Часть 1

Олимпиада: **Математика, 10 класс (1 часть)**

Шифр: **211005744**

ID профиля: **876078**

Вариант 10

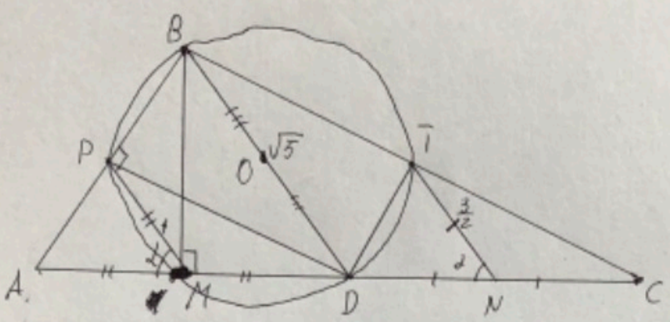
Чистовик

9) $S_{\triangle ABC} = BM \cdot AC \cdot \frac{1}{2} = 2 \cdot 5 \cdot 2 = 5$

Ответ: $\angle ABC = 90°$; $S_{\triangle ABC} = 5$

Чистовик

№1



Дано: O - центр окр

BD - диаметр

$PM \parallel TN$

$AM = MD$

$ND = NC$

$MP = 1$

$NT = \frac{3}{2}$

$BD = \sqrt{5}$

Найти: $\angle ABC$; $S_{\triangle ABC}$

Решение:

1) $PM \parallel TN \Rightarrow \angle PMA = \angle TND$

Пусть $\angle PMA = \alpha = \angle TND$

2) $\angle BTD = 90°$, так как BD - диаметр; $T \in$ окр. $\Rightarrow \angle DTC = 90° \Rightarrow \triangle DTC$ - прямоуг $\Rightarrow TN = \frac{1}{2} DC =$
$= DN = NC$

$\angle BPD = 90°$, т.к BD - диаметр; $P \in$ окр $\Rightarrow \angle APD = 90° \Rightarrow \triangle APD$ - прямоуг $\Rightarrow PM = \frac{1}{2} AD = AM = MD$.

3) $\angle MDP = \frac{1}{2}(180° - (180° - \alpha)) = \frac{1}{2}\alpha$

$\angle TDC = \frac{1}{2}(180 - \alpha) = 90 - \frac{\alpha}{2}$

$\angle MDP + \angle PDT + \angle TDC = 180°$

$\angle PDT + \frac{\alpha}{2} + 90 - \frac{\alpha}{2} = 180°$

$\angle PDT = 90°$

4) PBTD - вписанный в окр $\Rightarrow \angle PBT + \angle PDT = 180° \Rightarrow \angle PBT = \angle ABC = 90°$

5) BM - висота $\triangle ABC$ (т.к $\angle BMD = 90°$ (BD, диаметр; т. $M \in$ окр (т.к M-ср AD;

6) $BM = \sqrt{AM \cdot MC}$

7) $\left.\begin{array}{l} PM = AM = MD = 1 \\ TN = \frac{3}{2} = ND = NC \end{array}\right\} \Rightarrow AC = 5;\ AM = 1;\ MC = 4$

8) $BM = \sqrt{1 \cdot 4} = 2$

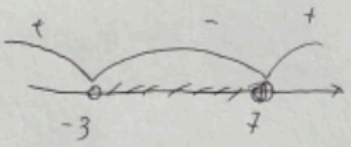
№2

$$\sqrt{x+3} - \sqrt{7-x} + 4 = 2\sqrt{21+4x-x^2}$$

1) ОДЗ: $\begin{cases} 21+4x-x^2 > 0 \\ \cancel{x^2}\ x+3 > 0 \\ 7-x > 0 \end{cases}$

$\begin{cases} x^2-4x-21 < 0 \\ x > -3 \\ x < 7 \end{cases}$

$\begin{cases} (x-7)(x+3) < 0 \\ x > -3 \\ x < 7 \end{cases}$



$x \in (-3; 7)$

2) $\sqrt{x+3} - \sqrt{7-x} = 2\left(\sqrt{21+4x-x^2} - 2\right) \quad \Big|^{\wedge 2}$

