King Fahd University of Petroleum & Minerals
Physics Department
Phys212- Quiz#1

Name: Key ID#:

1. At what speed does a clock move if it runs at a rate which is one-half the rate of a clock at rest?

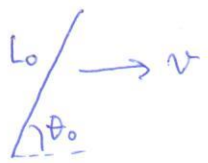
$$\Delta t = 2\,\Delta t' \qquad \Delta t : \text{time dilation}$$
$$= \gamma\,\Delta t' \qquad \Delta t' = \text{proper time}$$

$$\Rightarrow \gamma = 2 = \frac{1}{\sqrt{1 - v^2/c^2}} \Rightarrow 1 - \frac{v^2}{c^2} = \frac{1}{4} \Rightarrow \frac{v^2}{c^2} = \frac{3}{4}$$

$$v = \sqrt{\frac{3}{4}}\,c = \boxed{0.866c}$$

2. A rod of length L_0 = 2.0 m moves with speed v=0.98c along the horizontal direction. The rod makes an angle $\theta_0=30^0$ with respect to the x_0 axis.
   (a) Determine the length of the rod as measured by a stationary observer.
   (b) Determine the angle θ the rod makes with the x axis.

a)



$$x_0 = L_0 \cos\theta_0 \qquad x = \frac{x_0}{\gamma} = L_0 \cos\theta_0 \sqrt{1 - v^2/c^2}$$
$$y_0 = L_0 \sin\theta_0 \qquad y = y_0 = L_0 \sin\theta_0$$

$$L = \sqrt{x^2 + y^2} = \sqrt{L_0^2 \cos^2\theta_0 (1 - v^2/c^2) + L_0^2 \sin^2\theta_0}$$
$$= \sqrt{L_0^2 - L_0^2 \cos^2\theta_0\, v^2/c^2} = L_0 \sqrt{1 - \cos^2\theta_0\, v^2/c^2}$$

$$L = 2\sqrt{1 - \cos^2(30^\circ)(0.98)^2} = \boxed{1.06\text{ m}}$$

b)

$$\tan\theta = \frac{y}{x} = \frac{\cancel{L_0} \sin\theta_0}{\cancel{L_0} \cos\theta_0 \sqrt{1 - v^2/c^2}} = \frac{\tan\theta_0}{\sqrt{1 - v^2/c^2}} = \frac{\tan 30^\circ}{\sqrt{1 - 0.98^2}}$$
$$= 2.9$$

$$\theta = \tan^{-1}(2.9) = \boxed{71^\circ}$$