show understanding that all physical quantities consist of a numerical magnitude and a unit

Physical Quantities

Dr K M Hock

A physical quantity is somethng we can measure, like

length
time
mass
temperature

e.g. my height is 160. 160 what?
I must say 160 cm. cm is a unit.

Length can also be in metres, mm, inches, miles, ...

If I take 30 min to get to school, this quantity is time. minute is the unit here.

Time can also have units of second, hour, day, ...

If I say I am 60 kg, you know this is my mass, ∴ kg is the unit.

Mass can also be in gram, pound, kati, ...

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

SI Units

Dr K M Hock

Scientists standardise units for:

SI units

	unit	symbol
mass	kilogram	kg
length	metre	m
time	second	s
current	ampere	A
temperature	kelvin	K
amount of substance	mole	mol

These are called base units - all others can be derived.

e.g. 1 cm = $\frac{1}{100}$ m

1 gram = $\frac{1}{1000}$ kg

e.g. velocity : metre per second = m / s

density : gram per cubic cm = g / cm

force : newton = kg . m / s

energy : joule = kg . m / s

electric charge : coulomb = A . s

(will explain in later topics)

use the following prefixes and their symbols to indicate decimal sub-multiples and multiples of the SI units: nano (n), micro (μ), milli (m), centi (c), deci (d), kilo (k), mega (M)

Prefixes

Dr K M Hock

We know 1 kg = 1000 g, 1 cm = $\frac{1}{100}$ m.

k, c are prefixes.

Prefix	symbol	meaning
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}

e.g. $1\ \text{ns} = 10^{-9}\ \text{s}$

$1\ \mu\text{g} = 10^{-6}\ \text{g}$

$1\ \text{Mm} = 10^{6}\ \text{m}$

e.g. convert density of water from 1 g/cm^3 to km/m^3.

Recall $1\ \text{g} = 0.001\ \text{kg}$ ($\because 1\ \text{kg} = 1000\ \text{g}$)

$1\ \text{cm} = 0.01\ \text{m}$

Use algebra:

$1\ \text{g/cm}^3 = 0.001\ \text{kg}/(0.01\ \text{m})^3 = 1000\ \text{kg/m}^3$

show an understanding of the orders of magnitude of the sizes of common objects ranging from a typical atom to the Earth

Orders of Magnitude

Dr K M Hock

means rough value - in physics - within factor of 10

(Wiki) e.g.

0.1 nm	atom
10 nm	cell wall thickness
100 nm	virus
1 μm	red light wavelength
10 μm	blood cell water droplet
100 μm	hair width
1 mm	ant
1 cm	mosquito
10 cm	radio wavelength
1 m	human height
10 m	bus
100 m	football court
10 km	Mount Everest
10 000 km	diameter of Earth

Scalar and Vector

Dr K M Hock

Vector has direction. Scalar does not.

Scalar : e.g. mass, time, distance, speed, energy, temperature

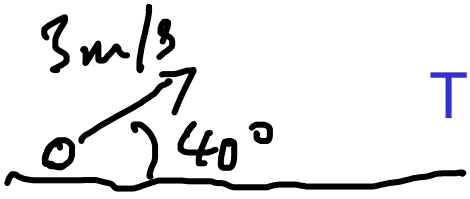
Vector : e.g displacement, velocity, acceleration, force.

e.g. I walk 100 m east.

distance = 100 m (scalar)

displacement = 100 m, east (vector)
(magnitude, direction)

e.g.



Throw a stone.

Speed = 3 m/s (scalar)

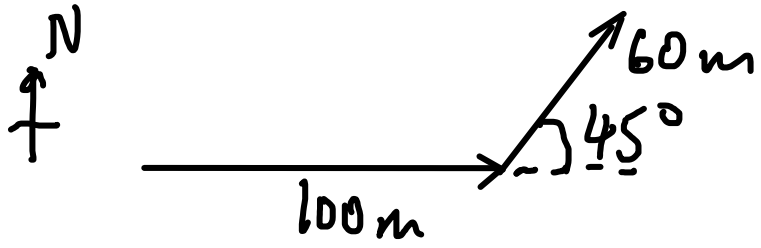
Velocity = 3 m/s, 40° to horizontal (vector)
(magnitude, direction.)

