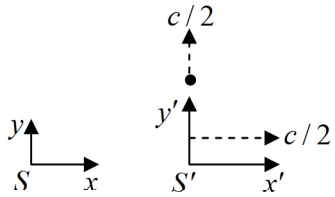
Class Test

(STR-Lorentz Transformation)

Q1. Consider an inertial frame S' moving at speed $\frac{c}{2}$ away from another inertial frame S along the common x-x' axis, where c is the speed of light. As observed from S', a particle is moving with speed $\frac{c}{2}$ in the y' direction, as shown in the figure. The speed of the particle as seen from S is:



(a) $0.3c$ (b) $0.5c$ (c) $0.6c$ (d) $0.9c$

Q2. Two events E_1 and E_2 take place in an inertial frame S with respective time space coordinates (in SI units): $E_1\left(t_1=0,\vec{r}_1=0\right)$ and $E_2\left(t_2=0,x_2=10^8,y_z=0,z_2=0\right)$. Another inertial frame S' is moving with respect to S with a velocity $\vec{v}=0.8c\hat{i}$. The time difference $\left(t_2'-t_1'\right)$ as observed in S' is

(a) 0.33 (b) 0.44 (c) 0.55 (d) 0.66

Q3. Muons are elementary particles produced in the upper atmosphere. They have a life time of $2.2\mu s$. Consider muons which are traveling vertically towards the earth's surface at a speed of $0.998c$. For an observer on earth, the height of the atmosphere above the surface of the earth is $10.4\,km$. Which of the following statements are true?

(a) The muons can never reach earth's surface

(b) The apparent thickness of earth's atmosphere in muon's frame of reference is $0.96\,km$

(c) The lifetime of muons in earth's frame of reference is $34.8\mu s$

(d) The lifetime of muons in earth's frame of reference is $50.0\mu s$

Q4. In an inertial frame S, two events A and B take place at $\left(ct_A=0,\vec{r}_A=0\right)$ and $\left(ct_B=0,\vec{r}_B=2\hat{y}\right)$, respectively. The times at which these events take place in a frame S' moving with a velocity $0.6c\,\hat{y}$ with respect to S are given by

(a) $ct_A'=0;\ ct_B'=-\frac{3}{2}$ (b) $ct_A'=0;\ ct_B'=0$

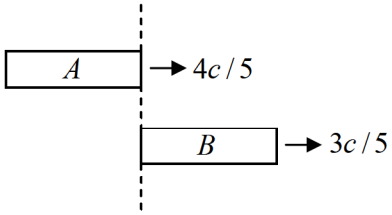
(c) $ct_A'=0;\ ct_B'=\frac{3}{2}$ (d) $ct_A'=0;\ ct_B'=\frac{1}{2}$

Q5. A rod of proper length l_0 oriented parallel to the *x*-axis moves with speed $2c/3$ along the x-axis in the S-frame, where c is the speed of light in free space. The observer is also moving along the x-axis with speed $c/2$ with respect to the S-frame. The length of the rod as measured by the observer is

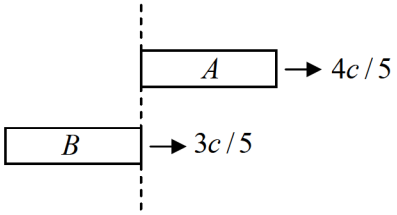
(a) $0.35l_0$ (b) $0.48l_0$ (c) $0.87l_0$ (d) $0.97l_0$

Q6. Two spaceships A and B, each of the same rest length L, are moving in the same direction with speeds $\frac{4c}{5}$ and $\frac{3c}{5}$, respectively, where c is the speed of light. As measured by B, the time taken by A to completely overtake B [see figure below] in units of L/c is

(i)



(ii)



(a) 3 (b) 5 (c) 7 (d) 9

Q7. Consider three inertial frames of reference A, B and C. the frame B moves with a velocity $\frac{c}{2}$ with respect to A, and C moves with a velocity $\frac{c}{10}$ with respect to B in the same direction. The velocity of C as measured in A is

(a) $0.42c$ (b) $0.57c$ (c) $0.14c$ (d) $0.25c$

Q8. If fluid is moving with velocity $v = 0.8c$ with respect to stationary narrow tube. If light pulse enter into fluid of refractive index $n - 1.5$ in the direction of flow. What is the speed of light pulse measured by observer who is stationary with respect to tube?

(a) c (b) $0.35c$ (c) $0.66c$ (d) $0.95c$

Q9. A light beam is emitted at an angle θ_0 with respect to the x'- axis in S frame which is moving with velocity $u\hat{i}$. Then the angle θ the beam makes with respect to x- axis in S' frame is

(a) $\sin\theta = \dfrac{\sin\theta_0\sqrt{1-\frac{u^2}{c^2}}}{1+\frac{u}{c}\cos\theta_0}$ (b) $\sin\theta = \dfrac{\sin\theta_0\sqrt{1-\frac{u^2}{c^2}}}{1+\frac{u}{c}\sin\theta_0}$

(c) $\sin\theta = \dfrac{\cos\theta_0+\frac{u}{c}}{1+\frac{u}{c}\cos\theta_0}$ (d) $\sin\theta = \dfrac{1+\frac{u\cos\theta_0}{c}}{\cos\theta_0+\frac{u}{c}}$

Q10. The area of a disc in its rest frame S is equal to 1 (in some units). The disc will appear distorted to an observer O moving with a speed $u = 0.8c$ with respect to S along the plane of the disc. The area of the disc measured in the rest frame of the observer O is (c is the speed of light in vacuum)

(a) 0.6 (b) 0.7 (c) 0.8 (d) 0.9