



МОСКОВСКИЙ  
ФИЗИКО-ТЕХНИЧЕСКИЙ  
ИНСТИТУТ

ОЛИМПИАДА "ФИЗТЕХ"  
ПО МАТЕМАТИКЕ



## 10 КЛАСС. Вариант 7

- [3 балла] Четвёртый член арифметической прогрессии равен  $6 - 9x$ , шестой член равен  $(x^2 - 2x)^2$ , а десятый равен  $9x^2$ . Найдите  $x$ .
- [4 балла] Найдите наибольшее значение выражения  $3y + 6x$  при условии
$$\begin{cases} |x - 2y| \leq 2 \\ |2x - y| \leq 1. \end{cases}$$
- [5 баллов] Найдите все пары  $(m, n)$  натуральных чисел, для которых одно из чисел  $A = m^2 + 4mn + 4n^2 - 7m - 14n$  и  $B = m^2n + 2mn^2 + 9mn$  равно  $11p^2$ , а другое равно  $75q^2$ , где  $p$  и  $q$  – простые числа.
- [5 баллов] Прямая, параллельная биссектрисе  $AX$  треугольника  $ABC$ , проходящая через середину  $M$  его стороны  $BC$ , пересекает сторону  $AB$  и продолжение стороны  $AC$  в точках  $Z$  и  $Y$  соответственно. Найдите  $BC$ , если  $AC = 6$ ,  $AZ = 3$ ,  $YZ = 4$ .
- [4 балла] Решите систему уравнений
$$\begin{cases} \sqrt{x+2} - \sqrt{7-y} + 7 = 2\sqrt{14+5x-y^2}, \\ x^3 + 3x - \sqrt{2y} = y^3 - \sqrt{2x} + 3y. \end{cases}$$
- [4 балла] На тетрадном листе нарисован квадрат  $10 \times 10$  клеток (стороны квадрата идут вдоль границ клеток), а все узлы сетки внутри квадрата или на его границе покрашены в чёрный цвет. Найдите количество способов перекрасить два узла в белый цвет, если раскраски, получающиеся друг из друга поворотом, считаются одинаковыми.
- [6 баллов] В треугольнике  $ABC$  на медиане  $AM$  и биссектрисе  $CL$  как на диаметрах построены окружности  $\Omega$  и  $\omega$  соответственно, пересекающиеся в точках  $P$  и  $Q$ . Отрезок  $PQ$  параллелен высоте треугольника  $ABC$ , проведённой из вершины  $B$ . Окружность  $\Omega$  пересекает сторону  $AC$  повторно в точке  $N$ . Найдите длины сторон  $AC$  и  $BC$ , если  $AB = 4$ ,  $AN = 5$ .



На одной странице можно оформлять только одну задачу. Отметьте крестиком номер задачи, решение которой представлено на странице. Также укажите номер страницы и суммарное количество страниц в решении каждой задачи отдельно.

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СТРАНИЦА  
1 ИЗ 1

Если отмечено более одной задачи или не отмечено ни одной задачи, страница считается черновиком и не проверяется. Страницы по каждой из задач нумеруются отдельно. Порча QR-кода недопустима!

Задача №1

$$\left\{ \begin{array}{l} a_1 + 3d = 6 - 9x \\ (x^2 - 2x)^2 = a_1 + 5d \end{array} \right.$$

$a_1$  - первый член,  $d$  - разность прогрессии

$$9x^2 = a_1 + 9d$$

$\Leftrightarrow$

$$x^2(x-5)(x+1) + 2(3x^2 + 3x - 2) = 0$$

$$\left\{ \begin{array}{l} x^2(x-5)(x+1) = -4d \\ 9x^2 + 9x - 6 = 6d \end{array} \right.$$

$$x^4 - 4x^3 + x^2 + 6x - 4 = 0$$

$$(x-1)(x^3 - 3x^2 - 2x + 4)$$

решение:

$$(x-1)^2(x^2 - 2x - 4) = 0$$

$$(x-1)^2((x-1)^2 - 5) = 0$$

$$x = 1 \text{ или } (x-1)^2 = 5$$

$$\left[ \begin{array}{l} x = 1 + \sqrt{5} \\ x = 1 - \sqrt{5} \end{array} \right]$$

Ответ: 1;  $1 - \sqrt{5}$ ;  $1 + \sqrt{5}$ .



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Задача №2.

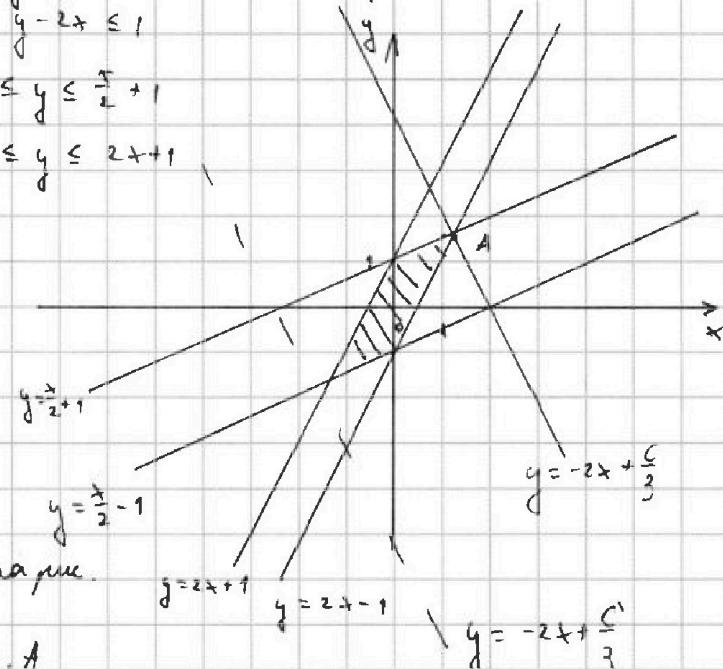
$$\begin{cases} |x - 2y| \leq 2 \\ |2x - y| \leq 1 \end{cases}$$

max  $(3y + 6x) - ?$

1)  $\begin{cases} -2 \leq 2y - x \leq 2 \\ -1 \leq y - 2x \leq 1 \end{cases}$

$$\begin{cases} \frac{x}{2} - 1 \leq y \leq \frac{x}{2} + 1 \\ 2x - 1 \leq y \leq 2x + 1 \end{cases}$$

2) График:



3) нужно max  $3y + 6x = C$

тогда  $y = -2x + \frac{C}{3}$

(свободный член  $\rightarrow$  max  
если при  $x = 0$   $y \rightarrow$  max)

тогда  $\frac{C}{3} \rightarrow$  max, в случае параллельности

$y = -2x + \frac{C}{3}$  проходит через т. A

находим её:  $\frac{x}{2} + 1 = 2x - 1$

$$\begin{aligned} \frac{3}{2}x &= 2 \\ x_A &= \frac{4}{3} \end{aligned}$$

$$y_A = \frac{2}{3} + 1 = \frac{5}{3}$$

Значит:  $\frac{5}{3} = -2 \cdot \frac{4}{3} + \frac{C}{3}$

$C = 5 + 8 = 13$  - искомый максимум

Ответ: 13.