Adding Vectors

Dr K M Hock

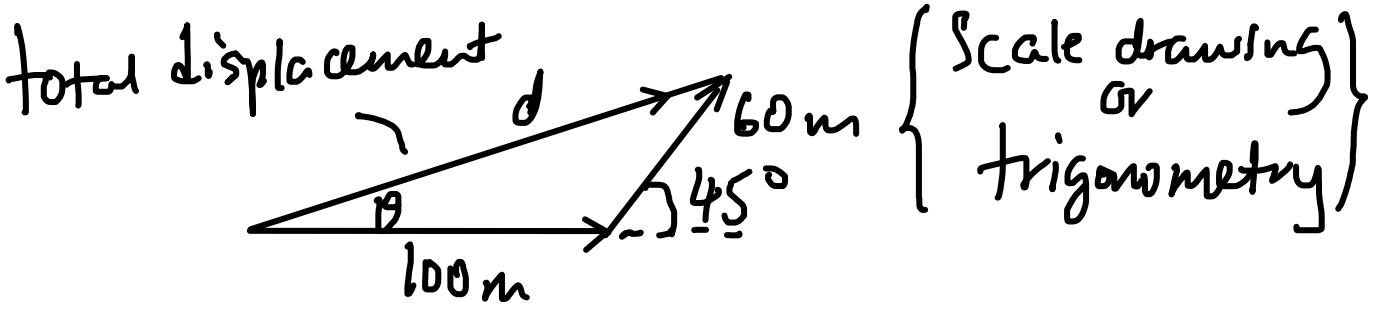
E.g. I walk 100 m east. Then 60 m north-east.
What is my total displacement?

Ans. draw arrows for the vectors:



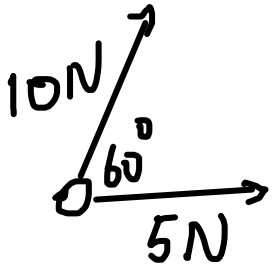
Join head to tail.

Then draw start to end:



The answer MUST give the magnitude (d)
AND the direction (e.g. θ).

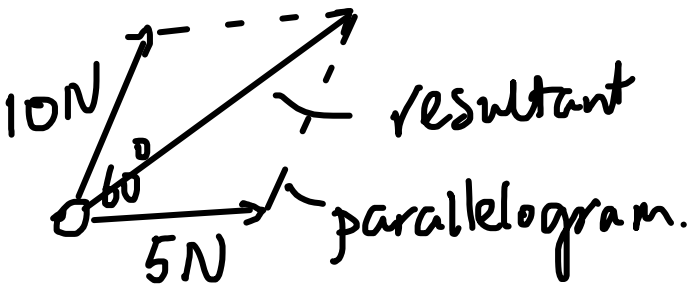
E.g.



Two force pull at a stone.

Find the resultant force.

Ans. Can also do this



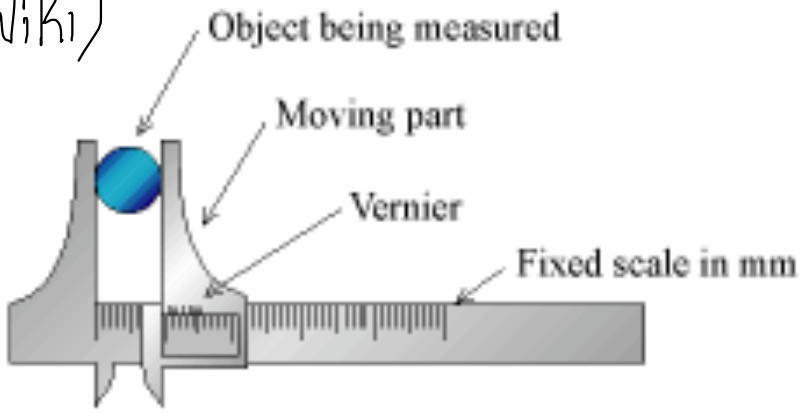
describe how to measure a variety of lengths with appropriate accuracy by means of tapes, rules, micrometers and calipers, using a vernier scale as necessary

