TEACHER INFORMATION

# Keep It Bottled Up: Linear Rates of Pressure Increase

1. There are currently 2 different combinations of equipment that will work for collecting pressure data. The most common method, which works for both the TI-83 Plus and TI-84 Plus families of calculators, is to use a Gas Pressure Sensor attached to a CBL 2 or LabPro.

   The TI-84 Plus calculators have USB ports located at the top right of each unit. Using the USB port, an EasyLink with a Gas Pressure Sensor can be connected to collect pressure data. For more information on EasyLink refer to Appendix A.

2. When connecting an EasyLink to a TI-84 Plus calculator using USB, the EasyData application automatically launches when the calculator is turned on and at the home screen.

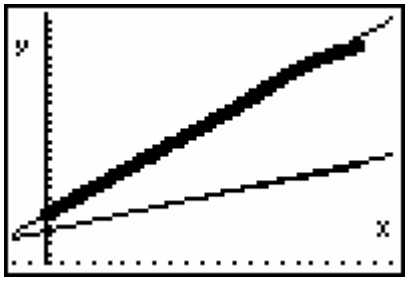
3. An empty 500-mL soda bottle works well as the container.

4. If a smaller container is used, use less water and half a tablet.

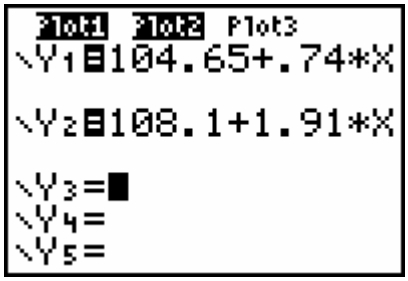
5. Supervise the students as they take the container apart after a reaction. You may want to release the pressure by disconnecting the plastic tubing from the stopper rather than removing the stopper.

6. The gas producing ingredient in the effervescent tablet is sodium bicarbonate. Antacids that don't contain this cannot be used for the activity.

## SAMPLE RESULTS




Raw Data with both models




Model expressions

## DATA TABLE

| | $x_1$ | $y_1$ | $x_2$ | $y_2$ | *y-intercept* | *slope* |
|---|---|---|---|---|---|---|
| **Room temp water** | 0 | 104.65 | 5.0 | 108.35 | 104 | 0.74 |
| **Warm water** | 0 | 108.10 | 5.0 | 117.65 | 108 | 1.91 |

## ANSWERS TO QUESTIONS

1. The initial pressure for both plots is about 100 kPa, and is due to atmospheric pressure. That's the same for both experiments.

2. The slope of the pressure *vs*. time plots measures the rate of pressure change. Presumably the pressure is due to the chemical reaction of the tablets.

3. Equations: Warm $y = 104.65 + 0.74\,x$

   Room Temp $y = 108.1 + 1.91\,x$

4. The fit is good.

5. Once the chemical reaction stops (when the tablet is used up) the pressure would stop increasing. That is, the graphs would level off to a constant value.

6. If the stopper popped off the measured pressure would drop back down to atmospheric pressure.

7. Half a tablet would have half the substance reacting, and so the rate of pressure increase would be lower than observed with a full tablet. For two tablets the rate of pressure increase would be higher than observed with one tablet.

8. The pressure increase is more rapid with the warm water; we can tell this from the higher slopes.