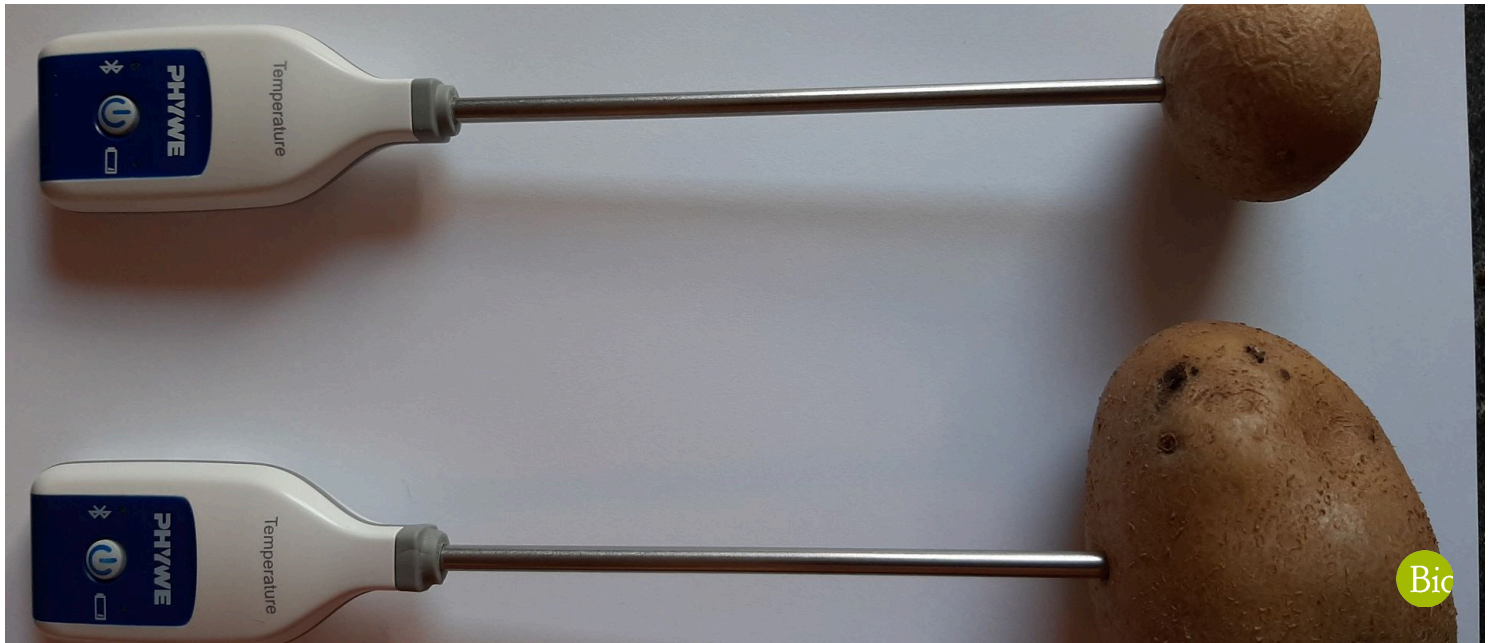


# The Bergmann rule: heat loss as a function of the body surface area and volume with Cobra SMARTsense



Biology

Human Physiology

Cardiovascular system



Difficulty level

easy



Group size

2



Preparation time

10 minutes



Execution time

20 minutes



## Teacher information

### Application



The so-called "Bergmannsche Regel" is considered one of the climate rules.

It states that animals from a species are larger in colder climates than in warm climates. By and large, this rule is mainly applicable to mammals or warm-blooded animals.

## Other teacher information (1/5)

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### Prior knowledge



The basic principle of Bergmann's rule is that a small body loses more heat than a large body. This can be explained by the ratio of body volume to body surface area: a small body has a relatively large surface area in relation to its volume, whereas the reverse is true for a large body.

### Scientific principle



Two differently sized bodies are heated to the same temperature. The temperature is measured in the middle of the body and the difference in the respective heat loss is considered.

## Other teacher information (2/5)

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### Learning objective



Students should realize that a large body loses less heat than a small body in the same time and under the same climatic conditions.

### Tasks



Students should use the Cobra SMARTsense Temperature to record the temperature in two different-sized potatoes over a period of 15 minutes.

