Physical Quantities & Measurements

* A quantity that can be measured is known as 'Physical Quantity'.

For example: Length, time, temperature, speed etc.

Physical Quantities



Scalar: A physical quantity that can be completely expressed in terms of magnitude only

example: time, length, speed, distance, energy

Note: The word "magnitude" means numeric value with a proper unit.

Vector: A physical quantity that is to be expressed in terms of magnitude and direction

example: Force, displacement, velocity, acceleration etc

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SI units

A Physical Quantity has to be expressed in terms of a suitable unit. By SI unit, we mean standard unit to represent a physical quantity.

* Table below lists some frequently used Physical Quantities with their standard units (SI units)

Quantity	SI unit	Quantity	SI units
length	meter (m)	density	$Kg\ m^{-3}$
mass	Kilogram (kg)	acceleration	$m\ s^{-2}$
time	Second (S)	work	Joules (J)
temperature	Kelvin (K)	energy	Joules (J)
electric current	ampere (A)	Power	Watt (W)
Speed	meter per second ($m\ s^{-1}$)	Pressure	Pascals (Pa)
Volume	Cubic meter (m^3)	Force	Newton (N)

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Prefixes

SI units are often described in terms of Prefixes, these are multiples of '10' which appear as multiples.

Some of the prefixes are listed below:

Prefix	10^x
nano, n	10^{-9}
micro, μ	10^{-6}
mili, m	10^{-3}
Centi, c	10^{-2}
deci, d	10^{-1}
kilo, k	10^{3}
mega, M	10^{6}
giga, G	10^{9}

Example

one_milimetre $= 10^{-3}$ m

$3\,km = 3 \times 10^{3}$ m

frequency $= 5\,GHz = 5 \times 10^{9}\,Hz$

Significant Figures: It is quite important for you to know how many significant figures, a quantity possesses.

value	no. of S.f.	value	no. of S.f
23	2	0.008	1
20	1	0.80	2
2.0	2	80.0	3

Rules about Significant figures:

- Non-zero digits are always Significant
- Zeroes between two Significant figures are also Significant
- ending zeroes in a hole number are non-Significant
  for example: 20 (1 S.f.), 430 (2 S.f.)
- Zeroes after decimal in digits like 0.003, 0.07 etc are non-Significant
- In decimal Part, ending zeroes are Significant
  for example, 24.0 (3 S.f.), 60.00 (4 S.f.) etc.

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(Measurement)

. Length measuring instruments

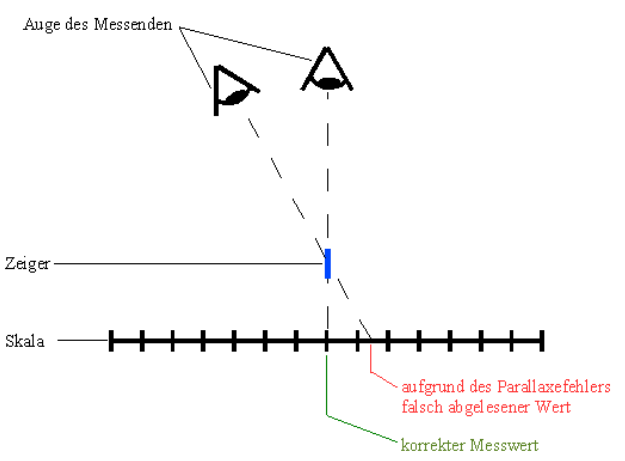
Instrument Name	range of use	least count	examples of usage
Measuring tape	Several meters	0.1 cm or 1 mm	length of a hall, a person's waist
Meter Rule	length upto 1m (more than 15 cm	0.1 cm or 1 mm	• height of chair • length of string
Vernier Callipers	lengths ranging from few cm to 20 cm	0.01 cm or 0.1 mm	• length of metal cylinder, diameter of a ball
Micrometer Screw guage	few mm to 1 or 2 cm	0.001 cm or 0.01 mm	• Thickness of wire • diameter of a small ball

