

Tutorial Sheet 2-Relativity

1. Using Lorentz transformation equations show that
$$x'^2 - c^2 t'^2 = x^2 - c^2 t^2$$
2. A frame of reference S' is moving with respect to frame S with velocity 0.8 c along the common axis X-X' axis. An event occurs in S' at $x' = 120$ m, $y' = 15$ m, $z' = 10$ m and $t' = 5 \times 10^{-3}$ s. Evaluate the space-time coordinates of this event in frame S.
3. A rocket ship is 100 metre long on the ground. When it is in flight, its length is 99 metre to an observer on the ground. What is the speed?
4. An airforce rocket is chasing enemy's spaceship. From earth, it is found that the speed of airforce rocket is 2.55×10^{10} cm/sec while that of enemy ship is 2.25×10^{10} cm/sec. What is the relative velocity of
 - (i) Enemy's ship as seen by airforce rocket.
 - (ii) Airforce rocket as seen by enemy's ship.
 - (iii) Airforce rocket with respect to enemy's ship as seen from earth
 - (iv) Enemy's ship with respect to airforce rocket as seen from earth.
5. Calculate the speed of the particle when its kinetic energy is (i) equal to its rest mass energy, (ii) twice of its rest mass energy, and (iii) half of its rest mass energy .
6. Calculate the rest mass, relativistic mass and momentum of photon of energy 5 eV.
7. Calculate the expected fringe shifts in the Michelson-Morley experiment, if the distance of each plate is 2 m and the wavelength of monochromatic radiation is (a) 6000 Å and (b) 4000 Å.
8. In an experiment similar to the one performed by Michelson and Morley, the distance l of the semi-silvered plate from either of the mirrors is 25.90 m. The wavelength of light used is 589.0 nm. (a) Calculate the time lag between the two beams reaching after reflection. (b) After the apparatus is rotated through 90° , what is the total time lag? (c) Determine the number of fringes shifted. Assume orbital v of the earth about the sun $= 3 \times 10^4$ m/s.
9. A neutral meson of Energy E moving at a speed v decays into two γ -rays, one is of energy $E_1 = 70$ MeV along the direction of the neutral meson and the other is of energy $E_2 = 60$ MeV opposite to the former. Calculate the rest mass of the meson.