

Name
Surname:
Student Registration Nr:
SIGNATURE:

05.06.2017

10617 Radiation Measurement Techniques Laboratory Final Exam (Experiment 1)

1. Student could setup the experiment efficiently and use cautiously the instruments. The duty imposed in making a BNC connection to a coaxial signal cable was successfully completed. (10 Points)
2.
 - a. Fill the table with the measurement results obtained for 10 seconds and comment on your results.

1	Source	Count	Net Count
2	Background		
3	α		
4	$\alpha + 1$ paper		
5	$\alpha + 2$ paper		
6	$\alpha + \beta + 2$ paper		
7	$\alpha + \beta + 1$ Al		
8	$\alpha + \beta + 2$ Al		
9	γ		
10	$\gamma + 2$ Al		

- b. Make the following measurements with a ^{204}Tl source by using the settings below and fill the Table. Calculate the net count rate and its uncertainty and comment on your results.

T_T (s)	T_B (s)	N_T	N_B	σ	R_{net}
10	10				
100	100				

Settings:

High Voltage: (+) 1000 V
Count type: Integral
Threshold: 0.5
Window: 0
Time : 10 sn

3. Assume that an experiment is made a gamma ray spectrometer having a cylindrical NaI(Tl) crystal by using an activity $8,6 \mu\text{Ci } ^{137}\text{Cs}$ source. The source was placed 3 cm distance away from the detector. The measurement was performed for a period of 500s. The net photo peak counts at the 662 keV energy in the gamma ray spectrum was determined to be 2504535. Calculate the intrinsic efficiency of this detector at 662 keV energy. (The radius of the NaI (Tl) crystal is 2.55 cm, the gamma emission probability for 662 keV energetic gamma ray is 85.21%)

- 4.
- Why energy calibration should be done for a counting system having a multi channel analyzer and explain the energy calibration methods for these systems
 - For a CdZnTe detector, peak to valley (P/V) ratio is calculated for the peaks ,for instance using a standard source(for example ^{137}Cs at energy of 662 keV) as you did in the experiment . Then what does this parameter (P/V) mean? Explain.
- 5.
- Describe the detection mechanism of plastic scintillation detectors and dedector components by drawing a figure.
 - Write three main advantages of Plastic Scintillators.
 - Write three main disadvantages of Plastic Scintillators.
 - Write three fields of application of plastic scintillators.
 - Are plastic scintillators suitable for use in medical applications? Why?

Exam time is 75 minutes. Good luck.
Prof.Dr. Haluk YÜCEL

10617 Radiation Measurement Techniques Laboratory Final Exam (Experiment 2)

- Student could setup the experiment efficiently and use cautiously the instruments. The duty imposed in making a BNC connection to a coaxial signal cable was succesfully completed. (10 Points)
- Use GM Detector set-up and the following measurement parameters
 - Preset time: 60 seconds
 - Operating voltage: 900 V
 - Position: Top shelf
 - Source used: ^{90}Sr , ^{204}Tl

Experiment	R ₁ (count/min)	R ₂ (count/min)	R ₁₂ (count/min)
1			
2			
3			
Average Value			

Calculate the dead time of the G-M counter with the help of two source method.

- Why organic Anthracene crystal is more suitable for α/β radiation detection? Explain the reasons.
- Explain Single Channel Analyzer (SCA) and describe window concept. Mention the difference between integral and differential spectrum?
 - Calculate the compton edge for ^{54}Mn isotope (834.848 keV).

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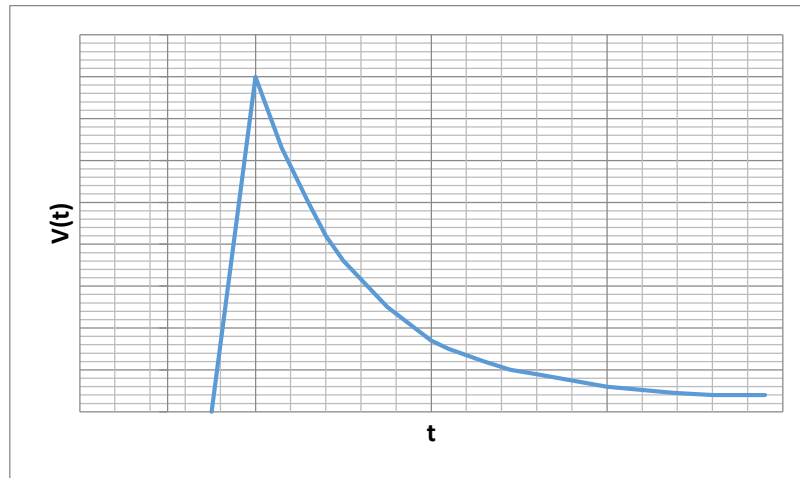
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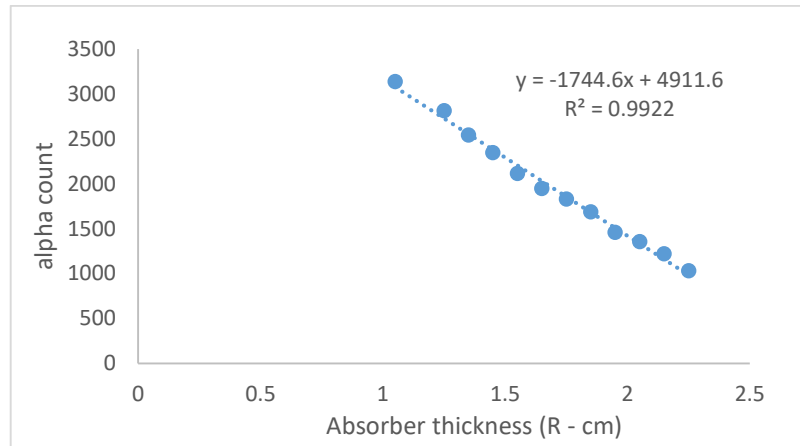
10. The following signal is taken from a spectroscopy system having a CdZnTe detector configured with analog NIM modules. When it is possible to obtain a signal as shown in the graph, Is it possible a signal like this form to use for spectroscopic purposes? If not, Why?



