CONTENTS

1 MATHEMATICAL TOOLS FOR PHYSICS-I

LEARNING OBJECTIVES:-

- To know how to find the mean
- To calculate squares, square roots, cube and cubic roots
- To know exponential and powers
- To know square and cube identities
- To convert standard form into scientific notation
- To solve quadratic equations

TEACHER ACTIVITY:-

Calculation of mean

1) In an examination the marks obtained by a student are: Tamil-78, English-84, Maths-100, Science-86 and social science-90. Calculate the mean.

$$Mean = \frac{78+84+100+86+90}{5} = \frac{438}{5} = 87.6$$

2) The runs scored by a batsman in a one day series are 80, 77, 164, 0, 96 and 111. Calculate the average runs

$$Mean = \frac{80+77+164+0+96+111}{6} = \frac{528}{6} = 88$$

3) In the experiment of determining thickness of the wire using screw gauge, the readings are (in mm) 1.83, 1.86, 1.85, 1.87 and 1.84. Find the mean thickness.

$$Mean = \frac{1.83+1.86+1.85+1.87+1.84}{5} = \frac{9.25}{5} = 1.85mm$$

Squares:-

$4^2 = 16$; This says "4 square is 16"

The 2 at the top stands for square and it indicates the number of times the number 4 appears in the product. The number 1, 4, 9, 16 ...... are square numbers.

The numbers end with 2,3,7 and 8 are not perfect squares

Numbers	Its square	Number	Its square	Number	Its square	Number	Its square
1	1	6	36	11	121	16	256
2	4	7	49	12	144	17	289
3	9	8	64	13	169	18	324
4	16	9	81	14	196	19	361
5	25	10	100	15	225	20	400

Examples:

1). The side of a square field is 56 m. Find its area.
Area of the square field $= a^2$ = side x side
$= 56 \times 56 = 3136\ m^2$

2) The inner length of the carrom board is 76 cm. Calculate the inner area.
Area of the inner side $= a^2$ = side x side
$= 76 \times 76 = 5776\ cm^2$

Square roots:

For the addition the inverse is subtraction, for multiplication inverse is division. Similarly, square roots are the inverse of squares. The square root of a number n, written as $\sqrt{n}$ or $n^{1/2}$, is the number that gives n when multiplied by itself. $\sqrt{81} = (81)^{1/2} = \sqrt{9 \times 9} = 9$. Similarly, $\sqrt{4} = 2$, $\sqrt{256} = 16$.

The positive square root of number is always denoted by the symbol $\sqrt{\ }$.

SQUARE ROOT	REASON
$\sqrt{1} = 1$	$1^2 = 1$
$\sqrt{4} = 2$	$2^2 = 4$
$\sqrt{9} = 3$	$3^2 = 9$
$\sqrt{16} = 4$	$4^2 = 16$
$\sqrt{25} = 5$	$5^2 = 25$
$\sqrt{36} = 6$	$6^2 = 36$
$\sqrt{49} = 7$	$7^2 = 49$
$\sqrt{64} = 8$	$8^2 = 64$
$\sqrt{81} = 9$	$9^2 = 81$
$\sqrt{100} = 10$	$10^2 = 100$

Also $(-4)^2 = -4 \times -4 = 16$
The square of $-10 = -10 \times -10 = 100$

Similarly square roots of 64 are 8, -8 because 8 x 8 = 64 and also -8 x -8 = 64. So while solving problems in physics we should write $\sqrt{256} = \pm 16$ and $\sqrt{100} = \pm 10$.

Square root through prime factorisation:

2	324
2	162
3	81
3	27
3	9
3	3
	1

Find the square root of 324 by prime factorisation

$$324 = 2 \times 2 \times 3 \times 3 \times 3 \times 3 = 2^2 \times 3^2 \times 3^2 = (2 \times 3 \times 3)^2$$

$$\sqrt{324} = \sqrt{(2 \times 3 \times 3)^2} = 2 \times 3 \times 3$$

$$\sqrt{324} = 18$$

Long division method:

Find the root of 576 by long division method $\sqrt{576} = 24$

		2 4
	2	5 76
4	4	1 76
		1 76
		0

Square root of decimal number:

Find the square root of 42.25 by long division method $\sqrt{42.25} = 6.5$

$$\begin{array}{r|l} & 6\ \ 5 \\ \hline 6 & \overline{42}\ \overline{25} \\ & 36 \\ \hline 125 & 6\ 25 \\ & 6\ 25 \\ \hline & \ \ 0 \end{array}$$

Teacher may give some more problems to students and ask to solve them.

Cube and cube roots:

Cube : If you multiply a number by itself and then by itself again, the result is cubic number. This means that a cube number is a number that is product of three identical numbers. If no is a number, its cube is represented by n^3($n \times n \times n = n^3$)

The perfect cubes of natural numbers are 1, 8, 27, 64, 125, 216 .... and so on.

Cube of 4 = 64 i.e., 4 x 4 x 4 = 64. It is expressed as $4^3 = 64$.

Cube root :

The cube root of the number is the value that when cubed gives the original number. For example, cube root of 64 is 4 because when 4 is cubed we get 64.

