SUPER PHYSICS

Chapter 1 Notes

Physical Quantities, Units & Measurement

Physical quantities and SI units

Basic Quantity	Name of SI Unit	SI Unit
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s
Thermodynamic temperature	Kelvin	K
Amount of substance	Mole	mol

Example 1:
What are the derived units of density?

$$\boldsymbol{Density = \frac{Mass}{Volume}}$$

$$\boldsymbol{therefore\ units\ for\ density = \frac{kg}{m^3}}$$

Prefixes

Prefix	Multiple	Symbol	Factor	Order of magnitude
Giga	1 000 000 000	G	10^9	9
Mega	1 000 000	M	10^6	6
Kilo	1000	K	10^3	3
Deci	0.1	D	10^{-1}	-1
Centi	0.01	C	10^{-2}	-2
Milli	0.001	M	10^{-3}	-3
Micro	0.000 001	μ	10^{-6}	-6
Nano	0.000 000 001	N	10^{-9}	-9

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Example 2:
Express 0.000 0023m in a suitable magnitude

$$0.000\,0023m = 2.3\mu m = 2.3 \times 10^{-6} m$$

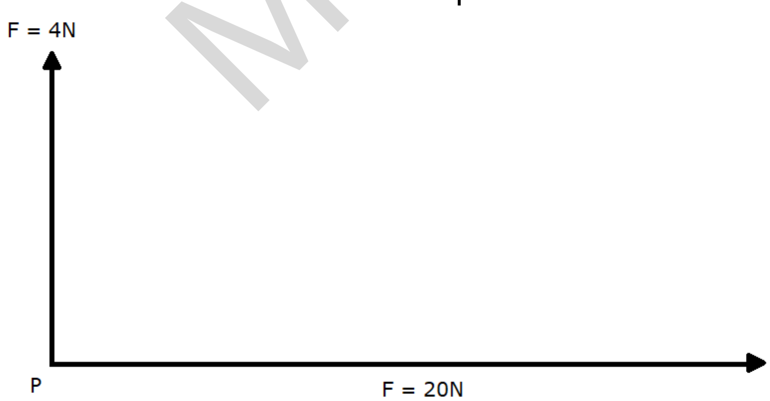
Scalars and vectors

- A scalar quantity has only magnitude but does not have direction.
- A vector has both magnitude and direction

Scalar	Vector
Distance	Displacement
Speed	Velocity
Energy	Force
Time	Acceleration
Volume	Weight
Density	
Mass	

Addition of Vector

Example 3:
Find the resultant force R at point P due to F = 4N and F = 20N.



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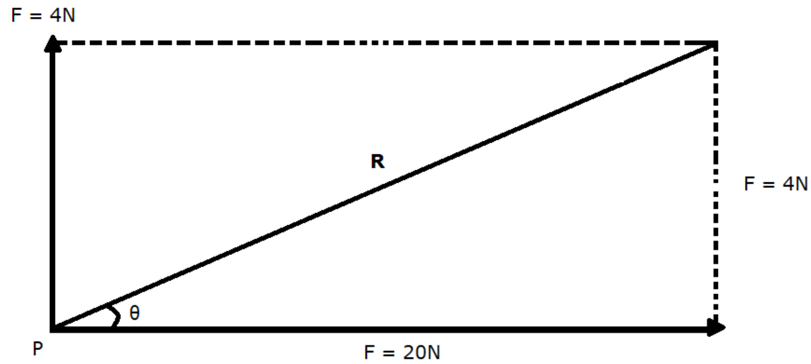
Method 1: Trigonometric Method



Using Pythagoras' Theorem:

$$R = \sqrt{4^2 + 20^2}$$

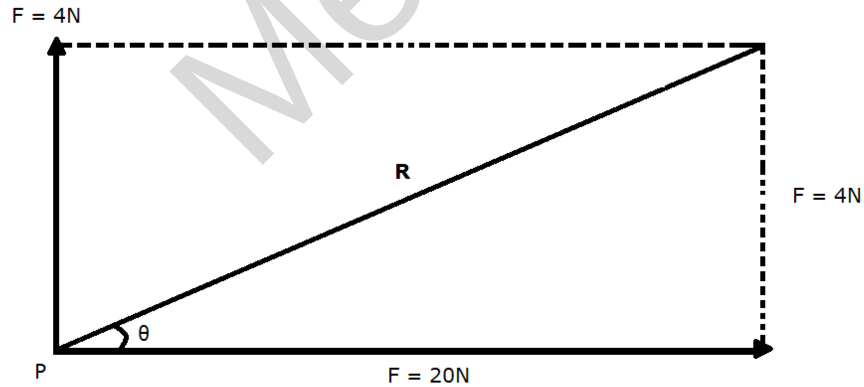
$$R = \sqrt{416}$$

$$R = 20.4N$$

$$\tan\theta = \frac{4}{20}$$

$$\theta = 11.3°$$

Method 2: Graphical Method



Step 1: select an appropriate scale (E.g. 1cm to 2N)
Step 2: Draw a parallelogram of vectors to scale
Step 3: measure the diagonal to find R
Step 4: Use the protractor to measure angle θ

