Lesson Note: Physics – Week One

Reference Text:

New System Physics by Dr. Charles Chow et al.

WEEK ONE

TOPIC:

Introduction to Physics

CONTENT OUTLINE

1. Meaning of Physics
2. Fundamental Quantities and Units
3. Dimensions of Physical Quantities

---

1. Meaning of Physics

Physics is the **scientific study of matter and energy** and how they interact with one another. Energy can take many forms such as motion, light, electricity, radiation, and gravity.

Physics deals with matter on all scales — from **sub-atomic particles** (those that make up atoms) to **stars and galaxies**. It can also be defined as a **natural science that studies matter and its motion through space and time**, including related concepts like **energy** and **force**.

In general, Physics seeks to **understand how the universe behaves**.

Physics is one of the **oldest academic disciplines**, tracing its origins to ancient astronomy. Until the 16th century, it was often studied alongside **Philosophy**, **Chemistry**, **Mathematics**, and **Biology**. However, during the **Scientific Revolution**, Physics became a distinct field.

Despite this, Physics still overlaps with some areas like **Mathematical Physics** and **Quantum Chemistry**.

Physics is **significant and influential** because:

- Its discoveries often lead to **new technologies**.
- Its theories influence other sciences, mathematics, and even philosophy.

For example:

- Understanding **electromagnetism** led to inventions like **television, computers, and electric appliances**.
- Advances in **thermodynamics** made **motorized transport** possible.
- Discoveries in **mechanics** inspired the development of **calculus**.

Branches of Physics

1. **Classical Physics** – Includes:
    - Mechanics
    - Heat (Thermodynamics)
    - Optics
    - Waves and Sound
    - Electricity and Magnetism
2. **Modern Physics** – Focuses on:
    - The behavior of matter and energy at the **atomic and subatomic levels**.

Other specialized branches include:

- Geophysics
- Astrophysics
- Biophysics
- Nuclear Physics
- Engineering Physics

Evaluation

1. What do you understand by the term *Physics*?
2. State the steps involved in the *scientific method*.

---

2. Fundamental Quantities and Units

Meaning of Measurement

Measurement plays a central role in Physics. Before any measurement can be made, **a unit must be defined**.

Over time, different systems of units have been used, such as:

- **FPS System** – Foot, Pound, Second
- **CGS System** – Centimetre, Gram, Second
- **MKS System** – Metre, Kilogram, Second

The **modern internationally accepted system** is the **Système International d'Unités (SI Units)**.

Fundamental Quantities

These are the **basic quantities** that are **independent** of others.
They cannot be defined in terms of other quantities.
All other quantities in Physics are derived from them.

Fundamental Units

These are the **units of the fundamental quantities**.
They form the foundation for all other derived units.

Quantity	**Unit**	**Abbreviation**
Length	Metre	m
Time	Second	s
Mass	Kilogram	kg
Electric Current	Ampere	A
Temperature	Kelvin	K
Amount of Substance	Mole	mol
Luminous Intensity	Candela	cd

Derived Quantities and Units

Derived quantities are obtained by **combining two or more fundamental quantities** through multiplication or division.

Derived Quantity	Derivation	Unit
Area (A)	Length × Breadth	m^2
Volume (V)	Length × Breadth × Height	m^3
Density (ρ)	Mass ÷ Volume	kg/m^3
Velocity (v)	Distance ÷ Time	m/s
Acceleration (a)	Change in Velocity ÷ Time	m/s^2
Force (F)	Mass × Acceleration	Newton (N)

Example:
The unit of **volume** = m × m × m = $\mathbf{m^3}$ ("metre cubed").
The unit of **density** = kg ÷ m^3 = $\mathbf{kg/m^3}$ ("kilogram per cubic metre").

Differences Between Fundamental and Derived Units

Fundamental Units	Derived Units
1. Standard units of measurement	1. Obtained from fundamental units
2. Universally accepted	2. Not all are universally used
3. Form the basis of measurement	3. Depend on fundamental units
4. Defined by international agreement (SI)	4. Formulated through relationships or laws
5. Examples: metre, kilogram, second	5. Examples: newton, joule, pascal

---

Differences Between Fundamental and Derived Quantities

Fundamental Quantities	Derived Quantities
1. Independent of other quantities	1. Dependent on fundamental quantities
2. Can stand alone	2. Cannot stand alone
3. Measured directly	3. Calculated from other quantities
4. Examples: mass, length, time	4. Examples: force, velocity, area

---

3. Dimensions of Physical Quantities

The **dimension** of a physical quantity shows **how it relates to mass (M), length (L), and time (T)**.

Quantity	Unit	Dimension
Mass	Kilogram (kg)	M
Length	Metre (m)	L
Time	Second (s)	T

Example: Dimensional Analysis

1. **Density**

Density=MassVolume\text{Density} = \frac{\text{Mass}}{\text{Volume}}Density=VolumeMass

Volume = Length^3 = L^3
Therefore,
Dimension of Density = M / L^3 = **$M L^{-3}$**