VIRAM SERIES

BASIC PHYSICS

AS PER SBTE, JHARKHAND SYLLABUS OF FIRST SEMESTER POLYTECHNIC STUDENTS

KHANNA PUBLISHERS

BASIC PHYSICS–I

As Per SBTE, Jharkhand Syllabus

for

First Semester Polytechnic Students

Compiled by

Khanna Editorial Team

KHANNA PUBLISHERS

4575/15, Onkar House, Ground Floor

Opp. Happy School, Darya Ganj, New Delhi-110002

Phones : **011.45033819** • *Mobile* : **9811541460**

Published by **:**

Romesh Chander Khanna & Vineet Khanna

for **KHANNA PUBLISHERS**

2-B, Nath Market, Nai Sarak,

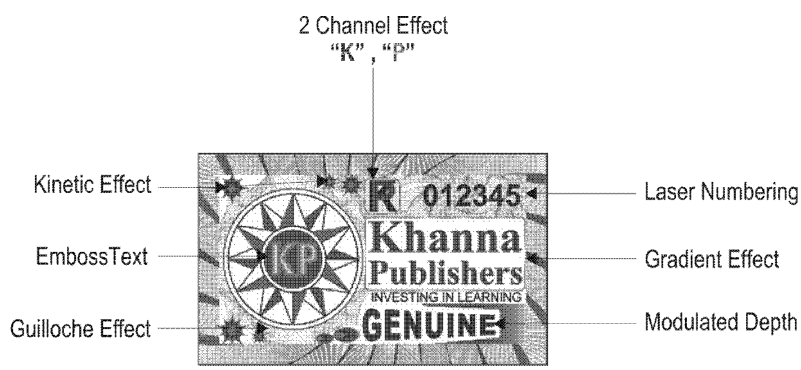
Delhi-110006 (India)

Visit us at : www.khannapublishers.in

Hologram & Description

To all readers of our books, to prevent yourself from being frauded by pirated books. Please make sure that there is an Hologram on the cover of our books with the below specifications. If you find any book without the Hologram or Description, please mail us at **contactus@khannapublishers.in**

Thanking you



ISBN : ***978-93-92549-85-4***

First Edition : ***2017***

Preface

The book physics has been written for the diploma students of SBTE, Jharkhand for their first semester course as per the E-scheme. The aim of writing this book is to be provide the students a clear understanding of the basic concepts and principles.

The subject matter has been developed in steps for easy understanding. Throughout the book, the stress has been given on the basic concepts through figures and solved examples.

Exercises, problems and Multiple Choice Questions (MCQs) with their answers and hints are provided at the end of each chapter.

The book is divided into seven chapters. At the end of each chapter, a brief summary is given for readers reference. Two model test papers are given in the end of the book.

Inspite of our best support, it is possible that some errors might have crept in. We shall acknowledge with gratitude, if any such error is brought in our notice.

Also, any suggestions and comments from students and teachers for improvement of the book are welcome.

We hope the book will be found useful by the readers.

Publishers

Contents

1

Units and Measurements

1.1 INTRODUCTION

Physics is a branch of science which deals with matter and energy and the relation between them. Physics deals broadly with nature and changes in nature. For a precise description of any such phenomena, the measurement of quantities is essential.

1.1.1 Need of Measurement and Unit in Engineering and Science

In almost every physical situation, we realize the necessity of measurement. If someone having fever, the measurement of body temperature is essential. When car runs on road by consuming petrol/deisel which costs us, the measurement of petrol/deisel consumed is must. Thus, we can say that the observation and measurement form the back bone of science and engineering.

The accurate measurements are essential for the development of physics, the perceptions beyond the given data shows are also important.

All the quantities in terms of which laws of physics are described and whose measurement are essential are called physical quantities.

The process of measurement is basically a comparison process. The measuring process involves the selection of unit of measurement and camparing quantity with the standard unit.

1.1.2 Definition of Unit

The description is based on the quantitative measurement of the physical quantities. So, length, mass, time, pressure, temperature, current and resistance are physical quantities.

