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A human bicep can exert $T_M = T$ Newtons on the forearm. Take $d_B = X$ meters and $d_{ball} = Y$ meters. What is the maximum weight of the ball so that the moment around the elbow is zero if θ is limited to $A < \theta < B$? At what angle is the moment caused by the ball maximized?

ANSWER:

We know that in this case, the sum of moments is zero.

$$\sum M_O = T_M \cdot d_b \cdot \cos(\theta) - W \cdot d_{ball} \cdot \cos(\theta) = TX \cos(\theta) - W \cdot Y \cos(\theta) = 0$$

$$TX \cos(\theta) = W \cdot Y \cos(\theta)$$

$$W = \frac{TX}{Y}$$

Since the weight of the ball acts purely in the vertical direction, the moment caused by the ball is maximized when the horizontal distance between the force and the elbow is maximized. This happens when the angle θ is as close to 90° as possible.