Exam time is 75 minutes. Good luck.

101617 Radiation Measurement Techniques Laboratory Final Exam (Experiment 3)

11. Student could setup the experiment efficiently and use cautiously the instruments. The duty imposed in making a BNC connection to a coaxial signal cable was successfully completed. (10 Points)
12. Adjust: Coarse gain=16, Fine gain=0.5; Count time: 20 second and the window of %5' for the ST 450 counting system setup with NaI (Tl) detector.
- Acquire differential spectrum for ^{137}Cs and ^{57}Co isotopes, respectively.
 - Acquire differential spectrum for ^{54}Mn and determine its channel number and then compare with channel value obtained from the calibration curve using ^{137}Cs and ^{57}Co sources.
 - Acquire an integral spectrum for ^{54}Mn source and interpret the spectrum.
13. In a GM counting system, an experiment was performed an ^{241}Am source and the maximum count is determined to be 3142. The alpha count - absorber thickness is shown as follow. Based on this information, explain and calculate the extrapolate range and the mean range for alpha particles.



14.

- Describe the detection mechanism of plastic scintillation detectors and the components of detector by drawing a figure.
- Write three main advantages of Plastic Scintillators.
- Write three main disadvantages of Plastic Scintillators.
- Write three fields of application of plastic scintillators.
- Are plastic scintillators suitable for use in medical applications? Why?

15. In the calibration NaI (Tl) detector several gamma rays are used and calibration equation is obtained as $E(x) = 1.0322x - 16.61$. The centroid of the photopeak is found at 135th channel. Calculate the energy of this photopeak.

**Exam time is 75 minutes. Good luck.
Prof.Dr. Haluk YÜCEL**

101617 Radiation Measurement Techniques Laboratory Final Exam (Experiment 4)

- Student could setup the experiment efficiently and use cautiously the instruments. The duty imposed in making a BNC connection to a coaxial signal cable was successfully completed. (10 Points)
- Calculate the energy resolution of the NaI (Tl) detector for ^{137}Cs . Explain the change of the energy resolution depending on the energy. (FWHM value should be calculated by yourself). Interpret the energy resolution with increase energy whether it is improved or degraded?

Settings

HV	:1,1 kV
Conv. Gain	: 2048
LLD	: %0,1
ULD	: %110
Input Size	: 2048
Live time	: 100 s

18. What does Chi square(χ^2) test mean? If 5 measurements are made for χ^2 test as given in the following Table, calculate χ^2 value by using these values and determine if your measurements agree with the Poisson statistics.

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Nr	X (Count)
1	2408
2	2427
3	2399
4	2400
5	2503

χ^2 distribution table									
Degrees of freedom	Probability								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
5	0.554	1.145	1.610	2.675	4.351	6.630	9.240	11.07	15.09

19. Calculate the dead time of the present G-M counter by using two source method from the following data, given in Table.

	R ₁ (count/min)	R ₂ (count/min)	R ₁₂ (count/min)
1	6500	7850	12595
2	6520	7755	12850

- 20.
- In the gas flow proportional counter system, how are α and β counts separated from each other. Which parameters of the system will affect the α counts and β counts during the counting ?
 - In the gas flow proportional counter system, write the main function of the guard detector in addition to the sample detector.

Exam time is 75 minutes. Good luck.

101617 Radiation Measurement Techniques Laboratory Final Exam (Experiment 5)

21. Student could setup the experiment efficiently and use cautiously the instruments. The duty imposed in making a BNC connection to a coaxial signal cable was successfully completed. (10 Points)
22. Calculate the energy resolution of CdZnTe detector for ²⁴¹Am and ⁵⁷Co isotopes. Explain the difference in energy resolution when increasing energy of incoming photons.

