2024/11

SET A

M.Sc. PHYSICS
THIRD SEMESTER
THEORY OF RELATIVITY-I
MSP - 304C

[USE OMR FOR OBJECTIVE PART]

Duration: 1:30 hrs. **Full Marks: 35**

(Objective)

Time: 15 mins. **Marks: 10**

Choose the correct answer from the following: ***1×10=10***

1. When a receiver is coming towards a transmitter, which one is correct?
   a. $\nu' = \sqrt{\frac{1+\beta}{1-\beta}}\nu$ b. $\nu' = \sqrt{\frac{1-\beta}{1+\beta}}\nu$
   c. $\nu' = \sqrt{\frac{1}{1-\beta}}\nu$ d. $\nu' = \sqrt{\frac{2\beta}{1-\beta}}\nu$

2. The correct energy transformation relation is by
   a. $E' = \gamma_0 (E - v\, p_x)$ b. $E' = \gamma_0 (E + v\, p_x)$
   c. $E' = \gamma_0 (-E - v\, p_x)$ d. $E' = \gamma_0 (-E + v\, p_x)$

3. The correct momentum transformation relation is by
   a. $p_x' = \gamma_0 (- p_x + \frac{v}{c^2} E)$ b. $E' = \gamma_0 (p_x - \frac{v}{c^2} E)$
   c. $E' = \gamma_0 (p_x + \frac{v}{c^2} E)$ d. $E' = \gamma_0 (-p_x - \frac{v}{c^2} E)$

4. The correct density transformation relation is given by
   a. $d' = \frac{d}{1-\beta}$ b. $d' = \frac{d}{1-\beta^2}$
   c. $d' = \frac{d}{1+\beta}$ d. $d' = (1-\beta)d$

5. Which one of the following is invariant under Lorentz transformation?
   a. 3D volume element b. 4D volume element
   c. Surface charge density d. Time

6. The determinant of Lorentzian operator Λ in the Lorentz transformation relation $X' = \Lambda X$ is
   a. -1 b. 0
   c. 1 d. γ

7. Two photons approaching each other with a speed c. Their relative velocity will be
   a. c b. 2c
   c. 0 d. c/2

8. The value of γ for $v=0.6c$ will be
   a. 1.15 b. 1.25
   c. 2.25 d. 1.75

9. The moving mass of a body is 2 times its rest mass m_0. Its kinetic energy will be

a. $E = m\,c^2$
b. $E = m_0\,c^2$
c. $E = 2m_0c^2$
d. $E = 3m_0c^2$

10. A body of rest mass m_0 is moving with a relativistic $v=0.6c$. Its momentum will be

a. $0.65\,m_0c$
b. $0.75\,m_0c$
c. $0.85\,m_0c$
d. $0.55\,m_0c$

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Descriptive

Time : 1 hr. 15 mins. Marks: 25

[Answer question no.1 & any two (2) from the rest]

1. Show that the energy-momentum relation $E^2 - p^2c^2$ is invariant under Lorentz transformation 5

2. **a.** Derive the relativistic kinetic energy relation. 6+4=10

   b. A particle of rest mass m_0 is moving with relativistic velocity 0.8c. Find its kinetic energy, momentum.

3. Show that (a) $\Gamma^{\mu}_{\mu\nu} = \frac{\partial}{\partial x^{\nu}}(\ln\sqrt{g})$. (b) $\Gamma_{\lambda,\mu\nu} + \Gamma_{\mu,\lambda\nu} = \frac{\partial g_{\mu\lambda}}{\partial x^{\nu}}$. 5+5=10

4. **a.** Explain Doppler effect in special theory of relativity. 6+4=10

   b. A signal of frequency 100Hz is moving with a relativistic velocity 0.8c. Find the apparent frequency received by an observer.

5. **a.** Discuss Minkowski space with its graphical representation. 4+6=10

   b. Define time-like, spacelike and light-like intervals with mathematical notations.

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