Introduction to physics

Physics is a branch of science that attempts to investigate movement and forces

Physics is the study of the properties of matter in relation to energy.
Matter is anything that occupies space and has weight. There are three states of matter.

(i) Solids
(ii) Liquids
(iii) Gases

Physics explain the various forms of energy as group below:

(i) Heat energy
(ii) Sound energy
(iii) Light energy
(iv) Nuclear energy
(v) Mechanical energy
(vi) Electrical energy
(vii) Biogas energy
(viii) Magnetic energy

In the study of physics, experiments theories and observations are used to;

(i) Understand and explore every puzzle disturbing occurrences in the world we live
(ii) Understand the world of science and modern technology
(iii) Explain why things occur the way they do
(iv) Discover scientific laws that explain the properties and behavior of matter
(v) Develop future career such as in engineering, electronics, information technology, medicine, science and education

Applications of physics

At home physics is applied for cooking and lighting
In industries it is applied in manufacturing of clothes, iron sheets, sodas, beers etc.
Physics is also applied in the construction of roads, bridges and dams.
In wars, guns, bombs and missiles result from the study of physics
In transport bicycles, cars, airplanes, as well as sub marines use knowledge from physics
Physics is therefore a very important subject that has daily life applications

Measurements and units of measurement

Measurements in physics are based on an internationally agreed system called the metric system. This system has universally agreed upon units called system international (S.I units). Al measurements are described in terms of the three fundamental quantities of matter namely

(i) Length
(ii) Mass
(iii) Time

All other quantities are derived from the three above as shown in the table below

Table I

Quantity	**S.I unit**	**Symbol**
Length	metre	m
Mass	Kilogram	Kg
Time	Second	S
Electric current	Ampere	A
Amount of substance	Mole	mol
Thermodynamic temperature	Kelvin	K
Luminous intensity	Candela	cd
Derived quantities		
Physical quantity	**Unit name**	**Symbol**
Areas	Square meter	m^2
Volume	Cubic meter	m^3
Speed	Metre per second	ms^{-1}
Force	Newton	N
Pressure	Pascal	Pa or Nm^{-2}
Energy	Joule	J

Basic and derived units can be expressed using prefixes

Factor	Prefix	Symbol
10^3	kilo	K
10^6	mega	M
10^9	giga	G
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-4}	nano	n
10^{-12}	Pico	P

Standard form or scientific notation.

A number is written in standard form when it has only one digit 1, 2, 3, 4, 5, 6, 7, 8, 9 in this case, since there is no decimal point after the number, they can be expressed as

$1 \times 10^0 = 1$, $2 \times 10^0 = 2$, $3 \times 10^0 = 3$

Note: $10^0 = 1$

Once the digits become more than one, to write them in standard form, decimal points are introduced. The numbers are then written as
A x 10^n where a is more than zero and less than 10 n is an integer or whole number
n is positive if the decimal point is moved from right to the left e.g. 436 in standard form is written as 4.36 x 10^2
n is negative if the decimal point is moved from left to right e.g. 0.0463 in standard form is written as 4.63 x 10^{-2}
The standard form of expressing number is also called the scientific notion

Length
Is the distance between two fixed points. The S.I unit is metre (m)

Other units include
- kilometer (km)
- centimetre (cm)
- millimetre (mm)

Unit	Symbol	Comparison with metre	
1 kilometer	1km	100m	10^3
1 meter	1m	1m	
1 centimetre	1cm	0.01m	10^{-2}
1millimeter	1mm	0.001m	10^{-3}
1 micrometer	1um	0.000001m	10^{-6}

Change cm to m
100cm = 1m
$\frac{100}{100}$cm = $\frac{1}{100}$m
1cm = $\frac{1}{100}$m
Exercise
Change 60cm to m change 56cm to m
Change the following to me
(a) 40cm (c) 570cm
(b) 840cm (d) 65cm

Changing mm to m
1000mm = 1m
$\frac{1000\text{mm}}{1000}$ =$\frac{1}{1000}$m
1mm = $\frac{\mathbf{1}}{\mathbf{1000}}$m
Exercise
Change 60mm to m
Length can be measured using a number of instruments
(i) Meter rule (ii) Caliper (iii) micrometer screw gauge

