Problem Set 3 — due May 14

1. A CsI crystal scintillator produces light output which (after wavelength shifting) impinges on the photocathode of a photomultiplier tube. This particular device produces 60 photoelectrons per MeV of energy deposited in the crystal. The inferred energy deposition is proportional to the photomultiplier output, which in turn is proportional to the number of photoelectrons. Statistical fluctuations in the number of photoelectrons (sampling fluctuations) control the energy resolution of the device. The fluctuations are Poisson for small average numbers of photons, but become Gaussian for larger numbers of photons. What is the fractional energy resolution, $\Delta E/E$, in percent, as a function of E(GeV) (for E in the GeV range)? Suppose layers of scintillator/photomultiplier tubes, with similar photoelectron yield to the above, were included as the sampling layers of a sampling calorimeter, and suppose they typically capture 1% of the shower energy deposited. Now what would the sampling contributions to the fractional energy resolution be, in percent, as a function of E(GeV)?

2. Problem 6.9 of Griffiths.
3. Problem 6.11 of Griffiths.
4. Problem 7.1 of Griffiths.
5. Problem 7.7 of Griffiths.
6. Problem 7.34 of Griffiths.