M^1N^1 bridge built (Figure 1).A point $M^1N^1$by parallel copying up to A^1 point harvest we do In it $AM^1 = A^1N^1$Since $AM^1N^1B$the length of the path $A^1N^1 + N^1B + M^1N^1, M^1N^1 -$ is constant, we need to find $N^1$the point $A^1N^1 + N^1B$ so that the sum is the smallest, ΔA^1N^1B and this happens when N^1 the point A^1B lies on the cross section. N^1 point on the coast lie down by necessity we take as A^1B the smallest position of N lying at the point of intersection of that edge with the cross section N^1.

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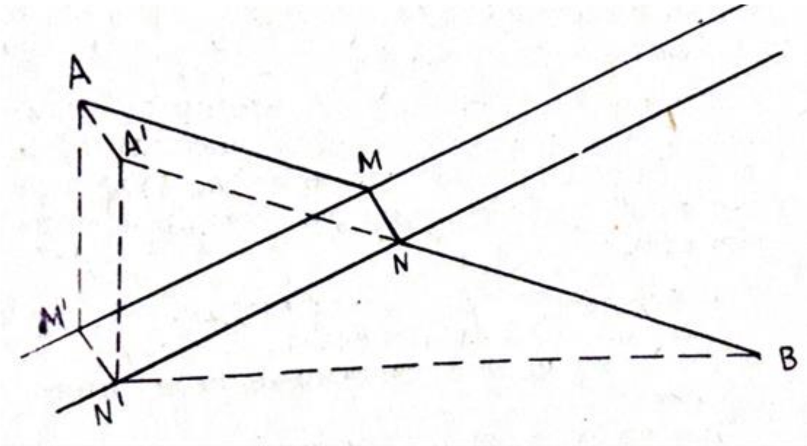


Figure 1.

Now the bridge $N$to make at the point N^1M^1, $AMNB$ we make the searched shortest (smallest) path by moving parallel up to N^1N.

Method 2. B method of moving point parallel. We can copy the path and points using A, B duplicating paper. Then as follows work we walk (Figure 2).

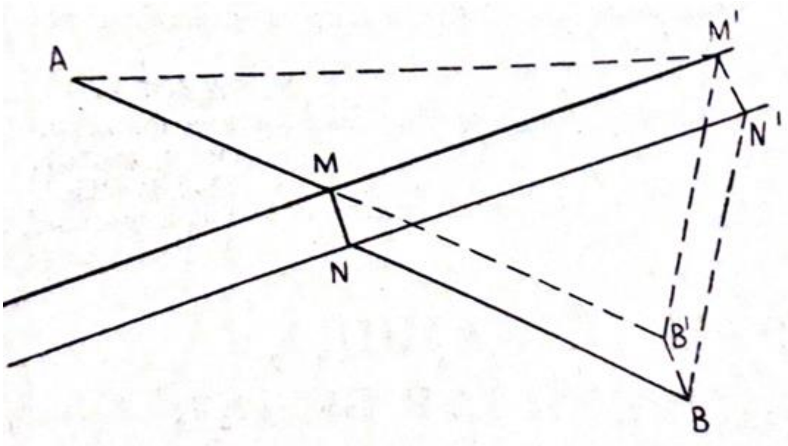


Figure 2

Hypothesis let's do it, optional to the place M^1N^1 bridge built$B$ point $\overrightarrow{N^1M^1}$ we create a point by moving parallel to B^1 Since BN^1M^1A the length of $B^1M^1 + M^1\mathrm{A} + M^1N^1$ the path is constant M^1, $BN^1 = B^1M^1$ we need to find $M^1N^1 -$ the point $B^1M^1 + M^1A$ where the sum is the smallest. This ΔB^1M^1Ahappens when M^1 the point B^1A lies on the cross section. M^1 knowing that the point must lie on the coast B^1A that's it of the coast intersected at the point lying down new situation M we can say.

Now the bridge M ni NM^1 to make in point M^1N^1 up to parallel copying $AMNB$ we make the shortest path.

It is made form previous form on top of it if MN we place the bridges are placed on top of each other and we witness that the bridge was built in one place.

Issue 2. $ABCD$ diagonals d_1 of a trapezoid and d_2. CD If the length $b$of the base is equal to and the angle between the diagonals α is equal to, AB find the length of the side (Figure 3).

