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

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

Question 1 [10]

A proton beam from a Tandem Van de Graaff accelerator is incident on and goes through a target composed of two adjacent metal foils, each of the same thickness. The emergent proton energy was measured. Derive a simple expression giving the emergent beam energy as a function of the incident beam energy and the thickness of each foil. Would the emerging proton energy be different if the foils had been interchanged? If so, what is this difference?

Question 2 [20]

A Monte Carlo generated digital gamma ray spectrum is provided to you. The spectrum was acquired using a HPGe detector for a ^{137}Cs source, where the resolution of the detector has not been included in the simulation. Comment comprehensively on the spectrum, indicating the different features with the appropriate calculations.

Question 3 [15]

Calculate the stopping power of nitrogen gas (1.251 g/L) for 5 MeV alpha particles? Compare your result to a SRIM calculation.

Hint: For the mean ionization potential you may refer to http://www.srim.org/SRIM/SRIMPICS/IONIZ.htm

Question 4 [5]

Among the isotopes emitted in the 1986 Chernobyl accident were ^{131}I and ^{137}Cs. There are about five times as many ^{137}Cs atoms as ^{131}I atoms produced in fission.

a) Which isotope of these two contributes the greater activity to the radiation cloud? Assume the reactor had been operating continuously for several days before the radiation was released.
b) How long after the original incident does it take for the two activities to become equal?
c) About 1% of fission events produce ^{131}I. Given a reactor of the Chernobyl size (1000 MW), calculate the activity of ^{131}I after 24 hours of operation.

Question 5 [15]

Explain in details why do we need, in general, higher beam currents for alpha induced nuclear reactions compared to proton induced reactions. Give examples.

Question 6 [5]

Calculate the ratio between the differential scattering cross section $d\sigma/d\Omega$ for a 10 keV photon compared to a 10 MeV photon when both are scattered at 0^0, 90^0 and 180^0. Comment on your results providing possible experimental implications.