Physics Laboratory
(20147)
Physics Laboratory Syllabus for first semester 2021 /2022

Exp. No.	Name of experiment	Week no.	Date-week starts on
-	Lab instructions	1	10/10/2021
1	Introduction to errors and graphs	2	17/10/2021
2	Basic Measurements I	3	24/10/2021
3	Basic Measurement II	4	31/10/2021
4	Static Equilibrium	5	07/11/2021
	عطلة المختبر اسبوع الامتحان الاول للجامعة	6	14/11/2021
5	Newton second law Acceleration due to gravity.	7	21/11/2021
	Midterm Exam	8	28/11/2021
6	Simple Harmonic Motion I.	9	05/12/2021
7	Simple Harmonic Motion II.	10	12/12/2021
	عطلة المختبر اسبوع الامتحان الثاني للجامعة	11	19/12/2021
8	Moment of Inertia.	12	26/05/2021
		13	02/01/2022
		14	09/01/2022
Final Exam		15	16/01/2022
الامتحانات النهائية		16	23/1/2022


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Grades

- **Reports.** **40%**
- **Mid Term Exam.** **20%**
- **Final Exam.** **40%**
- **Total Grades** **100%**

PHYSICS LAB.

(20147)

Experiment No. 1

Introduction to Errors and Graphs

Lab. 1 Introduction to Errors and Graphs

Types of Errors:

- Personal errors.
- Systematic errors.
- Random errors.

How to calculate random error:

In case of many readings :

Assume we have N readings for the same quantity X, and we want to write the final result of this quantity with its random error, then we follow the following steps:

- Step 1 : Calculation of the average quantity of X.

$$\text{Average of X} = \left(\frac{1}{N}\right)\sum_{i=1}^{N} x_i$$

- **Step 2 : Calculation of the standard deviation.**

The standard deviation is defined as :

$$S = \sqrt{\frac{1}{N-1}\sum_{i}^{N}(X_i\_average\ X)^2}$$

- **Step 3. Calculation of the random error σ .**

The random (standard) error σ is defined as :

$$\sigma_x = \frac{S}{\sqrt{N}}$$

Example :

Assume four measurements are made for the same quantity X, the results are: 18.6, 19.3, 17.7, and 20.4. Find the average value of X, the standard deviation S, and the random error σ_x, then write the final value of x.

- **Calculations of the average value.**

Average X = $\left(\frac{1}{N}\right)\sum_{i}^{N} X_i$

Average X = (18.6 + 19.3 + 17.7 + 20.4) / 4 = 19.0

- **Calculation of the standard deviation S.**

S = $\sqrt{\frac{1}{N-1}\sum_{i}^{N}(X_i - average\ X)^2}$

$$S = \sqrt{\frac{1}{4-1}\{(18.6-19.0)^2 + (19.3-19.0)^2 + (17.7-19.0)^2 + (20.4-19.0)^2\}}$$

$S = 1.14$

- Calculation of the random error σ_x .

$$\sigma_x = \frac{s}{\sqrt{N}}$$

$$\sigma_x = \frac{1.14}{\sqrt{4}}$$

$\sigma_x = 0.57$

The final result is $X = 19.0 \pm 0.57$

Incase of one reading only.

If we made only one measurement of some quantity, the the Random error σ in this value is given by :

$$\sigma = 0.5 \times \text{least count of the instrument used.}$$

Where the least count is the minimum value that the instrument used can read.

As an example, the least count of the simple ruler is 1 mm or 0.1 cm. so if we used the simple ruler to measure the length of a certain object, and we get it as 12.6 cm, the random error in our measurement is

$$\sigma_L = 0.5 \times 0.1 = 0.05 \text{ cm}$$

So our result of measurement is written as

$$\text{Length} = 12.6 \pm 0.05$$

Percentage error .

Percentage error = $\frac{|E - K|}{K}$ X 100%

Where

E is the experimental value and K is theoretical value.

Example:

let theo. Value of g = 9.85 and Exp. Value of g = 9.65

then Percentage error in exp. = $\frac{|9.65 - 9.85|}{9.85} X\ 100\% = 2\%$

Percentage difference.

Percentage difference = $\frac{|E_1 - E_2|}{\frac{(E_1 + E_2)}{2}} X\ 100\%$

Let E_1 = 9.65 and E_2 = 9.75 , then

Percentage difference = $\frac{|9.65 - 9.75|}{\frac{(9.65 + 9.75)}{2}} X\ 100\% = 1\%$

Using graphs to obtain results

In many cases, we need to plot a graph to obtain unknown values without making direct calculation and finally taking the required average.

The graph give us the average value directly.

Each experiment has a definite relation between the quantities understudying , we shall discuss here only three cases of this relation that will face us in our lab.

Case 1 : The form of relation is $R = \alpha T$

In this relation, R and T are two experimental quantities, α is unknown constant that will be determined from the graph between R and T.