The cube root of a number is denoted as

$$\sqrt[3]{x}\ (or)\ x^{\frac{1}{3}}$$

Cubes	Cube roots	Cubes	Cube roots
1	1	343	7
8	2	512	8
27	3	729	9
64	4	1000	10
125	5	1331	11
216	6	1728	12

Law of exponentials:

1) Product law:

According to this law, when multiplying two powers that have the same base we can add the exponents. That is

$$a^m \times a^n = a^{(m+n)}$$

Examples :

i) $10^5 \times 10^3 = 10^{(5+3)} = 10^8$ ii) $2^{(-4)} \times 2^4 = 2^{(-4+4)} = 2^0 = 1$

2) Quotient law:

According to this law, when dividing two powers that have the same base we can subtract the exponents. That is

$$\frac{a^m}{a^n} = a^{m-n}$$

Examples :

i) $\frac{10^5}{10^3} = 10^{5-3} = 10^2 = 100$ ii) $\frac{10^8}{10^{-34}} = 10^{8-(-34)} = 10^{42}$

3) Power law:

According to this law, when raising a power to another power we can just multiply the exponents. That is $(a^m)^n = a^{m \times n}$

Examples:

i) $(-2^3)^2 = (-2)^6 = 64$ ii) $(10^2)^2 = 10^6$

Standard form and scientific notation:

Standard form of a number is just the number as we normally write it.

Examples: 16500, 764.87, 0.0043

A number in scientific notation is written as the product of number and the power of 10.

$$5 \times 10^n$$

Here S is a number from 1 to 9, n may be positive or negative integer

Example: 1.65×10^4, 7.6487×10^2, 4.3×10^{-3}

Mass of the Earth = 5.98×10^{24} kg

Mass of an electron = 9.11×10^{-31} *kg*

Identities :

1. $(a + b)^2 = a^2 + 2ab + b^2$
2. $(a - b)^2 = a^2 - 2ab + b^2$
3. $(a^2 - b^2) = (a + b)(a - b)$
4. $(a + b)^2 (a-b)^2 = (a^2 - b^2)^2$
5. $(x + a)(x + b) = x^2 + (a + b)x + ab$

Cubic identities:

1. $(a + b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$
2. $(a - b)^3 = a^3 - 3a^2b + 3ab^2 - b^3$
3. $(x+ a)(x + b)(x + c) = x^3 + (a + b + c)x^2 + (ab + bc + ca)x + abc$

Quadratic equation

Let $ax^2 + bx + c = 0$, be a quadratic equation. Here **'a'** is a coefficient of x^2 and **'b'** is the coefficient of x and **'c'** is constant.

The solution of this quadratic equation is,

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Examples

1. $x^2 + 5x + 6 = 0$

$$\therefore x = \frac{-b \pm \sqrt{b^2 - (4ac)}}{2a}$$

here $a = 1 \quad b = 5 \quad c = 6$

$$\therefore x = \frac{-5 \pm \sqrt{25 - (4 \times 1 \times 6)}}{2 \times 1}$$

$$= \frac{-5 \pm \sqrt{25 - 24}}{2} = \frac{-5 \pm 1}{2} = \frac{-6}{2}, \frac{-4}{2} = -3, -2$$

$x = -3, -2$

Alternate method (by factorization)

1. $x^2 + 5x + 6 = 0$

$=(x + 3)(x + 2) = 0$

$x = -3; x = -2$

Solution set x = -3, -2

op	3,2
+	5
x	6

2. $x^2 - 5x + 6 = 0$

Here $a = 1 \quad b = -5 \quad c = 6$

$$\therefore x = \frac{-b \pm \sqrt{b^2 - (4ac)}}{2a}$$

$$= \frac{-(-5) \pm \sqrt{25 - (4 \times 1 \times 6)}}{2 \times 1}$$

$$= \frac{-5 \pm \sqrt{1}}{2} = \frac{5 \pm 1}{2} = \frac{6}{2}, \frac{4}{2} = 3, 2$$

$x = 3, 2$

Alternate method (by factorization)

2. $x^2 - 5x + 6 = 0$

=(x-3)(x-2)=0

x=3; x=2

Solution set x=3,2

op	-3,-2
+	-5
x	6

EVALUATION:

1. Find the square root of the following:

   (i) 400 (ii) 1764 (iii) 9801

   (iv) 2.89 (v) 67.24 (vi) 2.0164

2. The cube of the number is 729, then what is the square root?

3. Express in scientific notation.

   (i) 467800000000 (ii) 0.000001972

4. Solve

   (i) $\frac{10^{13} \times 10^{-2}}{10^5}$ (ii) $\frac{10^{-6} \times 10^{-3} \times 10^8}{10^4}$

