

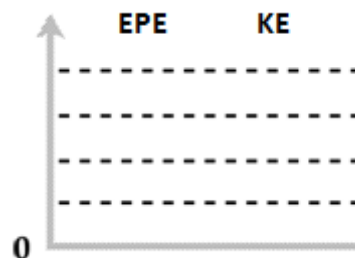
Name: \_\_\_\_\_

## Elastic Potential Energy Lab

### Introduction

If you've ever been shot with a rubber band then you know it has energy in it—enough energy to smack you in the arm and cause a sting! But have you ever wondered what the relationship is between a stretched rubber band at rest and the energy it holds? The energy the rubber band has stored is related to the distance the rubber band will fly after being released.

Look at the following picture. Estimate the EPE and KE before the student lets go of the rubber band.



Hopefully, you said there's a lot of EPE and no KE. To determine the EPE requires a little math.

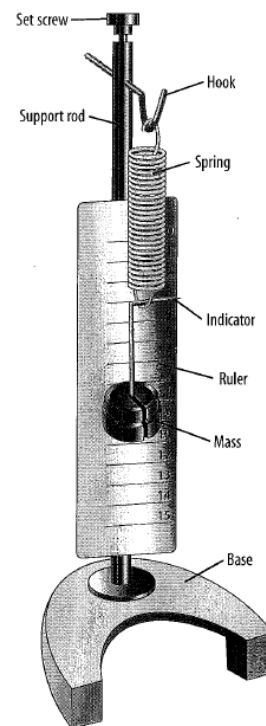
You input potential (stored) energy into the rubber band system when you stretched the rubber band back. When the rubber band is released, the potential energy is quickly converted to kinetic (motion) energy. Because it is an elastic system, this kind of potential energy is specifically called elastic potential energy. Elastic potential energy (measured in the unit joules) is equal to  $\frac{1}{2}$  multiplied by the stretch length ("x") squared, multiplied by the spring constant "k."

$$EPE = \frac{1}{2} k x^2$$

But how do you find what k is especially when the spring constant is different for every rubber band. To do this requires some math. The setup is located in the picture to the right. In our case though, we are going to swap out the spring with a rubber band because who likes shooting springs at someone?

### Directions

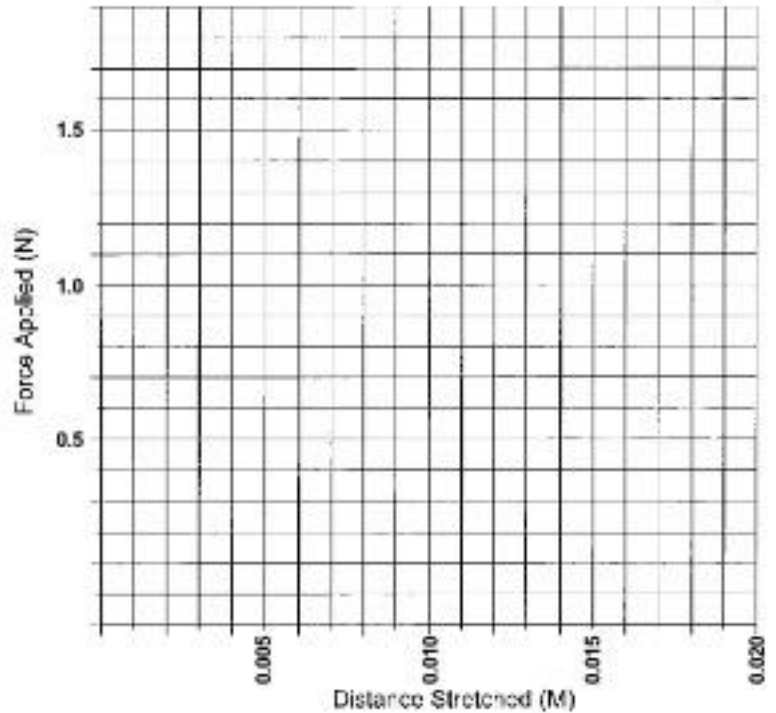
1. Using the colored rubber band (red, yellow, or blue color) hang it in place of the spring in the image to the right.
2. Without any weights on the holder, place the zero point at the end of the rubber band.
3. Add 20 grams (2 weights) to the holder and note in your chart how much the indicator dropped.
4. Keep adding weights to the holder noting the change in the indicator or until the weight bottoms out. Note to reach 100 grams you will need to add the 10 gram brass weight to the top of the flat weights.
5. Calculate the amount of force applied to the rubber band.



