T.Y.B.Sc (Sem VI) March. 2015

physics

Nuclear physics

Q.P. Code : 14685

[Total Marks : 75

(2½ Hours)

N.B.: (1) All questions are **compulsory**.
(2) Figures to the right indicate full marks.
(3) Draw **neat** diagrams wherever **necessary**.
(4) Symbols have their usual meanings unless stated otherwise
(5) Use of log table and non programmable calculator is allowed.

1. (a) Attempt any one.
   (i) Discuss alpha decay paradox. How did Gamow resolve it ? State the conclusions. **10**
   (ii) Define Q equation. Derive an expression for the same. Obtain its solution for exoergic nuclear reactions. **10**

   (b) Attempt any one.
   (i) With the help of a relevant graph, explain the Geiger-Nuttal law for alpha emitters. **5**
   (ii) Name the different types of nuclear reactions and explain any one with an example. **5**

2. (a) Attempt any one.
   (i) What were the difficulties involved in the interpretation of β-ray spectrum ? Explain them in brief. How did Pauli overcome these difficulties ? **10**
   (ii) What is Mossbauer effect ? Describe the experimental set up to study Mossbauer effect. Explain the significance of the movable source in the above setup. **10**

   (b) Attempt any one.
   (i) With the help of neat labeled diagram, describe experimental arrangement of Reines & Cowan's experiment for the detection of neutrino. **5**
   (ii) Explain the nuclear isomerism with the help of suitable example. **5**

3. (a) Attempt any one.
   (i) Discuss variation of ionization current (pulse height) with voltage. Explain each region with the help of graph. **10**
   (ii) Obtain Weizacker's semiempirical mass formula. Explain the contribution of each term. **10**

b) Attempt any one.

(i) Discuss the merits and demerits of cloud chamber. 5

(ii) Discuss energetics of mirror nuclei. 5

(a) Attempt any one.

(i) What is fission chain reaction ? What are the difficulties one comes across in achieving sustained chain reaction with uranium ? Describe neutron cycle in a thermal nuclear reactor. 10

(ii) What are elementary particles ? Give an account of the experimental detection of antiproton and antineutron. 10

(b) Attempt any one.

(i) Explain the process of energy production in stars. 5

(ii) What do you understand by prompt neutrons and delayed neutrons ? Explain the significance of delayed neutrons in a nuclear reactor. 5

5. (a) Attempt any one.

(i) $^{214}_{84}Po$ decays by emitting four groups of alpha particles having kinetic energies in (MeV) of 7.68, 8.28, 9.07 and 10.51 respectively. Calculate the alpha disintegration energies. Sketch the energy level scheme. 4

(ii) A neutron beam is incident on a stationary target of $^{19}_{9}F$ atoms. The reaction $^{19}_{9}F\ (n, p)\ ^{19}_{8}O$ has a Q value of – 3.9 MeV. Calculate the lowest neutron energy which will make the reaction possible. 4

(b) Attempt any one.

(i) Prove that $^{40}_{19}K$ shows β^+ activity when it decays into $^{40}_{18}A$ and calculate corresponding Q_{β^+}. 4

Given :- $M\ (^{40}_{19}K) = 39.964000\ u$

$M\ (^{40}_{18}A) = 39.962384\ u$

$m_e = 0.51\ MeV$

$1\ u = 931.5\ MeV$

(ii) Calculate the energy of γ rays emitted in the β decay of $^{14}_{6}C$ 4

Given :- $M\ (^{14}_{6}C) = 14.003242$ u

$M\ (^{14}_{7}N) = 14.003074$ u

End point energy = 0.65 MeV

1 u = 931.5 MeV

(c) Attempt any one.

(i) The ionization chamber is connected to an electrometer of capacity 0.6 pf and voltage sensitivity of 2 divisions per volt. A beam of α - particles causes a deflection of 1.0 division. Calculate the number of ion-pairs required and the energy for the source of α - particles. 4

Charge on electron $e = 1.6 \times 10^{-19}$ C.

(ii) For an isobaric family with A = 39, estimate the nuclear charge Z_0 for the most stable isobar. 4

Given :- $a_a = 19$ MeV, $a_c = 0.60$ MeV

$M_p = 1.007825$ u

$M_n = 1.008665$ u

1u = 931.5 MeV

(d) Attempt any one.

(i) A sample of 5 gram of $^{235}_{92}U$ is completely fissioned. Calculate the amount of energy released 3

Given : Energy released per fission of $^{235}_{92}U$ nucleus is 170 MeV.

Avogadro number $A_v = 6.023 \times 10^{23}$ mole^{-1}.

(ii) How many neutrons will there be in the 25th generation, if the fission process starts from 1000 neutrons and k = 1.03 ? 3