BPF–2232

M.Sc. (Final) Examination, 2022
PHYSICS

Paper – VI

(Nuclear and Particle Physics)

Time : 3 Hours]   [*Maximum Marks : 75*

Section–A   (Marks : 2 × 10 = 20)

Note :–   Answer all *ten* questions (Answer limit **50** words). Each question carries **2** marks.

Section–B   (Marks : 5 × 5 = 25)

Note :–   Answer all *five* questions. Each question has internal choice (Answer limit **200** words). Each question carries **5** marks.

Section–C   (Marks : 10 × 3 = 30)

Note :–   Answer any *three* questions out of five (Answer limit **500** words). Each question carries **10** marks.

Section–A

1.   (i)   If a nucleon emits a pion of rest mass 270 M_e, then find the range of nuclear force.

     (ii)   Define Q-value for a nuclear reaction.

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(iii) Write all magic numbers upto Z or/and A = 126.

(iv) What is the collective rotational motion of the nucleus ?

(v) Give the simplest examples of β^+ and β^- decay.

(vi) What is the cause of nuclear decay through the emission of γ-rays ?

(vii) A GM counter has a dead time 400 μs. What is the true counting rate when the observed rate is 1000 per minute ?

(viii) What are the advantages of the silicon *p-n* junction as a detector of heavy particles ?

(ix) Write the exchange quanta in the cases of fundamental interactions.

(x) What is the difference between 'leptons' and 'hadrons' ? Give some examples of 'leptons' and 'hadrons'.

Section–B

2. Write a short note on charge independence of nuclear force and isospin formation.

Or

State and explain reciprocity theorem.

3. Explain Bohr-Wheeler theory of nuclear fission on the basis of liquid-drop model.

Or

Use the single particle shell model to predict the ground state spin, parities and magnetic moments of $^{27}_{13}\text{Al}$, $^{33}_{16}\text{S}$ and $^{41}_{18}\text{Ar}$.

4. Plot the energy spectrum of β-decay and explain why it is a continuous spectrum. Describe properties of neutrino.

Or

Write a short note on 'nuclear isomerism'.

5. Give the theory and working of proportional counter detecting charged particle.

Or

Find the number of ion-pairs produced by 10 MeV proton. If in the proportionality region the amplification is 10^3, current pulse time is 10 μs and resistance between electrodes is 10^4 Ω. Find the voltage pulse height. The amount of energy required to produce one ion-pair is 34 eV.

6. With the help of conservation laws determine which of the following reactions are allowed or forbidden :

(i) $\pi^+ + n \rightarrow k^\circ + k^+$

(ii) $\pi^- + p \rightarrow n + \pi^\circ$
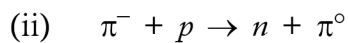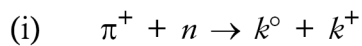
Or

Give the quark model of :

(i) Mesons

(ii) Protons

(iii) Neutrons

Section–C

7. Define Scattering cross-section and Scattering length. Give an account of effective-range theory of *n-p* scattering at low energies.

8. Give a brief account of single particle shell model which predicts the magic numbers. Assuming the shell model to be correct, what should be spin and parity of ground state of $^{15}_{7}\text{N}$?

9. List the conservation laws obeyed in β-decay. Which conservation law is violated ? How has this been experimentally verified ?

10. Describe a Scintillation Counter. What are organic and inorganic scintillators ? What advantages has it over other types of counters ?

11. Classify the elementary particles. What do you know about lepton and mesons ? What conservation laws are obeyed in the case of production and annihilation of particles ?