The chosen standard of measurement of a quantity which has essentially the same nature as that of the physical quantity is called the unit of the quantity.

Concept of Length

Length of an object may be defined as the distance of separation between any two points at the extreme ends of the object.

The most common unit of length is metre (m). One metre is defined as the distance between two lines marked on a platinum-iridium bar kept at a constant temperature of 273.16 K and at 1 bar pressure.

Concept of Mass

Mass of an object may be defined as the quantity of matter is the object, which can never be zero. The mass of an object is not affected by the presence of other objects.

The most common unit of mass is kilogram (kg). The kilogram (kg) is defined as the mass of one cubic decimetre of water 4°C.

Concept of Time

The concept of time occurred first from the motion of the moon across the sky, the formation of day and night as a result of rotation of the earth around the axis. According the Einstein, time is what clock reads. In fact, the phenomena that repeats itself regularly can serve as a measure of time. Rotation of earth around its axis, revolution of earth around the sun, etc. are examples of repetitive phenomena, which serve as measure of time. The most of common unit of time is second.

One second is defined as the time taken by a simple pendulum of length one metre is going from one extreme position to the other extreme position. One solar day is the time internal between two successive noons.

The length of a solar day average over a year is called mean solar day.

$$1 \text{ mean solar day} = 24 \times 60 \times 60 = 86400 \text{ seconds}$$

$$\therefore \quad \text{One mean solar second} = \frac{1}{86400} \text{ part of a mean solar day.}$$

1.1.3 Requirements of Standard Unit

The units chosen for measuring any physical quantity should meet the following essential requirements:

- It should be accurately defined,
- It should be easily accessible,
- It should be of suitable size,
- It should not change with time,
- It should be easily reproducible and
- It should no change with changing physical conditions like temperature, pressure etc.

1.1.4 Fundamental and Derive Quantities

Those physical quantities which are independent of each other are called **fundamental quantities.** All other physical quantities which can be express in terms of fundamental quantities are called **derived quantities.** There are seven fundamental quantities namely, length, mass, time, electric current, temperature, amount of substance and luminous intensity.

All other physical quantities can be derived from these seven physical quantities. The units chosen for the measurement of fundamental quantities are called **fundamental units.** The units obtained for derived quantities are called **derived unit.**

For example, unit of speed or velocity is a derived units.

As, $$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\therefore \text{ Unit of speed/velocity} = \frac{\text{Unit of distance}}{\text{Unit of time}} = \frac{\text{m}}{\text{s}} = \text{ms}^{-1}$$

Similarly, the derived unit of area is m^2, derived unit of acceleration is ms^{-2} and so on.

1.2 SYSTEMS OF UNITS

The common systems of units used in mechanics are given below:

The CGS System. In this system, the units of length, mass and time are centimetre, gram and second respectively.

The MKS System. In this sytem, the units of length, mass and time are metre, kilogram and second respectively.

Do you know?

The FPS System: In this system, the units of length, mass and time are foot, pound and second respectively. It is the British Engineering System of units.

International System of Units (SI)

The 14th General Conference on Weights and Measures (CGPM) in 1971 agreed upon a system of units called the 'International System of Units' abbreviated as SI. The abbreviation is based on its French name '*Le Systeme International d'* unites.

The system of units, which is at present internationally accepted for measurement. This system of units is essentially a modification over the MKS system and therefore, called rationalised MKS system.

The SI is based on the following seven fundamental units and two supplementary units are given below in Table 1.

Table 1. Fundamental and Supplementary Units on SI

S. No.	Fundamental Physical Quantity	Symbol	Fundamental Units	Symbol of Units
1.	Mass	*m*	kilogram	kg
2.	Length	*l*	metre	m
3.	Time	*t*	second	s
4.	Temperature	*T*	kelvin	K
5.	Electric current	*I*	ampere	A
6.	Luminous intensity	*L*	candela	cd
7.	Amount of substance	*n*	mole	mol

S. No.	Supplementary Physical Quantity	Symbol	Supplementary Units	Symbol of Units
1.	Plane angle	rad	radian	rad
2.	Solid angle	sr	steradian	sr

The definitions of units of fundamental quantities is SI are as follows:

1. **The metre.** The metre is the distance of the path travelled by light in vacuum during time interval of $\frac{1}{299,792,458}$ second.

