# Quiz 8

- Due to length contraction the length of a moving rod appears shrunk by 25% of its stationary value to an inertial observer. How long 1 second of a clock which is moving along with the rod would appear to the same observer ?

- Two supernovae (burst of some special stars) are observed to happen from earth, one after another - 3 years (~$10^8$ s) apart in two different galaxies which are 10 light years (~ 9 X $10^{16}$ m) apart and are on diametrically opposite sides of the earth. To an astronaut launched towards one of them in a uniformly speeding rocket, the two supernovae appear to have happened **simultaneously**. How fast the rocket was moving ? [Treat earth as an inertial frame for this problem]

# Quiz - 08

1. Let $L'$ and $T'$ be length of rod and time period of a clock in frame $S'$ which is moving at speed $V$ w.r.t. $S$. Then measurement in $S$ will yield

$$L = \frac{1}{\gamma} L' \quad \text{and} \quad T = \gamma T'$$

$$\Rightarrow \frac{L}{L'} = \frac{1}{\gamma} \quad \text{and} \quad \frac{T}{T'} = \gamma$$

$$\Rightarrow \text{Since } L < L' \Rightarrow \frac{\Delta L'}{L'} = \frac{L' - L}{L'} = 1 - \frac{1}{\gamma} = \frac{\gamma - 1}{\gamma} = \frac{25}{100} = \frac{1}{4}$$

$$\gamma = 4/3$$

But $T > T' \Rightarrow$ $$T = \gamma T' = \frac{4}{3} \times 1\,s = \frac{4}{3}\,s$$

2.

Given - from earth's frame the two supernovae happen with : $\Delta t = 10^8\,s$ , $\Delta x = 9 \times 10^{16}\,m$

For the moving rocket frame $\Delta t' = 0$

From, $$\Delta t' = \gamma \left( \Delta t - \frac{V}{c^2} \Delta x \right)$$

$$0 = \gamma \left( 10^8\,s - \frac{V}{c} \frac{9 \times 10^{16}\,m}{3 \times 10^8\,m\,s^{-1}} \right)$$

$$10^8\,s - \frac{V}{c} \times 3 \times 10^8\,s = 0$$

$$\Rightarrow V/c = 1/3 \Rightarrow V = 10^8\,m\,s^{-1}$$