*Data Table*

Total Mass (g)	Mass (kg) (divide gram/1000)	F(N) = Mass (kg) x 9.8		Stretch Length (mm)	Stretch Distance (M) (divide mm/1000)
20					
40					
60					
80					
100					

6. In the space to the right plot the Force Applied (N) vs. Stretch Distance (M).
7. Connect the dots on the graph and determine the slope (write it on the graph).
8. The slope represents the spring constant. The spring constant for the colored rubber band is: \_\_\_\_\_



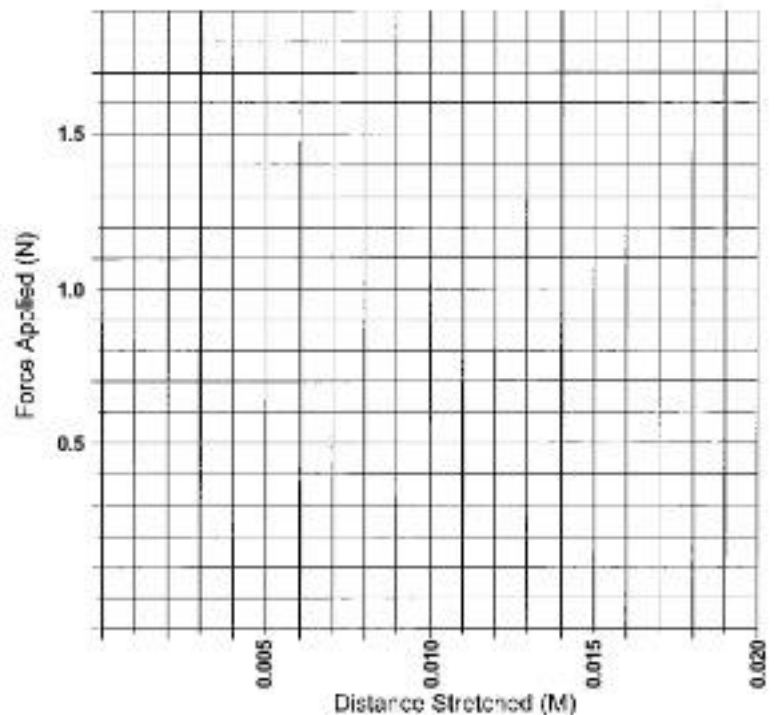
**Directions**

9. Using the tan rubber band hang it in place of the colored rubber band.
10. Without any weights on the holder, note the zero point of the indicator \_\_\_\_\_.
11. Add 20 grams (2 weights) to the holder and note in your chart how much the indicator dropped.
12. Keep adding weights to the holder noting the change in the indicator or until the weight bottoms out. Note to reach 100 grams you will need to add the 10 gram brass weight to the top of the flat weights.
13. Calculate the amount of force applied to the rubber band (it's the same as before)

*Data Table*

Total Mass (g)	Mass (kg) (divide gram/1000)	F(N) = Mass (kg) x 9.8	Stretch Length (mm)	Stretch Distance (M) (divide mm/1000)
20				
40				
60				
80				
100				

14. In the space to the right plot the Force Applied (N) vs. Stretch Distance (M).
15. Connect the dots on the graph and determine the slope (write it on the graph).
16. The slope represents the spring constant. The spring constant for the tan rubber band is: \_\_\_\_\_



## Analysis

17. Which rubber band has a higher spring constant?

18. Which rubber band do you think will fly further? Why? At this point it's a guess!

So can you guess one way to test how spring constant plays a role in rubber band shooting? Yeah, I figured you could.

## Materials

- A long uninterrupted surface
- Meter stick
- Rubber bands
- Safety Glasses

## Procedure

- Stand where there is lots of clearance in front of you. Place a small piece of tape to mark your starting line.
- Rest the edge of the ruler on the white plastic tube. **Remember the angle and height at which you hold the ruler because you will need to keep it the same for each rubber band launch.**
- Note the equilibrium length of each rubber band.
- Shoot the rubber band by hooking it on the front edge of the ruler, then stretching it back to 10 centimeters (cm) beyond the equilibrium point on the ruler and letting the rubber band go.
- Measure the distance from where you shot the rubber band to where it landed.
- Shoot at two more attempts with the same rubber band in the same way, stretching them back to 10 cm beyond its equilibrium point on the ruler each time. **Note: although I'm giving you the measurements in centimeters, please record your distances in meters; remember meters = cm/100!**

Rubber Band	Distance traveled (m)	Distance traveled (m)	Distance traveled (m)	Average Distance Traveled (m)
Colored				
Tan				

**Conclusion:**

1. Update your rule from the reading based on your spring constant knowledge and how it changes elastic potential energy.

2. Update your potential energy graphic organizer.

3. The elastic PE formula for a rubber band is  $EPE = \frac{1}{2} k x^2$ . The elastic PE formula for a spring is written as  $EPE = k x^2$ . Why is the spring EPE formula missing the  $\frac{1}{2}$ ? Hint: compare the picture to the right vs. the set-up you used with a rubber band.

