

V. Cooling down

Key Question: What does a cooling graph look like?



Student name:

Class:

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Activity 1 – A cup of tea

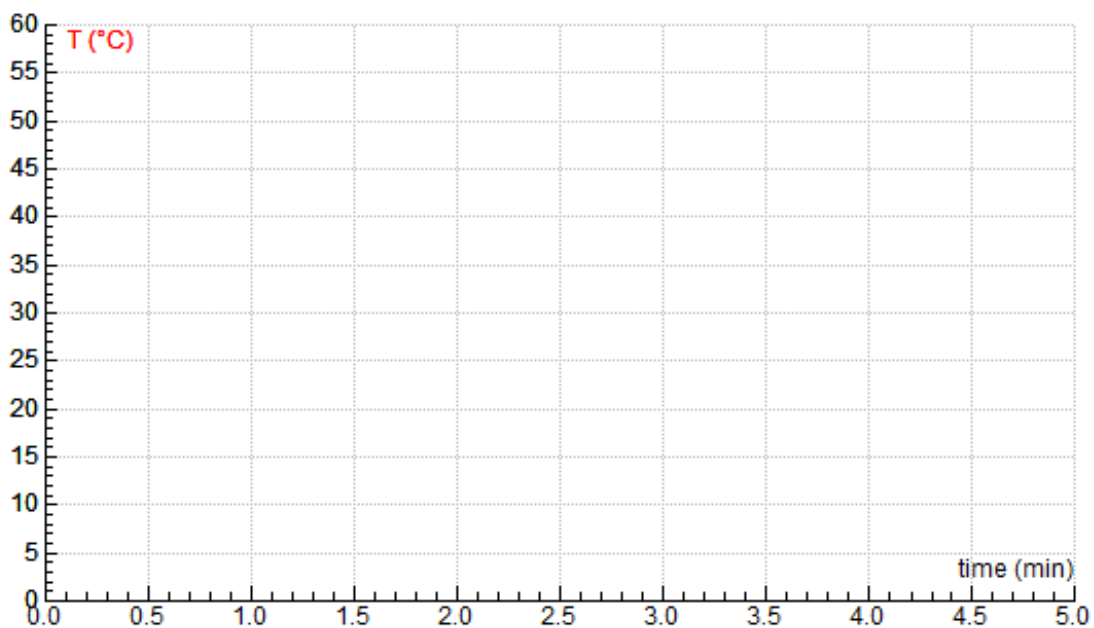
You have a cup of hot tea, but you are busy playing a computer game. You want to finish the game before drinking tea. After ten minutes you drink your tea. What do you think, is your tea still hot?

☐ Yes

☐ No

1. What do you think has happened to your tea? Do you know why?

2. Now you will measure the temperature of a cup of tea as it cools down. How do you think the temperature changes when the tea is cooling? Draw your predicted graph in the diagram below.



- Before you start your experiment use your temperature sensor to measure the room temperature.

The room temperature is _____ $^{\circ}\text{C}$.

- Fill the beaker with hot water and place the temperature sensor inside.
- Wait a while until the temperature sensor warms up and start your measurement.
- Record the cooling graph. The measurement takes 5 minutes.

3. What is the difference between your predicted and the measured graph?

- From your measurement graph estimate how many degrees °C the temperature decreases in each minute of the measurement. Write the results in the table below.

TIME	BEGIN TEMPERATURE (°C)	END TEMPERATURE (°C)	DECREASE IN TEMPERATURE (°C)
1 st minute			
2 nd minute			
3 rd minute			
4 th minute			
5 th minute			

4. Does the water cool each minute equally? In other words, does the temperature decrease by the same number of degrees in each minute?

5. In which minute does the water cool the fastest?

6. In which minute does the water cool the slowest?

7. If you would measure longer, for example one hour, which temperature would you expect at the end of the measurement? Explain your reasoning.

8. Where do you think the heat energy from the hot water is transferred?

Activity 2 – A cold bath

You are going to measure the temperature of the hot water in the beaker again but now the beaker will be placed in a bath with cold water.

9. Will the water in the beaker cool faster or slower, compared to the previous experiment? Why do you think so?

- Fill a large plastic container with the cold water.
- Measure the temperature of the cold water.

The cold water bath has a temperature of _____ °C.

- Fill the beaker with hot water and put the temperature sensor inside.
- Wait a while until the temperature sensor warms up, put the beaker in the cold bath and start your measurement.
- After your measurement is finished measure the temperature of the cold bath again.