[Taking velocity of light in vacuum, c = 299,792,458 ms^{-1}.]

2. **The kilogram.** The kilogram is the mass of a cylinder made of platinum-iridium alloy kept at the Internationl Bureau of Weights and Measures at Sevres near Paris (France).

3. **The second.** The second is the time taken by light of specified wavelength emitted by a Cs-133 (cesium-133) atom to execute 9,192,631,770 vibrations.

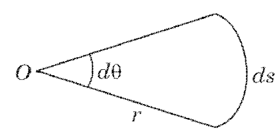
4. **The ampere.** The ampere is that current which when flowing in each of the two straight parallel conductors of infinite length and negligible cross-section, placed one metre apart in vacuum produces between the conductors, a force of 2×10^{-7} N/m length of each conductor.

5. **The kelvin.** One kelvin is $\frac{1}{273.16}$ of the thermo-dynamical temperature of the triple point of water.

6. **The mole.** The mole is the amount of substance that contains as many elementary entities (atoms or molecules) as there are atoms is 0.012 kg of pure carbon-12 (C–12). This number is called Avagadro's constant and its value is 6.023×10^{23}.

7. **The candela.** The candela is the luminous intensity of a black body of surface area $\frac{1}{6,00,000}$ sq. m placed at the temperature of freezing platinum (Pt) and at pressure of 101,325 Nm^{-2}, in the perpendicular to its surface.

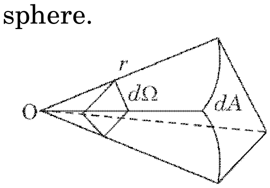
8. **The radian (rad).** The radian is the angle subtended at the centre of a circle by an arc equal in length to the radius of circle.



$$d\theta = \frac{ds}{r} \text{ radian}$$

where, $ds \rightarrow$ arc of length and subtends an angle = $d\theta$

9. **The steradian (sr).** the steradian is the solid angle subtended at the centre of the sphere by an area of its surface equal to the square of the radius of the sphere.



$$d\Omega = \frac{dA}{r^2} \text{ steradian}$$

where, $d\Omega$ = solid angle,

dA = area of spherical surface and

r = radius

1.2.1 Rules are Formulated for Writing the Symbols of SI Units

The following rules are given below:

(*i*) The symbol of a unit named after a scientist should be written in capital letter. For example, unit temperature namely is kelvin is to written as K. Unit of force namely newton is to be written N.

(*ii*) The symbol of a unit should not be followed by a full stop or any punctuation mark.

(*iii*) The full name of unit, even if it is named after a scientist should be written in small letters. It should not begin with a capital letter. For example, newton, watt, ampere etc.

(*iv*) The plural should not be used for units and their symbols. For example, (*a*) metre (m) and not metres (*b*) second (s) and not seconds etc.

Some Practical Units

(*a*) **Macro-cosm measurement (Very large distance)**

1. **Astronomical Unit (AU):** It is an average distance of the centre of the sun from the centre of the earth.

$$1 \text{ AU} = 1.496 \times 10^{11} \text{ m} \simeq 1.5 \times 10^{11} \text{ m}$$

2. **Light Year (LY):** One light is the distance travelled by light in vacuum in one year. The velocity of light in vacuum (c) = 3×10^8 ms^{-1}.

and $$1 \text{ year} = 365 \times 24 \times 60 \times 60 \text{ seconds}$$

$$\therefore \quad 1 \text{ light year} = 3 \times 10^8 \times 365 \times 24 \times 60 \times 60 \text{ m}$$

$$1 \text{ ly} = 9.46 \times 10^{15} \text{ m}$$

3. **Par sec:** One par sec is the radius of a circle at the centre of which an arc of the circle, 1 AU long subtends an angle 1″.

