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Chapter 1

UNITS AND MEASUREMENT

1. INTRODUCTION

- Science is regarded as a systematic and orderly study of knowledge.
- It is generally divided into Natural Science and Social Science.
- **Natural Science:** In this branch, we study nature and its components such as celestial bodies, energy, life, etc. It is further divided into ***Material Science*** and ***Life Science***. Material Science is the study of behaviour of all non-living objects. It is further divided into ***Physics*** and ***Chemistry***. In Physics, we study the matter-energy relations while in chemistry, we study the properties of various elements found in nature.
- **Life Sciences:** In it, we study the classification, characteristics, behaviour and mutual interactions of living organisms. It is further divided into ***Zoology*** (study of animals) and ***Botany*** (Study of Plants).

2. IMPORTANT BRANCHES OF PHYSICS

BRANCHES OF PHYSICS	STUDIES
Thermodynamics	Study of nature of heat and its transmission and effects
Optics	Study of the production, nature, transmission and effects of light
Acoustics	Study of the production, propagation, nature and effects of sound waves
Electricity	Study of generation, transmission, nature and effects of electric charge
Magnetism	Study of the properties of magnets, magnetic fields and the effects produced
Electromagnetism	Study of Electromagnets and Electromagnetic Radiation
Metrology	Scientific study of methods of measurement
Atomic physics	Study of the structure and properties of the atom
Astronomy	Study of the origin, evolution and position of galaxies, stars, planets, satellites and other celestial bodies located in the universe
Nuclear physics	Study of the structure of the nucleus of an atom, the behavior of nuclear particles, the nature, nuclear fission and nuclear fusion
Radiology	Study of various radiations and radioactive substances and their effects on the human body
Metallography	Study of the structure and properties of metals
Holography	Study of methods of obtaining a three dimensional picture of an object by laser rays
Hydraulics	Study of force, pressure and energy acting on a moving fluid
Hydrostatics	Study of force, pressure and their effects in stationary liquids
Seismology	Study of earthquakes
Selenology	Study of the composition, motion and position of the Moon
Cybernetics	Scientific study of communication and control (human and animal brains are compared with machines and electronic devices)
Chronology	Study of time and duration
Tribology	Study of forces acting between relative moving surfaces
Horology	Study and measurement of time
Micro mechanics	Study of the motion and behavior of very fine particles
Cryogenics (Low Thermodynamics)	Study of the methods of producing low temperatures and the properties of substances at this temperature.
Christology	Study of atomic structures of crystals with the help of X-rays
Spectroscopy	Study of the internal structure of different substances on the basis of their spectrum
Rheology	Study of deformation and flow of a substance

3. PHYSICAL QUANTITY, MEASUREMENTS & UNITS

I. Physical Quantity:

- It 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, etc.

- The quantities which can be expressed in terms of some other quantities are called derived quantities. Examples: Area, volume and density, etc.

II. Measurement:

- It is a process of comparison of the given physical quantity with the known standard quantity of the same nature.
- The standard quantity used to measure the given physical quantity is called unit. Thus "Unit is the quantity of a constant magnitude which is used to measure the magnitude of the other quantities of the same nature."
- For the measurement of any physical quantity two things are necessary *i.e.*, numerical value and its unit.

Physical Quantity = Numerical Value × Its Unit

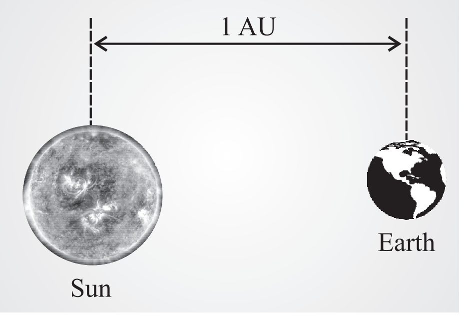
III. Units:

- 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.
- 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. Units are of two kinds, Fundamental Units and Derived Units.
  - **Fundamental Units:** Fundamental Unit is that which is independent of any other unit or which can neither be changed nor can be related to any other fundamental unit. There are seven (07) fundamental units and two (02) complementary units. These have been mentioned below:

Sl No.	Quantity	Units	Symbol
Basic Fundamental Units			
01.	Length	Meter	m
02.	Mass	Kilogram	kg
03.	Time	Second	s
04.	Temperature	Kelvin	K
05.	Luminous Intensity	Candela	Cd
06.	Electric Current	Ampere	A
07.	Amount of Substance	Mole	mol
Complementary Fundamental Units			
08.	Plane Angle	Radian	rad
09.	Solid Angle	Staradian	sr

(i) Length:

- It 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.
- The distance travelled by light in vacuum in one year is known as **Light Year (LY)**. It is equal to 9.46×10^{12} km or 9.46×10^{15} m.
- The average distance between the sun and the earth is known as the **Astronomical Unit (AU)**. It is equal to 1.496×10^{11} m.



Astronomical Unit

- Parsec means Para galactic Second and it is equal to 3.26 LY. Basically it is equal to 3.08×10^{16} m.
- The average diameter of the nucleus of an atom is known as Fermi meter. Fermi meter is equal to 10^{-15} m.
- The nearest star alpha centauri is about 1.34 parsecs from the sun.
- The total length of all the blood vessels in the human body is 96,000 km.
- When born, a baby giraffe is 1.8 m (6 ft) tall.
- A chameleon's tongue is twice the length of its body.
- A span is the distance measured by a human hand, from the tip of the thumb to the tip of the little finger.
  - ➔ One feet = 30.4 cm
  - ➔ One meter = 3.2 feet.
  - ➔ One inch = 2.54 cm
  - ➔ One meter = 40 inches
  - ➔ X-Unit = 10^{-14} m
  - ➔ 1 Yard = 0.9144 m

A. Area: Square of the length is known as area. Some of its units are:

- ➔ 1 Barn = 10^{-28} m^2
- ➔ 1 Acre = 4047 m^2
- ➔ 1 Hectare = 10^4 m^2

B. Volume: Cube of the length is known as volume. SI unit of volume is m^3 or cubic meter. Volume can also be measured in (*l*). Some of its units are:

- ➔ 1 pint= 0.57 litre
- ➔ 1 gallon = 4.5 litre (3.8 litres in US)
- ➔ 1 barrel = 159 litre = 0.159 m^3 = 42 US gallon = 34.97 UK gallon
- ➔ 10 millilitre (mL) = 1 centilitre (cL) = 0.018 pint (0.021 US pint)
- ➔ 100 centilitre = 1 litre (L) = 1.76 pint
- ➔ 10 litre (L) = 1 decalitre (daL) = 2.2 gallons (2.63 US gallons)

- ➔ 1 millilitre (mL) = 1 cubic centimeter (cm^3)
- ➔ 1 *l* = 1dm^3 = 1000 ml
- ➔ 1 ml = 1cm^3
- ➔ 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.

(ii) Mass:

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

It is defined as the mass of 5.0188×10^{25} atoms of Carbon-12.

