Bago University
Department of Physics
Second Semester Examination, September 2019

Fourth Year (BSc)
(Physics Specialization)

Phys 4104
Nuclear Physics
Time Allowed: (3) Hours

Answer any Six questions.

1 (a) What is meant by nuclear fission? How can you classify the nuclear fission? When will the nucleus be unstable?

(b) Show that the spontaneous fission should be energetically possible is $\frac{Z^2}{A} > 17.6$.
Surface energy = 0.019114 u, Coulomb energy = 0.0007626 u

2 (a) Show that the height of the Coulomb barrier for symmetric fission is given by $E_c(\text{MeV}) = 0.15\frac{Z^2}{A^{1/2}}$.

(b) Calculate the Coulomb potential energy of two fission fragments $^{148}_{57}$La and $^{87}_{35}$Br at contact. Taking $R_0 = 1.45\times10^{-15}$m.

3 (a) Distinguish between the process of nuclear fission and nuclear fusion.

(b) Calculate the approximate mass of uranium which must undergo fission to produce same energy as is produced by the combustion of 10^5 kg of coal. Heat of combustion of coal is 8000 kcal/kg; the energy released per fission of ^{235}U per gm-atom (1 cal = 4.2 joules).

4 (a) What is a nuclear reactor? How can you classify the types of nuclear reactor? Explain briefly them.

(b) What is the smallest value of the ratio of the number of ^{235}U atoms to water molecules in a homogeneous mixture of ^{235}U and water for which a thermal neutron chain reaction will be possible in an infinitely large system? Assume $\sigma_{aM} = 0.66$ b, $\sigma_U = 687$ b, $\eta = 2.07$.

5 (a) How do you understand multiplication factor?

(b) Calculate the reproduction factor for an enriched uranium-graphite moderated assembly, using 400 moles of graphite to 1 mole of uranium and a U^{238}/U^{235} ratio of 70. $\sigma_{a0} = 12.54$ b, $\sigma_{a1} = 0.0032$b, $\sigma_{s1} = 4.8$ b, $\xi = 0.158$, $\eta = 1.63$.

6 (a) Explain briefly the characteristics of major neutron producing sources.

(b) Calculate the Q-value for the D-T fusion reaction $^3_1H(d, n)^4_2He$.
$m_D = 2.01402$ amu, $m_T = 3.01603$ amu, $m_n = 1.008665$ amu, $m_{He} = 4.002603$ amu

7 (a) Derive neutron energy of the reaction depends of the angle of emission.

(b) The reaction ^{3}H (p, n) ^{3}He has the Q-value -0.765 MeV. If protons of 1 MeV energy are used to produce the reaction, what would be energy of the neutrons at 45°, 90° and 135° to the incident proton beam?

8 (a) Prove that $\frac{dE}{E} = 2\frac{d\theta}{\theta}$ for small glancing angle. Which quantity determines the energy spread of the beam at a given energy?

(b) Calculate the energy released per fusion of four hydrogen nuclei. $M(^1H) = 1.007825$ u, $M(^0_{+1}e) = 0.000549$ u, $M(^4He) = 4.002604$ u

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