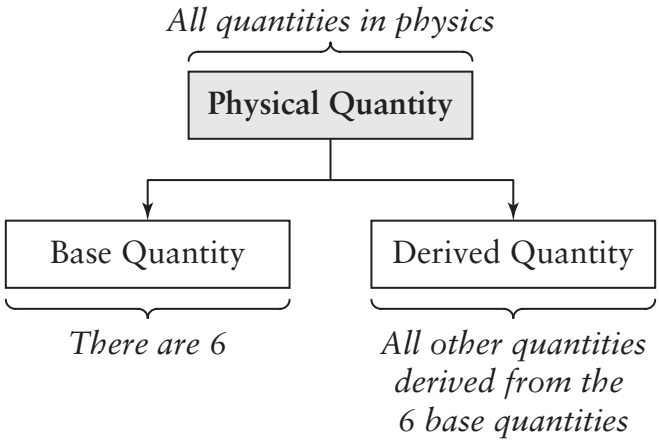
Contents

Introductory Physics - Physical Units

Physical Quantity



- Each physical quantity contains information on its numerical magnitude and unit of measurement.
- In 1954, an international system was derived from six **base units** and **standard quantities.**
- The standard system of measure adopted in physics is called **International System of Units** or **Systeme Internationale.** (SI)
- A **base quantity** contains a **base unit.**
- The following shows the 6 base quantities and the base units.

Base Quantity	Base Unit (symbol)	Base Unit (name)
Length	m	Metre
Mass	kg	Kilogram
Time	s	Second
Electric Current	A	Ampere
Temperature	K	Kelvin
Amount of Substance	mol	Mole

- A **derived quantity** results from the combination of the **base quantities.**
- Its derived unit is the product and/or quotient of the **base units.**

Conversion Between Units

- The conversion of units should be done systematically.
- If a sound echo took 10 ms to take across a room and back again, instead of interpreting "10 ms" as 10 metre second, which doesn't make sense, we must recognize that its actually 10 milliseconds.
- Next the conversion of units should be done systematically.
- For example, to convert 10 μg into its standard form, in terms of kilograms, it must be recognized that 10 μg $=10 \times 10^{-6}$ g $= 1.0 \times 10^{-5}$ g.
- Then, follow the fact that 1 g $= 1.0 \times 10^{-3}$ kg. Hence, 1.0×10^{-5} g $= 1.0 \times 10^{-8}$ kg.
- Furthermore, for units that have powers, extra care must be provided.
- For example, to convert 10 km^3 into its standard form, we must recognize that 10 km $= 1.0 \times 10^4$ m.
- Hence, 10 $km^3 = 10(10^3)^{3\ m3} = 10(10^9)m^3 = 10^{10}\ m^3$.
- In the case of more than two SI units, like 6 g/cm^3, we should know that,

$$\frac{6\ g}{1\ cm^3} = \frac{6 \times 10^{-3}\ kg}{\left(10^{-2}\right)^3\ m^3} = 6 \times 10^3\ kg/m^3$$

- In the above three examples, we can see that paying extra attention to the minor details, is very essential for physics and a systematic approach towards conversion could avoid unnecessary errors and mistakes.

Measurement Techniques

(i) Uncertainties

- All experimental data has to be associated with element of uncertainties.
- All data is derived from the observation or measurement of a value at one point on a measuring scale.
- Generally, a reading can be estimated to 0.5 of the smallest division on a measuring scale.
- For instances, when measuring using a ruler, the smallest determination of uncertainty would be 0.5 mm or 0.05 cm.

CHAPTER

Length and Time

1

Assessment Objectives

- Use and describe the use of rules and measuring cylinders to find a length or a volume
- Use and describe the use of clocks and devices, both analogue and digital, for measuring an interval of time
- Obtain an average value for a small distance and for a short interval of time by measuring multiples (including the period of a pendulum)
- Understand that a micro meter screw gauge is used to measure very small distances

Measuring Length

- There are several instruments used in the measurement of length.
- The more common ones are as follows.

1. Rulers
   - The ruler's smallest unit of measurement is up to 1 mm.
2. Vernier Calipers
   - In the Vernier Calipers, the smallest scale is 0.1 mm.
3. Micrometer Screw Gauge
   - The Micrometer can measure the thickness of tiny objects up to 0.01 mm.

Note

When measuring the diameter of a round object, a vernier caliper is preferred over a ruler.

6. The cm reading is taken at the division that comes just before the 0 mark on the vernier scale, i.e. in image above, it is 4.30 cm.
7. The mm reading is taken at the division on the vernier scale that coincides with the main scale, i.e. in the image above it is 0.5 mm.
8. Add the readings from the main scale and vernier scale to obtain the final reading.
9. 0.5 mm is converted to 0.05 cm. Therefore, 4.30 cm + 0.05 cm = 4.35 cm.
10. You can also convert to mm. Hence, in mm, the reading will be 43.5 mm.

Note

Due to reading scale error, the reading 43.5 mm, can be either 43.45 mm or 43.55 mm, as the reading error is 0.05 mm.

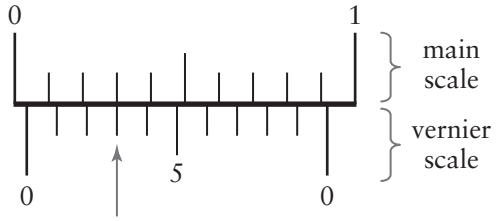
Zero errors on the Vernier Caliper

There can be 2 kinds of zero errors:

1. Positive zero error
2. Negative zero error

Positive zero error

- If the first zero on the Vernier scale is to the right of the zero on the main scale, then the error is said to be positive zero error.
- The zero correction should be reported with a positive sign.



3rd line of the vernier scale
so, zero error = +0.03 cm