Special and General Relativity (PHZ 4601) Fall 2017 Solutions

Set 2:

6. Mössbauer precision for measuring a gravitational frequency shift (Rindler 1.9).

Let a $22\,[m]$ long cabin fall freely in the gravitational field g and send a light signal from the top to the bottom. We need to show that when the light signal reaches the bottom, the cabin will already move with velocity $v > 10^{-5}\,[cm/s]$, so that the frequency shift can be detected. This is easily calculated.

Duration of the signal:

$$t = \frac{22\,[m]}{3 \times 10^8\,[m/s]} = 7.33 \times 10^{-8}\,[s]\,.$$

Velocity reached:

$$v = g\,t = (980\,[cm/s]) \times (7.22 \times 10^{-8}\,[s]) = 7.2 \times 10^{-5}\,[cm/s]\,.$$