STANDARD NINE

TERM - I

VOLUME 3

SCIENCE

Career Guidance

Engineering Courses B.E. / B.Tech
4 years

- Aeronautical Engineering
- Aerospace Engineering
- Architecture Engineering
- Automobile Engineering
- Automation & Robotics Engineering
- Avionics Engineering
- Bio Medical Engineering
- Bio Technology Engineering
- Civil Engineering
- Chemical Engineering
- Ceramic Engineering
- Computer Science Engineering
  Construction Management & Technology Engineering
- Electronics and Communication Engineering
- Electrical and Electronics Engineering
- Environmental Science Engineering
- Information Science Engineering
- Industrial Engineering
- Industrial Production Engineering
- Instrumentation Technology
- Marine Engineering
- Medical Electronics Engineering
- Mechanical Engineering
- Mining Engineering
- Manufacturing Science Engineering
- Naval Architecture
- Polymer Technology
- Silk Technology Engineering
- Carpet Technology Engineering
- Textile Engineering

Medical Course
5 years

- MBBS – Allopathy
- BSMS – Siddha
- BAMS - Ayurveda
- BUMS – Unani
- BHMS – Homeopathy
- BNYS – Naturopathy & Yoga
- BDS – Dental
- BVSc – Veterinary

Agriculture Courses|
(4 years)

- B.Sc. Agriculture Science
- B.Sc. Horticulture
- B.Sc. Forestry
- B.Tech Agricultural Engineering

Paramedical Diploma / UG
2/3 years

- Nursing
- Pharmacy
- Anaesthesia Technician
- Cardiac Technician
- Dental Mechanic
- Health Inspector
- Medical imaging & tech
- Medical Lab Tech
- Medical X-ray Tech
- Nuclear Medicine Tech
- Occupational therapist
- Operation Theatre Tech
- Ophthalmic Assistant
- Physiotherapy
- Radiographic Assistant
- Radiotherapy Tech
- Rehabilitation Tech
- Respiratory Therapy Tech
- Blood Transfusion Tech

Humanities
3 years

- Advertising
- BA-General Criminology
- Economics
- Fine Arts
- Foreign Languages
- Home Science
- Interior Design
- Journalism
- Library Sciences
- Physical Education
- Political Science
- Psychology
- Social Work
- Sociology
- Travel & Tourism

Road ahead after 12th...

B.Sc., Courses 3 years

- B.Sc. Physics
- B.Sc. Chemistry
- B.Sc. Botany
- B.Sc. Zoology
- B.Sc. Mathematics
- B.Sc. Computer Science
- B.Sc. PCM
- B.Sc. CBZ
- B.Sc. Dietician & Nutritionist
- B.Sc. Sericulture
- B.Sc. Oceanography
- B.Sc. Meteorology
- B.Sc. Anthropology
- B.Sc. Forensic Sciences
- B.Sc. Food Technology
- B.Sc. Dairy Technology
- B.Sc. Hotel Management
- B.Sc. Fashion Design
- B.Sc. Mass Communication
- B.Sc. Electronic Media
- B.Sc. Multimedia
- B.Sc. 3D Animation
- B.Sc. Home Science

PLAN

Commerce Courses 3 years

- CA – Chartered Accountant
- CMA Cost Management Accountant
- CS Company Secretary (Foundation)
- B.com – Regular
- B.com – Taxation & Tax Procedure
- B.com – Travel & Tourism
- B.com – Bank Management
- B.com – Professional
- BBA/BBM – Regular
- BFM – Bachelors in Financial Markets
- BMS – Bachelors in Management Studies
- BAF – Bachelors in Accounting & Finance
- Certified Stock Broker & Investment Analysis
- Certified Financial Analyst
- Certified Financial Planner
- Certified Investment Banker

Law Courses 3.5 years

- LLB
- BA+LLB
- B.Com + LLB
- BBM+LLB
- BBA+LLB

C.A

CPT → ATC IPCC → ITT (100 Hours) → Articleship (Work under in CA) → Clear Final Exam Become a C.A.

Management Courses (3 years)

- Business Management
- Bank Management
- Event Management
- Hospital Management
- Hotel Management
- Human Resources Management
- Logistics & Management

JOB / Post Graduation

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PREFACE

This book is developed in a holistic approach which inculcates comprehending and analytical skills and also aimed to help students for better understanding of higher secondary science, and competitive exams in future. Textbook designed in learner centric way to trigger the thought process of students and to excel in learning science not by rote learning instead by activities.

HOW TO USE THE BOOK

- This term-1 science book has 9 units.
- Three units for every month, each unit has simple activities that can be done by the teacher as demonstration and also few group activities given for students alone under the guidance of the teacher.
- Infographics and info-bits are added to enrich the learner's scientific perception.
- The "Do you know?" and "More to know" placed in the units will be an eye opener.
- Glossary has been introduced to learn scientific terms.
- ICT corner and QR code introduced in each unit for the digital native generation.

