Pakistan School
Kingdom of Bahrain

Rules of the Class:

- 1) Always be on time. for all your classes
- 2)Always Respect your all Class fellows.
- 3)Do not create any disturbance.
- 4)Raise hand if you have any question or you wish to answer any question.
- 5)Pay attention to your teacher.
- 6)Please, Enter into the class with your actual Name and CPR number.
- 7)Always follow your Time Table.

Engaging Starter

Difference between Actual and Measured value.

Welcome Back After Eid Vacations

Grade 11th ” Physics ”

Unit: 1

“Measurements”

Topic:1.? “Significant Figures, Precision and Accuracy”

Learning Objectives: By the end of the session, students will be able to:

1) **Define Significant Figures.**

2) **Differentiate between Precision and Accuracy**

Significant figures

In any measurement, the number of accurately known digits and the first doubtful digit are called significant figures.

Importance

The concept of significant figures is very important and useful. It shows the extent or limit to which readings are reliable.

Rules for finding significant figures

1. All non-zero digits from 1 to 9 are significant e.g, in 25.385m all the five digits are significant.
2. Zeros between two non-zero digits are significant e.g, in $x = 3.0056$cm the number of significant figures are five.
3. Zeros to the right of decimal symbol and to the left of non-zero digits are not significant e.g, in $y = 0.000063$ the number of significant figure are two i.e. 6 and 3 only.
4. All zeros to the right of decimal that appears after non-zero digit are significant. For example in a measurement $y = 3.0000$ the number of significant figures are five.

5. In an integer number like 8000 kg, the zeros may or may not be significant. Here the significance of these zeros depends upon the least count of the measuring instrument. If the least count is 1 kg then there are four significant figures and the measured value will be expressed as 8.000×10^3 kg. Similarly if the least count is 10 kg and the correct measurement in appropriate significant figures is 8.00×10^3 kg. Then there are three significant figures.

6. When measurement is recorded in scientific notation or standard form, the figures other than the power of ten are significant figures. For example the mass of an object measured with balance is $m = 2.80 \times 10^8$ kg.

The number of significant figures are three i.e. 2, 8, 0.

7. The precise measurement is the one which has smallest least count. The result obtained from addition or subtraction of measurement is retained to the measurement which is least precise in the data e.g. The lengths of three different pieces of string measured with different measuring instruments respectively are:

$x_1 = 3.5\text{cm}$ $\quad x_2 = 8.735\text{cm}$ $\quad x_3 = 9.73\text{cm}$

When we add them together, the result is

$x = x_1 + x_2 + x_3 = 3.5\text{cm} + 8.735\text{cm} + 9.73\text{cm} = 21.965\text{cm}.$

As the reading 3.5cm is least precise thus we round off the final result to a single digit after decimal point as:

$x = 21.965\text{cm} = 21.96\text{cm} = 22.0\text{cm}$

8. In multiplication and division, the final result is limited to the number containing the least number of significant figures.

Example Suppose $x_1 = 3.6\text{cm}$ and $x_2 = 3.856\text{cm}$, then their product is $x = x_1 \times x_2 = (3.6 \times 3.856)\ \text{cm}^2 \Rightarrow x = 13.8816\text{cm}^2$

The number that contains the least number of significant figures is $x_1 = 3.6\text{cm}$, thus the result x is also to be rounded off to two significant figures i.e

$x = 13.8816\text{cm}^2 = 13.882\text{cm}^2 = 13.88\text{cm}^2 = 13.9\text{cm}^2 = 14\text{cm}^2$

Similarly when $m_1 = 3.2\text{kg}$ is divided by 5.42

Then the resultant mass m is

$$m = \frac{m_1}{n} = \frac{3.2\text{kg}}{5.42} = 0.60544280\,\text{kg} = 0.61\text{kg}$$

... of significant figures is 3.2k

Practice: Count the number of sig figs in the following:

23.50	4 sig figs
402	3 sig figs
5,280	3 sig figs
0.080	2 sig figs

Examples

- 32445 = 5 sig figs
- 0.23435 = 5 sig figs
- 2348.23 = 6 sig figs
- 0.0023 = 2 sig figgs
- 0.02300 = 4 sig figs
- 1.009 = 4 sig figs
- 230,004 = 6 sig figs
- 100 = 1 sig fig
- 1.00×10^2 = 3 sig figs
- 100. = 3 sig figs

More Sig-Fig Examples

How many sig figs below?

