

**Al-Balqa Applied University**  
**Experimental Techniques in Nuclear Physics**  
*Midterm Exam*

Dr. Saed Dababneh

May 4<sup>th</sup>, 2008

*This exam is meant to measure, in addition to your knowledge, your talent for creative thinking.*

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**Question 1** [25]

- a) Using Bethe formula, calculate the stopping power of nitrogen gas (1.251 g/L) for 5 MeV alpha particles? Compare your result to a SRIM calculation for the same particles in air.  
*Hint: For the mean ionization potential you may refer to <http://www.srim.org/SRIM/SRIMPICS/IONIZ.htm>*
- b) What is the relative probability of getting 5 heads in 8 tosses of a coin? Use the three models for statistical distribution and compare the results.
- c) One gram of  $^{226}\text{Ra}$  is sealed for two weeks. What are the activity and the number of atoms of  $^{222}\text{Rn}$  after this period?
- d) What is the maximum count rate that can be recorded by a detector with dead time 200  $\mu\text{s}$ ? What is the statistical fluctuation of this rate?
- e) A 2 minute count of a sample yields 3124 counts, and a 2 minute background measurements gives 1604 counts. Compute the net count rate (counts/min) and its standard deviation.

**Question 2** [10]

- a)  $\text{Al}_2\text{O}_3$  targets 95  $\mu\text{g}/\text{cm}^2$  in thickness are used to measure a nuclear reaction induced by alpha particle beam from a Van de Graaff accelerator at  $E_\alpha = 600$  keV. What is the energy range that these targets would integrate in a search for resonances? What is the corresponding range for protons at the same energy?
- b) Explain why we need, in general, higher beam currents for alpha induced nuclear reactions compared to proton induced reactions.

**Question 3** [25]

- a) How can the 6.13 MeV transition in  $^{16}\text{O}$  be used to calibrate a gamma spectrometer? Mention more than one method to obtain it. In which cases do we need it?
- b) Discuss why a HPGe detector used for measuring environmental samples should not be necessarily suitable for experiments with high energy gamma radiation from nuclear reactions.
- c) Discuss different methods for continuum reduction in gamma-ray spectroscopy.
- d) Why are escape peaks generally more prominent in Ge detectors compared with scintillators?
- e) For incident 2.1 MeV gamma-ray, at what energy does the peak appear in the spectrum from a pair spectrometer?

The Uranium-238 Decay Series

- <sup>235</sup>U Series
- <sup>232</sup>Th Series
- <sup>238</sup>U Series
- <sup>237</sup>Np Series

The four natural radioactive series

Boxed values for half-life are for multiple decay paths