1    2    3    4    5    6    7

СТРАНИЦА  
1 ИЗ 1

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мин  
 $m, n \in \mathbb{N}$

$$A = m^2 + 4mn + 4n^2 - 7m - 4n \quad 1) \quad A = (m+2n)^2 - 7(m+2n) = (m+2n)(m+2n-7)$$

$$B = m^2 + 2mn + 3n^2$$

$$11p^2, 75q^2$$

$p, q$ -простые

$(m, n) - ?$

Задача №3.

$$B = mn(m+2n+9)$$

2) В случае, если  $B = 11p^2$ , Т.К.  $p$ -простое, то:

и 11-простое

$$\begin{cases} m=11 \\ n=p=m+2n+9 \end{cases} \text{ либо} \begin{cases} n=11 \\ m=p=m+2n+9 \end{cases} \text{ либо} \begin{cases} m=11 \\ n=p \end{cases}$$

$$11+m+9=0$$

$$2n+9=0$$

$$3n=2$$

$$11=-20$$

$$\text{нет}$$

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

неподходит

$$\text{нет}$$

$$\text{либо} \begin{cases} m=1 \\ n=ap \end{cases}$$

$$\text{либо} \begin{cases} n=1 \\ m=p \end{cases}$$

$$\text{либо} \begin{cases} m=1 \\ n=p \end{cases}$$

$$\text{либо} \begin{cases} m=11 \\ n=1 \end{cases}$$

$$\text{нет}$$

$$\text{нет}$$

$$\text{нет}$$

$$\text{нет}$$

$$\text{либо} \begin{cases} m=1 \\ n=11 \end{cases}$$

$$m+2n+9=p^2$$

нет

оставшиеся варианты не запишем Т.К.

учтено, что  $m+2n+9 > m$

$$m+2n+9 > n$$

3) Тогда в случае, если  $A = 11p^2$ ,  $B = 75q^2$ :

$$\begin{cases} m+2n=1 \\ m+2n+7=11p^2 \end{cases} \text{ либо} \begin{cases} m+2n=11 \\ m+2n+7=p^2 \end{cases} \text{ либо} \begin{cases} m+2n=11p \\ m+2n+7=p \end{cases} \text{ либо} \begin{cases} m+2n=11p^2 \\ m+2n+7=1 \end{cases}$$

$$\text{нет}$$

$$p^2=4$$

$$p=2$$

$$\text{нет}$$

$$\text{нет}$$

$$\Rightarrow \boxed{m+2n=11}$$

$$\text{либо} \begin{cases} m+2n=p \\ m+2n+7=11p \end{cases}$$

$$\text{нет}$$

$$\text{либо} \begin{cases} m+2n=p^2 \\ m+2n+7=11 \end{cases}$$

$$\text{нет}$$

$$4) \quad m+2n=11, \text{ Такие } mn(m+2n+9)=75q^2$$

$$\Rightarrow mn \cdot 20 = 75q^2$$

$$4mn = 75q^2$$

$$\Rightarrow 7 \cdot 2 \cdot q^2 \cdot 4, \text{ Т.К. } 25 \nmid 4$$

такое возможна только

$$\text{если } q=2$$

Т.К. квадрат нечёт = неёт,  
а единиц. чет присое - 2.

$$5) \quad m+2n=11 \quad \text{T.K. } m+2n < 15$$

$$4mn=15$$

To be:  $m=3$

$$n=5$$

$$\text{или } n=3$$

не подходит

ответ: (5, 3).

На одной странице можно оформлять только одну задачу. Отметьте крестиком номер задачи, решение которой представлено на странице. Та же укажите номер страницы и суммарное количество страниц в решении каждой задачи отдельно.



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Задача №4.

