UNIVERSITY OF EMBU

2017/2018 ACADEMIC YEAR

SECOND SEMESTER EXAMINATIONS

FOURTH YEAR EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE

SPH 402: NUCLEAR PHYSICS

DATE: APRIL 9, 2018   TIME: 2:00-4:00PM

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions.

You may find the following useful

$U = 1.66 \times 10^{-27}$ kg $= 931.5$ MeV

1 a.m.u $= 931$ eV

$_0^1 n = 1.00866$ u

$_{92}^{235} u = 235.643915$ u

$_{56}^{141} Br = 140.91390$ u

$_{36}^{92} Kr = 91.897$ u

QUESTION ONE (30 MARKS)

a) Differentiate between isobars and isomers   (2 marks)

b) Based on the odd-even rule, predict which of each pair is radio active

   i. $_{20}^{40}Ca$ and $_{20}^{45}Ca$ (2 marks)

   ii. $_{80}^{195}Hg$ and $_{80}^{196}Hg$ (2 marks)

c) Briefly explain the assumption and predictions of the shell model   (4 marks)

d) Describe briefly the classification of nuclear reactions and the conservation laws in analyzing nuclear reactions   (4 marks)

e) Briefly describe meson theory of nucleus stability   (3 marks)

f) Describe the characteristics of a nucleon-nucleon force   (3 marks)

g) Of the four categories of interactions in matter, the nuclear force is considered the strongest. What would you consider as evidence for this great strength   (2 marks)

h) Consider a simple two particle nuclear reaction represented by an expression of the form

$X + x \longrightarrow Y + y$, where X, x, Y and y are the target nucleus, incident projectile, product nucleus and product particle respectively. Deduce the energy balance equation of the reaction, by applying the principle of conservation of momentum.

            (4 marks)

i) Differentiate between nuclear fission and nuclear fusion   (2 marks)

j) Explain two characteristics of molecules in a drop of liquid which are analogous to those of the nucleus   (2 marks)

QUESTION TWO (20 MARKS)

a) Find the energy released in the fission reaction

$$^{1}_{0}n + {}^{235}_{92}U \longrightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3({}^{1}_{0}n)$$ (6 marks)

b) A tritium sample ($^{3}_{1}H$) has a half life of 4600 days. Determine

    i. the activity of the sample of tritium   (4 marks)

    ii. Initial mass in grams of the sample present   (4 marks)

c) What is the binding energy (BE) of a nucleus? Plot a curve showing the dependence of BE/nucleus on the atomic mass. What is the significance of low BE/nucleon and high atomic mass numbers?   (6 marks)

QUESTION THREE (20 MARKS)

    a) Briefly describe the Rutherford's atomic model   (6 marks)

    b) Consider the binding energy of particles in He^{4} nucleus which has an atomic mass of 4.00386amu. If the mass of hydrogen atom is 1.008142 amu and that of a neutron is 1.0089amu, calculate m

        i) . mass defect Δm (4 marks)

  ii) Binding energy   (4 marks)

 c) Discuss biological effects of nuclear radiations in humans   (6 marks)

QUESTION FOUR (20 MARKS)

 a) Elementary particles can be classified as either particles or force transmitters between particles. They can also be classified on spin, charge and composition

  i) Using the two groups, list and classify elementary particles   (8 marks)

  ii) Mesons and Byrons are also types of elementary particles, to which form of classification do mesons and byrons belong? Explain ?   (6 marks)

  iii) Distinguish between mesons and byrons   (6 marks)

QUESTION FIVE (20 MARKS)

 a) Bohr atom is an improvement on Rutherfords atomic model, Explain.

                         (6 marks)

 b) Calculate the wavelength of the first three spectral lines in the Balmer series

                         (9 marks)

 c) A relic is found to give an activity count of 12cpm(counts per minute) for each gram of carbon. If living tree give a count of 16cpm, find the approximate age of the relic.

                         (5 marks)

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