recall the following base quantities and their units: mass (kg), length (m), time (s), current (A), temperature (K), amount of substance (mol)

Base quantities.

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SI units

mass (kg)

length (m)

time (s)

current (A)

temperature (K)

amount of substance (mol)

Other units can be derived from these.

e.g. velocity $m\ s^{-1}$

force $N = kg\ m\ s^{-2}$ $(F = ma)$

charge $C = As$ $(Q = It)$

energy $J = N.m = kg\ m^2\ s^{-2}$ $(W = Fs)$

⋮

use the following prefixes and their symbols to indicate decimal sub-multiples or multiples of both base and derived units: pico (p), nano (n), micro (μ), milli (m), centi (c), deci (d), kilo (k), mega (M), giga (G), tera (T)

Prefixes

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pico (p)	10^{-12}
nano (n)	10^{-9}
micro (μ)	10^{-6}
milli (m)	10^{-3}
centi (c)	10^{-2}
deci (d)	10^{-1}
kilo (k)	10^{3}
mega (M)	10^{6}
giga (G)	10^{9}
tera (T)	10^{12}

Reasonable estimates

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Can be very rough, but should be within a few times ($< 10\times$).

e.g. height of adult ~ 1 – 2 m.
mass of adult ~ 50 ~ 100 kg

room temperature ~ 20 °C
diameter of earth ~ 10 000 km.
time to travel to school ~ 30 min

Technique: - memorise some examples
- then guess / estimate

show an understanding of the distinction between systematic errors (including zero errors) and random errors

Errors

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Systematic error

e.g. weighing machine - reading when no weight.

measuring height - with shoes on.

Always off by same amount.

Random error:

e.g. timing a pendulum

reading ruler to nearest mark

Sometimes a bit more, a bit less.

show an understanding of the distinction between precision and accuracy

Precision, Accuracy

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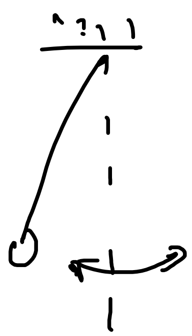
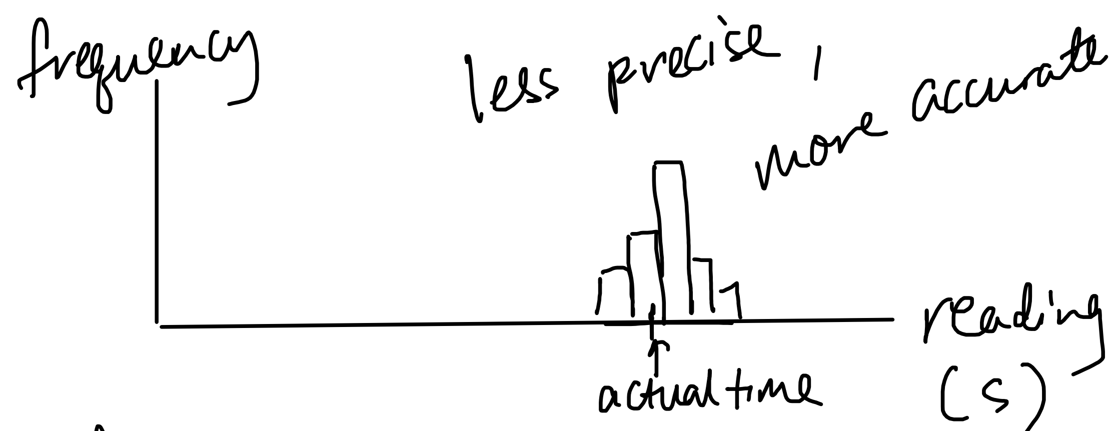
Precise : small random error

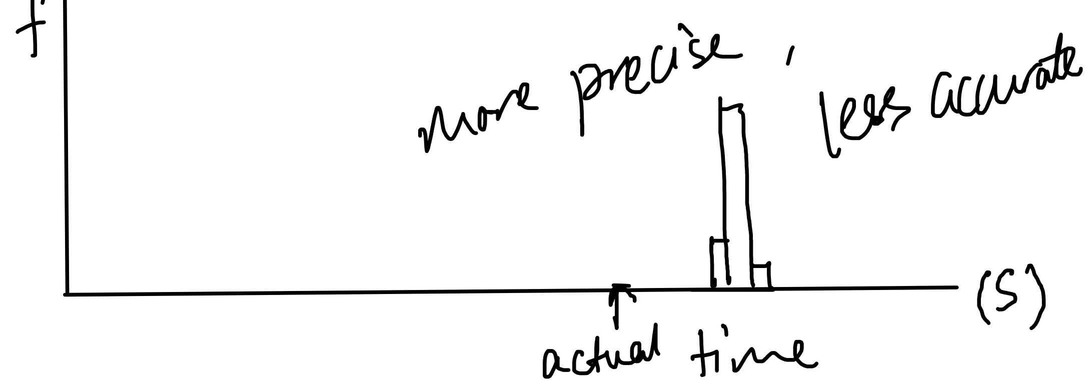
Accurate : small systematic error



e.g. - measure pendulum time

- repeat measurements





assess the uncertainty in a derived quantity by simple addition of actual, fractional or percentage uncertainties

Combining errors

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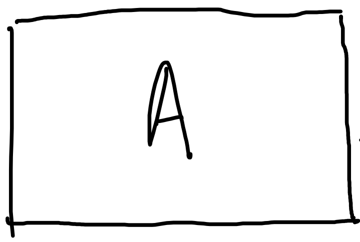

random error

$b \quad \delta b$

5.0 ± 0.2 cm

$a \quad \delta a$

10.0 ± 0.1 cm

Area, $A = ab = 10.0 \times 5.0$

$= 50 \text{ cm}^2$

fractional error, $\dfrac{\delta A}{A} = \dfrac{\delta a}{a} + \dfrac{\delta b}{b}$

$= \dfrac{0.1}{10} + \dfrac{0.5}{5}$

$= \dfrac{1.1}{10}$

$\therefore \delta A = \dfrac{1.1}{10} \times 50 = 5.5$ cm.