$$1 \text{ par sec} = 3.1 \times 10^{16} \text{ m}$$

$$1 \text{ par sec} = 3.26 \text{ ly}$$

Some useful units of length are

$$1 \text{ inch} = 0.0254 \text{ m}$$

$$1 \text{ foot} = 0.3048 \text{ m}$$

$$1 \text{ yard} = 0.9144 \text{ m}$$

$$1 \text{ mile} = 1.609 \times 10^3 \text{ m}$$

$$1 \text{ nautical mile} = 1.852 \times 10^3 \text{ m}$$

(*b*) **Micro-cosm measurement (Very small distances)**

(*i*) 1 micron (μ) = 10^{-6} m

(*ii*) 1 nanometre (nm) = 10^{-9} m

(*iii*) 1 angstrom (Å) = 10^{-10} m

(*iv*) 1 fermi (f_m) = 10^{-15} m

(*c*) **Measuring heavy masses**

(*i*) 1 tonne or 1 metric ton = 10^3 kg

(*ii*) 1 quintal = 100 kg

(*iii*) 1 slug = 14.57 kg

Chandra Shekhar Limit (CSL) is the largest practical unit.

1 CSL = 1.4 times of mass of sun.

(*d*) **Lunar month:** The time taken by the moon to complete one revolution around the earth in its orbit.

1 lunar month = 27.3 days.

(*e*) **Shake:** It is the smallest unit of time.

$$1 \text{ shake} = 10^{-8} \text{ s.}$$

SI Prefixes

The physical quantities whose magnitude is either too large or too small can be expressed more compactly by used of certain prefixes.

The prefixes commonly use for powers of 10 are listed below in Table 2.

Table 2: Prefixes

S.No.	Power of 10	Prefixes	Symbol
1.	10^{-18}	atto	*a*
2.	10^{-15}	femto	*f*
3.	10^{-12}	pico	*p*
4.	10^{-9}	nano	*n*
5.	10^{-6}	micro	*m*
6.	10^{-3}	milli	*m*
7.	10^{-2}	centi	*c*
8.	10^{-1}	deci	*d*
9.	10^{1}	deca	*da*
10.	10^{2}	hecto	*h*
11.	10^{3}	kilo	*k*
12.	10^{6}	mega	*M*
13.	10^{9}	giga	*G*
14.	10^{12}	tera	*T*
15.	10^{15}	peta	*P*
16.	10^{18}	exa	*E*

Do you know?

International system of units (SI) applies to all branches of science, whereas MKS system is confined to mechanics only.

Advantages of SI

The SI system of units has following advantages.

- It is is closely related to the CGS system.
- In SI system, only one unit is used for one physical quanitity. Therefore, it is a rationalised system of units.
- All derived units can be obtained by suitable manipulation of base and supplementary units and no numerical factors are encountered. Therefore, it is a coherent system of units.
- In metric system, multiples can be expressed as suitable powers of 10.

Do you know?

In our country, the responsibility of maintenance of physical standard of length, mass and time etc. have been given to National Physical Laboratory (NPL), New Delhi.

1.3 DIMENSIONS

The dimensions of a physical quantity are the powers to which the units of base quantities are raised to represent a derived unit of that quantity.

In mechanics, all the physical quantities can be written by the symbols of the dimensions of [L], [M] and [T].

For example, Area = length × breadth

$= [L] \times [L] = [L^2]$

The area is said to have two dimensions in length. So, we write, area = $[M^0L^2T^0]$ and say that area has zero dimensions in mass and zero dimension is time in addition to 2 dimensions in length.

Similarly, volume = length × breadth × height

$= [L] \times [L] \times [L] = L^3 = [M^0L^3T^0]$

Now, speed = $\frac{\text{distance}}{\text{time}} = \frac{\text{length}}{\text{time}} = \frac{[L]}{[T]} = [LT^{-1}] = [M^0LT^{-1}]$

So, the dimensions of speed or velocity are: zero in mass, +1 in length and –1 in time.