Settings

HV : -1,2 kV
Conv. Gain : 2048
LLD : %0,4
ULD : %100
Input Size : 2048
Live time : 120 sn

23. Explain integral and differential spectra by plotting their graphs. Show the important points on each spectrum.

24. A lead sheet is used for attenuation of photons emitted from ^{137}Cs source. In the experiment what is lead thickness(cm) to reduce the gamma ray intensity of ^{137}Cs source is a half ($\frac{1}{2}$) of the initial photon intensity (that is without lead sheet). Use data: mass attenuation coefficient of lead is $0.1035 \text{ cm}^2/\text{g}$ at 662 keV energy and lead density is 11.35 g/cm^3 .

25.

- Explain the effect of the coarse gain, fine gain and the operating voltage on the differential spectrum obtained with a single channel analyzer (SCA).
- Explain the function of scintillation crystal, photomultiplier tube (PMT), pre-amplifier and amplifier components in a scintillation counting system.

**Exam time is 75 minutes. Good luck.
Prof.Dr. haluk YÜCEL**

101617 Radiation Measurement Techniques Laboratory Final Exam (Experiment 6)

26. Student could setup the experiment efficiently and use cautiously the instruments. The duty imposed in making a BNC connection to a coaxial signal cable was successfully completed. (10 Points)

27. Set the following settings in front panel.

- Coarse gain : 10
- Conv.gain: 4096
- Fine Gain : 0.3
- LLD: %0.6
- Shaping time: $0.5 \mu\text{s}$
- ULD:% 110
- Input : norm(+)
- Zero: %0.01 Coinc. mode: check that it is “anti/norm”
- Set the counting time to 300 seconds.

Nuclide	Photopeak Energy (keV)	Gamma-ray emission probabilit, $P_\gamma(\%)$	Compton Edge, $E_{C\text{max}}(\text{keV})$	Channel Number of Compton peak
^{22}Na	511.00	180.7	340.67	
	1274.54	99.94	1061.70	
^{137}Cs	661.66	84.99	477.33	
^{54}Mn	834.84	99.97	639.21	

- Make an energy calibration of the system using the radioactive sources given in the table above.
- Plot an Energy(keV) vs channel number graph. Please fit the measured data in the form of a quadratic equation to obtain energy calibration equation.
- Compare the energy calibration equation obtained from the system with the calibration equation has been obtained from second step.
- Obtain a spectrum using a ^{241}Am alpha source at +750V operating voltage. Obtain a spectrum using a ^{90}Sr beta source at +920V operating voltage. Compare both of these spectra with each other.

28.

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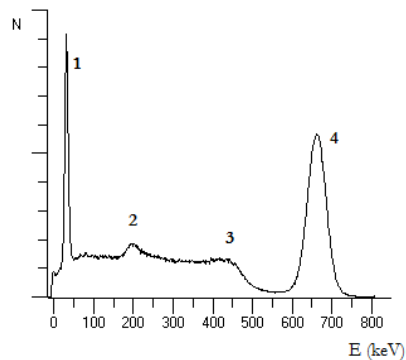
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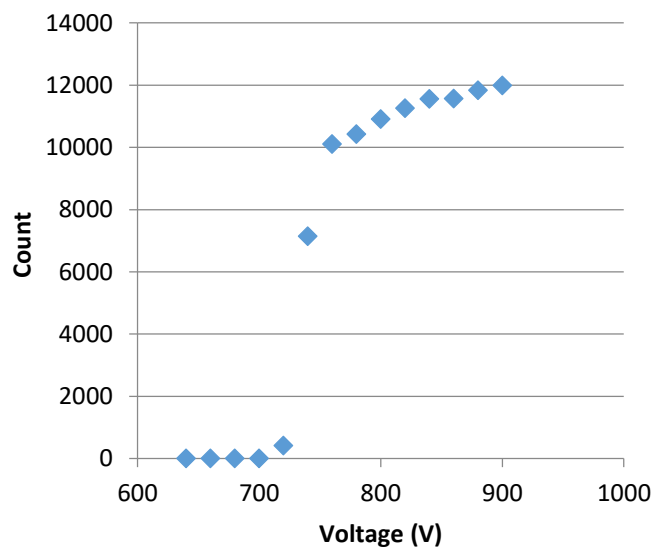
- a. Figure shows a differential spectrum obtained with NaI(Tl) detector for ^{137}Cs . Explain the regions indicated the numbers 1, 2, 3 and 4 observed on the ^{137}Cs source spectrum.



- b. Calculate the Compton edge for only 356 keV emitted from ^{133}Ba isotope.

29. Calculate the operating voltage for a GM system given the counting-voltage graph and values as follows. Calculate the minimum slope of the plateau will be determined by yourself.

Voltage (V)	Count	Voltage (V)	Count
640	0	780	10419
660	0	800	10909
680	0	820	11255
700	0	840	11560
720	417	860	11570
740	7143	880	11834
760	10104	900	11984



30.

- a. Why energy calibration should be done for a counting system having a multi channel analyzer and explain the energy calibration methods for these systems.
- b. For a CdZnTe detector, peak to valley (P/V) ratio is calculated for the peaks, for instance using a standard source (for example ^{137}Cs at energy of 662 keV) as you did in the experiment. Then what does this parameter (P/V) mean? Explain.

Exam time is 75 minutes. Good luck.
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