The cold water bath has at the end of experiment the temperature of _____ °C.

10. Does the water in the beaker cool now faster or slower than in the first measurement? How do you know?

- 11.** What is the temperature decrease in each minute of the measurement?

TIME	BEGIN TEMPERATURE (°C)	END TEMPERATURE (°C)	DECREASE IN TEMPERATURE (°C)
1 st minute			
2 nd minute			
3 rd minute			
4 th minute			
5 th minute			

- 12.** If you would measure longer, for example one hour, which temperature would you expect at the end of the measurement? Explain your reasoning.

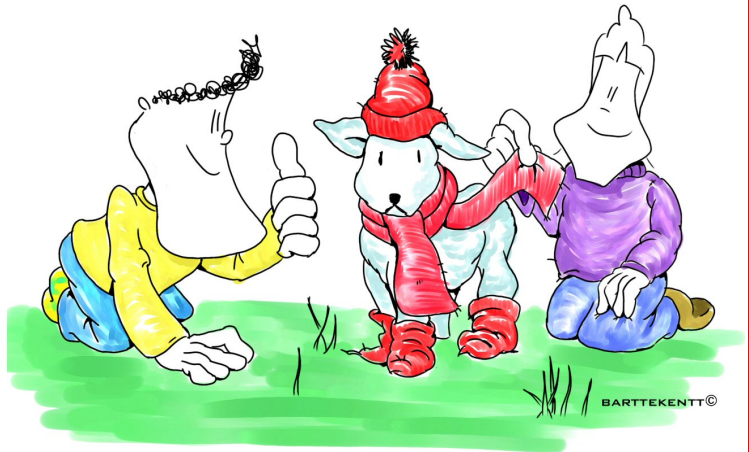
- 13.** Where do you think the heat energy from the hot water is transferred? Explain your reasoning.

Activity 3 – What cools faster a baby animal or an adult animal?

As you probably know, animals are warmer than their surroundings and they constantly lose heat energy through their skin.

Sometimes baby animals die from the cold at temperatures that adults can survive easily.

Which do you think will cool faster?



☐ A baby animal

☐ An adult animal

- Think about how you could investigate this problem. Design and describe below a fair experiment to find out which animal, a small baby animal or a large adult animal will cool faster. To ensure that your experiment is a fair test, you must change only one factor at a time while keeping all other conditions the same.

14. What will you measure in your test?

15. Which factor will you change in your test?

16. What will you keep the same?

- Start your measurement. The measurement is 5 minutes long. While waiting for the resulting graph read the explanation below "What cools faster".
- Write your measurement results in the table below.

ANIMAL	BEGIN TEMPERATURE °C	END TEMPERATURE °C
Baby		
Adult		

17. Which animal gets cold faster? Explain how you know this.

18. Was your hypothesis correct?

Explanation: What cools faster?

Size affects how well an animal keeps its body heat.

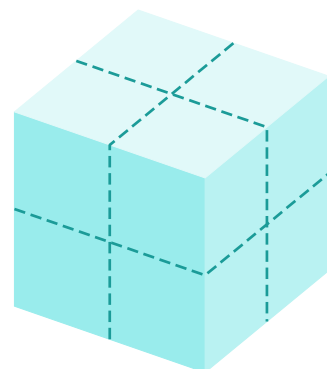
You can understand this by comparing two blocks of warm metal as shown on the right.

The big block is equal to eight small blocks joined together, so it holds 8 times as much heat.

Now compare the surface areas of two blocks. The small block has 6 squares over its surface. The large block has 24. Check yourself.

It means that the large block holds 8 times as much heat but it has only 4 times the surface area from which to loose its heat, so it cools down more slowly.

Now think of a small animal and a large animal. They are like the small and the large block. A small animal loses its heat faster and gets cold quicker than a large animal.



Questions:

- A.** Imagine you have baked an apple pie and you want to eat this pie as soon as possible. How would you cool the hot apply pie?

☐ By putting a pie on the kitchen table

☐ By putting a pie in the freezer

Explain why.

- B.** A teacher took a hot drink to her bath. She fell asleep and when she woke up the drink was cold but the bath was still warm. What happened?

- C.** A teacher made a cup of coffee but she was called away. She really would like to drink warm coffee, should she add the cold milk before she goes or after she gets back?

- D.** Is the following sentence true or false? (Give some examples.)

In normal conditions, heat energy always flows from a warmer to a cooler object.