Energy stored in elastic equals gravitational potential energy which is mass times distance dropped. Thus

\[ \Delta E_{0.34kG} = 34kG \times 0.36m \times g = 120J \]
\[ \Delta E_{0.54kG} = 56kG \times 0.48m \times g = 270J \]

If we assume \( E_{\text{elastic}} = 0.5kx^2 \) then we conclude \( k = 2\Delta E/x^2 \) so

\[ k_{34kG} = 2 \times 120/0.36^2 = 1900 \text{ N/m} \]
\[ k_{56kG} = 2 \times 270/0.48^2 = 2300 \text{ N/m}^2 \]

so since we get roughly the same \( k \) in the two cases we conclude that to roughly 20% accuracy (4 parts out of 20) the elastic is harmonic over this range of displacements.

From the trajectory (including knowledge that the angle at which the catapult shot the particle was about 45\(^{\circ}\)) we can infer the initial velocity and hence the initial kinetic energy.

Specifically, if the initial velocity has \( x \) and \( z \) components \( v_{x,z} \), the initial position is defined to be \( x = 0, z = 0 \) then we have

\[ z(t) = v_z t - 0.5gt^2 \]
\[ x(t) = v_xt \]

so if the particle travels a distance \( X \) in the horizontal direction \( t = X/v_x \) so

\[ z(t) = \frac{v_z}{v_x}X - 0.5 \frac{g}{v_x^2}X^2 \]

Because the angle at which the mass was shot was about 45\(^{\circ}\), \( v_z = v_x \) and \( v_x = v/\sqrt{2} \) so if the vertical distance travelled was \( Z \) then

\[ Z = X - \frac{g}{v_x^2}X^2 \]

or

\[ v^2 = \frac{gX^2}{X-Z} \]

We can use Eq. 6 to compute the kinetic energy \( 0.5mv^2 \) from the data we took in class. I then express this as a fraction of the energy stored in the elastic (from Eq. 1), obtaining
We see that only 2% or so of the elastic energy is converted to particle kinetic energy. I suspect that the differences between the faster velocity (larger elastic energy) and smaller are due to air resistance, which is more important for the less massive projectile.