- 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.
- 1 Pikogram = 10^{-12} g
- 1 Femtogram = 10^{-15} g
- 1 gram = $\frac{1}{1000}$ kg = 10^{-3} kg
- 1 milligram = $\frac{1}{1000}$ g = 10^{-6} kg
- 1 slug = 14.57 kg
- 1 Quintal = 100 kg
- 1 Metric Tonne = 1000 kg = 10 quintal
- 1 Solar Mass = 2×10^{30} kg
- Mass of 1 ml of water = 1g
- Mass of 1*l* of water = 1kg
- Please note that the masses of the other liquids vary with their densities.

- **Atomic mass unit (amu):** Mass of a proton, neutron and electron can be determined using atomic mass unit. 1 amu is equal to 1/12th of the mass of carbon-12 atoms. Its value is 1.66×10^{-27} kg
  - ➔ 1 Chandra Shekhar Limit (CSL) = 1.4 × Solar Mass = $1.4 \times 2 \times 10^{30}$ kg = 2.8×10^{30} kg

(iii) 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.
  - ➔ 1 Mean Solar Day = 24 Hours (86400 s)
  - ➔ 1 Lunar Month = 29.5 Solar Days
  - ➔ 1 millennium = 3.16×10^9 s.
  - ➔ 1 microsecond = 10^{-6} s
  - ➔ 1 picosecond = 10^{-12} s
  - ➔ 1 nanosecond = 10^{-9} s
  - ➔ 1 shake = 10^{-8} s
  - ➔ In villages, people still use different time scale *i.e.* Nazhigai.
  - ➔ One hour = 2.5 Nazhigai
  - ➔ One day = 60 Nazhigai, Day time = 30 Nazhigai and Night time =30 Nazhigai.
  - ➔ In day time Nazhikai starts at 6 am and ends at evening 6 pm. Total Nazhigai in daytime = 12 hours × 2.5 Nazhigai = 30 Nazhigai.
  - ➔ In the night time the Nazhikai starts at 6 pm and ends the next day at 6 am. Total Nazhigai in night time = 12 hours × 2.5 Nazhigai = 30 Nazhigai.

(iv) 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 waters (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.
- To convert temperature from one scale to another we use
  - ➔ **C/100 = (F – 32)/180 = (K–273) /100**

Example: Convert (a) 300 K into Celsius scale, (b) 104°F into 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

Units	Fahrenheit	Celsius	Kelvin
Fahren-heit (°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

Exam Pointers

- The temperature at which degree celsius and degree Fahrenheit are equal :

$$°F = °C \times \frac{9}{5} + 32 \quad \text{...(i)}$$

$$°C = (°F - 32) \times \frac{5}{9} \quad \text{...(ii)}$$

Putting the value of °F in equation (i) from equation (ii)

$$°C = °C \times \frac{9}{5} + 32$$

$$5°C = 9°C + 160$$

$$-4°C = 160$$

$$C = -40°$$

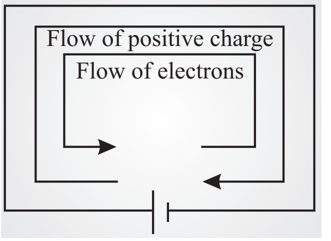
The temperature at which both are equal is – 40°

(v) Luminous Intensity: Light intensity or luminous intensity in physics is the amount of light falling on a surface over any given square foot or square meter. Light intensity is measured in terms of lumens per square foot (footcandles) or lumens per square meter (lux).

- The SI unit of the luminous intensity is Candela = lumen per steradian (cd = lm/sr).
- One candela approximately corresponds to the luminous intensity of an ordinary candle.

(vi) Electric current: An electric current is a stream of charged particles, such as electrons or ions, moving through an electrical conductor or space. It is measured as the net rate of flow of electric charge through a surface or into a control volume.

- The moving particles are called charge carriers, which may be one of several types of particles, depending on the conductor. In electric circuits the charge carriers are often electrons moving through a wire.
- In semiconductors they can be electrons or holes. In an electrolyte the charge carriers are ions, while in plasma, (an ionized gas), they are ions and electrons.
- Magnetic fields are created by electric currents and are used in motors, generators, inductors, and transformers. They cause Joule heating in conventional conductors, which produces light in incandescent light bulbs. Electromagnetic waves are produced by time-varying currents and are utilised to broadcast information in telecommunications.



(vii) Amount of substance: Amount of substance, symbol *n*, is a quantity that measures the size of an ensemble of entities. It appears in thermodynamic relations, such as the ideal gas law, and in stoichiometric relations between reacting molecules, as in the Law of Multiple Proportions. Familiar equations involving *n* are:

$$pV = nRT$$

for an ideal gas, and the equation

$$c = \frac{n}{V}$$

Here, V is the volume of a solution containing the amount of solute *n*.

(viii) Plane angle: A plane angle is defined by two straight lines intersecting at a point. The space between these lines in the plane defined by them is the plane angle.

- It is measured in radians (2π radians in a circle) or degrees (360 degrees to a circle).

(ix) Solid angle: The solid angle of a sphere subtended by a part of the surface whose area is equal to the square of the sphere's radius is defined as a steradian in the International System of Units (SI).

- **Derived Units:** Derived Units are those which depend on the fundamental units or which can be expressed in terms of the fundamental units. Some important derived units have been mentioned below:

Quantity	Units	Symbol	Quantity	Units	Symbol
Acceleration	Meter per Second Squared	m/s^2	Wavelength	Angstrom	Å
Speed	Meter per Second	m/s	Momentum	Kilogram-Meter per Second	kgm/s
Angular Velocity	Radian per Second	Rad/s	Impulse	Newton Second	Ns
Surface Tension	Newton/Metre	N/m	Electrical Resistance	Ohm	Ω
Electric Charge	Coulomb	C	Electrical Capacity	Faraday	F
Celestial Distance	Light Year	m			

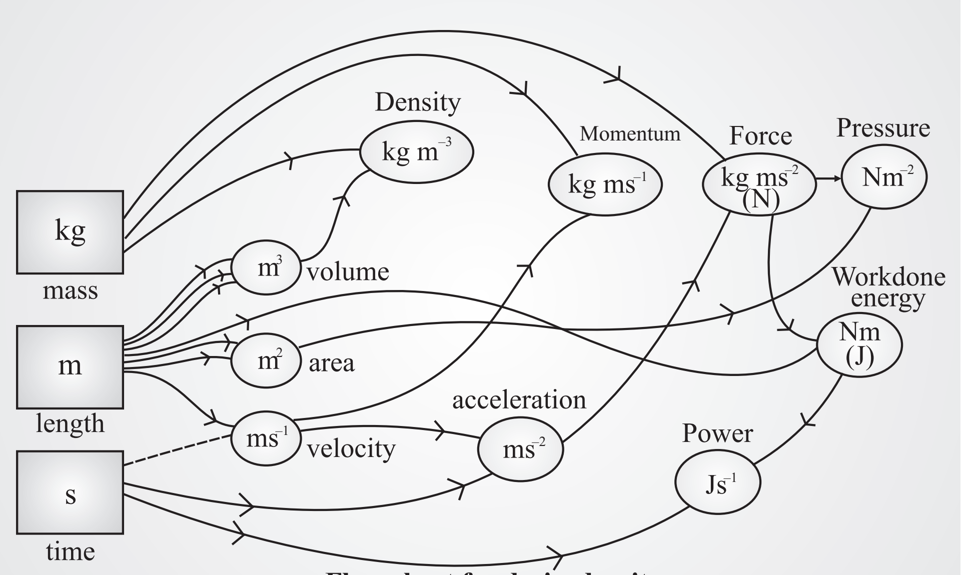
Exam Pointers

- The unit of Power (Electric Power) is Watt.
- The unit of Force is Newton.
- The unit of Work/Energy is Joule.
- Frequency is measured in Hertz.
- The unit of Electrical resistivity is Ohm-meter.
- 1 Feet = 0.305 m = 30.5×10^7 nm
- 6 Feet is equal to 183×10^7 nm.
- Megawatt is a unit used to measure the electricity produced in electricity generation plants.
- The Nautical Mile is used to measure distances on oceans. 1 Nautical Mile = 1.8 km.

