AUG 2 4 2001 RESERVE DESK

GEORGIA INSTITUTE OF TECHNOLOGY

The George W. Woodruff School of Mechanical Engineering

NRE Qualifier Exam

Spring Semester 2001 FEB 1 2002

__________Your ID Code

Monday, March 26, 2001

Fundamentals

Instructions

1. Use a separate page for each answer sheet (no front to back answers).
2. The question number should be shown on each answer sheet.
3. Answer 4 of the 6 questions attached.
4. Staple your question sheet to your answer sheets and turn in.

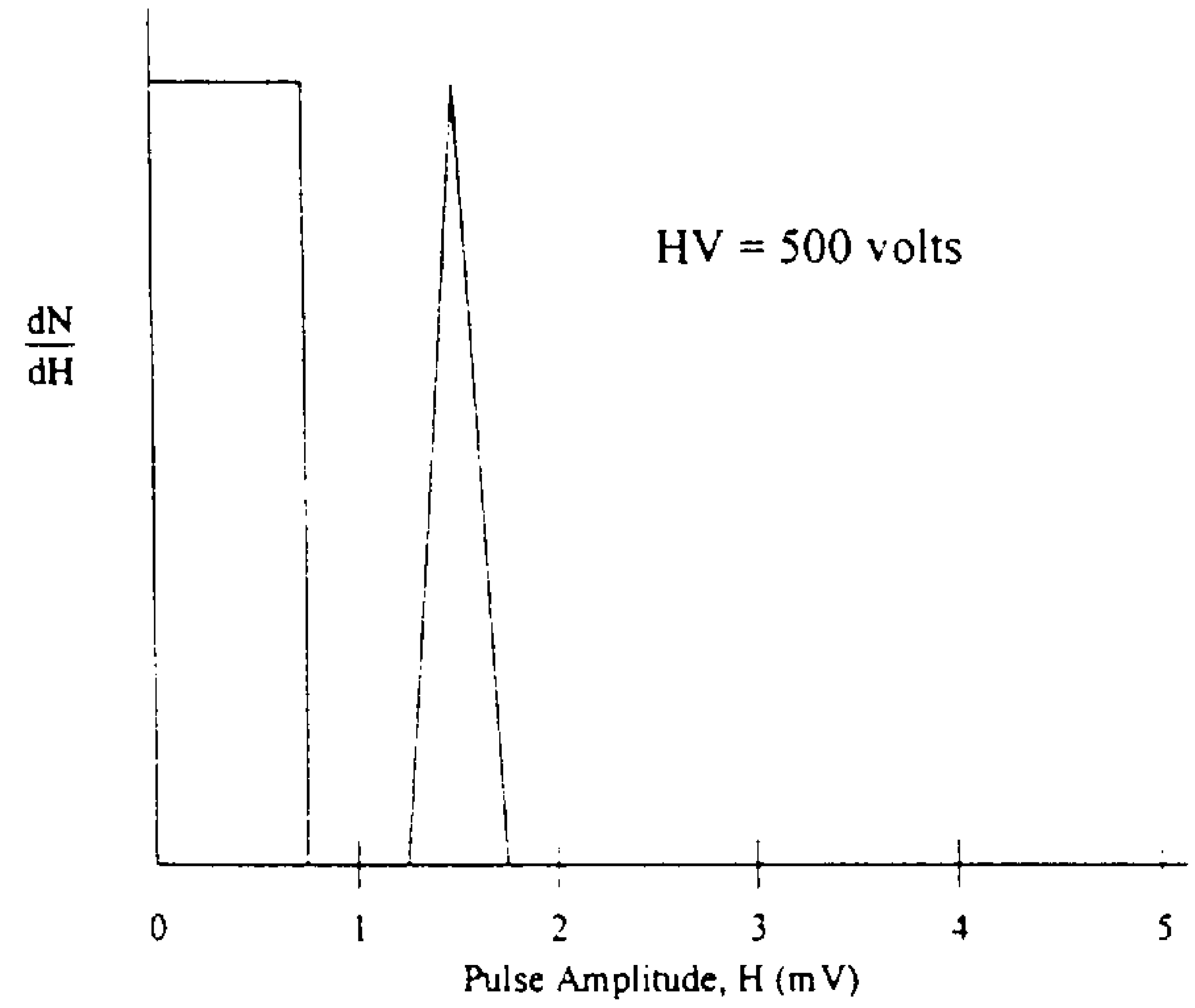
1. a. A given voltage-sensitive preamplifier requires a minimum input pulse amplitude of 20 mV for good signal-to-noise performance. What gas multiplication factor is required in a xenon-filled proportional counter with 10 pF capacitance if 60 keV X-rays are to be measured?

