Chemistry 988

Spring, 2oo9 Problem Set #2

Distributed: Tues., 10 Feb. o9 Due: Tues., 17 Feb. o9

1. A Frisch-gridded ion chamber for heavy ions is operated with methane gas at 100 mbar and 25°C. The grid is 1.0 cm from the anode and the voltage rise between the grid and anode is 50 V. The detector has a sensitive length of 5.0 cm along the path of incident ions. [N.B. some of the information necessary to solve this problem can be found in tables and figures in the textbook.]

   (a) Calculate the energy lost by an 6.0 MeV alpha particle in the sensitive region of this detector. Be sure to indicate your source of necessary reference data.

   (b) Estimate the theoretical resolution for this pulse if the Fano factor for methane is 0.15

   (c) Estimate the time at which the electronic pulse from this detector reaches its maximum value.

   (d) Estimate the minimum (total) capacitance of the electronic circuit with R=50Ω that would be appropriate to measure this pulse.

   (e) Estimate the pulse height of this signal in volts if the lumped capacitance of the circuit is actually 30 nF.

2. The empirical expression for the response of a proportional counter is written in the textbook as:

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

   where b is a constant that depends on the energy threshold for the multiplication. Calculate the Fano factor for P-10 gas if the measured resolution was found to be 13.2% for a 5.9 keV photon in a proportional counter that has b=0.5.

3. What is the multiplication factor for a proportional wire that has a 40 μm diameter and is operated at 500 V inside a cylindrical volume 1 cm diameter with propane gas at 100 mbar?