NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

DEPARTMENT OF APPLIED PHYSICS

SPH 4102 – NUCLEAR PHYSICS

SUPPLEMENTARY EXAMINATION

BSc HONOURS PART IV: JULY 2005 *DURATION: 3 HOURS*

ATTEMPT ALL PARTS OF QUESTION1 FROM SECTION A AND ANY THREE FROM SECTION B. DRAW NEAT DIGRAMS WHEREEVER NECESSARY.

Planck's Constant	h	$= 6.63 \times 10^{-34}$ J s
Permittivity of Free Space	ε_0	$= 8.85 \times 10^{-12}$ F m^{-1}
Permeability of Free space	μ_0	$= 4\pi \times 10^{-7}$ W m^{-1}
Avogadro's Number	N_A	$= 6.022 \times 10^{23}$ mol^{-1}
Boltzmann's Constant	k	$= 1.38 \times 10^{-23}$ J K^{-1}
Rest mass of an Electron	m	$= 9.1 \times 10^{-31}$ kg
Charge on an Electron	e	$= 1.6 \times 10^{-19}$ C
Atomic Mass Unit	M	$= 1.66 \times 10^{-27}$ kg

SECTION A

1. (a) What is meant by the term " cross section " as applied to nuclear reactions? [4]

(b) Explain the terms " Hydrons and Leptons" Give examples [5]

(c) Calculate the velocity of a proton of energy 10 MeV as afraction of the velocity of the light. How long a proton would take to move from the ion source to the target in a uniform 10 MV accelerating tube 3 m long? [6]

(d) Derive the semi empirical mass formula for a nucleus. [8]

(e) Calculate the binding energy and the binding energy per nucleaon for ^{114}Cd given that the mass excess are p = 7.29 MeV, n = 8.07 MeV, ^{114}Cd = - 90.01 MeV, ^{113}Cd = - 89.04 MeV ^{113}Ag = -87.04 MeV. [6]

(f) Explain the nuclear stability. [5]

(g) Explain the meaning of the term *magic numbers.* [6]

SECTION B

2. (a) Explain the displacement laws of the isotope formation in a radioactive series. Apply the rules to the radio acive disintgration of $^{231}_{92}Th$. [10]

(b) How neutron and neutrino were predicted and detected by Chadwick? Write the expressions for the velocities of proton and nitrogen nuclus in the Chadwick's experiment. [10]

3. (a) Explain the process of alpha decay and barrier penetration. [8]

(b) Discuss the Gamow's theory of alpha decay. [8]

(c) The Q value for alpha decay of RaC (^{214}Po) is 7.83 MeV. What is the energy of the alpha particles emitted? [4]

4. (a) Discuss in detail the shell model of the nucleus. How will you confirm the existence of the nuclear shells? [10]

(b) Using the relativistic relation between energy and momentum, find the minimum kinetic energy of an (i) electron, and (ii) a proton confined within a dimenssion of 7×10^{-15} m. Assume $\Delta p \times \Delta r = h$. [10]

5. (a) What do you understand by the term fission? Give illustartions. [6]

(b) Discuss the theory of the fission. [9]

(c) Calculate the energy release in the spontaneous fission of $^{232}_{92}U$ *to* $^{145}_{57}La$ *and* $^{87}_{35}Br$. The masses concerned are ^{231}U = 231.0363, ^{232}U = 232.0372, ^{146}La = 145. 9255, ^{145}La = 144.9217, ^{87}Br = 86.9203 and ^{1}n = 1.0087. [4]

6. Write notes on
   (i) Fusion,
   (ii) Tokamak Reactor,
   (iii) Nuclear reactions and
   (iv) Weak and strong interactions. [20]

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