20 Hammer Throw

In this experiment we will understand rotational dynamics, centripetal and centrifugal force, and the fundamental desire of fast-moving, heavy weights to travel in straight line. You will perform two experiments: first throwing the hammer by spinning horizontally, second spinning the hammer in an inclined plane to launch it, like ballistic projectile, for maximum distance. In the first experiment, spin as fast as you can while maintaining control and balancing and let the hammer go down range. Take several throws and record your best distance with each thrown. In the second experiment try, as best as you are able, to rotate at the same speed, but spin the hammer in an inclined plane so that on release it will follow a ballistic trajectory to achieve maximum distance.

**Experimental Data**

You will need to collect the following data:

Distance thrown flat plane spinning
Distance thrown inclined plane spinning
Your weight
The weight of the hammer.

**Problem:**

Calculate (from the distance thrown) the velocity of the hammer
Calcualte the time of flight of the hammer
From the weight of the hammer and your weight, the joint center of rotation and the distance to the center of mass of you and to the hammer
Calculate your RPMs at release
Sketch the free body diagram of the joint system of you and the hammer spinning.
Calculate the centrifugal force exerted on the joint center.
Calculate the optimal release angle to get the maximum distance throw.
Calculate your release angle as you attempted to release in an inclined plane.

Extra credit: the following is a detailed analysis of a hammer throw, including the mass of the cable and air friction on the various components.

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Using this detailed model, calculate the optimal release angle.
How does including the mass of the system (cable and handle) effect the results?
How does including air friction change the results?