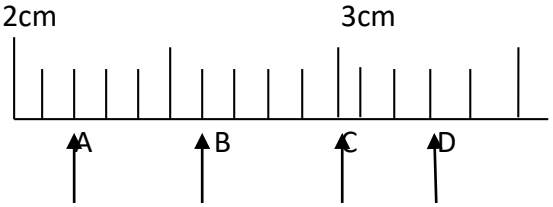
Metre ruler

It is an instrument for measuring length of objects

10 divisions = 1cm

1division $= \frac{1}{10}$cm

1division = 0.1cm



Length

A - 2.2cm

B – 2.6 cm

C – 3.0 cm

D – 3.3cm

Correct position for taking reading.

The position of the eye should be vertically above the scale.

Calipers

These are used to measure length on solid objects where ordinary metre cannot be applied directly.

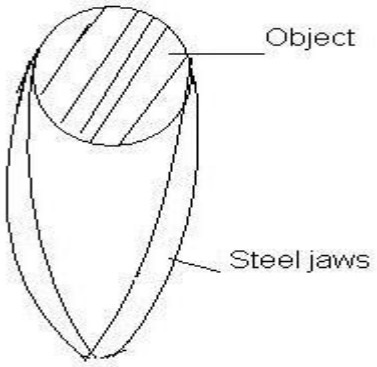
Types of caliper

There are two types of caliper namely

(i) Engineer's caliper

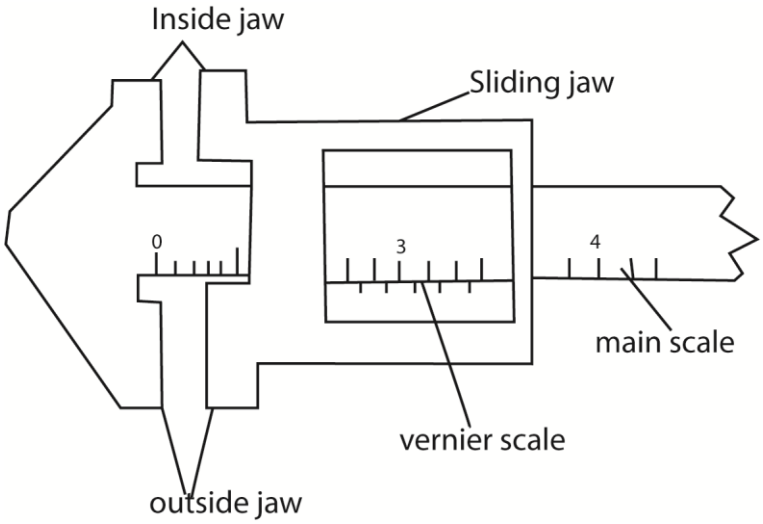
(ii) Vernier caliper

Engineer's caliper



The distance between the steel jaws is them measured on the ordinary metre rule scale

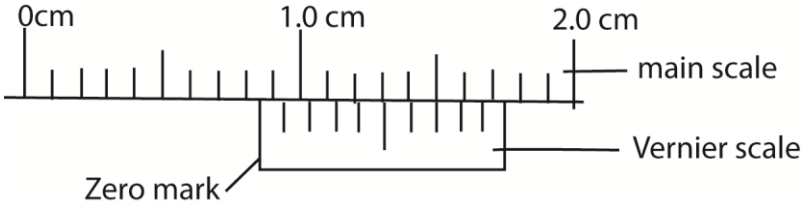
Vernier caliper



This consists of a steel scale with a fixed jaw at one end. A vernier caliper is for measuring outside and inside diameters of objects like a tube, pipe, and cylinder. The object for diameter measuring is placed between the outside jaws if the external diameter is required. If internal diameter is required, the inside jaws are used. A vernier caliper is used to measure internal and external diameter of a tube, pipe and cylinders.

