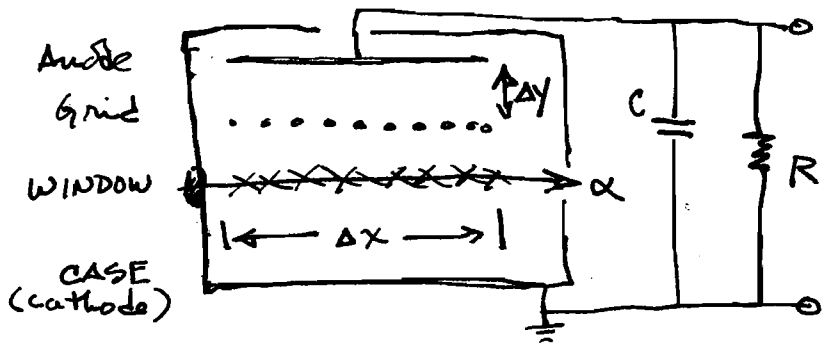
1) (a)



gas: 100 mbar CH_4 5cm path → $\rho_A = \frac{P}{RT} MM(\Delta X)$

$$\rho_A = \frac{0.1 \text{ bar } (16.9 \text{ g/mol}) \, 5.0 \text{ cm}}{0.08314 \frac{\text{bar-l}}{\text{K mol}} \times 10^{+3} \frac{\text{cm}^3}{\text{l}} (298 \text{ K})}$$

$$\rho_A = 3.23 \times 10^{-4} \text{ g/cm}^2 = 0.323 \frac{\text{mg}}{\text{cm}^2}$$

- since gas layer is "thin"

$$Q = \Delta E \sim \left(\frac{dE}{dx}\right) \Delta X = 340 \text{ keV}$$

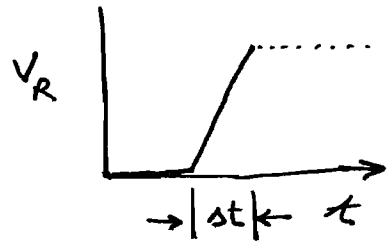
from Line^{tt} (85 keV/cm)

(b) $\left(\frac{\sigma_Q}{Q}\right)^2 = \frac{F}{N_{IP}} = \frac{0.15}{Q/W}$ $\quad W(CH_4) = 29.1 \frac{\text{eV}}{\text{IP}}$ Text Table 5.1

$$\frac{\sigma_Q}{Q} = \left(\frac{0.15 \times 29.1 \text{ eV/IP}}{340. \times 10^3 \text{ eV}}\right)^{1/2} = \left(\frac{4.36}{340\,000}\right)^{1/2} = 3.6 \times 10^{-3}$$

$\Gamma_{FWHM} = 2.354\sigma = 8.5 \times 10^{-3}$ resolution

(c) see fig 5.17 in text



$$\Delta t \sim \frac{\Delta Y \text{ (Grid} \rightarrow \text{Anode)}}{v_{elect}}$$

$$\Delta t \sim \frac{1.0 \text{ cm} \times 10^{-2} \text{ m}}{0.85 \times 10^{5} \text{ m/s}}$$ ← v_{elec} from Fig 5.2 text

$$\Delta t \sim 1.2 \times 10^{-7} \text{ s}$$

(120. ns)

$$E/p \frac{\text{V}}{\text{m atm}} \sim \frac{500 \text{ V}}{0.01 \text{ m} \; 0.1 \text{ atm}}$$

$$\sim 5 \times 10^{4} \frac{\text{V}}{\text{m-atm}}$$

also fig 6.15 $0.66 \frac{\text{V}}{\text{cm-torr}} \rightarrow 9 \times 10^{6} \frac{\text{cm}}{\text{s}}$

(d) see fig 5.15 in text $RC \gg t_{\ominus}$

$$C \gg \frac{1.2\times10^{-7}\ s}{50\ \Omega} = 2.4\times10^{-9}\ \text{Farads}\quad (2.4\ \text{nF})$$

(e) $$V_R = N_{IP}\, q_e / C = \left(\frac{340000\ \text{eV}}{29.1\ \text{eV/IP}}\right)\frac{1.602\times10^{-19}\ \text{Coul}}{30.\times10^{-9}\ \text{F}} = 6.2\times10^{-8}\ \text{V}$$

62 nV – yikes! – better lower that capacitance

2) $$\left(\frac{\sigma_Q}{Q}\right)^2 = \frac{F}{N_{IP}} + \frac{b}{N_{IP}}$$

$b = 0.5$

$W = 26\ \text{eV/IP}$ Table 6.2

[NB W = 27.1 in Table 5.1] for methane not P-10

NB Resolution is $\left(\frac{\text{FWHM}}{\text{PEAK}}\right)$

$$\left(\frac{0.132}{2.354}\right)^2 = \frac{F + 0.5}{[5900/26]}$$

$$F = \left(\frac{0.132}{2.354}\right)^2 \frac{5900}{26} - 0.5$$

$$F = 0.714 - 0.5 = 0.21$$

3) $$\ln M = \frac{V}{\ln(b/a)}\frac{\ln 2}{\Delta V}\left[\ln\frac{V}{K\,p\,a\ln(b/a)}\right]$$

$a = 40\ \mu\text{m}/2$

$b = 1\ \text{cm}/2$

$p = 100\ \text{mbar}$

$$\ln M = \left(\frac{500\ V \ln 2}{5.52\times 29.5\ V}\right)\ln\left(\frac{500\ V}{10^5\ \frac{V}{\text{cm atm}}\ 0.1\ \text{atm}\ 2\times10^{-3}\ 5.52}\right)$$

Table 6.1 { $\Delta V = 29.5\ V$; $K = 10.0\times10^4\ \frac{V}{\text{cm atm}}$ propane

$$\ln M = 2.13\ \ln(453)$$

$$\ln M = 3.22$$

$$M = 25.0$$