5. Solve the following quadratic equations

   (i) $x^2 + 8x + 15 = 0$ (ii) $x^2 + 12x + 32 = 0$ (iii) $x^2 - 9 = 0$

2 MATHEMATICAL TOOLS FOR PHYSICS-II

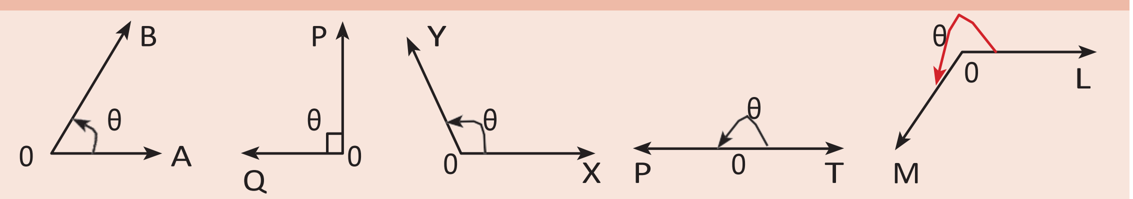
LEARNING OBJECTIVES

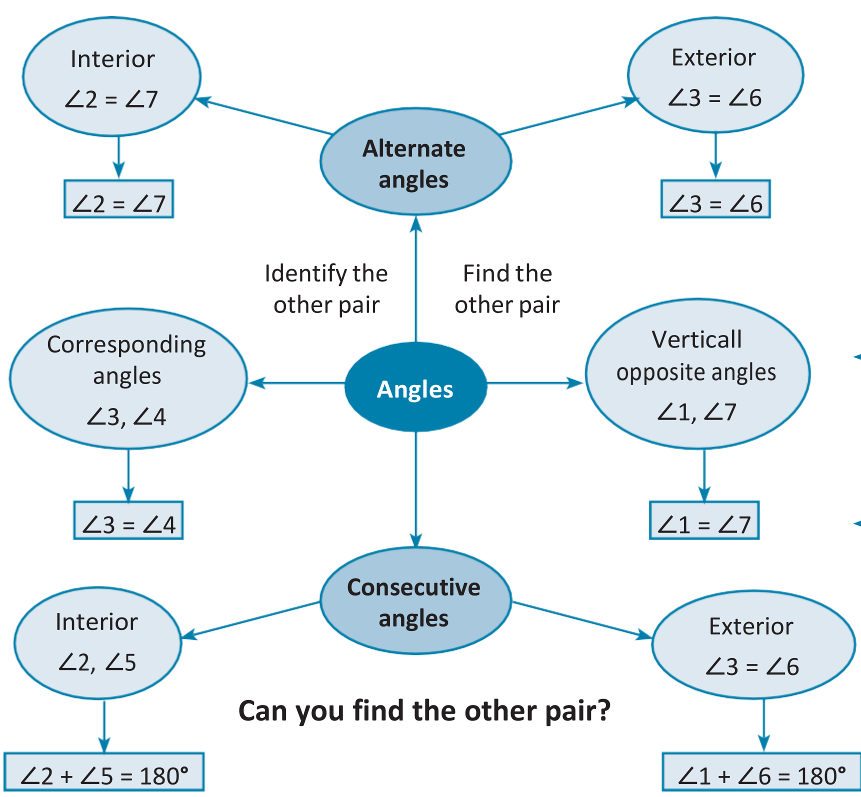
- To retrieve fundamentals of angles and triangles.
- To recall the formula of few known shapes.
- To recall trigonometric ideas & direct and indirect proportions.

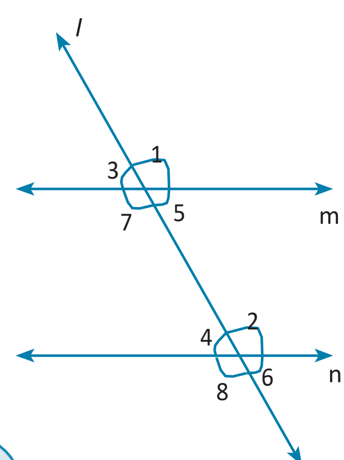
TEACHER ACTIVITY:

Angles

Acute Angle	Right Angle	Obtuse Angle	Straight Angle	Reflex Angle
$0 < \theta < 90^{\circ}$	$\theta = 90^{\circ}$	$90^{\circ} < \theta < 180^{\circ}$	$\theta = 180^{\circ}$	$180^{\circ} < \theta < 360^{\circ}$

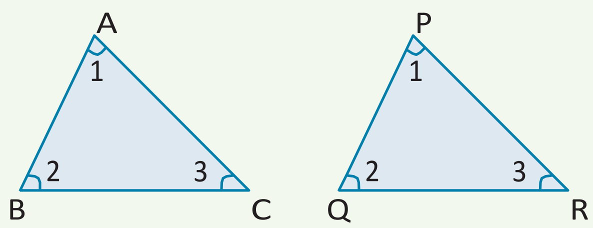
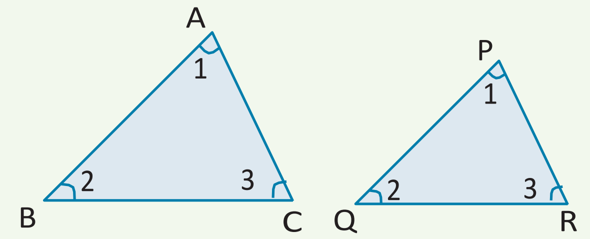




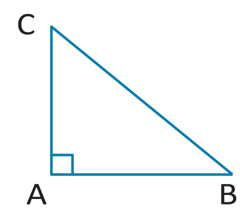


$\angle 4$ and $\angle 5$ are alternative angles

Triangles:

Congruent triangles	Similar triangles
	
$\Delta ABC \cong \Delta PQR$ $\angle A = \angle P,\ \angle B = \angle Q,\ \angle C = \angle R$ $AB = PQ,\ BC = QR,\ CA = RP$ $\frac{AB}{PQ} = \frac{BC}{QR} = \frac{CA}{RP} = 1$ Same shape and same size.	$\Delta ABC \sim \Delta PQR$ $\angle A = \angle P,\ \angle B = \angle Q,\ \angle C = \angle R$ $AB \neq PQ,\ BC \neq QR,\ CA \neq RP$ $but\ \frac{AB}{PQ} = \frac{BC}{QR} = \frac{CA}{RP} > 1\ or\ < 1$ Same shape but not same size.