How to read a vernier caliper

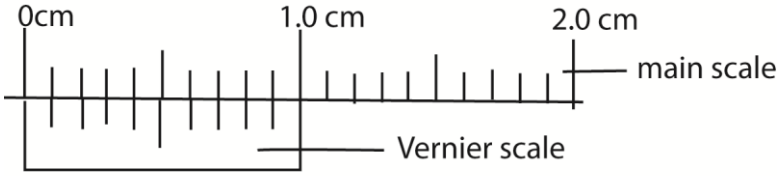
The vernier caliper has two scales the main scale and the vernier scale



Read the value on the main scale in cm on the left of the zero mark on the Vernier scale and add the first mark on the Vernier to coincide with any mark on the main scale x 0.01

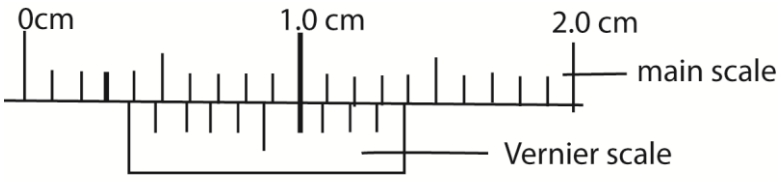
e.g.

(i)



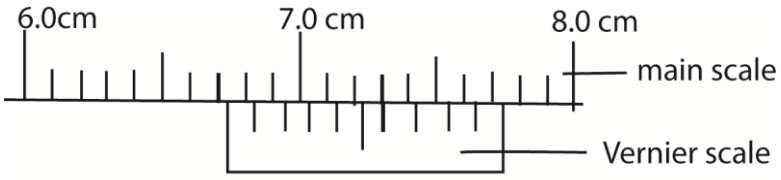
Reads $0.0 + 0 \times 0.1 = 0.00$ cm

(ii)



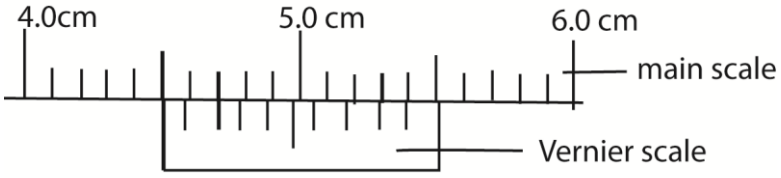
Reads 0.3 + 6 x 0.1 = 0.36 cm

(iii)



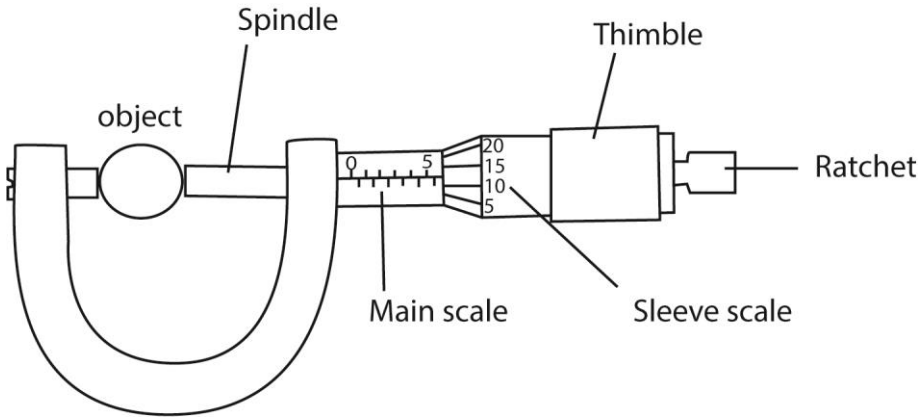
Reads 6.7 + 6 x 0.1 = 6.76 cm

(iv)



Reads 4.5 + 2 x 0.1 = 4.52 cm

Micrometre screw gauge



This is an instrument used for measuring small distances like a diameter of a wire. The instrument measures up to three decimals in cm scale. It has two scales namely
Shaft sleeve

