**AIM**

To study the contracted length of an object in the direction of its motion.

**THEORY**

In relativistic mechanics, the length of an object depends on its motion relative to the frame of reference in which its length is being measured.

Lorentz and Fitzgerald observed that, when an object moves with a velocity (comparable with velocity of light) relative to a stationary observer, its length appears to be contracted by a factor , in the direction of its motion. This decrease in length in the direction of its motion is called the length contraction.

S Y’ S’ y v x2

x1 x2’ O x1’ O’ x-x’ Z Z’

Let us consider two inertial frame of references S and S’. Frame S is at rest while S’ is moving with constant velocity v along the x-direction. Let us consider a rod parallel to the x-axis moving with a velocity v relative to a frame of reference S. The end points of rod measured by observer in S’ frame are . As the rod is stationary in frame S’ The length of rod, as measured in S’ frame, is

, where is known as proper length

At the same time, the end points measured by an observer in S frame are

Let us start from,

Or

Since

As it is practically impossible.

PRETEST

1. Define length of contraction.

2. Differentiate between proper and improper length.

3. A rod is moving with 30% of the velocity of light. Compare its contracted length along the direction of its motion.

PITFALL

1. If a rod moves with velocity of light, what will be effect on its length? Its length would be contracted,

a) Yes

b) No

2. If a rod moves with non-relativistic speed, its length would be contracted along the direction of its motion,

a) Yes

b) No

PROCEDURE

1. Select two inertial frames S and S’.

2. S is at rest and S’ moves with constant velocity v along + x axis.

3. Consider a rod of length whose end points can be measured by observers of S and S’ frames.

4. The rod moves along + x-x’ axis.

PROTEST

1. What is the length of a meter stick moving parallel to its length when its mass is 1.5 times of its rest mass? Ans 0.67m

2. How fast a rocket have to go relative to an observer for its length to be contracted to 95% of its length at rest? Ans v = 0.0975c

MCQ’s

1. A train is 200 feet long in its own frame, and a railroad platform is 160 feet long in its own frame. The train rushes past the platform so fast that, in the platform’s frame, the train and platform are the same length. How fast was the train moving?

a. 4/5c b) 5/4c c) 3/5c d) 5/3c

ans c

### 2. When does length contraction affect an object?

a. When it is not moving. b. Only at extremely slow speeds.

c. Only when its moving at speeds near the speed of light d. At all times when it is moving

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