$x+3+7-x-2\sqrt{21+4x-x^2} = 4\left(\sqrt{21+4x-x^2} - 2\right)^2$

$10 - 2\sqrt{21+4x-x^2} = 4\left(\sqrt{21+4x-x^2} - 2\right)^2$

$\sqrt{21+4x-x^2} = t$

$5 - t = 2(t-2)^2$

$5 - t = 2t^2 - 8t + 8$

$2t^2 - 7t + 3 = 0$

$t = 3; \frac{1}{2}$

Чистовик

Ч.з 4

$\sqrt{21+4x-x^2}=3$

$21+4x-x^2=9$

$x^2-4x-12=0$

$x=6; -2$

$\sqrt{21+4x-x^2}=\frac{1}{2}$

$21+4x-x^2=\frac{1}{4}$

$x^2-4x-20\frac{3}{4}=0$

$x=\frac{4\pm\sqrt{16+20\cdot4+3}}{2}=\frac{4\pm3\sqrt{11}}{2}=2\pm1{,}5\sqrt{11}$

3) $2+1{,}5\sqrt{11} \vee 7$

~~2+1,5~~

$1{,}5\sqrt{11} \vee 5$

$3\sqrt{11} \vee 10$

$\sqrt{11} \vee \frac{10}{3}$

$$\begin{array}{r} 3{,}33 \\ \times\; 3{,}33 \\ \hline 999 \\ +\;999 \\ 999 \\ \hline 11{,}0889 \end{array}$$

$11{,}0889>11 \Rightarrow \sqrt{11}<3{,}(3)=\frac{10}{3} \Rightarrow 2+1{,}5\sqrt{11}<7 \Rightarrow$ подходит

$2-1{,}5\sqrt{11} \vee -3$

$-1{,}5\sqrt{11} \vee -5$

$-3\sqrt{11} \vee -10$

$\sqrt{11} \vee \frac{10}{3}$

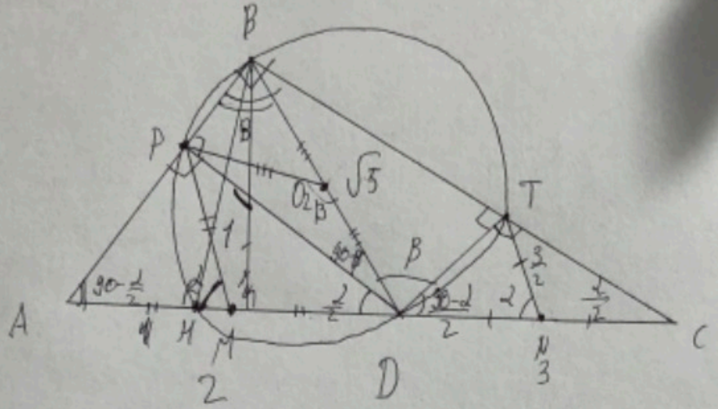
$\sqrt{11}<\frac{10}{3} \Rightarrow 2-1{,}5\sqrt{11}$ подходит

Ответ: $6; -2; 2+1{,}5\sqrt{11}; 2-1{,}5\sqrt{11}$

Черновик

№1

Дано: BD- диаметр
DN=NC ; PM//TN
AM=MD
O- центр окр
Найти: ∠ABC



1) ~~∠PMN=~~
∠PMA=∠TNA

$1\cdot 4$ $\quad \frac{2\cdot 5}{2}=5$

$\sqrt{5}\cdot\cos\beta\cdot\sqrt{5}\cdot\sin\beta=$

$2{,}5\sin 2\beta$

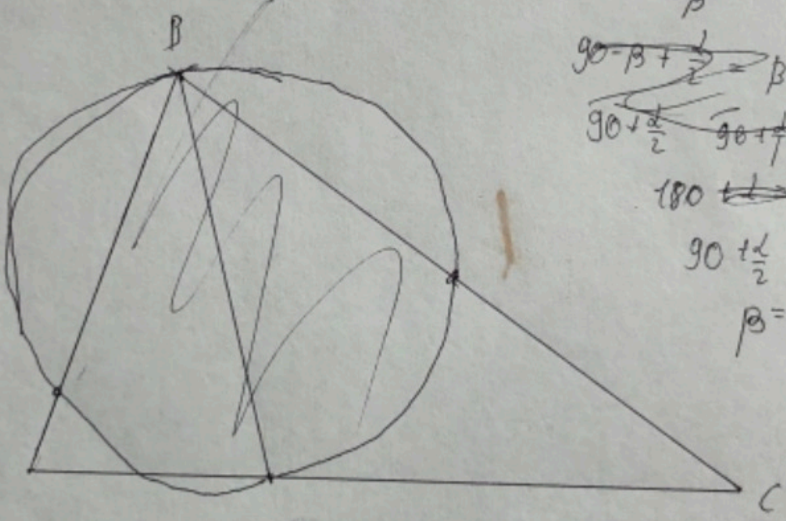
~~$90-\beta+\frac{\alpha}{2}=\beta$~~

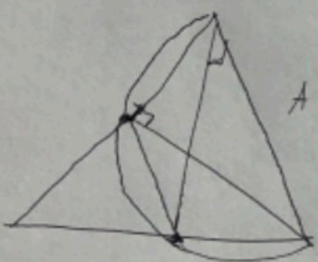
$90+\frac{\alpha}{2}$ ~~$90+\frac{\alpha}{2}$~~

