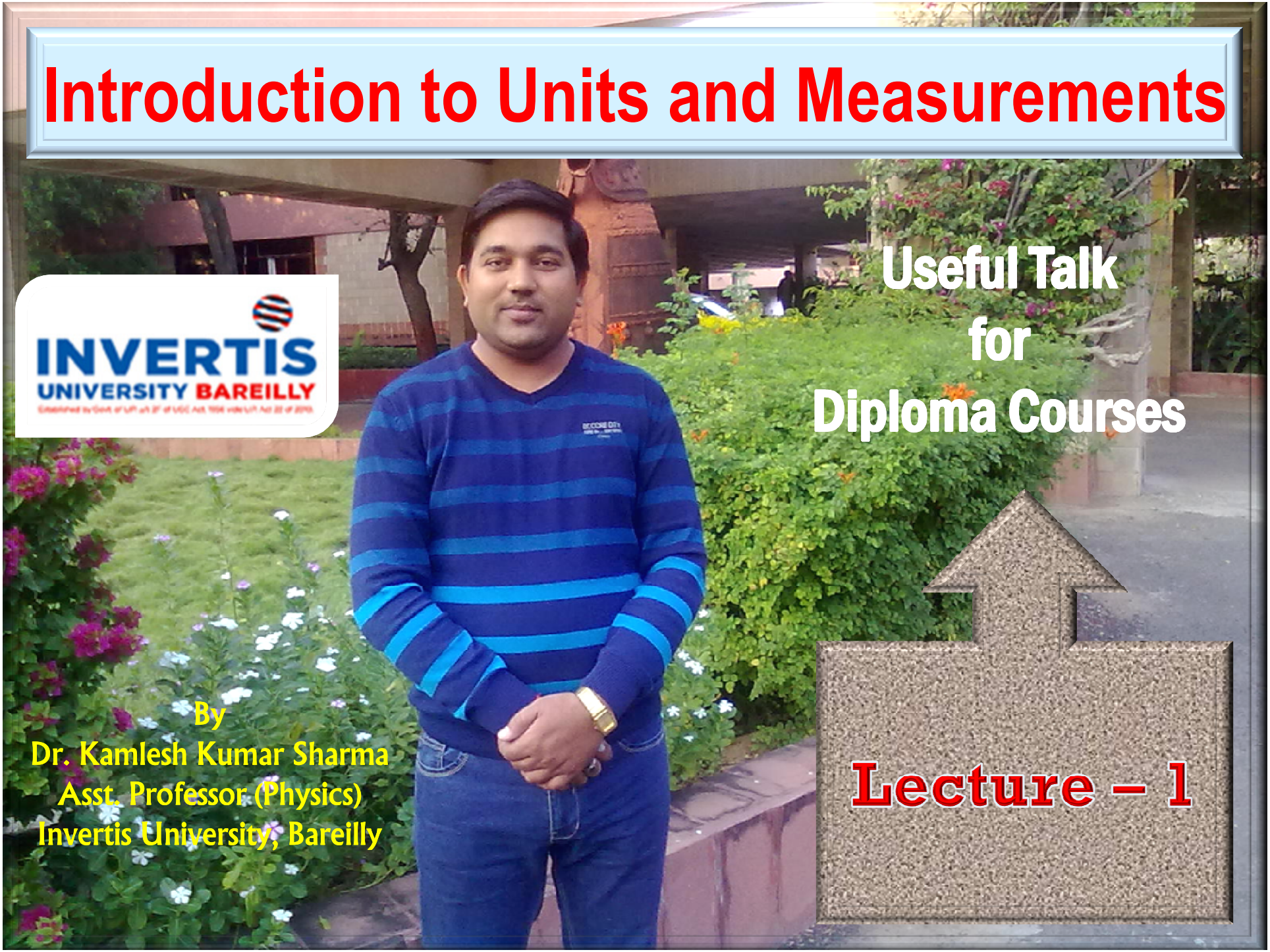
Introduction to Units and Measurements



INVERTIS UNIVERSITY BAREILLY

Useful Talk
for
Diploma Courses

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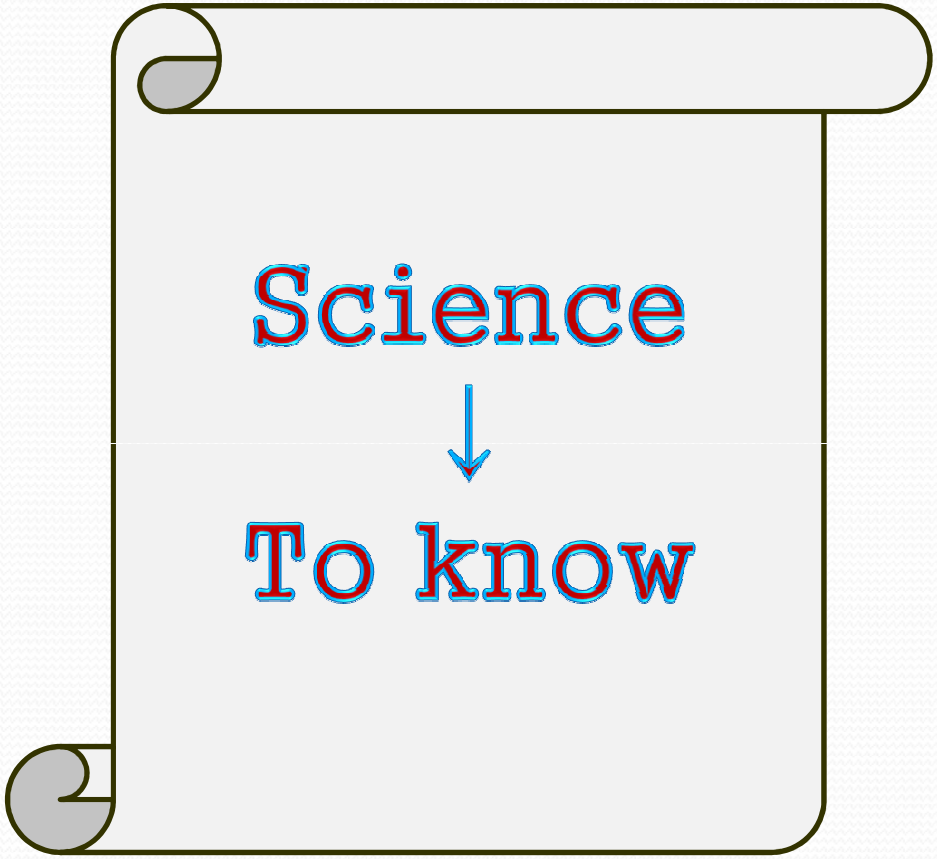
Lecture – 1

Outlines

- Physics
- Measurements
- Physical Quantity
- Units
- Types of Units
- Systems of Units



Elementary Idea of Physics

- **What is Physics**?
  - ✓Branch of Science
  - ✓Study of Nature
  - ✓Fundamental Laws
  - ✓King of Science

Physics is the branch of science in which we observe, measure and describe natural phenomena related to energy and matter.