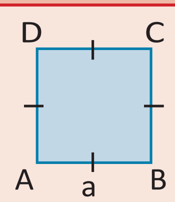
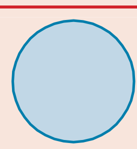
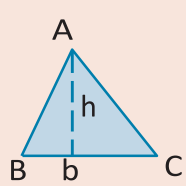
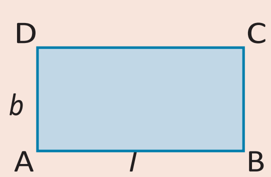
Right angle triangles:

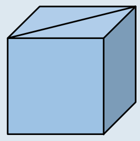
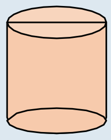
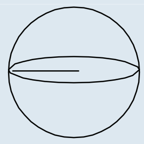
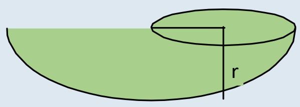


Inaright-angletriangle, thesquareonthehypotenuseisequaltothesumofthe squares of the other two sides.

$\Delta ABC,\ BC^2 = AB^2 + AC^2$

Perimeter and area of different shapes:

S.No	Shape	Name	Area (sq units)	Perimeter (units)
1		Square	a^2	4a
2		Circle	πr^2	$2\pi r$
3		Triangle	$\frac{1}{2} \times b \times h$	*Sum of all three sides*
4		Rectangle	$l \times b$	$2\ (l+b)$

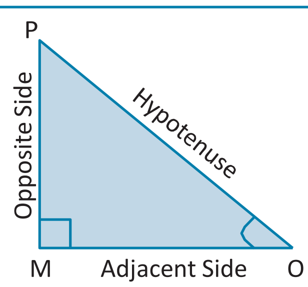
Solids	Picture	CSA /LSA (in SQ Units)	TSA (in SQ Units)	Volume (cubic units)
Cube		$4a^2$	$6a^2$	a^3
Right circular cylinder		$2\pi rh$	$2\pi r(h+r)$	$\pi r^2 h$
Sphere		$4\pi r^2$	$4\pi r^2$	$\frac{4}{3}\pi r^3$
Hemisphere		$2\pi r^2$	$2\pi r^2$	$2\pi r^3$

Trigonometry ratios:

Recall

Trigonometric Ratios

Let $0° < \theta < 90°$



Let us take right triangle OMP

$$\sin\theta = \frac{\textit{Opposite side}}{\textit{Hypotenuse}} = \frac{MP}{OP}$$

$$\cos\theta = \frac{\textit{Adjacent side}}{\textit{Hypotenuse}} = \frac{OM}{OP}$$

From the above two ratios we can obtain other four trigonometric ratios as follows.

Trigonometric ratios of complementary angle

$\tan\theta = \frac{\sin\theta}{\cos\theta}$; $\cot\theta = \frac{\cos\theta}{\sin\theta}$;	$\sin(90° - \theta) = \cos\theta$	$\cos(90° - \theta) = \sin\theta$	$\tan(90° - \theta) = \cot\theta$
$\operatorname{cosec}\theta = \frac{1}{\sin\theta}$; $\sec\theta = \frac{1}{\cos\theta}$	$\operatorname{cosec}(90° - \theta) = \sec\theta$	$\sec(90° - \theta) = \operatorname{cosec}\theta$	$\cot(90° - \theta) = \tan\theta$

These identities can also be rewritten as follows:

Identity	Equal forms
$\sin^2\theta + \cos^2\theta = 1$	$\sin^2\theta = 1 - \cos^2\theta$ (or) $\cos^2\theta = 1 - \sin^2\theta$
$1 + \tan^2\theta = \sec^2\theta$	$\tan^2\theta = \sec^2\theta - 1$ (or) $\sec^2\theta - \tan^2\theta = 1$
$1 + \cot^2\theta = \operatorname{cosec}^2\theta$	$\cot^2\theta = \operatorname{cosec}^2\theta - 1$ (or) $\operatorname{cosec}^2\theta - \cot^2\theta = 1$

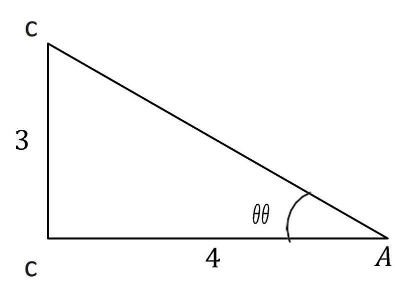
Table of Trigoometric Ratios for 0°, 30°, 45°, 60°, 90°

θ / Trigonometric Ratio	0°	30°	45°	60°	90°
sinθ	0	$\frac{1}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{\sqrt{3}}{2}$	1
cosθ	1	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{2}}$	$\frac{1}{2}$	0
tanθ	0	$\frac{1}{\sqrt{3}}$	1	$\sqrt{3}$	undefined
cosecθ	undefined	2	$\sqrt{2}$	$\frac{2}{\sqrt{3}}$	1
secθ	1	$\frac{2}{\sqrt{3}}$	$\sqrt{2}$	2	undefined
cotθ	undefined	$\sqrt{3}$	1	$\frac{1}{\sqrt{3}}$	0

Examples

1) Find the values of sin θ, cos θ and tan θ from the triangle ABC
By Pythagoras theorem $AC^2 = AB^2 + BC^2 = 3^2 + 4^2 = 25$

