Surface tension	force / length	N m^{-1}
Moment of force		
tongue	force x distance	N m
Electric charge	current x time	A s
Current density	current x area	A m-2
Magnetic induction force/	(current x length)	N A^{-1} m^{-1}

SI standards

- **Length:** Length is defined as the distance between two points. The SI unit of length is metre.

  One standard metre is equal to 1 650 763.73 wave lengths of the orange – red light emitted by the individual atoms of krypton – 86 in a krypton discharge lamp.

- **Mass:** Mass is the quantity of matter contained in a body. It is independent of temperature and pressure. It does not vary from place to place. The SI unit of mass is kilogram.

  The kilogram is equal to the mass of the international prototype of the kilogram (a platinum – iridium alloy cylinder) kept at the International Bureau of Weights and Measures at Sevres, near Paris, France. An atomic standard of mass has not yet been adopted because it is not yet possible to measure masses on an atomic scale with as much precision as on a macroscopic scale.

- **Time:** Until 1960 the standard of time was based on the mean solar day, the time interval between successive passage of the sun at its highest point across the meridian. It is averaged over an year. In 1967, an atomic standard was adopted for second, the SI unit of time.

  One standard second is defined as the time taken for 9 192 631 770 periods of the radiation corresponding to unperturbed transition between hyperfine levels of the ground state of cesium – 133 atom. Atomic clocks are based on this. In atomic clocks, an error of one second occurs only in 5000 years.

- **Ampere:** The ampere is the constant current which, flowing through two straight parallel infinitely long conductor of negligible cross-section, and placed in vacuum 1 m apart, would produce between the conductors a force of 2×10^{-7} newton per unit length of the conductors.

- **Kelvin:** The Kelvin is the fraction of $\frac{1}{273.16}$ of the thermodynamic temperature of the triple point of water.

- **Candela:** The candela is the luminous intensity in a given direction due to a source, which emits monochromatic radiation of frequency 540 x 10^{12} Hz and of which the radiant intensity in that direction is $\frac{1}{683}$ watt per steradian.

- **Mole:** The mole is the amount of substance which contains as many elementary entities are there are atoms in 0.012 kg of carbon-12.

Rules and conventions for writing SI units and their symbols:

1. The units named after scientist are not written with a capital initial letter.

   For example: newton, henry, watt

2. The symbols of the units named after scientist should be written by a capital letter.

   For example: N for newton, H for henry, W for watt

3. Small letters are used as symbols for units not derived from a proper nme

   For example: m for metre, kg for kilogram

4. No full stop or other punctuation marks should be used within or at the end of symbols.

   For example: 50 m and not as 50 m

5. The symbols of the units do not take plural form.

   For example: 10 kg not as 10 kgs

6. When temperature is expressed in Kelvin, the degree sign is omitted. For example: 273 K not as 273° K (If expressed in Celsius scale, degree sign is to be included.

   For example 100° C and not 100 C

7. Use of solidus is recommended only for indicating a division of one letter unit symbol by another unit symbol. Not more than one solidus is used.

   For example: m s^{-1} or m / s, J / K mol or J K^{-1} mol-1 but not J / K / mol.

8. Some space is always to be left between the number and the symbol of the unit and also between the symbols for compound units such as force, momentum, etc.

   For example, it is not correct to write 2.3m. The correct representation is 2.3m; kg m s^{-2} and not as $kgms^{-2}$.

9. Only accepted symbols should be used.

   For example: ampere is represented as A and not as amp. or am ; second is represented as s and not as sec.

10. Numerical value of any physical quantity should be expressed in scientific notation.

For an example density of mercury is $1.36x10^4$ kgm^{-3} and not as 13600 kg m^{-3}.

Expressing larger and smaller physical quantities

Power of ten	**Prefix**	**Abbreviation**
10^{-15}	femto	f
10^{-12}	pico	p
10^{-9}	nano	n

10^{-6}	micro	μ
10^{-3}	milli	m
10^{-2}	centi	c
10^{-1}	deci	d
10^{1}	deca	da
10^{2}	hecto	h
10^{3}	kilo	k
10^{6}	mega	M
10^{9}	giga	G
10^{12}	tera	T
10^{15}	peta	P

❖ **Light year:** Light year is the distance travelled by light in one year in vacuum.

Distance travelled = velocity of light x 1 year 1 light year = 3 x 10^{8} m s-1 x 1 year (in seconds)

= 3 x 10^{8} x 365.25 x 24 x 60 x 60

= 9.467 x 10^{15} m

1 light year = 9.467×10^{15} m

❖ **Astronomical unit:** Astronomical unit is the mean distance of the centre of the Sun from the centre of the Earth.

1 Astronomical unit (AU) = 1.496×10^{11} m

Determination of distance

❖ For measuring large distances such as the distance of moon or a planet from the Earth, special methods are adopted.

❖ Radio-echo method, laser pulse method and parallax method are used to determine very large distances.