- The unit of heat is Calorie.
- Knot is the unit to measure the speed of a ship. 1 Knot = 1.852 Km/h.
- Volt is the unit of Potential Difference.
- Horse Power is the unit of power. 1 HP = 746 Watt.
- Mach is the unit of high speed. 1 Mach = Speed of Sound
- Pascal (N/m^2) is the unit of Pressure.
- Decibel (dB) is the unit of intensity of sound.
- Atmospheric Pressure is measured in bars. 1 bar = 76 mm Hg = 10^5 N/m^2
- 1 bar = 10^6 $Dyne/cm^2$ = 1.02 kg/cm^2 = 100000 (10^5) Pascal
- Byte is the unit of digital information.
- Richter is the unit of seismic intensity.
- Dobson is the unit of the thickness of the ozone layer.
- 1 Dobson unit = 2.69×10^{20} Ozone molecules per square metre.

Knowledge Facts

- Cusec (Cubic Feet per Second) is the unit of flow of liquids. 1 cusec is equal to 28.317 litres per second.
- On multiplying centimetre with 0.39, we get an inch.
- Richter magnitude scale assigns a magnitude number to quantify the energy released by an earthquake.
- The thickness of ozone layer is measured in Dobson.
- 1 Dobson Unit (DU) is equal to 0.01 mm.
- 1 DU is equal to 2.687×10^{20} ozone molecules per square metre.



Flow chart for derived units

IV. SYSTEMS OF UNITS

- There are four systems of units:
  - **M.K.S. System:** In this system, units of length, mass and time are meter (m), kilogram (kg) and second (s) respectively.
  - **C.G.S. System:** In this system, units of length, mass and time are centimetre (cm), gram (g) and second (s) respectively.
  - **F.P.S. System:** In this system, units of length, mass and time are foot (ft), pound (lbs) and second (s) respectively.
  - **S.I. System (Systeme international d'unités):** In 1960, the General Conference of Weights and Measurement recommended that in addition to the unit of length, mass and time, the unit unit of temperature, luminous intensity, current and the amount of substance also be taken as fundamental units. The unit of angle and solid angle are the complementary fundamental units.

Unit	Length (In SI System)	Unit	Length (In SI System)
1 Kilometer	10^3 meter	1 Decimeter	10^{-1} meter
1 Hectometer	10^2 meter	1 Centimeter	10^{-2} meter
1 Decameter	10^2 meter	1 Millimeter	10^{-3} meter
1 Micron	10^{-6} meter	1 Picometer	10^{-12} meter
1 Millimicron	10^{-9} meter	1 Fermi Meter	10^{-15} meter
1 Angstrom	10^{-10} meter	1 Attometer	10^{-18} meter

Do you know?

- **Fortnight:** A fortnight is two weeks or 14 days.
- **Moment:** A moment is equal to the 1/40th of an hour or 1.5 minutes.
- **Atomus:** The smallest amount of time imaginable to us is a twinkling of the eye. This is called atomus. It is equal to 1/6.25 seconds or 160 milliseconds.
- **Donkey Power:** It is one third of horsepower. Its value is around 250 watt.

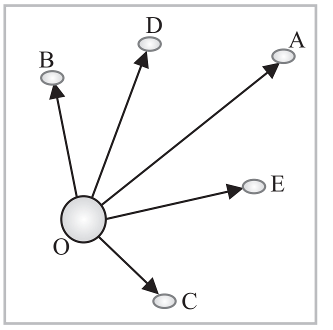
5. UNIT PREFIXES

- 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 following table:

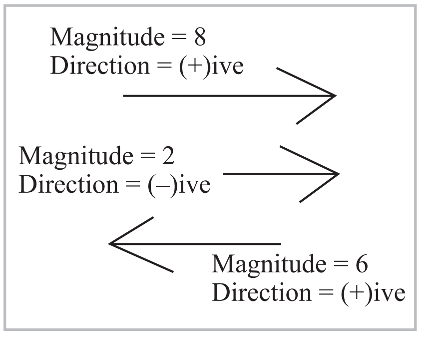
Power of ten	Prefix	Symbol	Example	
10^{-18}	atto	a	attometer	(am)
10^{-15}	femto	f	femtometer	(fm)
10^{-12}	pico	p	picofarad	(pF)
10^{-9}	nano	n	nanometer	(nm)
10^{-6}	micro	μ	micron	(μm)
10^{-3}	milli	m	milligram	(mg)
10^{-2}	centi	c	centimeter	(cm)
10^{-1}	deci	d	decimeter	(dm)
10^{1}	deca	da	decagram	(dag)
10^{2}	hecto	h	hectometer	(hm)
10^{3}	kilo	k	kilogram	(kg)
10^{6}	mega	M	megawatt	(MW)
10^{9}	giga	G	gigahertz	(GHz)
10^{12}	tera	T	terahertz	(THz)
10^{15}	peta	P	peta kilogram	(pKg)
10^{18}	exa	E	exa kilogram	(Ekg)

6. SCALAR AND VECTOR QUANTITIES

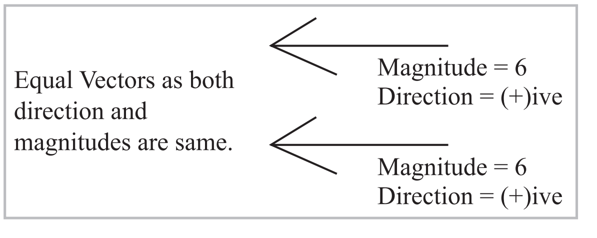
- There are a number of physical quantities and these have been grouped into two categories *i.e.*, scalar and vector quantities.
  - **Scalar Quantities:** The physical quantities which are completely specified by their magnitude or size alone are called scalar quantities. These quantities do not have directions. *Example:* Length, mass, time, volume, density, temperature, speed, electric current, work, power, energy and electric potential, etc.
  - **Vector Quantities:** These are those physical quantities which have both the magnitude and the direction. These obey certain laws such as Law of Vector Addition (Triangle Law), etc., *Example*: Displacement, velocity, acceleration, force, linear momentum, impulse, torque, angular momentum, electric field and magnetic field, etc.
    - **Vectors can be of following types:**
      - **Zero Vector:** A vector, whose initial and terminal points coincide, is called a zero vector or (null vector). It is denoted by 0. Zero vector cannot be assigned a definite direction as it has zero magnitude.
      - **Unit Vector:** A vector whose magnitude is unity (*i.e.,* 1 unit) is called a unit vector. The unit vector in the direction of a given vector $\vec{a}$ is denoted by $\hat{a}$.
      - **Coinitial Vector:** Two or more vectors having same initial point are called Coinitial vectors.



