**HW# 3-NT-Ch-9-T172**

**Prob: 9.2** Sketch the differential energy spectrum for the integral spectrum shown in the figure below.

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**Solution**

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**Prob: 9.4:** If the energy resolution of a NaI(Tl) scintillator system is 11 % at 600 keV, what is the width Γ of a peak at that energy?

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**Γ=RE0=0.11X 600=66 keV**

**Prob: 9.6** Prove that if a detection system is known to be linear, the calibration constants are given by:



 where **El** and **E2** are two energies recorded in channels C1 and C2 respectively.

**Prob: 9.8** Shown in the following figure is the spectrum of 22Na ,with its decay scheme to determine the calibration constants of the MCA that recorded this spectrum, based on the two peaks of the 22Na spectrum. The channel number cannot be read exactly. What is the uncertainty of the calibration constants *a1* and *a2* if the uncertainty in reading the channel is one channel for either peak?



**Prob: 9.10:** Consider the two peaks shown in the accompanying figure. How does the peak at *E1* affect the width of the peak at *E2* and vice versa? What is the width **Γ** for either peak?



**Prob: 9.8** Shown in the following figure is the spectrum of 22Na ,with its decay scheme to determine the calibration constants of the MCA that recorded this spectrum, based on the two peaks of the 22Na spectrum. The channel number cannot be read exactly. What is the uncertainty of the calibration constants *a1* and *a2* if the uncertainty in reading the channel is one channel for either peak?





**Derive equation for uncertainty in *a1* and *a2* using error propagation equations given in Chapter 3, Knoll assuming**

***a*1=(E2C1-E1C2)/(C1-C2) =D/G, where D= E2C1-E1C2, G= C1-C2**

**Calculate σD and σG with σC1=σC2 = 1 using error propagation equations. Finally calculate σ*a1/a1***

Similarly do the calculation for **σ*a2 using a*2=(E1-E2)/(C1-C2)= (E1-E2)(C1-C2)-1=(E1-E2)F, where F=(C1-C2)-1. Then calculate σ*a2* with σC1=σC2 = 1 using error propagation equations.**

**σ*a*1/*a*1=√ [( E22σ*c*12+ E12σ*c*22)/(E2C1-E1C2)2]+[ (σ*c*12+ σ*c*22)/(C1-C2)2]**

**σ*a*2=√ [( E2-E1)(σ*c*1+ σ*c*2)]/(C1-C2)2**

**Assuming C1=50 and C2=135 and E1=0.511 MeV and E2=1.277 MeV**

**σ*a*1/*a*1= 22.67 %; σ*a*1=**

**σ*a*2/*a*2= 2.22 %; σ*a*2=**

**Prob: 9.10:** Consider the two peaks shown in the accompanying figure. How does the peak at *E1* affect the width of the peak at *E2* and vice versa? What is the width **Γ** for either peak?



**Both peaks are overlapping each other therefore full width at half maximum of each peak has changed.**

**Centroid of E1=Channel # 125**

**Centroid of E2=Channel # 250**

**Separation between the two channels =E2-E1= 250-125=125 Channels**

**Due to superposition of the two peaks in the inner side ( between channels 125-250) FWHM Γ of the peaks cannot be determined from full peaks spectrum. However we can calculate Γ/2 from either peak in the region of channels less than 125 or greater than 250.**

**For peak 1 max. height =6000**

**Half of height = 3000**

**Channels corresponding to Half-height ( on the left side of peak)=75**

**Then Γ/2 = 125-75=50 channels; Γ= 100 channels.**

**Similarly for peak 2**

**For peak 2 max. height =4500**

**Half of height = 2250**

**Channels corresponding to Half-height ( on the left side of peak)=300**

**Then Γ/2 = 300-250=50 channels; Γ= 100 channels.**

**Separation between the two channels =E2-E1< 2Γ= 1.25 Γ**

**Conclusion**

**Separation between the two channels =Γ > E2-E1< 2Γ= 1.25 Γ suggests the peak to be unresolved .**