ATN – 10

B.Sc. (Semester – V) Examination, October/November 2018
PHYSICS (Paper – III)
Nuclear Physics

Duration : 2 Hours | Max. Marks : 80

Instructions : *1) **All** questions are **compulsory**.*
*2) Figures to the **right** indicates **maximum** marks.*
*3) **Use** of log tables and calculator is **permitted**.*
4) Symbols have their usual meaning unless specified.

1. Answer **any four** of the following : **16**

   a) How is the magnetic dipole moment associated with nucleus ? Explain how neutron has the moment despite neutral charge.

   b) Explain how radioactive C^{14} is formed in the atmosphere and enters in plants and animals.

   c) Explain K-capture process. Why it is considered as beta decay ?

   d) State the important assumptions on which liquid drop model is built.

   e) Assume when planet earth was formed, U^{238} and U^{235} were present in equal abundance. At present, the ratio of their abundance is 140 : 1. If their half-lives are 4.5×10^9 years and 7.14×10^8 years respectively, estimate the age of the earth.

   f) Show that in an orbit of given 'j' there may be at most 2j + 1 nucleons. How many nucleons are allowed in 'p' state ?

2. Answer **any four** of the following : **16**

   a) What do you mean by electric quadrapole moment ? How is the value of this moment correlated to shape of the nucleus ?

   b) What is Geiger-Nuttal rule ? Represent the rule graphically.

   c) Why is radioactive decay a statistical phenomenon ? Derive mathematical expression for radioactive decay using the concept of probability.

   d) Draw a schematic diagram of a nuclear chain reaction. Our country's submarine INS ARIHANT nuclear reactor became critical. What do you mean by nuclear reactor becoming critical ?

P.T.O.

e) Radioactive material reduces to 20% of its initial quantity in 10 hours. Find its decay constant and half life.

f) Determine the possible states of a deuteron if its total angular moment has quantum number J = 1. The ground state is mixture of which two states ?

3. A) p) Define : i) isotope ii) isotone iii) isobar. 3

q) The mass of meson is found to be 2.1×10^{-28} kg. Determine the range of nuclear force. ($h = 1.054 \times 10^{-34}$ joule-sec, $c = 3 \times 10^{8}$ m/sec.) 3

OR

A) x) Discuss briefly meson theory of nuclear forces. 3

y) Determine the radii of an O^{16} and a Pb^{208} nucleus ($R_0 = 1.5$ F). 3

B) How can you justify whether the nuclear force is a tensor force or non-central force ? 6

4. A) p) Write a short note on nuclear isomerism. 3

q) One gram of Ra^{226} is found to emit 3.7×10^{10} alpha particles per second. Find the half-life and average life. Avagadro number 6.023×10^{23}. 3

OR

A) x) Draw schematic diagram of alpha ray spectrograph and explain how it is used to determine kinetic energy of alpha particle. 3

y) State the properties of neutrino. During α-decay why there is no emission of neutrino ? 3

B) Describe qualitatively, how quantum mechanical concept - 'Tunnel Effect' explains alpha decay. Also elaborate how Gieger-Nuttal rule supported this theory. 6

5. A) p) According to shell model, what are the spins and parities of the nuclei $_{9}F^{17}$ and $_{15}P^{31}$ in their ground states ? 3

q) What are magic numbers ? State the evidences for the existence of magic numbers. 3

OR

A) x) Explain the role of Pauli's exclusion principle in nuclear shell model. **3**

y) The semi empirical mass formula can be simplified as

$${}_ZM^A = \alpha A + \beta Z + \gamma Z^2 + E_\delta$$

What is the nature of curve if ${}_ZM^A$ is plotted against Z ? Draw the curve for odd nuclide and hence explain beta decay. **3**

B) Derive Wiezsacker's semi-emperical mass formula on the basis assumptions of liquid drop model. **6**

6. A) p) Define multiplication factor K. What happens in nuclear chain reaction when $K < 1$, $K > 1$ and $K = 1$? **3**

q) Give the construction of ionization chamber and explain its working. **3**

OR

A) x) Calculate energy released by the fission of 2 gm of ${}_{92}U^{235}$ in kWh. Given that the energy released per fission is 200 MeV.

$(1\ eV = 1.603 \times 10^{-19}$ Joule) **3**

y) Give examples of visual detectors. Which information of elementary particles can be obtained from these detectors ? **3**

B) Draw neat labelled schematic diagram of nuclear reactor. Briefly describe role of essential components 1) reactive core 2) Moderator 3) Coolant 4) Heat exchanger. **6**