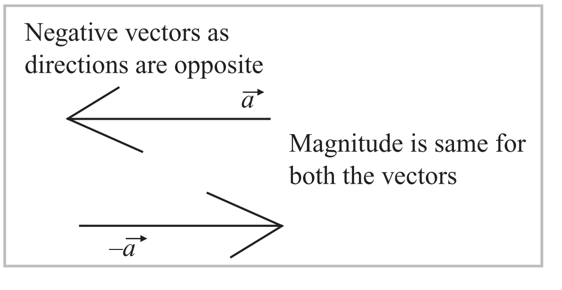
- **Collinear Vector:** Two or more vectors are said to be collinear if they are parallel to the same line, irrespective of their magnitudes and directions. For example: - Consider 3 vectors as shown in the figure, they all are parallel to each other but their magnitudes are different as well as the directions. But they are said to be collinear vectors because they are parallel to each other.



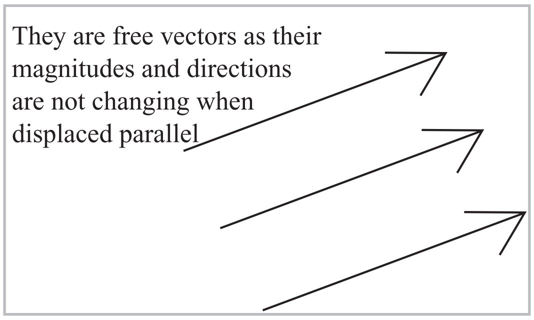
- **Equal Vectors:** Two vectors are said to be equal, if they have the same magnitude and direction regardless of the positions of their initial points. For *example:* Consider 2 vectors whose magnitudes and their directions are same irrespective of origin, then they are known as equal vectors.



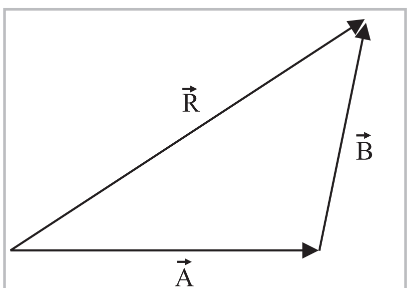
- **Negative Vectors:** A vector whose magnitude is same as that of a given vector but direction is opposite to that of it is called negative of the given vector.



- **Free Vectors:** Vectors that don't change even if it is displaced in parallel direction without changing its magnitude and direction are called free vectors.



- **Vectors follow the triangle law, parallelogram law of addition of two vectors.**
  - **Triangle Law of Vector Addition:** Triangle law of vector addition states that when two vectors are represented as two sides of the triangle with the order of magnitude and direction, then the third side of the triangle represents the magnitude and direction of the resultant vector.

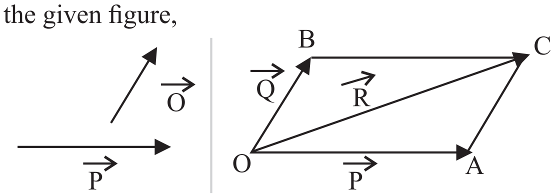


Triangle law of vector addition

To obtain $\vec{R}$ which is the resultant of the sum of vectors $\vec{A}$ and $\vec{B}$ with the same order of magnitude and direction as shown in the figure, we use the following rule:

$$\vec{R} = \vec{A} + \vec{B}$$

  - **Parallelogram Law of Addition:** If two vectors are acting simultaneously at a point, then it can be represented both in magnitude and direction by the adjacent sides drawn from a point. Therefore, the resultant vector is completely represented both in direction and magnitude by the diagonal of the parallelogram passing through the point. Consider the given figure,



(a) **(b)**

$$\overrightarrow{OA} + \overrightarrow{OB} = \overrightarrow{PC} \text{ (or)}$$

$$\vec{P} + \vec{Q} = \vec{R}$$

The vector P and vector Q represent the sides, OA and OB, respectively.

According to the parallelogram law, the side OC of the parallelogram represents the resultant vector R.

Knowledge Facts

- Time always flows in the forward direction but it is taken as scalar quantity. Similarly, the flow of charge in a particular direction constitutes an electric current but electric current is a scalar quantity.
- Scalar quantities of different units cannot be added or subtracted.

7. DIMENSIONS

- The dimensions of a physical quantity are the powers (or exponents) to which the base quantities are raised to represent that quantity.
- Note that using the square brackets [ ] round a quantity means that we are dealing with 'the dimensions of' the quantity.
- In mechanics, all the physical quantities such as length, mass, time, temperature, luminous intensity, amount of substance and current can be written in terms of the dimensions [L], [M], [T], [θ], [cd], [N] and [A].
- The dimensions of a physical quantity can be written as $[M^aL^bT^c\theta^d]$.
- For example, the volume occupied by an object is expressed as the product of length, breadth and height, or three lengths. Hence,

  Dimensions of volume = [L] × [L] × [L] = $[L^3]$
- **Dimensions of some quantities have been shown below:**

Physical quantity	Unit	Dimensional formula
Acceleration or acceleration due to gravity	ms^{-2}	LT^{-2}
Angle (are/radius)	rad	$M^0L^0T^0$
Angular displacement	rad	$M^0l^0T^0$
Angular frequency (angular displacement/time)	$rads^{-1}$	T^{-1}
Angular impulse (torque × time)	Nms	ML^2T^{-1}
Angular momentum (lω)	kgm^2s^{-1}	ML^2T^{-1}
Angular velocity (angle/time)	$rads^{-1}$	T^{-1}
Area (length × breadth)	m^2	L^2
Boltzmann's constant	JK^{-1}	$ML^2T^{-2}\theta^{-1}$
Bulk modulus $\left(\Delta P, \frac{V}{\Delta V}\right)$	Nm^{-2}, Pa	$M^1L^{-1}T^{-2}$
Calorific value	Jkg^{-1}	L^2T^{-2}
Coefficient of linear or areal or volume expansion	$°C^{-1}$ or K^{-1}	θ^{-1}

