FYZIKÁLNE PRAKTIKUM

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Tested:

Task No. **9:**   **Millikan's experiment**

1. Task

• Measure the size of elementary charge using speed of falling and rising oil droplets in homogenous electric field

2. 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. Radius r and absolute charge $|q|$ can be calculated by following equations:

$$r^2 = \frac{9\nu(v_1 - v_2)}{4g(\rho - \rho_{air})} \tag{1}$$
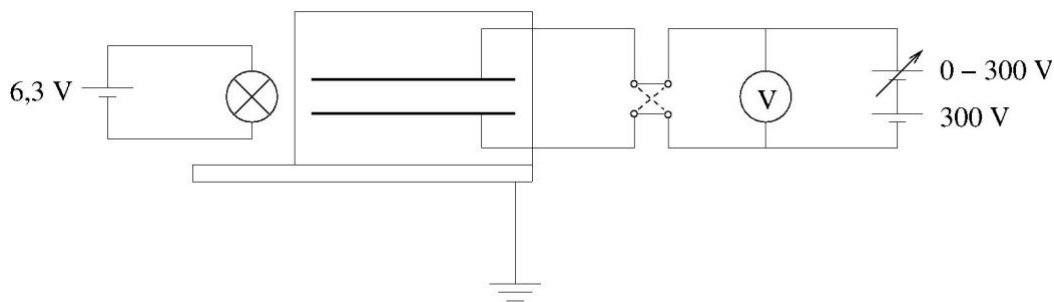
$$|q| = 3\pi\nu r d \frac{(v_1 + v_2)}{U} \tag{2}$$

Figure 1: Scheme of experiment

3. Measurement

Constants in experiment	
density of oil:	$\rho = 1030$ kg·m^3
density of air:	$\rho_{air} = 1185$ g·m^3
viscosity of air:	$\nu = 1{,}83{\cdot}10^{-5}$ Pa·s
gravitational acceleration:	$g = 9{,}81$ m·s^{-2}
distance of electrodes:	$d = 0{,}0025$ m

n	U [V]	v_1 [mm·s^{-1}]	v_2 [mm·s^{-1}]	r [μm]	$|q|$ [10^{-19} C]	N	e [10^{-19} C]
1	300	0,841	0,556	1,077	21,621	13	1,663
2	300	1,298	0,530	1,770	46,503	29	1,604
3	300	1,171	0,695	1,393	37,371	23	1,625
4	350	0,682	0,577	0,656	10,176	6	1,696
5	350	1,011	0,767	0,998	21,867	14	1,562
6	350	1,015	0,494	1,457	27,095	17	1,594
7	400	0,742	0,401	1,179	14,522	9	1,614
8	400	0,906	0,458	1,353	19,895	12	1,658
9	400	0,652	0,445	0,918	10,859	7	1,551
10	450	1,252	0,834	1,305	26,075	16	1,630
11	450	0,682	0,569	0,681	8,164	5	1,633
12	450	0,973	0,656	1,138	17,766	11	1,615
13	500	0,781	0,742	0,399	5,239	3	1,746
14	500	1,483	1,054	1,324	28,960	18	1,609
15	500	0,795	0,770	0,316	4,262	3	1,421
16	550	0,783	0,546	0,982	10,234	6	1,706
17	550	0,944	0,587	1,206	14,482	9	1,609
18	550	1,391	1,324	0,520	11,063	7	1,580
19	600	1,369	1,324	0,428	8,278	5	1,656
20	600	2,318	2,225	0,615	20,077	13	1,544
21	600	1,178	0,989	0,878	13,675	9	1,519

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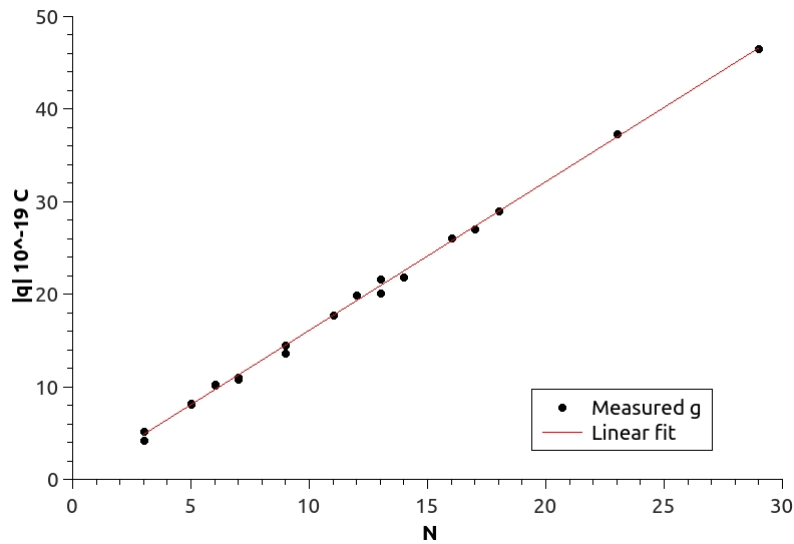

Figure 2: Charges $|q|$ of droplets of oil
Measured elementary charge:
$(1{,}61 \pm 0{,}02)10^{-19}$ C

4. Conclusion

In this experiment we were supposed to measure value of elementary charge. Our result is $(1{,}61 \pm 0{,}02)10^{-19}$ C. Table value of elementary charge is $1{,}6022 \cdot 10^{-19}$C. We can conclude that by this easy experiment we got relatively precise value of elementary charge.