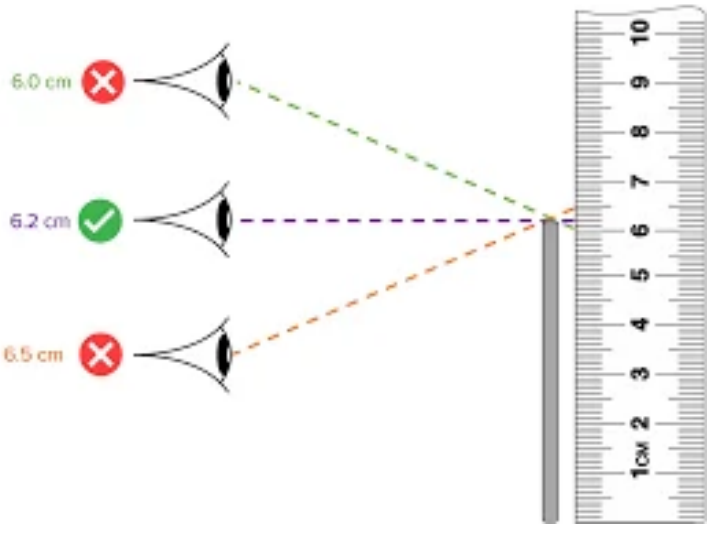
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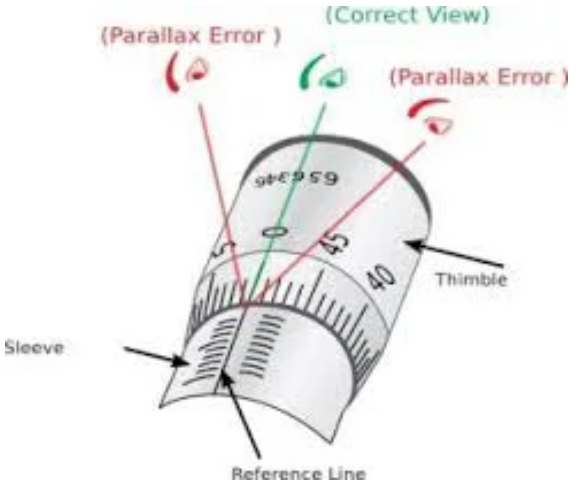
Errors in Measurement

Random Error

- Error not in a fixed pattern
- Can occur due to multiple causes such as lack of experience, human reactim time, incorrect eye (parallex error)
- Random error can be corrected by taking average of multiple readings
- Parallex error can be avoided by keeping eye in front of scale







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Systematic Error

- Error in measuring instrument (zero error)
- It is in a fixed pattern
- It can be corrected by subtracting zero error.

(for example, if a micrometer screw guage gives 0.02 mm more value, then subtract it from final answer)

(Measurement of time)

- Digital Stopwatch : 0.01 sec
- Common clock or digital watch : 1 sec

* Digital stopwatch is normally used in experiments such as measuring time period of a simple pendulum
  * Time period = time of one oscillation
  * Find time of 10 or 20 oscillations and divide by number of oscillations
  * In time related experiments, human reaction time causes random error.

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Example Past paper questions

1 Which instrument is most suitable to determine the volume of a small irregularly shaped stone?

A 30 cm ruler

B digital timer

C measuring cylinder

D tape measure

* We can drop the stone to a measuring cylinder containing water, the change in water level will represent volume of stone.

1 Which single apparatus is used to find the volume of a solid cube and which single apparatus is used to find the volume of a quantity of liquid?

	volume of solid cube	volume of liquid
A	balance	balance
B	balance	measuring cylinder
C	ruler	balance
D	ruler	measuring cylinder

* We can measure the length of edge by using ruler and use formula of volume, and volume of liquid can be found by using measuring cylinder

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