Mechanics, Optics, Thermodynamics, Electromagnetism, Atomic Physics, Nuclear physics, Modern Physics and Quantum Mechanics etc.

Introduction to measurements

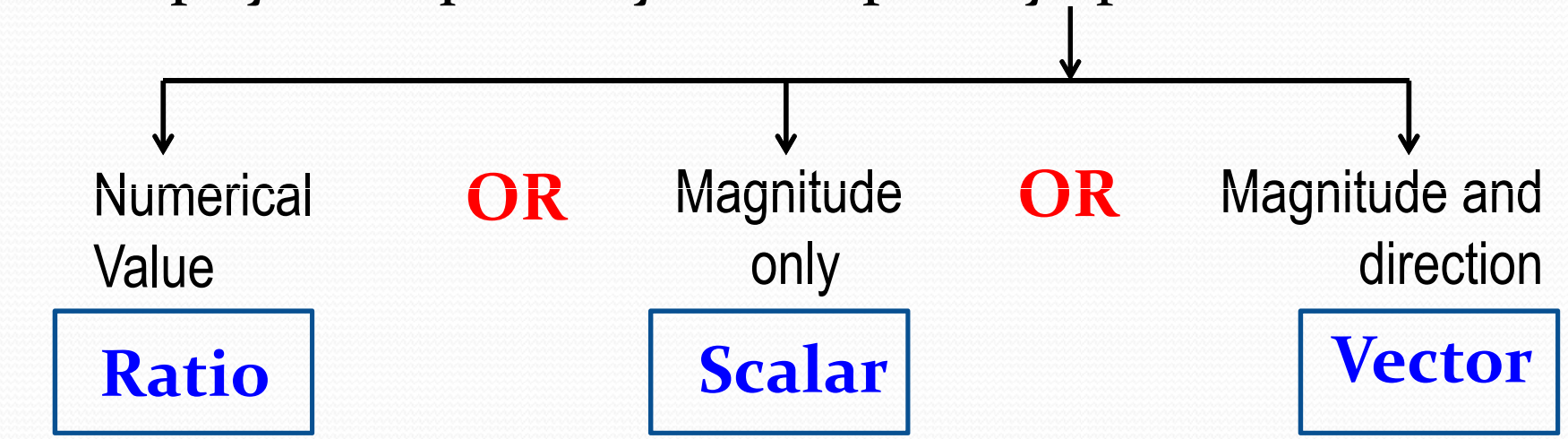
Measurements are a part of our lives

- Anybody can think individual examples for the introduction of measurements. Because everybody makes measurements of some kind.
- Here I am taking a most common examples as:
  - ✓ If you buy some fruits (like apples, grapes, oranges etc.), the seller measures the mass of the fruits using his balance and standard weights.
  - ✓ Every period in your school has a fixed duration, which is measured using a clock.