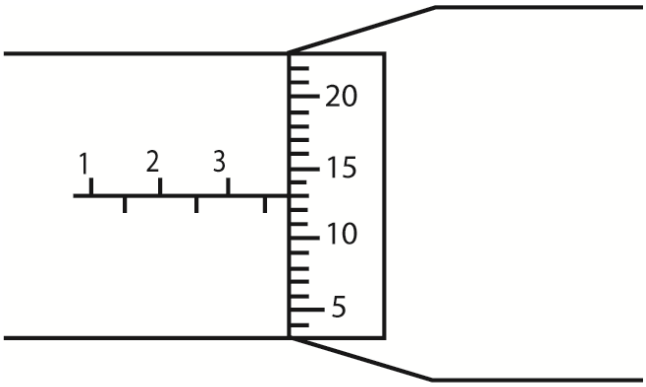
How to read the instrument

One complete turn of the drum (thimble) is called the pitch. It opens the jaws by one division on the scale of the sleeve. The smallest division on the scare of the thimble of the micrometre screw gauge is 0.01mm.

The reading on the micrometre screw gauge = reading on the main scale + a reading on the thimble x 0.01 mm

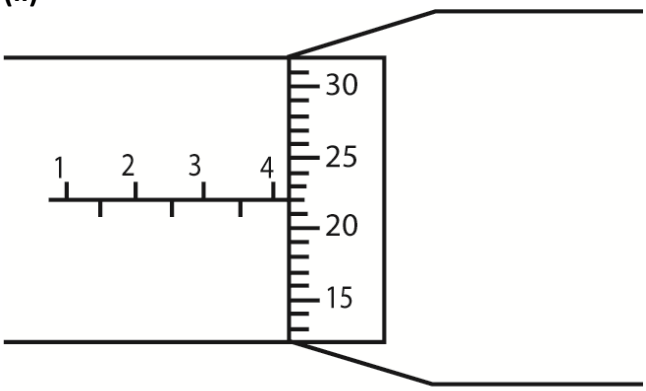
Examples

(i)



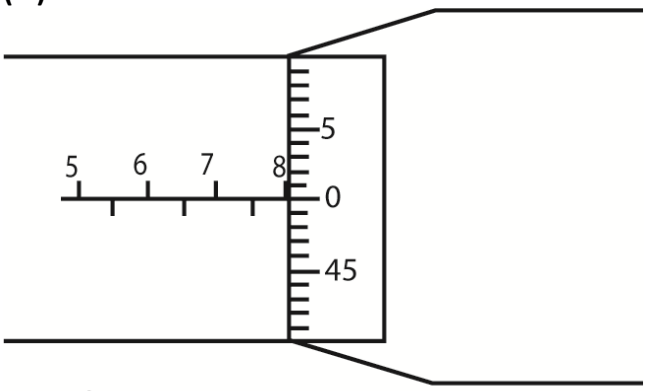
Reads 3.5 + 12 x 0.01 = 3.62mm

(ii)



Reads 4.0 + 22 x 0.01 =4.22mm

(iii)



Reads 8.0 + 0 x 0.01 =8.00mm

Volume

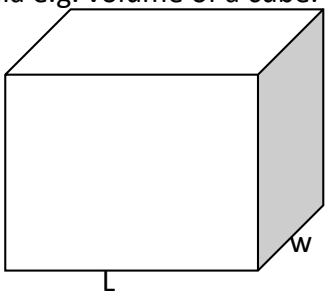
Volume is the amount of space occupied by an object. The unit of measuring volume is cubic metre (m^3) other include cubic centimetre (cm^3). Liquid volumes are also expressed in litre

1 litre = $1000cm^3$

1 millilitre= $1cm^3$

Volume of regular objects

Volume of regular objects is got by measuring the lengths of the object and then apply a known formula e.g. volume of a cube.