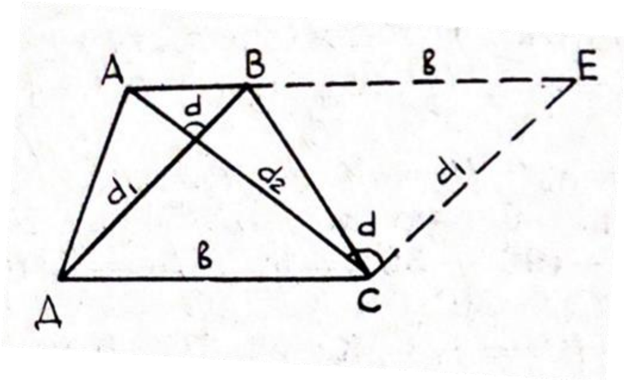


Figure 3.

Solution. Method 1. DC the side $\overrightarrow{DB}$ parallel copying until, and then $CDBE$we form a parallelogram. ΔACE according to the theorem of cosines.

$$(AB + b)^2 = d_1^2 + d_2^2 - 2d_1 \cdot d_2 \cdot \cos\alpha,$$

$$AB + b = \sqrt{d_1^2 + d_2^2 - 2d_1 \cdot d_2 \cdot \cos\alpha},$$

$$AB = \sqrt{d_1^2 + d_2^2 - 2d_1 \cdot d_2 \cdot \cos\alpha} - b.$$

Method 2. DC side $\overrightarrow{CA}$ We create a parallelogram ΔDEB by $CDEB$ moving it parallel up to. to cosines theorem support, answer is obtained (Figure 4).

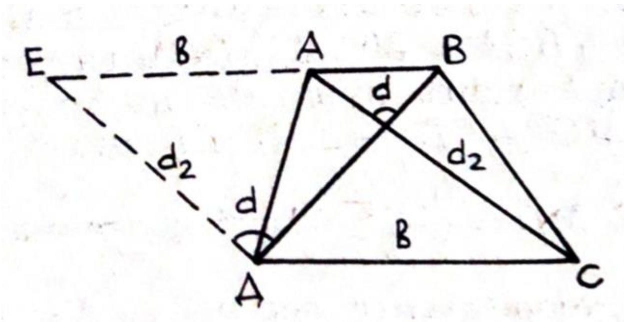


Figure 4.

Method 3. AB cross section $\overrightarrow{AC}$ parallel copying until, and then $ABEC$ we form a parallelogram. ΔDBE using the theorem of cosines, the answer is obtained (Figure. 5).

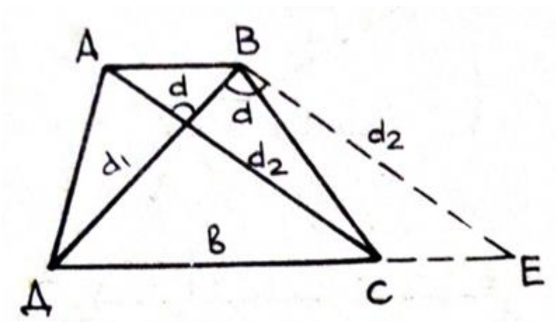


Figure 5.

Method 4. AB cross section $\overrightarrow{BD}$ parallel copying until, and then $ABDE$ we form a parallelogram (Fig. 6). ΔEAC by applying the theorem of cosines, the answer is obtained.

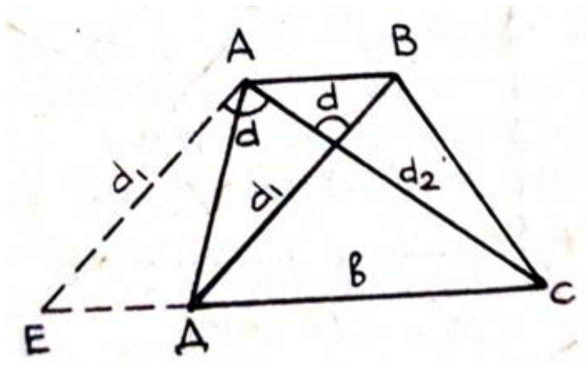


Figure 6.

