Experiment 212

Determination of the latent heat of fusion of ice

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1 Theory

1. Inner energy, heat and temperature in statistical mechanics [1], [2].
2. The zeroth, first and second laws of thermodynamics [1], [2].
3. Theory of melting and solidification [2].
4. A specific heat, a heat capacity, a latent heat of fusion and their SI derived units [1], [2].
5. Determination of the heat equivalent of fusion of ice [3].
6. The difference of temperatures extrapolation in an immediate heat exchange [4].

2 Preliminary tasks

1. Study theory of a measurement of the heat equivalent of fusion and read carefully a description of your experiment.
2. Propose heat balance for this experiment and find the latent heat of fusion of ice. The heat capacity of the thermometer is insignificant.
3. Prepare a project of a data table and a list of quantities which values have to be verified at the laboratory.
4. Applying the difference of temperatures extrapolation in an immediate heat exchange find a method to determine the initial and the final temperature of melting of the ice.
5. Find the formula estimating the maximum uncertainty in the heat equivalent of fusion of ice. *Hint* Use the Taylor's series expansion.

3 The measuring set

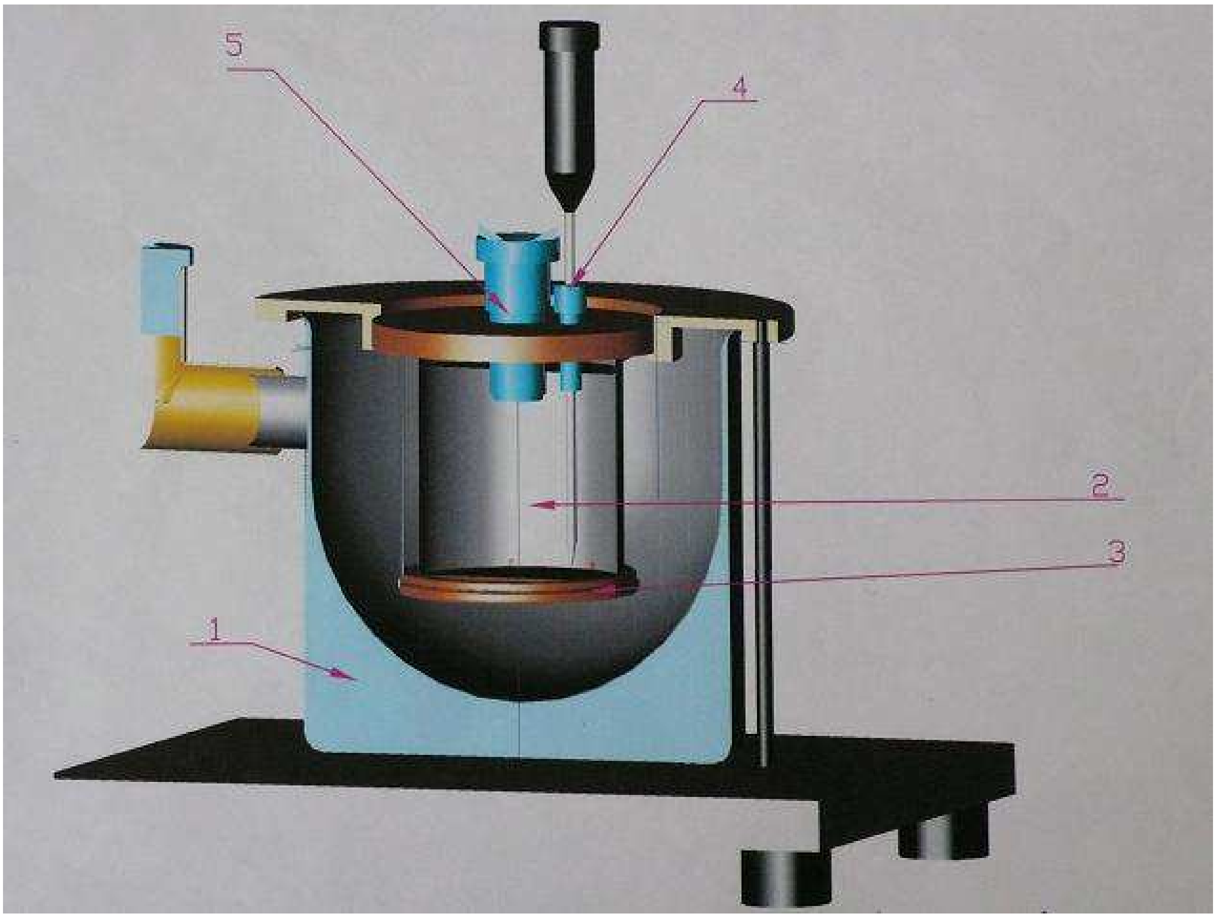

Figure 1: A water jacket calorimeter

1. A water jacket
2. a calorimeter
3. a stand of the calorimeter
4. a thermometer
5. a plug.

4 Measurements

1. Wash, dry carefully and weigh the calorimeter.
2. Fill the $\frac{2}{3}$ of the calorimeter with distilled water and weigh the calorimeter with it.

3. Switch the electric cooker for about 10 min.
Caution! The electric cooker has no on/off botton. It is switched on/off directly at a socket.

4. **Switch the electric cooker off,** put the calorimeter on it and warm the water up to 210 K. The temperature of the water sholud be controlled for all the time of warming. **Warming the water over 220 K may cause your skin burn. Moreover, it intensifies vaporization.**

5. With the use of protective gloves put the calorimeter into the water jacket. Then insert the termometer into the small hole in the lid and block the central hole with the plug.

6. After approx. 1 min. start measuring of the temperature of the water. Check the temperature every 30 s. by 5 min.

7. In the meantime fetch a syringe with ice, keep it for $2-3$ min. in the ambient temperature and then inject the ice ($2-3$ g)) into the calorimeter by the central hole. Plug the hole as fast as possible. It is assumed that the ice temperature is 273 K.

8. The temperature decreases rapidly. During this fast decrease control the temperature every 10 s.

9. When the system comes back to a thermal quasi- equilibrium measure the temperature every 30 s. and continue this process for 5 min.

10. Weigh the calorimeter.

5 Analysis of results

1. An introduction of the report should comprise short description of the method of measurement of the latent heat of fusion of ice, a list of symbols and final formulas of the heat equivalent of fusion of ice and its the maximum uncertainty.

2. Add the data table. Remember to present results in SI or SI derived units.

3. Draw a graph presenting the dependence of the temperature on time. Indicate the initial and final temperature of the melting of the ice. Apply the difference of temperatures extrapolation in an immediate heat exchange method.

4. Calculate the latent heat of fusion of ice. Make the substitution to the formula contained in the introduction and write the final result.

5. Estimate the maximum uncertainty of the heat equivalent of fusion of ice. Substitute your data to the formula given in the introduction and present the final result.

6. Write the latent heat of fusion of ice estimated by its maximum uncertainty.

7. Discuss your result, add some comments and conclusions.

References

[1] D. Halliday, R. Resnick, J. Walker *Fundamentals of Physics Extended*, Wiley John & Sons 2007.

[2] H. D. Young, R. A. Freedman, *University Physics with Modern Physics*, Addison - Wesley Publishing Company 2000.

[3] J. Karniewicz, T. Sokoowski, *Podstawy fizyki laboratoryjnej*, skrypt Lodz 1996.

[4] T. Dryński, *Ćwiczenia laboratoryjne z fizyki*, PWN Warszawa 1980.