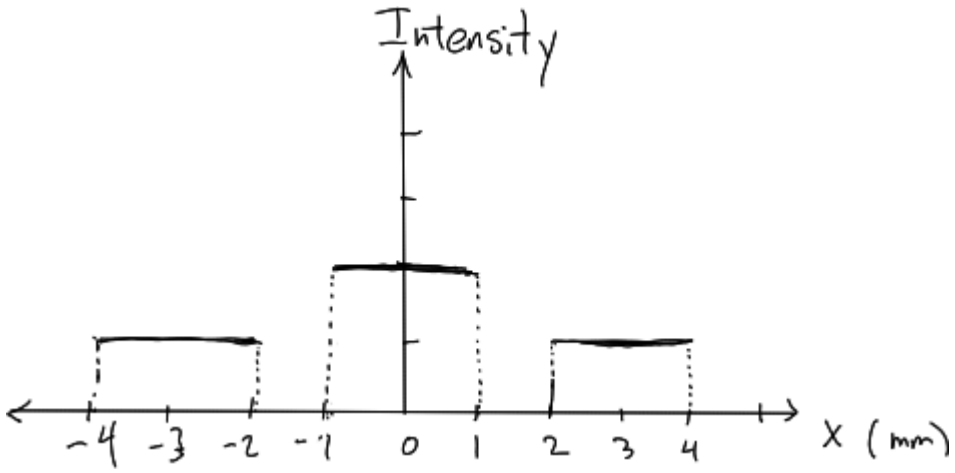
Problem 1

a) Estimate how many photons enter your eye per second if you are looking in the direction of the sun on a clear day. (Hint: it may be helpful to look up the flux of energy from the sun at the surface of the Earth).

b) Astronomers use the "magnitude" scale to describe how bright objects appear. For an object with magnitude 1, the observed intensity of light is $100^{1/5} = 2.512$ times smaller than for an object with magnitude 0. For an object with magnitude 2, the observed intensity of light is 2.512 times less than an object with magnitude 1, and so forth. The Sun has magnitude -26.7, while the dimmest star observable by the Hubble telescopehas magnitude 30. How often does a photon from such a star enter the Hubble telescope (diameter 2.4m) if the Hubble is pointed towards the star?



Problem 2

The intensity pattern for a certain double slit apparatus is plotted in the graph above. The graph shows the intensity of light hitting the screen at various locations. Suppose we reduce the intensity such that only one photon goes through the apparatus at a time. If we send in 2 photons, what are the chances that both will hit the screen in the region 2mm < x < 4mm? What are the chances that just one of the photons will hit in this region? What are the chances that neither of the photons will hit in this region?

Problem 3

Explain why there is a limit to how short (in time) a musical note can be. Roughly how short can the note middle C be? Explain how this is related to the statement in quantum mechanics that we cannot precisely know the position of a particle with a well-defined momentum.