Useful information

Powers of 10

10^{-1}	deci (d)	10^{1}	deca (da)
10^{-2}	centi (c)	10^{2}	hecto (h)
10^{-3}	milli (m)	10^{3}	kilo (k)
10^{-6}	micro (μ)	10^{6}	Mega (M)
10^{-9}	nano (n)	10^{9}	Giga (G)
10^{-12}	pico (p)	10^{12}	Tera (T)
10^{-15}	femto (f)	10^{15}	Peta (P)
10^{-18}	atto (a)	10^{18}	Exa (E)

Scientific Notation

The value of a quantity X in scientific notation is written as $X = A \times 10^n$.
Examples:

- f=5789 Hz.
  In scientific notation, f =5.789 $\times 10^3$ Hz.
- I=0.003 98 A.
  In scientific notation, I =3.98 $\times 10^{-3}$ A.

Mean or average

Suppose a quantity X is measured n times and we get the following values:

Trial no.	X
1	x_1
2	x_2
3	x_3
$\vdots$	$\vdots$
n	x_n.

The mean of the quantity X is denoted as $\langle X\rangle$ or $\bar{X}$ and is calculated as

$$\langle X\rangle = \frac{x_1 + x_2 + x_3 + \cdots + x_n}{n}.$$

Logarithms

Logarithms are very useful functions when dealing with powers of numbers.
If $a^x = y$ then we define

$$\log_a(y) = x.$$

Examples:

$$\begin{aligned} 2^3 &= 8 \\ \implies \log_2 8 &= 3. \\ 3^2 &= 9 \\ \implies \log_3 9 &= 2. \end{aligned}$$

- Frequently we use only $\log_{10}(y)$ and $\log_e(y)$.
- The symbol ln is used for writing $\log_e$.
- Here $e = 2.71828$, Euler's number.
- $\log_a(1) = 0$.
- $\log_a(0)$ is undefined.

Antilogarithm is the inverse function for a logarithm function.

$$\log_a(y) = x \implies \text{antilog}_a(x) = y.$$

- Antilog of a number with respect to a base is just power of the number with base.
- Antilog of 3 with base 2 is 8, i.e., $2^3 = 8$. or $\text{antilog}_2(3) = 8$.
- Antilog of 2 with base 3 is 9, i.e., $3^2 = 9$. or $\text{antilog}_3(2) = 9$.
- Frequently used antilogs are $\text{antilog}_{10}(x) = 10^x$ and $\text{antilog}_e(x) = e^x$.

Some properties of logarithm function

$$\begin{aligned}
\log_a(y^b) &= b\log_a(y) \\
\log_a(xy) &= \log_a(x) + \log_a(y) \\
\log_a\left(\frac{x}{y}\right) &= \log_a(x) - \log_a(y) \\
\log_a(b) &= \frac{\log_c(b)}{\log_c(a)} \\
\ln(y) &= \frac{\log_{10}(y)}{\log_{10}(e)}
\end{aligned}$$

Some properties of indices

$$\begin{aligned}
\frac{1}{a^x} &= a^{-x} \\
(a^x)^y &= a^{xy} \\
a^x a^y &= a^{x+y} \\
\frac{a^x}{a^y} &= a^{x-y}
\end{aligned}$$

Accuracy and Precision

- The **accuracy** of a measurement tells how close the measured value is to the true value of the quantity.
- The **precision** tells us to what resolution the quantity is measured. A data set is said to be precise if there are more values repeated.

Correct value of $g = 9.80\,\text{ms}^{-2}$
Measured value of g (ms^{-2})
9.81
9.80
9.82
9.80
9.81

Table 1: Data accurate but not precise.

Correct value of $g = 9.80\,\mathrm{ms}^{-2}$
Measured value of g (ms^{-2})
9.83
9.84
9.84
9.84
9.84

Table 2: Data precise but not accurate.

Correct value of $g = 9.80\,\mathrm{ms}^{-2}$
Measured value of g (ms^{-2})
9.80
9.81
9.80
9.80
9.80

Table 3: Data accurate and precise.

Errors

Error: It is the difference between the measured value and the true value of a physical quantity. The errors in measurement can be classified as

- Systematic errors.
- Random errors.

Systematic Errors
Systematic errors are those errors that tend to be in one direction, either positive or negative. This type of error are due known errors. Systematic errors can be of three types:

- Instrumental error.
- Personal error.
- Imperfection in experimental technique.

Random Errors

- These errors occur irregularly and are random with respect to size and sign.
  e.g. Fluctuating current in ammeter.
- To minimize random errors we take many measurements and then the average of these measurements will be taken as true value.

Calculator tips and common mistakes

- $\dfrac{35+50}{2}$ should be evaluated as $(35+50) \div 2$.
- $\dfrac{1}{2\pi\sqrt{0.368 \times 10^{-6} \times 10 \times 10^{-3}}}$ can be evaluated in a single step in scientific calculator as
  $1 \div (2\pi\sqrt{}(0.368 \times 10\hat{} - 6 \times 10 \times 10\hat{} - 3))$.

- Avoid step by step simplification to avoid mistakes.
- While substituting values into formula, convert all of them into SI units and then substitute.
- While calculating $\log_{10}$ use **log** button. While calculating $\log_e$ use **ln** button.
- For trigonometric functions, make sure the mode is set to degrees (D) while using angles in degrees, and set to radians (R) while using angles in radians.
- Make sure your calculator is set in the correct mode. Sometimes, calculators round-off small quantities like 10^{-8} to zero, thereby showing syntax error or math error.

Graph plotting

- Label the axes with name, symbols and write units within brackets.
  e.g.
  - Current, I_0(mA).
  - Frequency, f(kHz).
- Write scale at top right corner.
  X-axis - 1 cm = x units.
  Y-axis - 1 cm = y units.
- Write title of the graph at the top center.
- Mark all the data points and encircle them.
- After marking all the data points, draw a smooth curve. The curve need not pass through all the data points.
- When taking slope of a straight line, the slope can be calculated anywhere as the slope of a straight line is constant everywhere.
- Show all the data points on the graph whether they fit the curve or not.
- Hiding data points is considered dishonest.
- Do not fabricate the data so as to fit the curve.