

Q7. A wrist watch keeps correct time on earth. If it is worn by pilot in spaceship, leaving earth with constant velocity of 10^9 cm/sec. How many seconds does it appear to lose in one day with respect to the observer on the Earth.

Given:- $v=10^9$ cm/sec $=10^7$ m/sec; $t = 24$ hrs in a day

Formula:- $t = \frac{t_0}{\sqrt{1-\frac{v^2}{c^2}}}$

Solution:- $24 = \frac{t_0}{\sqrt{1-\frac{1}{900}}}$

$$t_0 = 24 \left[1 - \frac{1}{900} \right]^{-1/2}$$

Here, $1/900$ is very small w.r.t 1 hence we can use the binomial expansion and neglect higher order terms

$$t_0 = 24 \left[1 - \frac{1}{1800} \right] = 24 - \frac{1}{75} \text{ hrs}$$

$$\text{hence loss in 24 hours} = \frac{1}{75} \text{ hrs} = 48 \text{ sec}$$

Ans:- wrist watch loses 48 sec in a day with respect to observer on earth.