Rubber Bands

Apparatus

selection of rubber bands, including broken ones, hung from retort stand, weights with hangers, a ruler

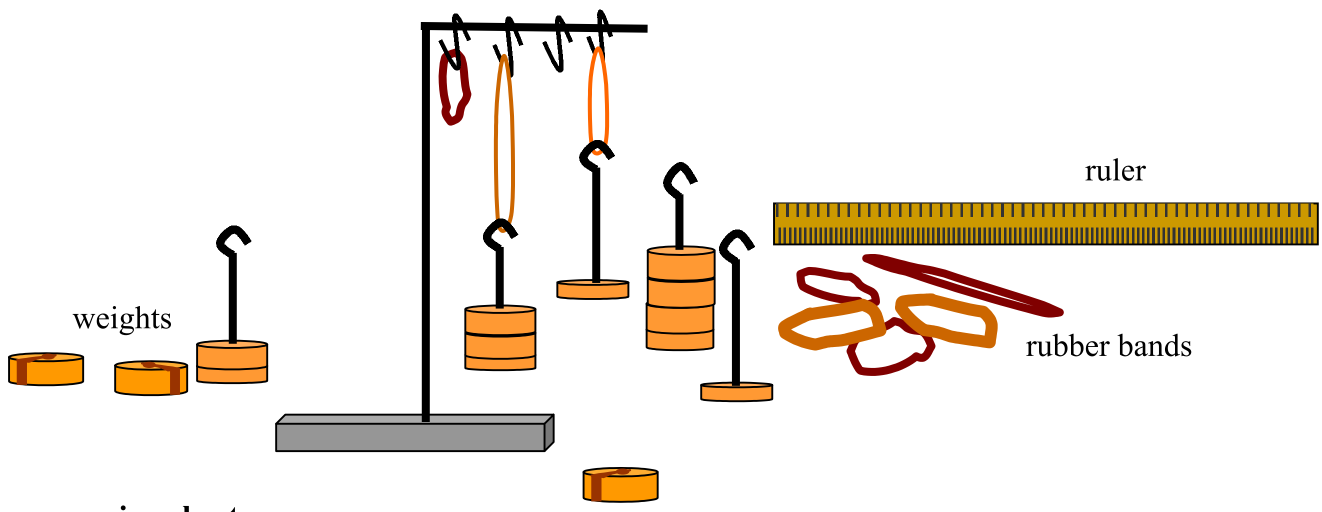
Action

The students hang weights from the rubber bands to determine the spring constant of the rubber bands, and how linear the stress strain relationship for the bands is. They can estimate the Young's modulus of a band, or compare the Young's moduli of bands with similar cross sectional area. They can experiment with attaching bands in series and parallel to see how this affects the stress-strain relationship. They may also want to determine the ultimate strength of the rubber, by hanging on larger weights until a band breaks, although this can be a bit dangerous.

The Physics

The Young's, E, modulus is given by $F/A = E\times \Delta L/L$, where L is the length, F is the applied force (mg for the weight in this case), and A is the cross sectional area of the material (rubber). Note that rubber bands obey this linear relationship for small applied forces only, however they can be subjected to large forces without being permanently deformed. The ultimate strength is measured by breaking the material.

The rubber band that stretches the least for a given weight (applied force) has the greatest spring constant. If you had rubber bands of the same cross sectional area then the one that stretches the least also has the greatest elastic modulus. If you cut a strip of rubber in half it would stretch less for a given weight, so its spring constant will have decreased. The modulus of elasticity depends on the material, and will not have changed. If you joined two rubber strips or bands together in parallel they would also stretch less, but again the modulus of elasticity has not changed. Effectively you will have doubled the spring constant by doubling the cross sectional area.



Accompanying sheet

Rubber Bands

Use the weights to find the spring constant of the rubber bands.
How linear is the stress - strain relationship for these bands?

Cut a band into a strip, and measure its spring constant.
Now cut it in half and repeat the measurement.
What has happened?
What happens if you connect two strips in parallel?