## Other teacher information (3/5)



### Further information

- Animals, such as penguins, wild boar and deer, which are found in different regions of the world, can have completely different body sizes.
- There is a connection to the Allenschen proportion rule (related mammalian species have shorter limbs in colder regions than in warmer ones).
- In long, evolutionary processes, different species have been formed from one species through regional migrations.
- This rule can be studied by simple means.

## Other teacher information (4/5)

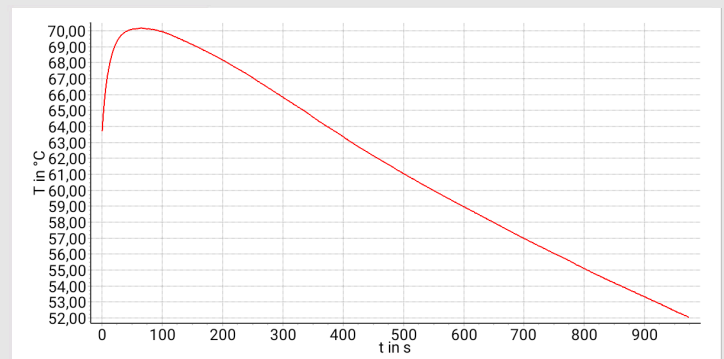
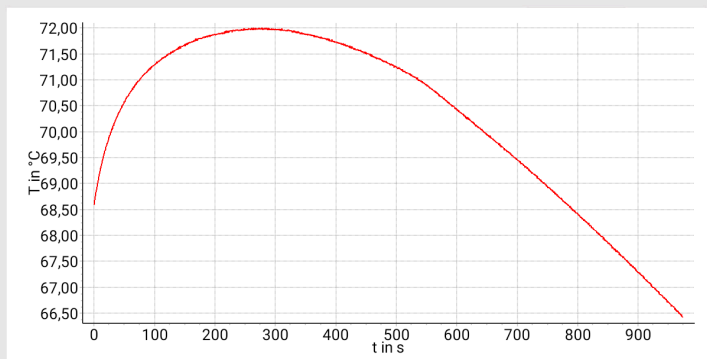
### Further information

- This experiment can also be carried out quantitatively by determining the volume of the potato with a balance according to the Archimedean principle.
- Performing the experiment with the potatoes is the simplest experimental set-up. Heat potatoes of roughly two different sizes in water to a maximum temperature of 60°C and hand them out to your students.
- To ensure the highest possible accuracy and above all repeatability of the measurement results, this experiment can also be carried out with two differently sized round bottom flasks.

## Other teacher information (5/5)

### Experiment: expected result

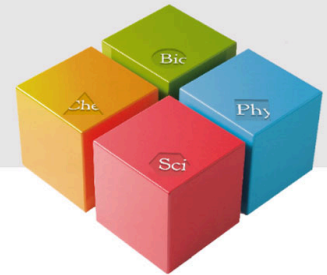
- The temperature of the large potato (left) is 10°C higher than that of the small potato with the same measuring time.



## Safety instructions



- Make sure that the water in which the potatoes are heated is not hotter than 60°C to prevent skin burns.
- The general instructions for safe experimentation in science lessons apply to this experiment.



## Student information

### Motivation



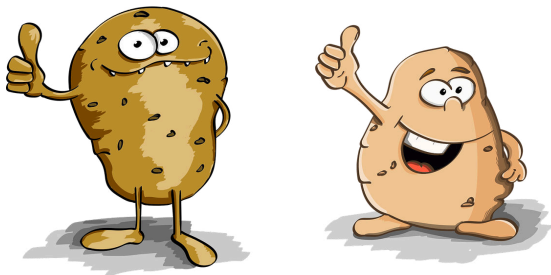
The desert fox is much smaller than related fox species in more moderate climate regions.

The theory of evolution of the natural scientist Charles Darwin says that those individuals who are best adapted survive.

In this experiment you will understand that there is a correlation between body size and heat loss. This then explains why the same species or genus of animal has a different body size in warm areas than in cold ones (e.g. penguins in Antarctica or the Galapagos Islands, or even desert foxes and European foxes). The corresponding rule is also known as the "Law of Bergmann".

## Tasks

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Measure the course of temperature inside a large and a small potato and compare the results of the two measurements. Use the Cobra SMARTsense Temperature Sensor and the PHYWE measureAPP.