How to get connected to QR Code?

- Download the QR code scanner from the google play store/ apple app store into your smartphone
- Open the QR code scanner application
- Once the scanner button in the application is clicked, camera opens and then bring it closer to the QR code in the textbook.
- Once the camera detects the QR code, a URL appears in the screen. Click the URL and go to the content page.

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E - book

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Assessment

B121_9_SCI_EM

DIGI links

UNIT 1

Measurement and Measuring Instruments

EJC4ZT

Learning Objectives

To get exposed to:

- the rules to be followed while expressing physical quantities in SI units
- the derived units
- the usage of scientific notations
- the three characteristics of measuring instruments
- the usage of vernier caliper and screw gauge for small measurements
- to try and find the weight of an object using a spring balance
- the importance of accurate measurements

Introduction

Measurement is the basis of all important scientific study. It plays an important role in our daily life also. When finding your height, buying milk for your family, timing the race completed by your friend and so on, you need to be able to make measurements. Measurement answers questions like, how long, how heavy and how fast? Measurement is the assignment of a number to a characteristic of an object or event which can be compared with other objects or events. It is defined as the determination of the size or magnitude of something. In this lesson you will learn about units of measurements and the characteristics of measuring instruments.

1.1 Physical Quantities and Units

1.1.1 Physical quantities

Physical quantity is a quantity that can be measured. Physical quantities can be classified into two: fundamental quantities and derived quantities. Quantities which cannot be expressed in terms of any other physical quantities are called fundamental quantities. Example: Length, mass, time, temperature. Quantities like area, volume and density can be expressed in terms of some other quantities. They are called derived quantities.

Physical quantities have a numerical value (a number) and a unit of measurement (say, 3 kilogram). Suppose you are buying

3 kilograms of vegetable in a shop. Here, 3 is the numerical value and kilogram is the unit. Let us see about units now.

1.1.2 Unit

A unit is the standard quantity with which unknown quantities are compared. It is defined as a specific magnitude of a physical quantity that has been adopted by law or convention. For example, feet is the unit for measuring length. That means, 10 feet is equal to 10 times the definite predetermined length, called feet. Our forefathers used units like muzham, furlong (660 feet), mile (5280 feet) to measure length.

Many of the ancient systems of measurement were based on the dimensions of human body. As a result, unit of measurement varied from person to person and also from location to location. In earlier time, different unit systems were used by people from different countries. Some of the unit systems followed earlier are given below in Table 1.

Table - 1 Unit systems of earlier times

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

But, at the end of the Second World War there was a necessity to use worldwide system of measurement. Hence, SI (International System of Units) system of units was developed and recommended by General Conference on Weights and Measures in 1960 for international usage.

1.2 SI System of Units

SI system of units is the modernised and improved form of the previous system of units. It is accepted in almost all the countries of the world. It is based on a certain set of fundamental units from which derived units are obtained by multiplication or division. There are seven fundamental units in the SI system of units. They are also known as base units as in Table 2.

The units used to measure the fundamental quantities are called fundamental units and the units which are used to measure derived quantities are called derived units.

Table - 2 Fundamental physical quantities and their units

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

With the help of these seven fundamental units, units for other derived quantities are obtained and their units are given below in Table-3.

DO YOU KNOW?

Fortnight: A fortnight is two weeks or 14 days.

Moment: If you ask someone to wait for a moment, you know it is a short period of time. But, how short? It is 1/40 th of an hour or 1.5 minutes.

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Table - 3 Derived quantities and their units

S.No	Physical quantity	Expression	Unit
1	Area	length × breadth	m^2
2	Volume	area × height	m^3
3	Density	mass/volume	Kgm^{-3}
4	Velocity	displacement/time	ms^{-1}
5	Momentum	mass × velocity	$kgms^{-1}$
6	Acceleration	velocity/time	ms^{-2}
7	Force	mass × acceleration	$kgms^{-2}$ or N
8	Pressure	force/area	Nm^{-2} or Pa
9	Energy (work)	force × distance	Nm or J
10	Surface tension	force/length	Nm^{-1}

Atomus: The smallest amount of time imaginable to us is a twinkling of the eye. This is called atomus. Do you know the value of this? It is 1/6.25 seconds or 160 milliseconds.