$BC = ?$

<img alt="Diagram of triangle ABC with point M on base BC. Line segment AM is drawn. Line segment BM is labeled 1, and line segment MC is labeled 6. Angle AYB is labeled d. Angle AYM is labeled 3. Angle BAY is labeled 2. Angle YAM is labeled 1. Angle BMA is labeled 4. Angle MAC is labeled 5. Angle YAC is labeled 6. Angle YAM is labeled 7. Angle YAC is labeled 8. Angle YAM is labeled 9. Angle YAC is labeled 10. Angle YAM is labeled 11. Angle YAC is labeled 12. Angle YAM is labeled 13. Angle YAC is labeled 14. Angle YAM is labeled 15. Angle YAC is labeled 16. Angle YAM is labeled 17. Angle YAC is labeled 18. Angle YAM is labeled 19. Angle YAC is labeled 20. Angle YAM is labeled 21. Angle YAC is labeled 22. Angle YAM is labeled 23. Angle YAC is labeled 24. Angle YAM is labeled 25. Angle YAC is labeled 26. Angle YAM is labeled 27. Angle YAC is labeled 28. Angle YAM is labeled 29. Angle YAC is labeled 30. Angle YAM is labeled 31. Angle YAC is labeled 32. Angle YAM is labeled 33. Angle YAC is labeled 34. Angle YAM is labeled 35. Angle YAC is labeled 36. Angle YAM is labeled 37. Angle YAC is labeled 38. Angle YAM is labeled 39. Angle YAC is labeled 40. Angle YAM is labeled 41. Angle YAC is labeled 42. Angle YAM is labeled 43. Angle YAC is labeled 44. Angle YAM is labeled 45. Angle YAC is labeled 46. Angle YAM is labeled 47. Angle YAC is labeled 48. Angle YAM is labeled 49. Angle YAC is labeled 50. Angle YAM is labeled 51. Angle YAC is labeled 52. Angle YAM is labeled 53. Angle YAC is labeled 54. Angle YAM is labeled 55. Angle YAC is labeled 56. Angle YAM is labeled 57. Angle YAC is labeled 58. Angle YAM is labeled 59. Angle YAC is labeled 60. Angle YAM is labeled 61. Angle YAC is labeled 62. Angle YAM is labeled 63. Angle YAC is labeled 64. Angle YAM is labeled 65. Angle YAC is labeled 66. Angle YAM is labeled 67. Angle YAC is labeled 68. Angle YAM is labeled 69. Angle YAC is labeled 70. Angle YAM is labeled 71. Angle YAC is labeled 72. Angle YAM is labeled 73. Angle YAC is labeled 74. Angle YAM is labeled 75. Angle YAC is labeled 76. Angle YAM is labeled 77. Angle YAC is labeled 78. Angle YAM is labeled 79. Angle YAC is labeled 80. Angle YAM is labeled 81. Angle YAC is labeled 82. Angle YAM is labeled 83. Angle YAC is labeled 84. Angle YAM is labeled 85. Angle YAC is labeled 86. Angle YAM is labeled 87. Angle YAC is labeled 88. Angle YAM is labeled 89. Angle YAC is labeled 90. Angle YAM is labeled 91. Angle YAC is labeled 92. Angle YAM is labeled 93. Angle YAC is labeled 94. Angle YAM is labeled 95. Angle YAC is labeled 96. Angle YAM is labeled 97. Angle YAC is labeled 98. Angle YAM is labeled 99. Angle YAC is labeled 100. Angle YAM is labeled 101. Angle YAC is labeled 102. Angle YAM is labeled 103. Angle YAC is labeled 104. Angle YAM is labeled 105. Angle YAC is labeled 106. Angle YAM is labeled 107. Angle YAC is labeled 108. Angle YAM is labeled 109. Angle YAC is labeled 110. Angle YAM is labeled 111. Angle YAC is labeled 112. Angle YAM is labeled 113. Angle YAC is labeled 114. Angle YAM is labeled 115. Angle YAC is labeled 116. Angle YAM is labeled 117. Angle YAC is labeled 118. Angle YAM is labeled 119. Angle YAC is labeled 120. Angle YAM is labeled 121. Angle YAC is labeled 122. Angle YAM is labeled 123. Angle YAC is labeled 124. Angle YAM is labeled 125. Angle YAC is labeled 126. Angle YAM is labeled 127. Angle YAC is labeled 128. Angle YAM is labeled 129. Angle YAC is labeled 130. Angle YAM is labeled 131. Angle YAC is labeled 132. Angle YAM is labeled 133. Angle YAC is labeled 134. Angle YAM is labeled 135. Angle YAC is labeled 136. Angle YAM is labeled 137. Angle YAC is labeled 138. Angle YAM is labeled 139. Angle YAC is labeled 140. Angle YAM is labeled 141. Angle YAC is labeled 142. Angle YAM is labeled 143. Angle YAC is labeled 144. Angle YAM is labeled 145. Angle YAC is labeled 146. Angle YAM is labeled 147. Angle YAC is labeled 148. Angle YAM is labeled 149. Angle YAC is labeled 150. Angle YAM is labeled 151. Angle YAC is labeled 152. Angle YAM is labeled 153. Angle YAC is labeled 154. Angle YAM is labeled 155. Angle YAC is labeled 156. Angle YAM is labeled 157. Angle YAC is labeled 158. Angle YAM is labeled 159. Angle YAC is labeled 160. Angle YAM is labeled 161. Angle YAC is labeled 162. Angle YAM is labeled 163. Angle YAC is labeled 164. Angle YAM is labeled 165. Angle YAC is labeled 166. Angle YAM is labeled 167. Angle YAC is labeled 168. Angle YAM is labeled 169. Angle YAC is labeled 170. Angle YAM is labeled 171. Angle YAC is labeled 172. Angle YAM is labeled 173. Angle YAC is labeled 174. Angle YAM is labeled 175. Angle YAC is labeled 176. Angle YAM is labeled 177. Angle YAC is labeled 178. Angle YAM is labeled 179. Angle YAC is labeled 180. Angle YAM is labeled 181. Angle YAC is labeled 182. Angle YAM is labeled 183. Angle YAC is labeled 184. Angle YAM is labeled 185. Angle YAC is labeled 186. Angle YAM is labeled 187. Angle YAC is labeled 188. Angle YAM is labeled 189. Angle YAC is labeled 190. Angle YAM is labeled 191. Angle YAC is labeled 192. Angle YAM is labeled 193. Angle YAC is labeled 194. Angle YAM is labeled 195. Angle YAC is labeled 196. Angle YAM is labeled 197. Angle YAC is labeled 198. Angle YAM is labeled 199. Angle YAC is labeled 200. Angle YAM is labeled 201. Angle YAC is labeled 202. Angle YAM is labeled 203. Angle YAC is labeled 204. Angle YAM is labeled 205. Angle YAC is labeled 206. Angle YAM is labeled 207. Angle YAC is labeled 208. Angle YAM is labeled 209. Angle YAC is labeled 210. Angle YAM is labeled 211. Angle YAC is labeled 212. Angle YAM is labeled 213. Angle YAC is labeled 214. Angle YAM is labeled 215. Angle YAC is labeled 216. Angle YAM is labeled 217. Angle YAC is labeled 218. Angle YAM is labeled 219. Angle YAC is labeled 220. Angle YAM is labeled 221. Angle YAC is labeled 222. Angle YAM is labeled 223. Angle YAC is labeled 224. Angle YAM is labeled 225. Angle YAC is labeled 226. Angle YAM is labeled 227. Angle YAC is labeled 228. Angle YAM is labeled 229. Angle YAC is labeled 230. Angle YAM is labeled 231. Angle YAC is labeled 232. Angle YAM is labeled 233. Angle YAC is labeled 234. Angle YAM is labeled 235. Angle YAC is labeled 236. Angle YAM is labeled 237. Angle YAC is labeled 238. Angle YAM is labeled 239. Angle YAC is labeled 240. Angle YAM is labeled 241. Angle YAC is labeled 242. Angle YAM is labeled 243. Angle YAC is labeled 244. Angle YAM is labeled 245. Angle YAC is labeled 246. Angle YAM is labeled 247. Angle YAC is labeled 248. Angle YAM is