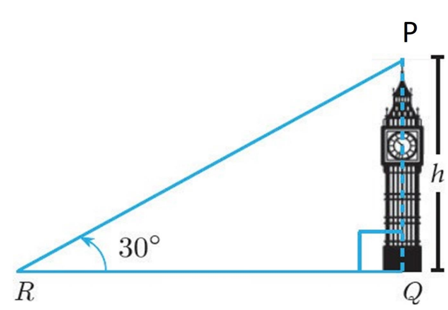
$$AC = \sqrt{25} = 5$$
$$\sin\theta = \frac{BC}{AC} = \frac{3}{5}$$
$$\cos\theta = \frac{AB}{AC} = \frac{4}{5}$$
$$\tan\theta = \frac{BC}{AB} = \frac{3}{4}$$



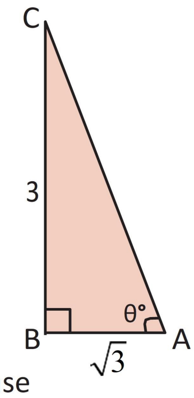
2) A tower stands vertically on the ground. From a point on the ground, which is 48 m away from the foot of the tower, the angle of elevation of the top of the tower is 30. Find the height of the tower.

In the right angle triangle Δ PQR, ∠PRQ = 30°

$$\tan\theta = \frac{PQ}{QR}$$
$$\tan 30° = \frac{h}{48}$$
$$h = 48 \times \tan 30° = 16 \times \sqrt{3}\,m$$



3) Find the values of tan θ and θ from the triangle ABC



$$\tan\theta = \frac{BC}{AB} = \frac{3}{\sqrt{3}} = \sqrt{3} = 1.732$$

$$\theta = \tan^{-1}\left(\sqrt{3}\right) = 60°$$

(From the table of trigonometry ratio)

Direct proportion and inverse proportion:

1) If the radius (r) of the circle increases area (A) will increase

$A \,\alpha\, r^2 \Rightarrow \pi r^2$ (direct proportion)

2) When men power (N) increases working time (t) decreases

$N\alpha \frac{1}{t} \Rightarrow N = \frac{k}{t}$ (inverse proportion)

3) When the pressure (P) of gas increases the volume (V) will decrease

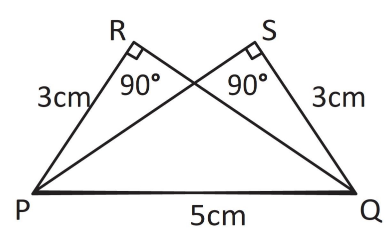
$P \,\alpha\, \frac{1}{v}$ (inverse proportion)

4) If the travelling distance (d) increases ticket fare (R) will also increase.

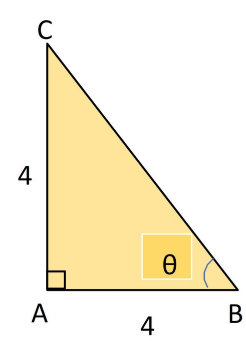
$R \,\alpha\, d$ (direct proportion)

EVALUATION:

1. Is ΔPRQ ≡ ΔQSP? Why?

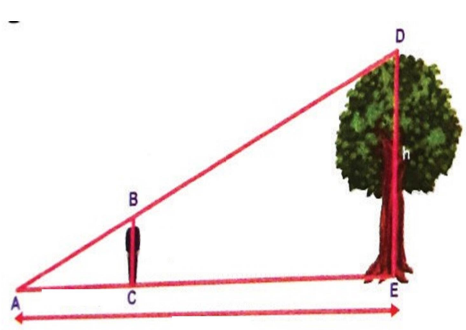


2. Find the values of trigonometric ratios and the value of θ.



3. The height of a man and his shadow form a triangle similar to that formed by a near by tree and its shadow. What is the height of the tree?

AE = 96 ft, AC =12 ft and BC = 5 ft.



3 MATHEMATICAL TOOLS FOR PHYSICS-III

LEARNING OBJECTIVES:

- To know about graphs.

TEACHER ACTIVITY:

Graph sheets:

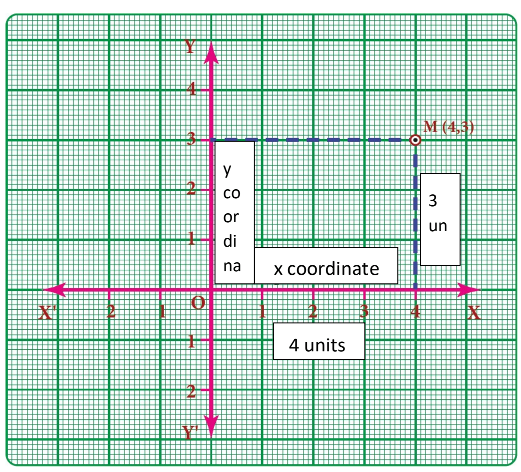
Graph is just a visual method of showing relationship between numbers. We take two number lines, (one is horizontal, and another is vertical) and keep them mutually perpendicular at "0". The horizontal line named as **XOX'** is called the x axis. The vertical line named as **YOY'** is called the y axis. Both the axes are called coordinate axes. The plane containing x and y axes is known as coordinate plane or the cartesian plane.

