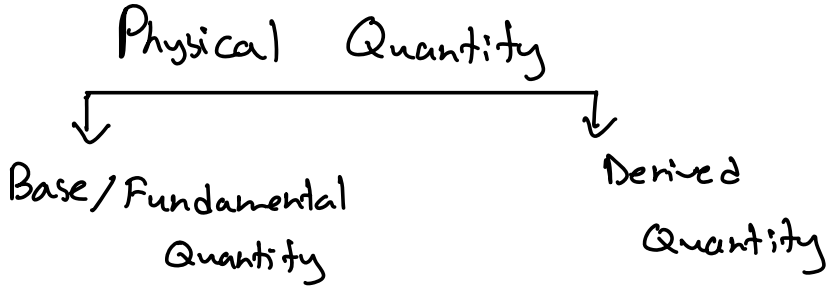


Base Quantity: A base quantity is one that is not dependent on other base quantities.

SI is formed of 7 fundamental or base units.

Base Quantity	Base Unit	Symbol
1) length	meter	m
2) Time	seconds	s
3) Mass	kilogram	kg
4) Electric Current	Ampere	A
5) Temperature	Kelvin	K
6) Amount of Substance	mole	mol
7) luminous intensity	Candela	cd

Derived Quantities

All quantities apart from the base quantities can be measured using derived quantities.

Derived quantities consist of some combination of base units. The base units can be multiplied together or divided but never be added or subtracted.

Derived Quantity	Derived Unit	Base Unit	Solution
① Force	N	$kg\ ms^{-2}$	$F = ma$
② Energy	J	$kg\ m^2\ s^{-2}$	$W = F \times d$ $kg\ m^2 s^{-2}$
③ Power	W	$kg\ m^2\ s^{-3}$	$\frac{kg\ m^2\ s^{-2}}{s}$
④ Pressure	Pa	$kg\ m^{-1}\ s^{-2}$	$\frac{kg\ m\ s^{-2}}{m^2}$
⑤ Voltage	V	$kg\ A^{-1}\ m^2\ s^{-3}$	$\frac{kg\ m^2\ s^{-2}}{A\ s}$

⑥ Resistance	Ω	$kgA^{-2}m^2s^{-3}$	$\frac{kgA^{-1}m^2s^{-3}}{A}$

Prefix	Symbol	Value
Peta	P	10^{15}
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}
Kilo	K	10^{3}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

Homogenity

An equation becomes homogenous when all terms in an ecuation have same unit.

$v = u + at$

$ms^{-1} = ms^{-1} + ms^{-2} \times s$

$ms^{-1} = ms^{-1}$

LHS = RHS

Show that the equations are homogeneous with respect to base units.

1) $s = ut + \frac{1}{2}at^2$

2) $v^2 = u^2 + 2as$

3) $T = 2\pi\sqrt{\frac{l}{g}}$

4) $T = 2\pi\sqrt{\frac{m}{k}}$

s = displacement

l = length

m = mass

k = spring constant

T = time

1)

$ms^{-1} \times s + \frac{1}{2} ms^{-2} \times s^2$

$\Rightarrow m + \frac{1}{2}m$

$m = m + \frac{1}{2}m$

$m = m$

Ans

2) $(ms^{-1})^2 = (ms^{-1})^2 + 2\, ms^{-2}\, m$

$$m^2 s^{-2} = m^2 s^{-2} + 2\, m^2 s^{-2}$$

$$m^2 s^{-2} = m^2 s^{-2}$$

Ans

3) $T = 2\pi \sqrt{\frac{l}{g}}$

$$s = 2\pi \sqrt{\frac{m}{m s^{-2}}}$$

$$s = \sqrt{s^2}$$

$$s = s$$

4) $s = 2\pi \sqrt{\frac{m}{k}}$

$$s = \sqrt{\frac{\cancel{N}}{\cancel{m} s^{-2}} \times \frac{\cancel{m}}{\cancel{N}}}$$

$$s = \sqrt{s^2}$$

$$s = s$$

LHS = RHS

$F = ma$

$m = \frac{F}{a}$

$F = ke$

$k = \frac{F}{e}$

1) Average KE of Athlete in 100m race $= \frac{1}{2} \times 80 \times 10^2 = 4000\,J$