labeled 249. Angle YAC is labeled 250. Angle YAM is labeled 251. Angle YAC is labeled 252. Angle YAM is labeled 253. Angle YAC is labeled 254. Angle YAM is labeled 255. Angle YAC is labeled 256. Angle YAM is labeled 257. Angle YAC is labeled 258. Angle YAM is labeled 259. Angle YAC is labeled 260. Angle YAM is labeled 261. Angle YAC is labeled 262. Angle YAM is labeled 263. Angle YAC is labeled 264. Angle YAM is labeled 265. Angle YAC is labeled 266. Angle YAM is labeled 267. Angle YAC is labeled 268. Angle YAM is labeled 269. Angle YAC is labeled 270. Angle YAM is labeled 271. Angle YAC is labeled 272. Angle YAM is labeled 273. Angle YAC is labeled 274. Angle YAM is labeled 275. Angle YAC is labeled 276. Angle YAM is labeled 277. Angle YAC is labeled 278. Angle YAM is labeled 279. Angle YAC is labeled 280. Angle YAM is labeled 281. Angle YAC is labeled 282. Angle YAM is labeled 283. Angle YAC is labeled 284. Angle YAM is labeled 285. Angle YAC is labeled 286. Angle YAM is labeled 287. Angle YAC is labeled 288. Angle YAM is labeled 289. Angle YAC is labeled 290. Angle YAM is labeled 291. Angle YAC is labeled 292. Angle YAM is labeled 293. Angle YAC is labeled 294. Angle YAM is labeled 295. Angle YAC is labeled 296. Angle YAM is labeled 297. Angle YAC is labeled 298. Angle YAM is labeled 299. Angle YAC is labeled 300. Angle YAM is labeled 301. Angle YAC is labeled 302. 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Angle YAM is labeled 379. Angle YAC is labeled 380. Angle YAM is labeled 381. Angle YAC is labeled 382. Angle YAM is labeled 383. Angle YAC is labeled 384. Angle YAM is labeled 385. Angle YAC is labeled 386. Angle YAM is labeled 387. Angle YAC is labeled 388. Angle YAM is labeled 389. Angle YAC is labeled 390. Angle YAM is labeled 391. Angle YAC is labeled 392. Angle YAM is labeled 393. Angle YAC is labeled 394. Angle YAM is labeled 395. Angle YAC is labeled 396. Angle YAM is labeled 397. Angle YAC is labeled 398. Angle YAM is labeled 399. Angle YAC is labeled 400. Angle YAM is labeled 401. Angle YAC is labeled 402. Angle YAM is labeled 403. Angle YAC is labeled 404. Angle YAM is labeled 405. Angle YAC is labeled 406. Angle YAM is labeled 407. Angle YAC is labeled 408. Angle YAM is labeled 409. Angle YAC is labeled 410. Angle YAM is labeled 411. Angle YAC is labeled 412. Angle YAM is labeled 413. Angle YAC is labeled 414. Angle YAM is labeled 415. Angle YAC is labeled 416. 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Angle YAM is labeled 455. Angle YAC is labeled 456. Angle YAM is labeled 457. Angle YAC is labeled 458. Angle YAM is labeled 459. Angle YAC is labeled 460. Angle YAM is labeled 461. Angle YAC is labeled 462. Angle YAM is labeled 463. Angle YAC is labeled 464. Angle YAM is labeled 465. Angle YAC is labeled 466. Angle YAM is labeled 467. Angle YAC is labeled 468. Angle YAM is labeled 469. Angle YAC is labeled 470. Angle YAM is labeled 471. Angle YAC is labeled 472. Angle YAM is labeled 473. Angle YAC is labeled 474. Angle YAM is labeled 475. Angle YAC is labeled 476. Angle YAM is labeled 477. Angle YAC is labeled 478. Angle YAM is labeled 479. Angle YAC is labeled 480. Angle YAM is labeled 481. Angle YAC is labeled 482. Angle YAM is labeled 483. Angle YAC is labeled 484. Angle YAM is labeled 485. Angle YAC is labeled 486. Angle YAM is labeled 487. Angle YAC is labeled 488. Angle YAM is labeled 489. Angle YAC is labeled 490. Angle YAM is labeled 491. Angle YAC is labeled 492. Angle YAM is labeled 493. Angle YAC is labeled 494. Angle YAM is labeled 495. Angle YAC is labeled 496. Angle YAM is labeled 497. Angle YAC is labeled 498. Angle YAM is labeled 499. Angle YAC is labeled 500. Angle YAM is labeled 501. Angle YAC is labeled 502. Angle YAM is labeled 503. Angle YAC is labeled 504. Angle YAM is labeled 505. Angle YAC is labeled 506. Angle YAM is labeled 507. Angle YAC is labeled 508. Angle YAM is labeled 509. Angle YAC is labeled 510. Angle YAM is labeled 511. Angle YAC is labeled 512. Angle YAM is labeled 513. Angle YAC is labeled 514. Angle YAM is labeled 515. Angle YAC is labeled 516. Angle YAM is labeled 517. Angle YAC is labeled 518. Angle YAM is labeled 519. Angle YAC is labeled 520. Angle YAM is labeled 521. Angle YAC is labeled 522. Angle YAM is labeled 523. Angle YAC is labeled 524. Angle YAM is labeled 525. Angle YAC is labeled 526. Angle YAM is labeled 527. Angle YAC is labeled 528. Angle YAM is labeled 529. Angle YAC is labeled 530. Angle YAM is labeled 531. Angle YAC is labeled 532. Angle YAM is labeled 533. Angle YAC is labeled 534. Angle YAM is labeled 535. Angle YAC is labeled 536. Angle YAM is labeled 537. Angle YAC is labeled 538. Angle YAM is labeled 539. Angle YAC is labeled 540. Angle YAM is labeled 541. Angle YAC is labeled 542. Angle YAM is labeled 543. Angle YAC is labeled 544. Angle YAM is labeled 545. Angle YAC is labeled 546. Angle YAM is labeled 547. Angle YAC is labeled 548. Angle YAM is labeled 549. Angle YAC is labeled 550. Angle YAM is labeled 551. Angle YAC is labeled 552. Angle YAM is labeled 553. Angle YAC is labeled 554. Angle YAM is labeled 555. Angle YAC is labeled 556. Angle YAM is labeled 557. Angle YAC is labeled 558. Angle YAM is labeled 559. Angle YAC is labeled 560. Angle YAM is labeled 561. Angle YAC is labeled 562. Angle YAM is labeled 563. Angle YAC is labeled 564. Angle YAM is labeled 565. Angle YAC is labeled 566. Angle YAM is labeled 567. Angle YAC is labeled 568. Angle YAM is labeled 569. Angle YAC is labeled 570. Angle YAM is labeled 571. Angle YAC is labeled 572. Angle YAM is labeled 573. Angle YAC is labeled 574. Angle YAM is labeled 575. Angle YAC is labeled 576. Angle YAM is labeled 577. Angle YAC is labeled 578. Angle YAM is labeled 579. Angle YAC is labeled 580. Angle YAM is labeled 581. Angle YAC is labeled 582. Angle YAM is labeled 583. Angle YAC is labeled 584. Angle YAM is labeled 585. Angle YAC is labeled 586. Angle YAM is labeled 587. Angle YAC is labeled 588. Angle YAM is labeled 589. Angle YAC is labeled 590. Angle YAM is labeled 591. Angle YAC is labeled 592. Angle YAM is labeled 593. Angle YAC is labeled 594. Angle YAM is labeled 595. Angle YAC is labeled 596. Angle YAM is labeled 597. Angle YAC is labeled 598. Angle YAM is labeled 599. Angle YAC is labeled 600. Angle YAM is labeled 601. Angle YAC is labeled 602. Angle YAM is labeled 603. Angle YAC is labeled 604. Angle YAM is labeled 605. Angle YAC is labeled 606. 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1)  $\frac{BZ}{AZ} \cdot \frac{AY}{CY} = 1$

