Class XI: Physics

Chapter 1: Unit of Measurement

Chapter Notes

Key Learnings:

1. In India National Physical Laboratory maintains the standards of measurements.

2. The system of units used around the world is International System of SI.

3. The units for the base quantities are called fundamental or base units. The units of all other physical quantities can be expressed as a combination of base units. Such units obtained are called derived units.

4.

Base quantity	Name	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K
Amount of substance	mole	Mol
Luminous intensity	candela	cd

5. Other physical quantities, derived from the base quantities, can be expressed as a combination of the base units and are called derived units. A complete set of units, bother fundamental and derived, is called a system of units.

6. In computing any physical quantity, the units fro derived quantities involved in the relationship(s) are treated as though they were algebraic quantities till the desired units are obtained.

7. The apparent shift in the position of the object against the reference point in the background is called parallax.

8. Parallax is caused whenever there is change in the point of observation. The distance between the two points of observation is called the basis. Let the basis be b and angle subtended by this at some point is θ then and distance of the point D= $\frac{b}{\theta}$.

9. The size of the molecules of solution = volume of film / area of film

10. The unit used to measure the size of the nucleus of an atom is Fermi which is 10^{-15} m.

11. The unit used to measure the distance between the earth and the sun is the astronomical unit.

12. The smallest value measured by an instrument is called its least count. The least count of vernier calipers is 0.01 cm and that of screw gauge is 0.001 cm.

13. Different types of errors: absolute error, relative error and percentage error

14. True value is the mean of all the observed readings.

15. Absolute error is the magnitude of the difference between the individual measured value and the true value.

Absolute error: Measured value - True value.

16. The fractional error is the ratio of mean absolute error to the true value. It is also known as relative error.

$$\text{Relative error} = \frac{\text{Mean absolute error}}{\text{True value}}$$

17. Direct and indirect methods can be used for the measurement of physical quantities. In measured quantities, while expressing the result, the accuracy and precision of measuring instruments along with errors in measurements should be taken into account.

18. Significant Figures in a measured or observed value, is the number of reliable digits plus the first uncertain digit.

19. Rules to identify the significant figures

i. All non zero digits are significant. Powers of ten are not counted in significant figures. For example 1.7×10^5 has 2 significant figures.

ii. In a number with a decimal, Zeroes appearing to the left of a digit are not counted in significant figures. For example 0.002 has only one significant figure in it.

iii. In a number with a decimal, the number of zeroes at the end is counted in significant figures. For example 1.700 has 4 significant figures.

iv. Shifting the position of the decimal does not change the number of significant figures. For example 2.340 and 234.0 have 4 significant figures.

v. All the zeros between two non-zero digits are significant, no matter where the decimal place is, if at all. For example, 203.4 cm has 4 significant digits, 2.05 has 3 significant digits

vi. The terminal or trailing zeros in a number without a decimal point are not significant. Thus 125 m=12500cm=125000 mm has three significant figures.

20. Changing the units do not change the number of significant figures

21. Dimensions of a physical quantity are the powers (or exponents) to which the base quantities are raised to represent that quantity.

22. Dimensional formula: The expression which shows how and which of the base quantities represent the dimensions of a physical quantity.

23. Applications of dimensional analysis

i. Dimensional analysis can be used to derive a physical equation

ii. Dimensional analysis can be used to verify if the given equation is dimensionally correct.

iii. Dimensional analysis can be used to find the dimensions of unknown parameter in the equation.

Top Formulae

1. Mean value: $a_{mean} = (a_1 + a_2 + a_3 + \ldots + a_n) / n$

or,

$$a_{mean} = \sum_{i=1}^{n} a_i / n$$

2. The errors in the individual measurement values from the true value (Absolute Error):

$\Delta a_1 = a_1 - a_{mean}$

$\Delta a_2 = a_2 - a_{mean}$

…. = …. …..

…. = …. …..

$\Delta a_n = a_n - a_{mean}$

3. Mean absolute errors:

$\Delta a_{mean} = (|\Delta a_1| + |\Delta a_2| + |\Delta a_3| + \ldots + |\Delta a_n|/n$

$$= \sum_{i=1}^{n} |a_i|/n$$

4. Relative error = $\Delta a_{mean} / a_{mean}$

5. Percentage error:

$\delta a = (\Delta a_{mean} / a_{mean}) \times 100\%$

6. Error of a sum or a difference:

$$\pm \Delta Z = \pm \Delta A \pm \Delta B$$

or,

The maximum value of the error ΔZ is $\Delta A + \Delta B$.

7. Error of a product or a quotient:

$\Delta Z / Z = (\Delta A / A) + (\Delta B / B)$

8. Error in case of a measured quantity raised to a power

If $Z = A^p B^q / C^r$

$\Delta Z / Z = p (\Delta A / A) + q (\Delta B / B) + r (\Delta C / C)$