Physical quantity	Unit	Dimensional formula
Coefficient of surface tension (force/length)	Nm^{-1} or JM^{-2}	MT^{-2}
Coefficient of thermal conductivity	$Wm^{-1}K^{-1}$	$MLT^{-3}\theta^{-1}$
Coefficient of viscosity $\left(F = \eta A \frac{dv}{dx}\right)$	poise	$ML^{-1}T^{-1}$
Compressibility (1/bulk modulus)	Pa^{-1}, m^2N^{-2}	$M^{-1}LT^2$
Density (mass/volume)	kgm^{-3}	ML^{-3}
Displacement, wavelength, focal length	m	L
Electric capacitance (charge/potential)	CV^{-1}, farad	$M^{-1}L^{-2}T^4l^2$
Electric conductance (1/resistance)	Ohm^{-1} or mho or siemen	$M^{-1}L^{-2}T^3l^2$
Electric conductivity (1/resistivity)	siemen/metre or Sm^{-1}	$M^{-1}L^{-3}T^3l^2$
Electric charge or quantity of electric charge (currnet × time)	coulomb	IT
Electric current	ampere	l
Electric dipole moment (charge × distance)	Cm	LTI
Electric field strength or Intensity of electric field (force/charge)	NC^{-1}, Vm^{-1}	$MLT^{-3}l^{-1}$
Electric resistance $\left(\frac{\text{potential difference}}{\text{current}}\right)$	ohm	$ML^2T^{-3}l^{-2}$
Emf (cr) electric potential (work/charge)	volt	$ML^2T^{-3}l^{-1}$
Energy (capacity to do work)	joule	ML^2T^{-2}
Energy density $\left(\frac{\text{energy}}{\text{volume}}\right)$	Jm^{-3}	$ML^{-1}T^{-2}$
Entropy ($\Delta S = \Delta Q/T$)	$J\theta^{-1}$	$ML^2T^{-2}\theta^{-1}$
Force (mass × acceleration)	newton (N)	MLT^{-2}
Force constant or spring constant (force/extension)	Nm^{-1}	MT^{-2}
Frequency (1/period)	Hz	T^{-1}
Gravitational potential (work/mass)	Jkg^{-1}	L^2T^{-2}
Heat (energy)	J or calorie	ML^2T^{-2}
Illumination (Illuminance)	lux (lumen/metre^2)	MT^{-3}
Impulse (force × time)	Ns or $kgms^{-1}$	MLT^{-1}
Inductance (L) $\left(\text{energy} = \frac{1}{2}LI^2\right)$ or coefficient of self-induction	henry (H)	$ML^2T^{-2}l^{-2}$
Intensity of gravitational field (F/m)	Nkg^{-1}	L^1T^{-2}
Intensity of magnetization (l)	Am^{-1}	$L^{-1}l$
Joule's constant or mechanical equivalent of heat	$Jcal^{-1}$	$M^0L^0T^0$
Latent heat (Q = mL)	Jkg^{-1}	$M^0L^2T^{-2}$
Linear density (mass per unit length)	kgm^{-1}	ML^{-1}
Luminous flux	lumen or (Js^{-1})	ML^2T^{-3}
Magnetic dipole moment	Am^2	L^2l
Magnetic flux (magnetic induction × area)	weber (Wb)	$ML^2T^{-2}l^{-1}$
Magnetic induction (F = Bill)	$Nl^{-1}m^{-1}$ or T	$MT^{-2}l^{-1}$
Magnetic pole strength (unit: ampere = meter)	Am	Ll
Modulus of elasticity (stress/strain)	Nm^{-2}, Pa	$ML^{-1}T^{-2}$
Moment of inertia (mass × radius^2)	kgm^2	ML^2
Momentum (mass × velocity)	$kgms^{-1}$	MLT^{-1}
Permeability of free space $\left(\mu_0 = \frac{4\pi Fd^2}{m_1m_2}\right)$	Hm^{-1} or NA^{-2}	$MLT^{-2}l^{-2}$
Permittivity of free space $\left(\varepsilon_0 = \frac{Q_1Q_2}{4\pi Fd^2}\right)$	Fm^{-1} or $C^2N^{-1}m^{-2}$	$M^{-1}L^{-3}T^4l^2$
Planck's constant (energy/frequency)	Js	ML^2T^{-1}
Poisson's ratio (lateral strain/longitudinal strain)	—	$M^0L^0T^0$
Power (work/time)	Js^{-1} or watt (W)	ML^2T^{-3}
Pressure (force/area)	Nm^{-2} or Pa	$ML^{-1}T^{-2}$
Pressure coefficient or volume coefficient	$°C^{-1}$ or θ^{-1}	θ^{-1}

Physical quantity	Unit	Dimensional formula
Pressure head	m	M^0LT^0
Radioactivity	disintegrations per second	$M^0L^0T^{-1}$
Ratio of specific heats	—	$M^0L^0T^0$
Refractive index	—	$M^0L^0T^0$
Resistivity or specific resistance	$\Omega - m$	$ML^3T^{-3}I^{-2}$
Specific conductance or conductivity (1/specific resistance)	siemen/metre or Sm^{-1}	$M^{-1}L^{-3}T^3I^2$
Specific entropy (1/entropy)	KJ^{-1}	$M^{-1}L^{-2}T^2\theta$
Specific gravity (density of the substance/density of water)	—	$M^0L^0T^0$
Specific heat (Q = mst)	$Jkg^{-1}\theta^{-1}$	$M^0L^2T^{-2}\theta^{-1}$
Specific volume (1/density)	m^3kg^{-1}	$M^{-1}L^3$
Speed (distance/time)	ms^{-1}	LT^{-1}
Stefan's constant $\left(\frac{\text{heat energy}}{\text{area} \times \text{time} \times \text{temperature}^4}\right)$	$Wm^{-2}\theta^{-4}$	$ML^0T^{-3}\theta^{-4}$
Strain (change in dimension/original dimension)	—	$M^0L^0T^0\theta$
Stress (restoring force/area)	Nm^{-2} or Pa	$ML^{-1}T^{-2}$
Surface energy density (energy/area)	Jm^{-2}	MT^{-2}
Temperature	^0C or θ	$M^0L^0T^0\theta$
Temperature gradient $\left(\frac{\text{change in temperature}}{\text{distance}}\right)$	$°Cm^{-1}$ or θm^{-1}	$M^0L^{-1}T^0\theta$
Thermal capacity (mass × specific heat)	$J\theta^{-1}$	$ML^2T^{-2}\theta^{-1}$
Time period	second	T
Torque or moment of force (force × distance)	Nm	ML^2T^{-2}
Universal gas constant (work/temperature)	$Jmol^{-1}\theta^{-1}$	$ML^2T^{-2}\theta^{-1}$
Universal gravitational constant $\left(F = G.\frac{m_1m_2}{d^2}\right)$	Nm^2kg^{-2}	$M^{-1}L^3T^{-2}$
Velocity (displacement/time)	ms^{-1}	LT^{-1}
Velocity gradient (dv/dx)	s^{-1}	T^{-1}
Volume (length × breadth × height)	m^3	L^3
Water equivalent	kg	ML^0T^0
Work (force × displacement)	J	ML^2T^{-2}

8. MEASUREMENT & MEASURING INSTRUMENTS

I. Vernier Calipers:

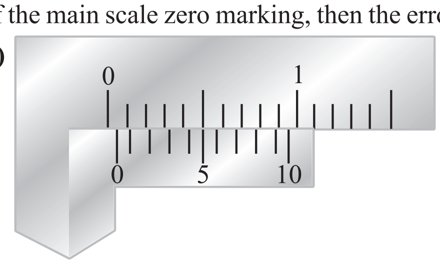
- The smallest length which can be measured by metre scale is called least count. Usually the ***least count*** of a scale is 1 mm.
- The objects having lengths in mm can be measured using this scale. But the size of small spherical objects can be measured with a Vernier caliper and screw gauge.
- Vernier Calipers is an instrument which is used to measure the diameters of spherical objects such as cricket balls and hollow objects such as a pen cap which cannot be measured with a meter scale. Please note that vernier calipers can measure the inner and outer diameters of objects. Pierre Vernier (1580 – 1637) is known to have invented this instrument.
- Vernier caliper is to find out its least count, range and zero error.
- On dividing the value of one smallest division on vernier caliper by the total number of vernier scale divisions.
- Please note that the value of the smallest main scale division is 1 mm.