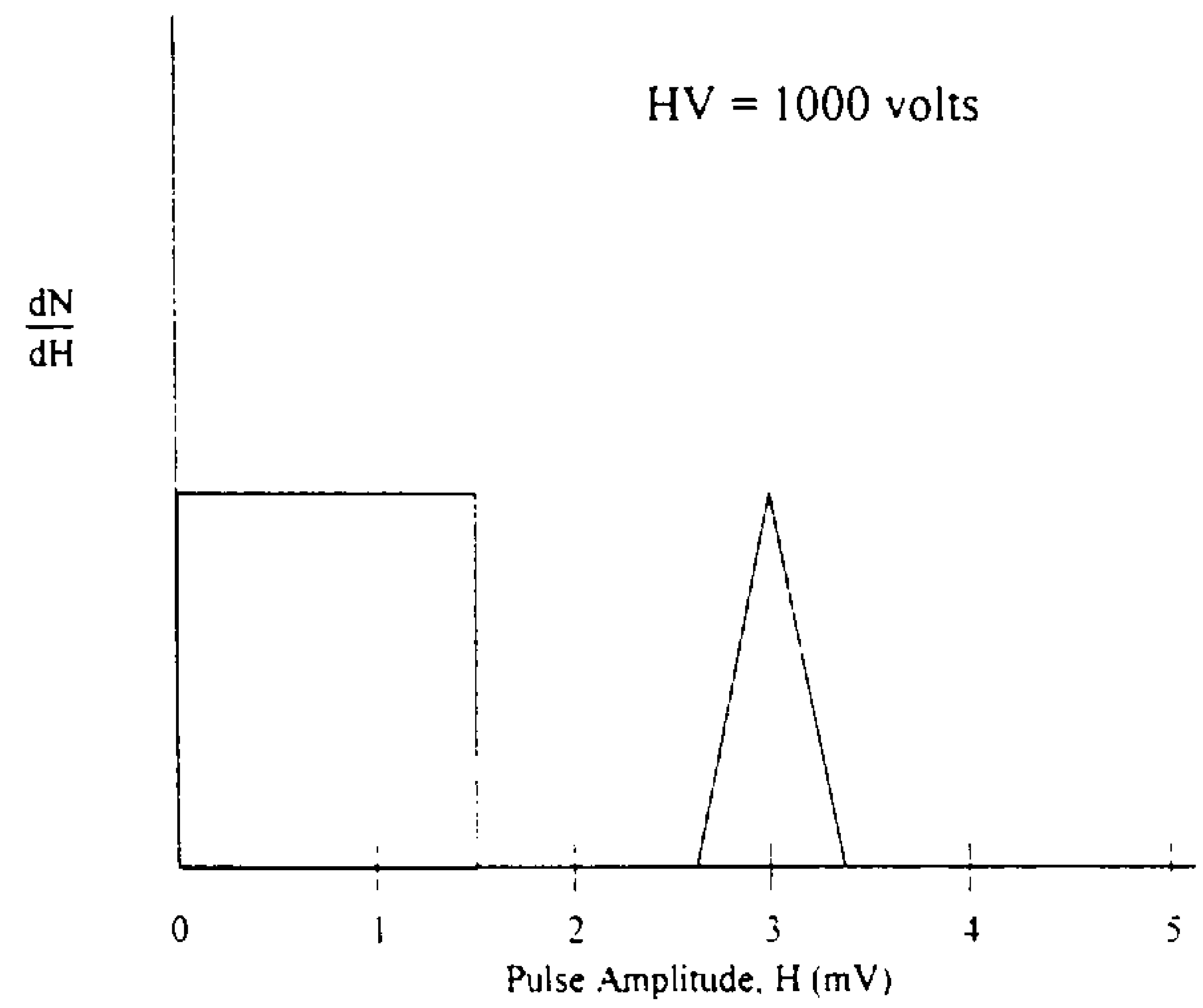
b. A cylindrical proportional tube has an anode wire radius of 0.006 cm and a cathode radius of 2.0 cm. It is operated with an applied voltage of 2800 V. If a minimum electric field of 1.5×10^{6} V/m is required to initiate gas multiplication, what fraction of the internal volume of the tube corresponds to the multiplication region?