2)  $\frac{BZ}{AZ} \cdot \frac{3}{9} = 1$

$BZ = 9$

3)  $\sin \frac{\pi - 2d}{2} = \frac{2}{3}$

$\cos d = \frac{2}{3}$

$\cos 2d = 2 \cos^2 d - 1 = 2 \cdot \frac{4}{9} - 1 = -\frac{1}{9}$

$BC^2 = AB^2 + AC^2 - 2AB \cdot AC \cdot \cos 2d$

$BC^2 = 12^2 + 6^2 + 2 \cdot 12 \cdot 6 \cdot -\frac{1}{9} = 144 + 36 + 16 = 196$

$BC = 14$

Ответ:  $BC = 14$ .



На одной странице можно оформлять только одну задачу. Отметьте крестиком номер задачи, решение которой представлено на странице. Также укажите номер страницы и суммарное количество страниц в решении каждой задачи отдельно.

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| <input type="checkbox"/> 1 | <input type="checkbox"/> 2 | <input type="checkbox"/> 3 | <input type="checkbox"/> 4 | <input checked="" type="checkbox"/> 5 | <input type="checkbox"/> 6 | <input type="checkbox"/> 7 |
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СТРАНИЦА  
1 ИЗ 1

Если отмечено более одной задачи или не отмечено ни одной задачи, страница считается черновиком и не проверяется. Страницы по каждой из задач нумеруются отдельно. Порча QR-кода недопустима!

Задача №5.

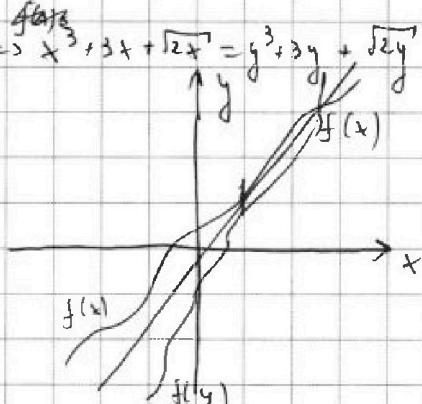
$$\begin{cases} \sqrt{x+2} - \sqrt{7-y} + 7 = 2\sqrt{4+5x-y^2} \quad (1) \\ x^3 + 3x - \sqrt{2y} = y^3 - \sqrt{2x} + 3y \quad (2) \end{cases}$$

1) Заметим, что:

$$(2) \Leftrightarrow x^3 + 3x - \sqrt{2x} = y^3 - \sqrt{2y} + 3y \quad (2)$$

2)  $f(x)$  и  $f(y)$  - возрастающие

3)  $f(x)$  и  $f(y)$  симметричны  
отн.  $y=x$



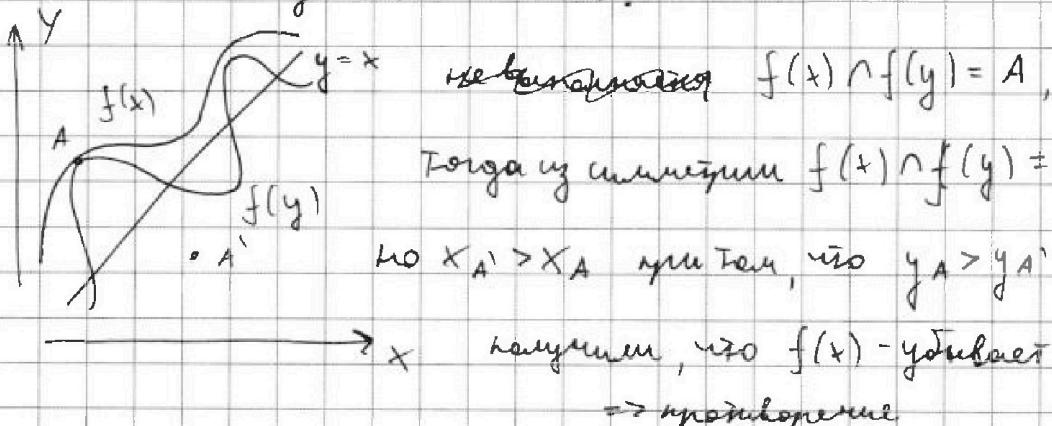
Значит они могут пересекаться

Только на прямой  $y=x$ .

$$\text{посл } x^3 + 3x - \sqrt{2x} = f(x)$$

$$y^3 + 3y - \sqrt{2y} = f(y)$$

Док. ч: пусть это не так:



4) Тогда система эквивалентна:

$$\begin{cases} \sqrt{x+2} - \sqrt{7-x} + 7 = 2\sqrt{4+5x-y^2} \\ x = y \end{cases}$$

$$\begin{cases} \sqrt{x+2} - \sqrt{7-x} + 7 = 2\sqrt{(x+2)(7-x)} \\ x = y \end{cases}$$

$$\text{посл } \sqrt{x+2} = a, \sqrt{7-x} = b$$

$$\text{такие } a^2 + b^2 = 9$$

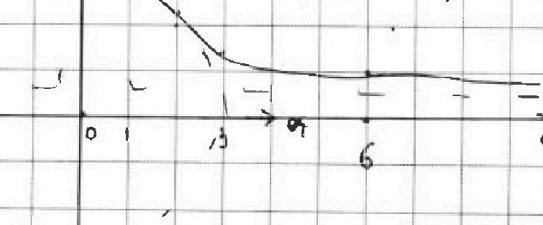
5) по Декартам:

$$\begin{cases} a - b + 7 = 2ab \\ a^2 + b^2 = 9 \end{cases}$$

$$b(a) = \frac{a+7}{1+2a}$$

$$b(\infty) = \frac{1}{2}$$

$$b'(a) = 0 \text{ при } a = 6$$





На одной странице можно оформлять только одну задачу. Отмьте крестиком номер задачи, решение которой представлено на странице. Также укажите номер страницы и суммарное количество страниц в решении каждой задачи отдельно.

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| 1                        | 2                        | 3                        | 4                        | 5                        | 6                                   | 7                        |
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СТРАНИЦА  
1 ИЗ 1

Если отмечено более одной задачи или не отмечено ни одной задачи, страница считается черновиком и не проверяется. Страницы по каждой из задач нумеруются отдельно. Порча QR-кода недопустима!

Задача 6.

1) Всего способов:  $121 \cdot 120$ , из них нужно вычесть те, которые одинаковые при перевороте.

На одной странице можно оформлять только одну задачу. Отметьте крестиком номер задачи, решение которой представлено на странице. Также укажите номер страницы и суммарное количество страниц в решении каждой задачи отдельно.





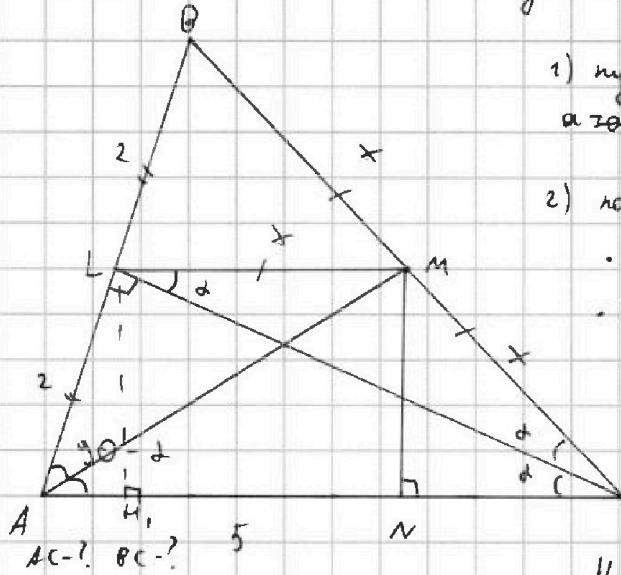




СТРАНИЦА  
1 ИЗ 1

Если отмечено более одной задачи или не отмечено ни одной задачи, страница считается черновиком и не проверяется. Страницы по каждой из задач нумеруются отдельно. Порча QR-кода недопустима!

Задача №7.



