

## CSAAPT Spring 2022 Semi-Virtual Meeting



Chesapeake Section of the  
American Association of Physics Teachers  
Spring 2022 Semi-Virtual Meeting  
April 2, 2022 @ **RADFORD** UNIVERSITY

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# Optimal shot-put release angle revisited: solving a maximization problem without calculus

*Saturday, April 2, 2022 10:00 AM (15 minutes)*

It is well known that  $45^\circ$  is the optimal angle to send a projectile, to achieve the maximal range,  $R$  (on flat ground). Yet, the best shot putters release at much less than  $45^\circ$  instead. The resolution to this “puzzle” was traced to the landing site being lower than the height of release [Lichtenberg and Wills, *AJP*, 1978]. A standard problem, its solution typically involves setting to zero the derivative of  $R$  with respect to the initial angle. We present an alternative method which requires no calculus, but only geometry (and algebra) in velocity space. In particular, given an initial speed and height of the target, the initial and final velocities are always orthogonal—for the trajectory with maximal  $R$ . From this condition and energy conservation, the optimal angle is easily found.

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