

A-2 MEASUREMENT AND UNCERTAINTY ANALYSIS (Manual)

OBJECTIVES:

- 1) To understand standard error determination
- 2) To understand standard error propagation
- 3) To understand determination of standard deviation/standard error
- 4) To understand standard uncertainty and its propagation
- 5) To understand significant figures and its correct use.
- 6) To know what is standard form

INTRODUCTION:

In your laboratory work in this physics course you will observe that when you make repeated measurements of a physical quantity the measurements do not exactly agree. These slight physical variations are made insignificant in the following systematic manner: the measured value (or measurements) are given uncertainty and shown to be by using error bar representation (error bar method) or the number of the figures shown about the value in the experiment (the uncertainty).

Consequently, we will study and use the uncertainty in the following steps:

Reasons of errors and uncertainties:

There are two general categories of errors: random and systematic.

Random errors are the unpredictable errors caused by the changing physical laws for observation. Example is a meter that is not calibrated properly, which has a systematic error because of faulty calibration or change in the reading of a meter as an angle. Although random errors cannot be eliminated, the use of statistical techniques can reduce the effect of random errors on the observation or through the use of statistical testing methods.

Systematic errors are errors that affect the accuracy of the measurements. These errors are caused by the operation, the used value and physical quantities being measured. Consequently, repeated measurements of a physical quantity will not produce accurate data.

In our study of the physics course we will understand all of random errors and their best minimization (minimizing) and systematic errors and their best minimization (minimizing) steps.

Accuracy versus Precision

The precision measures the closeness of the results to the exact value.

Accuracy refers to the closeness of results that is compared with the true value. Consequently, precision and accuracy are not the same.

$$\text{Accuracy} = \text{measured value} - \text{true value}$$
$$\text{Precision} = \frac{\text{measured value}}{\text{true value}}$$

Precision is measured by how close the measured value is to the true value represented by

Uncertainty Analysis Manual

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Uncertainty Analysis Manual:

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