Laser pulse method:

❖ The distance of moon from the Earth can be determined using laser pulses. The laser pulses are beamed towards the moon from a powerful transmitter. These pulses are reflected back from the surface of the moon.

- The time interval between sending and receiving of the signal is determined very accurately. It t is the time interval and c the velocity of the laser pulses, then the distance of the moon from the Earth is d = $\frac{ct}{2}$

Determination of mass

- The conventional method of finding the mass of a body in the laboratory is by physical balance.
- The mass can be determined to an accuracy of 1 mg.
- Now-a-days, digital balances are used to find the mass very accurately.
- The advantage of digital balance is that the mass of the object is determined at once.

Measurement of time:

- We need a clock to measure any time interval. Atomic clocks provide better standard for time. Some techniques to measure time interval.
- **Quartz clocks:** The piezo-electric property of a crystal is the principle of quartz clock. These clocks have an accuracy of one second in every 109 seconds.
- **Atomic clocks:** These clocks make use of periodic vibration taking place within the atom. Atomic clocks have an accuracy of 1 part in 10^{13} seconds.

VIII. FORCE, MOTION AND ENERGY

- **Force:** Force is a push or a pullLcating on an object which charges or tends to change the state of the object. In the international system of units (SI System), the unit of force is newton (N).

Sir Issac Newton (1642 – 1727)

- One of the greatest scientist the world has ever seen. He was an English mathematician, physicist and astronomer. The SI unit of force is named after him.
- There are also under units that are used to measure force. They are dyne, kilogram weight and pound.

Forces of nature:

- Sir Issac Newton was the first one to give an exact definition for force. "Force is the external agency applied on a body to change its state of rest and motion".
- There are four basic forces in nature. They are gravitational force, electromagnetic force, strong nuclear force and weak nuclear force.

Gravitational force:

- It is the force between any two objects in the universe. It is an attractive force by virtue of their masses.

- By Newton's law of gravitation, the gravitational force is directly proportional to the product of the masses and inversely proportional to the square of the distance between them.
- Gravitational force is the weakest force among the fundamental forces of nature but has the greatest large-scale impact on the universe.
- Unlike the other forces, gravity works universally on all matter and energy, and is universally attractive.

Electromagnetic force:

- It is the force between charged particles such as the force between two electrons, or the force between two current carrying wires.
- It is attractive for unlike charges and repulsive for like charges.
- The electromagnetic force obeys inverse square law
- It is very strong compared to the gravitational force.
- It is the combination of electrostatic and magnetic forces.

Electrostatic Force:

- The force exerted by a charged body on another charged or uncharged body is known at electrostatic force. This force acts when the bodies are not in contact.
- The electrostatic force is another example of non contact force.

Strong nuclear force:

- It is the strongest of all the basic forces of nature.
- It, however, has the shortest range, of the order of 10^{-15} m. This force holds the protons and neutrons together in the nucleus of an atom.

Action of force and its effects:

- Can move an object from rest.
- May change the speed of an object if it is already moving
- May change the direction of motion of an object.
- May bring about a change in the shape of an object
- May cause some or all of these effects
- It is important to note that none of these actions is possible without the action of a force.

Contact Forces:

- Generally, to apply force on an object, we need to come in contact with that object
- A force that can cause or change the motion of an object by touching it is called Contact Force.

- The force of friction arises due to contact between the ball and ground
- It acts between any two bodies when both are in contact with each other and either any one or both are moving.

- **Non-contact Forces:** A non-contact force is any force applied to an object by another body without any contact.
- **Magnetic Forces:** A magnet can exert a force on another magnet without touching it. Magnetic force is a non contact force.

First law of motion:

- **Galileo** observed the motion of objects on an inclined plane. He deduced that object move with a **constant speed** when no force acts on them
- Newton studied **Galileo's ideas** on force and motion and presented three fundamental laws that govern the motion of objects. These **three laws** are known as Newton's Laws of Motion.

- The first law of motion is stated as: An object remains in the state of rest or of **uniform motion** in a straight line unless compelled to change that state by an applied unbalanced force.

- In other words, all objects resist a change in their state of motion. The tendency of undisturbed objects to stay at rest or to keep moving with the **same velocity** is called inertia. This is why, the first law of motion is also known as the law of inertia.

- Certain experiences that we come across while travelling in a motor car can be explained on the basis of the **law of inertia.** We tend to remain at rest with respect to the seat until the driver applies a breaking force to stop the motor car.

- With the application of brakes, the car slows down but our body tends to continue in the same state of motion because of inertia.

- A sudden application of brakes may thus cause injury to us **by collision** with panels in front.
- An opposite experience is encountered when we are standing in a bus which begins to move suddenly. Now we tend to fall **backwards.** This is because a sudden start of the bus brings motion to the bus as well as to our feet in contact with the floor of the bus. But the rest of our body opposes this motion because of its inertia.

- When a motor car makes a sharp turn at a high speed, we tend to get thrown to one side. This can again be explained on the basis of the law of inertia. We tend to continue in our **straight line motion.** When an unbalanced force is applied by the