Ionization Counter HW

#1- A beam of alpha particles produces a current of 10.14 A in a ionzation chamber for 8 s. The chamber contains air at STP (W = 36 eV/ip) . (ip - ion pair)

(a) How many ion pairs are produced?

$$n = Q/e = \frac{I\Delta t}{e} = (10.14A)(8s)/1.6\times10^{-19}C = 5.07\times10^{20} \text{ ions}$$

(b) How much energy did the beam deposit in the chamber?

$$\Delta E = n\ W = (5.07'10^{20})\ 36 \text{ eV/ip} = 1.83\times10^{22} \text{ eV} = 2920 \text{ J}$$

(c) If the chamber volume is 240 cc, what is the energy absorbed per unit mass in units of gray (1 gray absorbed dose = 1 J/kg).

$$m_{gas} = \rho V = (1.297kg/10^{6}cc)(240cc) = 3.11\times10^{-4}kg$$

$$Absorbed\ \ Dose = E/m(kg) = 2920J/3.11\times10^{-4}kg = 9.38\times10^{6}G$$

#2- A Po-210 (5.30 MeV) α source is placed in an air ionization chamber and a saturation current of 8x10^{-12} A is observed. Assuming the ionization is due to the aphas stopping in the chamber. How many stop per second?

$$N = \frac{\Delta E_{\alpha}}{W} = \frac{5.3\times10^{6}eV/\alpha}{36eV} = 1.47\times10^{5}\ ip/\alpha$$

$$\frac{dn}{dt} = \frac{1}{e}\frac{dq}{dt} = \frac{8\times10^{-12}}{1.6\times10^{-19}} = 5.0\times10^{7}\ ip/s$$

$$n_{\alpha} = \frac{1}{N}\frac{dn}{dt} = \frac{5.0\times10^{8}\ ip/s}{1.47\times10^{5}\ ip/\alpha} = 340\ \alpha/s$$

#3. The oscilloscope pulse seen in a gas filled proportional chamber (gas gain 10^{3}) is 10 mV in pulse height and 20ns in pulse duration. The oscilloscope has a 50Ω input impedance. Determine the charge and number of ion pairs contained in the pulse.

$$q = \frac{1}{R}\int V(t)dt = \frac{1}{50\Omega}[\underbrace{\frac{1}{2}(0.010V)(20\times10^{-9}s)}_{1/2\ base\ x\ height}] \simeq 2pC$$

$$n_{e} = \frac{2\times10^{-12}C}{1.6\times10^{-19}C/e} = 1.25\times10^{7} = n_{pair}\times gain$$

$$n_{pair} = \frac{1.25\times10^{7}}{gain} = \frac{1.25\times10^{7}}{10^{3}} = 12{,}500$$

#4. Why is a GM counter not useful for determining the aborbed energy in a gas?

The charge released in a GM avalanche is not proportional to the incident energy.

#5. An argon filled GM tube counts a 30 keV X-ray source at a measured rate of Rx = 100/s. Using the efficiency ε curve from the X-ray Data Booklet, find the actual decay rate Ro of the source, where Rx = Ro x ε.

Ro = 100s-1 / 0.05 = 2000 s^{-1} where ε~0.05