SPA 3609 Tutorial 3, Questions for formative feedback

1. Find the *minimum energy* that an electron must have to produce Cherenkov radiation in silica (SiO_2, quartz) at a wavelength of 400 nm (remember that refractive index varies with wavelength).

   Calculate the minimum energy for a gamma-ray photon to produce (by Compton scattering) the energy of the electron you have just calculated in the first part of Q1.

2. Calculate the number of Cherenkov photons emitted per metre in water ice (take n = 1.3 at λ = 550 nm) if the photodetector has a uniform 50% response in the range 400 nm to 700 nm but completely insensitive outside the visible light range. Ignore the variation of refractive index with wavelength.

3. The semiconductor pn junction plays a very important role in modern tracking detectors as well as photodetectors.

   Intrinsic silicon is doped **n** type such that $n = 10^{15}$ cm^{-3}, in this doped silicon calculate the thermal equilibrium concentration of holes.

   Sketch the space-charge, internal electric potential and the internal electric field for an abrupt junction device.

4. Explain qualitatively why the energy resolution of a silicon “ionisation” detector will be better that that of an air ionisation detector **for the same deposited energy** (say from the passage of a 100 MeV proton). Estimate by what factor it will be improved (assume energy resolution is determined by Poisson statistics).