Can wet towels reduce heat?

Note: This task is designed so that it can be solved with the incremental hints.
The hints are available on the media portal for printing, or the students can use them online on a tablet or smartphone via the QR code included on the worksheet.
The worksheet for the students and the hints for printing are available as separate files on the media portal of the Siemens Stiftung. General information on using tasks with incremental hints in the classroom is provided in the “Tasks with incremental hints – an introduction” document, which is also available on the media portal.
The task and the related hints are available as two versions: with and without the model experiment. In the task with the model experiment, the students should also come up with an experiment that proves the solution they have found.

1 Topical aspects

The task is related to the energy balance during the transition between the states of aggregation, and it specifically addresses the cooling of indoor air through the evaporation of water from damp towels.

2 Learning prerequisites and level of difficulty

The students should know the states of aggregation of water and also the fact that the transitions between them are always associated with an energy balance. Previous experiments or specific observations of the evaporation of water from puddles or bowls that have been set out are beneficial.
Since these considerations should ultimately flow into a simple model experiment, the students should have previously developed simple decision experiments in other thematic contexts.
The level of difficulty of the task depends on the grade: low to medium.

3 Background on the task

When water changes to steam (at the boiling point) and similarly when water evaporates (below the boiling point), considerable amounts of energy are extracted from the surroundings or must be added from the outside. Approximately 2.2 MJ are required to change 1 kg of water from the liquid to the gaseous state. For comparison: With this amount of heat, you could heat 550 kg water by 1°C or heat just about 7 kg of water from 20°C to 100°C. The fact that such large amounts of energy are required to change water from the liquid to the gaseous state has to do with the strong intermolecular forces (dipole forces, hydrogen bonds).
The high enthalpy of vaporization (the scientifically correct term) of water is used technically in many places. Examples include the cooling towers of power plants, wine coolers made of clay, and, as a traditional household remedy for hot rooms, hanging damp towels in a room.
The higher the ambient temperature and the lower the relative humidity, the faster the water will evaporate from a damp towel. That is why damp towels work particularly well during hot and rather dry summer weather.

4 The task

In the simplest form, the task can be formulated as follows:

Explain how the temperature in a room can be lowered by hanging up damp towels.

Because the context from which a task is developed fosters learning, depending on the teacher's assessment, a contextual scenario can be developed, such as the following:

It's summer vacation and Anna is allowed to stay overnight at her friend Kim's home. Kim suggests that they sleep in the small cottage in the backyard.
"But it's terribly hot in there since the sun has been shining on it all day," says Anna.
"Then we'll simply hang up a couple of damp towels, which will cool things down," Kim replies.
"How is that supposed to work?" asks Anna.
"I have no idea," answers Kim, "but I know that it helps."

Your task:
Find out how damp towels can cool the air in a hot room.
Develop a simple model experiment that you can use to check your ideas.

The expected solution is to alternately place a damp cloth and a dry cloth or a suitable piece of paper over a thermometer or over a temperature probe and to compare the change in temperature. In the explanation, the students should refer to heat of evaporation (or evaporative cooling, depending on the term used in class).
The experiments are easy to conduct with the materials from the "Experimento | 10+" experiment kit from the Siemens Stiftung.
Materials:

- Digital thermometer
- Paper towel or fabric cloth (alternative: cotton pad)
- Water
- Wristwatch with a second hand
- Paper and pen

Measurement of room temperature.

Measurement of room temperature with cooling.

When the experiment is conducted, make sure that the fabric cloths are dampened with water at room temperature. The students can accelerate the temperature drop by moving the thermometer

with the damp fabric cloth back and forth. This also quickly draws the moisture-laden air away from the surface of the fabric so that more water can evaporate.

5 Variations

If the students have not yet had much practice in developing experiments for checking a guess, hypothesis, or preliminary explanation, then the task can be modified. In this case, the students should only find the explanation. Versions of the worksheet and the hints omitting the work assignment to develop an experiment have been provided. This also applies in the event that the "Experimento | 10+: A4 Evaporation heat" experiment, which is available on the media portal, has already been conducted.
A related task that addresses cooling through evaporation in a biological context, namely the release of water vapor through the stomata of leaves, is also available on the media portal of the Siemens Stiftung: "Not all shade is the same."

6 Overview of the hints

Note: The hints have been prepared as a separate file for printing or can be used online via the QR codes on the worksheet. A video showing how the experiment is conducted is available on the media portal. The video is already integrated in the online hints.

Hint 1 Explain the task to each other again in your own words. State what you understood the task to be and what is still unclear to you.	**Answer 1** We're supposed to find an explanation for how damp towels cool the air in a room when they are hung up inside. We're also supposed to develop a model experiment so that we can check our explanation.
Hint 2 Consider the following: What happens with a damp towel that you hang up in a warm room?	**Answer 2** The towel eventually dries. It releases the moisture into the air.
Hint 3 So liquid water changes to water vapor. Remember what you learned about the transition from a liquid to a gas.	**Answer 3** Energy must be added to liquid water so that the water can evaporate.
Hint 4 Now specifically consider: Where does the energy come from so that the liquid water can evaporate from the damp towel and change to water vapor?	**Answer 4** The energy can come only from the heat of the air in the room. This means the air must cool down while the water is evaporating.
Hint 5 With this knowledge, now develop a simple model experiment that you can use to check your ideas.	**Answer 5** We will place a wet cloth or paper towel over a thermometer. The temperature should drop. As a comparison, we will place a dry cloth or paper towel over a second thermometer.

Hint 6	**Answer 6**
Now write down a summary of how damp towels can cool a room and how you can check this with your model experiment.	The moisture evaporates from a wet towel. Energy is needed for evaporation. This energy is extracted from the heat of the air in the room, and the air cools down. In the model experiment, we will check how the temperature changes when we place a damp cloth or paper towel over a thermometer. As a comparison, we will place a dry cloth or paper towel over a second thermometer. In this way we can check how the temperature changes when the moisture evaporates. (You can also watch the related video named “Can wet towels reduce heat?”)