Muddy Water
ID: 11621

Time Required
45 minutes

Activity Overview
In this activity, students will analyze the effect of storm water run-off on local water turbidity.

Topic: Earth's Surface/Exponential Functions

- *Identify exponential relationships*
- *Interpret and analyze scatter plots*
- *Make a model that demonstrates storm water run-off*
- *Use a variety of tools and methods to conduct a scientific inquiry*

Teacher Preparation and Notes

- *Demo the activity using the overhead calculator so the entire class can see the process. If you have only one CBL 2, have each group individually perform this activity. If you have enough CBL 2 units, have students work in small groups.*

- *You will need the following materials to complete this activity.*
    - *Calculator-Based Laboratory (CBL 2)*
    - *Data Mate Light sensor*
    - *Clear 1000 ml container*
    - *50 g of dirt*
    - *Spoon or scoop,*
    - *Stirrer*
    - *Flashlight*

- ***To download the student worksheet, go to education.ti.com/exchange and enter "11621" in the quick search box.***

Associated Materials

- *SciAct08_MuddyWater_worksheet_TI73.doc*

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Suggested Related Activities
To download any activity listed, go to education.ti.com/exchange and enter the number in the quick search box.

- *Topographic Maps – What can they tell us? (TI-73 Explorer) — 2616*
- *Give Me a Hand or Leaf Me Alone (TI-73 Explorer) — 5576*
- *Graphing Non-Linear Functions (TI-73 Explorer) — 4119*
- *River of Life (TI-Navigator) — 5601*

Overview

Anyone who has done any canoeing or kayaking knows that the water in streams, rivers, and lakes can sometimes look "muddy," or "turbid," especially after a rainstorm. Turbidity is the cloudiness created when dirt and other foreign particles get stirred up and suspended in the water.

When rain hits the land, whatever is not absorbed into the earth flows into the local waterways. As the rainwater flows over surfaces, it gathers speed and picks up foreign particles, such as soil. As the water moves faster and increases in volume, more particles are carried into the local bodies of water.

Setup

1. To save class time, put 10 g of dirt into small cups. Prepare 5 cups of dirt for each lab group.

2. If possible, use the same kind of flashlight for each group.

3. Connect the CBL 2 to the calculator using the I/O unit-to-unit cable.

4. Plug the TI light sensor into Channel 1 (CH 1) on the CBL 2.

5. Pour 1000 ml of water into a clear container.

6. Align the flashlight, container of water, and the CBL 2 light sensor so that the light passes through the container of water directly into the light meter.

7. To launch the DATAMATE program, press the A key, select **DataMate** and then press e to view the DataMate screen.

    Note: DataMate may be listed under Programs (press p).
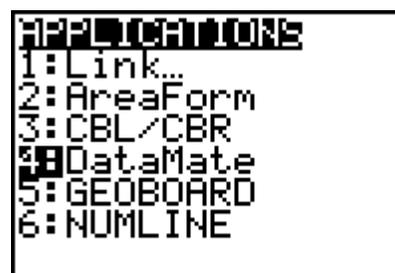
NOTES: For help with transferring DataMate from the CBL 2, see the Appendix at the end of the document.

        DATAMATE moves slowly between screens. As you make selections, be patient as the program executes the command.

8. The DataMate screen changes to the Main Screen. Select **1:SETUP**. Then, select **CH1.** Select **7:MORE** and **5:LIGHT.** Select the appropriate light sensor.

9. Select **MODE**, and then select **5:SELECTED EVENTS.** Select **1:OK** to return to the Main Screen.

NOTE: This experiment can be done as a qualitative demonstration using spoonfuls of dirt rather than measuring the dirt.

Data Collection

1. Turn on the flashlight. When you are ready to begin, select **2:START.**

2. When the light intensity reading is steady, press e. The value is collected.

3. Add 10 g of dirt to the water and stir.

4. When the dirt is dissolved in the water and the light reading is steady, press e to collect the reading.

5. Repeat steps 3 and 4 until 50 g of dirt have been added to the water.

6. After you have added all of the dirt and collected the last light reading, press =. A scatter plot is displayed showing the light reading for each test. Use < and > to move to each data point. Record the values in the table on the worksheet.

