166.

Problem 21.17 (RHK)

An experimenter arranges to trigger two flashbulbs simultaneously, a blue flash located at the origin of his reference frame and a red flash at $x = 30.4\ \text{km}$. *A second observer, moving at a speed of* $0.247\ c$ *in the direction of increasing x also observes the flashes.* (a) *We have to find the time difference between the flashes measured by the moving observer;* (b) *we have to answer which flash is observed first.*

Solution:

(a)

In the frame of reference of the experimenter the space-time co-ordinates of the two synchronous events are:

blue flash, $x = 0,\ t = 0$;

red flash, $x = 30.4 \times 10^3\ \text{m},\ t = 0.$

A second observer moving with speed $v = 0.247c$ in the direction of increasing *x* observes these events. The space-time co-ordinates of the events as observed by the

moving observer will be related to those of the experimenter by the Lorentz transformation:

$$t' = \frac{t - xv/c^2}{\sqrt{1 - v^2/c^2}}.$$

Using the Lorentz transformation the times of the two events measured by the moving observer will be:

blue flash, $t_{blue}{}' = 0$ s,

red flash,

$$t_{red}{}' = \frac{-30.4\times10^3 \times 0.247/3\times10^8}{\sqrt{1-0.247^2}} \text{ s},$$

$$= -2.58\times10^{-5} \text{ s} = -25.8\ \mu\text{s}.$$

The time interval between the two simultaneous flashes in the experimenter's frame as observed by the moving observer will be $25.8\ \mu$s .

(b)

And, according to the moving observer the red flash occurs earlier than the blue flash and will be Doppler shifted.