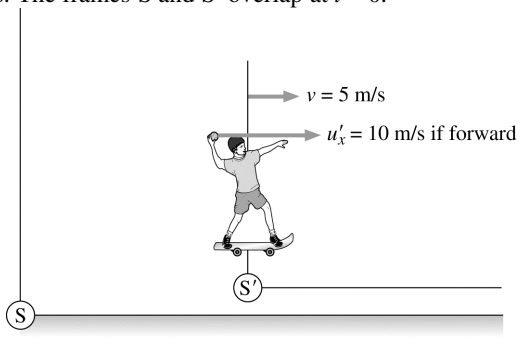
36.5. Model: The boy on a skateboard is frame S′ and the ground is frame S. S′ moves relative to S with a speed $v = 5$ m/s. The frames S and S′ overlap at $t = 0$.

Visualize:



The figure shows a pictorial representation of the two frames.

Solve: **(a)** When the ball is thrown forward, $u'_x = 10$ m/s. The Galilean transformation of velocity is

$$u_x = u'_x + v = 10 \text{ m/s} + 5 \text{ m/s} = 15 \text{ m/s}$$

(b) When the ball is thrown backward, $u'_x = -10$ m/s. In this case

$$u_x = u'_x + v = -10 \text{ m/s} + 5 \text{ m/s} = -5 \text{ m/s}$$

Thus the speed is 5 m/s.

(c) When the ball is thrown to the side, $u_y = u'_y = 10 \text{ m/s}$. Also,

$$u_x = u'_x + v = 0 \text{ m/s} + 5 \text{ m/s} = 5 \text{ m/s}$$

Thus the ball's speed is

$$u = \sqrt{u_x^2 + u_y^2} = \sqrt{(5 \text{ m/s})^2 + (10 \text{ m/s})^2} = 11.2 \text{ m/s}$$