Class 9 Physics

Chapter 1 — Physical Quantities and Measurement

Short Answer Questions — Solved

1.1. Can a non-physical quantity be measured? If yes, then how?

Physical quantities are those that can be measured and possess a proper unit, such as length, mass, time and temperature. Non-physical quantities are those that cannot be measured directly and have no standard unit — for example the intensity of love, anger, affection, beauty or taste.

Yes, a non-physical quantity can be measured, but only indirectly — by measuring the physical change or effect it produces. For example, the intensity of a person's anger cannot be measured directly with any instrument, but it can be judged from the increase in that person's heartbeat, blood pressure or body temperature, all of which are physical quantities that can be measured. Thus, a non-physical quantity is estimated indirectly through its measurable physical effects.

1.2. What is measurement? Name its two parts.

Measurement is the process of comparing an unknown physical quantity with a known standard quantity (called a unit) of the same kind, in order to find out how many times the standard quantity is contained in the unknown quantity.

Every measurement consists of two parts: (i) a number (numerical magnitude), which tells how many times the unit is present, and (ii) a unit, which tells the standard in which the quantity is measured. For example, if the length of a table is 5 metres, then "5" is the number and "metre" is the unit. Both parts are essential; a number without a unit (just "5") or a unit alone is meaningless. That is why a measurement without a unit has no meaning.

1.3. Why do we need a standard unit for measurements?

A standard unit is needed so that the measurement of a quantity remains the same everywhere and is understood by everyone in the same way.

In the past, people measured length using body parts such as the hand, foot, arm or step. The size of these parts differs from person to person, so the same object gave different measurements to different people, causing confusion and disputes — especially in trade and in the exchange of scientific information between countries. To remove this confusion, a fixed and unchanging standard is used that is the same for everyone. A good standard unit must be well-defined, constant (it should not change with time, place or conditions), easily reproducible and internationally accepted. Using standard units, scientists and traders all over the world can compare results, share information and do business without confusion.

1.4. Write the name of 3 base quantities and 3 derived quantities.

Base quantities are those that cannot be derived from any other physical quantity; they are independent and form the base of all measurements. Three base quantities: length, mass and time.

Derived quantities are those obtained (derived) from base quantities by multiplying or dividing them. Three derived quantities: area, volume and speed. For example:

Area = length × length

Volume = length × length × length

Speed = distance ÷ time

1.5. Which SI unit will you use to express the height of your desk?

The height of a desk is a kind of length, and the SI base unit of length is the metre (m); therefore, the height of the desk is expressed in metre. Since a desk is usually about 0.75 metre high, its height is often written in a smaller unit, the centimetre (cm), as about 75 cm. However, the centimetre is only a sub-multiple of the metre (1 cm = 10^{-2} m = 0.01 m), so the proper SI unit remains the metre.

1.6. Write the name and symbols of all SI base units.

There are seven SI base units, given below:

Physical quantity	Unit	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Intensity of light	candela	cd
Amount of substance	mole	mol

These seven base units are fixed with reference to international standards and are used all over the world.

1.7. Why is a prefix used? Name three sub-multiple and three multiple prefixes with their symbols.

A prefix is a word or symbol placed before an SI unit to express very large or very small quantities conveniently as powers of ten. Prefixes save us from writing very long numbers with many zeros. For example, 1000 metre is written as 1 kilometre (1 km), and one-thousandth of a metre (1/1000 m) is written as 1 millimetre (1 mm).

Three sub-multiple prefixes (smaller than one unit): milli (m) = 10^{-3}, micro (μ) = 10^{-6}, nano (n) = 10^{-9}.

Three multiple prefixes (greater than one unit): kilo (k) = 10^3, mega (M) = 10^6, giga (G) = 10^9.

1.8. What is meant by: (a) 5 pm (b) 15 ns (c) 6 µm (d) 5 fs

Each of these is a physical quantity written with a prefix attached to an SI unit; the prefix tells the power of ten by which the unit is multiplied.

(a) 5 pm → "p" is pico = 10^{-12} and m is metre, so 5 pm = 5 picometre = 5×10^{-12} m (a very small length).

(b) 15 ns → "n" is nano = 10^{-9} and s is second, so 15 ns = 15 nanosecond = 15×10^{-9} s = 1.5×10^{-8} s (a very small time).

(c) 6 µm → "µ" is micro = 10^{-6} and m is metre, so 6 µm = 6 micrometre = 6×10^{-6} m (a very small length).

(d) 5 fs → "f" is femto = 10^{-15} and s is second, so 5 fs = 5 femtosecond = 5×10^{-15} s (an extremely small time).

1.9. Vernier Callipers

(a) Purpose: A Vernier Callipers is used to measure small lengths accurately, up to 0.1 mm (0.01 cm). It can measure the length, thickness or diameter of a small object, the external and internal diameter of a hollow pipe, and the depth of a small hole or vessel.

(b) Two main parts: (i) the main scale, a fixed steel scale graduated in centimetres and millimetres; and (ii) the Vernier scale, a small scale that slides along the main scale and is usually divided into 10 equal divisions.

(c) Least count: the smallest length that can be measured accurately with the instrument.

Least count = (smallest division of main scale) ÷ (number of divisions on Vernier scale) = 1 mm ÷ 10 = 0.1 mm = 0.01 cm.

(d) Zero error: when the two jaws are closed and the zero of the Vernier scale does not coincide with the zero of the main scale, the instrument has a zero error. If the Vernier zero lies to the right of the main-scale zero the error is positive; if to the left, it is negative. It is removed by subtracting (positive) or adding (negative) the zero error from the observed reading to get the correct reading.

1.10. State the least count and Vernier scale reading shown in the figure (Fig. 1.17), and hence find the length.

Least count = (smallest main-scale division) ÷ (number of Vernier divisions) = 1 mm ÷ 10 = 0.1 mm = 0.01 cm.

From the figure:

Main scale reading (mark just before the Vernier zero), M.S.R. = 2.6 cm

Vernier division coinciding with a main-scale line = 5th division

Vernier scale reading, V.S.R. = coinciding division × least count = $5 \times 0.01 = 0.05$ cm

Total length = M.S.R. + V.S.R. = 2.6 + 0.05 = 2.65 cm.

1.11. Which reading out of A, B and C shows the correct length and why? (Fig. 1.18)

Reading B (6.0 cm) shows the correct length.

This is because at position B the eye is placed vertically above (perpendicular to) the end of the object and the scale mark. When the line of sight is perpendicular to the scale, there is no parallax error, so the reading is correct. Readings A (5.9 cm) and C (6.1 cm) are wrong because the eye is placed at an angle to the scale — A looks from the left and C from the right. Viewing a scale from a slanting position causes a parallax error, giving a reading smaller or larger than the true value. Hence only reading B, taken with the eye directly above the mark, is correct.