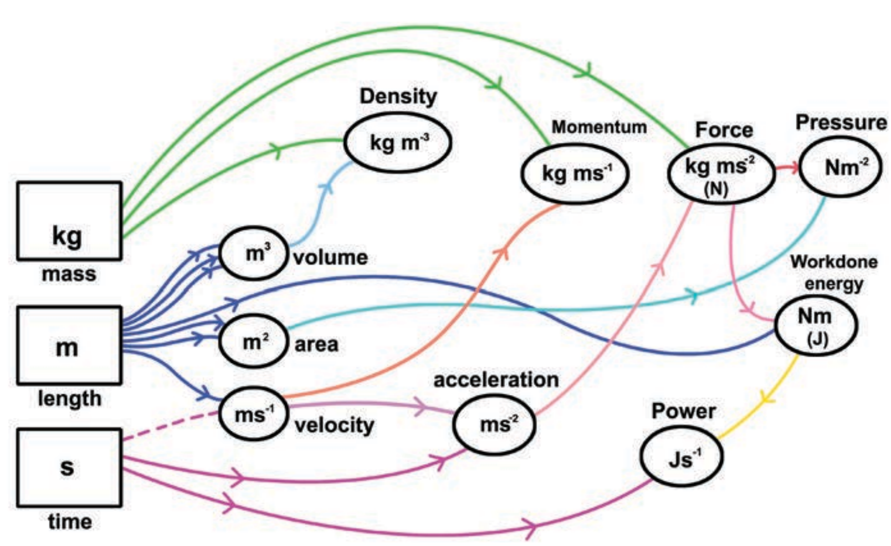
Donkey Power: You might have heard about horse power. But do you know donkey power? It is one third of a horse power. Its value is around 250 watt.

1.3 Fundamental Units of SI System

1.3.1 Length

Length is defined as the distance 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.

In order to measure very large distance (distance of astronomical objects) we use the following units.



Flow chart for derived units

- Light year
- Astronomical unit
- Parsec

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

DO YOU KNOW?

Light travels 3×10^8 m in one second or 3 lakhs kilometre in one second. In one year we have 365 days. The total number of seconds in one year is equal to $365 \times 24 \times 60 \times 60 = 3.153 \times 10^7$ second.

1 light year = $(3.153 \times 10^7) \times (3 \times 10^8) = 9.46 \times 10^{15}$ m.

Astronomical unit (AU): It is the mean distance of the centre of the Sun from the centre of the earth. 1 AU = 1.496×10^{11} m Figure 1.

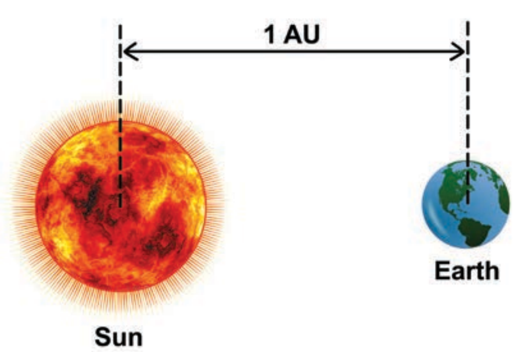


Figure 1 Astronomical unit

DO YOU KNOW?

1 AU is equal to 14,95,97,871 km or approximately equal to 150 million km or 1,500 lakhs km.

Parsec: Parsec is the unit of distance used to measure astronomical objects outside the solar system.

1 parsec = 3.26 light year.

DO YOU KNOW?

The nearest star alpha centauri is about 1.34 parsec from the sun. Most of the stars visible to the unaided eye in the night sky are within 500 parsec distance from the sun.

To measure small distances such as distance between two atoms in a molecule, the size of the nucleus and the wavelength, we use submultiples of ten. These quantities are measured in Angstrom unit (Table 4).

DO YOU KNOW?

The total length of all the blood vessels in human body is 96,000 km.

When born, a baby giraffe is 1.8 m (6ft) tall.

A chameleons tongue is twice the length of its body.

Info bits

In Tamil Nadu, people still use some common length scales other than SI units. It is advisable to know the relationship between SI units with these length scales.

One feet = 30.4 cm, one meter =3.2 feet.

One inch = 2.54 cm, one meter is approximately equal to 40 inches.

These length scales are still used in hardware shops to measure house hold things like pipes, wood. Carpenters still use inch scale.

1.3.2 Mass

Mass is the quantity of matter contained in a body. The SI unit of mass is kilogram. One kilogram is the mass of a particular international

Table - 4 Smaller and larger units

Smaller units	In metre	Larger units	In metre
Fermi (f) *	10^{-15} m	Kilometre (km)	10^{3} m
Angstrom (Å)**	10^{-10} m	Astronomical unit (AU)	1.496×10^{11} m
Nanometre (nm)	10^{-9} m	Light year (ly)	9.46×10^{15} m
Micron (micrometre μ m)	10^{-6} m	Parsec (pc)	3.08×10^{16} m
Millimetre (mm)	10^{-3} m		
Centimetre (cm)	10^{-2} m		

* unit outside SI system and not accepted for use with it
** Non-SI unit accepted for use with it.

prototype cylinder made of platinum-iridium alloy, kept at the International Bureau of Weights and Measures at Sevres, France.

