Newton’s law of cooling

Driving Question:
How fast an object cools down and what are the factors, which affect the rate of cooling?

Thinking about the question

As soon as a cup of hot coffee is poured, it begins to cool. How fast does a cup of coffee cool down? What are the crucial factors that affect its rate of cooling?

Write down factors which you think affect the rate of cooling:

A formula that mathematically describes the rate of cooling is known as Newton’s law of cooling. In this activity you are going to observe how fast temperature changes during a cooling process. You will also check the validity of Newton's law of cooling.

Materials

In your investigations you will use:

- Data-logger e.g. CLAB,
- Temperature sensor,
- A beaker,
- Hot water.

Safety

To avoid burns use water below 50° Celsius.

Investigations

1. Connect the temperature sensor to input 1 of your data-logger.
2. Open Coach Activity ‘Newton's law of cooling’.
3. First determine the room temperature. Hold the sensor in the air and read the measured temperature value.

4. Place the temperature sensor inside a glass beaker with hot water. Start the measurement and record temperature during the cooling process.

5. How fast does the temperature change in the first minute of the measurement?

6. How fast does the temperature change in the following minutes of the measurement?

7. What do you think is the factor, which affects the rate of cooling?

8. What are other possible factors that can influence the rate of cooling? How would you test these?

9. Read the Science background for this activity. Is Newton's law of cooling valid for the collected data? Describe they way you are verify it.

10. Find the experimental value of the constant k by using one of the methods described above.

11. What do you think this constant represents?

12. What unit would this constant have?

13. What should you do: add the room temperature coffee cream after 2 minutes or after 12 minutes if you wish to drink the coffee as hot as possible about 15 minutes after it is poured. Write your hypothesis and then verify it experimentally.

14. Repeat your experiment but this time start with the temperature sensor in an ice bath and allow it warm up when removed from the bath. Explain the results.

15. Does the Newton's law of cooling hold also for warming?

Resources:

Coach Activity: Newton's law of cooling.cma7