7. Sketch the graph on the worksheet.

8. To exit the DATAMATE program, press e to return to the Main Screen. Select **6:QUIT** and press e.

9. Answer the questions on the worksheet to analyze the effects of storm water run-off on water turbidity.

Extension Activity

Set up an experiment to test the run-off from different types of land surfaces as illustrated. Place materials in the carton such as dirt, gravel, or rooted grass. Create a rainstorm onto your carton. Set up the flashlight and CBL 2 light sensor as before to test the turbidity of water. Write up the results in a report.

Discussion Notes

The relationship of the amount of suspended particles in water to the water's turbidity is exponential. If students are not familiar with exponential functions, have them complete a function table for $y = 2x$. Then have them graph the ordered pairs.

Graphs of exponential functions can take on one of four basic shapes. They will always form a curve, but which quadrants they occupy change according to characteristics of the function. Students can explore the graphs of exponential functions in the Navigator Extension Activity.

Worksheet Answers

NOTE: The data in these tables is simulated. Actual data will be slightly different.

1.

Amount of Dirt (g)	Intensity of Light Passing Through Water
0	1.95
10	0.76
20	0.23
30	0.06
40	0.05
50	0.04
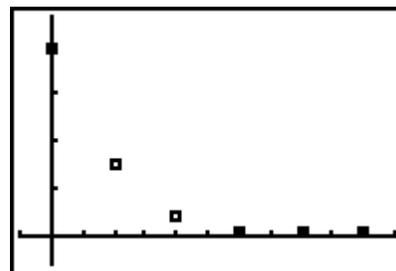
2. Sample data shown in Figure 2.

3. Possible answers: It forms a curve; it decreases exponentially.

4. The intensity of light passing through the water when there was no dirt in the water

5. Sunlight

6. Between 0 g and 10 g

7. For sample data, between 30 g and 40 g and between 40 g and 50 g

8. Water clarity will decrease the most with the initial-run off. The turbidity will continue to increase as the run off continues, but it will do so with less of an impact.

TI-Navigator™ Extension Activity

1. Explain that the parent, or basic, exponential function is $y = ab^x$, where $a \neq 0$, $b \neq 1$, and $b > 0$.

2. In Activity Center, enter $y = 2x$ under the Equation tab and have the class view it under the Graph-Equation tab. Explain that $a = 1$ and $b = 2$. Have students submit an equation that is the same shape but translated up. It may involve some trial and error if they are unfamiliar with translations. Supply hints if needed. Repeat with translating down.

3. Have students submit equations, in the form of the parent exponential equation, with each of the following conditions. (Remind them to use parentheses if needed.)

    • $a > 0$ and $b > 1$

    • $a < 0$ and $b > 1$

    • $a > 0$ and $0 < b < 1$

    • $a < 0$ and $0 < b < 1$

4. Have students write down rules that can help them know the shape of a graph based on the values of a and $b.$ Ask students which of the four conditions fits the graph of the data they collected with the light sensor.

Appendix – Transferring DataMate™

The DataMate software comes already loaded on the CBL 2™. Before you use the CBL 2 for the first time, you must transfer the DataMate software to the TI-73 Explorer.

To transfer DataMate to a TI-73 Explorer, follow these steps:

1. Connect the TI-73 Explorer to the CBL 2 with the I/O init-to-unit link cable.

2. Put the calculator in RECEIVE mode.

   a. Press A.

   b. Press > to select RECEIVE

   c. Press e.

3. On the CBL 2, press TRANSFER. The program or App is transferred and appears in the calculator's list or application list.

4. When the transfer is complete, press ` î on the calculator.

Need Help?

Contact Texas Instruments:

http://education.ti.com

ti-cares@ti.com

1-800-TI-CARES