ScienceMath-project: **Cooling Process and Temperature**
Idea: Päivi Kukkonen,
Turku teacher-training school, Finland

Education and Culture
Lifelong learning programme
COMENIUS

Teaching material

This sequence is divided into three different subsequences/ experimental settings:

I Getting familiar with cooling:

Idea: Ready-made experimental setting/ letting 100 g hot water to cool

II More about cooling

Idea: Ready-made experimental setting/ comparing the cooling of different masses of water

III Investigating cooling

Idea: Given equipment/ finding out one more factor that affects the rate of cooling

Procedures and equipment needed/ Worksheets

(to copy - see next pages)

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I. Getting familiar with cooling

Equipment and materials:

Scales / Measuring cylinder
Electric kettle / Bunsen burner
Beaker
Tripod
Gauge
Container
TI EasyTemp/ thermometer, stop watch, graph paper

Procedure:

1) Boil some water in an electric kettle.
2) Measure 100 g (= 100 ml) hot water into container.
3) Measure the temperature of water for 5 minutes using TI EasyTemp or measure the temperature of water every 30 seconds for 5 minutes with a thermometer and draw a graph from your results.

Table 1: Measured data

Time / s ± s	Temperature /° ± °

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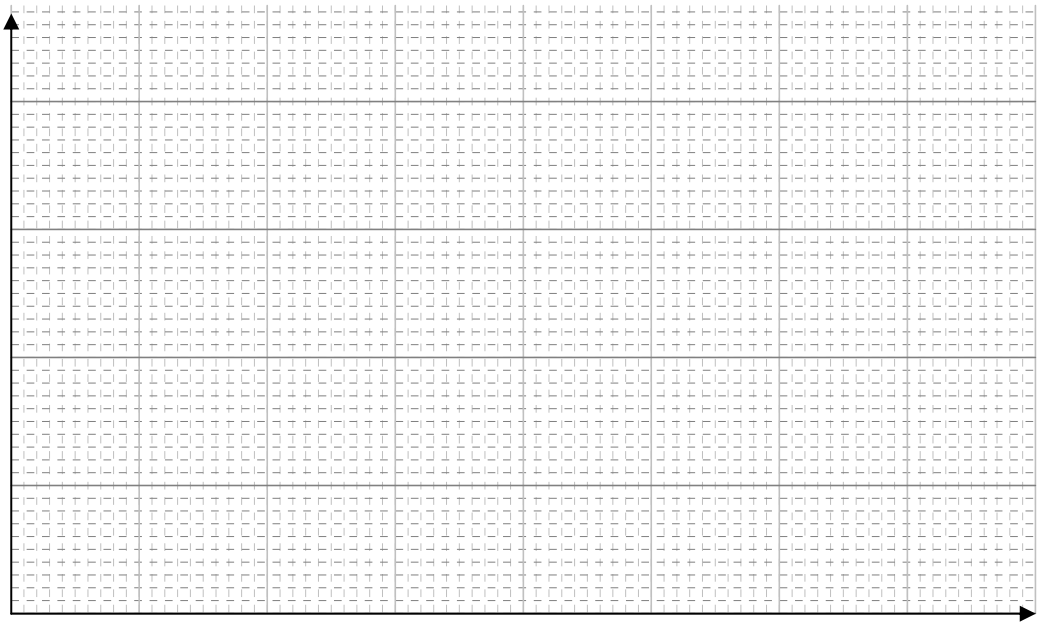


Graph 1. Temperature as the function of time

Questions:

What variables were measured?

What was the initial temperature of the water?

How did the temperature change?

Describe the change in temperature over time.

