Ministry of Higher Education and Scientific Research
University of Al-Mustaqbal
The College of Science
General Physics
Frist Stage

A Lecture one Title / Theoretical

Standard Units of Measurement

By

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General guidelines:

- Keep your mobile phone on silent mode during the lecture.
- Maintain quiet and avoid noise inside the hall.

Structure Path

General Objective of the Lecture

The general objective of this lecture is to enable students to understand the fundamental concepts of general physics related to measurement, units, mechanics, velocity, and acceleration, and to build a solid foundation for analyzing and describing physical phenomena scientifically.

Behavioral (Performance/Learning) Objectives: By the end of this research/presentation, the candidate is expected to demonstrate the ability to:

- **(Remembering)** that the student recalls the definition of physics and its main areas **by the end of the lecture.**
- **(Understanding)** the difference between base quantities and derived quantities **by the end of the lecture**
- **(Applying)** That the student applies SI units correctly when solving problems **by the end of the lecture.**

You don’t just measure radiation —you safeguard lives with every unit you record.

General Physics

Measurement

Physics is the study of the interactions of matter and energy in all their diverse forms. Like all scientists, physicists strive for accuracy and objectivity when describing these interactions, and they reduce uncertainty by using precise measurement methods. Assuming proper measurements, different observers using the same physical methods will obtain consistent results within experimental uncertainty.

In the SI system (International System of Units), there are seven base quantities that form the foundation of all physical measurements: length (measured in meters), mass (measured in kilograms), time (measured in seconds), electric current (measured in amperes), thermodynamic temperature (measured in kelvins), amount of substance (measured in moles), and luminous intensity (measured in candelas). These base quantities are considered fundamental because all other physical quantities are derived from them. Derived quantities are obtained by combining one or more of the base quantities. For example, volume is the cube of length (L^3), mass density is mass divided by volume (M/L^3), and velocity is length divided by time (L/T)

Units

Every measurement has two parts: a magnitude and a unit. For example, the SID is 100 cm. The magnitude, 100, is not meaningful unless a unit is also designated. Here, the unit of measurement is the centimeter.

SI Prefixes

Factor	Prefix	Symbol
10^{18}	Exa	E
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
10^{-6}	Micro	μ
10^{-9}	Nano	n
10^{-12}	Pico	p
10^{-15}	Femto	f
10^{-18}	Atto	a

Special Quantities in Radiologic Science & Their Units

Why it matters:

SI units are globally standardized, ensuring consistency in compliance to standards, patient safety ,and dosimetry.

Special Quantities of Radiologic Science and Their Associated Special Units

	CUSTOMARY UNIT		SI UNIT	
Quantity	Name	Symbol	Name	Symbol
Exposure	roentgen	R	air kerma	Gy_a
Absorbed dose	rad	rad	gray	Gy_t
Effective dose	rem	rem	seivert	Sv
Radioactivity	curie	Ci	becquerel	Bq

Exposure: Measured in *roentgen (R)* → convert to SI unit *air kerma (Gy_a)* by multiplying R × 0.00876.
Also shown: Exposure (R) converts to *C/kg* (coulomb per kilogram) via R × 2.583×10^{-4}
Absorbed Dose: *rad* → *gray (Gy_r)*; multiply rad × 0.01.
Effective Dose: *rem* → *sievert (Sv)*; multiply rem × 0.01.
Radioactivity: *curie (Ci)* → *becquerel (Bq)*; multiply Ci × 3.7×10^{10}.

Special Quantities in Radiologic Science & Their Units

Conversion Factor	SI Unit	Traditional Unit	Quantity
1 R = 2.583 × 10^{-4} C/kg	Coulomb/kg (C/kg)	Roentgen (R)	Exposure
1 R ≈ 0.00876 Gy_a	Air kerma (Gy_a)		
1 rad = 0.01 Gy	gray (Gy_r)	rad	Absorbed Dose (D)
1 rem = 0.01 Sv	sievert (Sv)	rem	Effective Dose
1 Ci = 3.7 × 10^{10} Bq	becquerel (Bq)	curie (Ci)	Radioactivity

Quick Quiz – 3 Minute! (Individual activity)

Total score: 0.5 point

Scan → Think → Submit

Question (1) ❓ An exposure of 3 R is measured. Find the air kerma?