Volume= L x W X H

(b) Volume of a sphere

$V = \frac{4}{3}\pi r^3$

c) Volume of a cylinder

$V = \pi r^2 h$

Changing cm^3 to m^3

1cm = $\frac{1}{100}$m …….. (i)

1 cm^3 = 1cm x 1cm x 1cm ……..(ii)

Substituting (i) in (ii)

$1cm^3 = \frac{1}{100}m \times \frac{1}{100}m \times \frac{1}{100}m$

$\therefore 1cm^3 = 1 \times 10^{-6}m^3$

$\therefore 6000cm^3 = 6000 \times \frac{1}{100 \times 100 \times 100}\ m^3$

$=\frac{6}{1000}m^3$**$= 0.006m^3$**

Changing mm^3 to m^3

1mm = $\frac{1}{1000}$m …….. (i)

$1mm^3$ = 1mm x 1mm x 1mm ……(ii)

Substituting (i) in (ii)

$1mm^3 = \frac{1}{1000}m \times \frac{1}{1000}m \times \frac{1}{1000}m$

$1mm^3 = \frac{1}{1000 \times 1000 \times 1000}m^3$

Example: change $600mm^3$ to m^3

$1mm^3 = \frac{1}{1000 \times 1000 \times 1000}m^3 = 1 \times 10^{-9}m^3$

$\therefore 6000mm^3 = 6000 \times \frac{1}{1000 \times 1000 \times 1000}m^3 = \frac{6}{1000000}m^3$**$= 0.000006\ m^3$**

Changing litre

1litre = $1000cm^3$

But $1cm^3 = \frac{1}{100 \times 100 \times 100}$

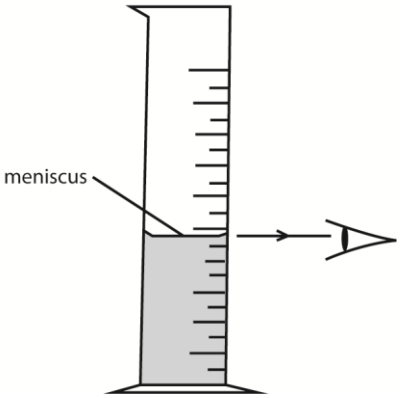
1litre = $\frac{1}{1000}m^3$

1litre $=1000cm^3 = \frac{1}{100 \times 100 \times 100} \times 1000 = 10^{-3}m^3$

Measurement of volume of liquids

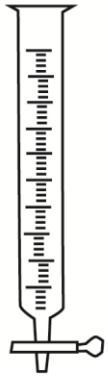
The volume of a liquid is obtained by using a measuring cylinder. When taking the reading of the liquid level, the eye position should be upright at the bottom mark of the curved liquid surface.

Measuring cylinder



The volume of a liquid can be measured accurately using burette, pipette or measuring cylinder

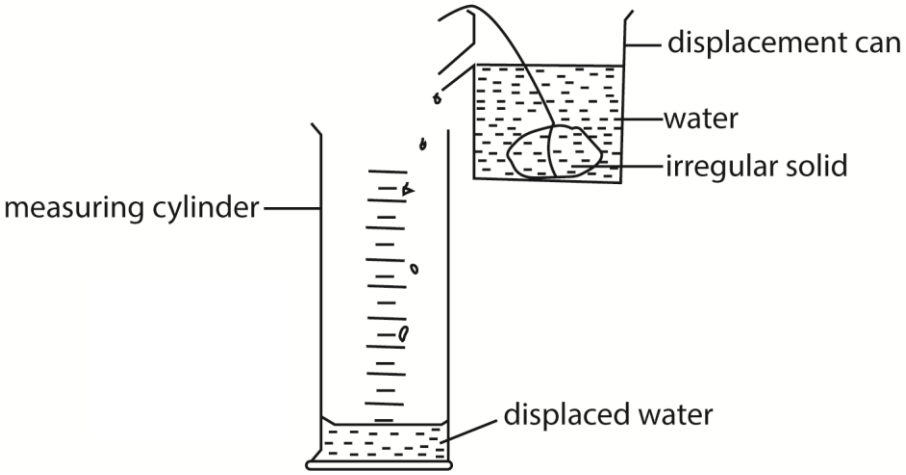
Burette



Volume of irregular objects

The volume of irregular objects like a stone is measured by displacement method using a displacement can

Apparatus to measure volume ofirregular object



Water is poured in the displacement can until it over flows. Then with the measuring cylinder in position, the irregular object is lowered into the displacement can until it is completely immersed. The displaced water is collected in a measuring cylinder.