## Equipment

Position	Material	Item No.	Quantity
1	<a href="#">Cobra SMARTsense - Temperature, - 40 ... 120 °C (Bluetooth)</a>	12903-00	2
2	<a href="#">measureAPP - the free measurement software for all devices and operating systems</a>	14581-61	1

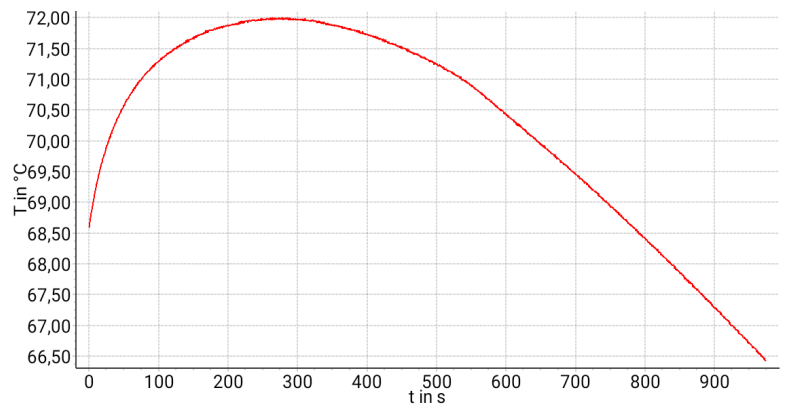


## Setup

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### Setup of the experiment

- Make sure that Bluetooth is enabled on the mobile device.
- Turn on the "Cobra SMARTsense Temperature" sensor by pressing the power button.
- Open the PHYWE measureAPP and select the sensor Temperature.



Temperature curve in the PHYWE measureAPP

## Procedure

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### Performing the measurement

- Get two potatoes from your teacher. Careful, these are hot!
- Insert the "Cobra SMARTsense Temperature" sensors in the middle of the potatoes (see picture on the left).
- Start the measurement and measure for 15 minutes.



# Protocol

## Task 1

What does the "Law of Bergmann" say?

Two related species cannot occur in warm and cold places.

If two species that are closely related occur in both warm and cold places, the individuals in cold places are usually smaller than those in warm places.

When two species that are closely related occur in both warm and cold places, individuals in cold places tend to be larger than those in warm places.

## Task 2

Why is that so?

Because large animals can eat more and therefore create more body heat.

Because of the ratio between volume and surface.

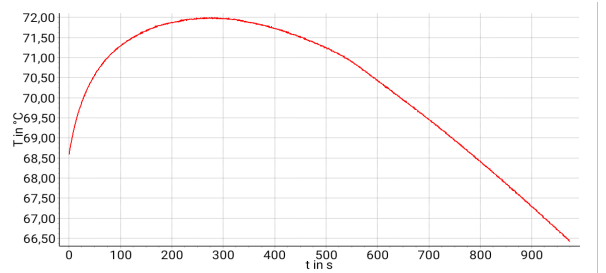
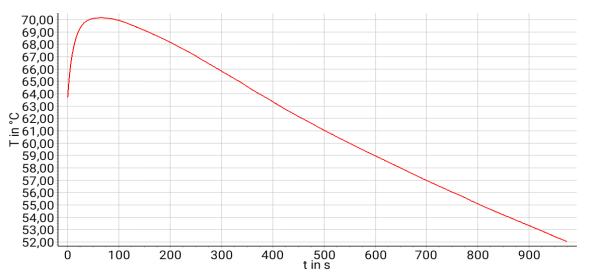
Because of the ratio between weight and volume

## Task 3

Fill in the missing words

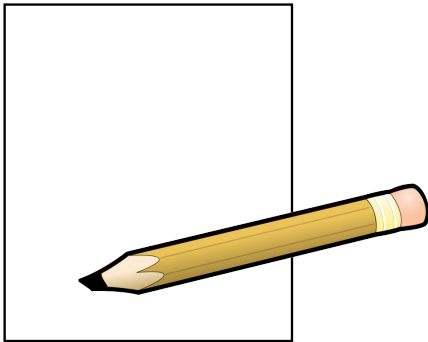
These two graphs show the temperature curve in two potatoes. The left graph shows the course of the  potato and the right graph shows the course of the temperature of the  potato.

Check




## Task 4

If you compare your curves in class, you will find that not every temperature curve is the same. Nevertheless, you have all taken potatoes out of the water at the same temperature. Discuss in class why this is so. Remember the miner's rule.



Slide	Score/Total
Slide 16: Bergmann statement	0/1
Slide 17: Bergmann explanation	0/1
Slide 18: Temperature curve	0/2

Total Score  0/4

 Show solutions

 Retry