1. Assuming the $w=26.2\text{eV/ion pair}$ and the Fano factor $F=0.17$ for argon, find the mean and expected standard deviation in the number of ion pairs formed by the absorption of $1\text{MeV}$ radiation energy.

$J=1\text{MeV}/w=38167.9$ ion pairs $\approx 38168$ ion pairs (1 pt.)

$\sigma = \sqrt{(FJ)} = \sqrt{(0.17 \cdot 38168)} = 80.55 \approx 81$ ion pairs (1 pt.)

2. If you have a homogeneous electric field of $1\text{KV/cm}$ applied across a gas volume at standard temperature and pressure (STP): How long does it take for a CH$_4^+$ ion to travel $1\text{cm}$ in

a) pure CH$_4$?

b) 80/20 Ar/CH$_4$?

Mobility from table on page 13 of the lecture, Monday, Nov 28 (1 pt.)

Pure CH$_4$: mobility $\mu = 2.26 \text{cm}^2/\text{V/s}$ times $1\text{kV}$ equals $2260 \text{cm/s}$. Invert: It takes $442 \mu\text{s}$ to travel $1\text{cm}$ (1 pt.)

Ar/CH$_4$: $\mu = 1.61 \text{cm}^2/\text{V/s} \rightarrow 621 \mu\text{s}$ (1 pt.)

3. If you use $1 \text{kV}$ on a cylindrical proportional tube with $1\text{cm}$ inner radius and a $30\mu\text{m}$ diameter anode wire at its center: What is the field at the surface of the anode wire and how far out does the amplification region extend, if you assume that amplification takes place for fields above $10 \text{kV/cm}$?

$E = \frac{V_0}{r/\ln(b/a)}$ (1 pt.)

$= \frac{1\text{kV}}{15\mu\text{m}/\ln(1\text{cm}/15\mu\text{m})} = 103\text{kV/cm}$ (1 pt.)

$R = \frac{V_0}{E/\ln(b/a)} = 153.8\mu\text{m}$ (1 pt.)

4. The plot on slide 2 in today’s (Wednesday, November 30) lecture shows the Townsend coefficient for various mixtures of Argon and Methane. What field do you need in pure Argon and in pure CH$_4$ both at 1atm to produce 6 ionization collisions per 1 cm?

8 kV for Argon and 27 kV for CH$_4$ (2 pt.)