



DP-003-2016031

Seat No. _____

B. Sc. (Sem. VI) Examination

March / April - 2022

Physics : P - 601

(Nuclear & Particle Physics) (New Course)

Faculty Code : 003

Subject Code : 2016031

Time : $2\frac{1}{2}$ Hours]

[Total Marks : 70

- Instructions :** (1) Attempt all questions.
(2) Figure on right side indicate marks.
(3) Symbols have their usual meanings.

- 1 (a) Write short answers : 4
- (i) How many protons, neutrons and nucleons respectively in the $^{106}_{82}\text{Pb}$ nucleus ?
 - (ii) _____ used in a screen in alpha particle scattering experiment.
 - (iii) The radius of atom is 10^4 times that of the nucleus. (True / False)
 - (iv) Nuclear force is repulsive force. (True / False)
- (b) Answer any **one** of the following questions : 2
- (i) The radius of HO^{165} is 7.731 fermi. Deduce the radius of He^4 .
 - (ii) Calculate the B.E. of an α -particle in MeV. Mass of proton, neutron and α -particle are 1.007276u, 1.008665u and 4.001506u respectively take $1\text{u} = 931.3 \text{ MeV}$.
- (c) Answer any **one** out of two : 3
- (i) Explain the stability of a nucleus.
 - (ii) Discuss Rutherford's atomic model.
- (d) Answer in detail any **one** out of two : 5
- (i) Derive semi empirical mass formula.
 - (ii) Describe shell model.

- 2 (a) Write short answers : 4
- Give relative ionization power of α, β and γ .
 - During the life time of a radio active element as time passes the number of its nuclei _____.
 - Half life of a radioactive element is 5 min at the end of 20 min. its _____ % quantity will remain undisintegrated.
 - In radioactive transformation :

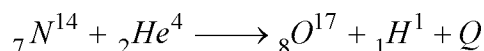
$$X \xrightarrow{\alpha} X_1 \xrightarrow{\beta^-} X_2 \xrightarrow{\beta^-} X_3 \text{ which two are isotopes ?}$$
- (b) Answer any **one** out of two : 2
- Half life of a radioactive element is 0.693 hr. What time would it take to disintegrate 80% of its nuclei ?
 - Calculate the time required for 10% of a sample of thorium to disintegrate. Assume the half life of thorium to be 1.4×10^{10} years.
- (c) Answer any **one** out of two : 3
- Explain natural radio activity.
 - Explain the phenomenon of β -decay.
- (d) Answer any **one** out of two : 5
- Derive and explain exponential law of radio active decay.
 - Explain alpha decay paradox.
- 3 (a) Write short answers : 4
- For nuclear radiation energy loss per unit length is called _____.
 - In a case of β -particle, range is less than actual travel distance. (True/False)
 - In a process of pair production, the γ -rays disappear and is converted to _____ and _____ pair.
 - What is X in reaction ?

$${}_6C^{12} + X \longrightarrow {}_0n^1 + {}_7N^{13}$$

(b) Answer any **one** out of two : **2**

(i) The linear attenuation coefficient for 2 MeV gamma rays in water is 5 m^{-1} . Find the relative intensity of a beam of 2 MeV gamma rays after it has passed through 0.1 m of water.

(ii) Determine Q-value in the reaction



The atomic masses of the particles are :

$\text{MN}^{14} = 14.003074 \text{ amu}$ $\text{MHe}^4 = 4.002604 \text{ amu}$

$\text{MO}^{17} = 16.99913 \text{ amu}$ $\text{MH}^1 = 1.007825 \text{ amu}$.

(c) Answer any **one** out of two : **3**

(i) Explain interaction of α -particle with water.

(ii) Obtain formula for threshold energy for endoergic reaction.

(d) Answer any **one** out of two : **5**

(i) Describe in detail G.M. Counter.

(ii) Describe nuclear transmutation with examples.

4 (a) Write short answers : **4**

(i) Synchrocyclotron consists of two dees placed in a vacuum chamber. (True / False)

(ii) Betatron is a device to accelerate _____ to very high energy.

(iii) Give the working principle of atom bomb.

(iv) The material which can slow down the neutron is called _____.

(b) Answer any **one** out of two : **2**

(i) A cyclotron in which the flux density is 1.4 Wb/m^2 to accelerate proton. How rapidly should the electric field between the dees be reversed ? Mass of proton = $1.67 \times 10^{-27} \text{ kg}$ and Charge = $1.6 \times 10^{-19} \text{ C}$.

(ii) Find the energy released in fission of 1 kg of U^{235} .

(1 Fission produce 200 MeV)

- (c) Answer any **one** out of two : 3
- (i) Write a note on synchrocyclotron.
 - (ii) Write a note on atom bomb.
- (d) Answer in detail any **one** out of two : 5
- (i) Explain working of cyclotron and derive formula of maximum KE of ions produced by cyclotron.
 - (ii) What is nuclear reactor ? Explain in detail.
- 5** (a) Write short answers : 4
- (i) The sun radiates _____ Joule of energy each second.
 - (ii) Hydrogen bomb is working on the principle of nuclear fusion. (True/False)
 - (iii) Who discovered the neutron ?
 - (iv) Basically there are _____ types of quarks.
- (b) Answer any **one** out of two : 2
- (i) Find the energy released in the fusion of two deuterium nuclei., $H^2 + {}_1H^2 \longrightarrow {}_2He^4$,
 $M_1H^2 = 2.014102 \text{ amu}$, $M_2He^4 = 4.002604 \text{ amu}$,
 $1 \text{ amu} = 931.3 \text{ MeV}$.
 - (ii) Estimate the fusion temperature for the DT reaction if K.E. per each particle is 0.225 MeV. The radius of the Deuterium nucleus is 1.5 Fm and tritium is 1.7 Fm. Boltzmann constant = $1.38 \times 10^{-23} \text{ J/K}$.
- (c) Answer any **one** out of two : 3
- (i) Write a note on magnetic bottle.
 - (ii) Give properties of quarks.
- (d) Answer any **one** out of two : 5
- (i) Explain proton-proton cycle.
 - (ii) Write note on leptons.
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