Solutions to all problems in Robert Resnick's Introduction to Special Relativity

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Resnick's book can be accessed for free here – you will just need to enter your email address.

Problems for Chapter 1

Q1. Justify the relations $y = y'$ and $z = z'$ of Eq1-1a by symmetry arguments.

Solution. Eq1-1a describes the Galilean transformation between the two frames of reference depicted in Fig 1.

$$x' = x - vt$$
$$y' = y$$
$$z' = z$$

The transformation between y and y' because for $y = y_0$, $y' = y_0$ (see red lines in Fig 1). Similarly for z and z'.

*Corrections to `me@vgg.cz`.

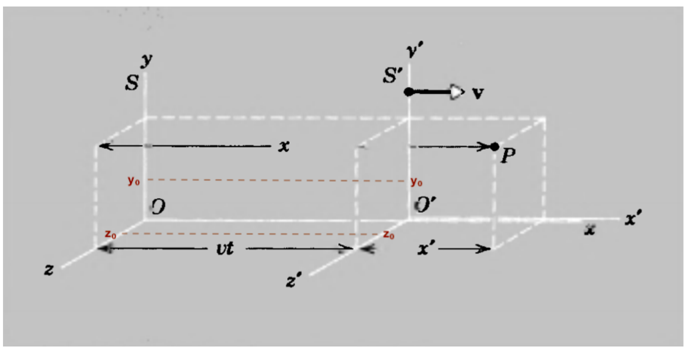

Figure 1: Resnick's diagram depicting the two inertial frames of reference S and S'. S' is moving with velocity v with respect to S. Point P is an event, whose space-time coordinates may be measured by each observer.

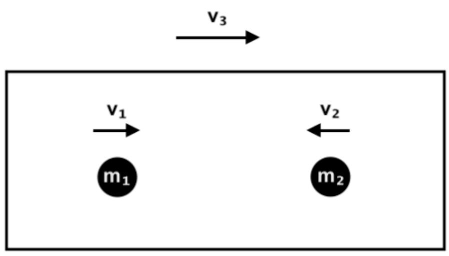

Figure 2: Two particles colliding inside a train travelling at velocity v_3 $\mathrm{m\,s^{-1}}$.

Q2. Momentum is conserved in a collision of two objects as measured by an observer on a uniformly moving train. Show that momentum is also conserved for a ground observer.

Solution. Consider two point particles of mass m_1 kg and m_2 kg travelling at speeds v_1 $\mathrm{m\,s^{-1}}$ and v_2 $\mathrm{m\,s^{-1}}$ respectively (Fig 2). Take the direction of motion of v_1 as being the positive direction. Then the total momentum for an observer inside the train before the collision is

$$p = m \cdot v,\ p_{\text{before}} = m_1 v_1 - m_2 v_2 \tag{1}$$