Alexandria University **MODERN PHYSICS**
Faculty of Engineering **1st YEAR EE**
EE-Department **EE-131 SHEET:1**

SUBJECT:SPECIAL THEORY OF RELATIVITY

1- An airplane travels from A to B with a velocity C, if the distance AB=L, calculate the time taken by the airplane to go from A to B and back to A if:
   a) The air is still.
   b) A wind of velocity (v) blows from A to B.
   c) A wind of velocity (v) blows perpendicular to (A-B).

2- As measured by O a flashbulb goes off at x=100Km, y=10km, z=1Km,t=$5*10^{-4}$ sec. What are the coordinates x',y',z',t' of this event as determined by a second observer O' moving relative to O at velocity of (-0.8C) along the (x-x') axis?

3- The space-time coordinates of two events as measured by O are $x_1=6*10^4$ m, $y_1=z_1=0$m, $t_1=2*10^{-4}$sec and $x_2=12*10^4$ m, $y_2=z_2=0$m, $t_2=1*10^{-4}$sec.
   a) What must be the velocity of O' w.r.t. O if O' measures the two events to occur simultaneously?
   b)What is the spatial separation of the two events as measured by O'?

4- Calculate the Lorentz contraction of the earth's diameter as measured by an observer O' who is stationary w.r.t the sun.Take the orbital velocity of the earth around the sun as $3*10^4$m/s and the diameter of the earth as 12750 Km.

5- The average life time of (μ-mesons) with a speed of 0.95C is measured to be $6*10^{-6}$s.Compute the average life time of these (μ-mesons) in a system in which they are at rest.

6- Observer O and O' approach each other with a relative velocity of (0.6C) . If O measured initial distance to O' to be 20m.How much time will it take as determined by O and O' before the two observers meet?

7- A pilot in a rocket-ship traveling with a velocity of (0.6C) passes the earth and adjusts his clock so that it coincides with 12:00 p.m. on the earth. At 12:30 p.m. as measured by the pilot, the rocket-ship passes station that is stationary w.r.t. the earth. What time is it at the station? What is the distance from the earth to the space station as measured by the pilot and an observer on the earth.

8- O and o' are two synchronized clocks at the same point in the space. O' starts its motion w.r.t. O by a velocity of $\sqrt{3}/2C$. After 10 min, by the clock O, an observer, with the clock O, regards through a telescope the clock O'. What is the reading of O' at this instant?

9- Protons are moving in a circular path with a linear velocity of 0.7C, relative to the laboratory system. Determine the relative velocities of two protons which are diametrically opposite.

10- The relative speed of O and o' is 0.8C. At $t'=2*10^{-7}$sec a super bullet is fired from x'=100m, traveling in the negative x' direction with a constant speed and strikes a target at O' at $t'=6*10^{-7}$sec. As determined by O, what is the velocity of the bullet and how far did it travel?

11- A proton (speed=C) travels in X-Y plane of an inertial frame making an angle θ with the x-axis . Prove that the photon velocity determined in any other inertial frame in a relative motion (constant velocity) with the first, is also C. Is the angle θ'(with the x'-axis) measured in the new inertial frame, equal to θ? "This confirms the Einstein's 2nd postulate."

12- A proton of unknown momentum p is sent through a uniform magentic field B = 1.0 tesla T, perependicular to p and is found to move in a circle of radius 1.4m. What are the proton's momentum and enrgy?.

13- The mass of an electron is $9.11*10^{-31}$ kg. Make a table showing an electron's momentum, both the correct relativistic momentum and the norelativstic one at speeds of 0.1C, 0.5C, 0.9C, and 0.99C.

14- At what speed would a body's relativistic energy E be twice its rest energy m_oC^2?

15- An electron (rest mass $9*10^{-31}$ kg) is moving at 0.6C. What is its energy E? At this speed, what fraction of its energy is the rest energy?

16- At what speed is a body's kinetic energy equal twice its rest energy?

17- A spacecraft receding from the earth at 0.97 C transmits data at the rate of $1.0x10^{4}$ pulses/sec. At what rate are they received?

18- A car moving at 140150 km/h is approaching a stationary police car whose radar speed detector operates at a frequency of 15 GHz. What frequency change is found by the speed detector?

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