Probability and Statistics

Set no. 1

uncertainty, the least square method

1. Assuming that n_i is a number of random experiments, in which the same result x_i has occurred and $\bar{x}$ is the mean value, please find:

a) n_5

x_i	n_1
3.2	1
3.5	2
5.3	4
4.3	5
5.3	n_5
2.5	5
7.8	3
8.1	2

$\bar{x}$ = 4.913333333

b) x_4.

x_i	n_1
5	1
6	2
9	4
x_4	5
14	8
16	5
20	3
22	2

$\bar{x}$ = 13.3

2. Measurements of time collision of two metal balls were carried out. Obtained results (in μs) were following: 125, 131, 121, 128, 127, 129, 129, 125. Please calculate the mean value of measured data and standard deviation (estimator) of the average.

3. The systematic uncertainty of the time measurement in the previous problem is 1 μs. Discuss whether the obtained standard deviation of the mean is a good measure of uncertainty or the total uncertainty should be calculated (taking into account the systematic uncertainty). If so, please determine the total uncertainty.

4. The diameter and height of a metal cylinder was measured by the calliper with declared uncertainty as 0.02 mm. During the measurement device presents 25.40 mm for the diameter and 104.10 mm for the height. On the basis of presented results find the volume of the cylinder and calculate its uncertainty.

5. Please find the value of critical resistance, R_c and uncertainty of it for the RLC circuit. Parameter L = 0.050 H was measured with uncertainty u(L) = 0.001 H . Please assume capacitance as (17,5 ± 0,1) μF. Hint: A formula for critical resistance as following $R_c = 2\sqrt{L/C}$.

6. Measurements of the gravitational acceleration, g, was carried out using the model of mathematics pendulum. The length of the pendulum was L = 72 cm with the maximum uncertainty equals to 1 cm, and the oscillation period T = 1.7s measured by stopwatch with precision Δt = 0.1 s. On the basis of presented results, please provide the value of the gravitational acceleration and find its uncertainty.

7. To determine gravitational acceleration another experiment was taken. This time the oscillation period T was recorded for different lengths L of the mathematics pendulum. Obtained data are presented below:

L (mm):	190	280	330	390	520
T (s):	0.935	1.061	1.160	1.257	1.404

Please calculate g together with its uncertainty u(g) relying on the results given in the table below:

a) by finding mean values of L and T,
b) using the least square method.

8. In the table below you can find the results of the simultaneous measurements of voltage and current intensity. The uncertainties of single measurements are as follows: $\Delta U = 0.1$ V, $\Delta I = 1$ mA. The aim is to:

a) prepare a suitable plot;

b) calculate the value of the electrical resistance R together with its uncertainty u(R) on the basis of the given data using the Ohm's law and the least square method.

U [V]	7.8	11	14.2	17.4	19	20.5	22	24	25.5
I [mA]	4	6	8	10	12	14	16	18	20