Evaporation and Cooling

OverView

This experiment is written for use with the Vernier Thermal Analysis for FLIR ONE™ app for iOS and FLIR ONE™ thermal camera for iOS. It is appropriate for middle and high school students.

Students should be able to see that even a paper towel with hot water on it will cool off to below room temperature in a short amount of time.

RELATED SKILLS

* Use the Thermal Analysis app to place multiple spot thermometers.
* Use the temperature *vs*. time graph in the Thermal Analysis app to answer questions about respiration.

Estimated Time

It is estimated that data collection and analysis and class discussion can be completed in one 45-minute class period.

Next Generation Science Standards (NGSS)

|  |  |  |
| --- | --- | --- |
| Disciplinary Core Ideas | Crosscutting Concepts | Science and Engineering Practices |
| PS3.A Definitions of EnergyPS3.B Conservation of Energy and Energy Transfer | Cause and effectSystems and system modelsEnergy and matter: Flows, cycles, and conservation | Constructing explanations and designing solutions |

Safety Note

Students should be mindful that the hot plate is hot and boiling water can scald their skin.

EQUIPMENT TIPS

1. Cups can be used in place of the three beakers that hold the paper towels.

2. Any type of paper towel can be used—or use a single layer of cloth. The paper towel should not tear when the water is added.

3. Charge the FLIR ONE camera before use.

Data-Collection and Analysis Tips

1. The exact data-collection duration doesn't really matter. The two things to consider are the long term (around 5–10 minutes) behavior of the wet paper towels, and the data collecting capacity of the Thermal Analysis app. The longer the video, the more time is needed for processing the data. Videos that are too long may not save, and data may be lost.

2. As long as the paper towels are wet and don't have standing water on top, they should start to cool off. After a couple of minutes, even the hot wet paper towel should be colder than room temperature.

SAMPLE DATA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Temperature at Time = 0 s(°C) | Temperature at Time = 60 s(°C) | Temperature at Time = 6 min(°C) | Temperature at Time = 7 min(°C) |
| Dry towel | 24.0 | 24.0 | 22.0 | 21.9 |
| Towel with room temperature water | 23.0 | 22.5 | 18.8 | 18.5 |
| Towel with hot water | 65.8 | 62.2 | 20.5 | 20.2 |

Answers to ANALYSIS Questions

1. After 7 minutes, the lowest temperature paper is the one with the room temperature water poured onto it. The next coldest paper is the towel with the hot water poured on it followed by the warmest paper being the dry towel. The room temperature wet towel is the coldest because as the liquid water evaporates, it takes energy from the rest of the water and decreases its temperature.

2. Although the hot water paper towel started off at a much higher temperature than the dry paper towel, the hot wet paper towel had water that could evaporate. This evaporating water cools off the towel to a lower temperature than the dry towel.

3. If the relative humidity is high, there will be a lower evaporation rate. With a lower evaporation rate the wet towel will not decrease in temperature as much.

4. A fan blowing air over the wet towels will increase the evaporation rate and decrease the temperature.