

Investigation

Making a motion detector

Part 1 The relationship between the movement of an object and voltage

Materials

TI Graphing Calculator with DataMate program installed	2 cables,
CBL2 interface	2 crocodile clips,
Voltage probe,	4.5V battery,
Tank with copper electrodes,	Copper metal point
0.1 mol dm ⁻³ Copper (II) Sulphate solution	



Starting the DataMate Program and setting up

1. Use the following steps to start the DataMate program on your calculator:

TI-83 Plus Calculators:

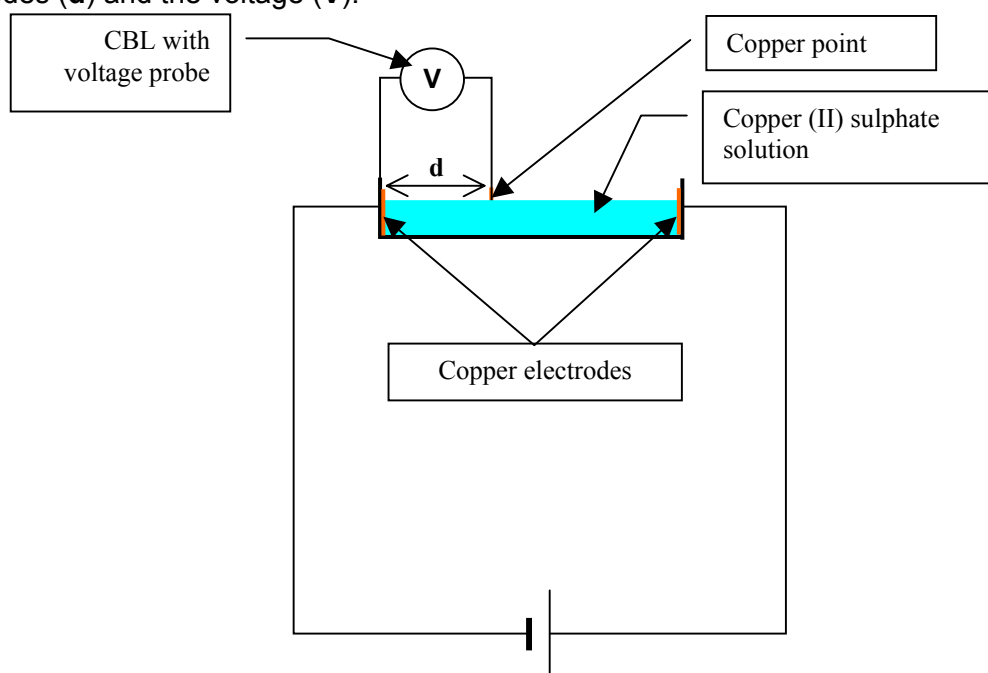
Press **APPS**, then press the calculator key for the number that precedes

DATAMATE. Press **ENTER**. An introductory screen will appear, followed by the main screen.

2. Plug the Voltage Probe into channel **CH 1** on the CBL2 interface.
3. Start the DataMate program. Press **CLEAR** to reset the program. DataMate will detect the auto-ID sensor, set the data collection parameters, and display the current sensor reading.
4. Press **1: SETUP** and using the cursor buttons,  or  (be patient it's a bit sluggish!) select **MODE** press **ENTER**. (Note: It is easier to go up to get to the bottom item of the list)
5. In the **SELECT MODE** menu choose **3: EVENTS WITH ENTRY**.
6. Press **1: OK** to return to the main screen.



Collecting data

1. Set up the following circuit to investigate the relationship between distance of the copper point from the electrodes (**d**) and the voltage (**V**).



- Select **2**: **START** to begin data collection. Press **ENTER** to record your first measurement. Then enter the distance 1. Press **ENTER** again.
- Move the point to 2cm and press **ENTER**. Then type in the distance 2. Press **ENTER** again and you will find the calculator producing an autoscaled scattergram of the measurements.
- Continue to take measurements across the tank of copper (II) sulphate.
- You may stop data collection at any time by pressing the **STO→** key
- Store your data and rename the lists **L₁** and **L₂**.