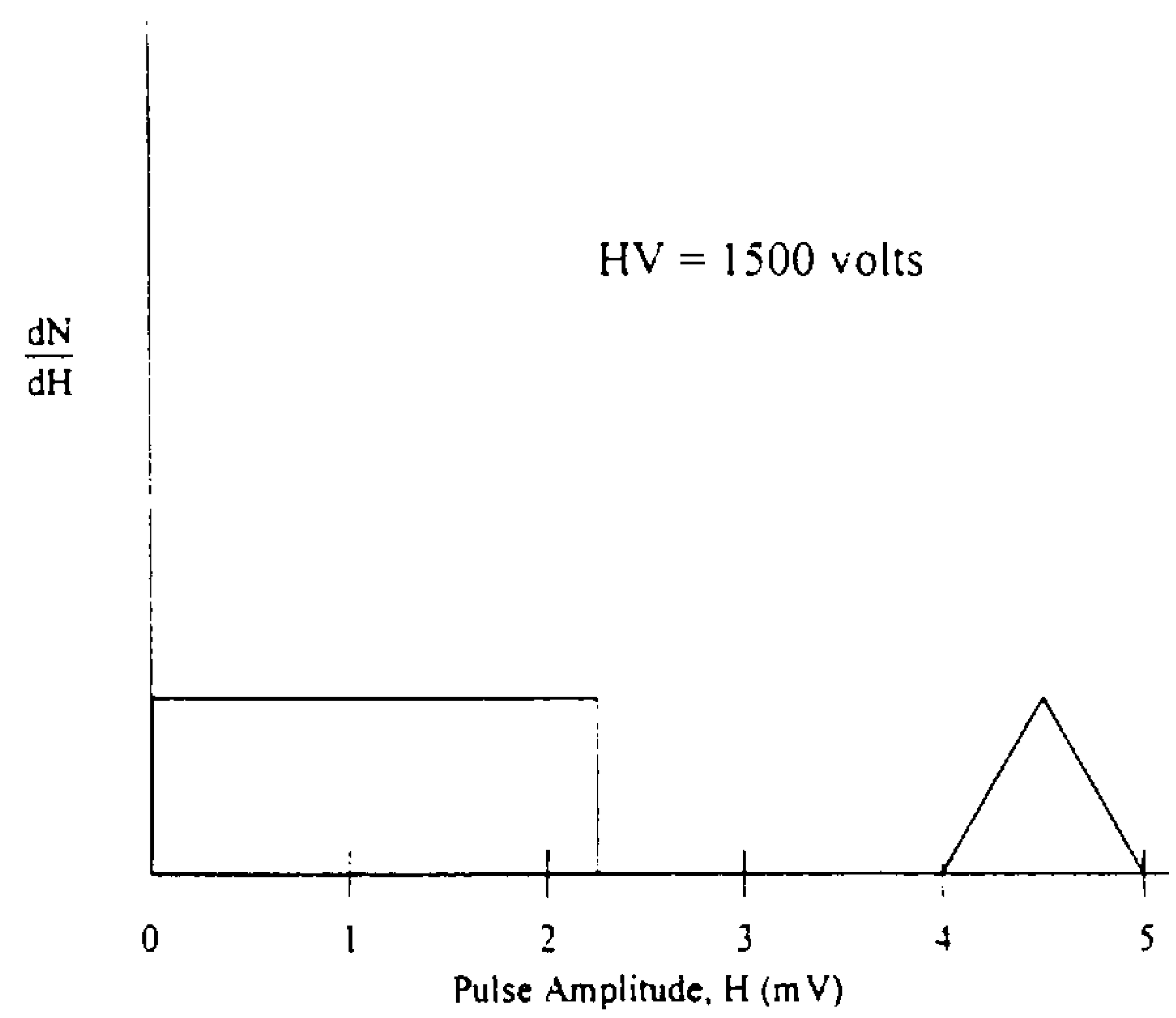
2. Assuming that a collimated beam of 2 MeV gamma rays is incident on an intermediate-sized, gamma-ray spectroscopy detector, sketch the expected pulse height spectrum. Label all features in the spectrum.