1)  $\angle O_1$  и  $\angle O_2$  - углы при вер.  $O_1$  и  $O_2$   
а также середина  $AM$  и  $CL$

2)  $\angle CLB$  - вспомог. угл:

- $PQ \perp O_1, O_2$
- $\angle O_1 = \angle O_2$
- $CL \perp AC$
- $\Rightarrow Q, O_2 \parallel AC$

т. е. в четырехугольнике  
сторон, сегд. середины сторон  
 $\parallel$  стор.  $\Rightarrow$  это л. трапеции

3) т. к.  $AM$  - диагональ, то  $\angle ANM = 90^\circ$

$\Rightarrow AL \parallel AC$

4)  $ML$  - сред. линия  $\Rightarrow AL = BL = \frac{AB}{2} = 2$

5)  $CL$  - бисект. медиана  $\Rightarrow \angle CLA = 90^\circ$ ,  $\triangle ABC$  - правильн.  
т. е.  $AC = BC$

6) по т. Пифагора:  $AM^2 = 25 + MN^2$ ,  $\text{посл } MN = R$

$$AM^2 = 25 + R^2$$

7)  $\sin B \Delta ALH$ :

$$\sin(\beta_0 - d) = \frac{R}{2}, 2\cos d = R$$

8)  $B \Delta BCL$ :  $\sin d = \frac{2}{2x} = \frac{1}{x}$

9) по т. Косинусов:  $AM^2 = 4 + x^2 - 2 \cdot 2 \cdot x \cdot \cos(\beta_0 + d)$

Тогда имеем:

$$\begin{cases} 4M^2 = 25 + R^2 \\ R = 2\cos d \\ \sin d = \frac{1}{x} \\ 4M^2 = 4 + x^2 + 4x \sin d \end{cases} \Rightarrow \begin{aligned} 4 + x^2 + 4x \cdot \frac{1}{x} &= 25 + 4\cos^2 d \\ 16x^2 &= 17 + 4 \cdot \frac{x^2 - 1}{x^2} \\ x^4 &= 21x^2 - 4 \\ x^2 &= \frac{+21 \pm \sqrt{21^2 - 4^2}}{2} = \frac{21 \pm 5\sqrt{17}}{2} \end{aligned}$$

т. к.  $BC = AC > 5$

$$\text{то получает } x^2 = \frac{21 + 5\sqrt{17}}{2}$$

$$\Rightarrow AC = BC = 2 \sqrt{\frac{21 + 5\sqrt{17}}{2}} = \sqrt{42 + 10\sqrt{17}}$$

Ответ:  $AC = BC = \sqrt{42 + 10\sqrt{17}}$ .

На одной странице можно оформлять только одну задачу. Отметьте крестиком номер задачи, решение которой представлено на странице. Также укажите номер страницы и суммарное количество страниц в решении каждой задачи отдельно.



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СТРАНИЦА  
ИЗ

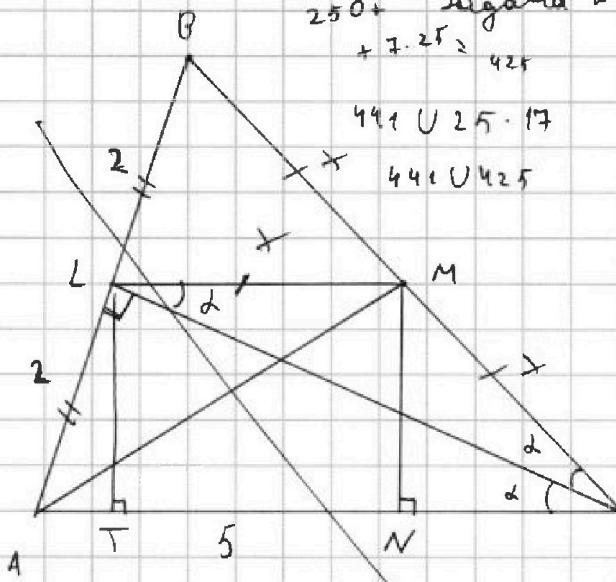
Если отмечено более одной задачи или не отмечено ни одной задачи, страница считается черновиком и не проверяется. Страницы по каждой из задач нумеруются отдельно. Порча QR-кода недопустима!

Задача №4.

$$\begin{array}{r} 250 \\ + 7 \cdot 25 \\ \hline 425 \end{array}$$

$$441 \vee 25 \cdot 17$$

$$441 \vee 425$$



$$\begin{array}{l} AC = ? \\ BC = ? \end{array}$$

$$4) \text{ док } \triangle BLM \sim \triangle BAC$$

$$c : k = \frac{1}{2} \text{ т.к. } ML \parallel AC, BM : MC = 3$$

$$\Rightarrow BL : AL = \frac{A8}{2} = 2$$

т. к. в четырёхугольнике  $ALNC$  отрезок, соединяющий середины диагоналей — это средняя линия

$$\Rightarrow ML \parallel AC$$

5) т.к.  $\angle ABC$  прямой  $CL$  бисектриса, медиана  $\Rightarrow \triangle ABC$  равнобедренный

т. к.  $BC = AC$

$CL \perp AB$

$$\cos d = \frac{2}{2x} = \frac{1}{x}$$

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

$$x = \frac{2 \pm \sqrt{4 - 4 \cdot 4}}{2} = \frac{2 \pm \sqrt{21 - 4^2}}{2}$$

$$6) \frac{L}{2} = \frac{LC}{AC} = \frac{CT}{CL}$$

$$x^2 + 4 + \sin d + 4 \sin^2 d - 25 = 0$$

$$2ML \cdot A = S_{\Delta}$$

$$2x \cdot a = \frac{1}{2} \cdot 4 \cdot 2x \cos d$$

$$a = 2 \cos d$$

$$\cos d = \frac{1}{2}$$

$$\frac{5 \pm \sqrt{25 - 8}}{2} =$$

$$x^2 + 4 + \sin d = \frac{5 \pm \sqrt{17}}{2}$$

$$x = \frac{-2 \sin d \pm \sqrt{4 \sin^2 d - 4 \sin^2 d + 25}}{2} =$$

$$= -2 \sin d \pm 5$$

$$AM^2 = 4 + x^2 + 2 \cdot 2 \cdot x \sin d$$

$$AM^2 = 5^2 + h^2$$

$$x = 5 - 2 \sin d$$

$$x = 5 - \frac{2}{\sin d}$$

$$= 25 + 4 \cos^2 d$$

$$x^2 + 4 + \sin d = 25 + 4 - 4 \sin^2 d$$

$$x^2 - 5x + 2 = 0$$

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$$\sqrt{x+2} - \sqrt{7-x} + 7 = 2\sqrt{(x+2)(7-x)}$$

$$-\alpha = -x-1$$

$$\alpha^2 - 2\alpha(6-x) + (6-x)^2 = 4\alpha(6)$$

$$\alpha^2 - 6\alpha + 14x + 6^2 - 14x + 49 = 0$$

$$\alpha^2 - 6\alpha + 49 = 2\alpha(6)$$

$$-\alpha + 49 = 2x + 6$$

$$\begin{cases} \sqrt{x+2} = 4 \\ \sqrt{7-x} = 6 \end{cases}$$

$$x^2 = x+2$$

$$6^2 = 7-x$$

$$-\alpha + 49 = -x + 7 = 6$$

$$\alpha^2 - (7-x) = 2\alpha(5-x)$$

$$2\alpha - 2 = 2\alpha(5-x)$$

$$\alpha - 1 = 9 - \alpha^2$$

$$14x + 6 = 16^2 + 16 =$$

$$= 2^2 + 2^2$$

Крн  $x > \frac{5}{2}$  Крн.