Analysing the data

- Describe the overall shape of the line set out by the scattered points on the graph. (Is it linear or curved? Which way does the trend go?)
- Use the cursor keys  or  to examine the data points.
- Determine the relationship between the distance of the copper point from the electrode and the voltage.

$$d = cV$$

Where:

d is distance in cm

V is volts

c is a constant

Part 2 Movement in two directions

Materials

TI Graphing Calculator with DataMate program installed
 Lab Pro or CBL2 interface
 Voltage probe,
 Tank with copper electrodes,
 0.1 mol dm⁻³ Copper (II) sulphate solution

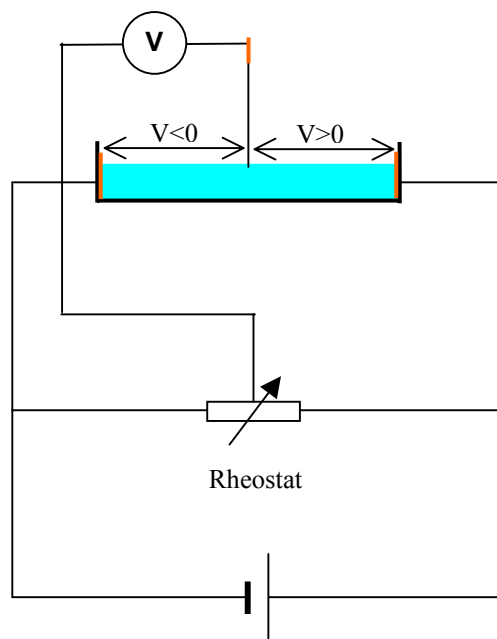
4 cables,
 2 crocodile clips,
 4.5V battery,
 Copper metal point
 Rheostat

Setting up the DataMate Program

Select the same mode as before **3: Events with entry**.



Collecting data

- Set up the circuit opposite to investigate the relationship between distance of the copper point from the electrodes and the voltage.
- Set the copper point in the middle of the tank between the two copper electrodes. Adjust the rheostat so that the voltage on the calculator reads 0 volts, or as close to it as possible.
- Select **2**: **START** to begin data collection. Press **ENTER** to record your first measurement. Then enter the distance 0. Press **ENTER** again.



4. Move the point 1cm to the right and press **ENTER**. Then type in the distance 1. Press **ENTER** again and the calculator will start to produce an autoscaled scattergram of the measurements.
5. Continue to take measurements across the tank of copper (II) sulphate. **When you move the point to the left of centre enter negative values.**
6. Stop data collection by pressing the **STO→** key. Store your data and rename the lists **L₁** and **L₂**.

Analysing the data

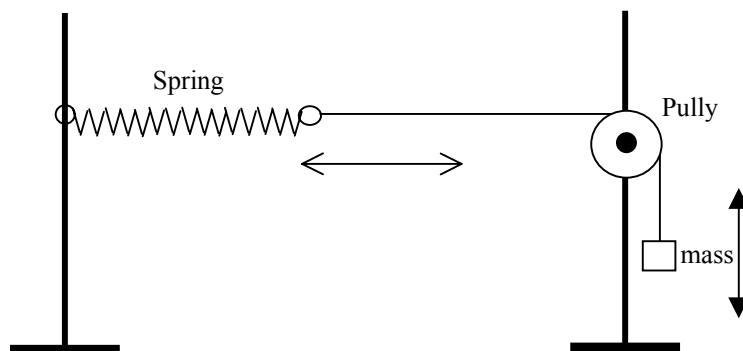
1. Describe the overall shape of the line set out by the scattered points on the graph. Did you get the same trend as the first time?
2. Use the cursor keys  or  to examine the data points.
3. Is the relationship between the distance of the copper point from the electrode and the voltage the same?.

$$d = cV$$

You have just made a probe capable of detecting the position of an object.

Part 3 Using the probe to study an oscillation

1. Set up the following apparatus.



2. Pull on the mass and let go to make the system oscillate. Using a stop watch time 5 oscillations and estimate the period of one oscillation.
3. Change the mass and try again.
4. Change the spring and try again.
5. Design a method to use your motion detector to determine the period of the oscillation of different springs with different masses.