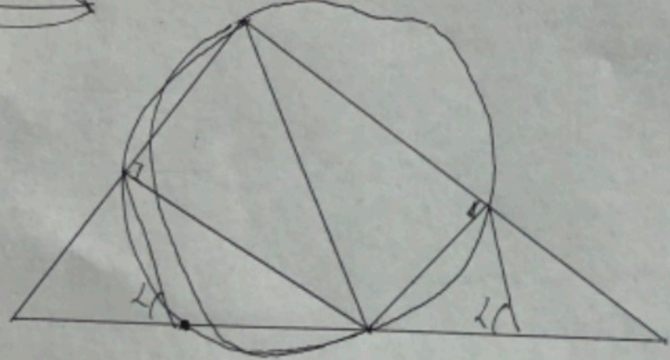
$180+\alpha=4\beta$

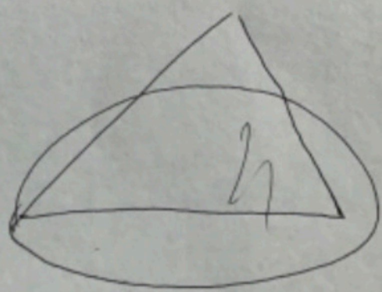
$90+\frac{\alpha}{2}=2\beta$

$\beta=\frac{90+\frac{\alpha}{2}}{2}$









Черновик

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№2

$\sqrt{x+3} - \sqrt{7-x} + 4 = 2\sqrt{21+4x-x^2}$

$\sqrt{x+3} - \sqrt{7-x} = 2\left(\sqrt{(2-x)^2+17} - 2\right)$

$x+3+7-x-2\sqrt{(x+3)(7-x)} = 4\left((2-x)^2+17+4-4\sqrt{(2-x)^2+17}\right)$

$\cancel{1}5 - \sqrt{(x+3)(7-x)} = 2\left((2-x)^2+21-4\sqrt{(2-x)^2+17}\right)$

$5 - \sqrt{21+4x-x^2} = 2\left((2-x)^2+21-4\sqrt{(2-x)^2+17}\right)$

$5-\sqrt{(2-x)^2+17} = 2\left((2-x)^2+17+4-4\sqrt{(2-x)^2+17}\right)$

$\sqrt{(2-x)^2+17} = t$

$5-t = 2(t^2-4t+4)$

$2t^2-8t+8+t-5=0$

$2t^2-7t+3=0$

$t = \frac{7 \pm \sqrt{49-24}}{4} = \frac{7\pm5}{4}$ = 3 ; = $\frac{1}{2}$

$\sqrt{(2-x)^2+17} = 3$

$(2-x)^2+17 = 9$

$\cancel{x^2=10}$

$x = \cancel{\pm}\sqrt{10}$

$4+x^2-4x+8=0$

$x^2-4x+12=0$

$x = \frac{4\pm\sqrt{16-11\cdot4}}{2}$; $D<0$ => нет корней

$\sqrt{(2-x)^2+17} = \frac{1}{2}$

$(2-x)^2+17 = \frac{1}{4}$

$4+x^2-4x+16\frac{3}{4}=0$

$x-4x+20\frac{3}{4}=0$

$\cancel{x = \frac{4\pm\sqrt{16}}{}}$

$D = 16-4(20\frac{3}{4})<0$

=> нет корней

Черновик

Зад 5

$$\sqrt{x+3} - \sqrt{7-x} + 4 = 2\sqrt{\cancel{4+4x-x^2+}\ 21+4x-x^2}$$

$21+4x-x^2 > 0$

$(x-7)(x+3) < 0$

$x \in (3;7)$

$$\sqrt{x+3} - \sqrt{7-x} = 2\sqrt{21+4x-x^2} - 4$$

$$x+3+7-x+2\sqrt{(x+3)(7-x)} = 4(21+4x-x^2+4-\cancel{2}4\sqrt{21+4x-x^2}$$

$$\cancel{10}\,5+\sqrt{-x^2+21+4x} = 2(\sqrt{21+4x-x^2} - 4\sqrt{21+4x-x^2}+4)$$

$1{,}3 \cdot 3{,}3$: 43, $4\,5$, $4{,}95$

$$\sqrt{21+4x-x^2} = t \geq 0$$

$2+1{,}5\cdot 3{,}3 =$

$= 6{,}95$

$2-1{,}5\cdot 3{,}3 = 2-4{,}95 =$

$= -2{,}95$

$$5+t = 2(t^2-4t+4)$$

$3{,}33 \cdot 3{,}33$: 999, 999, 999, $11{,}0889$

$$2t^2-8t+8-5+t=0$$

