

Homework 1

(Due Date: Monday, Jan. 31)

In this homework you will practice how to calculate the mean, variance and apply error propagation seen in the first class (see website the slides for lecture 1.)

Problem 1:

Consider a cart rolling down a slope. If you measure the velocity of the cart at two points separated by a distance “ d ”, you can estimate the acceleration “ a ” of the cart using the constant-acceleration formula:

$$v_2^2 = v_1^2 + 2ad$$

If a student performs the measurements of the velocities and distance 12 times with results:

d	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7	197.7
V_1	186	184.3	185.8	186.8	181.9	185.2	184	185.7	186	185.5	182.5	183.8
V_2	323.5	320.6	323.2	324.8	316.4	322.1	320	322.9	323.5	322.6	317.4	319.6

- (a) Calculate the average and the standard deviation for each of the measured quantities.
- (b) Calculate the acceleration “ a ”.
- (c) Calculate the different contributions to the error in a , and calculate the total error of a using error propagation of a multivariable function.

Problem 2: A student measures the voltage drop across a resistor of as a function of applied current to the resistor. She/he takes six runs of data shown in the table below.

Current	Run 1	Run 2	Run 3	Run 4	Run 5	Run6	Average	St. Dev.
I (mA)	V1	V2	V3	V4	V5	V6	Vave	σ_v
1	5.03	3.58	2.67	2.72	2.63	3.42		
2	7.31	7.31	9.39	9.39	8.84	7.27		
4	12.78	11.80	11.57	11.38	10.85	12.15		
6	13.33	14.95	15.27	12.69	16.78	15.58		
8	16.55	17.77	16.64	16.52	17.69	19.44		
10	20.03	21.26	20.75	20.92	21.57	20.17		

- (a) For the data runs obtain the average voltage as a function of applied current, and the standard deviation of the voltage for each value of applied current. Show the equations for the calculation.
- (b) Using Matlab, plot the voltage as a function of current for the 6 runs in the same figure.

(c) In a second figure plot the average voltage (**V_{ave}**) as a function of current and show for each point its standard deviation (σ_v) with an error bar (use “errorbar” function in Matlab.)

Note: Include axes with labels for the figures. Also include a legend identifying each run for Fig. 1 and a legend identifying **V_{ave}** and σ_v in Fig.2.

(d) Assume that the current has a relative error (σ_I/I)= 1×10^{-3} so that $\sigma_I = I * 1 \times 10^{-3}$ in every run. Using the values of the voltage (**V_{ave}** and σ_v) and the current (**I** and σ_I) for each row with a constant current value, estimate the resistance **R** and its error σ_v for every row (to determine the error you need to use error propagation.)

3.- Review:

- Review the required parts for the formal lab report and the guidelines: [Formal Report Guidelines](#)
- Review the required parts for the lab notebook and the guidelines: [Lab notebook Guidelines](#)