Name ______________________________

Date ______________________________

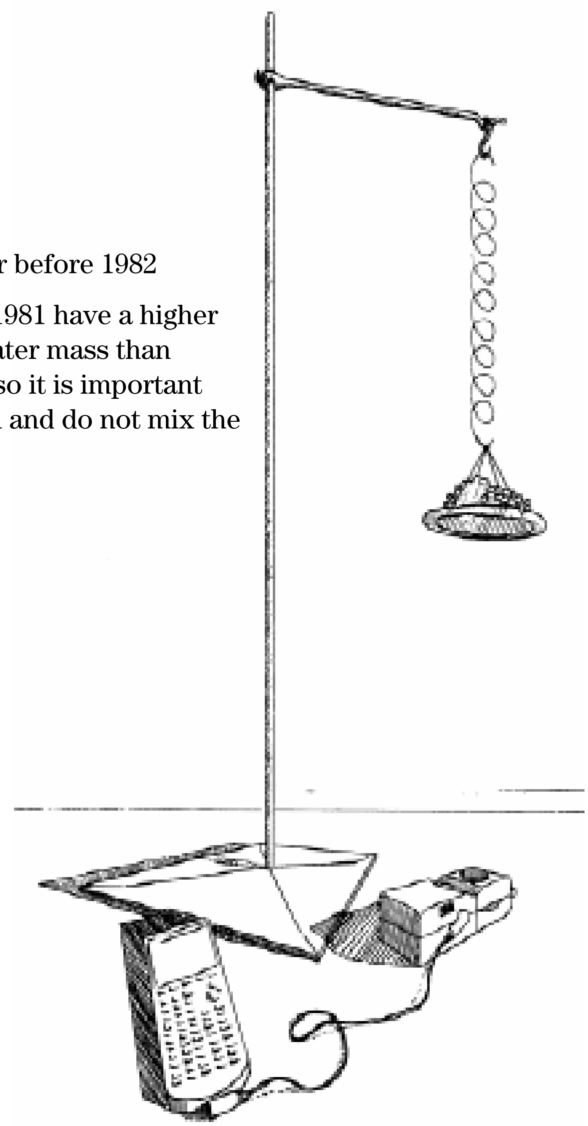
EXPLORATIONS

ACTIVITY 1

Stretching a Penny

Hooke's law states that the force applied to a spring is directly proportional to the distance the spring is stretched, $F \propto x$. The more weight pulling on the spring, the farther the spring stretches.

In this activity, you will investigate how a spring stretches when various weights pull on the spring. You will then relate the stretch of the spring directly to the number of pennies and vice-versa.



You'll Need

- 1 CBR unit
- 1 TI-83 or TI-82 Graphing Calculator
- *BIG* handful of pennies dated after 1983 or before 1982

  Note: Pennies minted between 1959 and 1981 have a higher percentage of copper and thus have a greater mass than pennies minted from 1983 to the present, so it is important that you sort the pennies before you begin and do not mix the two different types of pennies.
- Spring or slinky
- Paper bowl or plate
- Ring stand or hook

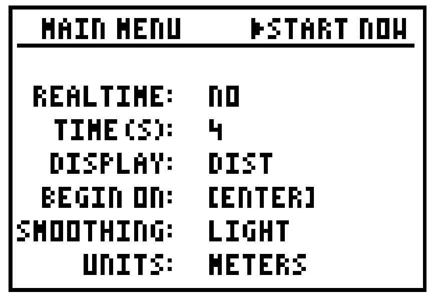
Instructions

1. Attach the paper bowl or plate to the spring. Hang the spring from the ceiling or a ring stand.

2. Position the CBR face up under the plate.

3. Run the **RANGER** program on your calculator.

4. Enter the setup instructions.
   a. From the **MAIN MENU** select **1:SETUP/SAMPLE** to access the setup menu.
   b. Press [ENTER] until the **REALTIME** option reads **no**.
   c. Press [▼] (the down arrow) to select the next line **TIME (S)** and press [ENTER] [4] [ENTER] to change the time to **4** seconds.
   d. Press [▼] to select the next line. Correct or verify the settings and press [ENTER]. Repeat until the options for each line read as shown at right.
   e. Press [▼] to move the cursor to the **START NOW** command. Press [ENTER] and follow the directions on the calculator screen.



5. The graph should be a horizontal line. If you are not satisfied with your results, press [ENTER] and select **5:REPEAT SAMPLE**. Trace along the graph to approximate the distance between the plate and the CBR. Record this distance in the data table below.

6. Add 5 pennies to the plate. Press [ENTER] and select **5:REPEAT SAMPLE**.

7. Repeat step 6 until a total of 20 pennies have been added to the plate.

8. Press [ENTER] and select **7:QUIT** to exit the **RANGER** program.

Data Collection

Number of Pennies	**Distance to the Plate (meters)**
0	
5	
10	
15	
20	

Questions

1. Calculate the total amount of stretch every time 5 pennies is added to the plate by subtracting each distance from the distance when there were no pennies on the plate. Record the stretch in the second column of the table below. This is the stretch measured in meters.

Number of Pennies	Stretch (meters)	Stretch (centimeters)	Stretch per Penny (centimeters/penny)
0			
5			
10			
15			
20			

2. Convert each of the measurements in the second column to centimeters and record it in the third column.

3. Now calculate the amount of stretch per penny by dividing the stretch (the third column) by the total number of pennies on the plate and record the data in the last column of the table.

4. What do you notice about the stretch per penny for each trial?

   ____

5. Grab a big handful of pennies and place them gently on the plate. Trigger the CBR and collect the distance as you did in **Instructions** steps 6, 7, and 8 (page 2). Record this distance.

   Distance in meters: ______________________

   Distance in centimeters: ______________________

6. What would the stretch be in both meters and centimeters for this handful of pennies?

   Stretch in meters: ______________________

   Stretch in centimeters: ______________________

7. Using the information found in question 4, what is the stretch per penny in both meters per penny and centimeters per penny.

   Stretch in meters per penny: ______________________

   Stretch in centimeters per penny: ______________________

8. Predict the number of pennies on the plate:

Number of Pennies = ______________________________

9. Count the number of pennies on your plate. How close was your prediction to the actual number of pennies?

____

10. Suppose that you had 100 pennies on the plate. Calculate the amount of stretch for this handful of pennies in both meters and centimeters. Show how you arrived at this number.

Stretch = ______________________________

11. Suppose that the stretch was 0.5 meters. How many pennies would have been on the plate? Show how you arrived at this number.

Number of Pennies = ______________________________

Make A Mathematical Statement

1. If s is the amount of stretch in centimeters, then show how to predict how many pennies, p, there would be in the plate.

p = ______________________________

2. Since $F \propto x$, then $F = kx$. What would the force, F, be equal to?

____

3. What is the constant of proportionality, k, equal to?

____

4. If p is the number of pennies in the plate, then show how to predict the stretch, s.

s = ______________________________

5. This is also a direct variation. In this case the __________________ is directly proportional

to the __________________.

6. What is the proportionality constant for this variation?

k = ______________________________