

2020**PHYSICS
[HONOURS]****Paper : VIIA**

Full Marks : 50

Time : 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 **five** questions: 2×5=10
- What is 'Mass defect' of a nucleus? How it is related to packing fraction?
 - What do you know about 'Geiger-Nuttal' law?
 - What are 'exoergic' and 'endoergic' reactions? Give examples.
 - A pion beam is moving at a speed $0.99c$ and its half life is 1.77×10^{-8} sec. What would be its half life in laboratory frame?
 - Does $\vec{F} = m\vec{a}$ valid in relativity? Give reasons.
 - What is the importance of liquid drop model?
 - Differentiate between quarks and photons.

[Turn Over]

- h) Two spaceships A and B approaching each other at same velocity $0.99c$ measured from earth. What is the velocity of A measured from spaceships B?

GROUP-A**(Nuclear and Particle Physics)**Answer any **three** questions: 5×3=15

- What are neutrinos? How neutrino hypothesis has been evolved? Give examples for different types of β -decay. 1+2+2
- A beam of 7.3 Mev α -particles is used to produce a reaction $^{27}\text{Al}(\alpha, p)^{30}\text{Si}$. The protons emitted at 0° are found to have an energy of 9.34 Mev. What is the Q-value of the reaction? 5
- What are the four fundamental forces in nature? What are their relative strength?
 - Classify the following particles:
 $\pi^\pm, \gamma, \Lambda^0, \nu_\mu$. 3+2
- How the pi-mesons were discovered from the cosmic rays.
 - What is cosmic ray shower?
 - What do you mean by Geomagnetic effect of cosmic rays? 1+2+2

6. a) What do you mean by internal conversion and nuclear isomerism?

b) Calculate the wavelength and frequency of γ -rays of energy 2.6 MeV.

[Given $h = 6.626 \times 10^{-34}$ JS; $c = 3 \times 10^8$ m/s]

$$1 \frac{1}{2} + 1 \frac{1}{2} + 2$$

Answer any **one** question: $10 \times 1 = 10$

7. Examine the following processes and state with reasons whether it is possible or impossible:

$$2 \times 5 = 10$$

i) $\Sigma^- \rightarrow n + e^- + \bar{\nu}_e$

ii) $e^+ + e^- \rightarrow \mu^+ + \mu^-$

iii) $p \rightarrow e^+ + \gamma$

iv) $\mu^- \rightarrow e^- + \bar{\nu}_e$

v) $\pi^0 \rightarrow \gamma + \gamma$

8. a) What are the properties of a neutrino? Explain qualitatively how the neutrino hypothesis solves the apparent break down of conservation of momentum and energy in β -decay. Discuss about the Curie Plot.

$$2 + 3 + 2$$

b) What do you mean by secondary cosmic rays and what is their composition at the sea level?

$$1 \frac{1}{2} + 1 \frac{1}{2}$$

GROUP-B

(Relativity)

Answer any **one** question: $5 \times 1 = 5$

9. a) Write down the basic postulates of special theory of relativity.

b) Derive Lorentz transformation equation for a moving inertial frame S' with velocity v with respect to another frame S . $2 + 3$

10. A relativistic particle of rest mass ' m_0 ' is moving with a kinetic energy T . Show that its de-Broglie wavelength is given by

$$\lambda = \frac{hc}{\sqrt{T(T + 2m_0c^2)}}$$

where h, c have their standard meaning. What would happen if $T \ll c^2$? $3 + 2$

Answer any **one** question: $10 \times 1 = 10$

11. a) What is causality and simultaneity in different frames?

b) Explain space-like, time-like and light-like four vectors in Minkowski space-time.

c) Given a system S' moving to the right relative to S at a speed $\frac{3}{5}C$ and another system S'' moving to the right relative to S at a speed $\frac{1}{3}C$. Find the velocity of S'' relative to the frame S' . 3+4+3

12. a) Prove that Maxwell's equation's are invariant under Lorentz transformation.

b) Show that the D'Alembert operator $\square^2 = \nabla^2 - \frac{1}{c^2} \frac{\partial^2}{\partial t^2}$ is invariant under Lorentz transformation. 7+3
