LABORATORY EXERCISE NO. 1
DETERMINATION OF THE INTEGRAL HEAT OF SOLUTION OF A SALT

Objective: Determination of the integral heat of solution of a salt.

Experiment and calculations

In this study Dewar vessel is used as a calorimeter, so as to minimize the loss of heat radiation. The constant of calorimeter *K* is known.

1. Take a sample of a salt (KCl, NH_4Cl) with mass of 7–10 g. Fill appropriate volume of water ($m_{solution}$ = 200 g) in the Dewar vessel and place *Beckmann thermometer* (Fig. 1) in the calorimeter. A Beckmann thermometer is a device used to measure small differences of temperature, but not absolute temperature values. The length of Beckmann thermometer is usually 40–50 cm. The temperature scale typically covers about 5 ^oC and it is divided into hundredths of a degree. The peculiarity of Beckmann thermometer design is a reservoir ***R*** at the upper end of the tube (see Fig. 1), by means of which the quantity of mercury in the lower bulb can be increased or diminished so that the instrument can be setted to measure temperature differences at either high or low temperatures. In contrast, the range of a typical mercury-in-glass thermometer is fixed, being set by the calibration marks etched on the glass or the marks on the printed scale. In setting the Beckmann thermometer, a sufficient amount of mercury must be left in the bulb and stem to give readings between the required temperatures. First, the thermometer is inverted and gently tapped so that the mercury in the reservoir lodges in the bend ***B*** (see Fig. 1) at the end of the stem. Next, the bulb is heated until the mercury in the stem joins the mercury in the reservoir. The thermometer then is placed in a bath one or two degrees above the upper limit of temperatures to be measured. If now the upper end of the tube is gently tapped with the finger, or the entire instrument gently tapped on the palm of the hand, the mercury suspended in the upper part of the reservoir will be jarred down, thus separating it from the thread at the bend ***B***. The thermometer will then be set for readings between the required temperatures.

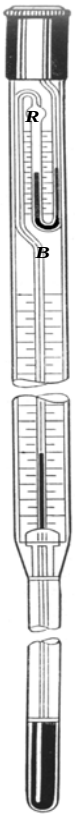

Fig. 1. Beckmann thermometer

Dissolution of a salt in this study is an endothermic process, therefore the thermometer is set for readings between 3.5–5 °C.

2. *Initial period of the experiment* is passed during 4–5 minutes and for this time change of temperature is practically constant. Write the thermometer reading every 30 seconds. After that the weighed sample of a salt is poured out in the calorimeter and *main period* will be started. Dissolution of a salt passes during 1–3 minutes. During this time the temperature will be dramatically changed.

3. *Final period* is started when all salt will be dissolved. The temperature is slightly changed with time. Write the thermometer reading every 30 seconds during 4–5 minutes.

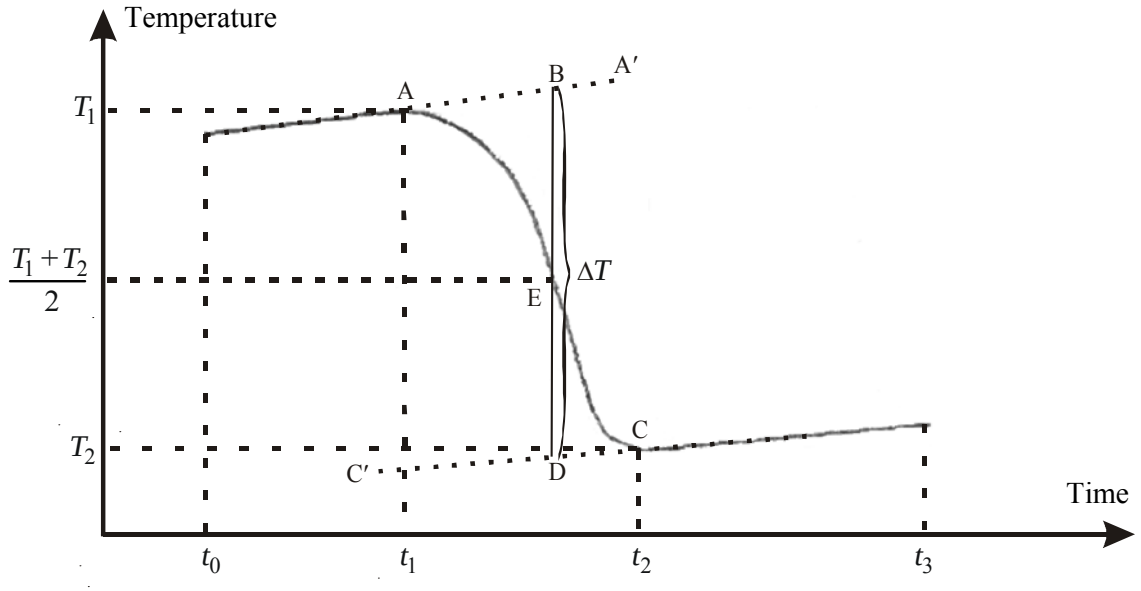

Fig. 2. Graphical determination of true temperature changes for the reaction

4. Draw a graph of temperature *vs* time dependence with following scale on X-axis – 1 minute = 1 cm and on Y-axis – 0.1° = 1 cm. Find ΔT value (true temperature changes for the reaction) using this graph (Fig. 2).

5. The integral heat of solution is calculated using following equation

$$\Delta H = K\Delta T \frac{M}{g}, \qquad (1)$$

where K – the constant of calorimeter, kJ/K; g – weight of the sample of salt, gram; M – molar weight of salt, g/mol.