Signs in the graph

1. X- coordinate of a point is positive along OX and negative along OX'.
2. Y- coordinate of a point is positive along OY and negative along OY'

Ordered pairs:

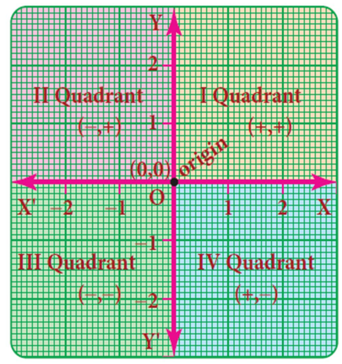
A point represents a position in a plane. A point is denoted by a pair (a,b) of two members a and b listed in specific order in which "a" represents distance along the x axis and "b" represents distance along the y axis. It is called an ordered pair (a,b).



Quadrants:

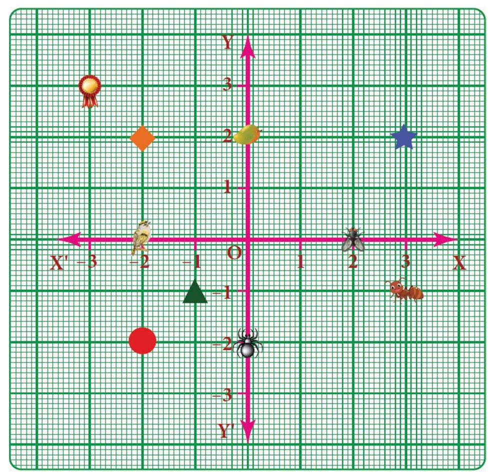
The coordinate axes divide the plane of the graph into four regions called quadrants. It is a convention that the quadrants are named in the anti-clock wise sense starting from the positive side of the x axis.

Quadrant	Sign
I the region XOY	x > 0, y > 0, then the coordinates are (+, +) Examples: (5, 7) (2, 9) (10, 15)
II the region XOY	x < 0, y > 0, then the coordinates are (−, +) Examples: (− 2, 8) (−1, 10) (−5, 3)
III the region XOY	x < 0, y < 0, then the coordinates are (−, −) Examples: (−2, −3) (−7, −1) (−5, −7)
IV the region XOY	x > 0, y > 0, then the coordinates are (+, −) Examples: (1, −7) (4, −2) (9, −3)



Use the graph to determine the coordinates where each figure is located .

a) star_______________
b) bird_______________
c) red circle___________
d) diamond_______________
e) triangle_____________
f) ant_______________
g) mango_______________
h) house fly_______________
i) medal_______________
j) spider_______________

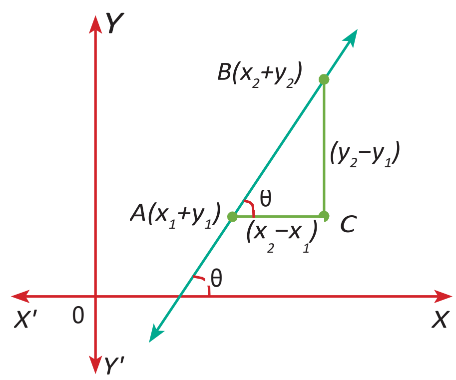


Slope:

If θ is the angle of inclination of a non vertical straight, then tan θ is called slope of the line and it is denoted by "m"

$$Slope\ \ m = \tan\theta = \frac{opposite\ side}{adjacent\ side} = \frac{BC}{AC} = \frac{y_2 - y_1}{x_2 - x_1}$$

$$Slope\ \ m = \frac{difference\ in\ y\ coordinate}{difference\ in\ x\ coordinate}$$



When the line is on the x axis and parallel to x axis the angle of inclination is 0°.

Here the slope is 0. (m=tan 0° = 0)

When the line is on the y axis and parallel to y axis, the angle of inclination is 90°.

Here the slope is undefined. (m = tan 90^0 = ∞)

EVALUATION :

1. Draw a straight line by joining the points A (-2,6) and B (4,-3).
2. Draw straight lines by joining the points A (2,5) B (-5,-2) & M (-5,4) N (1,-2). Also find the point of intersection.
3. Draw the graph of x = 5
4. Draw the graph of y = 5x

4 MEASUREMENT-I

LEARNING OBJECTIVES:

- To understand the fundamental and derived quantities and their units.
- To know the rules to be followed while expressing physical quantities in SI units.
- To get familiar with the usage of scientific notations.

TEACHER ACTIVITY:

Introduction:

Measurement is the basis of all important scientific studies. It plays an important role in our daily life also. While finding our height, buying milk for our family, timing the race completed by friend and so on, we need to make measurements. Measurement answers questions like, how long, how heavy and how fast?. Physical quantity is a quantity that can be measured. Physical quantities can be classified into two:

1. Fundamental quantities
2. Derived quantities.

1. Quantities which cannot be expressed in terms of any other physical quantities are called fundamental quantities. Example: length, mass, time, temperature etc. ,
2. Quantities which can be expressed in terms of fundamental quantities are called derived quantities. Example: area, volume, density etc.,

Units: A unit is a standard quantity with which the unknown quantities are compared. It is defined as a specific magnitude of a physical quantity that has been adopted by law or convention.

System	Length	Mass	Time
CGS	centimetre	gram	second
FPS	foot	pound	second
MKS	metre	kilogram	second

S.I SYSTEM OF UNITS:-

S.I System of units is the modernised and improved form of the previous system of units. It is accepted in almost all the countries. It is based on a certain set of fundamental units from which derived units are obtained by proper combination. There are seven fundamental units in the SI System of units.