II. More about cooling

Equipment and materials:

Scales / Measuring cylinder
Electric kettle / Bunsen burner
Beaker
Tripod
Gauge
3 similar containers
TI EasyTemp/ thermometer, stop watch, graph paper

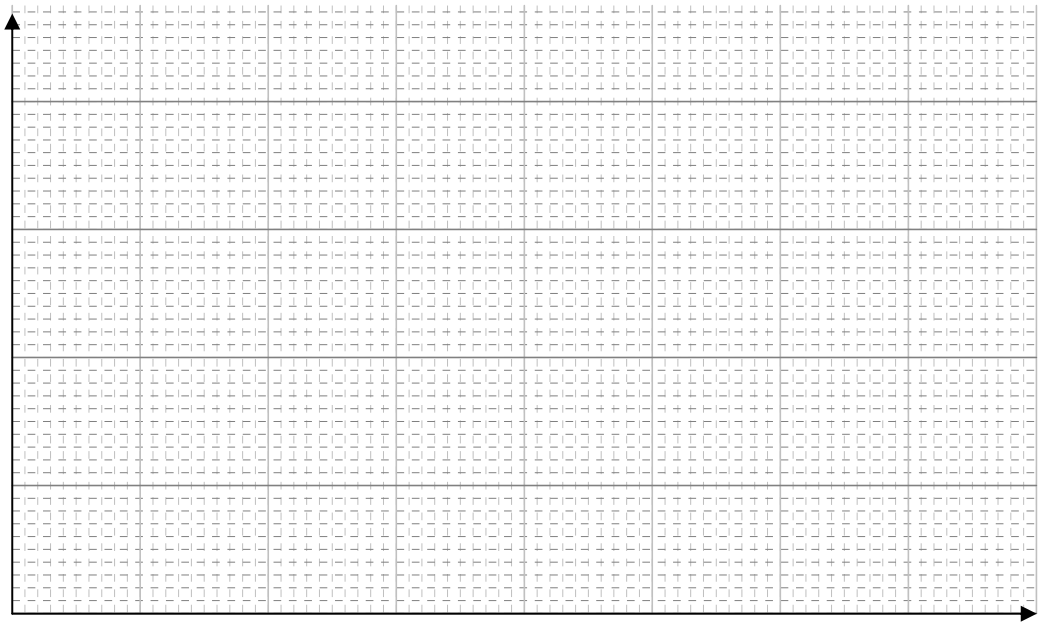
Procedure:

1) Boil some water in an electric kettle.
2) Measure 150 g (= 150 ml) hot water into a container. The temperature of water should be very near 100 ºC or three groups should start the steps 2, 4 and 6 at the same time and take the water from the same vessel.
3) Measure the temperature of water for 5 - 10 minutes using TI EasyTemp or measure the temperature of water every 30 seconds for 5 - 10 minutes with a thermometer and draw a graph from your results.
4) Measure 100 g (= 100 ml) hot water into a container.
5) Measure the temperature of water for 5 - 10 minutes using TI EasyTemp or measure the temperature of water every 30 seconds for 5 - 10 minutes with a thermometer and draw a graph from your results.
6) Measure 50 g (= 50 ml) hot water into a container.
7) Measure the temperature of water for 5 - 10 minutes using TI EasyTemp or measure the temperature of water every 30 seconds for 5 - 10 minutes with a thermometer and draw a graph from your results.

Hypothesis / Prediction what will happen?

Table 2: Measured data

Mass m = 150 g		Mass m = 100 g		Mass m = 50 g	
Time / s ± s	Temperature /° ± °	Time / s ± s	Temperature /° ± °	Time / s ± s	Temperature /° ± °



Graph 2. Temperatures of waters of different masses as a function of time

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Questions:

1. Why should the temperature of water should be very near 100 ºC or three groups should start the steps 2, 4 and 6 at the same time and take the water from the same vessel?