  Least count of the instrument (L.C.)

  $$= \frac{\text{Value of one smallest main scale division}}{\text{Total number of vernier scale division}}$$

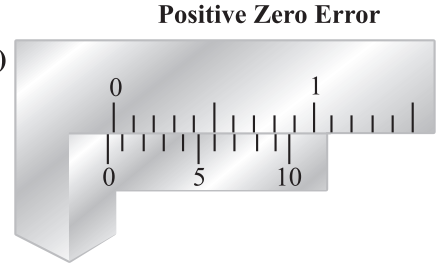
- When we unscrew the slider and move it to the left, both the jaws touch each other and the zero marking of the main scale coincides with that of the Vernier scale. If they are not coinciding with each other, the instrument is said to possess zero error.
- If the zero mark of the Vernier is shifted to the right, it is called positive error.
- On the other hand, if the Vernier zero is shifted to the left of the main scale zero marking, then the error is negative.

(a)



Positive Zero Error

(b)



Negative Zero Error

II. Screw Gauge:

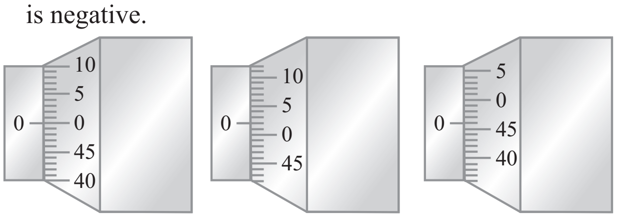
Measurements made with a Vernier caliper can be made in centimeter only. Hence to measure the length and thickness of very small objects we use a screw gauge. This instrument can measure the dimensions upto 1/100th of a millimeter or 0.01 mm.

- The ***pitch of the screw*** is the distance between two successive screw threads. It is also equal to the distance travelled by the tip of the screw for one complete rotation of the head. It is equal to 1 mm in typical screw gauges.
- The distance moved by the tip of the screw for a rotation of one division on the head scale is called the ***least count of the screw gauge.***
- The value of least count is 0.01 mm.
- On dividing the value of one smallest pitch scale reading by the total number of head scale divisions, we get the ***least count of screw gauge***.

Least count of the instrument (L.C.)

$$= \frac{\text{Value of one smallest pitch scale reading}}{\text{Total number of Head scale division}}$$

- When the plane surface of the screw and the opposite plane stud on the frame area are brought into contact, if the zero of the head scale does not coincide with the pitch scale axis then the instrument has ***zero error***.
- If the zero of the head scale lies below the pitch scale axis, the zero error is positive but if it is above, then the zero error is negative.



(a) No zero error (b) Positive zero error (c) Negative zero error

III. Weighing Instruments:

- **Common (Beam) Balance:** A beam balance compares the sample mass with a standard reference mass. (Standard reference masses are 5g, 10g, 20g, 50g, 100g, 200g, 500g, 1kg, 2kg, 5kg). This balance can measure mass accurately up to 5g.

- **Two Pan Balance:** This type of balance is commonly used in provision and grocery shops. This balance compares the sample mass with the standard reference mass. The pans rest on top of the beam and can be conveniently placed on a table top. This balance can measure mass accurately upto 5 g.

- **Physical Balance:** This balance is used in labs and is similar to the beam balance but it is a lot more sensitive and can measure mass of an object correct to a milligram. The standard reference masses used in this physical balance are 10 mg, 20 mg, 50 mg, 100 mg, 200 mg, 500 mg, 1 g, 2 g, 5 g, 10 g, 20 g, 50 g, 100 g, and 200 g.

- **Digital Balance:** Nowadays for accurate measurements digital balances are used, which measures mass accurately even up to a few milligrams, the least value being 10 mg. This electrical device is easy to handle and commonly used in jewellery shops and labs.

- **Spring Balance:** This balance helps us to find the weight of an object. It consists of a spring fixed at one end and a hook attached to a rod at the other end. It works by 'Hooke's law' which explains that the addition of weight produces a proportional increase in the length of the spring. A pointer is attached to the rod which slides over a graduated scale on the right. The spring extends according to the weight attached to the hook and the pointer reads the weight of the object on the scale**.**

	Mass	Weight
1.	Fundamental quantity	Derived quantity
2.	Has magnitude alone – scalar quantity	Has magnitude and direction – vector quantity

	Mass	Weight
3.	It is the amount of matter contained in a body	It is the normal forced exerted by the surface on the object against pull
4.	Remains the same	Varies from place to place
5.	It is measured using physical balance	It is measured using spring balance
6.	Its unit is kilogram	Its unit is newton

A. Accuracy in Measurements:

- Accuracy represents how close a measurement comes to a true value. In order to get accurate values of measurement, it is always important to check the correctness of the measuring instruments. Also, repeating the measurement and getting the average value can correct the errors and give us an accurate value of the measured quantity.

B. List of Some Important Measuring Instruments and Scales:

Measuring instruments	Uses
Altimeter	Measures height of aeroplanes
Actinometer	Measures intensity of solar radiation (especially UV-radiation)
Atmometer	Measures Evaporation
Barograph	Continuous recording of atmospheric pressure
Bolometer	Power of incident electromagnetic radiation
Calorimeter	Heat absorbed or released by a substance
Cardiograph	Records heart speed (mechanical movements of the heart)
Chronometer	Measures time (Used by Sailors)
Colorimeter	Intensity of Colours
Cathetometer	Measures Vertical Height
Cryometer	A thermometer that measures extremely low temperatures
Cyclotron	Increases the speed to charged particles
Dilatometer	Measures the changes in the volume
Dip Circle	Measures dip angle at a place
Dynamo	Converts mechanical energy into electrical energy
Dynamometer	Measures force, torque and power
Electroencephalogram (EEG)	Measures Electrical Activity of brain
Electrometer	Measures electrical charge or electrical potential difference
Electroscope	Identifies the presence of electrical charge in a system
Evaporimeter	Measures the rate of evaporation of water in atmosphere
Endoscope	Inspects the internal organs of body
Flux Meter	Measures magnetic flux
Galvanometer	Measures electrical current
Gravimeter	Measures Gravitational acceleration
Gyroscope	Measures angular velocity
Hydrometer	Measures the density of fluids
Hydrophone	Records the sound inside water
Hygrometer	Measures the humidity
Hypsometer	Measures elevation
Kymograph	Monitors body movements such as blood pressure, contraction of muscles, etc.
Luxmeter	Measures the intensity of light
Lysimeter	Measures transpiration
Magnetometer	Measures the intensity of magnetic field
Microphone	Converts sound energy into electrical energy
Microtome	Divides an object into tiny parts
Nephroscope	Measures the height, velocity and direction of movement of clouds
Odometer	Measures the distance travelled by a vehicle
Periscope	For observation over, around or through an object, obstacle or condition that prevents direct line-of-sight observation from an observer's current position. Generally used in submarines.
Phonograph	Mechanical recording and regeneration of sound
Photometer	Measures the intensity of light
Potentiometer	Measures the electromotive force (emf) of a cell
Pycnometer	Specific Gravity of liquids
Psychrometer	Measures relative humidity
Rain Gauge	Measures rainfall (precipitation, snow and hail)
Radiometer	Measures energy received from radiation
Refractometer	Measures refractive index