$$2t^2-7t+3=0$$

$3{,}5 \cdot 3{,}5$: 175, 105, $12{,}25$

$3{,}3 \cdot 3{,}3$: 99, 99, $10{,}89$

$$t = \frac{7\pm\sqrt{49-24}}{4} = \frac{7\pm5}{4} \begin{cases} 3 \\ \frac{1}{2} \end{cases}$$

$3{,}2 \cdot 3{,}2$: 64, 96, $10{,}24$

$$\sqrt{21+4x-x^2} = 3 \qquad\qquad \sqrt{21+4x-x^2} = \frac{1}{2}$$

$$21+4x-x^2 = 9$$

$2\sqrt{2}\cdot 2\cdot x = 12$

$$21+4x-x^2 = \frac{1}{4}$$

$$x^2-4x-12=0$$

$4\sqrt{2}\cdot x = 12$

$x = \frac{\sqrt{2}}{3}$

$$x^2-4x-20\tfrac{3}{4}=0$$

$$x = \frac{4\pm\sqrt{16+48}}{2} = \frac{4\pm8}{2} \begin{cases} 6 \text{ - подходит} \\ -2 \text{ - подходит} \end{cases}$$

$$x = \frac{4\pm\sqrt{16+4\cdot 20+3}}{2} = \frac{4\pm\sqrt{99}}{2} = \frac{4\pm3\sqrt{11}}{2} = \begin{cases} 2+1{,}5\sqrt{11} \\ 2-1{,}5\sqrt{11} \end{cases}$$

$$\cancel{x} = 2\pm1{,}5\sqrt{11}$$

$1{,}5\sqrt{11}$ $\quad 5$

$3\sqrt{11}$ $\quad 10$

$3\sqrt{11}$ $\quad \cancel{10}\ 3\cdot 3{,}(3)$

$\sqrt{11} \approx 3{,}3 \Rightarrow 2+1{,}5\sqrt{11} \approx 6{,}95$

$2-1{,}5\sqrt{11} \approx -2{,}95$

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Черновик

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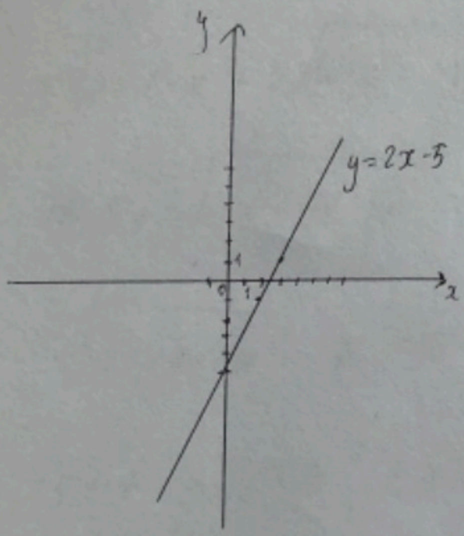
√3

$2x - y = 5 \qquad y = 2x - 5$



$5a^2 - 4ay + 8x^2 - 4xy + y^2 + 12ax = 0$

Т.А $8x^2 + 12ax - 4xy + y^2 - 4ay + 5a^2 = 0$

$ax^2 - 2a^2x - ay + a^3 + 3 = 0$

$y = x^2 - 2ax + a^2 + \frac{3}{a}$

$x_B = \frac{-6}{2a} = \frac{+2a}{2} = a$

$y_B = a^2 - 2a^2 + a^2 + \frac{3}{a} = \frac{3}{a} +$

Т.А: $(y^2 - 4ay + 4a^2) + (8x^2 + 12ax + \frac{2}{9}a^2) + \frac{7}{9}a^2 = 0$

$(y - 2a)^2 + (2\sqrt{2}x + \frac{\sqrt{2}}{3}a)^2 + \frac{7}{9}a^2 = 0$

$y = 2a$

$2\sqrt{2}x + \frac{\sqrt{2}}{3}a = 0$

$\frac{7}{9}a^2 = 0$

$y = 0$

$x = 0$

$a = 0$

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~~Чистовик~~ Черновик 5 из 5