Fundamental quantities and their units

Fundamental quantities	Units	Symbol
Length	metre	m
Mass	kilogram	kg
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Luminous intensity	candela	cd
Amount of substance	mol	mol

Derived quantities and their units

S.No	Physical quantity	Expression	Unit
1	Area	Length x Breadth	m^2
2	Volume	Area x height	m^3
3	Density	Mass/volume	kgm^{-3}
4	Velocity	Displacement/time	ms^{-1}
5	Momentum	Mass x velocity	$kgms^{-1}$
6	Acceleration	Velocity/time	ms^{-2}
7	Force	Mass x acceleration	$kgms^{-2}$ or N
8	Pressure	Force/area	Nm^{-2} or Pa
9	Energy (Work)	Force x distance	Nm or J
10	Surface Tension	Force/length	Nm^{-1}

EVALUATION:

1. What do you mean by measurement?.
2. Define unit.
3. What is SI unit?
4. What are fundamental and derived quantities? Give examples.
5. Write any five derived quantities and their SI units.

5 MEASUREMENT-II

LEARNING OBJECTIVES:

- To learn the units of Fundamental quantities
- To learn the rules and conventions for writing SI units and their symbols

TEACHER ACTIVITY:

Length:

Length is the extent of something between two points. The SI unit of length is metre. One metre is the distance travelled by light through vacuum in 1/29,97,92,458 second.

To measure small distances such as distance between two atoms in a molecule, size of the nucleus and wavelength etc. we use submultiples of ten. These quantities are measured in Angstrom unit.

Smaller units of length are

Fermi (f)= 10^{-15}m

Angstrom (A°) = 10^{-10}m

Nanometre (nm) = 10^{-9}m

Micron (micrometre, μ m) = 10^{-6}m

Millimetre (mm) = 10^{-3}m

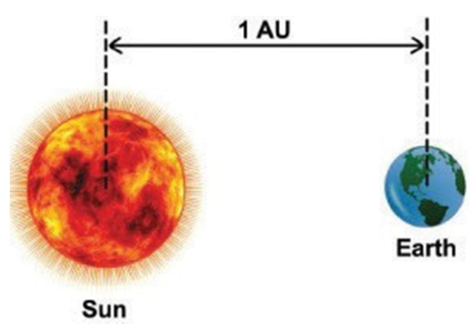
Centimetre (cm) = 10^{-2}m

Larger units of length: To measure larger distances we use astronomical unit light year and parsec.

Astronomical Unit : It is the mean distance of the centre of the sun from the centre of the earth. 1AU = 1.496 x 10^{11}m

Light year:

It is the distance travelled by light in one year in vacuum and it is equal to 9.46 x 10^{15}m



Parsec: Parsec is the unit of distance used to measure astronomical objects outside the solar system.   1 Parsec = 3.26 light year.

Mass:

Mass is the quantity of matter contained in a body. The SI unit of mass is kilogram (kg). One kilogram is the mass of a particular international prototype cylinder made of platinum-iridium alloy, kept at the International Bureau of Weights and Measures at Sevres, France.

The units gram (g) and milligram (mg) are the submultiples of ten (1/10) of the unit kg. Similarly quintal and metric tonne are multiples of ten (. 10) of the unit kg.

Smaller units of mass

1 g = 1/1000 kg = 0.001 kg;   1 mg = 1/1000000 kg = 0.000001 kg

Larger unit of mass:

1 quintal = 100 kg ; 1 metric tonne = 1000 kg = 10 quintal

Atomic mass unit

Mass of a proton, neutron and electron can be determined using atomic mass unit (amu).

1 amu = $(1/12)^{th}$ of the mass of C^{12} atom.

Time: Time is a measure of duration of events and the intervals between them. The SI unit of time is second.

It is also defined as 1/86, 400th part of a mean solar day. Larger units for measuring time are:

One day, = 86400 s

Month = 25 ,97, 000 second (30 days)

One year = 94,60,80,000 second (365 days)

1 millenium = 3.16×10^{9}s.

Temperature:

Temperature is the measure of hotness or coldness of a body. SI unit of temperature is kelvin (K). One kelvin is the fraction (1/273.16) of the thermodynamic temperature of the triple point of water (The temperature at which saturated water vapour, pure water and melting ice are in equilibrium).

Zero kelvin (0 K) is commonly known as absolute zero. The other units for measuring temperature are degree celsius (°C) and fahrenheit (F).

Power of 10	Prefix	Symbol
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M

10^{3}	kilo	k
10^{2}	hecto	h
10^{1}	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	µ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f

Rules and conventions for writing SI units and their symbols:

1. The units named after scientists are not written with a capital initial letter. E.g. newton, henry, ampere and watt.
2. The symbols of the units named after scientists should be written by the initial capital letter. E.g. N for newton, H for henry, A for ampere and W for watt.
3. Small letters are used as symbols for units not derived from a proper noun. E.g. m for metre, kg for kilogram.
4. No full stop or other punctuation marks should be used within or at the end of symbols. E.g. 50 m and not as 50 m.
5. The symbols of the units are not expressed in plural form. E.g. 10 kg not as 10 kgs.
6. When temperature is expressed in kelvin, the degree sign is omitted. E.g. 283 K not as 283° K (If expressed in celsius scale, degree sign should be included e.g. 100°C not as 100 C, 108° F not as 108 F).
7. Use of solidus (/) is recommended for indicating a division of one unit symbol by another unit symbol. Not more than one solidus is used. E.g. ms^{-1} or m/s. J/K/mol should be $JK^{-1}\,mol^{-1}$.
8. The number and units should be separated by a space. **Example :** 15kg ms^{-1} not as $15kgms^{-1}$.
9. Accepted symbols alone should be used**. E.g.** ampere should not be written as amp and second should not be written as sec.
10. The numerical values of physical quantities should be written in scientific form. E.g The density of mercury should be written as 1.36×10^{4} kg m^{-3} not as 136000 kg m^{-3}

EVALUATION:

1. What is length?
2. Write the SI units of length, mass and time.
3. Write some of the smaller units of length.
4. What are the bigger units of time we use?
5. What are the terms AU and amu denote?