Measuring instruments	Uses
Salinometer	Measures salinity of a solution
Solarimeter	Measures intensity of solar radiation
Saccharimeter	Measures the concentration of a solution containing sugar
Sextant	Measures the angular distance between two objects
Sphygmomanometer	Measures blood pressure
Stethoscope	Used to hear heart speed
Speedometer	Indicated the speed of a vehicle
Tachometer	Measures the rotational speed of engines or shafts
Viscometer	Measures viscosity of liquids
Wind Vane	Measures the direction of wind

Knowledge Facts

- Audiometer is used to measure the intensity of sound.
- Anemometer is used to measure the velocity of wind.
- SONAR (Sound Navigation and Ranging) is used to measure the depth of submerged objects.
- Tacheometer is used to measure horizontal and vertical distances and directions.
- Pyrometer is used to measure high temperatures. These are also known as radiation thermometers.
- Total Radiation Pyrometer is used to measure a temperature of 2000°C.
- Pyro heliometer is used to measure solar radiation.
- Manometer is used to measure the pressure of a liquid or gas.
- Ondometer (Wave-meter) is used to measure the frequency of electromagnetic waves.
- Ammeter is used to measure electric current.
- Barometer is used to measure the atmospheric pressure. Water, mercury and alcohol are used in different types of barometers.
- Lactometer is used to measure the relative density of milk.
- Butyrometer is used to measure the amount of fat in milk.
- Eudiometer is used to measure the changes in volume of a mixture due to chemical and physical changes.
- Spectrometer is used to measure the variation of a physical characteristics over a given range *i.e.* spectrum.
- Thermistor is an electronic thermometer and it changes its resistance with change in the temperature of the instrument.
- A Caratometer is used to measure the purity of gold.
- RADAR (Radio Detection and Ranging) is used to detect the position of an object using radio waves.
- Richter scale is used to measure seismic intensity (amplitude of seismic waves).
- Fathometer measures the depth of the ocean/sea through ultrasonic waves.
- Polygraph (Lie Detector) is used to identify the lie spoken by a person. It measures and record several physiological indices such as blood pressure, Pulse respiration and skin conductivity while the subject is asked and answers a series of questions.
- Seismograph is a seismometer device which detects the seismic waves generated during an earthquake or measures the intensity of earthquake.
- Geiger counter is a particle detector that detects radioactivity or radiation.
- A rheumatoid factor (Rh Factor) test measures the amount of rheumatoid factor in your blood. Rheumatoid factors are proteins produced by your immune system that can attack healthy tissue in your body.
- Carburettor is a device that blends air and fuel for internal combustion engine.
- Phonometer is an instrument which is used for testing the force of the human voice in speaking.
- A gyroscope is a spinning wheel or disc in which the axis of rotation is free to assume any orientation.
- Kymograph is an instrument for recording variations in pressure as of the blood or in tension as of a muscle by means of a pen or stylus that marks a rotating drum.
- Theodolite is an optical instrument which is used for measuring angular distances between designated visible points in the horizontal and vertical planes.
- A bar balance is used to compare the masses of two objects.
- The weight of a balanced object is equal in magnitude to the force of gravity acting on the object. The weight of an object is measured with a spring balance.

Important Questions

1. Consider the following statements about Light year :

1. Light year is a unit for measurement of very large distances.
2. Light year is a unit for measurement of very large time intervals.
3. Light year is a unit for measurement of intensity of light.

Which of the statements given above is/are correct?

(A) 1, 2 and 3

(B) 2 and 3 only

(C) 1 and 2 only

(D) 1 only

2. Which one of the following is NOT the unit of energy ?

(A) Joule

(B) Watt–hr

(C) Newton–metre

(D) kg–metre/sec^2

3. 1 dyne (a unit of force in CGS system) equals to :
(A) 10^3 g cm/s^2 (B) 10^{-3} g cm/s^2
(C) 10^5 kg m/s^2 (B) 10^{-5} kg m/s^2

4. Which one of the following is the correct relation between A and nm ?
(A) 1 nm = 10^{-1}Å (B) 1 nm = 10 Å
(C) 1 nm = 1 Å (D) 1 nm = 10^{-2} Å

5. Which one of the following physical quantity has the same unit as that of pressure ?
(A) Angular momentum
(B) Stress
(C) Strain
(D) Work

6. The S.I. unit of acceleration is :
(A) ms^{-1} (B) ms^{-2}
(C) cms^{-2} (D) kms^{-2}

7. Match List I with List II and select the correct answer using the code given below the Lists :

List I (Physical quantity)		**List II (Unit)**	
a.	Distance	1.	Mole
b.	Amount of material	2.	Coulomb
c.	Amount of electrical charge	3.	Light year
d.	Energy	4.	Watt hour

Code:

	a	b	c	d
(A)	3	1	2	4
(B)	3	2	1	4
(C)	4	2	1	3
(D)	4	1	2	3

8. The dimension of 'impulse' is the same as that of:
(A) Pressure
(B) Angular momentum
(C) Work
(D) Linear momentum

9. What is the dimension of gravitational constant ?
(A) $ML^{43}T^{-2}$ (B) $M^{-1}L^3T^{-2}$
(C) $M^2L^{-2}T^{-2}$ (D) $M^2L^{-1}T^{-2}$

10. 'Femto' means ten raised to the power of—
(A) –16 (B) –15
(C) –20 (D) –12

11. Which one among the following measures the same quantity as that is measured by the SI unit 'pascal' ?
(A) Watt (B) Torr
(C) Newton (D) Joule

12. In terms of SI prefixes 10–15 is called :
(A) Yocto (B) Zepto
(C) Atto (D) Femto

13. Coulomb per second is equivalent to ______.
(A) Ohm (B) Ampere
(C) Volt (D) Joule

14. All the non-zero vectors are called ______.
(A) Coplanar vectors
(B) Proper vectors
(C) Co-initial vectors
(D) Equal vectors

15. Which of the following has the same dimension as that of linear momentum?
(A) Impulse (B) Stress
(C) Work (D) Energy

16. Electron-volt is a unit of ______.
(A) Current
(B) Energy
(C) Power
(D) Potential difference

17. Which of the following quantities is measured using a torsion balance?
(A) Pressure (B) Force
(C) Charge (D) Magnetism

18. What is the name of the instrument used for measuring the speed and rate of flow of a fluid that is flowing in a pipe ?
(A) Cryometer (B) Machmeter
(C) Venturimeter (D) Odometer