Volume of irregular objects =Volume of the displaced water.

Mass

Mass is the amount of matter in a substance. The S.I unit of mass is kilogram (kg)

Unit	Symbol	Comparison with kg
1 tonne		1000kg
1 kilogram	kg	1kg
1 gram	g	$\frac{1}{1000}$kg = 0.001kg
1Milligram	mg	$\frac{1}{1000000}$kg = 0.000001kg

Mass does not vary with temperature, pressure or any other physical change. Mass will have the same value one earth, moon or in free space. In short mass is constant. The common instrument for measuring mass is a beam balance. Other instruments include triple- beam balance, lever arm balance and an electronic balance

Changing grams (g) to kilogram (kg)

1kg = 1000g

1000g = 1kg

Dividing by 1000

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

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

Change 640g to kg

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

640 g = 640 x $\frac{1}{1000}$kg= $\frac{64}{100}$= **0.64kg**

Note: Mass is also a scalar quantity (one with magnitude only)

Differences between mass and weight

Mass	Weight
- Is quantity of matter in substance	- Is force of gravity acting on body
- S.I unit in kg	- S.I unit is N
- Is constant	- Weight varies
- Is measured using beam balance	- Is measured using a spring balance
- Is scalar quantity	- Is a vector quantity
-Is a fundamental physical quantity	- Is a derived physical quantity

Time

Time is the period or interval between events. S.I unit of time is seconds(s) and other units are hours, days, weeks, or months.

Density
Density is mass per unit volume of substance.

SCALARS AND VECTORS
Physical quantities can be divided into two types namely:
(i) Scalar and (ii) vector quantity

A scalar quantity is one which has magnitude only.
Examples: Mass, Volume, time, temperature distance, pressure etc.
A vector quantity is one which has both magnitude and direction.
Examples: Velocity, acceleration. Force, momentum displacement etc.

Difference between vector and scalar.

Vector	**Scalar**
has both magnitude and direction	has magnitude only

Exercise

1. Which one of the following list contains vector quantities only?
    A. Kinetic energy, potential energy, velocity
    B. Acceleration, displacement, force
    C. Displacement, kinetic energy, power
    D. Time, velocity, density
2. Which of the following sets contains only vector quantities?
    A. weight, displacement, acceleration, magnetic field
    B. energy, electric field, momentum, distance
    C. mass, negatively, force, speed
    D. specific heat capacity, power, time, volume
3. Which of the following group consists of vectors only
    A. momentum, acceleration, work, energy
    B. speed, velocity, displacement, energy
    C. displacement, velocity, acceleration, force
    D. velocity, work, power, momentum
4. Length, mass and current are
    A. units of measurement
    B. derived quantities
    C. fundamental quantities

D. measured in metres, Newton and amperes respectively

5. A set of apparatus that is suitable for measurement of the volume of an irregular object includes;
   A. Over flow can, measuring cylinder, irregular object and a string.
   B. Measuring cylinder, irregular object, over flow cans, flask
   C. Overflow can,. Irregular objects, string, retort sand and burette
   D. Burette, overflows can, irregular object, a string, measuring cylinder, and retort stand .
6. Which one of the following can be used to measure the diameter of a bicycle spoke accurately?
   A. metre rule
   B. vernier caliper
   C. tape measure
   D. micrometer screw gauge
7. The width of a metre rule is accurately measured by a

   A. micrometer screw gauge. B. vernier caliper.

   C. tape measure, D. metre rule.

8. The three basic quantities of measurement are

   A. mass, frequency and power. B. time, density and pressure.

   C. area, electric current and volume. D. length, mass and time.

9. The most suitable instrument for measuring the outer diameter of a test tube is

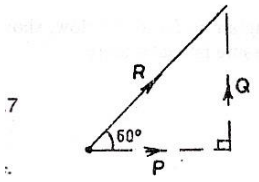
   A. a ruler. B. a tape measure.

