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SIMIODE Systemic Initiative for Modeling Investigations and Opportunities with Differential Equations

STUDENT VERSION
RELAY THE BALL HOME

Brian Winkel
Director SIMIODE
Cornwall NY USA

STATEMENT

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.