№2

$$\sqrt{x+3} - \sqrt{7-x} + 4 = 2\sqrt{21+4x-x^2}$$

$$\sqrt{x+3} - \sqrt{7-x} = 2\left(\sqrt{21+4x-x^2} - 2\right) \quad |\ \wedge 2$$

$$x+3+7-x-2\sqrt{21+4x-x^2} = 4\left(\left(\sqrt{21+4x-x^2}\right)^2 + 4 - 4\sqrt{21+4x-x^2}\right)$$

$$\sqrt{21+4x-x^2} = t$$

$$10 - 2t = 4(t^2 - 4t + 4)$$

Часть 2

Олимпиада: **Математика, 10 класс (2 часть)**

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Вариант 10

Чистовик 1 из 5

№4

$$\begin{cases} \dfrac{6}{x^2+y^2} + x^2y^2 = 10 \\ x^4+y^4+7x^2y^2 = 81 \end{cases}$$

$$\boxed{\text{ОДЗ: } x^2+y^2 \neq 0}$$

$$\begin{cases} \dfrac{6}{x^2+y^2} + x^2y^2 = 10 \\ (x^2+y^2)^2 + 5x^2y^2 = 81 \end{cases}$$

$x^2+y^2 = b > 0$

$x^2y^2 = a \geq 0$

$$\begin{cases} \dfrac{6}{b} + a = 10 \quad | \cdot 5 \\ b^2 + 5a = 81 \end{cases} \qquad \begin{cases} \dfrac{30}{b} + 5a = 50 \\ b^2 + 5a = 81 \end{cases} \ominus$$

$b^2 - \dfrac{30}{b} - 31 = 0 \quad | \cdot b \neq 0$

$b^3 - 31b - 30 = 0$

$b = 6$ подходит

$$\begin{array}{r|l} b^3 + 0b^2 - 31b - 30 & b-6 \\ \cline{2-2} -\underline{b^3 - 6b^2} & b^2+6b+5 \\ 6b^2 - 31b & \\ -\underline{6b^2 - 36b} & \\ 5b - 30 & \\ -\underline{5b - 30} & \\ 0 & \end{array}$$

$(b-6)(b^2+6b+5) = 0$

$b = \dfrac{-6 \pm \sqrt{36-20}}{2} = \dfrac{-6 \pm 4}{2} \; \begin{matrix} -5 < 0 \\ -1 < 0 \end{matrix} \Big\} \Rightarrow$ не подходит

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Чистовик.

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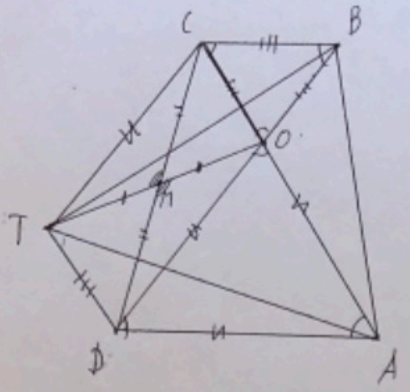
№6



Дано: $\triangle BOC$; $\triangle AOD$ – правильные

т. T симм. т. O отн. ср. CD

$BC = 2$

$AD = 7$

Док-ть: $\triangle ABT$ – правильный

Найти: $\dfrac{S_{\triangle ABT}}{S_{ABCD}}$

Решение:

1) $\left.\begin{array}{l} OM = MT \\ CM = MD \end{array}\right\}$ (т. T симм. т. O отн. ср. CD) $\Rightarrow$ TDOC – парал. $\Rightarrow TC = OD$; $CO = TD$

2) $\angle COD = 180^\circ - \angle COB = 120^\circ = \underset{\text{(CTDO-парал.)}}{\angle CTD} = \underset{\text{(вертик.)}}{\angle BOA}$

3) $\angle TDO = 180^\circ - \angle CTD = 60^\circ$

$\angle TDA = \angle ODA + \angle TDO = 120^\circ$

4) $\triangle$ ~~TDA~~ ~~TD~~ $\triangle TDA$; $\triangle TCB$; $\triangle BOA$:

$\left.\begin{array}{l} TD = CB = OB \\ DA = TC = AO \\ \angle TDA = \angle TCB = \angle BOA = 120^\circ \end{array}\right\} \Rightarrow \triangle TDA = \triangle TCB = \triangle BOA \Rightarrow AT = TB = BA \Rightarrow \triangle ABT$ – правильный $\boxtimes$

5) $\triangle TDA$:

По т. косинусов

$TA^2 = TD^2 + DA^2 - 2\,TD \cdot DA \cdot \cos\angle TDA = CB^2 + DA^2 - 2 \cdot CB \cdot DA \cdot \cos 120^\circ$