2) Volume of small bean $= 0.5\ cm^3$

3) Diameter of atom $= 3 \times 10^{-10}\ m$ *

4) Diameter of nucleus $= 6 \times 10^{-15}\ m$ *

5) Energy required to boil a kettle of water $= 900\,kJ$

6) Resistance of domestic filament $= 500\,\Omega$

7) wavelength of visible light $=$ (400nm – 700nm violet – red)

8) Room temperature $= 25°C$

9) Power of hair drier $= 500\,W$

10) Power of electric fan $= 800\,W$

11) Power input of heater/AC $= 2kW$

12) Gap between rail lines $= 1\,m$

13) Time period of pendulum $= 2s$

14) Time between heart beat $= 0.85s$

15) Electric current of cooker $= 5A$

16) Force on a tennis ball when served $= 150\,N$

17) Take off speed of jet plane $= 80\,ms^{-1}$

18) Acceleration of jet plane $= 25\,ms^{-2}$

19) Distance between earth and sun $= 1.5 \times 10^8\,m$.

20) seconds in a year $= 3 \times 10^7\,s$

21) power of light bulb $= 60\,W$

22) No. of Joules of energy in 1 kWh $= 3.6 \times 10^6\,J$

23) Mass of protractor $= 10g$

24) Mass of apple $= 100g - 150g$

25) Mass of person = 70kg - 80kg

26) Mass of nail = 5g

27) Mass of 15 cm ruler = 10g

28) Mass of car = 1000 kg

29) Density of wood = 800 - 900 $kg\,m^{-3}$

30) Volume of adult's head = 2000 cm^3

31) Height of bench = 40 cm

32) height of table = 80 cm

33) width of pencil lead / ball point pen = 0.5 mm

34) volume of water in a cup = 50 cm^3

35) Volume of standard swimming pool = 2500 m^3

36) Temperature of human body = 310 K

Errors and uncertainity

Q1. What is a systematic error?

Ans. The error that occurs due to the flaw in the instrument is called systematic error. The error remains constant all through the readings.

A systematic uncertainity will result in all readings being either above or below the accepted value.

This error cannot be eliminated by repeating and then averaging. It can be eliminated by changing the instrument.

eg. ① zero error of micrometer screw gauge or voltmeter / ammeter.

② Wrongly calibrated scale

Q2. What is random error?

Ans: The error that occurs due to human reaction and the difficulty in reading instrument. It fluctuates all through the reading or the readings are scattered about the true value. This error can be eliminated by:

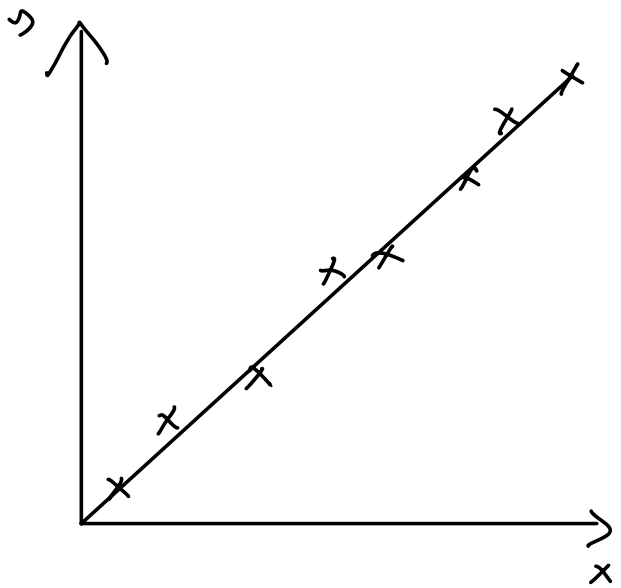
1) repeated measurements and then average
2) taking large no. of readings and plotting points in the graph paper and form a best fit line.
3) By operating system periodically.