Issue 3. $ABCD$ in a rectangle $AB = 6\sqrt{3}\,sm$, $CD = 12\,sm$, $\angle A = 60°$, $\angle B = 150°$, $\angle D = 90°$ (7th century). BC and AD find the lengths of the sides.

Solution. Method 1. 1) $ABCD$ from a rectangle

$$\angle BCD = 360° - (60° + 150° + 90°) = 60°.$$

2) B from the point AD and we draw perpendiculars to the sections and denote its bases by DC and H respectively K.

3) is correct angular ΔAKB from

$$\angle ABK = 30°, AK = \frac{1}{2}AB = 3\sqrt{3}, KB = AB \cdot \cos 30° = 9;$$

$$HC = DC - DH = DC - KB = 3.$$

4) is correct angular ΔBHC at

$$\angle HBC = 150° - (90° + 30°) = 30°, BC = 2 \cdot HC = 6,$$

$$BH = BC \cdot \cos 30° = 3\sqrt{3}, AD = AK + KD = AK + BH = 6\sqrt{3}.$$

Answer: $BC = 6\,sm, AD = 6\sqrt{3}\,sm.$

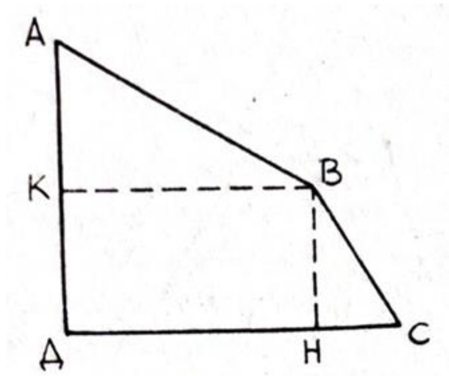


Figure 7.

Method 2. 1) $ABCD$ from a rectangle

$$\angle BCD = 360° - (60° + 150° + 90°) = 60°.$$

2) AB the side we create a parallelogram BC by moving it parallel to $ABCM$ (Figure 8). In it

$$\angle BCM = \frac{360° - 2 \cdot 150°}{2} = 30°, \angle MCD = BCD - BCM = 30°.$$

3) ΔDCM by the theorem of cosines MD at

$$MD^2 = MC^2 + CD^2 - 2 \cdot MC \cdot CD \cdot \cos 30° = 36°, MD = 6, MD = \frac{1}{2} CD$$

being the rest of the sinuses to the theorem basically, ΔCMD it follows that, is right-angled $\angle CDM = 60°$.

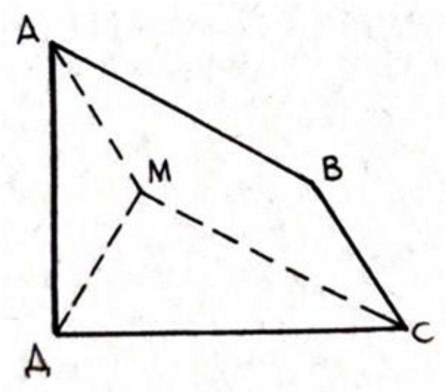


Figure 8.

4) $\angle MAD$ at

$$\angle MAD = \angle ADM = 30°, \angle AMD = 120°, MA = MD = 6$$

the account taking, cosines to the theorem basically:

$$AD^2 = 2MA^2 - 2MA \cdot \cos 120° = 6\sqrt{3}.$$

Answer: $BC = 6\ sm, AD = 6\sqrt{3}\ sm.$

Method 3. 1) AB the side $\overrightarrow{AD}$ parallel copying up to $ABED$ parallelogram harvest we do (Figure 9). In it

$$\angle BED = \angle DAB = 60°, \angle DFE = \angle ADF = 90°.$$

From this $\angle FDE = 30°$.

2) $ABCD$ in a rectangle

$$\angle BCO = 360° - (60° + 150° + 90°) = 60°, \angle BFC = 90°$$

that it was for $\angle FBC = 30°$.