$TA = \sqrt{4 + 49 + 2 \cdot 7 \cdot 2 \cdot \frac{1}{2}} = \sqrt{67}$

6) $S_{\triangle ABT} = \frac{1}{2} ab \sin\alpha = \frac{1}{2} \cdot \sqrt{67} \cdot \sqrt{67} \cdot \sin 60^\circ = \frac{67\sqrt{3}}{4}$

7) $S_{ABCD} = \frac{1}{2} h (DA + CB) = \frac{1}{2}(2+7) \cdot h = \frac{9}{2} h$

$h = CO \cdot \sin 60 + DO \cdot \sin 60 = (CB + DA)\frac{\sqrt{3}}{2} = \frac{9\sqrt{3}}{2} \Rightarrow S_{ABCD} = \frac{81\sqrt{3}}{4}$

Чистовик 2 из 5

$b = 6 > 0$ - подходит

$b^2 + 5a = 81$

$a = \frac{81 - b^2}{5} = \frac{81-36}{5} = \frac{45}{5} = 9 > 0$ - подходит

$$\begin{cases} x^2y^2 = 9 \\ x^2 + y^2 = 6 \end{cases}$$

$x^2 = 6 - y^2$

$\cancel{(6-y^2)x}$

$(6-y^2)y^2 = 9$

$-y^4 + 6y^2 - 9 = 0$

$y^4 - 6y^2 + 9 = 0$

$(y^2 - 3)^2 = 0$

$y^2 = 3$

$y = \pm\sqrt{3}$

$x^2 = 6 - y^2 = 3$

$x = \pm\sqrt{3}$

Ответ: $(\sqrt{3}; \sqrt{3})$; $(-\sqrt{3}; \sqrt{3})$; $(\sqrt{3}; -\sqrt{3})$; $(-\sqrt{3}; -\sqrt{3})$

Чистовик

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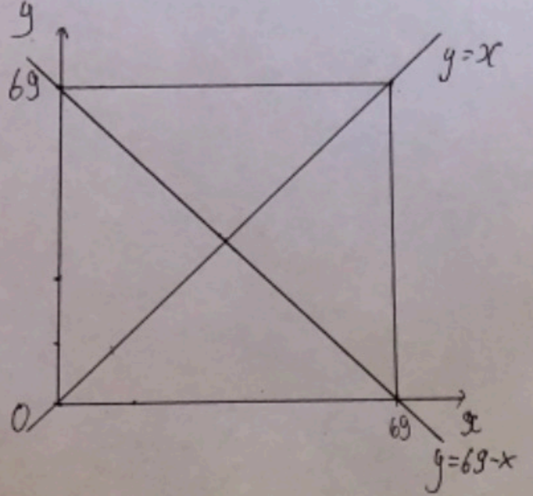
8) $\frac{S_{\triangle ABT}}{S_{ABCD}} = \frac{67\sqrt{3}}{4} \cdot \frac{4}{\sqrt{3} \cdot 81} = \frac{67}{81}$

Ответ: $\frac{67}{81}$

Чистовик



Решение:

Всего ~~для~~ доступных узлов на обеих прямых: $67+66=133$ узла

Всего доступных узлов в квадрате: $69^2-67\cdot4-4=69^2-68\cdot4=n$

Способов выбрать 2 узла: $133\cdot(n-1-\cancel{68\cdot68})$ 66·66

↓ чтобы выбрать другой узел

→ чтобы не попасть на горизонтальные и вертикальные линии

$$133\cdot(69^2-68\cdot4-66\cdot2-1)=133\cdot(7051-272-132-1)=133\cdot6646=\cancel{883918}\ 883918$$

Ответ: 883918

Черновик

№4

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$\cancel{x \neq y \neq 0}$ $x^2+y^2 \neq 0$

$$\begin{cases} \frac{6}{x^2+y^2} + x^2y^2 = 10 \\ x^4+y^4+7x^2y^2 = 81 \end{cases}$$

$y^4 + 7x^2y^2 + x^4 - 81$

$$y^2 = \frac{-7x^2 \pm \sqrt{49x^4 - 4x^4 + 81}}{2} = \frac{-7x^2 \pm 3\sqrt{5x^4+9}}{2}$$

$\cancel{x^2+y^2}$

$$\begin{cases} \frac{6}{x^2+y^2} + x^2y^2 = 10 \\ (x^2+y^2)^2 + 5x^2y^2 = 81 \end{cases}$$

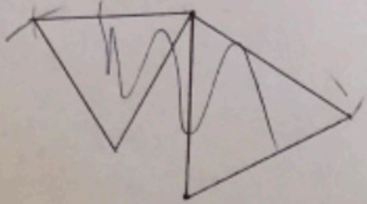
$$\begin{cases} 6 + x^2y^2(x^2+y^2) = 10x^2+10y^2 \\ (x^2+y^2)^2 + 5x^2y^2 = 81 \end{cases}$$