Example of random error

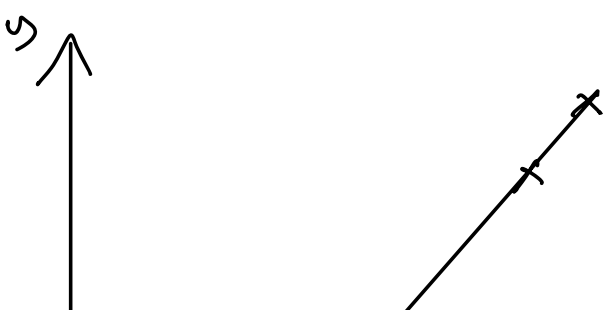
1) Parall ex error

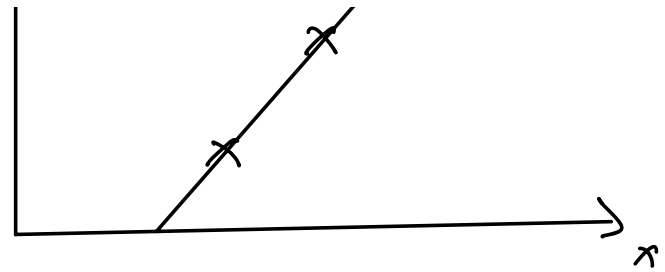
2) Timing oscilation without the use of referance marker.

In systematic error all the readings will increase or decrease in an orderly manner. But in random error readings fluctuate.



All readings are scattered so it is a random error.





the graph shows the line is not passing through origin.
so it has systematic error.
But no random error.

True / original value = x_0

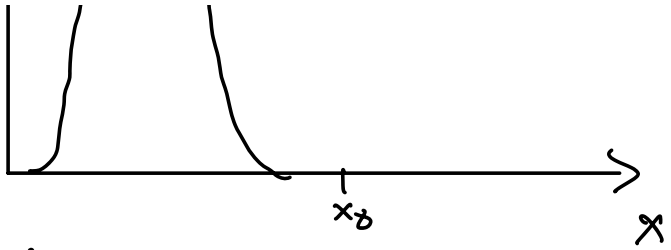
x => time

n = number of times

small systematic error

small random error

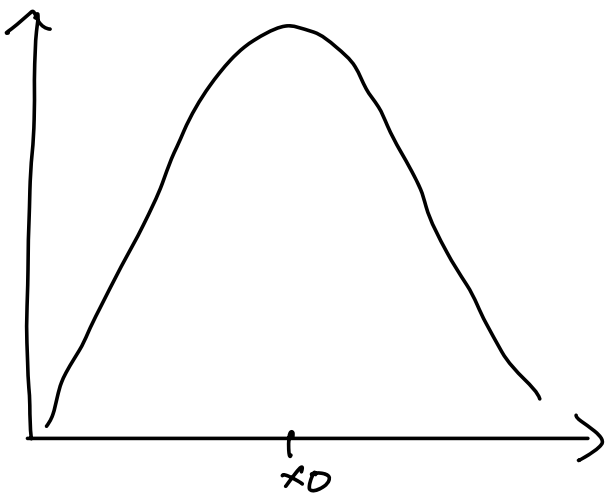
(2)



large systematic error

small random error

(3)



small systematic error

large random error.

Accuracy → is the degree to which a measurement approaches the true value

Accuracy depends on

1) the experiment used
2) skill of experimenter

3) the instrument used

Reducing error or uncertainity in a measurement improves its accuracy.

Precision → is that part of accuracy which is within control of experimenter.
The experimenter may choose different measuring instrument and may use them with the level of skills. Thus affecting the precision of measurement.
eg. finding the value of g.

g = 9.49, 9.48, 9.47 (precise)
g = 9.81, 9.82, 9.83 (precise and accurate)

Uncertainity: the total range of values within which the measurement is likely to lie is known as its uncertainity.

In every measurement, there must be an error / uncertainity.

