Task II. Property of liquids

Required knowledge: Property of liquids

1. Viscosity

Main tasks:
Measuring and calculation of kinematic viscosity of unknown liquid.

Needs for measurement:
The Ostwald viscometer, electric heater with electromagnetic stirrer, stirring bar, stand, stopwatch, thermometer, water (vacuum) pump, beaker, pipettes, distilled water, liquid of unknown viscosity.

Procedure:
1) The stirring bar is putted on the bottom of the beaker. Fill the beaker with tap water and put it on the electric heater. Fix the Ostwald viscometer into the stand and immersed it in to the water bath so that its level may be if possible above the reservoir in the capillary arm of the viscometer.
2) Pipette 10ml liquid of unknown viscosity into the wider arm of the viscometer, switch on the stirrer without heating and after ca one minute measure the temperature T_1 of water bath.
3) Attach a green pump to the rubber tube in the end of the capillary arm of the viscometer. Measure the time necessary for the level drop of distilled water from the upper gauge mark to the lower one (it is necessary to press and hold white button on a green pump). Repeat the measurement several times to obtain at least three results with small diffusion. Then calculate average time.
4) Switch on heating (stirrer is incessantly on) and follow the temperature of the water bath. On reaching temperature T_2 (T_2=T_1+5°C) switch off the heating and in the way described above measure the times necessary for the level drop of distilled water in the capillary arm of the viscometer from the upper gauge mark to the lower one.
5) In the same way measure times at temperature T_3 and T_4 of the water bath (T_3=T_2+5°C, T_4=T_3+5°C).
6) Empty the viscometer (put the unknown liquid back to the vessel). Prepare a new water bath and immerse the viscometer into this bath. Into the wider arm of the viscometer pipette 10ml of distilled water and repeat the experiment. If it is possible, start the experiment with same temperature of the water bath as during measurement with unknown liquid.
7) In the similar way measure the times of level drop at temperatures T_1, T_2, T_3 and T_4 of the water bath.
8) **Make a table of results.** Calculate kinematic viscosity of studied liquid (**ν**) at temperatures T_1, T_2 T_3 and T_4. (For the calculation of kinematic viscosity of distilled water (ν_0) use the values for the density and dynamic viscosity of distilled water from enclosed table use the equation $\nu_0 = \eta/\rho$). Plot a graph of dependence of kinematic viscosity of distilled water and studied liquid on temperature into one coordinate system of the graph.

$$\nu = t\,\nu_0/t_0$$

t – average time of studied liquid
t_0 – average time of water

Table of temperature dependence of density ρ, and dynamic viscosity η of distilled water

t [°C]	ρ [kg.m^{-3}]	η10^{-3} [N.s.m^{-2}]
0	999,84	1,79
5	999,97	1,52
10	999,7	1,31
12	999,5	1,24
14	999,24	1,18
16	998,94	1,1
18	998,6	1,05
20	998,21	1
22	997,77	0,96
24	997,3	0,91
25	997,05	0,89
30	995,65	0,8
35	994,03	0,72
40	992,1	0,65
45	990,1	0,6
50	988,05	0,55
55	985,7	0,51
60	983,2	0,47
65	980,56	0,44
70	977,75	0,406
75	974,82	0,38
80	971,8	0,36

2. The surface tension of liquids

Main tasks:
Determine the surface tension of variously concentrated solutions of bile acid and a comparison with the surface tension of water.
Verification of the surface tension for variously concentrated solutions of bile acid by means of stalagmometer

Needs for measurement:
Digital tensiometer K9, stalagmometer, distilled water, bile acid, thermometer.

Task 1
Determine the surface tension of variously concentrated solutions of bile acid and a comparison with the surface tension of water

Procedure:
1) Measurement accomplish by the digital tensiometer K9. Switch on the tensiometer – press ON.
2) Set mode PLATE (by button MODE, if it isn`t set).
3) Pour bile acid into **glass** vessel of tensiometer.
4) Drive up with table almost up to the lower edge of lamella by means of roller for general shift on right side. (You can watch reflection of the lower edge of the lamella on surface of liquid for better setting).
WARNING- if you use roller for general setting the screw button on left side must be open
5) Lock the table by screw on left side. Reset the system for measuring of force by press button ZERO.
6) Drive up with the table so that the lamella was whole made wet.
7) By rotation of the right screw go down with the table and at the same time follow display of tensiometer. Tightly before breakaway the value of the surface tension will be the greatest. Write down this value

8) Measurement repeat in the same way for all accessible concentrations of bile acid. Results write down into a table. **After the measurements put back bile acids into the vessels**.

Task 2
Verification of the surface tension for variously concentrated solutions of bile acid by means of stalagmometer

Procedure:
1) Find the mass of **four** dry weighing vessels by analytical balance (the are prepared in front of bile acids). The container **under** the stalagmometer is **only** for leakage of liquid! Every vessel is prepared for specific liquid.
2) Pipette the distilled water into the stalagmometer. After dropping of several drops below the outlet part of the stalagmometer place of the weighing vessel and leave it so that it will drop of 50 drops.
3) Find the mass of weighing vessel with liquid and determine mass of 50 drops.

4) Repeat the measurements for all solutions of bile acids (**After the measurements put back bile acids into the vessels)**.

5) Count the surface tension of the solutions of the acid from equation“ $\frac{\gamma}{\gamma_{ref}} = \frac{m}{m_{ref}}$**,** where the index **ref** represent values for comparative liquid (distilled water), and its surface tension is presented in the table

In the discusion compare measured values of distilled water with values of variously concentrated solutions of bile acid. Compare values for solutions of bile acid when the tensiometer K9 was used for measuring with values when stalagnometer was used. Write down why and how are the values different. Try to justify mistakes made by measuring.

International tables of the surface tension of water

temperature (°C)	ST (mN/m)	temperature (°C)	ST (mN/m)	temperature (°C)	ST (mN/m)
1	75,5	31	71,05	61	66,06
2	75,36	32	70,89	62	65,88
3	75,23	33	70,73	63	65,71
4	75,09	34	70,57	64	65,53
5	74,94	35	70,41	65	65,36
6	74,8	36	70,25	66	65,18
7	74,66	37	70,09	67	65
8	74,52	38	69,93	68	64,83
9	74,38	39	69,76	69	64,65
10	74,23	40	69,6	70	64,47
11	74,09	41	69,44	71	64,29
12	73,94	42	69,27	72	64,11
13	73,79	43	69,11	73	63,93
14	73,65	44	68,94	74	63,75
15	73,5	45	68,78	75	63,57
16	73,35	46	68,61	76	63,39
17	73,2	47	68,44	77	63,21
18	73,05	48	68,28	78	63,03
19	72,9	49	68,11	79	62,85
20	72,75	50	67,94	80	62,66
21	72,6	51	67,77	81	62,48
22	72,45	52	67,6	82	62,3
23	72,29	53	67,43	83	62,11
24	72,14	54	67,26	84	61,93
25	71,99	55	67,09	85	61,74
26	71,83	56	66,92	86	61,56
27	71,67	57	66,75	87	61,37
28	71,52	58	66,58	88	61,19
29	71,36	59	66,4	89	61
30	71,2	60	66,23	90	60,81

Source: N.B. Vargaftik et al.:International tables of the surface tension of water.J. Phys. Chem. Ref. Data, 12, 817,1983