1.3.1 Dimensional Formula and Dimensional Equations

The expression for a physical quantity obtained in terms of fundamental quantities shows the powers or indices to which the fundamental quantities are raised. These indices are the dimensions of the given physical quantity, and the expression obtained is called the **dimensional formula.**

For example, speed = $[M^0LT^{-1}]$ signifies that the dimensional formula for the speed is $[M^0LT^{-1}]$.

The relation between the physical quantity and the fundamental quantities expressed in the form of equation is called dimensional equation.

For example, if speed/velocity represented by (v).

Then, $[v] = [M^0LT^{-1}]$ is called dimensional equation of velocity.

Table 3, gives the dimensional formulae and units of various derived physical quantities.

Table 3. Dimensions formulae and units.

S.No.	Physical quantity	Relation with other quantity	Dimensional formula	SI units
1.	Volume	length × breadth × height	$[L] \times [L] \times [L] = L^3$ $= [M^0 L^3 T^0]$	m^3
2.	Force	mass × acc.	$M \times LT^{-2} = [M^1 L^1 T^{-2}]$	N(newton)
3.	Acceleration	$\frac{\text{change in velocity}}{\text{time taken}}$	$\left[\frac{L/T}{T}\right] = [LT^{-2}]$ $= [M^0 L^1 T^{-2}]$	ms^{-2}
4.	Acceleration due to gravity (g)	$\frac{\text{change in velocity}}{\text{time taken}}$	$\frac{L/T}{T} = LT^{-2} = [M^0 L^1 T^{-2}]$	ms^{-2}
5.	Density	$\frac{\text{mass}}{\text{volume}}$	$\frac{[M]}{[L^3]} = [M^1 L^{-3} T^0]$	m^{-3}
6.	Pressure	force/area	$\frac{MLT^{-2}}{L^2} = [M^1 L^{-1} T^{-2}]$	Nm^{-2}
7.	Impulse	force × time	$MLT^{-2} \times T = [M^1 L^1 T^{-1}]$	Ns
8.	Specific gravity	$\frac{\text{density of body}}{\text{density of water at 4°C}}$	$\frac{[M/L^3]}{[M/L^3]} = 1 = [M^0 L^0T^0]$	No units
9.	Work	force × distance	$MLT^{-2} \times L = [M^1 L^2 T^{-2}]$	J (joule)
10.	Universal constant of gravitation (G)	From Newton's law of gravitation. $F = \frac{GM_1m_2}{r^2}$	$G = \frac{(MLT^{-2})\,L^2}{MM}$,	$Nm^2\ kg^{-2}$