6 MOTION

LEARNING OBJECTIVES:

- To know about rest and motion, distance and displacement, objects describing a circular path.
- To classify uniform motion and non uniform motion and distinguish between speed and velocity.

TEACHER ACTIVITY:

Motion is the change in the position of an object with respect to its surrounding. Everything in the universe is in motion. Even though an object seems to be not moving, actually it is moving because the Earth is moving around the Sun. Motion is a relative phenomenon.

TYPES OF MOTION:

1. **Linear motion:** Motion along a straight line.
2. **Circular motion:** Motion along a circular path.
3. **Oscillatory motion:** Repetitive to and fro motion of an object at regular interval of time.
4. **Random motion:** Motion of the object which does not fall in any of the above categories.

UNIFORM AND NON-UNIFORM MOTION:

Uniform motion:

An object is said to be in uniform motion if it covers equal distances in equal intervals of time.

Non-uniform motion:

An object is said to be in nonuniform motion if it covers unequal distances in equal intervals of time.

Distance:

The actual length of the path travelled by a moving body irrespective of the direction is called the distance travelled by the body. It's SI unit is metre. It is a scalar quantity having magnitude only.

Displacement:

It is defined as the change in position of a moving body in a particular direction. It is a vector quantity having both magnitude and direction. It is also measured in metre in SI system.

Speed:

Speed is the rate of change of distance or the distance travelled in unit time. It is a scalar quantity, its unit is ms^{-1}.

Speed = distance travelled / time taken

Problem 1:

An object travels 100 metre in 10 second. What is the speed of the object?

Speed = Distance travelled / Time taken

= 100/10

= 10 ms^{-1}

Problem 2:

A sound is heard 10 s later than the lightning is seen in the sky on a rainy day.

Find the distance of location of the lightning? Given the speed of sound =346 ms^{-1}

Speed = Distance travelled / Time taken

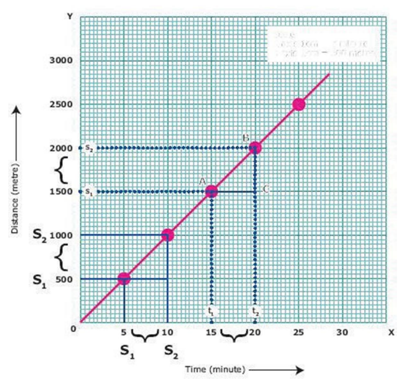
Distance = Speed x time

= 346 x 10

= 3460 m

Distance - time graph:

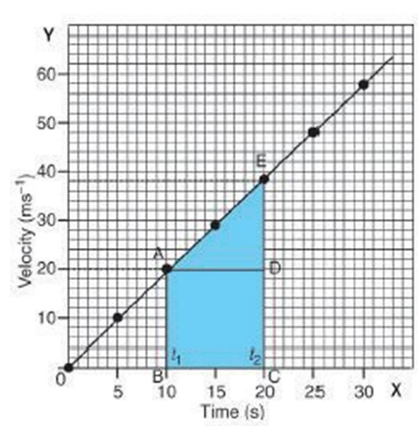
The **slope** of the distance time graph gives **speed.**



Velocity:

Velocity is the rate of change of displacement. It is the displacement in unit time. It is a vector quantity. The SI unit of velocity is ms^{-1}

Velocity = displacement / time taken



Velocity – Time Graph:

The **slope** of the graph gives **acceleration**

The area under velocity time graph represents the displacement covered by the moving object.

Acceleration:

Acceleration is the rate of change of velocity or it is the change of velocity in unit time. It is a vector quantity. The SI unit of acceleration is ms^{-1}.

Acceleration = Change in velocity/Time

= (Final velocity – Initial velocity)/Time

$a = (v-u)/t$

Equations of Motion:

Newton studied the motion of an object and gave a set of three equations. These equations relate displacement, velocity, acceleration and time of an object under motion. An object in motion with initial velocity 'u' attains a final velocity 'v' in time 't' due to acceleration 'a' and reaches a distance 's'. Three equations can be written for this motion.

$$v = u + at$$

$$s = ut + \frac{1}{2} a t^2$$

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

Motion of freely falling body:

The equation of motion for a freely falling body can be obtained by replacing 'a' in equation with 'g', the acceleration due gravity.

For a freely falling body which is initially at rest, u = 0 and s = h , we get the equations as follow.

$v = gt$; $h = \frac{1}{2} gt^2$; $v^2 = 2gh$

EVALUATION:

1. A racing car has a uniform acceleration of 4 ms^{-2}. What distance it covers in 10 s after the start?
2. An object is moving with initial velocity of 25 ms^{-1} and after 10 s it reaches a final velocity of 50 ms^{-1}. Find its acceleration?
3. A freely falling body reaches the ground after 4 s, what is the height which it reaches?
4. An object is falling freely from a building of height 20 m. Find the velocity with which it strikes the ground?
5. When will the object get the same displacement and distance?