Uncertainity is expressed in 3 forms:

1. absolute
2. fraction
3. percentage

$l_1 = 24.6 \pm 0.1$ cm
$l_2 = 52.1 \pm 0.1$ cm

* $P = l_1 + l_2$
$P = 24.6 + 52.1$
$\Rightarrow 76.7$ cm

absolute uncertainity $= \pm 0.2$ cm
$\%.\ \Delta P = \frac{0.2}{76.7} \times 100$

* $Q = L_2 - L_1$
$Q = 52.1 - 24.6$
$\Rightarrow 27.5$

Absolute uncertainity $= \pm 0.2$ cm
$\%\ \Delta Q = \frac{0.2}{27.5} \times 100$

$*S = \frac{L_2}{L_1}$

$S = \frac{52.1}{24.6} = 2.12$

$\%\Delta S = \%\Delta L_1 + \%\Delta L_2$

$\frac{0.1}{24.6} \times 100 + \frac{0.1}{52.1} \times 100$

$\Rightarrow 0.60\%$ of 2.12

$*T = L_1^5 \times L_2^2$

$\%\Delta T = 5(\%\Delta L_1) + 2(\%\Delta L_2)$

$* \quad X = \sqrt{L_1 L_2}$

$\%\Delta X = \frac{1}{2}(\%\Delta L_1 + \%\Delta L_2)$

Physical quantities are of two types

i) scalar

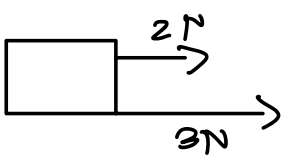
ii) vector

i) scalar : quantities which have magnitude only.
eg. mass, work, energy, power.

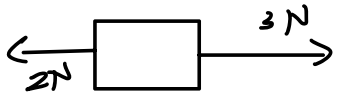
ii) vector : the physical quantities which have both magnitude and direction.
Change of value or direction or both cause to change a vector quantity.

Resultant / Net vectors

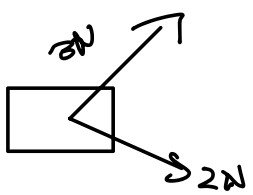
The resultant of two or more vectors is a single vector that can produce the same effect as the two or more vectors.



$R = 2 + 3 = 5N$



$R = 3 - 2 = 1N$



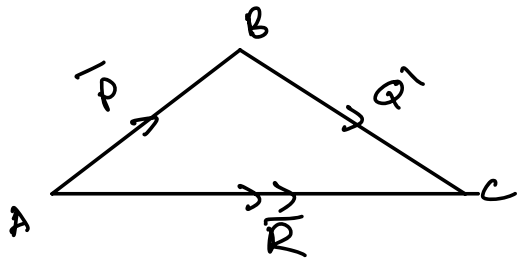
$R = ?$

there are two common polygon rules for vector calculations.

i) triangle rule
ii) parallelogram rule

→ scale diagram
→ trigonometry

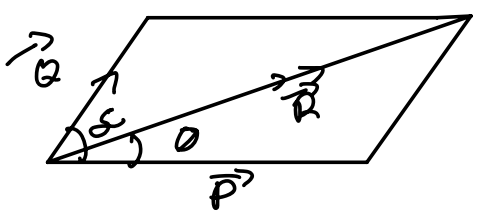
Triangle rule: Each one of the two vectors is represented by the sides of the triangle in sequence, then the resultant is represented by the third side of the triangle in opposite sequence.



$\overline{R} = \overline{P} + \overline{Q}$

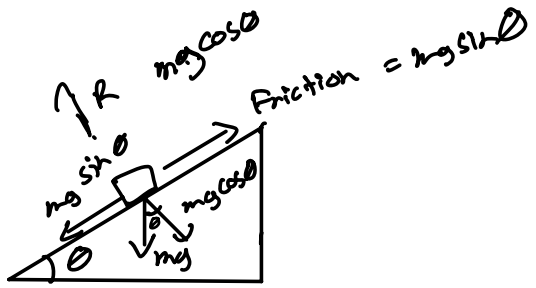
2) parallelogram rule

If two vectors are represented by two adjacent sides of a parallelogram, then their resultant will be diagonal from the origin of two vectors.



