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OFFICE OF THE DEPUTY PRINCIPAL
ACADEMICS, STUDENT AFFAIRS AND RESEARCH

UNIVERSITY EXAMINATIONS

2020 /2021 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER REGULAR EXAMINATION

FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE

COURSE CODE: PHY 318

COURSE TITLE: NUCLEAR AND ATOMIC PHYSICS

DATE: 12/03/2021 TIME: 1400 – 1700HRS

INSTRUCTION TO CANDIDATES

- SEE INSIDE

THIS PAPER CONSISTS OF 4 PRINTED PAGES PLEASE TURN OVER

REGULAR-MAIN EXAM

PHY 318: NUCLEAR AND ATOMIC PHYSICS

STREAM: BED (Science) **DURATION: 3 Hours**

INSTRUCTIONS TO CANDIDATES

i. *Answer **TWO** questions in section **A** and any other **THREE** questions in section **B**.*

You may need to use the following constants

- *Mass of an electron, Me* $=9.11\times10^{-31}$ *Kg*
- *Mass of a proton, Mp* $=1.67\times10^{-27}$ *Kg*
- *Electronic charge, e* $= 1.6 \times 10^{-19}$ *C*
- $1eV = 1.6\times10^{-19}J$
- *Avogadro's number*$= 6.02 \times 10^{23} particles$

SECTION A (28 MARKS)

Question One (12 Marks)

(a) What are magic numbers? (2 Marks)

(b) Explain the salient features of the shell model (4 Marks)

(c) Differentiate between nuclear fission and nuclear fusion (2 Marks)

(d) Highlight the main source of background counts during Nuclear radiation detection experiments (4 Marks)

(e) What is radiation? Give examples. (2 Marks)

Question Two (12 Marks)

(a) What is Zeeman's effect? Explain. (3 Marks)

(b) Sketch the continuous x-ray radiation spectrum from a tungsten target (4 Marks)

(c) With aid of a diagram show how the potential energies of hydrogen atom varies. (3 Marks)

(d) What are the possible values of total angular momentum quantum number j and m_j for an electron in the $L = 2$ state? (4 Marks)

SECTION B (42 MARKS)

Question Three (14 Marks)

(a) What is internal conversion? (1 Mark)

(b) Radium ($^{226}_{88}Ra$) has a decay constant of $\lambda = 1.36 \times 10^{-11} s^{-1}$, determine how long it can take 2g to reduce to 1g (4 Marks)

(c) Highlight the key preliminary assumption of nuclear and its forces made in liquid drop model? (3 Marks)

(d) What are the essential similarities of the liquid-drop model compared to nucleons in the nucleus? (6 Marks)

Question Four (12 Marks)

(a) Show that the Lande's g factor is given by the expression $g = 1 + \frac{[J(J+1)+S(S+1)-L(L+1)]}{2J(J+1)}$, the symbols have their usual quantum meanings. (5 Marks)

(a) By derivation, show that in Compton effect, an increase in the photon's wavelength as a function of the scattering angle is given by $\Delta\lambda = \lambda' - \lambda = \frac{h}{m_0 c}(1 - \cos\theta)$, where the symbols have their usual meaning (9 Marks)

Question Five (12 Marks)

(a) What are fundamental interactions (1 Marks)

(b) Give four basic classes of fundamental forces (4Marks)

(c) Derive the Q-equation that governs the nuclear kinematics. (9 marks)

Question Six (14 Marks)

(a) ((i) Define the following terms, radioactivity, absorbed dose, activity, as used in nuclear physics (6 Marks)
(ii) Highlight the key precautions on radiation safety measures (2 marks)
(iii) State factors on which effects of radiation depend on? (2 Marks)

(b) Write a note on quarks model baryons as elementary particles (4 Marks)

Question Seven (14 Marks)

(a) Explain briefly the sodium spectrum (8 Marks)

(b) Explain the working principle behind the Doppler-free two-photon spectroscopy (6 Marks)

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