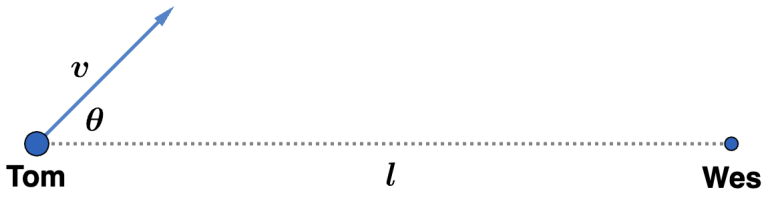
2013 F=ma Exam: Problem 3

Kevin S. Huang



- A) This statement is true. Recall the range equation,

$$R = \frac{v^2 \sin(2\theta)}{g}$$

which is maximized by $\theta = \pi/4$ so $\sin(2\theta) = 1$,

$$R_{\max} = \frac{v^2}{g}$$

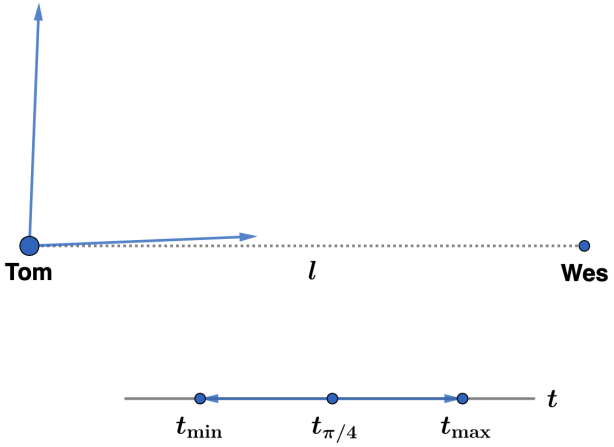
If Tom can throw with maximum speed $v_{\max}$, then we need

$$l \leq R_{\max} = \frac{v_{\max}^2}{g}$$

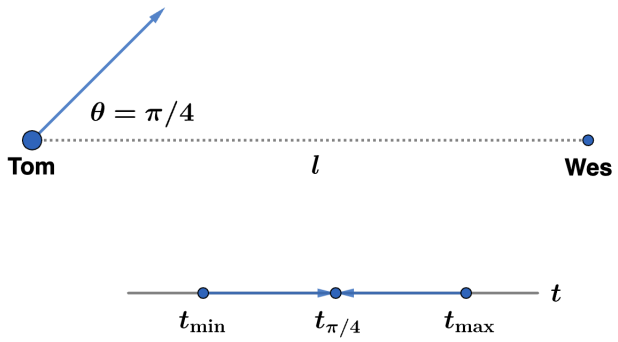
$$v_{\max} \geq \sqrt{gl}$$

for the ball to reach Wes.

- B) This statement is true. When $v_{\max} = \sqrt{gl}$, there is only one trajectory which reaches Wes so $t_{\min} = t_{\max} = t_{\pi/4}$ where $t_{\pi/4}$ is the time taken by the trajectory with $\theta = \pi/4$. As $v_{\max} \to \infty$, the window of times expands since at high speeds we can launch almost horizontally to reduce t and almost vertically to increase t.



- C) This statement is true as explained in answer choice B.
- D) This statement is true. At small l, we have a range of times the ball could take to reach Wes depending on launch angle. As l increases, this window closes since at the maximum $l = v_{\text{max}}^2/g$ there is only one trajectory which reaches Wes so $t_{\text{min}} = t_{\text{max}} = t_{\pi/4}$.



- E) This statement is false as explained in answer choice D.

Thus, the answer is $\boxed{\text{E}}$.