3) is correct angular ΔBFC and ΔDFC from the similarity based on the equality of the acute angles of

$$\frac{BF}{BC} = \frac{DF}{DE} \text{ or } \frac{BF}{BC} = \frac{12 - FC}{6\sqrt{3}} \text{ from this } \frac{BF}{BC} = \sin 60° = \frac{3}{2}$$

the account if we get

$$\frac{3}{2} = \frac{12 - FC}{6\sqrt{3}}.$$

From this

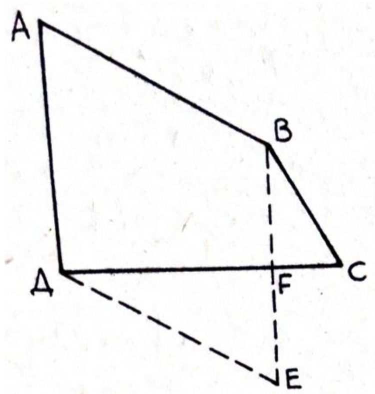
$$FC = 3, BC = 2, FC = 6 \cdot \frac{BF}{6} = \frac{\sqrt{3}}{2}$$

from

$$BF = 3\sqrt{3}, DF = DC - FC = 9.$$

4) is correct angular ΔDFE at Pythagoras to the theorem basically

$$EF = \sqrt{DE^2 - DF^2} = \sqrt{108 - 81} = 3\sqrt{3},$$
$$AD = BE = BF + FE = 3\sqrt{3} + 3\sqrt{3} = 6\sqrt{3}.$$



Answer: $BC = 6\ sm, A = 6\sqrt{3}.$

Figure 9.

Method 4. 1) $ABCD$ in a rectangle (Figure 10)

$$\angle BCD = 360° - (60° + 150° + 90°) = 60°.$$

2) side $\overrightarrow{CB}$ by $BCDM$ parallel copying until parallelogram harvest we do In it

$$\angle DMK = \angle BCD = 60°, \angle MKD = \angle ADC = 90°.$$

From this

$$\angle MDK = 30°, \angle MDC = \angle MBC = 120°,$$
$$\angle ABM = \angle ABC - \angle MBC = 30°.$$

3) is correct angular ΔAKB at

$$AK = \frac{1}{2} \cdot 6\sqrt{3} = 3\sqrt{3}, KB = AB \cdot \cos 30° = 9,$$
$$MK = MB - KB = DC - KB = 12 - 9 = 3, BC = MD = 2MK = 2 \cdot 3 = 6.$$

4) is correct angular ΔMKD at

$$KD = \sqrt{MD^2 - MK^2} = \sqrt{36 - 9} = 3\sqrt{3},$$
$$AD = AK + KD = 3\sqrt{3} + 3\sqrt{3} = 6\sqrt{3}.$$

Method 5. 1) DC the side $\overrightarrow{DA}$ by $DAEC$ parallel copying until right the rectangle harvest we do (Figure 11). BE making the cross section, ΔABE based on the theorem of cosines $BE = 6$ that we $BE = \frac{1}{2}AE$ find that it was for sinuses to the theorem according to ΔABE that's right angular will be, that is $ABE = 90°$.

2) $ABCD$ from a rectangle

$$\angle BCD = 360° - (60° + 150° + 90°) = 60°, BCD = 90° - 60° = 30°.$$

3) ΔABC at

$$\angle EBC = 360° - (90° + 150°) = 120°,$$
$$\angle BEC = 180° - (30° + 120°) = 30°.$$

So, ΔEBC equal to side since: $BC = BE = 6$.

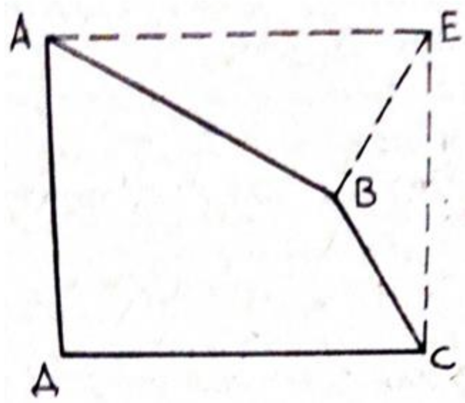


Figure 11.

4) ΔEBC at cosines to the theorem according to

$$EC^2 = 2BE^2 - 2BE^2 \cdot \cos 120° = 108, EC = 6\sqrt{3}, AD = EC = 6\sqrt{3}.$$

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