1. 0.02628 Gy_a
2. 1.02628 Gy_a
3. 2.02628 Gy_a
4. 3.02628 Gy_a

Google forms

Equivalent Dose and Quality Factor

Equivalent Dose (H)

- A quantity used to account for the biological effect of different types of radiation.

Formula:

$$H = D \times Q$$

Unit:

- Traditional: rem
- SI Unit: sievert (Sv)

Where:

- H = Dose Equivalent (Sv)
- D = Absorbed Dose (Gy)
- Q = Quality Factor (depends on radiation type)

Common Quality Factor (Q) Values:

- X-rays & Gamma rays: **Q = 1**
- Beta particles: **Q = 1**
- Neutrons: **Q = 5–20**
- Alpha particles: **Q = 20**

Quick Quiz – 3 Minutes! (Group activity)

Total score: 0.5 points

Scan → Decide → Submit

Question (2) An absorbed dose of 0.02 Gy from X-rays is given Calculate the dose equivalent?

1. 0.02 Gy_a
2. 0.02 Gy
3. 0.02 Gyr
4. 0.02 Sv

Google forms

Operational Dose Quantities in Radiologic Science

- **Operational Dose Quantities are used for radiation protection and monitoring in clinical and occupational environments.**

Main Types:

1-Directional Dose Equivalent (H)(0.07)'

•**Used for skin and eye exposure assessment**

2.Ambient Dose Equivalent (H*(10))

1. **Used for area monitoring**
2. **Represents dose at 10 mm depth in tissue**

3. Personal Dose Equivalent (Hp(10), Hp(0.07))

•**Used for individual monitoring with dosimeters**

•**Hp(10): deep dose (whole body).**

•**Hp(0.07): skin dose**

Unit:

•**Traditional: rem**

•**SI Unit: sievert (Sv)**

Importance:

- **Essential for radiation safety**
- **Helps ensure compliance with dose limits for workers and patients**

Quick comparison

Symbol	Quantity Name	Use	Depth
H'(0.07)	Directional Dose Equivalent	Skin / eye dose	0.07 mm
H*(10)	Ambient Dose Equivalent	Area monitoring	10 mm
Hp(10)	Personal Dose Equivalent	deep dose (whole body)	10 mm
Hp(0.07)	Personal Dose Equivalent	Skin dose	0.07 mm

Summary

Topic	Key Point
SI Base Units	7 base quantities: meter (m), kilogram (kg), second (s), ampere (A), kelvin (K), mole (mol), candela (cd)
Radiologic Units (Traditional → SI)	R → C/kg & Gy_a; rad → Gy; rem → Sv; Ci → Bq
Dose Equivalent (H)	H = D × Q; accounts for biological impact (e.g., X-rays: Q = 1; alphas: Q = 20).
Operational Dose Quantities	Hp(10) = deep dose; Hp(0.07) = skin dose; H*(10) = area monitoring; H'(0.07) = directional/skin.


Any
Question

Homework // Q//Solve Problems and submit your answer via the Classroom platform

Problem 1: A radiation survey meter reads 76.2 R.

(a) Calculate the corresponding air kerma.

(b) Compute the associated C/kg.

Problem 2:

A radiographer wrote in a report: "The absorbed dose was 0.15 Sv, and the dose equivalent was 1.5 Gy"

Rewrite the sentence correctly.

Problem 3:

A worker is exposed to a mixed radiation field:
0.03 Gy from X-rays (Q = 1)
0.002 Gy from alpha particles (Q = 20)
0.005 Gy from neutrons (Q = 10)
Calculate: The total dose equivalent

Problem 4: A radiologic technologist wears two dosimeters: one on the chest and one on the thumb. Weekly readings are:

$$H_p(10) = 0.38\ mSv$$

$$H_p(0.07) = 4.2\ mSv$$

Explain the physical meaning of the difference between $H_p(10)$ and $H_p(0.07)$.

References

- Science Introduction to Physics in Modern Medicine, (Suzanne Amador 2002), Radiation Physics for Medical Physicists (Ervien B, Poodgorasak.2006)

- Physics Utah Science Standards, 2019

- Science Direct, Google Scholar. Web of Science

Thank you for listening