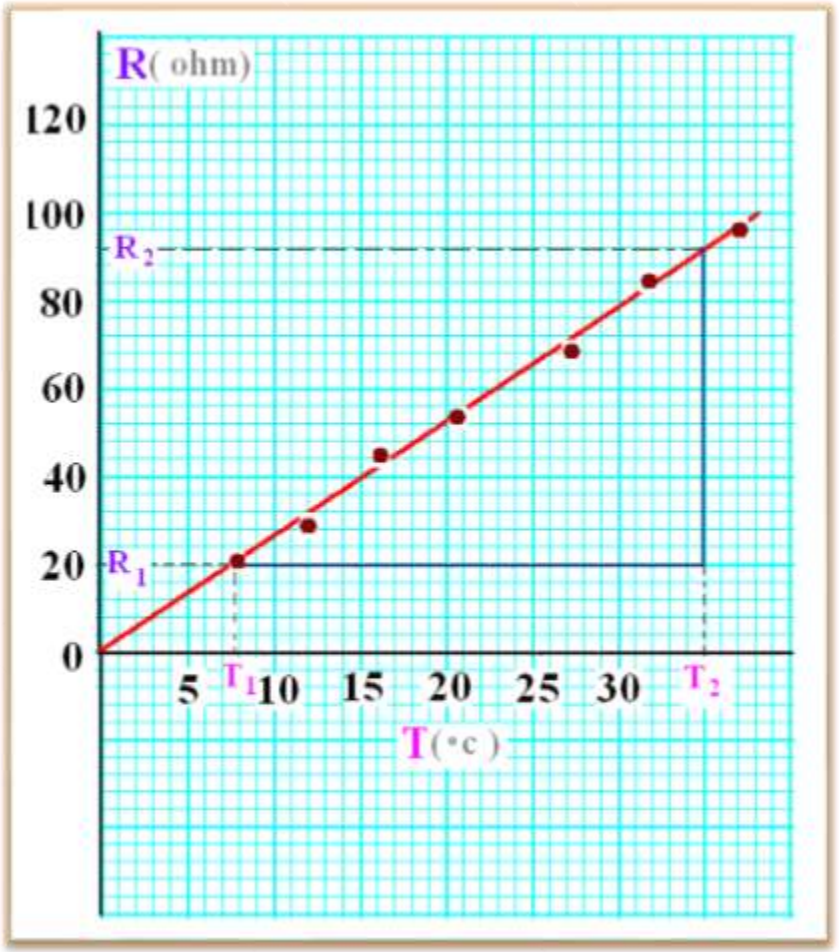
The above relation, when plotted give us the graph shown in the figure .

From the graph, the constant α is determined by

$$\alpha = \frac{R_2 - R_1}{T_2 - T_1}$$

or

α = Slope of the graph



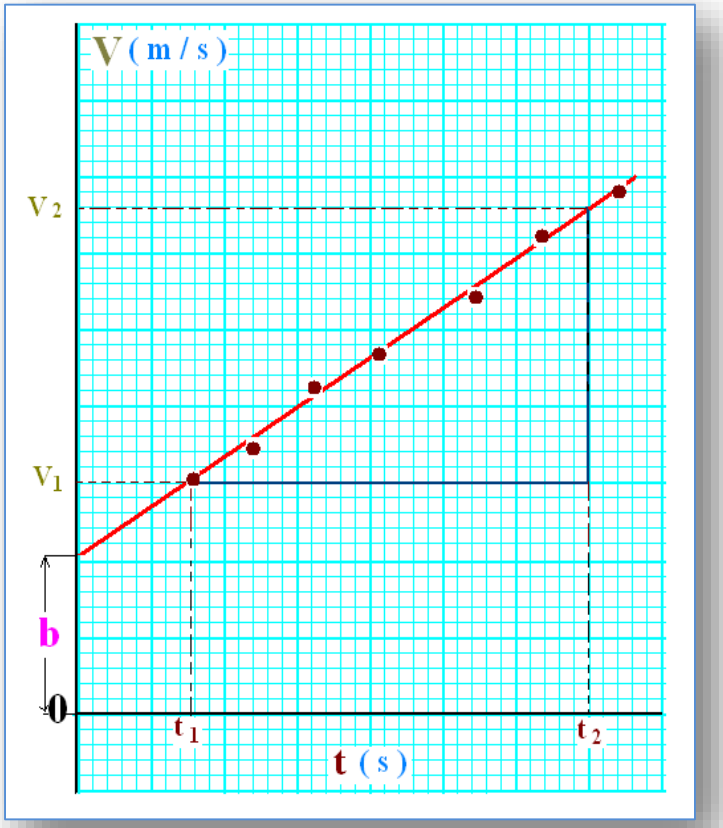
Case 2 : The form of relation is V = b + a t

In this relation, V and t are two experimental quantities, a and b are unknown constant that will be determined from the graph between V and t.

The above relation, when plotted give us the graph shown in the figure .

From the graph, the constant a is determined by $\alpha = \frac{V_2 - V_1}{t_2 - t_1} = slope$

and $b = Positive\ y - intercept$



Case 3 : The form of relation is F = m a - d

In this relation, F and a are two experimental quantities, m and d are unknown constant that will be determined from the graph between F and a.

The above relation, when plotted give us the graph shown in the figure .

From the graph, the constant m is determined by $m = \text{Slope of the graph}$

and $d = \text{negative } y - \text{intercept}$