1. How does an interval change under L.T. ? From this obtain the expression for Time dilation.

2. Show that the Time interval between two events is minimum in the Lorentz frame in which events take place at same place.

3. Half life of pion at rest is 1.77×10^{-8} sec. A collimated pion beam leaving the accelerator at a velocity $0.99c$ is found to drop to half its original intensity. Find the distance travelled by the pions in the lab.

4. A star is 'd' light year away from an observer on earth. A spaceship, travelling from the earth to the star with a uniform velocity takes 'd' year to get there according to pilot's measure of Time. Show that the speed of spaceship w.r.t. earth is $\frac{c}{\sqrt{2}}$.

5. A rocket propels itself rectilinearly through the empty space by emitting radiation whose recoil provides the needed thrust. If v is the final velocity w.r.t. its initial rest frame prove that the ratio of the initial & final rest mass of the rocket is $[(1+\beta)/(1-\beta)]^{\frac{1}{2}}$, $\beta = v/c$

6. Two rods of proper length l_0 move lengthwise towards each other, parallel to the common axis with same velocity 'v' w.r.t. lab frame. Show that the length of each rod in the reference frame fixed to the other rod is $l = l_0 \frac{1-\beta^2}{1+\beta^2}$

7. A space traveller with velocity 'v' synchronizes his clock ($t'=0$) with the earth bound friend ($t=0$). The earth friend then observes both clocks simultaneously 't' directly and t' through a telescope. Show that when t' reads one hour, t reads $[(1+\beta)/(1-\beta)]^{1/2}$.

8. A particle moving with speed of $0.8c$ collides with another of the same mass and they stick together. What is the rest mass and speed of the composite particle?

9. In a frame S the two events occur as $E_1: x_1 = x_0,\ t_1 = \frac{x_0}{c}$; $E_2: x_2 = 2x_0,\ t_2 = \frac{x_0}{2c}$. Find the velocity of S' w.r.t. S in which the events occur at same time, find the value of that time.

10. In S-frame two events have space-time coordinates $(0,0,0,0)$ and $(5c, 0, 0, 3)$ where time coordinates are in second. Find the space time interval between there events. Calculate the velocity of a frame in which i) the two events are simultaneous ii) 1st event occurs 1 sec earlier than the 2nd (iii) 2nd event occurs 1 sec earlier than the 1st one. What is the limit of maximum time interval between there events?

11. The density of a stationery body is ρ_0. Find the velocity of a frame w.r.t. which the density would be 25% greater

12. Show that one dimensional e-m wave eq^n does not remain invariant under G.T.

13. A pion at rest decays into muon and a neutrino moving in opposite direction. Find the energy of outgoing muon.

14. In a certain inertial frame light pulses are emitted by two sources 5km apart and time interval is $5\mu s$. An observer moving with speed v along the line joining these sources notes that the pulses are simultaneous. Find v.

15. Two rockets of rest length l_0 are approaching each other from opposite direction with a speed $\frac{c}{2}$. How long does one of them appear to the other?

16. A neutral pion of rest mass m_0, relativistic momentum $\frac{3}{4} m_0 c$ decays into two photons. One of the photons is emitted in the same direction as original pion, other in the opposite direction. Find the energy of each photon.

17. A particle of rest mass m_0 moving with speed v collides and sticks with a stationary particle of rest mass M_0. Find the speed of composite particle.

18. Show that L.T. can be regarded as rotation of axes $(t-x)$ through an imaginary angle $\theta = \tan^{-1}(i\beta)$, $\beta = \frac{v}{c}$

19. Show that the ordering of events will remain unaltered in two inertial frames with uniform speed relative to each other provided that it is not possible to send any signal with speed greater than the speed of light.

20. Two lumps of clay each of rest mass m_0 move towards each other with equal speed $\frac{3}{5}c$ & stick together. What is the speed of composite particle?

21. Show that $E^2 - p^2c^2$ is L.I.

22. A reference frame s' moves with velocity v w.r.t. s along x axis. Another frame s'' moves with vel v' w.r.t. s' along x axis. Show that velocity of s'' w.r.t. s is $(v+v')/(1+\frac{v'v}{c^2})$

23. In Minkowski space let u^μ is Time like vector. Prove that there always exists a space-like 4-vector v^μ such that $u_\mu v^\mu = 0$ [use $|\vec{p}\cdot\vec{q}| \le |\vec{p}||\vec{q}|$]

24. If the interval between two events is spacelike then there exists a Lorentz system in which the two events are simultaneous. explain.

25. A kaon decays at rest via $K^+ \longrightarrow e^+ + \pi^0 + \nu_e$. Calculate the max^m energy of positron emitted.

$m_{K^0} = 494\ \text{MeV}/c^2 \quad m_{\pi^0} = 135\ \text{MeV}/c^2 \quad m_e = 0.5\ \text{MeV}/c^2$

26. By what factor density changes with velocity ?

27. Using the square of the norm of a 4-vector show that under L.T. a Time like or space like vector can have a maximum of its three components equal to zero. Is such transformation possible for light like 4-vector ?

28. Show that these processes are dynamically impossible (a) A single photon strikes a stationary electron and gives up all energy to it.
(b) A single photon in empty space is transformed into electron-positron
(c) A fast positron and a stationary electron annihilate producing only one photon.

29. Antiprotons are produced when a beam of protons strikes stationary protons according to the reaction $p + p = p + p + p + \bar{p}$. Considering the collision between two protons in the c.m. frame of reference find the minimum energy to which proton must be accelerated for production of antiproton. $m_p = m_{\bar{p}} = 938\ \text{MeV}$.

30. Show that the circle $x^2 + y^2 = a^2$ in frame S appears to be an ellipse with eccentricity $\frac{v}{c}$ in frame S' moving with velocity v, w.r.t. S.