Activity 7 - Rubber Band Force

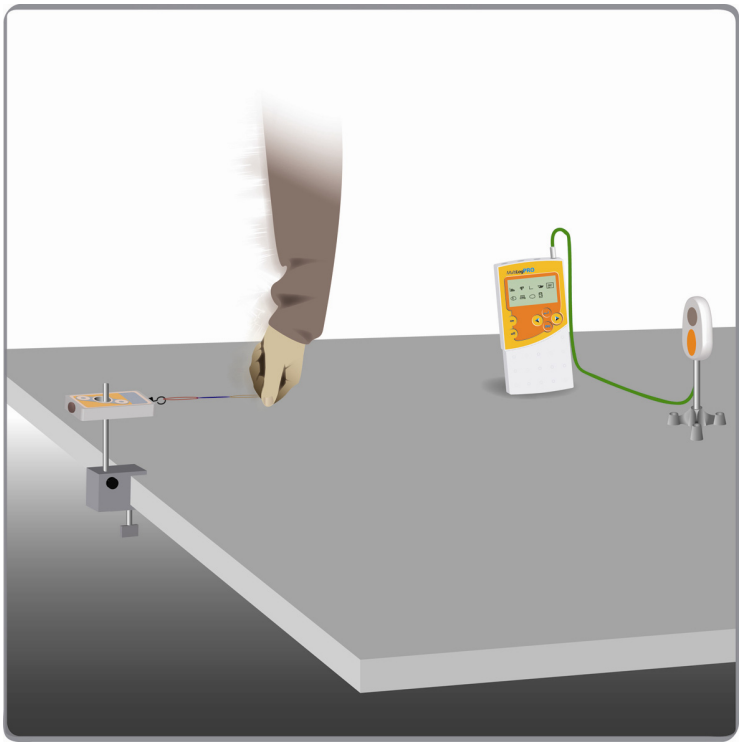

Figure 7-1

Introduction

You probably know that the more you stretch a rubber band – the more force it takes, but is there a simple mathematical relation between the amount of stretching and the force taken to stretch?

In this activity you will measure both the lengthening and the force while stretching a rubber band, and then try to formulate it.

Equipment

- MultiLogPRO, Nova or TriLink data logger
- Distance sensor
- Force sensor (±10N)
- Few rubber bands
- Table clamp with rod
- Table stand
- Tape

Equipment Setup Procedure

1. Assemble the equipment as shown in Figure 2-1.
2. Turn on the data logger
3. Connect the Force sensor to input 1 (I/O-1) of the data logger
4. Connect the Distance sensor to input 2 (I/O-2) of the data logger
5. Connect the data logger to the computer
6. Run MultiLab
7. Click **Setup wizard**  on the upper toolbar and program the data logger according to the specifications below

Data Logger Setup

Sensors:

Input 1: Force ±10N

Properties  : measurement: check **Force - Pull positive**
Un-check **Force - Push positive**

Input 2: Distance

Properties  : measurement: check **Distance (Incoming)**
un-check **Distance (Outgoing)**

Rate:

10 samples per second

Recording time:

20s (200 samples)

Experimental Procedure

1. Link together three rubber bands to make a three-piece chain. Fix one end of the rubber chain to the Force sensor's hook and hold the other end in you hand so that the back of the hand points to the Distance sensor (see Figure 3-1)

2. On the line connecting the sensors measure and mark with a piece of tape a point 50cm away from the Distance sensor

Set the current readings to zero

As we want to measure only the lengthening of the rubber band we need to set the zero point at point where the rubber just starts to stretch.

1. Click **Setup wizard**  on the upper toolbar
2. Click **Properties**  next to *input 2: Distance*, then click the **Set Zero** tab
3. Check the **Set the current reading to zero** check box, then click **OK**
4. Stretch the rubber chain just to point where you begin to feel the tension of the rubber. Mark this point with a piece of tape. Keep your hand in this position
5. Click **Finish**

Collect the data

1. Click **Run**  on the upper toolbar to begin recording data
2. Move your hand to stretch and relax the rubber chain several times

Note: you must keep your hand within the two marks while data is being collected

3. When logging ends save your data by clicking **Save**  on the upper toolbar

Data Table

Quantity	value
Manual curve fit equation	
Automatic curve fit equation	

Data Analysis

Produce force vs. distance

1. Click **Edit graph**  on the graph (lower) toolbar
2. Select **Exp. #: Distance (incoming) I/O-2** in the X-axis list by clicking on it
3. Select **Exp. #: Force, Pull - positive I/O-1** in the Y-axis list by clicking on it
4. Click **OK**
5. Click **Add graph to project**  on the graph toolbar to preserve the current graph, then click **Save** 

Find the slope by trial and error

You can also use MultiLab's manual curve fit tool to find the best line fit to your data by trial and error

1. Click **Analysis** on the menu bar, then click **Manual curve fit** to open a dialog
2. Select **Exp. #: Distance (incoming) I/O-2** in the X-axis list by clicking on it
3. Select **Exp. #: Force, Pull - positive I/O-1** in the Y-axis list by clicking on it
4. Click **OK**
5. Select the fit type:

– Linear

– Quadratic

– Exponential

– Power

6. Use the sliders to fit the line to your data

7. The fit equation appears at the bottom of the fit window. Record it in your data table

8. Click **Add fit to Project**  on the manual curve fit window to add the resulting fit to the data map and exit the manual curve fit mode

9. Save your data by clicking **Save**  on the upper toolbar

Apply an automatic curve fit to the graph

1. Remove the manual fit curve from the graph by clicking its icon on the data map

2. Click **Linear fit**  on the main toolbar

3. The linear fit equation appears in the information bar below the graph. Record it in your data table

Questions

1. Formulate the relation between the amount of stretching and the force taken to stretch

2. What are the units of the slope?