   C. vernier callipers. D. a micrometer screw gauge

10. Which one of the following is a derived unit?
    A. Newton
    B. Meter
    C. Kilogram
    D. second

11. a) What is a vector quantity?

    b) The figure shows the resultant R of two forces P and Q. R makes an angle of 60^0 with a horizontal and P is 50N.



Find the magnitude of (i) Q (ii) R

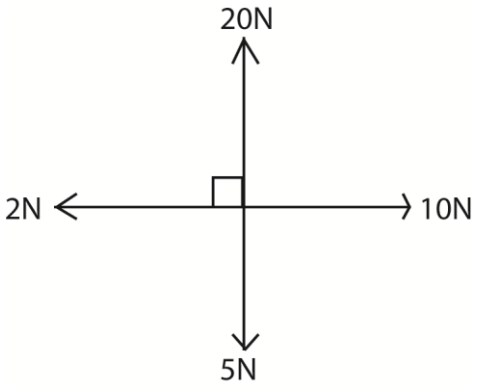
12. (a) (i) Distinguish between scalar and vector quantities

A scalar quantity has only magnitude e.g. speed, distance, mass, volume

Vector quantities have both magnitude and direction, e.g. velocity, displacement, force weight,

(ii) Give one example in each

(b) Four forces of 2N, 5N, 10N and 20N act on a doll as shown in the figure below



Find the magnitude of the resultant force acting on the doll.

Resultant upward force = 20 – 5 = 15N

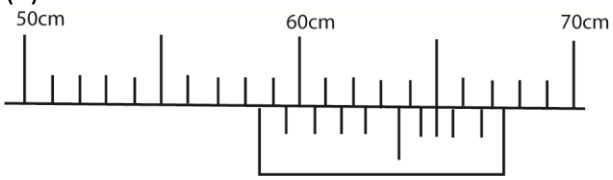
Resultant horizontal force = 10 – 2 = 8N

Using Pythagoras theorem

Resultant force = $\sqrt{(15^2 + 8^2)}$ =17N

13. What are the lengths of the objects below?

(a)



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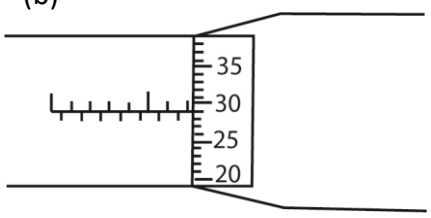

Suggested answers

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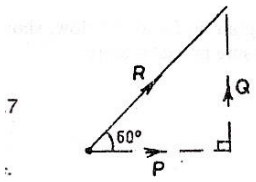

    Find the magnitude of

    (i) Q
    Q=Rsin 60
    = 100 sin 60
    = 86.6N

    (ii) R
    Rcos 60 = 50N
    R = 100N

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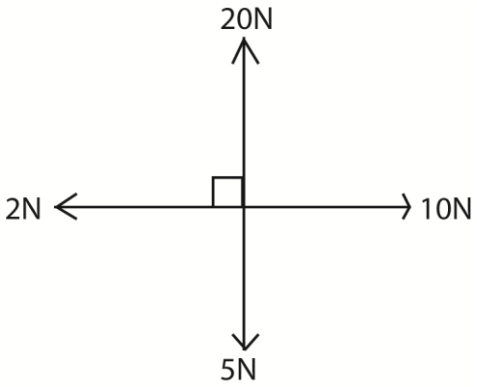

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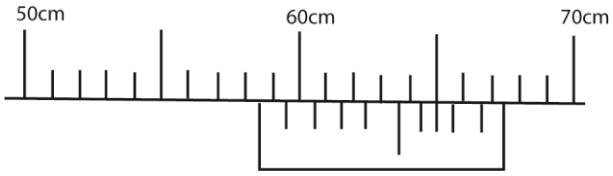
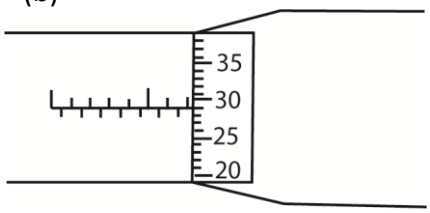


Reads = 58.7cm

(b)



Reads = 7.29mm

Thank you