S.No.	Physical quantity	Relation with other quantity	Dimensional formula	SI units
		or $G = \frac{F r^2}{m_1 m_2}$ where F is force between masses m_1, m_2 at a distance r	$= [M^{-1} L^3 T^{-2}]$	
11.	Moment of force	force × distance	$MLT^{-2} \times L = [M^1 L^2 T^{-2}]$	N-m
12.	Power	$\frac{\text{work}}{\text{time}}$	$\frac{ML^2 T^{-2}}{T} = [M^1 L^2 T^{-3}]$	W(watt)
13.	Surface tension	$\frac{\text{force}}{\text{length}}$	$\frac{MLT^{-2}}{L} = [M^1 L^0 T^{-2}]$	Nm^{-1}
14.	Surface energy	Energy of free surface	$[M^1 L^2 T^{-2}]$	J
15.	Thrust/Tension	force	$[M^1 L^1 T^{-2}$	N (newton)
16.	Strain	$\frac{\text{change in dimension}}{\text{original dimension}}$	$\frac{L}{L} = 1\ [M^0 L^0 T^0]$	No units
17.	Coefficient of elasticity	$\frac{\text{stress}}{\text{strain}}$	$\frac{M^1 L^{-1} T^{-2}}{1} = [M^1 L^{-1} T^{-2}]$	Nm^{-2}
18.	Radius of gyration (K)	distance	$L = [M^0 L^1 T^0]$	m
19.	Moment of inertia (I)	mass(radius of gyration)^2	$ML^2 = [M^1 L^2 T^0]$	kg m^2
20.	Angle (θ)	length(l)/radius (r)	$\frac{L}{L} = 1 = [M^0 L^0 T^0]$	radian
21.	Angular velocity (ω)	$\frac{\text{angle } (\theta)}{\text{time } (t)}$	$\frac{1}{T} = T^{-1} = [M^0 L^0 T^{-1}]$	rad s^{-1}
22.	Angular momentum	I ω	$(ML^2)(T^{-1}) = [M^1 L^2 T^{-1}]$	kg m^2 s^{-1}
23.	Torque	I α	$(ML^2)(T^{-2}) = [M^1 L^2 T^{-2}]$	N-m
24.	Frequency (ν)	number of vibrations/sec.	$1/T = T^{-1} = [M^0 L^0 T^{-1}]$	s^{-1} or Hz (hertz)
25.	Angular frequency (ω)	2π × frequency	$T^{-1} = [M^0 L^0 T^{-1}]$	radian/sec
26.	Planck's constant (h)	$\frac{\text{energy (E)}}{\text{frequency } (\nu)}$	$\frac{ML^2 T^{-2}}{T^{-1}} = [M^1 L^2 T^{-1}]$	J-s
27.	Heat (Q)	Energy	$[M^1 L^2 T^{-2}]$	J (joule)
28.	Temperature (θ)	—	$[M^\circ L^\circ T^\circ K^1]$	K
29.	Latent heat (L)	$\frac{\text{heat } (Q)}{\text{mass } (m)}$	$\frac{M L^2 T^{-2}}{M} = [M^\circ L^2 T^{-2}]$	J kg^{-1}
30.	Electric current (I)	ampere (A) is fundamental unit of current	$[M^\circ L^\circ T^\circ A^1]$	A (ampere)

1.4 PRINCIPLE OF HOMOGENEITY OF DIMENSIONS

According to principle of homogeneity, the dimensions of all the terms in the physical equation must be same. This principle basically signifies that only similar physical quantities can be added, subtracted or equated.

1.4.1 To Check the Correctness of an Equation

To check the correctness of the given equation, we shall write the dimensions of the quantities of both sides of the equation. For the correct equation, the principle of homogeneity of dimensions is obeyed.

Example 1. *A car starting with a velocity u and moving with a constant acceleration a travels a distance s in time t. The given equation related these quantities is* $s = ut + \frac{1}{2}at^2$.

Solution. Given equation is $s = ut + \frac{1}{2}at^2$

The correctness of the given equation is checked using the dimensions as follows:

$$[s] = [L],\ [ut] = [\text{velocity} \times \text{time}]$$

$$[LT^{-1}]\ [T] = [M^0\ LT^0] \qquad ...(i)$$

$$[at^2] = [\text{acceleration} \times \text{time} \times \text{time}]$$

$$= [M^0\ LT^{-2}]\ [T^2] = [M^0\ LT^0] \qquad ...(ii)$$

Equating eqn. (*i*) and (*ii*), we get,

$$[M^0\ LT^0] = [MLT^0] \quad \Rightarrow \quad \text{LHS} = \text{RHS}$$

Hence, the equation is correct dimensionally.

Example 2. *Check the correctness of the equation* $t = 2\pi\sqrt{\frac{l}{g}}$*, where l is the length, t is the time period of pendulum and g is acceleration due to gravity.*

Solution. We have, $t = 2\pi\sqrt{\frac{l}{g}}$

We write the dimensions of the both sides of equation.

$$\therefore \quad \text{LHS} = [t] = [T] = [M^0L^0T] \qquad ...(i)$$

and

$$\text{RHS} = 2\pi\sqrt{\frac{l}{g}} = \sqrt{\frac{L}{LT^{-2}}} = \sqrt{T^2} = T = [M^0L^0T] \qquad ...(ii)$$

Since eqn (*i*) and (*ii*) are equal

$$\therefore \quad \text{LHS} = \text{RHS}$$

Thus, the given equation is correct.