2. What changes?

3. What variables were measured?

4. What variables were expected to be constant each time?

5. What connections or relations there are between the variables?

6. What was different in the set of three tests just carried out?

7. How did the change in the mass of water affect the cooling?

8. What was similar with the set of three tests just carried out?

III. Investigating cooling

Equipment and materials:

Scales / Measuring cylinder
Electric kettle / Bunsen burner
Beaker
Tripod
Gauge
Similar and different containers (different shapes, material and colour, lid etc.)
Hot water bath
Water, milk, buttermilk, food oil, spirit (ethanol), syrup
TI EasyTemp/ thermometer, stop watch, graph paper

Procedure:

1. Choose one factor that you think affects on cooling.

_____

2. How do you make this a fair test?
   (keeping other variables constant)

3. What data is measured?

4. What varies?

5. Which variables are measured?

6. Which variables are expected to be constant?

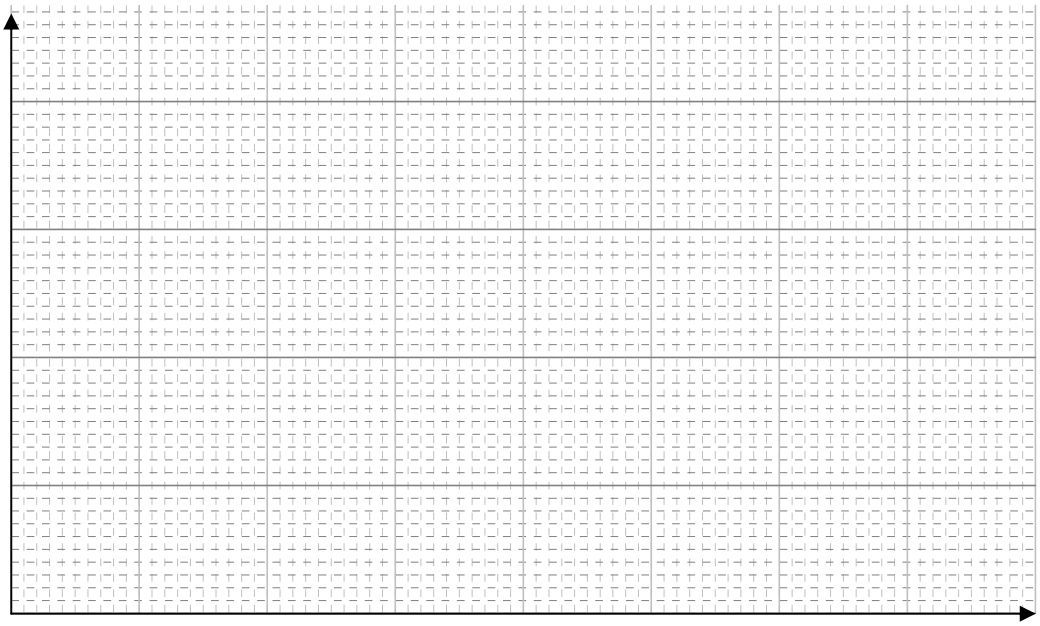
7. How they are kept constant?

8. Explain your procedure:

Hypothesis/Prediction: I think that …

Table 3: Measured data

Time / s ± s	Temperature /° ± °	Time / s ± s	Temperature /° ± °	Time / s ± s	Temperature /° ± °



Graph 3. Temperatures of water samples the function of time

9. Your result: _____

Explanation:

Answers

I

What variables were measured? (Time, temperature, mass of water)

What was the initial temperature of the water? (Read from graph)

How did the temperature change? (Temperature decreases)

Describe the change in temperature over time. (First it decreases faster and then slows down)

II

1. Why should the temperature of water should be very near 100 ºC or three groups should start the steps 2, 4 and 6 at the same time and take the water from the same vessel? (same initial temperature → fair test)
2. What changes?
3. What variables were measured? (Time, temperature, mass of water)
4. What variables were expected to be constant each time?
   (Initial temperature of container, measuring time, substance, temperature of environment, shape of container etc.)
5. What connections or relations there are between the variables?
6. What was different in the set of three tests just carried out?
   (Mass of water)
7. How did the change in the mass of water affect the cooling?
   (The more the water, the slower the cooling
   / the less the water, the quicker the cooling)
8. What was similar with the set of three tests just carried out? (initial temperature, initial temperature of container, measuring time, substance, temperature of environment, shape of container etc.)