

Units of Measurement

SI Units

Seven Base
SI units

Derived units

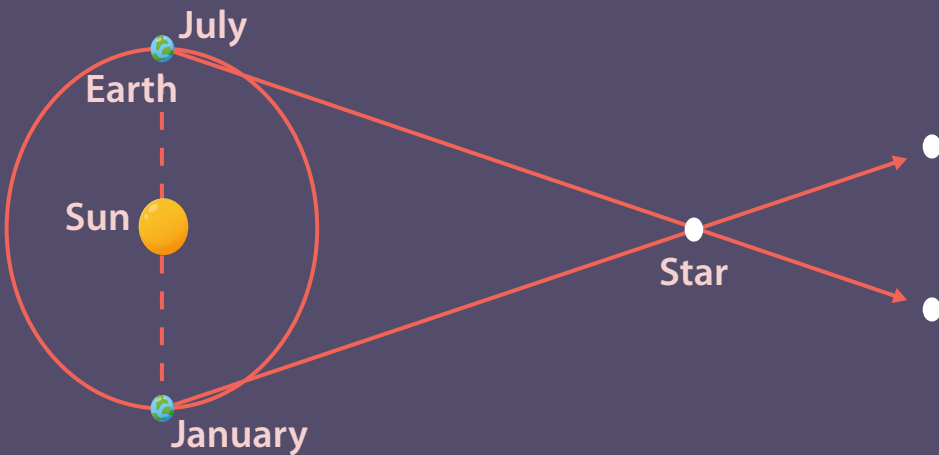
Supplimentary
units

Interstellar Distance



Parallax method

Method to measure such interstellar distances from earth



Units of Length

1 A° (angstrom) = 10^{-10} m
1 fermi = 10^{-15} m
1 AU = 1.49×10^{-11} m
1 ly = 9.46×10^{-15} m
1 parsec = 3.08×10^{-16} m

Units of Mass

Mass of atoms in a.m.u.
1 metric ton = 10^3 kg
1 solar mass $\approx 10^{30}$ kg

Dimension

A “Dimension” can be measured or derived.

The “Fundamental dimensions” (length, time, mass, temperature, amount) are distinct and are sufficient to define all the others.

Five Base Quantities

Mass M

Length L

Time T

Electric Current A

Temperature K

Dimensional Analysis

- Show the relationship between different system of units
- Implicitly tell how to derive a relation
- Provide a check on relation between quantities

Significant Figures

Accurately known digits plus first uncertain digit in a measurement

- Rule 1:** All non-zero digits are always significant
- Rule 2:** Zeros in between significant figures are always significant
- Rule 3:** Space holder zeros in numbers < 1 are never significant
- Rule 4:** Zeros at the end of a number are only significant when a decimal is in the number

Errors in Measurement

Uncertainty in the measured values

Systematic Errors

Range of observed values

Precision of measurement

Causes

Zero Error

The error cause by zero error is reduced by subtracting the obtained reading fom the zero error

Incorrect calibration

Minimizing Method

By improving the structures of apparatus

Random Errors

Absolute error

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

Relative error

$$\text{Rel } \Delta a = \frac{\Delta a_m}{a_m}$$

Percentage error

$$\delta_a = \frac{\Delta a_m}{a_m} \times 100 \%$$

Combination of Errors

$$Z = A \pm B$$

$$\Delta Z = \Delta A + \Delta B$$

$$Z = A^2$$

$$\frac{\Delta Z}{Z} = 2 \frac{\Delta A}{A}$$

$$Z = A . B \text{ or } A / B$$

$$\frac{\Delta Z}{Z} = \frac{\Delta A}{A} + \frac{\Delta B}{B}$$

Systematic Errors Vs Random Errors

Systematic Errors

Systematic error is the one that deviates from the true value of measurement by a fixed amount.

It remains constant or changes in a regular fashion in repeated measurements of the same quantity.

Caused by some flaw in the experimental apparatus or a flawed experimental design.

It can be eliminated using proper technique, calibrating equipment and employing standards.

Random Errors

Random error is the one that varies and which is likely to be positive or negative.

It is inconsistent and does not repeat in the same magnitude or direction except by chance.

Caused by unpredictable variations in the readings of a measurement device.

It can be reduced by taking average of a large number of observations.