**B02 Cool Cans**

[Subject symbol Ma]

Time  
10-20 minutes

Level  
From grade 2

Concepts: heat flow, insulation, evaporation, thermodynamics, Newton's cooling law

[Introductory box]

We show students that the cooling of objects is influenced by the environment. This very simple experiment is quick to set up, yields good results, and gets students thinking. The two cans cool down, but there is a clear difference in temperature when comparing the can with the wet handkerchief used as "insulation".

[end box]

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| NvVXXFig1_opstelling.JPG |  |
| *Figuur 1* | *Figuur 2* |

Figure 1 Figure 2

[B02\_NvV04\_fig1; caption]

*Figure 1. The two cans contain hot water (same initial temperature) and a temperature sensor. The temperature measurements are displayed on a digital board using Coach.*

[B02\_NvV04\_fig2; caption]

*Figure 2. We immediately see the difference in cooling between the two cans. The can with the wet handkerchief (green) cools much faster than the can without.*

**Required**

Two cans filled with hot water at the same initial temperature; two temperature sensors or thermometers; Coach as measurement software; a screen or digital board for projecting the temperature graphs; hot and cold water; a handkerchief.

**Preparation**

Set up the apparatus as shown in figure 1. Connect the two temperature sensors to the interface. Start Coach and create an activity where the temperature of the water in the cans can be clearly read.

Ensure that hot water is available and a handkerchief that can be soaked in cold water. Pour the hot water into the cans and place the temperature sensors in the cans. Wrap one of the cans in a wet handkerchief. Start the measurement. Optionally provide graph paper to the students.

**Execution**

[Note numbering]

1. Ask the students how to keep a hot liquid at temperature for as long as possible. What insulation methods do they know? Which form of heat transfer does the insulation method involve?
2. Explain that you are going to conduct an experiment that demonstrates the difference in insulation between two heat sources.
3. Explain how the experiment will proceed and ask the students to write down their expectations.
4. Carefully pour the hot water into the cans and wrap one of the two cans in the wet (cold) handkerchief.
5. Start the computer measurement. Optionally, have students write down the measured values after, for example, 10 s, 20 s, etc. They can then create their own graph of the measurements.
6. Ask the students to explain why the can with the handkerchief cools faster than the other can. After all, heat flows outward in both cans, and the cold water from the handkerchief cannot enter.
7. Discuss exactly what happens in this experiment.

**Physics Background**

The can with the handkerchief cools down quickly, especially at the beginning, because there is a greater temperature difference with the surroundings than with the other can. As the handkerchief warms up, this decreasing temperature difference will decrease the heat flow. Now, the evaporation of water from the handkerchief will further contribute to cooling. This experiment fits well with upper-level physics because of:

ΔQ/Δt = λA ΔT/d

with:

ΔQ/Δt the heat removed per second;

λ the thermal conductivity;

A the surface area;

ΔT the temperature difference;

d the thickness.

**Tips**

[Attention to bullet points]

* Place the setup on a raised platform so that students can see clearly when wrapping the can.
* Since there isn't much to see with the setup, it's important for students to be able to follow the temperature changes closely. A projection screen is a useful aid for this experiment.
* Have some exercises or questions ready for students to work on while the measurements are running.

**Further Research**

Isolation contests are often held to keep hot water warm for as long as possible. Following this demonstration, ask students how they would cool down a hot liquid as quickly as possible. How would you design such a cooler, and what requirements would it need to meet?