

Chemistry 988

Spring, 2009

Problem Set #4

Distributed: Tues., 7 Apr. 09

Due: Tues., 14 Apr. 09

1. General Electric manufactures boron-coated proportional counters (e.g., model number RS-P7-0812-117) and the specifications indicate that the device has a capacitance of 7 pf and a resistance of $10^{12} \Omega$. The manufacturer reports that the average charge output is 2×10^{-13} coulombs at 600 V. (1) What is the ratio of the signal current to the leakage current in this device? You can leave Δt the time duration of the charge collection as a parameter. (2) Estimate the average gain of this proportional tube. You can either leave W as a parameter or assume $W \approx 30$ eV/IP for the Ar/CO₂ fill gas since the composition is not given in the specifications.
2. Make an estimate of the efficiency of a thermal neutron counter that is based on a gas-filled proportional counter that has a boron coated wall as the active ingredient. The boron coating on the wall has a effective thickness of 0.9 mg/cm² and is enriched to 92% ¹⁰B.
3. Attenuators for electrical circuits are often labeled in decibel units (dB) which can lead to confusion. Formally, dB's were introduced in acoustics and are equal to $10 \log_{10}(P_{out}/P_{in})$ where P is the power. In electronic circuits, $P=V^2/R$ so a dB is also $20 \log_{10}(V_{out}/V_{in})$ and many people don't remember the factor of 2. Using the network shown in Figure 16.5b in the textbook, calculate the values of the resistors that will create a -3 dB reduction of a signal with a 50 Ω load.
4. The Tennelec TC-241 shaping amplifier is used in many experiments at the NSCL to amplify signals from charge-sensitive preamps connected to silicon detectors of many shapes and sizes. This device has one stage of differentiation followed by amplification and then three stages of integration. Make an accurate graph of the output signal from such an amplifier if a 0.1 V step function (e.g., a Fermi function with $a=1$ ns) is applied and all of the time constants are set to 1 μ s.