

Activity 1.1.5: Time of Death

Introduction

The emergency call came in at 9:45 am. The police and the EMT arrived at the scene at 9:56 am. Anna Garcia, a 38 year old woman, was found dead lying face down in her entry hallway in a pool of blood. It was a comfortable 73˚F inside Anna’s house despite it being 92˚F outside. She was last seen alive the night before by her former husband Alex Garcia. Investigators are trying to piece together what happened between the time that she was last seen alive and when she was found dead at the scene. Clues hidden within the body will enable medical examiners to estimate her time of death. These signs include rigor mortis (the stiffening of the muscles that occurs shortly after death), lividity (the pooling of blood), algor mortis (the cooling of the body), clouding of the corneas, evidence of decomposition, and/or drying of the tissues.

After death, a body will lose heat at a rate approximately one-and-a-half degrees per hour until it reaches the temperature of the surrounding environment. Many factors influence the rate of heat loss including clothing, victim size, and environmental factors such as temperature and humidity. The body core temperature can be measured rectally or with a hypodermic probe of the liver or brain, because of their large mass and density. In this activity you will investigate how ambient temperature, the temperature in a room or the temperature surrounding an object, affects the cooling rate of a simulated body. You will also estimate Anna’s time of death based on her core body temperature.

Equipment

* Computer with Logger *Pro* software
* Laboratory journal
* PBS Course File
* PLTW Biomedical Science Experimental Design Resource Sheet
* Time of Death Experimental Design Resource Sheet
* Logger *Pro* Resource Sheet
* Unit 1- Investigative Notes Resource Sheet
* Vernier Temperature Probe
* Goggles
* Gloves
* Laboratory apron
* Thermometer
* 37˚C Water
* Graduated cylinder
* Hot water bath set to approximately 50˚C
* Ice water bath
* Room temperature water
* Oven mitt

Procedure

Part I: Experimental Design

1. Take notes in your laboratory journal as your teacher presents the Experimental Design presentation.
2. Obtain and read through the PLTW Biomedical Science Experimental Design resource sheet. Highlight important pieces of information as you read. You will use this resource sheet throughout the PLTW Biomedical Science courses to help guide you whenever you design an experiment.
3. Answer Conclusion question 1.

Part II: How Does Temperature Affect Body Cooling?

1. Obtain a Time of Death Experimental Design Resource Sheet.
2. Look through Step 1 *Identify the Problem or Question* and read the Problem Statement for this experiment. Note that as a class, you will be performing a modified version of this experiment.
3. Read through Step 2 *Predict a solution to the problem or an answer to the question* and fill in your hypothesis for this experiment as well as identify the independent and dependent variables.
4. Read through Step 3 *Design the experiment to be used to test your hypothesis,* including the Materials and Procedure.
5. **Put on the appropriate Personal Protective Equipment.**
6. For whichever temperature you are assigned,
	* 40 degrees C (hot)
	* 20 degrees C (room)
	* 0 degress C (cold)

Grab your 250ml beaker and a thermometer. Fill the beaker with 200ml of water. Either use a hotplate on medium heat (and oven mit) or ice from the red ice buckets to get your water to the appropriate temperature. Use the thermometer and make sure the temperature is consistent and not getting hotter or colder after about a minute.

1. Obtain a Vernier Temperature Probe
2. Open LoggerPro.
3. Start Logger Pro® software on your computer.
4. Click on File Open and open the Forensics with Vernier folder.
5. Open the program titled 14 Hot Air, Cold Body.
6. Connect the LabQuest Mini to the computer using the USB cable.
7. Connect the Temperature Probe into CH 1 of the LabQuest Mini using the British Telecom connector.
8. You will be placing your temperature probe into the 37 degree C hot dog (98.6 F dead body), which you can find in the water bath on the counter.
9. Once your water bath is very close to the assigned temperature and it is consistent, record the EXACT temperature of your water bath in your notebook.
10. From this point forward, you must be fast. **Collect your hot dog from the 37 degree Celcius water bath.**  Place the temperature probe into the top of one end of the hotdog. Record the temperature of the hotdog. This is time zero in your data below. This represents the rectum of the person that died, should be close to 37 degrees Celcius, which is 98.6 degrees F.
11. Make sure you are all connected and ready to begin because once you place your temperature probe and hot dog into the YOUR water bath, you must Click  to begin data collection, so be ready!
12. Record the temperature of the victim (hotdog) every minute until it stops changing. Time zero is when you first put it in the water bath and the temp should be as close as possible to 37˚C at time zero (MUST be within 2 degrees or you start over).