$$R = \sqrt{P^2 + Q^2 + 2PQ\cos\alpha}$$

$$\theta = \tan^{-1}\left(\frac{Q\sin\alpha}{P + Q\cos\alpha}\right)$$

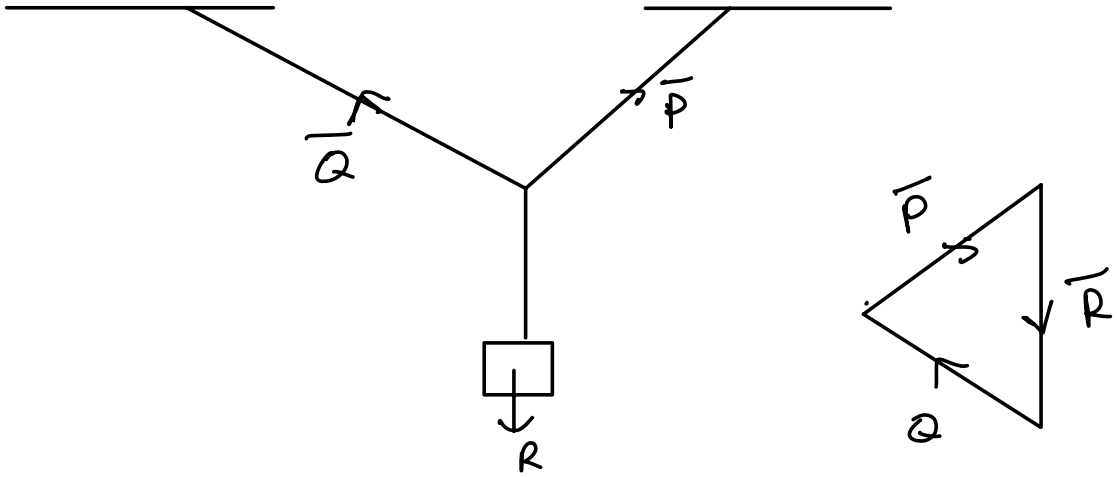


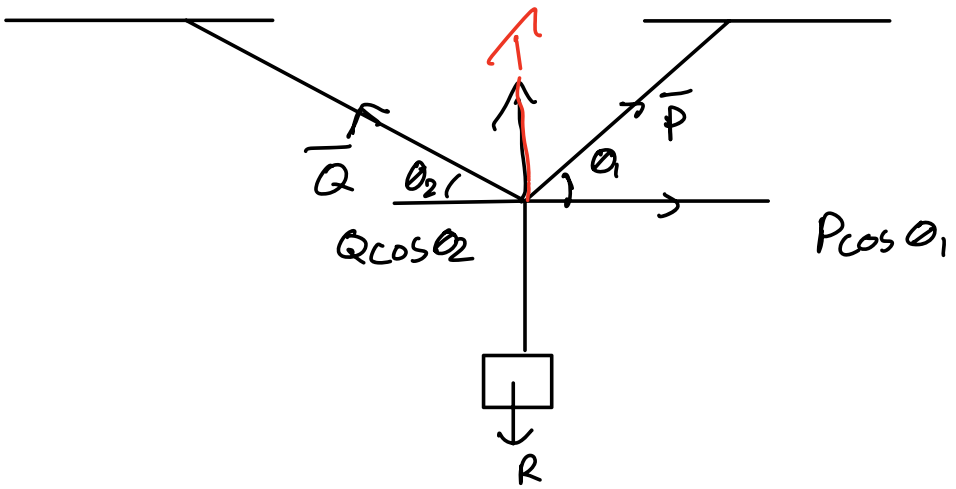
Equilibrium case

If $\vec{P}$, $\vec{Q}$, $\vec{R}$ vectors create an equilibrium then:

1) Resultant of any two will be equal and opposite to third.

2) Three vectors must form a closed triangle.





$$Q\cos\theta_2 = P\cos\theta_1$$

$$Q\sin\theta_2 + P\sin\theta_2 = R$$