U.G. 5th Semester Examination-2021

PHYSICS

[HONOURS]

Discipline Specific Elective (DSE)

Course Code : PHY-H-DSE-T-02

(Nuclear and Particle Physics)

Full Marks : 60 Time : $2\frac{1}{2}$ Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer any **ten** questions from the following: 2×10=20

a) What is nuclear parity? How will you determine the parity of hydrogen-like atoms?

b) Compare atomic magnetic moment and nuclear magnetic moment.

c) What are the importance of packing fraction curve?

d) Which quantities are not conserved in a nuclear reaction?

e) What is Geiger-Nuttal law? Explain.

f) Why stable nuclei have more neutrons than protons?

g) What is Compton scattering?

h) What is the basic principle of a van-de Graaff generator?

i) What are stripping and pick-up reactions?

j) Indicate the relative strength of the different types of interaction.

k) Write down the quark contents of pions.

1) What are strange particles?

m) What is s- process path?

n) Define activity of a radioactive substance. What is its unit?

o) What is Bethe-Block formula?

2. Answer any **four** questions from the following: 5×4=20

a) What is mirror nuclei? How will you estimate the nuclear size from mirror nuclei method? 2+3

b) Mention the properties of neutrino? Explain qualitatively how the hypothesis of a neutrino solves the apparent breakdown of conservation of energy and momentum in β decay. What is internal conversion? Explain. 1+2+2

c) Write a short notes on Fermi gas model. 5

d) What is the basic difference between liquid drop model and shell model of the nucleus? What is the evidence for the shell structure of the nuclei? 2+3

e) What do you mean by quarks? Give the charge and quantum number associated with each quark. What are color quantum number and gluons? 1+2+2

f) i) Check if the following reactions are allowed or forbidden:

$\pi^- + p \rightarrow \Lambda^0 + \pi^0$ and $p + p \rightarrow 2\pi^+ + 2\pi^- + 2\pi^0$

ii) Find the distance of closet of approach of 1 MeV protons incident on gold nuclei. 3+2

3. Answer any **two** questions from the following: 10×2=20

a) i) Write down semi-empirical mass formula explaining the significance of its various terms. Derive an expression for the nuclear charge of the most stable nucleus for a given isobaric family using this formula.

ii) Predict the ground state spin and parity of the following nuclei: $_{15}P^{30}$ and $_{29}Cu^{63}$ (3+3)+(2+2)

b) i) What is the nature of nuclear force? Explain briefly.

ii) What is Q value of a nuclear reaction? Calculate the Q values of the reaction $^3_1H + ^2_1H \rightarrow ^4_2He + ^1_0n$

Given: $M\left(^3_1H\right) = 3.0169982$, $M\left(^2_1H\right) = 2.0147361$, $M\left(^4_2He\right) = 4.0038727$ and $M\left(^1_0n\right) = 1.0089832$ all in amu. What is the nature of the reaction?

iii) Define cross-section of reactions and write down its unit. 4+(1+2+1)+2

c) Describe a GM counter and explain its operation. Deduce the expression for the maximum energy of an emerging proton beam in a cyclotron in terms of the radius of the dees and the magnetic field. (3+3)+4

d) i) A μ^- meson $\left(m_\mu = 207m_e\right)$ decays into an electron and a pair of neutrinos. Calculate the maximum available energy for the process and the average electron energy.

ii) Identify the unknown particle in the reactions given below, using the conservation laws:

$\mu^- + p \rightarrow n + ...$ and $\pi^- + p \rightarrow K^0 + ...$

iii) Show that the nature of binding fraction curve is complementary to the nature of the packing fraction curve.

iv) What is isomer? 3+3+3+1

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