   Sketch and briefly describe how this pulse height spectrum would change if the spectroscopy detector was surrounded by a thick annular detector with length much greater than the dimensions of the spectroscopy detector and the two detectors were operated in (a) anticoincidence mode, (b) coincidence mode, and (c) coincidence mode with the analog signals from the two detectors summed?

3. Considering the following differential pulse height spectra, a) sketch the expected counting curve over a high voltage range of 0-1500 volts for a lower-level discriminator set at 2 mV, and b) sketch the histogrammed multichannel spectrum for each of the three high voltage settings if each bin or channel is 1 mV wide (i.e., channel 1 corresponds to 0-1 mV, channel 2 corresponds to 1-2 mV, etc.).







3a) Counting Curve

3b) MCA spectrum for HV = 500 volts

3b) MCA spectrum for HV = 1000 volts

3b) MCA spectrum for HV = 1500 volts

4. ^{252}Cf decays via both alpha emission and spontaneous fission (SF), and the corresponding branching fractions are 96.9% and 3.1%, respectively. Given that the half-life of ^{252}Cf is 2.64 years and that each SF in average produces 3.7 neutrons, calculate the neutron yield (neutrons sec^{-1}) for 1 mg of ^{252}Cf.

5. A (n,γ) resonance is observed for neutron energy at 1.0 MeV in a laboratory experiment using ^{16}O as the target. Use the attached atomic-mass data to calculate the total gamma-ray energy that will be emitted in this resonance $^{16}O(n,\gamma)^{17}O$ reaction.

Z	Element	Symbol	A	Atomic Mass, u	Relative Abundance, %	Half-Life
7	Nitrogen	N	12	12.018 613		11.0 ms
			13	13.005 739		9.97 min
			14	14.003 074	99.63	
			15	15.000 109	0.37	
			16	16.006 099		7.10 s
			17	17.008 449		4.17 s
8	Oxygen	O	14	14.008 597		70.5 s
			15	15.003 065		122 ms
			16	15.994 915	99.758	
			17	16.999 131	0.038	
			18	17.999 159	0.204	
			19	19.003 576		26.8 s
9	Fluorine	F	17	17.002 095		64.5 s
			18	18.000 937		109.8 min
			19	18.998 403	100	
			20	19.999 982		11.0 s
			21	20.999 949		4.33 s
10	Neon	Ne	18	18.005 710		1.67 s
			19	19.001 880		17.2 s
			20	19.992 439	90.51	
			21	20.993 845	0.57	
			22	21.991 384	9.22	
			23	22.994 466		37.5 s
			24	23.993 613		3.38 min
11	Sodium	Na	22	21.994 435		2.60 y
			23	22.989 770	100	
			24	23.990 963		15.0 h
12	Magnesium	Mg	23	22.994 127		11.3 s
			24	23.985 045	78.99	
			25	24.985 839	10.00	
			26	25.982 595	11.01	
13	Aluminum	Al	27	26.981 541	100	
14	Silicon	Si	28	27.976 928	92.23	
			29	28.976 496	4.67	
			30	29.973 772	3.10	
15	Phosphorus	P	30	29.978 310		2.50 min
			31	30.973 763	100	
16	Sulfur	S	32	31.972 072	95.02	
			33	32.971 459	0.75	
			34	33.967 868	4.21	
			35	34.969 032		87.2 d
			36	35.967 079	0.017	
17	Chlorine	Cl	35	34.968 853	75.77	
			36	35.968 307		3.01×10^5 y
			37	36.965 903	24.23	

6. A 1-MeV neutron undergoes elastic scattering with a hydrogen nucleus. Assume that the scattering is isotropic in the center-of-mass system; use the conservation equations of kinetic energy and momentum to show that all the scattered neutrons are forwardly directed in the lab system.