$$2^2 - 2^2 - 2^2 + 44 = 20$$

$$2^2 - 2^2 - 2^2 + 44 = 20$$

$$0 + 7$$

$$-128 = 16$$

$$\sqrt{x+2} - \sqrt{7-x} + 7 > 9$$

$$x - 4 = (3 - \sqrt{x+2})(3 + \sqrt{x+2})$$

$$x = -2 + \frac{3}{2} = -2 + \frac{5}{2}$$

$$f(x) = \frac{3}{2} \cdot \frac{3}{2} = \frac{81}{4} \quad 6^2 = (3-\alpha)(3+\alpha)$$

$$1: \quad 2 \cdot \frac{3}{2} + 3 = 6$$

$$\begin{aligned} 4x^4 - 4x^3 - 34x^2 + 22x + 40 &= 0 \\ 2x^4 - 2x^3 - 17x^2 + 11x + 20 &= 0 \end{aligned}$$

$$\sqrt{x+2} - \sqrt{7-x} + 7 > 2$$

$$\sqrt{x+2} - \sqrt{7-x} + 7 = 2\sqrt{(x+2)(7-x)}$$

ОДЗ:

$$\frac{1}{2\sqrt{x+2}} + \frac{1}{2\sqrt{7-x}} = 0 \quad \alpha^2$$

$$\begin{cases} x+2 \geq 0 \\ 7-x \geq 0 \end{cases} \quad [-2; 7]$$

$$\alpha^2 - 6 + 7 = 2\alpha(6)$$

$$\begin{cases} x+2 \geq 0 \\ 7-x \geq 0 \end{cases} \quad [-2; 7]$$

$$\beta^2 + \alpha^2 = 9$$

$$\alpha = \frac{-7+6}{1-2\alpha}$$

$$\beta^2 + \frac{(6-\alpha)^2}{(1-2\alpha)^2} = 9$$

$$\begin{cases} x+2 \geq 0 \\ 7-x \geq 0 \end{cases} \quad [-2; 7]$$

$$\beta^2(1-2\alpha)^2 + (6-\alpha)^2 = 9(1-2\alpha)^2$$

$$\begin{cases} x+2 \geq 0 \\ 7-x \geq 0 \end{cases} \quad [-2; 7]$$

$$(\alpha + \beta)^2 =$$

$$4\beta^4 - 4\beta^3 + \beta^2 + \beta^2 - 14\beta + 4y - 9 + 36\beta - 36\beta^2 = 0$$

$$= 16 + \alpha - 6$$

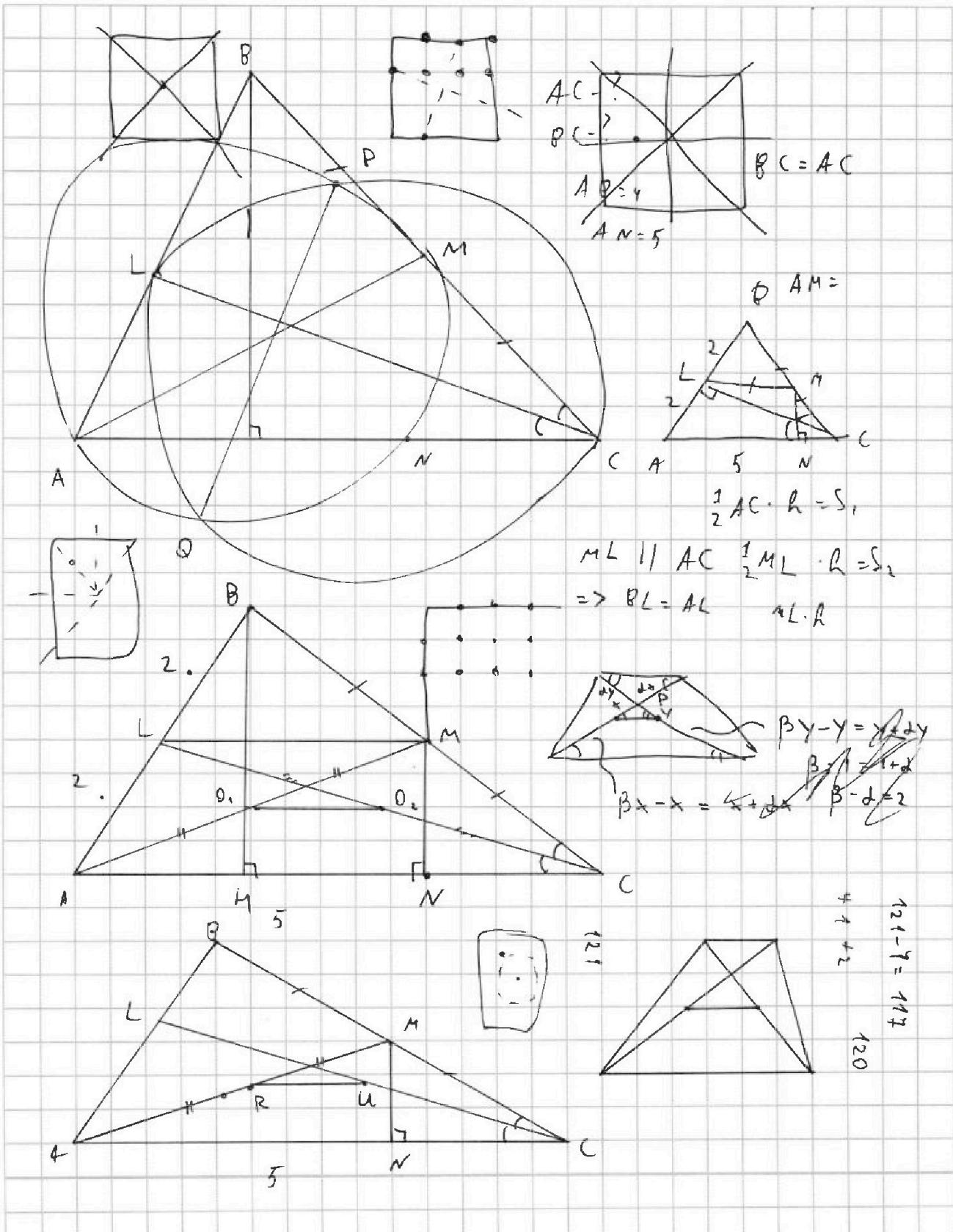


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$$\begin{aligned} & \left\{ \begin{array}{l} \sqrt{x+2} - \sqrt{y-4} + 7 = 2\sqrt{14+5x-y^2} \\ x^3 + 3x - \sqrt{2y} = y^3 - \sqrt{2x} + 3y \end{array} \right. \\ & \sqrt{x+2} - \sqrt{y-x} + 7 = 2\sqrt{14+5x-z^2} \end{aligned}$$

