University of Alabama
Department of Physics and Astronomy

PH 102 / LeClair — Summer II 2010

Quiz 1 Solution

1. The period of a pendulum is measured to be $3.00\,\mathrm{s}$ in its own reference frame. What is the period as measured by an observer moving at a speed of $0.950c$ with respect to the pendulum?

9.61 **sec.** The proper time is that measured by in the reference frame of the pendulum itself, $\Delta t_p = 3.00\,\mathrm{sec}$. The moving observer has to observe a *longer* period for the pendulum, since from the observer's point of view, the pendulum is moving relative to it. Observers always perceive clocks moving relative to them as running slow. The factor between the two times is just γ:

$$\Delta t' = \gamma \Delta t_p = \frac{3.0\,\mathrm{sec}}{\sqrt{1-\frac{0.95^2c^2}{c^2}}} = \frac{3.0\,\mathrm{sec}}{\sqrt{1-0.95^2}} \approx 9.61\,\mathrm{sec} \tag{1}$$

2. If you are moving in a spaceship at high speed relative to the earth, would you notice a difference in your pulse rate? In the pulse rate of the people back on earth? Explain, briefly.

no; yes. There is no relative speed between you and your own pulse, since you are in the same reference frame, so there is no difference in your pulse rate (possible space-travel-related anxieties aside). There is a relative velocity between you and the people back on earth, however, so you would find their pulse rate *slower* than normal. Similarly, they would find *your* pulse rate slower than normal, since you are moving relative to them. Relativistic effects are always attributed to the other party – you are always at rest in your own reference frame.

3. A stick of length $L = 1\,\mathrm{m}$ is at rest on one system and is oriented with its length along the x axis. What is the apparent length of this stick as viewed by an observer moving at a speed v with respect to the first system?

Along the direction of motion, the moving observer will see contracted lengths. If the relative motion is along the x axis, then the meter stick appears shorter by a factor γ for the moving observer:

$$L'_{\text{obs}} = \frac{1\,\mathrm{m}}{\gamma} = 1\,\mathrm{m}\sqrt{1-\frac{v^2}{c^2}}$$