**SIES COLLEGE OF ARTS, SCIENCE AND COMMERCE**

SION(WEST), MUMBAI-400 022

 **PHYSICS DEPARTMENT 28 Nov. 2015**

**SEMESTER VI(2015-2016)**

**USPH604: Special theory of Relativity**

**Class assignment 1(on length contraction..)**

1. At what relative velocity v will the Galilean and Lorentz transformations of x′ differ by 10% of Lorentz transformations of x′ ?
2. A spaceship is 100 m long on the ground. When it is in flight it appears to be 98 m long. Find its speed. Use c=3 × 108 m/s.
3. An astronaut whose height is 1.8 m on the earth is lying parallel to the axis of the spaceship, in the direction of motion of the spaceship relative to the earth. If the velocity of the spaceship relative to the earth is 0.8c find the height of the astronaut as measured by (i) an observer in the same spaceship (ii) an observer on the earth.
4. A spaceship is travelling at a speed of 0.8c.Find the contraction of length observed as a fraction of its proper length.
5. The length of a spaceship is measured to be exactly half its proper length. What is the speed of the spaceship relative to the observer?
6. The velocity of S’ frame with respect to S is 0.9992 c. Calculate $\sqrt{1-\frac{v^{2}}{c^{2}}}$ .
7. The length of a metre scale is found to be 0.06 m. Find its speed.
8. Find the speed with which a spacecraft should move so that its length appears to be contracted to 94% of its length?
9. In an inertial frame S, an observer O measures the volume of a cube as 1728m3. What will be the volume of the same cube measured by an observer S’ moving with a velocity 0.6c relative to the cube in a direction parallel to one edge?
10. The length of a metre scale is found to be contracted by 1 cm. Find its speed.
11. A rod is moving with a velocity 0.6c relative to an observer in the laboratory. Its length in the direction of motion appears to be 1 metre. What is its proper length?
12. A circular loop having diameter 100cm is at rest in X’ – Y’ plane of the frame S’. Find out its diameter in the direction of X axis and Y axis as observed by the observer in the frame S relative to which the frame S’ is moving with a velocity 0.8c along X-axis. What is the shape of the loop for the observer in the frame S?

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 **PHYSICS DEPARTMENT 28 Nov. 2015**

**SEMESTER VI(2015-2016)**

**USPH604: Special theory of Relativity**

 **Class assignment 2(on time dilation..)**

1. A particle with proper life time of 2micro sec moves in a laboratory with a speed 0.9c. Calculate the life time as measured in the laboratory.
2. The lifetime of a pion moving with a velocity 0.8c appears to be 2.5 × 10-7 sec. calculate its proper lifetime.
3. What is the dilation of the spaceship’s unit time if the length of a spaceship measured is exactly half its proper length?
4. The average lifetime of muons stopped in a lead block in the laboratory is measured to be 2.3 ×10-6 sec. The average lifetime of muons found in the burst of cosmic rays from the earth is measured to be 4.6 μs. Find the speed of the cosmic ray muons.
5. The average proper lifetime of a μ meson is 2.3 ×10-6 sec. What average distance would it travel in vacuum before decaying as measured in the reference frame in which its velocity is 0.9c? Compare this distance with the distance the meson sees travelling through by itself.
6. A space ship 1000m long is moving with a velocity 0.8c relative to you. Find the length of the spaceship as measured by you. How long will the ship take to pass you?
7. A pion is found to be moving with a velocity 0.9c and its lifetime measured is 0.3 μs. Find its proper lifetime.
8. In a rest frame, a particle has life span of 0.75 × 10 -8 sec. In the laboratory frame, it is observed to decay after covering a distance of 3m. Find the speed of the moving particle.
9. The mean lifetime of π mesons is 0.07 μs and it is found to be moving with a speed 0.73c. Find the proper lifetime of mesons.
10. An aircraft is moving with respect to the earth with a speed 750m/sec. How long will it take for the aircraft’s clock to run behind the clock placed on the earth by 5 microseconds?

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**SIES COLLEGE OF ARTS, SCIENCE AND COMMERCE**

SION(WEST), MUMBAI-400 022

 **PHYSICS DEPARTMENT 31st Jan 2016**

**SEMESTER VI(2015-2016)**

**USPH604: Special theory of Relativity**

 **Class assignment 3 (mass-energy)**

1. Derive the following relations for relativistic particles using $E^{2}=p^{2}c^{2}+m\_{0}^{2}c^{4}$
2. $K=c \sqrt{m\_{0}^{2}c^{2}+p^{2}} -m\_{0 }c^{2}$ b) $p=\frac{1}{c}( \sqrt{K^{2}+2m\_{0}c^{2} K} )$ c) $m\_{0 }=\frac{1}{c^{2}} (\sqrt{E^{2}-p^{2}c^{2}})$
3. Show that 1 amu =931MeV. Use 1 amu =1.66× 10 –27Kg.
4. What is the speed of an electron whose kinetic energy is equal to its rest energy? Does the result depend on the mass of the electron?
5. What should be the velocity of the particle so that its mass is ten times its rest mass?
6. What is the ratio of mass of a particle to its rest mass if it is moving with a velocity 0.8c?
7. What is the velocity of a body when its total energy is twice its rest energy?
8. An electron has kinetic energy equal to twice its rest energy. Find its speed in terms of c.
9. Calculate the fractional increase in the rest mass of a particle moving with velocity 0.99c.
10. Calculate the percentage increase in rest mass of a body when it is moving with a velocity 0.6c.
11. The density of silver is 10.5g/cc when it is at rest relative to an observer. What is its density when the relative velocity is 0.7c?
12. The mass of an electron is twice its rest mass. What is the speed with which the electron is moving?
13. The rest energy of an electron is 0.511MeV. If it is moving with0.9c, what is its momentum?
14. Find the momentum of a photon having energy 2eV.

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**SIES COLLEGE OF ARTS, SCIENCE AND COMMERCE**

SION(WEST), MUMBAI-400 022

 **PHYSICS DEPARTMENT 7th Feb. 2016**

**SEMESTER VI(2015-2016)**

**USPH604: Special theory of Relativity**

 **Class assignment 4 (mass-energy)**

1. The rest mass energy of an electron is 0.511MeV. Find the momentum of 2MeV electron. (Hint: Use $E^{2}=p^{2}c^{2}+m\_{0}^{2}c^{4}$)
2. Rest masses of proton, neutron and He nucleus are 1.007825amu, 1.008665amu and 4.003871amu respectively. Calculate the mass defect and the binding energy of a nucleus of 2 He 4 in MeV.
3. Compute the speed of electrons which fall through an electrostatic potential difference of 10million volts.( Hint: KE= qV)
4. A nucleus of mass 235.124amu breaks into 2 nuclei of masses 97.936amu and 135.951amu and a neutron of mass 1.009amu respectively. Calculate the energy released.
5. What is the velocity that an electron must be given so that it attains a momentum of 10m0c?
6. Find the mass, momentum and kinetic energy of a photon of λ =6000Å. Given: h=6.63 × 10-34 J-s

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