Measurements are made to find information about a variety of quantities. Length is one such quantity. One may wish to measure the length of corona, book, table, class room and the distance between earth and the sun etc. We say that length is a physical quantity.

Physical Quantity

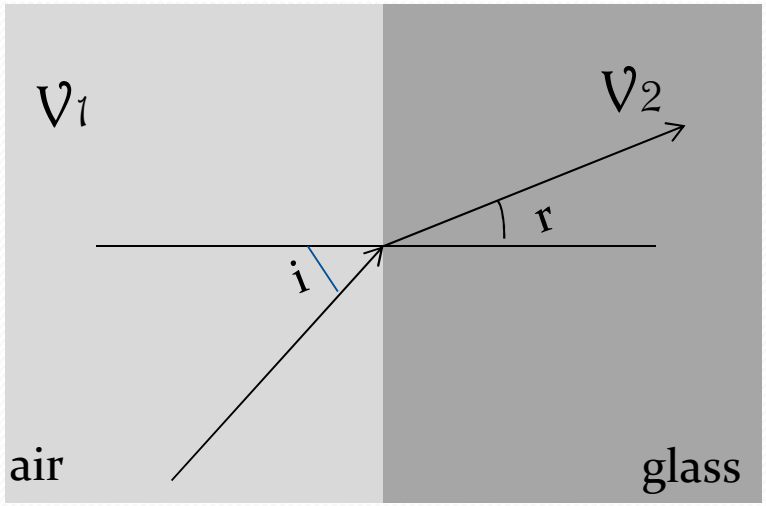
- The quantities by means of which we describe the laws of physics are called physical quantities.
- A physical quantity is completely specified if it has ...



There are physical quantities which are not completely specified even by magnitude, unit and direction. These physical quantities are called **Tensors**. e.g. Moment of Inertia.

Ratio: Refractive index

- Refractive index of any medium is a numerical value
- It is denoted by ‘n’ or ‘μ’
- It is unitless



Refractive index of glass with respect to air (n) = $\frac{V_1}{V_2}$

where

V_1 = speed of light in air

V_2 = speed of light in glass

Let its value “n” = 1.51

Scalar quantities

- **The physical quantities having magnitude alone are called scalars**.
- They are added and subtracted according to simple laws.
- e.g. Distance, speed, current, charge, mass, density, pressure and energy etc.

- In general, for expressing the magnitude of a physical quantity we choose a unit and then find physical quantity how many times that unit is contained in the given physical quantity.

Magnitude of physical quantity = numerical value (n) x **unit** (u)

From this relation, it is clear that for a given physical quantity:

(a) As the unit will change, numerical value will also change. e.g.,

(i) Density of water = 1 g/cc = 1000 kg/m^3

(ii) Length of table = 1 m = 100 cm

(iii) Duration of class = 1 h = 60 min

(b) Larger the unit smaller will be the numerical value and *vice versa.*

e.g., Current = 1 ampere = 1/10 biot (emu of current)

As 1 is greater than (1/10), ampere is a smaller unit than emu of current

Conclusion: (i) $n \propto 1/u$

(ii) **n x u = Constant**

(iii) $n_1 \times u_1 = n_2 \times u_2$

Vector quantities

- **The physical quantities having magnitude as well as direction are called vectors**.
- They are added and subtracted according to special laws, such as law of parallelogram of forces, law of triangle of forces, law of polygon of forces etc.
- e.g. Displacement, velocity, force, torque, momentum, current density, intensity of field etc.
- A vector quantity is represented by an arrow. Length of the arrow represents magnitude and arrow head represents direction.

Units

- **Units are the chosen standards which when applied in front of a number, gives complete information regarding the physical quantity.**

- A physical quantity = n u

- Smaller the units, more is the numerical value.

- Units are of two types (i) **Fundamental units**
  (ii) **Derived units**

Fundamental Units

- **The units of base quantities are called fundamental / absolute / base units.**
- Following are seven base quantities and their units:

Quantity	SI Unit	Symbol
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Luminous Intensity	candela	cd
Amount of substance	mole	mol
Plane angle	radian	rad
Solid angle	steradian	sr

Supplementary units

Derived Units

- **The units of derived quantities are called derived units.**

Following are some derived quantities and their units:

(1) Quantity: **speed** = distance/time

Unit: **m/s**

(2) Quantity: **momentum** = mass x velocity

Unit: **kg m/s**

Note: Base or fundamental quantities are a group of physical quantities that are independent of each other and are such all other physical quantities can be derived from them.

System of units

- **A complete set of units, both fundamental and derived for all kinds of physical quantities, is called system of units.**
- Few common systems are given below:

➢ **CGS System** of units
(centimetre-gram-second system)

➢ **FPS System** of units
(foot-pound-second system)

➢ **MKS System** of units
(metre-kilogram-second system)

➢ **SI system** of units
(international system of units)

Length: It is the measure of intervals in space.

Mass: It is a basic property of matter.

Time: It is one of the phenomena which we cannot define in the dictionary sense.

- Thank you

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