19. Which scientific instrument is used to measure the height of an aircraft above a fixed level ?
(A) Wattmeter (B) Fathometer
(C) Altimeter (D) Barometer

20. Infrared optical .... can be used for measuring and monitoring temperatures and hot spots of jet engine rotor blades.
(A) Pyrometer (B) Ammeter
(C) Hygroemeter (D) Machmeter

21. The instrument that measures and records the relative humidity of air is:
(A) Hydrometer (B) Hygrometer
(C) Lactometer (D) Barometer

22. Which of the following pairs of physical quantities have the same dimensions?
(A) Force and Power
(B) Work and Power
(C) Work and Energy
(D) Momentum and Energy

23. The temperature which has the same reading on both Fahrenheit and Celsius scales is:
(A) 40° (B) –40°
(C) –34° (D) –140°

24. A micron is equal to
(A) 0.1 mm (B) 0.01 mm
(C) 0.001 mm (D) 0.0001 mm

25. One bar is equal to:
(A) 10^3 Pa (B) 100 Pa
(C) 10^5 Pa (D) 10^4 Pa

26. The dimension MLT–2 corresponds to:
(A) force (B) work done
(C) acceleration (D) velocity

27. The dimensional formula for universal gravitational constant is:
(A) $M^{-1}L^3T^2$ (B) ML^2T^{-2}
(C) M^{-2} (D) $M^{-1}L^3T^{-2}$

28. Which of the following have the same unit?
(A) Work and power
(B) Torque and moment of inertia
(C) Work and torque
(D) Torque and angular momentum

29. Which of the following is a scalar quantity?
(A) Velocity
(B) Force
(C) Angular momentum
(D) Electrostatic potential

30. Which of the following is not a vector quantity?
(A) Speed (B) Velocity
(C) Torque (D) Displacement

31. 'Parsec' is the unit measurement of:
(A) Density of stars
(B) Astronomical distance
(C) Brightness of heavenly bodies
(D) Orbital velocity of giant stars

32. Which one of the following is a non-dimensional quantity?
(A) Gas constant
(B) Strain
(C) Co-efficient of viscosity
(D) Planck's constant

33. The SI unit of luminous emittance is:
(A) Lux (B) Candela
(C) Lumen (D) Lumen second

34. Which of the following is the unit of Astronomical Distance?
(A) Meter/sec. (B) Sec.
(C) Para/sec. (D) Parsec

35. One nanometer is equal to ....
(A) 10 raised to the power (–3)
(B) 10 raised to the power (–6)
(C) 10 raised to the power (–9)
(D) 10 raised to the power (–12)

36. The SI unit of acceleration is ....
(A) meters per second squared
(B) meters per second
(C) second per meter
(D) seconds per meter squared

37. Which of the following is not a vector quantity?
(A) Momentum (B) Displacement
(C) Torque (D) Speed

38. Maxwell is the unit of which one of the following?
(A) Magnetic flux
(B) Permeability
(C) Magnetic susceptibility
(D) Intensity of magnetisation

39. What is the SI unit of frequency?
(A) Newton (B) Watt
(C) Farad (D) Hertz

40. Which one of the following statement is true about the mass of an object?
(A) It varies at different locations.
(B) It remains constant.
(C) It can be measured using spring balance.
(D) It is in the direction of gravitational force.

41. Which of the following is not one of the fundamental quantities in physics?
(A) Length (B) Time
(C) Weight (D) Mass

42. If a physical quantity has the units-ampere meters per second squared, then what are it's dimensions?
(A) $[I LT^{-2}]$ (B) $[ALT^{-2}]$
(C) $[I MS^{-2}]$ (D) $[AMS^{-2}]$

43. A nautical mile is equal to ....
(A) 2000 meters (B) 1852 meters
(C) 2450 meters (D) 2450 meters

44. Instrument used to study the behaviour of a vibrating string is:
(A) barometer (B) Hydrometer
(C) Hygrometer (D) Sonometer

45. Hydroscope is an instrument that shows changes in:
(A) Sound under water
(B) Atmosphere humidity
(C) Density of liquid
(D) Elevation of land

46. The instrument for measuring intensity of earthquakes is called:
(A) Ediograph (B) Pantagraph
(C) Ergograph (D) Seismograph

47. How can the height of a person who is six feet tall, be expressed (approximately) in nanometre?
(A) 183×10^6 nm (B) 234×10^6 nm
(C) 183×10^7 nm (D) 181×10^7 nm

48. Ampere is the unit of:
(A) Voltage (B) Electric current
(C) Resistance (D) Power

49. Which one of the following SI unit is not correctly matched?
(A) Work – Joule (B) Force – Newton
(C) Mass – kg. (D) Pressure – Dyne

50. What is the unit of pressure?
(A) Newton/sq. meter
(B) Newton-meter
(C) Newton
(D) Newton/meter

51. One pikogram is equal to:
(A) 10^{-6} gram (B) 10^{-9} gram
(C) 10^{-12} gram (D) 10^{-15} gram

52. Which one of the following pair is not correctly matched?
(A) Odometer : Measuring instrument for distance covered by motor wheels
(B) Ondometer : Measuring instrument for frequency of electromagnetic waves
(C) Audiometer : Device for measuring sound intensity
(D) Ammeter : Measuring instrument for electric power

53. Pyrometer is used to measure:
(A) Air pressure
(B) Humidity
(C) High temperature
(D) Density

54. The apparatus used for detecting lie is known as:
(A) Polygraph (B) Pyrometer
(C) Gyroscope (D) Kymograph

55. I barrel of oil is equals to which of the following?
(A) 131 litre (B) 159 litre
(C) 179 litre (D) 201 litre

56. 'Dobson' Unit is used for the measurement of:
(A) Thickness of Earth
(B) Thickness of Diamond
(C) Thickness of Ozone layer
(D) Measurement of Noise

57. 'Pyreheliometer' is used for measuring:
(A) Sun spots
(B) Solar radiation
(C) Air temperature
(D) Temperature of plants

58. Fathometer is used to measure:
(A) Earthquake (B) Rain
(C) Depth of sea (D) Sound intensity

Answers

1. (D)	**2.** (D)	**3.** (D)	**4.** (B)	**5.** (B)
6. (B)	**7.** (A)	**8.** (D)	**9.** (B)	**10.** (B)
11. (B)	**12.** (D)	**13.** (B)	**14.** (B)	**15.** (A)
16. (B)	**17.** (B)	**18.** (C)	**19.** (C)	**20.** (A)
21. (B)	**22.** (C)	**23.** (B)	**24.** (C)	**25.** (C)
26. (C)	**27.** (D)	**28.** (C)	**29.** (C)	**30.** (A)
31. (B)	**32.** (B)	**33.** (A)	**34.** (D)	**35.** (C)
36. (A)	**37.** (D)	**38.** (A)	**39.** (D)	**40.** (B)
41. (C)	**42.** (A)	**43.** (B)	**44.** (D)	**45.** (C)
46. (D)	**47.** (C)	**48.** (B)	**49.** (D)	**50.** (A)
51. (C)	**52.** (D)	**53.** (C)	**54.** (A)	**55.** (B)
56. (C)	**57.** (B)	**58.** (C)		

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