0 min = \_\_\_\_\_\_\_\_\_\_\_ 6 min = \_\_\_\_\_\_\_\_\_\_\_

1 min = \_\_\_\_\_\_\_\_\_\_\_ 7 min = \_\_\_\_\_\_\_\_\_\_\_

2 min = \_\_\_\_\_\_\_\_\_\_\_ 8 min = \_\_\_\_\_\_\_\_\_\_\_

3 min = \_\_\_\_\_\_\_\_\_\_\_ 9 min = \_\_\_\_\_\_\_\_\_\_\_

4 min = \_\_\_\_\_\_\_\_\_\_\_ 10 min =\_\_\_\_\_\_\_\_\_\_\_

5 mn = \_\_\_\_\_\_\_\_\_\_\_ 11 min =\_\_\_\_\_\_\_\_\_\_\_

22. Record the final temperature of your victim in your notebook (the temp when the temperature stopped changing).

23. Record the change in temperature in your notebook. Find it by subtracting the final temperature from the initial temperature. If the temperature went DOWN, record it as a negative number. If the temperature went UP, record it as a positive number.

24. When data collection is complete click the Statistics button, , to display a Statistics box.

25. Record the minimum temperature recorded and the maximum temperature recorded in the appropriate spot in the Evidence Record table.

 26. Record the temperature change in the Evidence Record table. (Note: The temperature change is displayed in the Statistics box as Δy.)

 27. Save the data to a file as lastname\_bodycooling. Save this on your desktop.

 28. Read Step 5 *Analyze the data and observations* on the Time of Death Experimental Design Resource Sheet.

29. Copy the graph by placing the mouse cursor over the graph, left clicking, and then pressing both the *Control* and the *C* keys simultaneously. Paste the graph into a Word document and save it.

30. To paste the graph, press both the *Control* and the *V* keys simultaneously. Repeat this step in order to copy and paste the Data Table on the Resource Sheet under the heading *Graph* or paste the Data Table into a word document and print and attach it to the Resource Sheet.

31. Work with your classmates to fill in the data table under the heading *Class Results* on the Resource Sheet.

32. Calculate the average temperature change for each temperature tested. Record the results on the *Class Results* data table.

**CLASS DATA**

|  |  |  |  |
| --- | --- | --- | --- |
| Assigned Temperature | Actual Initial Temp (°C) | Final Temp (°C) | Change in Temp (°C)*record as + or - #* |
| COLD |  |  |  |
| COLD |  |  |  |
| COLD |  |  |  |
| ROOM |  |  |  |
| ROOM |  |  |  |
| ROOM |  |  |  |
| HOT |  |  |  |
| HOT |  |  |  |
| HOT |  |  |  |

33. Find the AVERAGE change in temperature for each ambient temperature, showing your work for each and circling or boxing the final answer.

 COLD:

 ROOM TEMP:

 HOT:

34. Read Step 6 *State the conclusion* and write a conclusion statement for this experiment on the Resource Sheet.

35. Read Step 7 *Summary Paragraph* and write a summary paragraph for this experiment on the Resource Sheet.

**ANALYSIS/CONCLUSION**

36. This lab was about finding the relationship between ambient (environmental) temperature and the rate at which a body cools. Use the data from the lab to make a statement about the effect of ambient temperature upon the rate of cooling. Use numberical evidence from your lab in your answer.

**Clean Up:** Wipe off your thermometers, rinse out your beaker set it on drying rack. Put your Vernier equipment back. Wipe down your station with a Clorox wipe. Get checked before heading out.

**Part III: Anna’s Time of Death**

The Glaister equation is one formula used to approximate the postmortem interval, or time since death. Note: This equation uses degrees Fahrenheit.

Glaister Equation:

 98.4 – measured rectal temperature = approximate hours since death

 1.5

37. Use the Glaister equation to estimate Anna’s time of death. Show your work below.

Note: The medical examiner measured Anna’s rectal temperature to be 92.4˚F at 11:00am.

Approximate time of death:

38. Note Anna’s time of death on your Unit 1 - Investigative Notes Resource Sheet.

39. Answer Conclusion question 5.

Conclusion

1. Why is it important to include a control group whenever possible in an experiment?
2. How were all outside variables that could affect the outcome of the experiment controlled?
3. How could this experiment be improved?
4. Algor mortis, or postmortem cooling of the body, varies with ambient temperatures. Based on your results, how does ambient temperature affect the rate of cooling of a body after death? Explain your answer.
5. The Glaister equation is just one formula used to approximate the postmortem interval. If Anna had died outside instead of inside her air conditioned house, would the Glaister equation be an appropriate model to use to determine her time of death? (Remember that they were in the middle of a heat wave and it was 92˚F outside.) Why or why not?