TEACHER INFORMATION

Pool Plunge:
Linear Relationship between Depth and Pressure

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 calculator has a USB port located at the top right corner. 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 Page *ix* located in the front section of this book.

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.

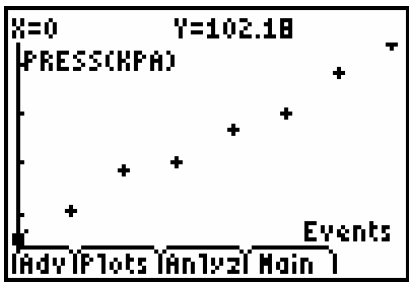
3. Note that the unit for pressure measurement is the kPa, or kilopascal. Water pressure increases by about 9.8 kPa for every depth increase of 1 meter, and the pressure at the surface of the water is about 100 kPa. Accordingly, the pressure *vs.* depth equation should be close to $p = 100 + 9.8d$. You may wish to have your students compare their findings with this typical result.

4. Instead of using a clear tube to contain the water, a PVC pipe or a swimming pool can be used. However, it is then difficult to measure the actual height of the air column in the tubing. Since water is forced into the tubing end, you cannot simply measure the length of submerged tubing and still obtain the expected slope. If you do measure only the tubing length, you'll get a linear relationship but the slope will be reduced by about 20% smaller due to water intrusion.

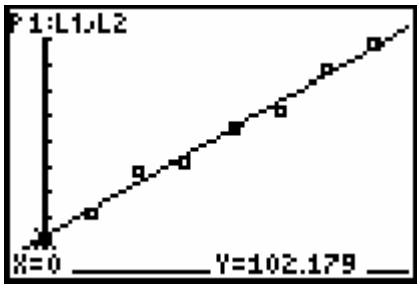
5. Gas Pressure Sensors come with a short piece of tubing with two luer locks attached. Remove one luer lock from the tubing for use with the long tubing used in this activity.

6. We used a clear tube called a Tube Lamp Guard, designed to fit over a fluorescent lamp. A 1-¼ inch PVC cap will fit snugly over the open end. Lamp Guards are available at home improvement stores or lighting shops. Other clear tubes can also be used.

SAMPLE RESULTS



Raw data in EasyData



Data with regression line

DATA TABLE

x:Depth (m)	*y*: Pressure (kPa)
0.0	102
0.7	109

ANSWERS TO QUESTIONS

1. Slope is 11 kPa/m.
2. The y intercept is 102 kPa.
3. The model expression is $y = 100 + 11x$.
4. The fit is fair; the line passes through the two points used to find the slope.
5. Fitted line is $y = 10.5x + 102$.
6. The least-squares fit is slightly different from the model fit; the least-squares fit is closer to the points on average. The fit is different because the least-squares fit used all the points to determine the slope and intercept, while the model equation used only two or three (the two used for slope calculation and the intercept).

APPLICATIONS

The following applications were calculated using the relation $p = 100 + 9.8d$. Values will differ for other models.

1. Recognizing the atmospheric pressure varies with weather and altitude, for the data presented here, one atmosphere is about 100 kPa.
2. At 2.5 * 4 m, or 10 meters depth, the pressure is 198 kPa, or about two atmospheres.
3. 18 m.
4. 1.08×10^5 kPa, or 1080 atmospheres!
5. 390 atm.