



Murder in the First Degree

The Death of Mr. Spud Student Activity

Name _____

Class _____

Introduction

In a murder investigation, a forensic expert may be called in to determine the time of death. Such determinations may involve examining the contents of the victim's stomach or inspecting decomposing insects on the body. One interesting approach is to examine the temperature of the body. Human body temperature is approximately 37 degrees Celsius. Immediately after a person dies, the body temperature begins to drop. By determining how far the temperature has dropped, you may be able to arrive at an accurate measure of the time of death. This information could play an important role in either the prosecution or defense of an alleged criminal.

Objectives

In this activity, you will:

- use a potato to model the process of cooling of the human body after death.
- use a cooling curve to simulate a forensic scenario to predict the time of death.

You'll Need

- TI-84 Plus CE calculator
- Vernier EasyTemp® Sensor
- 2 medium potatoes, at different temperatures

The Problem

Mr. Spud is found dead by the side of the road near his house on a cold morning at about 7:00 am. The temperatures that night were between 4°C and 8°C. At this time, it appears that the death was not a result of natural causes. You arrive at the scene at 7:30 am, and the Medical Examiner wants you to determine time of death.

Background

Forensic experts measure the temperature drop in corpses in order to establish **standard curves** under controlled conditions. When a person is found dead and foul play is suspected, the forensic expert measures the temperature of the body. The forensic pathologist can approximate the time of death by determining where the temperature is on the standard curve.

You will simulate the drop in a person's body temperature at the time of death. Your teacher placed a potato in a pot of hot water, let it warm up to above 37 °C and then you put the potato into ice water. Putting the potato into the ice water will simulate the time of death in an outdoor cold-weather situation. When the potato is put into the ice water, its temperature will drop toward the temperature of its surroundings, just as the temperature of a body drops following death. You will plot this data to establish a standard curve for outdoor deaths.



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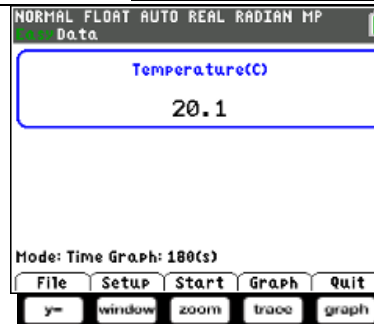
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Name _____

Class _____

Using the Vernier EasyTemp® and Vernier EasyData® App

Connect the handheld with the EasyTemp sensor, and EasyData will immediately open, and the temperature probe will begin collecting temperature data. In the EasyData app, the tabs at the bottom indicate the menus that can be accessed by pressing the actual calculator keys directly below the tab.

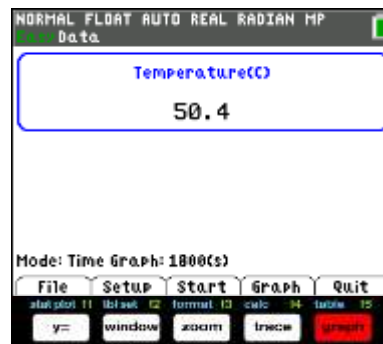


Making the Standard Curve

1. Before getting your potato, set up the sampling times for a time graph that are shown to collect temperature data every 30 seconds for 30 minutes. (Note: EasyData displays the time in seconds.)



2. For the standard curve, use a toothpick or similar sharp object to penetrate to the center of the potato with a hole that is smaller than the temperature probe. Insert the temperature probe so that the tip of the temperature probe reaches the center of the potato.
3. Place the potato in ice water so that the ice water is not affecting the temperature probe. Caution: The potato may come off of the temperature probe if you use the probe to maneuver the potato too much. So hold the potato in the water instead of holding the temperature probe. Wait until the temperature starts to drop before pressing **zoom** to select the **Start** tab.



Note: Your teacher may choose to provide you with the data for the standard curve.



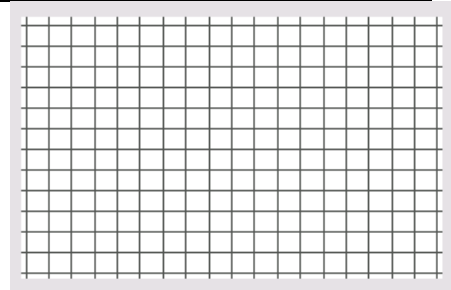
Murder in the First Degree

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4. Draw your standard curve on the coordinate grid at the right. Select **Main** by pressing **GRAPH** and quit the app. The time is in L1 and the temperature is in L2. Do an exponential regression, store the regression equation in Y1, and record the equation here:



Collecting the Data

Mr. Spud is found dead by the side of the road near his house on a cold morning at about 7:00 am. The temperatures that night were between 4°C and 8°C. At this time, it appears that the death was not a result of natural causes. You arrive at the scene at 7:30 am, and the Medical Examiner wants you to determine time of death.

Your teacher will give you a potato whose “time of death” (being placed into the ice water bath) is unknown. This partially cooled potato will simulate Mr. Spud’s body.

- Record Mr. Spud’s body temperature at 7:30 am _____.
- Enter Mr. Spud’s body temperature in Y2 and enter 37 in Y3. Graph these two horizontal lines and the regression equation. Find the intersections of the horizontal lines with the Standard Curve. Record the times below. Using each second in your time graph to represent a **minute** in “Spud Time,” calculate your estimate of Mr. Spud’s time of death.

Time of Mr. Spud’s body temperature = _____

Standard Curve time for 37°C = _____

I estimate Mr. Spud’s time of death to be _____



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Analyzing the Data

1. Describe the shape of the time versus temperature plot.

2. What temperature does the plot appear to be approaching? What does that temperature correspond to in the situation being studied?

3. Explain why the plot is not linear.

4. In what way(s) is this simulation not consistent with a real forensic study of the drop in body temperature following death?

5. Which model—exponential or linear—would be the better model to describe the following situations? Explain your answer in each case.
 - a. A car slowing down by $\frac{1}{3}$ of the speed it was going the previous second.

 - b. A car slowing down by 5 mph each second.



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Going Further

In this activity, you determined the time of death by the drop in temperature. A similar problem that has a similar solution (conceptually) is to date the time of death when an organism died *thousands* of years ago. To solve this problem, scientists use a technique called **radioactive dating**. It is based on the decay of a substance called carbon-14 (C-14).

Most carbon in a living organism is called carbon-12 (C-12) and it does not decay. There is a small amount of C-14 in all living tissue. Once the organism dies, however, it no longer incorporates this substance in its body. The C-14 begins to decay. By examining how much C-14 is present (the ratio of C-12:C-14), you can determine the time since death. Carbon-14 has a half-life of about 5,600 years (actual half-life is 5,780 years). Instead of examining the drop in temperature of a corpse, radioactive dating is based on the decay of C-14 over thousands of years.

Consider the problem of dating an animal's remains. Assume that by analyzing the amount of carbon in its remains, you believe that it originally had 1000 grams of C-14, but now has only 100 grams.

Determine the amount of C-14 that remains after each 5,600-year interval, starting with 1000 grams of the substance.

Number of time intervals	0	1	2	3	4	5	6
Time (years)	0	5600	11200	16800	22400	28000	33600
C-14 (Grams)	1000						

1. What exponential model simulates this situation?

2. Using the same technique as in estimating Mr. Spud's time of death, estimate how many years since this ancient animal died.

Amount of C-14 in Recovered Organism: 100 Grams

Years Since Organism Died: _____ years.