KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2020/2021 ACADEMIC YEAR

FIRST YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF MASTERS IN SCIENCE (PHYSICS)

COURSE CODE: SPH 817

COURSE TITLE: NUCLEAR AND PARTICLE PHYSICS

DATE: 4/10/2021 **TIME:** 8:00-10:00AM

INSTRUCTIONS TO CANDIDATES

TIME: 2 HOURS

Answer any THREE questions

QUESTION ONE [20 MARKS]

a) Differentiate between the following terms-: [5 marks]

(i) Isobars and isotones

(ii) Dynamical and beta instabilities

(iii) Nuclear fusion and nuclear fission

(iv) Pick up and stripping off nuclear reaction processes

(v) Mass defect and binding fraction

b) In Fermi gas nuclear model, using the thermodynamic relation $P = -\frac{\partial U}{\partial V}$ show that the pressure inside the nucleus is given by $\frac{2}{5}\rho_n E_F$ where ρ_n is the neutron density. [5 marks]

c) A nuclear fission process is given by:- ${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{141}_{56}Ba + {}^{92}_{36}Kr + 3{}^{1}_{0}n + Q$. Calculate the energy Q released during the process. [mass of ${}^{235}_{92}U$=235.04278u, $m_n = 1.008665u$, mass of ${}^{141}_{56}Ba$=1409192u and mass of ${}^{92}_{36}Kr$=91.81719u] [5 marks]

d) How long does is take for 60% of a radioactive sample to decay if it has half life of $3.82days$. [5 marks]

QUESTION TWO [20 MARKS]

Explain in detail any two nuclear models [20 marks]

QUESTION THREE [20 MARKS]

Discuss the properties of the nucleus under the subheadings:- [20 marks]

(a) Its size, mass, volume and density.

(b) Its composition

(c) Its binding energy

(d) Nuclear forces

QUESTION FOUR [20 MARKS]

In detail discuss and classify elementary particles [20 marks]

QUESTION FIVE [20 MARKS]

a) The electric quadrupole moment of nuclear charge distribution which is symmetric about z-axis is given by:- [10 marks]

$\mu = \frac{1}{e}\int(3z^2 - r^2)\rho(x,y,z)dxdydz$ for a uniformly charged ellipsoid of revolution defined by the equation:- $\frac{x^2+y^2}{a^2} + \frac{z^2}{b^2} = 1$. Show that the electric quadrupole moment is given by:- $\mu = \frac{6z}{5}R_0^2\left(\frac{\delta R_0}{R_0}\right)$.

b) Show that the Coulomb energy is given by:- $E_C = \frac{3}{5}\frac{kZ(Z-1)e^2}{R}$ for a proton in nucleus if the charge is uniformly spherically distributed. [10 marks]