

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Department of Physics

Physics 8.811

Fall Term 2003

PROBLEM SET 5

Due: November 25, 2003.

Problem 1

An experiment on proton decay is to be carried out using a large cubical tank of water as the proton source, and the possible decay mode $p \rightarrow e^+\pi^0$ is to be detected via the Cherenkov light emitted when the electromagnetic showers from the decay products traverse the water. How big should the water tank be to contain such showers? Estimate the total track length of the showers in the decay event and hence the total number of photons emitted in the visible region (wavelength 400-700 nm). The light is to be detected by an array of PMTs placed at the cube surfaces. If the optical transmission of water is 20% and the quantum efficiency is 15%, what fraction of the surface must be covered by photocathode to give an energy resolution of 10%?