- Part I: Physical Quantities and SI Units

A *physical quantity* is a quantity that can be measured. It consists of a numerical magnitude and a unit.

Base Quantity	SI Unit
Length	metre (m)
Mass	kilogram (kg)
Time	second (s)
Electric current	ampere (A)
Thermodynamic temperature	kelvin (K)
Luminous intensity	candela (cd)
Amount of substance	mole (mol)

A *derived quantity* is derived from the seven base quantities. The following table show a few examples of derived quantities.

Derived Quantity	SI Unit
Area	Metre (m^2)
Volume	Cubic metre (m^3)
Speed	Metre per second ($m\ s^{-1}$)

Scalar quantities have magnitude only. (e.g. distance, speed, temperature, mass, volume, density, pressure, energy, power, time)
Vector quantities have both magnitude and direction. (e.g. displacement, velocity, acceleration, weight, force)

- Part II: Prefixes and Standard Form

Standard form is scientific notation. e.g. $100000 \rightarrow 1.0 \times 10^5$

Factor	Equivalent	Prefix	Symbol
10^9	1000000000	giga-	G
10^6	1000000	mega-	M
10^3	1000	kilo-	k
10^{-1}	0.1	deci-	d
10^{-2}	0.01	centi-	c
10^{-3}	0.001	milli-	m
10^{-6}	0.000001	micro-	μ
10^{-9}	0.000000001	nano-	n

Tip: Remember M for million, which has 6 zeros as well.

Examples

Express 50 metres per second in scientific notation. $50ms^{-1}$

Express 2500 ms^{-1} in km h^{-1}.

$ms^{-1} = \frac{1000m\ (1km)}{3600s\ (1\ hour)} = \frac{5}{18}$

$2500ms^{-1} = 2500 \times \frac{18}{5} = 9000km\ h^{-1}$

Express J in SI base units.

$E_K = \frac{1}{2}mv^2$

$J = kg(ms^{-1})^2$

$J = kgm^2s^{-2}$

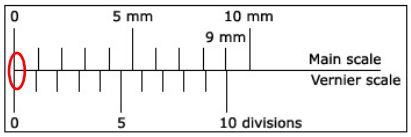
- Part III: Errors
  There are 2 types of errors that can exist in experiments, random error and systematic error.

- Random Errors include parallax errors, unfixed patterns, etc. **Accuracy** can be corrected by **repeating the experiments** a few times.

- Systematic Errors
  Systematic Errors are errors that are usually from measuring instruments such as the zero error in vernier calipers and micrometer screw gauge. This can be easily removed.

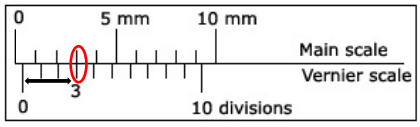
  Vernier caliper (precision 0.01cm) zero error

No error



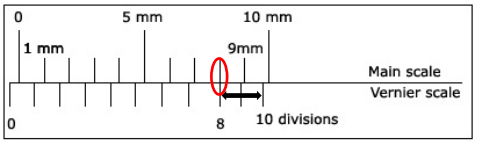
Add to your calculations: 0cm

Positive zero error



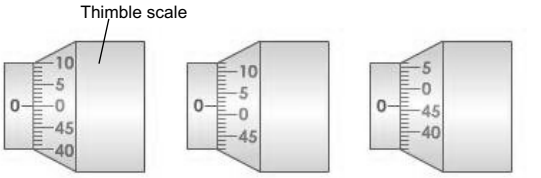
Add to your calculations: -0.03cm

Negative zero error



Add to your calculations: +0.02cm

Micrometer screw (0.01mm) gauge zero error



No zero error
Add to your calculations: 0mm

Positive zero error
Add to your calculations: -0.02mm

Negative zero error
Add to your calculations: +0.04mm

- Part IV: Precision

Precision is half the smallest division	Precision is the smallest division
Measuring Cylinder	Metre Rule
Thermometer	Protractor
Spring Balance	Stopwatch (Electronic → consider HRT[1])
Ammeter	Micrometer screw gauge (0.01mm)
Voltmeter	Vernier Caliper (0.01cm)

When data are **added or subtracted**, the final answer should follow the data with the **smallest** number of **decimal place**. e.g. 5.0 + 2.25 = 7.3 (1d.p.)

When data are **multiplied or divided**, the final answer should follow the data with the **smallest** number of **significant figures**. e.g. 5.0 × 2.25 = 11 (2s.f.)

When finding **average**, the calculated answer should **follow the same precision as the measuring instrument**. The reason for this is that the calculated value should not be more accurate than the least accurate measured data.

If calculation is using a constant with no exact precision, **do not follow** the constant's SF or DP. e.g. Time taken for 20 oscillations is 37.9s.
Time taken for 1 oscillation = $\frac{37.9}{20}$ = 1.89s (Not 1.9s!!)

[1] HRT is Human Reaction Time which the number is rounded to 1 decimal place.

- Part V: Recording Data in a Table
  There should be a consistent number of decimal **places which reflects the precision of the instrument** on the table. There should also be units in the headings in the title of the table. (e.g., t_1 / s) The independent variable should have values of equal increment.

- Part VI: Graph
  Graphs are graded according to the scale, title, axis, points and line.

- **S**cale
  Use scales that are well spread out on the entire graph paper.
- **T**itle
  Graph of (y/unit) against (x /unit).
- **A**xis
  Label axis with symbol and units.
- **P**oints
  Plot the points as accurate as possible, with crosses.
- **L**ine
  Shift the ruler till it passes through the most number of points. If some plots cannot be on the line, ensure that these plots are **equally positioned** on each side of the line. If there are about an equal number of points below and above the line, it is still the best-fit line.
- **E**vidence / Conclusion of Graph
  If it does not pass through the **origin** (0,0) but slopes up from **left to right**, it is linearly related.
  If it does not pass through the **origin** (0,0) but slopes up from **right to left**, it is linearly related with a negative constant.
  If it passes through the **origin** (0,0), the graph is directly proportioned.