- Zeros between
  - 60.8 has __ significant figures
  - 39008 has __ sig-figs
- Zeros in front
  - 0.093827 has __ sig-figs
  - 0.0008 has __ sig-fig
  - 0.012 has __ sig-figs
- Zeros at end
  - 35.00 has __ sig-figs
  - 8,000.000 has __ sig-figs
  - 1,000 has ___ sig figs

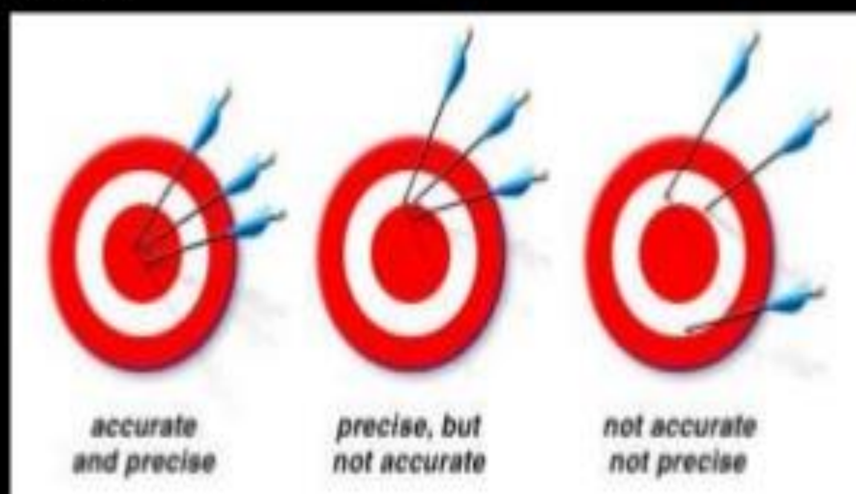
More Sig-Fig Examples

- Zeros between
  - 60.8 has 3 significant figures
  - 39008 has 5 sig-figs
- Zeros in front
  - 0.093827 has 5 sig-figs
  - 0.0008 has 1 sig-fig
  - 0.012 has 2 sig-figs
- Zeros at end
  - 35.00 has 4 sig-figs
  - 8,000.000 has 7 sig-figs
  - 1,000 could be 1 or 4 … if 4 intended, best to write 1.000E4