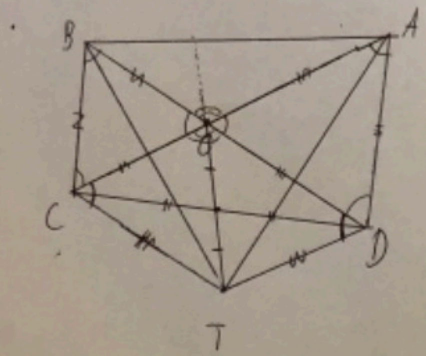
$$\begin{cases} x^2y^2(x^2+y^2) - 10(x^2+y^2) + 6 = 0 \\ (x^2+y^2)^2 + 5x^2y^2 - 81 = 0 \end{cases}$$

$$\begin{cases} (x^2y^2 - 10)(x^2+y^2) + 6 = 0 \\ (x^2+y^2)^2 + 5x^2y^2 - 81 = 0 \end{cases}$$

Черновик

№6



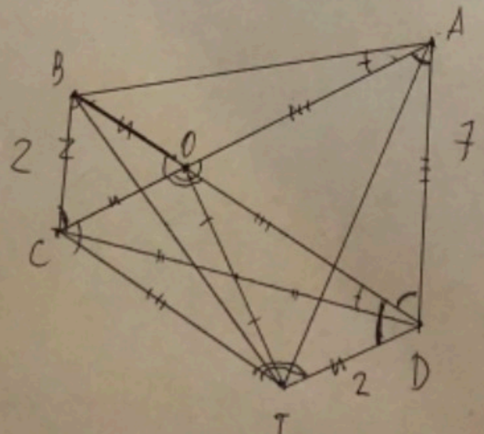


$S_{ABCD} =$

$= \frac{(2+7)}{2} \cdot (2+7) \cdot \frac{\sqrt{3}}{2} =$

$= \frac{81\sqrt{3}}{4}$

$AB = CD$



$\triangle CTD = \triangle TDA = \triangle BOA$

т.к $\angle BOA = \angle BCT = \angle TDA$

$AT = \sqrt{49+4-2 \cdot 7 \cdot 2 \cdot \cos 120^\circ} =$

$= \sqrt{53+2 \cdot 7 \cdot 2 \cdot \frac{1}{2}} = \sqrt{53+14} = \sqrt{67}$

$S_{ABT} =$

$\sqrt{67} \cdot \sqrt{67} \cdot \frac{1}{2} \cdot \frac{\sqrt{3}}{2} = 67\frac{\sqrt{3}}{4}$

Чернетка

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$$\begin{cases} \frac{6}{x^2+y^2} + x^2y^2 = 10 \\ x^4+y^4+7x^2y^2=81 \end{cases}$$ | ·7

$$\begin{cases} \cancel{\frac{42}{x^2+y^2}} + 7x^2y^2 = 70 \\ x^4+y^4+7x^2y^2=81 \end{cases}$$

$\cancel{x^4+y^4-}$

$$\begin{cases} \frac{30}{x^2+y^2} + 5x^2y^2 = 50 \\ (x^2+y^2)^2 + 5x^2y^2 = 81 \end{cases}$$

$\cancel{(x^2+y^2)^2 - \frac{30}{x^2+y^2} = 31}$

$(x^2+y^2)^3 - 31(x^2+y^2) - 30 = 0$

$\cancel{6 + x^2y^2 = 10}$

$$\begin{cases} 6 + x^2y^2(x^2+y^2) - 10x^2y^2 = 0 \\ (x^2+y^2)^2 + 5x^2y^2 = 81 \end{cases}$$

$$\begin{cases} \cancel{\frac{6}{x^2+y^2} + x^2y^2 = 10} \\ x^2+y^2+5\frac{x^2y^2}{x^2+y^2} - \frac{81}{x^2+y^2} = 0 \end{cases}$$

