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STUDENT VERSION
RELAY THE BALL HOME

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Abstract: We use a differential equations of one dimensional projectile motion and an integration of velocity for total distance to model the relay between an outfielder and an infielder in throwing the ball to home plate. We determine the location of the infielder so as to minimize the time of the relay.

SCENARIO DESCRIPTION

A baseball player (outfielder) throws a ball with initial velocity 135 ft/s (about 92 mi/hr - less than a good pitcher's high speed fastball of 100 mi/hr) toward home plate some 400 feet away. Another player (an infielder who cuts the ball off - catches it - from the outfielder's throw) places himself in direct line between the outfielder and home plate and catches the ball x feet from home plate and then throws (relays) the ball home with initial velocity 110 ft/s.

It takes 2 seconds to accomplish the relay. Assume that due to air resistance the velocity $v = v(t)$ obeys the differential equation (1).

$$v'(t) = -0.1v(t)\,, \tag{1}$$

and ignore vertical motion.

1. Find the time, T, it takes for the ball to reach home plate as a function of x, the distance from the plate of the infield cut-off player.
2. Find x which minimizes T.
3. For a range of infielder capabilities, i.e. initial throwing velocities from 60 ft/s to 140 ft/s, prescribe the cutoff distance x and the total time for the relay to the plate.
4. Consider the infielder who can throw 110 ft/s. Would you rather improve the infielder's relay time, say down to 1.8 sec, or increase his initial velocity on the ball by 10 ft/s? Explain.