Physics

Q.P.Code : 02143

(2 1/2 Hours) [Total Marks : 75

N.B. : (1) Allquestions are **compulsory.**

(2) **Figures** to the **right** indicate **full** marks.

(3) Draw **neat** diagrams wherever **necessary.**

(5) Symbols have usual meaning unless otherwise stated.

(5) Use of **logtable** and **non-programmable** calculator is allowed.

1. (a) Attempt any **one:—**

(i) Using Lorentz transformation equation derive velocity transformation equation. Write inverse velocity transformation equation. **10**

(ii) State postulates of special theory of relativity. Obtain the Lorentz transformation equations for space time co-ordinates of an event. **10**

(b) Attempt any **one:—**

(i) Velocity of light 'c' is a limiting velocity in the universe , Explain **5**

(ii) What is mean life of π meson travelling with 0.6c, If proper mean life is $3x10^{-8}$ second, what is the distance travelled at v = 0.6c during one mean life? What distance will be covered by it without relativistic effect? Given $c=3x10^{8}$m/s. **5**

2. (a) Attempt any **one:—**

(i) Derive Einstein's Mass-Energy relation $E = mc^2$. Hence discuss the equivalence of mass and energy. **10**

(ii) Derive Lorentz transformation equations for the components of momentum and the energy. **10**

(b) Attempt any **one:—**

(i) Show that the relativistic expression for kinetic energy reduces to Newtonian expression, for very small velocities. **5**

(ii) Find the mass and speed of an electron accelerated from rest through a potential of 10000volt. assume standard values of m and e. **5**

3. (a) Attempt any **one:—**

(i) Derive Lorentz transformation equations for the components of the current density $\vec{J}$ and volume density of charge ρ. **10**

(ii) Using Lorentz transformations for $\vec{E}$ and $\vec{B}$ and the space time coordinates prove the invariance of the following Maxwell's equations **10**

$$curl\vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad ; \text{ assume } \operatorname{div}\vec{B} = 0 \text{ is invarient}$$

(b) Attempt any **one:—**

(i) Show that $E^2 - c^2B^2$ is invariant under Lorentz electric and magnetic transformations **5**

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(ii) If field is purely electric in S frame. What will be field in inertial frame S' which is moving with constant velocity 'v' with respect to S. 5

4. (a) Attempt any **one:---**

(i) Explain in detail the gravitational red shift, hence obtain the expression for modified frequency of photon when it is emitted from the star and reaches the earth. 10

(ii) Explain the calibration of Minkowski's space time diagram hence demonstrate time dilation geometrically. 10

(b) Attempt any **one:---**

(i) Write a short note on Twins Paradox. 5

(ii) State and Explain in brief the Hubble's Law. 5

5. (a) Attempt any **one:---**

(i) Assuming Lorentz transformation equation for a space and time co-ordinates of an event, obtain an expression for Einstein's time dilation. 4

(ii) Find the shift in the wavelength in the Doppler effect for a light of wavelength 6000°A emitted by a source moving in a circle with speed 0.8c relative to the observer fixed at the center of the circle. 4

(b) Attempt any **one:---**

(i) A particle in a certain frame of reference has the total energy 5×10^9eV and momentum 3×10^9eV/c. What is the mass of the particle in the unit of eV/c^2? 4

(ii) What is the length of the metre stick moving parallel to its length when its mass in motion is 3/2 of its rest mass? 4

(c) Attempt any **one:---**

(i) Show that $j^2 - c^2 \rho^2$ is invariant under Lorentz transformations for current and charge density 4

(ii) If $\vec{E}.\vec{B}=0$ in frame S then show that $\vec{E'}.\vec{B'}=0$ in S' frame which is moving with constant velocity 'v' with respect to S Frame 4

(d) Attempt any **one:---**

(i) Explain the different types of galaxies. 3

(ii) Write a short note on Optical Astronomy. 3
