BOWEN UNIVERSITY, IWO. OSUN STATE. NIGERIA

COLLEGE OF AGRICULTURE, ENGINEERING, AND SCIENCES

PHYSICS PROGRAMME

FIRST SEMESTER EXAMINATION, 2023

PHY 445: NUCLEAR AND PARTICLE PHYSICS I (2 CREDITS)

DATE: SATURDAY, 11TH FEBRUARY 2023   TIME: 3.30p.m – 5.30p.m

INSTRUCTION: ATTEMPT ANY THREE QUESTIONS
      (Each question carries 33 marks plus 1 mark for neat and clear presentation)

....

Use the following constants where applicable.

Planck's constant, h = 6.63 x 10^{-34} J.s,   charge on an electron e = 1.6 x 10^{-19} C,

1u (atomic mass unit) = 1.66 x 10^{-27} kg,   1 eV = 1.602 X 10^{-19},

rest mass of proton = 1.007276u,   rest mass of electron = 1.008665u

rest energy equivalent (1u) = 931.494 MeV/u,   mass of electron Me = 9.1 x 10^{-31} kg

....

1.   (a)   On the basis of mediating particle, the strength, the range and where they exist explain
              in details, the four fundamental forces of nature.   [12marks]

      (b)   (i) Differentiate between quarks and leptons •   [5marks]

             (ii) What are bosons?   [5marks]

      (c)   Find the energy emitted in alpha decay in Pu-239, given that the decay equation is;

             $$^{239}Pu \rightarrow \;^{235}U + \;^{4}He.$$

             where   Pu = 239.052157, U = 235.043924 and He (alpha particle) = 4.002602 •   [11marks]

2.   (a)   Write short notes on the properties of the nucleus of an atom with regards to its:
             (i) constituents,
             (ii) charge and
             (iii) size•   [15marks]

      (b)   Explain why the nucleons in the nucleus of an atom are still tightly knitted despite
             the presence of coulomb's repulsive force.   [8 marks]

      (c)   Given that the mass of Iron (Fe-56) is 56 u and r_0 = 1.2 fm, Find

             (i) its radius (ii) its volume and (iii) the density of Fe-56 •   [10marks]

3.   (a)   (i) What are Nuclear models? (ii) Mention three nuclear models you know?   [5 marks]

(b)   (i) State four (4) effects taken into consideration (and explain two), when Dr. Neil Bohr was developing his own nuclear model.   [15 marks]

(ii) What is the name of his model called?   [3 marks]

(c) $^{226}_{88}$Ra nucleus undergoes alpha decay such that

$^{226}_{88}$Ra ----------- $^{222}_{86}$Rn + $^{4}_{2}$He

Calculate the Q-value for this process, if;

^{226}Ra has mass 226.025403u ,
^{222}Rn has mass 222.017570u ,
^{4}He has mass 4.002603u .   [10 marks]

4.   (a)   Explain the term **thermonuclear** fusion reaction?   [5 marks]

What do you understand by the term '**nuclear enrichment**'?   [6 marks]

(b)   (i) Explain what 'K- factor' is and its importance in the operation of a Nuclear Reactor.   [6 marks]

(ii) In setting up a self-sustained Nuclear Reactor, what are the things one must put into consideration before doing this?   [6 marks]

(c)   (i) Calculate the energy released in a nuclear reaction when 1.00 kg of U-235 is made to undergo fission, if the disintegration energy per event, Q = 208 MeV.   [10 marks]

Moderated

24/01/2023