> **Note:** (*i*) Numbers and dimensionless.
> (*ii*) Mathematical constant like, π, e, etc. are dimensionless.

1.4.2 To Convert Unit of One System into Another

The conversion of unit based on the fact that magnitude of a physical quantity remains the same, whatever be the system of its measurement.

$$Q = n_1u_1 = n_2u_2 \qquad ...(i)$$

where u_1 and u_2 are two units of measurement of the quantity Q and n_1 and n_2 are their numerical values.

Let M_1, L_1, T_1 are the fundamental units of mass, length and time in one system and M_2, L_2, T_2 are the fundamental units of mass, length and time in other system. Let a, b and c are the respective dimensions of mass, length and time of the both the systems.

Now, the units of measurement u_1 and u_2 of the quantity of the two systems would be

$$u_1 = [M_1^a \; L_1^b \; T_1^c]$$

and $$u_2 = [M_2^a \; L_2^b \; T_2^c] \quad ...(ii)$$

From eq. (i), we get

$$n_2 = \frac{n_1 u_1}{u_2} \quad ...(iii)$$

Putting the values of u_1 and u_2 in eq. (iii), we get

$$n_2 = n_1 \frac{[M_1^a \; L_1^b \; T_1^c]}{[M_2^a \; L_2^b \; T_2^c]}$$

$$\Rightarrow \quad n_2 = n_1 \left[\frac{M_1}{M_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \left[\frac{T_1}{T_2}\right]^c \quad ...(iv)$$

Example 3. *Convert 1 newton into dyne.*

Solution. One newton is the unit of force in SI unit and one dyne is unit of force in CGS system. The dimensional formula of force, $[F] = [MLT^{-2}]$. Now, the dimensions of force in mass, length and time are $a = 1$, $b = 1$, $c = -2$.

So, we convert SI system into CGS system,

$$M_1 = 1 \text{ kg}, \quad L_1 = 1 \text{ m} \quad \text{and} \quad T_1 = 1 \text{ s}$$

and $$M_2 = 1 \text{ g}, \quad L_2 = 1 \text{ cm} \quad \text{and} \quad T_2 = 1 \text{ s}$$

$$n_1 = 1 \text{ newton and } n_2 = ?$$

We know that, $$n_2 = n_1 \left[\frac{M_1}{M_2}\right]^a \left[\frac{L_1}{L_2}\right]^b \left[\frac{T_1}{T_2}\right]^c$$

$$= 1\left(\frac{1 \text{ kg}}{1 \text{ g}}\right)^1 \left(\frac{1 \text{ m}}{1 \text{ cm}}\right)^1 \left(\frac{1 \text{ s}}{1 \text{ s}}\right)^{-2}$$

$$= \left(\frac{10^3 \text{ g}}{1 \text{ g}}\right)\left(\frac{10^2 \text{ cm}}{1 \text{ cm}}\right) \times 1$$

$$= 10^3 \times 10^2 = 10^5$$

$\therefore$ 1 newton $= 10^5$ dyne.

Example 4. *Convert 1 joule into erg.*

Solution. 1 joule is the unit of work in MKS system and 1 dyne is the unit of force in CGS system. The dimensional formula of work $[W] = [ML^2T^{-2}]$. Then, the dimensions of work in mass, length and time are $a = 1$, $b = 2$ and $c = -2$.

So, we convert MKS system into CGS system.

$$M_1 = 1 \text{ kg}, \quad L_1 = 1 \text{ m} \quad \text{and} \quad T_1 = 1 \text{ s}$$

and $$M_2 = 1 \text{ g}, \quad L_2 = 1 \text{ cm} \quad \text{and} \quad T_2 = 1 \text{ s}$$