The related units in submultiples of 10 (1/10) are gram and milligram and in multiples of 10 are quintal and metric tonne.

1 quintal = 100 kg

1 metric tonne = 1000 kg = 10 quintal

1 solar mass = 2×10^{30} kg

Atomic mass unit (amu):

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

1 amu = 1/12th of the mass of carbon-12 atom.

More to Know

SI unit of volume is m^3 or cubic metre. Volume can also be measured in (*l*).

1 *l* = 1dm^3 = 1000 m*l*

1m*l* = 1cm^3

Mass of 1 m*l* of water = 1g

Mass of 1*l* of water = 1kg

Mass of the other liquids vary with their density.

DO YOU KNOW?

1 TMC is (thousand million cubic feet) hundred crore cubic feet.

1 TMC = 2.83×10^{10} litre.

1 TMC is approximately 3000 crore litres.

1.3.3 Time

Time is a measure of duration of events and the intervals between them. The SI unit of time is second. One second is the time required for the light to propagate 29,97,92,458 metres through vacuum. It is also defined as 1/86, 400th part of a mean solar day. Larger unit for measuring time is millennium. 1 millenium = 3.16×10^{9} s.

DO YOU KNOW?

In villages, people still use different time scales other than SI time units.

One hour = 2.5 Nazhikai (நாழிகை)

One day = 60 Nazhikai, Day time = 30 Nazhikai and Night time =30 Nazhikai.

In day time nazhikai starts at 6 am and ends at evening 6pm. Total nazhikai in daytime= 12 hours × 2.5 Nazhikai = 30 Nazhikai. Similiarly in the night time the Nazhikai starts at 6 pm and ends next day at 6 am. Total nazhikai in night time =12 hours × 2.5 Nazhikai = 30 Nazhikai. For example, night 12 pm is equivalent to 15 Nazhikai (6 hours × 2.5 Nazhikai=15 nazhikai).

1.3.4 Temperature

Temperature is the measure of hotness. SI unit of temperature is kelvin(K). One kelvin is the fraction of 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 and Fahrenheit (Table 5). To convert temperature from one scale to another we use

$$C/100 = (F - 32)/180 = (K-273)/100$$

Example:

Convert (a) 300 K in to Celsius scale, (b) 104°F in to Celsius scale.

Solution

(a) Celsius = K-273 = 300-273 = 27°C

(b) Celsius = (F – 32) × 5/9 = (104-32) × 5/9 =72 × 5/9 = 40°C

1.4 Unit Prefixes

Unit prefixes are the symbols placed before the symbol of a unit to specify the order of magnitude of a quantity. They are useful to express very large or very small quantities. k(kilo) is the unit prefix in the unit, kilogram. A unit prefix stands for a specific positive or negative power of 10. k stands for 1000 or 10^3. Some unit prefixes are given in Table-6.

The physical quantities vary in different proportion like from 10^{-15} m being the diameter of nucleus to 10^{26} m being the distance between two stars and 9.11×10^{-31} kg being the electron mass to 2.2×10^{41} kg being the mass of the milky way galaxy.

Table – 6 Unit prefixes

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

Contd. on next page

Table - 5 Temperature conversion table

Units	Fahrenheit	Celsius	Kelvin
Fahrenheit (°F)	F	(F – 32) × 5/9	(F – 32) × 5/9 + 273
Celsius (°C)	(C × 9/5) + 32	C	C + 273
Kelvin (K)	(K – 273) × 9/5 + 32	K-273	K

Table – 6 Unit prefixes (*Contd*)

Power of 10	Prefix	Symbol
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f

1.5 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 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. E.g. 15 $kgms^{-1}$ not as 15$kgms^{-1}$.
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 13600 kg m^{-3}.

1.6 Vernier Caliper and Screw Gauge

In our daily life, we use metre scale for measuring lengths. They are calibrated in cm and mm scales. The smallest length which can be measured by metre scale is called least count. Usually the least count of a scale is 1 mm. We can measure the length of objects up to mm accuracy using this scale. But this scale is not sufficient for measuring the size of small spherical objects. So, Vernier caliper and screw gauge are used.

Can you ask for milligram measures of groceries or gram measures of rice from the nearby shop? Can you ask for millimetre measure of cloth? What are the things that you could buy in smaller measures? Why?

1.6.1 Vernier scale

The diameters of spherical objects such as cricket ball and hollow objects such as a pen cap cannot be measured with a meter scale. For that we use an instrument named Vernier caliper which can measure the inner and outer diameters of objects.

Pierre Vernier (1580 – 1637) was a French government official. Vernier