Chapter 5. {3, 4, 8, 10, 15}

Sanetullaev Alisher

5.3 For an air equivalent chamber,

$$X = \frac{\Delta Q}{M},$$

where ΔQ is the charge created by sec. electrons, M is the mass contained in the active volume.

$$M = 1.293\times10^{-6}\,kg/cm^3 \cdot 50\,cm^3 = 6.465\times10^{-5}\,kg$$

Also, Q is equal to change in charge of electrodes,

$$\Delta Q = CV_0 - CV = C(V_0 - V)$$

$$Q = 75\,pF\,(25V - 20V) = 0.375\,nC$$

$$\Rightarrow \quad X = \frac{0.375\,nC}{6.465\times10^{-5}\,kg} = 5.8\times10^{-6}\,\frac{C}{kg}$$

5.8 μGray

convert to dose or "exposure" (energy/mass)

$$dose = 5.8\times10^{-6}\,\frac{C}{kg}\left(\frac{34\,eV}{Ion\,Pair}\right)\left(\frac{Ion\,Pair}{2\times1.6\times10^{-19}\,Coul}\right)$$

$$= 6.2\times10^{14}\,eV/kg \,/\, 6.2\times10^{16}\,\frac{eV}{kg\text{-}rad}$$

$$= 10^{-2}\,Rad \text{ or } 10\,mR$$

5.4 The drift velocity is

$$v = \frac{\mu \mathcal{E}}{p}$$

where $\mathcal{E}$ is electric field, p - gas pressure, μ - mobility.

$$\frac{\mathcal{E}}{p} = \frac{1000\,V/5\,cm}{1\,atm} = 2\times10^4 \ \frac{V/m}{atm}$$ ✓

From Fig 5.2, the corresponding v is $10^5\,m/s$. (ok a little less)

The maximum electron collection time is

$$t = \frac{d}{v} = \frac{5\,cm}{10^7\,cm/s} = 0.5\,\mu s$$ ✓

5.8 The ionization current is

$$I = \frac{E\alpha e}{W}, \quad E = 49\,keV$$

$\alpha = 150\,kBq$, W-value for Ar is 26.4 eV/ion pair

$$\Rightarrow \quad I = \frac{49\,keV/dis \cdot 150\,\frac{kdis}{s} \cdot 1.6\times10^{-19}\,C}{26\,eV/ion\,pair} = \boxed{4.523\times10^{-11}\,A}$$

5.10 In electron sensitive mode

$$V_{max} = \frac{n_0 e}{C} \cdot \frac{x}{d}$$

(The ion drift is neglected).

$$V_{max} = \frac{1000 \cdot 1.6 \times 10^{-19} C}{150 \times 10^{-12} F} \cdot \frac{2cm}{5cm} = 4.27 \times 10^{-7} V$$

$$V_{max} = 0.43 \mu V$$ ✓

5.15. We can see from Eq. 5.15 in the textbook

$$V_R = \frac{n_0 e}{dC} (v^+ + v^-) t$$

that the ratio of slopes (V/t) is equal to $\frac{v^-}{v^+}$.

As the book says, electrons are typically 1000 times more mobile than ions, therefore the ratio of the slopes is equal to

$$\boxed{\frac{v^-}{v^+} \approx 1000}$$

OK