$\therefore A = 50 \pm 5.5 \rightarrow 50 \pm 6 \text{ cm}^2$

If $A = a + b$, just add: $\delta A = \delta a + \delta b$.

Scalar, Vectors

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Vector has magnitude and direction,

e.g. Velocity, magnetic flux density

displacement

acceleration

momentum

force

Scalar is just number

e.g. distance, current

speed, voltage

time, temperature

work, magnetic flux

energy

power

Add, subtract vectors

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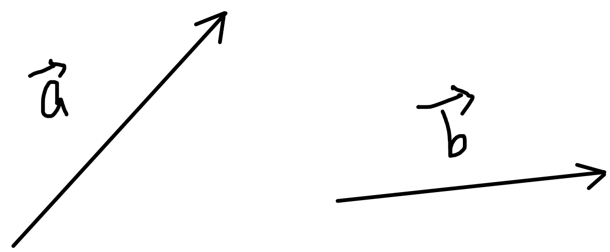
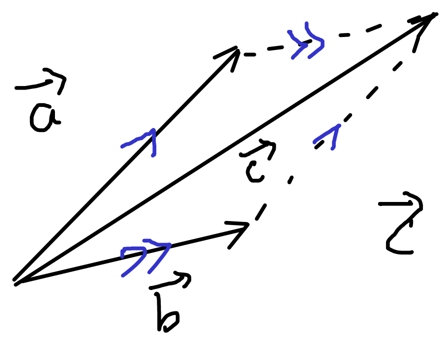
e.g. forces to add:



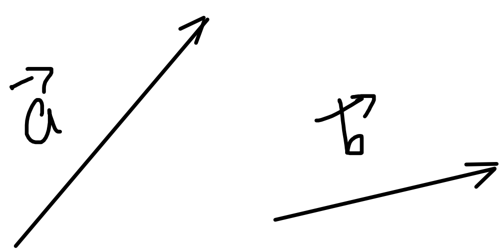
Parallelogram law of addition



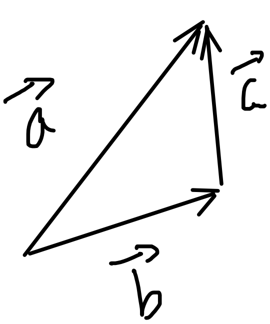
$\vec{c} = \vec{a} + \vec{b}$

e.g. resultant force

e.g. $\vec{a}$ is resultant of $\vec{b}$ and another force.



Triangle law of subtraction



$\vec{c} = \vec{a} - \vec{b}$

e.g. the other force

represent a vector as two perpendicular components

Perpendicular Components

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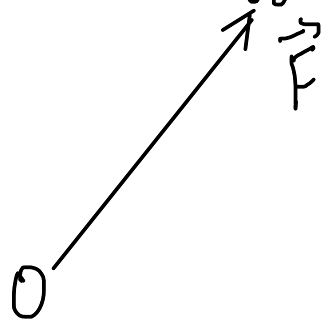
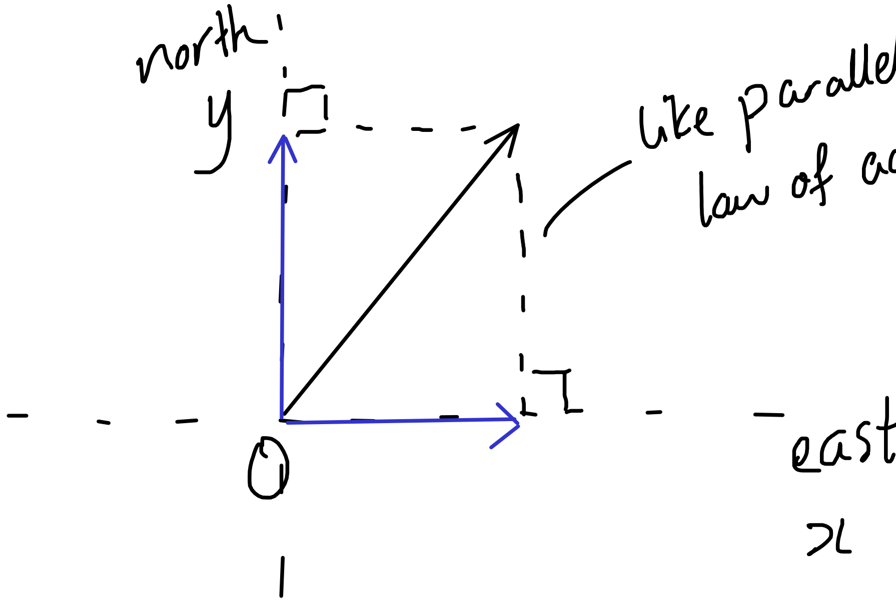
e.g. force on a ball.



Pretend it is resultant of 2 forces - in north, east directions.



Like on x-y plane

- magnitudes of components - x, y values

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