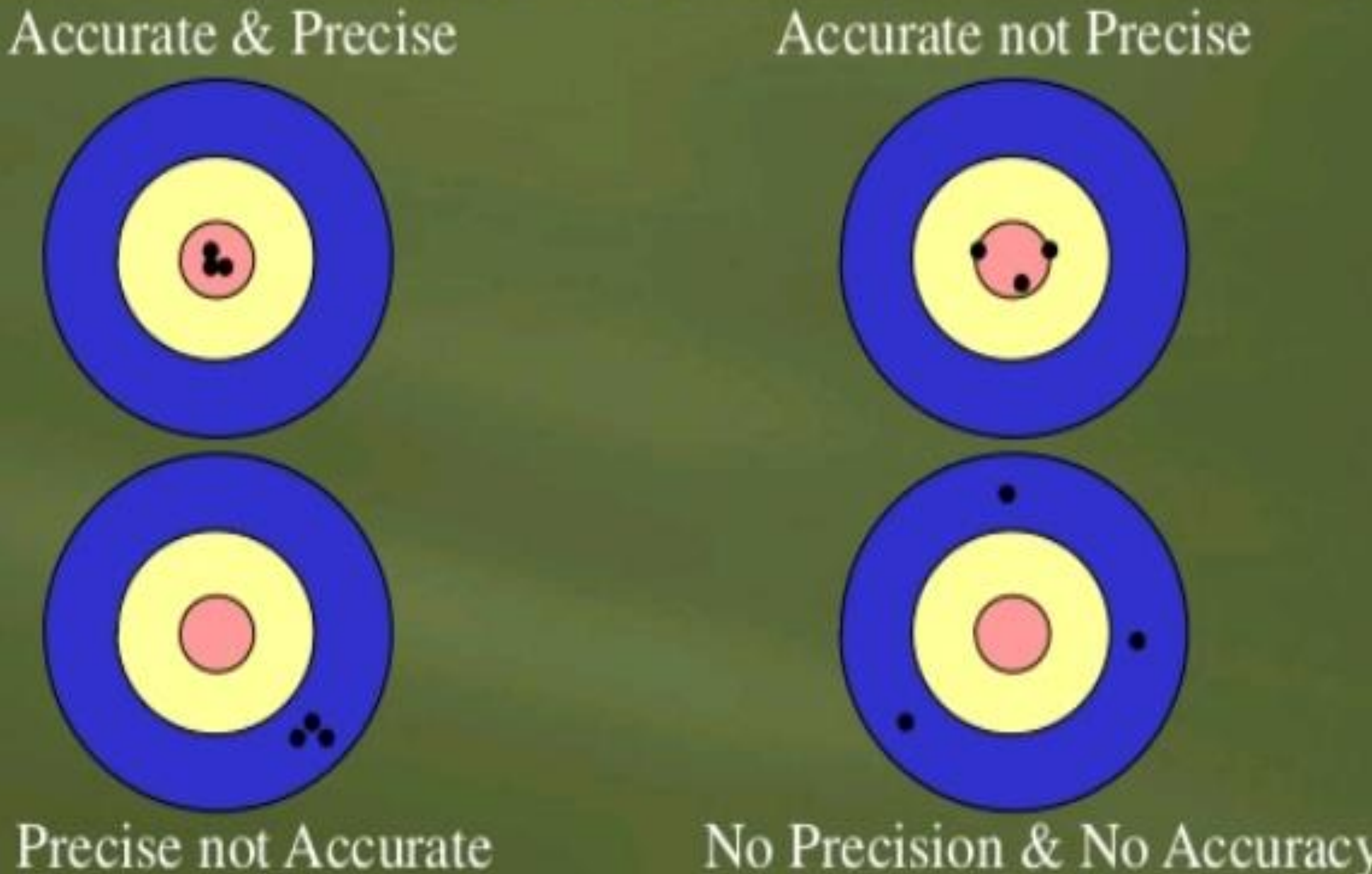
Scientific Measurements

Precise values – experimental values that are close to each other

Accurate values – experimental values that are close to the true value



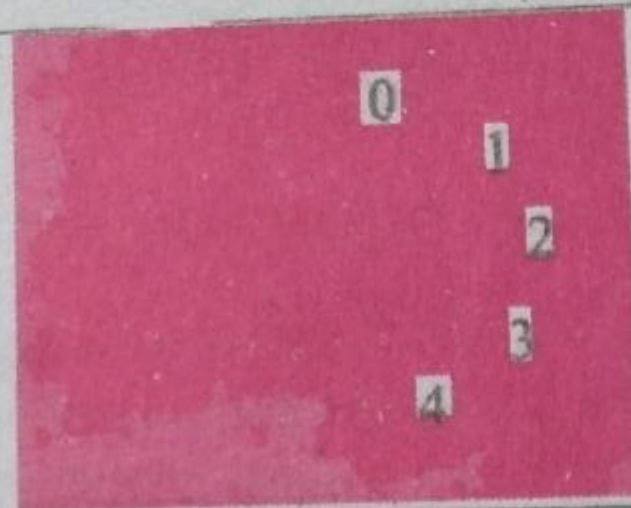
Accuracy and Precision



1.6. Precision and Accuracy

The terms precision and accuracy are frequently used in measurement made in physics. It is very much important that they must be distinguished clearly. The precision of a measurement is associated with the least count of the measuring instrument where as accuracy is associated with the magnitude of fractional error or relative error in that measurement. Precision does not mean accuracy but both are highly demanded while making measurements in physics.

Point to Ponder



How would looking at the pointer from position A and B affect the accuracy of the measurement?

Precision and accuracy can be readily understood as, smaller the least count of measuring instrument better will be its precision. Similarly, smaller the magnitude of fractional or relative error better will be its accuracy. Precision is also indicated by the magnitude of uncertainty in a measurement. To understand the concept of precision and accuracy more clearly first we need to understand how to indicate uncertainty in a measurement.

Definition: Precision and Accuracy

Precision

- The magnitude of the error in any measurement is called precision
- The maximum possible error in any measuring instrument is half of the least count of that apparatus.
- The precision in the meter rod reading when doubled is then called absolute uncertainty which is the least count.
- Smaller the least count greater will be the precision.
- Example: The meter graduated in mm and cm has a least count equal to 1mm then the magnitude of error i.e Precision on the meter rod is 0.5mm=0.05cm

Accuracy

- Accuracy can be measured in terms of magnitude of the relative error in any measurement ..
- The relative error is the ratio of the magnitude of error to the quantity measured i.e
- Accuracy(Relative error) = $\frac{Magnitude\ of\ error}{Quantity\ Measured}$
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- and is also called fractional error. If we multiply it by 100 we get %age uncertainty
- Example: if the length of pencil is 13.4cm & if measured with meter rod with L.C 1mm then

=> Relative error=0.05cm/13.4cm=0.0037 or its percentage will be 0.37% or 0.4%

Closure

a) Define Significant Figures .

b) Define Precision.

c) Define Accuracy.

d) Differentiate between Precision and Accuracy.

Example 1.1 The reading taken with different time devices are

$t_1 = 2.5$ s $\quad$ $t_2 = 32.54$ s $\quad$ $t_3 = 10.52$ s

Find the total time up to correct precision.

Solution:

The total time T is

$$T = t_1 + t_2 + t_3 = (2.5 + 32.54 + 10.52)\ \text{s}$$

$$T = 45.56\ \text{s}$$

According to the rules discussed above the least precise number is $t_1 = 2.5$s. Thus we round off their sum to one digit after decimal point i.e.

$$T = 45.6\ \text{s}$$

Home Work

Assignment is given in uploaded notes.

Thank you.....