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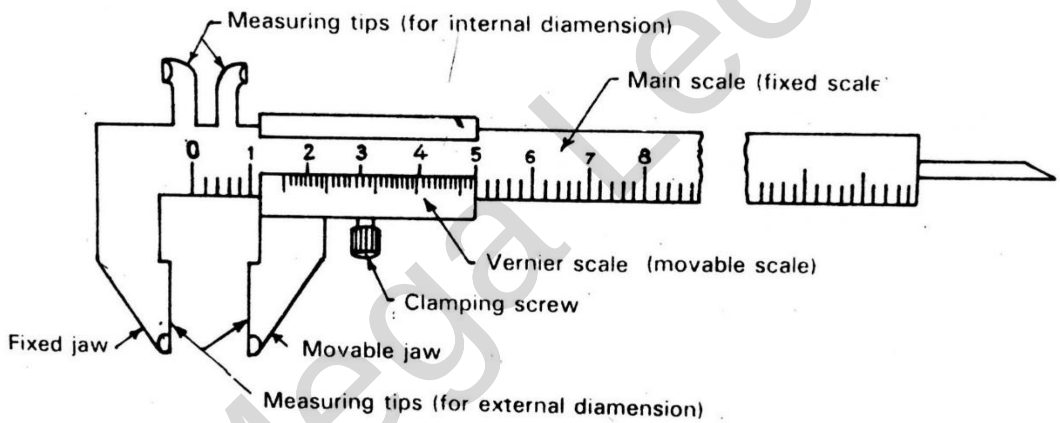
Measurement of length and time

Range of length, l	*Instrument*	*Accuracy*	*Example*
$l > 100cm$	Measuring tape	±0.1 cm	Waistline of a person
$5cm < l < 100cm$	Metre rule	±0.1cm	Height of an object
$1cm < l < 10cm$	Vernier calipers	±0.01cm	Diameter of a breaker
$l<2cm$	Micrometer screw gauge	±0.001cm	Thickness of a length of wire

Vernier Callipers



- A pair of vernier callipers can be used to measure the thickness of solids and the external diameter of an object by using the external jaws.
- The internal jaws of the calliper are used to measure the internal diameter of an object.
- The tail of the calliper is used to measure the depth or a hole.
- Vernier callipers can measure up to a precision of ±0.01cm

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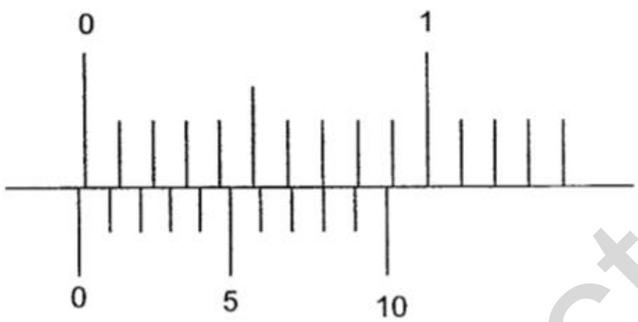
Example 4:

The reading on a vernier callipers when an object is between its jaws is 2.55 cm.
The diagram below shows the reading of the vernier callipers without any object between its jaws.



What is the actual length of the object?

$$Apparent\ length = 2.55cm$$

$$Zero\ error = -0.02\ cm$$

$$Actual\ length\ =\ Apparent\ length - \ Zero\ error$$
$$Actual\ length\ =\ 2.55cm - (-0.02)cm$$
$$Actual\ length\ =\ 2.57cm$$

