

## Intermediate Dynamics: Group Exercises 5

### Relativity Review

#### 1 Rocket ball game

A rocket travels to the right relative to a space station and, according to an observer at rest with respect to the space station, the rocket travels with speed  $4c/5$  and passes the space station when the space station clock reads 0 min. An observer at the left end of the rocket arranges for his clock to read 0 min at this moment. The length of the rocket, according to observers at rest on the rocket is 3 lt-min. At the moment that the left end of the rocket passes the space station, the observer on the space station throws a rocket ball to the right. According to an observer on the rocket, the ball travels with speed  $3c/5$  to the right. Our aim will be to determine when and where the ball hits the rocket according to observers on the space station.

- a) Describe two events in the history of the ball that may be relevant for its motion in this scenario.
- b) Is the space station stationary and the rocket moving? Or is the space station moving and the rocket stationary?
- c) Decide on a primed and unprimed observer and say which is which.
- d) List as much as possible about the time and position coordinates for the two events for both observers.
- e) Is it possible to use time dilation to analyze this situation, given the information that you have at present?
- f) Determine the time at which the ball reaches the right end of the rocket according to the rocket observer.
- g) Determine all the time and position coordinates for both events according to both observers.
- h) Determine the speed with which the ball was thrown according to the space station observers. Do this directly from position and time data and also from velocity transformations.