Conceptual Academy

Conceptual Physics Hands-On Activity

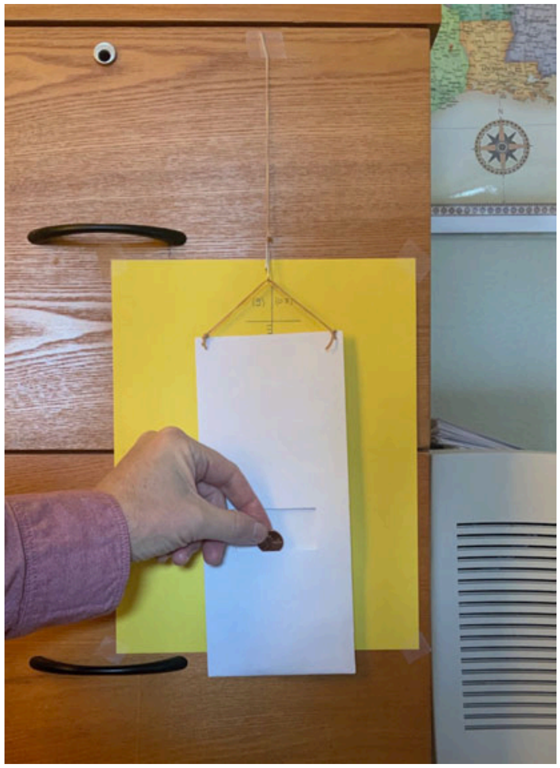
Rubber Band Balance

Materials Needed: Mailing envelope, thin rubber bands, paper clip, ruler, scissors, tape, pennies, nickels, and quarters

Purpose: To create a spring scale that measures the force on an object.

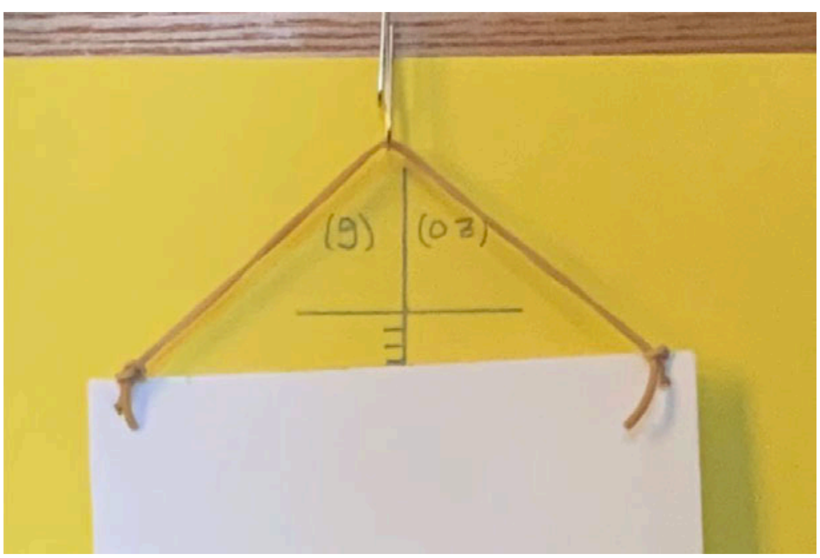
Field Joural: Make a compete record of your performing this activity within your field journal. This may include attaching the pages of this activity as an insert. Be sure to include the date, any graphs, collected data, photos of yourself performing the activity, your conclusion, and anything else you feel appropriate.

Procedure: Cut a thin rubber band and tie the ends to the end corners of an envelope with the flap cut off. Cut a second thin rubber band and tie it to a paper clip that holds the first rubber band as shown. Cut out a little window in the front of the envelope and place some tape around the lower open edge of the envelope so that coins won't roll out. Hang the envelope from the loose end of the second rubber band. Tape a sheet of paper on the wall behind the envelope. Use a ruler to draw a straight line centered behind the envelope. With the envelop hanging freely, mark the top of the envelop on that paper.



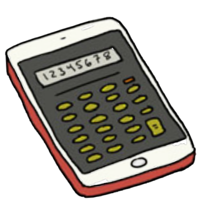
On the left side of the line you can calibrate in units of grams. Insert a post-1982 penny into the envelop through the front window. The weight of that penny will cause the rubber bands to stretch causing the envelope to lower. Draw a mark to at the new level of the envelope. Add another post-1982 penny and mark the new level of the envelope. Keep adding pennies until the envelop stretches close to the bottom of the paper. Warning: Be mindful that the top rubber band is attached securely. (For fun, check out what happens with a pre-1982 penny)

Look up the mass of a post-1982 penny in units of grams. Use this information to label your tick marks in units of grams and to complete Data Table 1.



Data Table 1: Pennies versus rubber band stretch

Number of pennies	Mass (g)	Mass (kg) (Convert g to kg)	Force (N) (F = ma; use $9.81 m/s^2$)	Stretch From Resting Position (mm)
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

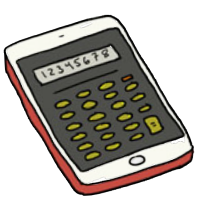


Data Analysis: Show the mathematics of converting grams to kilograms and also kilograms to Newtons.

Remove the pennies and repeat the above procedure by adding quarters and making tick marks on the right side of the center line. Look up the weight of a U.S. quarter coin in units of ounces. Use this information to label your tick marks in units of ounces and to complete Data Table 2.

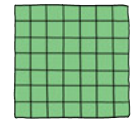
Data Table 2: Quarters versus rubber band stretch

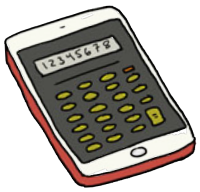
Number of quarters	Weight (oz)		Force (N) (Use 1 oz = 0.28 N)	Stretch From Resting Position (mm)
0				
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				



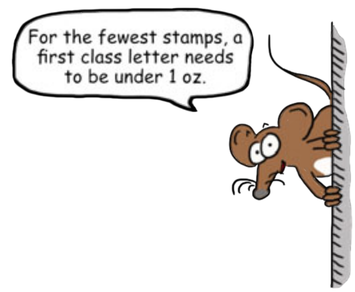
Data Analysis: Use the space below to show the mathematics of converting ounces to Newtons.

Graph: Create a graph for each of your data tables plotting Force (N) against the stretch of the rubber band (mm). Be sure to label all axes.





Data Analysis: If the lines in your graphs are linear, then what are the slopes? Show your work. Include units.



Note: Save your rubber band scale which can be used for subsequent activities.

Conclusion:

Formulate a conclusion by answering the following questions: What events in the experiment were expected? What events in the experiment were unexpected? What human error occurred (i.e. measurement errors, mathematics errors, etc)? What equipment error occurred (i.e. friction, air resistance, improper calibration, broken equipment, etc)? How could the activity be improved? How could this activity apply to physics in the everyday world?

What similar experiment could be done next to further study this phenomenon? For example, is there a difference between the force required to get a weighted envelope sliding on the floor compared to keeping it sliding?