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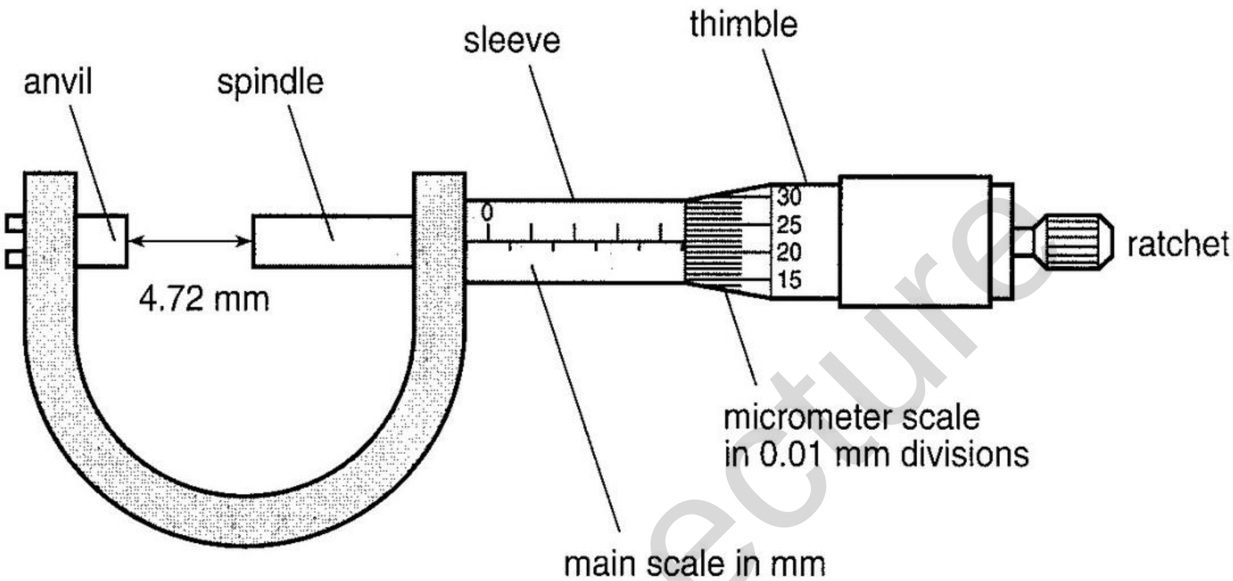
Micrometre Screw Gauge



- The jaws of the Micrometre screw gauge are used to measure the external diameter of an object.
- Micrometre screw gauges can measure up to a precision of ±0.01mm

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Example 5:

A micrometer has a zero error as shown in Fig 1.1 and this same instrument is used to measure an object with a reading as shown in Fig 1.2.
What is the actual measurement of the object?

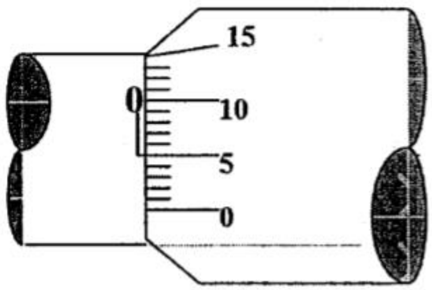

Fig. 1.1

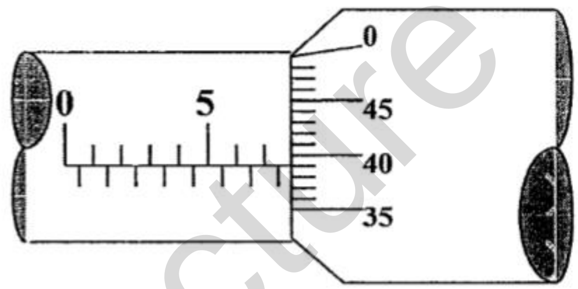

Fig. 1.2

$$Apparent\ length = 7.50mm + 0.39mm$$
$$= 7.89mm$$

$$Zero\ error = +0.05\ mm$$

$$Actual\ length\ =\ Apparent\ length - Zero\ error$$
$$Actual\ length\ =\ 7.89mm - (0.05)mm$$
$$Actual\ length\ =\ 7.84mm$$

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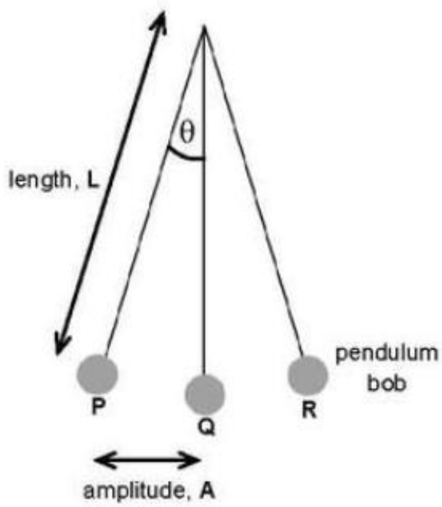
Simple Pendulum



- Period is the time taken to move from P > Q > R > Q > P

- One oscillation is when the bob travels from P > Q > R > Q > P

- The amplitude is the distance between the rest position (point Q) of the bob to the extreme end of the oscillation (either point P or point R)

- The period of the pendulum, T, is affected only by the
  - Length of the string, l
  - Acceleration due to gravity, g

- T is not affected by the mass of the pendulum bob.

How to find the period:

1. Take the total time for 20 oscillations
2. Repeat step 1
3. Calculate the average of the two timings
4. Divide the average calculated by 20 to obtain the period