Seat No. _____

H-003-2016031

B. Sc. (Sem. VI) (CBCS) (W.E.F. 2019) Examination

April - 2023

Physics - 601

Faculty Code : 003

Subject Code : 2016031

Time : $2\frac{1}{2}$ Hours / Total Marks : **70**

Instructions : (1) All questions are compulsory.
(2) Symbols have their usual meanings.
(3) Figures to the right indicate marks.

1 (a) Answer the following in short : **4**

(1) The proton and neutron are jointly called _____.

(2) Isobars are atoms of different elements having the same number of _____.

(3) Define mirror nuclei with an example.

(4) Write the volume term in the semi-empirical formula.

(b) Answer in brief : (any **one**) **2**

(1) The binding energy of $_{21}Sc^{50}$ is 425 MeV. How much energy is required to remove a nucleon from it ?

(2) Calculate the binding energy of $_{21}Sc^{50}$ using semi-empirical mass formula, if $a = 14$, $b = 13$, $c = 0.583$, $d = 19.3$ and $\delta = 33.5$.

(c) Answer in detail : (any **one**) **3**

(1) Write a note on nuclear density.

(2) Give evidences of shell model of nucleus.

(d) Write notes : (any **one**) **5**

(1) Explain variation of binding energy with mass number.

(2) Write a note on liquid drop model of the nucleus.

2 (a) Answer the following in short : **4**

(1) Define natural radioactivity.

(2) α-particles produce _____ when they fall on zinc sulphide screen.

(3) The penetrating power of β-particles is _____ (more/less) than that of α-particles.

(4) γ-rays are not affected by _____ and _____ fields.

(b) Answer in brief : (any **one**) **2**

(1) A radioactive substance has a half-life of 50 days. Calculate the radioactive disintegration constant and the average life period.

(2) A radioactive substance has a decay constant 0.0182 per day. Calculate the time taken for 20% of the original number of atoms to remain unchanged.

(c) Answer in detail : (any **one**) **3**

(1) Write general rules of alpha and beta decay.

(2) Write a note on Nuclear isomerism.

(d) Write notes : (any **one**) **5**

(1) Explain half life and mean life.

(2) Write applications of radioisotopes.

3 (a) Answer the following in short : **4**

(1) What is pair production ?

(2) Write in abbreviated form

$${}_4Be^9 + {}_2He^4 \rightarrow {}_0n^1 + {}_6C^{12}.$$

(3) Complete the reaction

$${}_{29}Cu^{65} + \_\_\_\_\_ \rightarrow {}_{30}Zn^{65} + {}_0n^1.$$

(4) What is Compton scattering ?

(b) Answer in brief : (any **one**) **2**

(1) Find the Q-value for the reaction ${}_7N^{14}\left(n, \alpha\right){}_5B^{11}$ given

$m\left({}_7N^{14}\right) = 14.003074\ u,\ m\left({}_2He^4\right) = 4.002604\ u,$

$m\left({}_5B^{11}\right) = 11.009305\ u,\ m\left(n\right) = 1.008665\ u$

(Take 1u = 931 MeV). State whether the reaction is endothermic or exothermic.

(2) Write in expanded form :

(a) $K^{39}\left(n, 2n\right)K^{38}$

(b) $Na^{23}\left(p, \alpha\right)Ne^{20}$

(c) Answer in detail : (any **one**) **3**

(1) Explain energy balance in nuclear reactions.

(2) Explain transmutation by neutrons.

(d) Write notes : (any **one**) **5**

(1) Explain the conservation laws for nuclear reactions.

(2) Expain the construction and working of Scintillation counter.

4 (a) Answer the following in short : **4**

(1) Write the formula for the length of the n^{th} cylinder of a linear accelerator.

(2) Which accelerator contains four magnets connected by four straight sections?

(3) Name the reactor used to produce fissile materials from fertile materials?

(4) What are moderators used for in a reactor?

(b) Answer in brief : (any **one**) **2**

(1) Deuterons are accelerated in the cyclotron which has magnetic field of 20000 gauss. Calculate the maximum frequency of the dee voltage, given $q = 1.6 \times 10^{-19}$ C, $m_p = 1.66 \times 10^{-27}$ kg, $m_d = 2.014$ amu.

(2) Calculate the energy released by following fission reaction:

${}_{92}U^{235} + {}_0n^1 \rightarrow {}_{42}Mo^{98} + {}_{50}Sn^{136} + 2{}_0n^1 + Q$

Given $m\left(U\right) = 235.05\ u,\ m\left(n\right) = 1.008665\ u,$

$m\left(Mo\right) = 97.906\ u,\ m\left(Sn\right) = 135.9072\ u\ .$

[Take 1u = 931 MeV]

(c) Answer in detail : (any **one**) **3**

(1) Derive betatron condition.

(2) Describe self sustaining chain reaction.

(d) Write notes on : (any **one**) **5**

(1) Explain the construction and working of a linear accelerator.

(2) Explain the construction and wroking of a power reactor.

5 (a) Answer the following in short : **4**

(1) Define nuclear fusion.

(2) Name the method of plasma confinement in stars.

(3) What is the antiparticle of neutron called? Give its symbol.

(4) What is the range of gravitational interaction ?

(b) Answer in brief : (any **one**) **2**

(1) Calculate the energy released when a single helium nucleus is formed by the fusion of a deuterium and a tritium nucleus. Given : $m(d) = 2.07478$ amu, m(tritium) = 3.017633 amu, m(helium) = 4.00388 amu $m(n) = 1.008665$ amu. [Take 1u = 931 MeV].

(2) Give the quark model for protons and neutrons. Write their charge, Baryon numbers and strangeness numbers.

(c) Answer in detail : (any **one**) **3**

(1) Explain the construction and working of hydrogen bomb.

(2) Explain classification of elementary particles.

(d) Write notes : (any **one**) **5**

(1) Explain source of stellar energy.

(2) Describe conservation laws for elementary particles.