Molecular physics and thermodynamics

2.1 Surface tension

THEORETICAL PREPARATION

Free surface of a liquid is of the same qualities as a thin elastic membrane. For example, when you put a small metal coin on the water level carefully, the water surface bents a bit, but the coin does not submerge, although its density is higher than density of the liquid. This quality of a liquid is dependent on its surface tension.

Surface tension is equal to surface force to length of an edge of surface film ratio, (length of an edge, on which the force exerts vertically to the liquid surface).

When pulling the stick out of the fluid use the dynamometer to determine the elastic force F_p of a stick submerged in a fluid. The surface tension is calculated by using a formula $\sigma = \frac{F_p}{2l}$, where l is length of the stick.

EQUIPMENT

Dynamometer PS-2189 (with high accuracy of measurement 0,002N), USB link, notebook with a DataStudio program, bowl, water, spirit, cleaning liquid, sticks, thread, ruler.

PROCEDURE

1) Tie the thread to 10cm and 20cm long sticks, so they can be hooked to the dynamometer.

2) Pour water into the bowl and hook the stick onto the dynamometer, which is connected to the notebook through the USB link. Place the entire stick on the water level.


3) Set the sampling frequency to 10Hz in Setup in the DataStudio program. Set the visualising of the graph of force – time relationship.

4) Push the button Start, pull out the dynamometer and the stick and stop the measurement by pushing the button End.

5) The magnitude of the surface force is determined as an absolute value of the difference between the smallest measured value of force (gravitational + surface, it is negative, because of its down direction) and the value of gravitational force after the takeout of the stick. Use the button Smart Tool to determine this force.
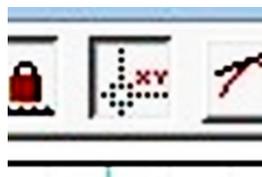
Click the left mouse button on the first point in the graph and by dragging the small triangle place the cursor on the second point in the graph. Their distance in both axis (horizontal and vertical) is viewed. See the picture below.
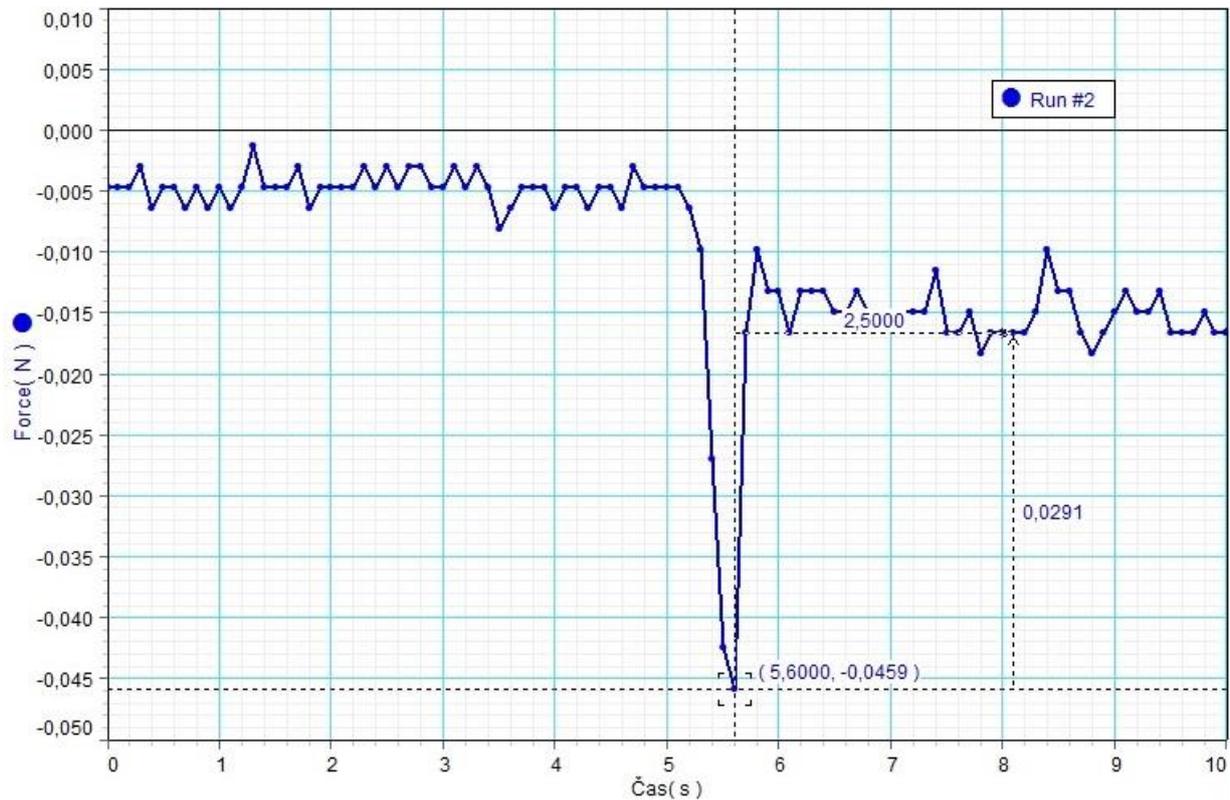
6) Read the value of the elastic force, and calculate the surface tension from an equation

$\sigma = \frac{Fp}{2l}$. Note down the data.

7) Apply the same procedure with the stick of different length and repeat the procedure with ethanol, water and cleaning liquids.

8) At the end compare measured values of surface tensions to the stated values.