

KARACHI EDU

CLASS 10 PHYSICS • UNIT 12

Electromagnetic Spectrum

Coaching Center Professional Notes & Wave Propagation Dynamics

Dispersion of Light



Definition

Splitting of white light into component colors via a prism.



Root Cause

Different wavelengths yield varied refractive indices.



Color Sequence

VIBGYOR (Violet to Red spectrum order).

Prism Deviation Dynamics

- **Red Light**

Longest wavelength (~650 nm).

Travels fastest; least deviation.

- **Violet Light**

Shortest wavelength (~400 nm).

Travels slowest; most deviation.

Rainbow Formation Mechanism

01

Refraction

Sunlight enters water droplet.

02

Internal Reflection

Reflection at droplet rear.

03

Exit Dispersion

Refraction toward observer eye.

Core Wave Characteristics

Transverse Nature

Oscillating electric and magnetic fields perpendicular to motion.

Vacuum Speed

Constant velocity $c = 3 \times 10^8$ m/s ($c = f \lambda$).

Medium Impact

Velocity reduces in transparent media by refractive index n .

Wavelength & Frequency Ranges

Component	Wavelength Range	Source / Characteristic
Radio Waves	> 0.1 m	Accelerating charges / Antennas
Microwaves	1 mm - 0.1 m	Specialized tubes / Thermal motion
Infrared (IR)	700 nm - 1 mm	Thermal agitations / Warm bodies
Visible Light	400 nm - 700 nm	Electronic transitions / Sun
Ultraviolet (UV)	100 nm - 400 nm	Very hot bodies / Mercury vapor
X-Rays	0.01 nm - 10 nm	Inner electronic collisions
Gamma Rays	< 0.01 nm	Radioactive atomic nuclei decay

Radio Waves & Microwaves



Radio Waves

Broadcasting TV and radio programs (VHF/UHF).

Diffraction around obstacles and Earth curvature.



Microwaves

Satellite comms, mobile telephony, and ovens.

Highly directional; penetrates clouds and haze.

Infrared, Visible & UV

Infrared (IR)

TV remote controllers and intruder thermal alarms.

Visible Light

Human vision and optical fibers for telecom/endoscopes.

Ultraviolet (UV)

Sunbeds, fluorescent tubes, and medical sterilization.

X-Rays & Gamma Rays



X-Rays

Medical diagnostics, CT scans, and industrial crack detection.



Gamma Rays

Gamma knife radiosurgery, PET scans, and metal inspection.

Infrared Frequency Calculation

Given Data

Wavelength $\lambda = 15 \mu\text{m} = 15 \times 10^{-6} \text{ m}$

Speed $c = 3 \times 10^8 \text{ m/s}$

Solution Result

$$f = c / \lambda = 2 \times 10^{13} \text{ Hz}$$

Result: $2 \times 10^{13} \text{ Hz}$

Microwave Wavelength Calculation

Given Data

Frequency $f = 2.45 \text{ GHz} = 2.45 \times 10^9 \text{ Hz}$

Speed $c = 3 \times 10^8 \text{ m/s}$

Solution Result

$$\lambda = c / f \approx 0.1224 \text{ m}$$

Result: 0.1224 m (122.4 mm)

Coaching Center Review

- White light splits into 7 colors via dispersion (Red least, Violet most).
- All EM waves are transverse and share constant speed $c = 3 \times 10^8$ m/s in vacuum.
- Spans radio waves to gamma rays, powering communications & medical technology.

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