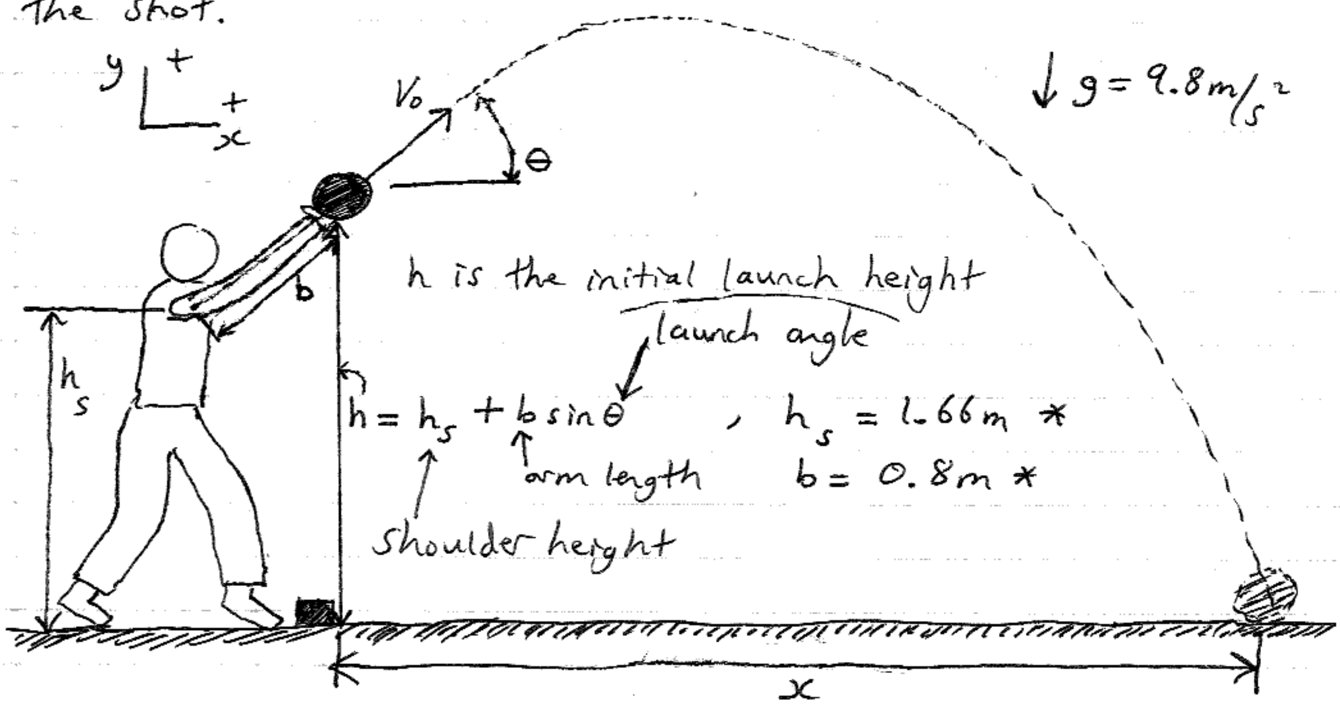
A shot putter wishes to maximize the distance of the shot.



It is given that the launch velocity V_0 of the shot putter is given by

$$V_0^2 = 2\left[\frac{E(\theta)}{m} - gb\sin\theta\right] \quad * \quad (1)$$

where $E(\theta) = 106.18\, m\left(\frac{2+\cos\theta}{3}\right)$, where m is the shot put mass

We can easily ignore air resistance in this problem because the shot put weight is much larger than the air resistance it would experience.

Find θ in order to maximize x, the shot put distance.

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reference: * "The optimal angle of Release in Shot Put", Alexander Lenz, Institut für Physik, Technische Universität (cont'd)

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Solution:

The equations for projectile motion are:

position
$$\begin{cases} x(t) = (V_0 \cos\theta)\, t & , \ t \text{ is time} \\ y(t) = (V_0 \sin\theta)\, t - \frac{1}{2} g t^2 \end{cases}$$

Combine the above two equations and eliminate t. We get

$$y(x) = x \tan\theta - \frac{g x^2}{2 (V_0 \cos\theta)^2}$$, with xy origin located at the launch position

We wish to solve for x when the shot put lands on the ground. This occurs at $y = -h$. Substitute $y = -h$ into the above equation and solve for x. We get

$$x = \frac{V_0^2 \cos\theta}{g} \left(\sin\theta + \sqrt{\sin^2\theta + \frac{2gh}{V_0^2}} \right)$$

Substitute $h = h_s + b\sin\theta$ ($h_s = 1.66\,m$, $b = 0.8\,m$) and V_0^2 from equation (1) into the above equation and find θ to maximize x. We find θ to be equal to $37.94°$.