Measuring Lengths

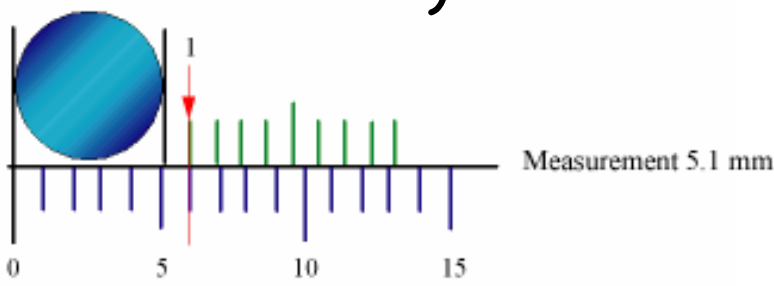
Dr K M Hock

Vernier Calipers

(Wiki)

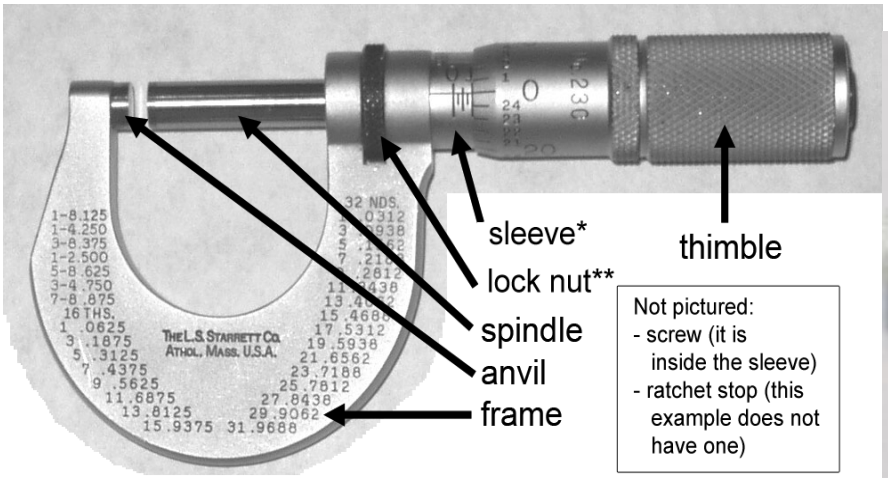


Reading



$$5 + 0.1 = 5.1 \text{ mm}$$

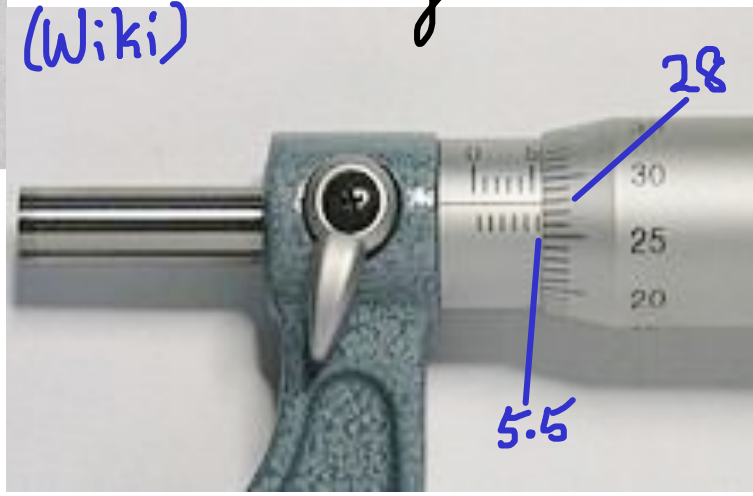
Micrometer screw gauge



Sleeve is the most prevalent name. May also be called the *barrel* or *stock*.
**Aka *lock-ring*. Some mics have a *lock lever* instead.

Reading

(Wiki)



$$5.5 + 0.28 = 5.78 \text{ mm}$$

describe how to measure a short interval of time including the period of a simple pendulum with appropriate accuracy using stopwatches or appropriate instruments

Short Time Intervals

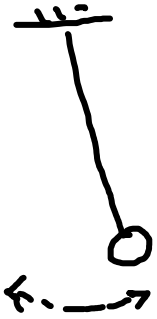
Dr K M Hock

e.g. Can use stop watch to measure time.

W.ki

What if interval is very short?

Time taken to press stop watch can give error.



e.g. about $\frac{1}{2}$ s per cycle.

One way to reduce error:

1. Count many cycles, e.g. 20.
2. Measure total time. e.g. 17.2 s
3. Divide by no. of cycles, eg. $\frac{17.2}{20}$ s