Units And Measurements

- The ancient people use hand-span, foot-span, finger width, palm length, the distance of a step, etc. as units of measurements. These are known as non-standard methods of measurement.

  Bigger Units:

- For length, the bigger units use are:

  (i) Astronomical unit (A.U.): It is the mean distance between Earth and Sun. 1 A.U. = 1.496 ×× 10^{11} m
  (ii) Light year (ly): It is the distance travelled by light in vacuum, in one year. 1 ly =9.46 ×× 10^{12} km
  (iii)Parsec: 1 Parsec = 3.26 ly

- For mass, the bigger units use are:

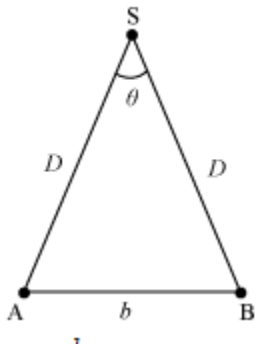
  (i) quintal: 1 quintal = 100 kg
  (ii) metric tonne: 1 metric tonne = 1000 kg = 10 quintal

- For time:

  (i) lunar month: 1 lunar month =29.5 days
  (ii) Leap year
  (iii) Decade
  (iv) Century
  (v) Millennium

- **Measurement of length**

  - SI unit is metre (m).
  - For measurement of large distances, parallax method is used.



$$D = \frac{b}{\theta}$$

- Units for expressing large distances are light year, Astronomical unit (AU), and parsec.
  - 1 light year = 9.46×10^{15} m
  - 1 AU = 1.5×10^{11} m
  - 1 Parsec = 3.26 light years = 3.08×10^{16} m

- Units used to express small distances:
  - 1 micron (1 mm) = 10^{-6} m
  - 1 nanometre (1 nm) = 10^{-9} m
  - 1 angstrom ($1A^0$) = 10^{-10} m
  - 1 fermi (1 fm) = 10^{-15} m

Measurement of mass

- SI unit of mass – Kilogram
- While dealing with atoms and molecules, we use unified atomic mass unit (u or amu) as standard unit.

1 u = $(1/12)^{th}$ of the mass of C^{12} atom
or, 1 u = 1.66×10^{-27} kg

- Masses of common objects can be measured by balance.
- Large masses can be measured by using gravitational method.
- Masses of sub-atomic particles can be measured by using mass spectrograph.
- Range of variation of mass – from 10^{-30} kg to 10^{55} kg

Time measurement

1. Time-measuring device – watch or clock
2. Motion of hands of clock is periodic.
3. Motion of pendulum is periodic and oscillatory (to-and-fro).
4. Techniques - Electrical oscillators, electronic oscillators, quartz crystal clocks, atomic clocks.

Time period

Basic unit It is the time taken by a pendulum to complete one oscillation. It is given as .

of time is second (s).

Types of Error

- Systematic errors

  - Arise due to faulty instruments
  - Arise due to imperfect experimental procedure
  - Arise due to individual carelessness

- Random errors

  - Arise due to random and unpredictable fluctuations in experimental conditions

- Least-count errors

  - Associated with the resolution of the instrument

- Personal errors

  - Arise due to fault of an observer in taking reading, lack of proper setting of the apparatus etc.

Ways of Expressing an Error

- Absolute error: Magnitude of the difference between the actual value of the quantity and the individual measured value

- Relative error: Ratio of the mean absolute error to the value of the quantity being measured

  Relative error = ΔXXmeanΔXXmean

- Percentage error:

  Percentage error = ΔXXmean×100ΔXXmean×100

Rules for determining the number of significant figures:

- All non-zero digits are significant.

- All zeroes between two non-zero digits are significant.

- Zeroes preceding the first non-zero digits are not significant.

- Zeroes at the end or right of a number are significant, provided they are on the right side of the decimal point.
- If the number is less than 1, then the zero(s) on the right of the decimal point and left of the first non-zero digit are not significant. (For example: In 0.0013, the underlined zeroes are not significant)

Rules for arithmetic operations with significant figures

- For addition and subtraction, the result cannot have more digits to the right of the decimal point than either of the original numbers.
- In multiplication or division, the final result should retain as many significant figures as there are in the measurement with the least significant figures.

Rules for rounding off the uncertain digits

- If the rightmost digit to be removed is more than 5, then the preceding number is increased by 1.
- If the rightmost digit to be removed is less than 5, then the preceding number is not changed.
- If the rightmost digit to be removed is 5, then the preceding number is not changed if it is an even number, but it is increased by one if it is an odd number.

Units

- A unit is the chosen standard of measurement of quantity, which has the same nature as the quantity.

Systems of Units

- CGS System: Base units for length, mass and time in this system are centimeter, gram and second respectively.
- FPS System: Base units for length, mass and time in this system are foot, pound and second respectively.
- MKS System: Base units in this system are metre, kilogram and second.
- International System (SI) of Units: Based on seven base units; at present the internationally accepted system.

SI Base Quantities and Units

- Length – metre (m)
- Mass – kilogram (kg)
- Time – second (s)
- Electric current – ampere (A)
- Thermodynamic temperature – kelvin (K)
- Amount of substance – mole (mol)

- Luminous intensity – candela (cd)

Derived units

- These are units of the physical quantities which are derived from the seven basic fundamental units.