$x^2y^2 = a > 0$

$x^2+y^2 = b > 0$

$b^3+0b^2-31b-30 \mid b-6$

$b^3-6b^2 \quad\quad b^2+6b+5$

$6b^2-31b$

$6b^2-36b$

$5b-30$

$5b-30$

0

$b \neq 0$

$\cancel{125-155-30=0}$

$216-186-30=0$

$b^3-31b-30 \mid b-6$

$b^3-6b^2 \quad\quad b^2-$

$6b^2-31b$

$$\begin{cases} \frac{6}{b} + a = 10 \\ b^2+5a=81 \end{cases}$$

$$\begin{cases} \frac{30}{b} + 5a = 50 \\ b^2+5a=81 \end{cases}$$

$b^2 - \frac{30}{b} - 31 = 0$

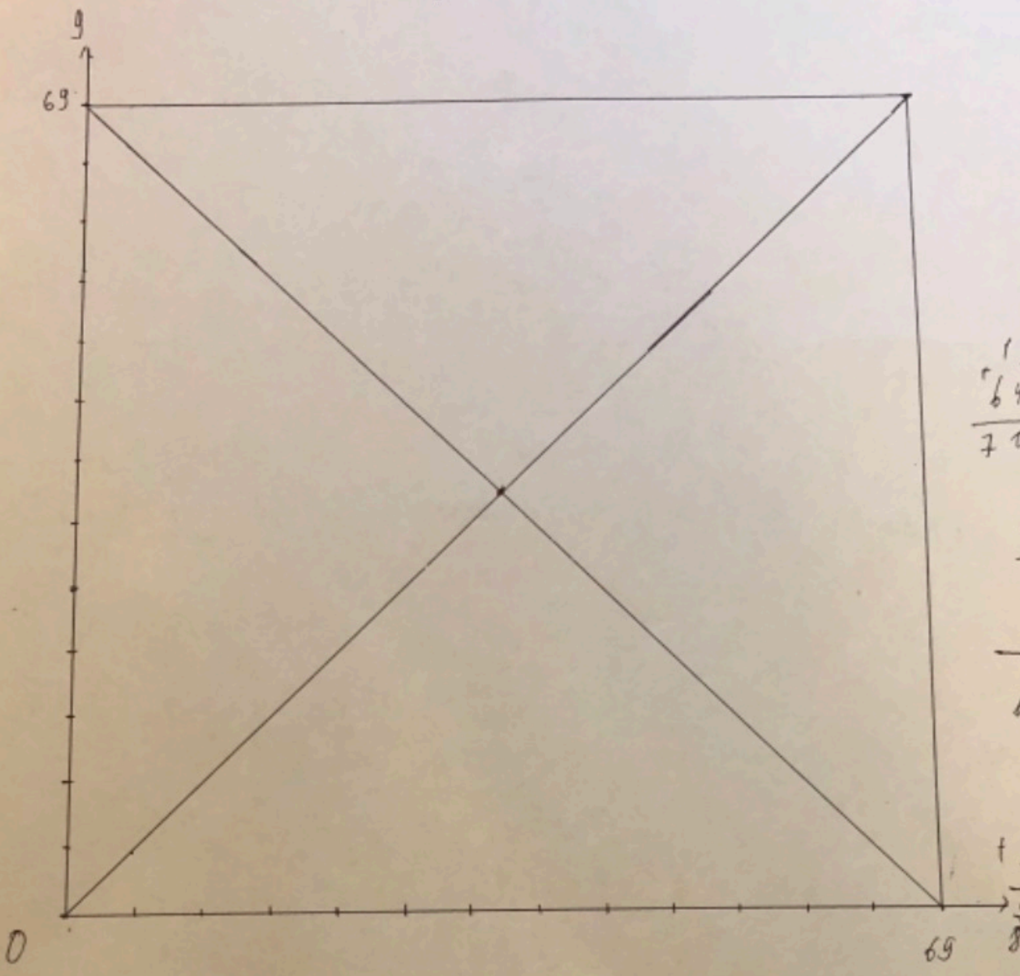
$b^3 - 31b - 30 = 0$

$(b^2+6b+5)(b-6)=0$

$b = \frac{-6\pm\sqrt{36-20}}{2} = \frac{-6\pm\sqrt{16}}{2} = \frac{-6\pm 2}{2}$ ↙ -4, -2

$b = -4; -2; 6$

Черновик



$69 \cdot 69 = 4761$

$68 \cdot 4 = 272$

$7050 - 404 = 6646$

$6646 \cdot 133 = 883918$

~~69·68~~

~~69·69 − 69·4 − …~~

$n = 69\cdot 69 - 67\cdot 4 - 4 = 69^2 - 68\cdot 4$ – кол-во узлов в сетке

$133 \cdot 130$

$k = 2$

$A_n^k = A_n^2 = \dfrac{n!}{(n-2)!}$ – способов выбрать 2 узла

На 2-х прямых $67 + 66 = 133$ узла $= n$

$133 \cdot (133 - 1 - 2) = 133 \cdot 130 =$

$A_{133}^2 = \dfrac{133}{131} = 133 \cdot 132$ – выбрать 2 узла

$= 133 \cdot (69^2 - 68 \cdot 4 - \cancel{2})$