

PHYSICAL PRACTICUM

Physical practicum 3

Author: Patrik Žilka**Date:** 3rd may 2012**Field of Study:** AF **Grade:** II **Semester:** IV**Tested:****Task No. 9: Millikan's experiment****1. Theory**

The experiment entail balancing the downward gravitational force with the upward drag and electric forces on tiny charged droplets of oil suspended between two metal electrodes. For this experiment is needed to known density of oil $\rho = 1030 \text{ kg/m}^3$, density of the air $\rho_{air} = 1185 \text{ g/m}^3$, viscosity of air $\nu = 1.83 \times 10^{-5} \text{ Pa}\cdot\text{s}$, gravitational acceleration $g = 9.81 \text{ m/s}^2$ and intensity of electric field $E = \frac{U}{d}$, where d is the distance between the plates ($d = 2.5 \text{ mm}$) and U is measured voltage. Then we can calculate radius r and absolute charge $|q|$ of the drop by following equations:

$$r^2 = \frac{9\nu(v_1 - v_2)}{4g(\rho - \rho_{air})}, \quad |q| = 3\pi\nu r \frac{v_1 + v_2}{E},$$

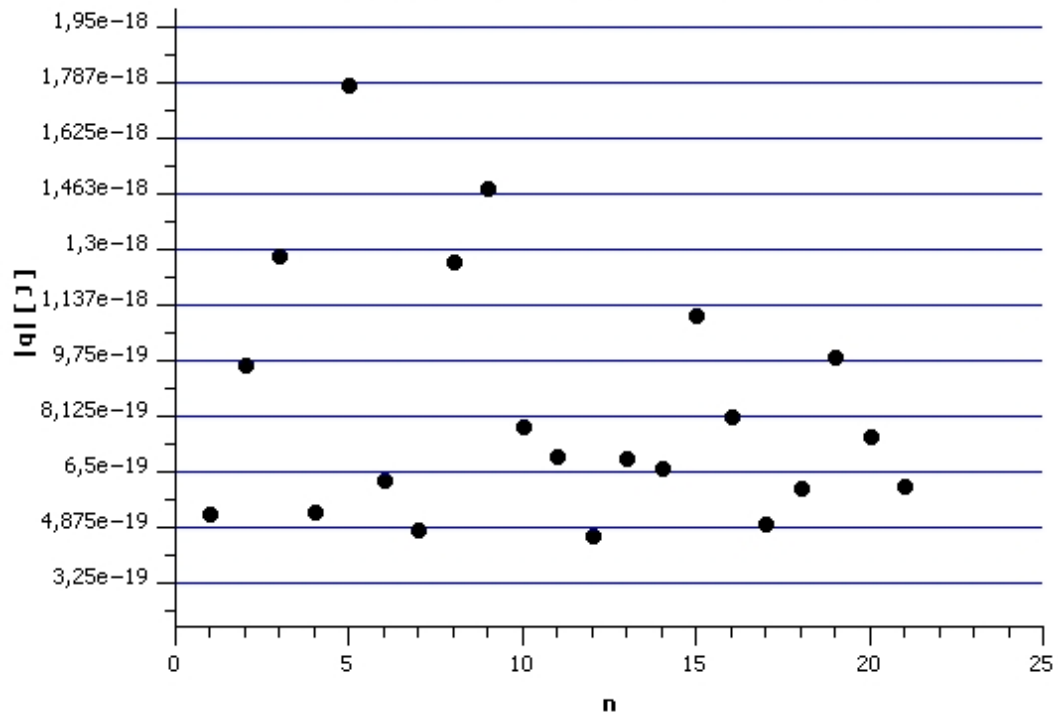
where v_1 and v_2 are velocities of oil drop in both polarities of electric field.

2. Measurement

Table 1: Measured velocities of oil drops and their radius and charge. N is expected coefficient of elementary charge and e is expected elementary charge.

n	U [V]	v_1 [km/s]	v_2 [km/s]	r [μm]	$ q $ [$\times 10^{-19}\text{C}$]	N	e [$\times 10^{-19}\text{C}$]
1	300	0,343	0,403	0,50	5,31	3	1,77
2	315	0,142	0,469	1,15	9,65	6	1,61
3	315	0,319	0,583	1,04	12,82	8	1,60
4	330	0,139	0,328	0,88	5,37	3	1,79
5	350	0,208	0,758	1,50	17,81	11	1,62
6	390	0,224	0,417	0,89	6,28	4	1,57
7	400	0,133	0,347	0,93	4,84	3	1,61
8	415	0,469	0,725	1,02	12,67	8	1,58
9	430	0,241	0,766	1,46	14,78	9	1,64
10	445	0,397	0,569	0,84	7,85	5	1,57
11	460	0,253	0,495	1,00	6,98	4	1,74
12	475	0,230	0,395	0,82	4,67	3	1,56
13	490	0,323	0,530	0,92	6,91	4	1,73
14	500	0,312	0,521	0,92	6,62	4	1,66
15	500	0,339	0,708	1,23	11,09	7	1,58
16	510	0,406	0,620	0,94	8,11	5	1,62
17	520	0,221	0,430	0,92	4,99	3	1,66
18	550	0,316	0,525	0,92	6,08	4	1,52
19	570	0,679	0,855	0,85	9,85	6	1,64
20	590	0,475	0,675	0,90	7,58	5	1,52
21	600	0,292	0,544	1,02	6,10	4	1,53

Graph 1: Charges |q| of droplets of oil with lines, which values are multiplied by measured elementary charge



Measured elementary charge: $e = (1.625 \pm 0.018) \times 10^{-19} \text{ C}$ $\delta_r = 1.1\%$

3. Conclusion

Result of this practicum is relatively accurate value of elementary charge $1,625 \pm 0,018 \times 10^{-19} \text{ C}$.
Table value of elementary charge is $1,6022 \times 10^{-19} \text{ C}$.