$$x^3 + 3x + \sqrt{2} = y^3 + 3y + \sqrt{2}y$$

$$(x+2)(-x+4)$$

$$or -6 + 7 = 2af$$

$$A = h^2 + 4mn + 4n^2 - 4m - 14n =$$

$$f = h^2 n + 2m_n n^2 + 3m_n z =$$

$$\therefore (h+2h)^2 - 7(h+2h) =$$

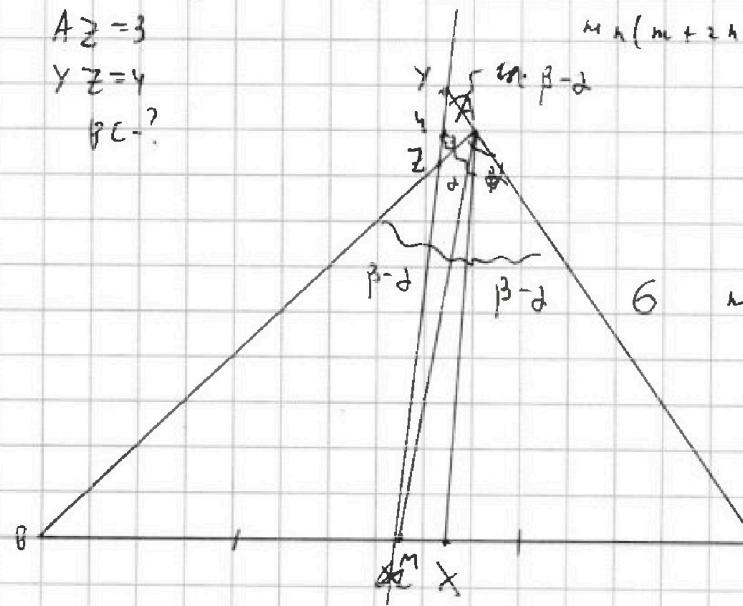
$$= (m+2n)(m+2n-4)$$

$$= m_n(m + 2n + 9)$$

$$A_2 = 3$$

$$y - z = y$$

fC = ?



$$(m+2n)(m+2n-4) = 4^2 \cdot 3 \cdot 9^2 \cdot 8^4(a) = \frac{1+2a-(a+\frac{4}{a})}{(1+2a)^2} =$$

$$m_n(m+2n+g) = 1 + p^2 \quad \Rightarrow \quad \frac{2+2\alpha-g}{(1+2\alpha)^2} = 0$$

$$V_m = 14, h = p = m + 2n + 3 \quad n=6$$

$$m + n \neq 0 \quad \text{if } (2, 2)$$

$$n = 11 \quad , \quad 22 + p_n + 3 = 11 \quad f(0) = 7$$

$$3x + 3 = 11 \quad f = \frac{x+2}{5}$$

$$k > \frac{2}{3}$$

$$Q_1 - 84.4 = 20 \times 6$$

$$\alpha(1-2\beta) = 6 - 4$$

$$Q_L = \frac{V}{1-2\beta} = \frac{20}{1-2\beta}$$

$$z - 1 = \frac{w + z}{z - w}$$

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$$(x^2 - 2x - 3x)(x^2 - 2x + 3x) = -4d$$

$$9x^2 - 6x + 9x = 6d$$

$$(x^2 - 5x)(x^2 + x) = -4d$$

$$9+12=4$$

$$x^2(x-5)(x+1) = -4d$$

$$x^4 + x^3 - 5x^3 - 5x^2 + 6x^2 + 6x - 4 = 0$$

$$+ \left\{ \begin{array}{l} 3x^2(x-5)(x+1) = -12d \\ 6(3x^2 + 3x - 2) = 12d \end{array} \right.$$

$$x^4 - 4x^3 + x^2 + 6x - 4 = 0$$

$$\underline{6(3x^2 + 3x - 2)} = 12d$$

$$(x-1)(x^3 + 3x^2 - 2x + 4) = 0$$

$$x^2(x-5)(x+1) + 2(3x^2 + 3x - 2) = 0$$

$$3x^2 - 6x - 2 = 0$$

$$x^4 - 4x^3 + x^2 + 6x - 4 \mid x-1$$

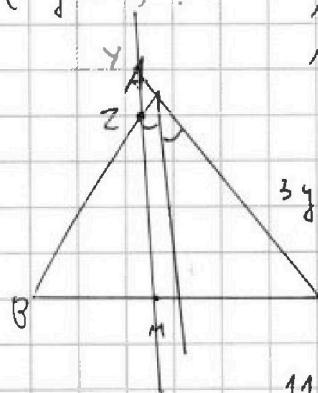
$$\begin{cases} |x-2y| \leq 2 \\ |2x-y| \leq 1 \end{cases}$$



$$9+6=15$$

$$\begin{matrix} 1 < 2 \\ 3 < 4 \end{matrix}$$

$$\max(3y+6x) = ?$$



$$AC = 6$$

$$AZ = 3$$

$$YZ = 4$$

$$BC = ?$$

$$3y + 6x = c$$

$$y = -2x + \frac{c}{3}$$

$$11 - 11 = (21 \text{ углов})$$

$$12 \cdot$$

$$-2 \leq x - 2y \leq 2$$

$$x+2 \geq 2y \geq x-2$$

$$\frac{x}{2} + 1 \geq y \geq \frac{x}{2} - 1$$

$$2x - y \leq 2$$

$$-1 \leq y - 2x \leq 1$$

$$2x - 1 \leq y \leq 2x + 1$$

$$\begin{cases} -2x + 2y \leq 2 \\ -1 \leq 2x - y \leq 1 \end{cases}$$

$$\begin{cases} 2 \geq 2y - x \geq -2 \\ 1 \geq y - 2x \geq -1 \end{cases} \rightarrow$$

$$\begin{cases} -4 \leq -4y + 2x \leq 4 \\ 1 \geq y - 2x \geq -1 \end{cases} \rightarrow$$

$$-5 \leq -4y + 2x + y - 2x \leq 5$$

$$\begin{cases} -2x + \frac{c}{3} = \frac{5}{3} \\ -8 + c = 5 \end{cases} \rightarrow \boxed{c = 13}$$

$$c - 5 \leq -5y \leq 5$$

$$x^3 - 3x^2 + 3x - 1 = (x-1)^3$$

$$y = \frac{8}{3} - 1 = \frac{5}{3}$$

$$(x-1)^3 - 5(x-1) = 0$$

$$\boxed{x = \frac{4}{3}}$$

$$\frac{x}{2} + 1 = 2x - 1$$

$$x + 2 = 4x - 2$$

$$3x = 4$$