

# MOMENTUM CONSERVATION

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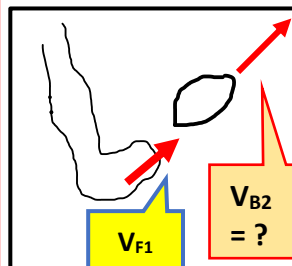
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## The N.F.L.'s Most Valuable Player Might Be ... a Punter?

THOUSAND OAKS, Calif. **Since entering the N.F.L. in 2012, Hekker, 27, has come to dominate as a punter like few others. He confounds opponents by marrying distance, direction and hang time to smash records, last year compiling what is regarded as the best punting season in N.F.L. history. He broke his own mark for net average, with 46.0 yards per kick,** and dropped 51 punts inside the 20-yard line with only one touchback, a ratio that the Rams' special-teams coach, John Fassel, described as "just stupid." Beyond his punting witchcraft, which all but neutralizes the opposition's return game, Hekker is a former high school quarterback whose passing ability has emboldened his coaches to call fakes at any time, from anywhere on the field. "Pound for pound, the best value I've gotten for any player has been Johnny Hekker," Rams General Manager Les Snead said. "Not just that he's a starting punter, which would have been a success.



**INTRODUCTION:** Assumption in this application is Hekker's above average body and leg size causes higher than average launch speeds ( $V_{B2}$ ).



$V_{B1}$  = ball velocity before kick  
 $V_{F2}$  = foot velocity after kick.  
 For inelastic collisions, the coefficient of restitution = eq.1  
 $e = [V_{B2} - V_{F2}] / [V_{F1} - V_{B1}]$   
 From linear momentum conservation: (eq. 2)  
 $m_F V_{F1} + m_B V_{B1} = m_F V_{F2} + m_B V_{B2}$

Get bigger in mass

**At 6-foot-5 and 241 pounds, Hekker is the biggest punter in the N.F.L.** No less a special-teams enthusiast than Patriots Coach Bill Belichick, while game-planning against the Rams last season, called Hekker "as good a player as I've ever seen at the position." **Punting eight times against New England,** Hekker netted an average of 52.9 yards and deposited five punts inside the 20. "I would like to think I'm a top-10 guy in the league," Hekker said, "but really I have a lot more work to do." That claim is not drenched in hyperbole, and does not insinuate any bias from a man who in September tacked two more years onto the six-year, **\$18 million deal Hekker signed in 2014.** **Hekker Stands Apart** Johnny Hekker of the Rams **leads in two of punting's most important statistics: net yards and pinning the opponent inside their 20.**

**QUESTIONS:** (a) Consider initial velocity of ball  $V_{B1} = 0$  prior to kick by foot at velocity  $V_{B1}$ . Using eq. 1 & 2 show (show algebraic steps)  $V_{B2} = [m_F / (m_F + m_B)] [1 + e] V_{F1}$ , (b) Consider  $[1 + e] V_{F1}$  being constant. Consider  $m_F = 5 m_B$ , find  $V_{B2}$  in terms of  $[1 + e] V_{F1}$ ?, (c) Consider  $m_F$  (mass of foot) =  $7 m_B$ . Find  $V_{B2}$  in terms of  $[1 + e] V_{F1}$ ?, (d) Consider  $m_F = 9 m_B$ . Find  $V_{B2}$  in terms of  $[1 + e] V_{F1}$ ? (e) **Comment on  $V_{B2}$  values as  $m_F$  increases?** In all these cases the coefficient of restitution is constant and a constant number  $e < 1$  not needed to be specified.

**ANSWERS:** (a)  $V_{B2} = [m_F / (m_F + m_B)] [1 + e] V_{F1}$ , (b)  $V_{B2} = 0.83 [1 + e] V_{F1}$ , (c)  $V_{B2} = 0.875 [1 + e] V_{F1}$   
 (d)  $V_{B2} = 0.90 [1 + e] V_{F1}$ , (e) As kickers foot and leg ( $m_F$ ) become larger (with ball kicked at the same speed  $V_{F1}$  of foot and leg) you can see in computation results (answers (b) to (d)) the launch velocity of ball  $V_{B2}$  increases with foot and leg mass increase. **Thus, having a more massive leg and foot has its advantage In producing longer kick distances having larger initial launch velocities.** Dr J. C.