RQC Russian Quantum Center | HIGHLAND GOLD | NQL National Quantum Laboratory

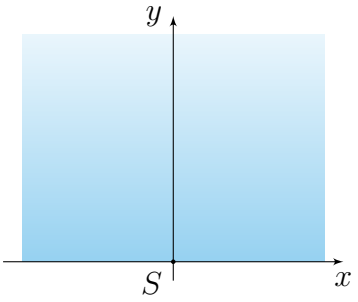
LPR Cup 2023

11.s04.e02

Once you know, it's actually very obvious.
The Prestige (film)

Illusion of Hidden

Hidden was quietly dozing at the point $S(0,0)$ of the layered medium, the refractive index of which is equal to $n(y) = \sqrt{n_0^2 - \alpha^2 y}$, when suddenly he was disturbed by the steps of Seeker. To confuse him, Hidden created one bright flash of light.



1. *(1 point)* To what maximum height $y_{\max}$ will the beam, emitted by Hidden at an angle $\pi/3$ to the x-axis, rise.
2. *(3 points)* Find the trajectory of the ray emitted by Hidden at an arbitrary angle φ to the x-axis. Give an answer as $y(x)$.
3. *(1 point)* In this point assume that $n_0 = 2$, $\alpha = 2\ m^{-1/2}$, and Seeker is located at a point with coordinates (1; 0.5) m. Find the moments in time when the light from the flash reaches Seeker. Assume that the flash occurred at zero moment in time.
4. *(3 points)* Where should Seeker be located to see the light from the flash created by Hidden?
5. *(2 points)* Seeker froze at the boundary of the area which is possible for the light from the flash to reach. How much time it takes for light to reach this boundary, depending on the initial angle φ between the ray emitted by Hidden and the x-axis.

First hint — 01.05.2023 20:00 (Moscow time)
Second hint — 03.05.2023 12:00 (Moscow time)

Final of the second round — 05.05.2023 20:00 (Moscow time)