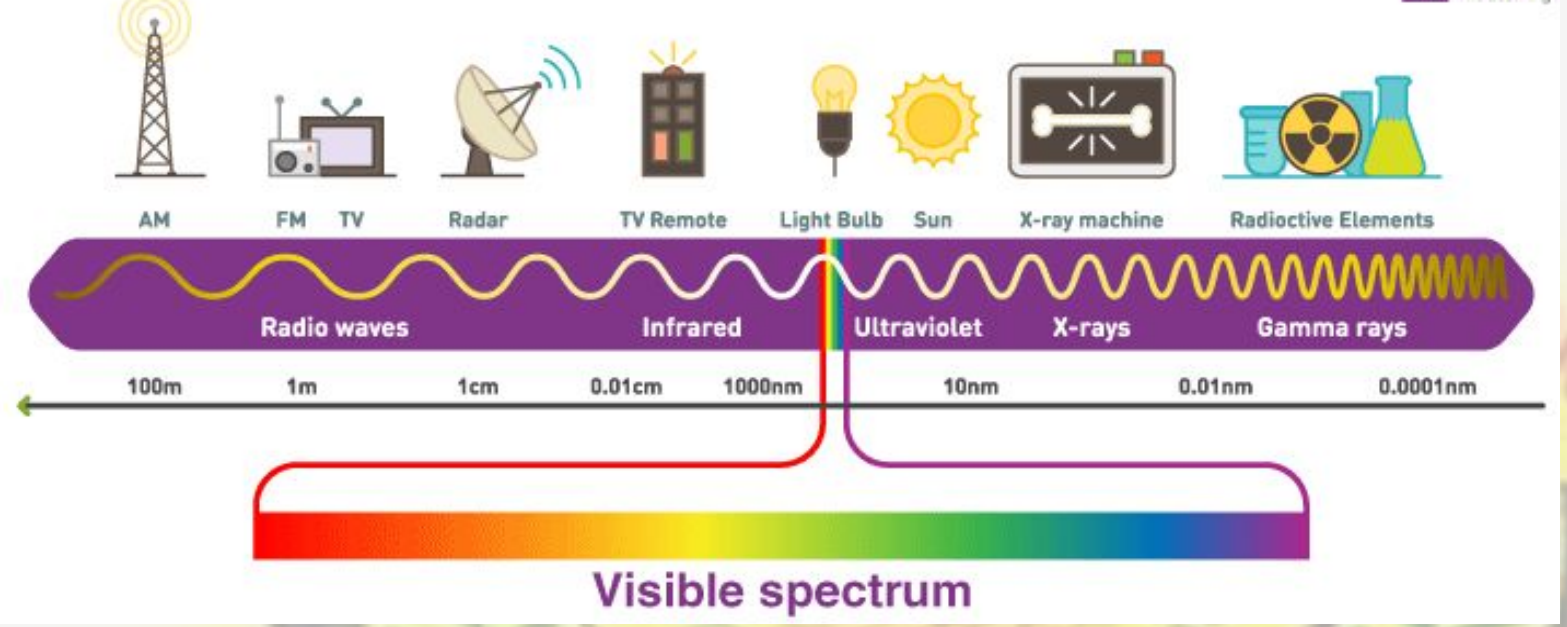
Electromagnetic Spectrum: X-rays

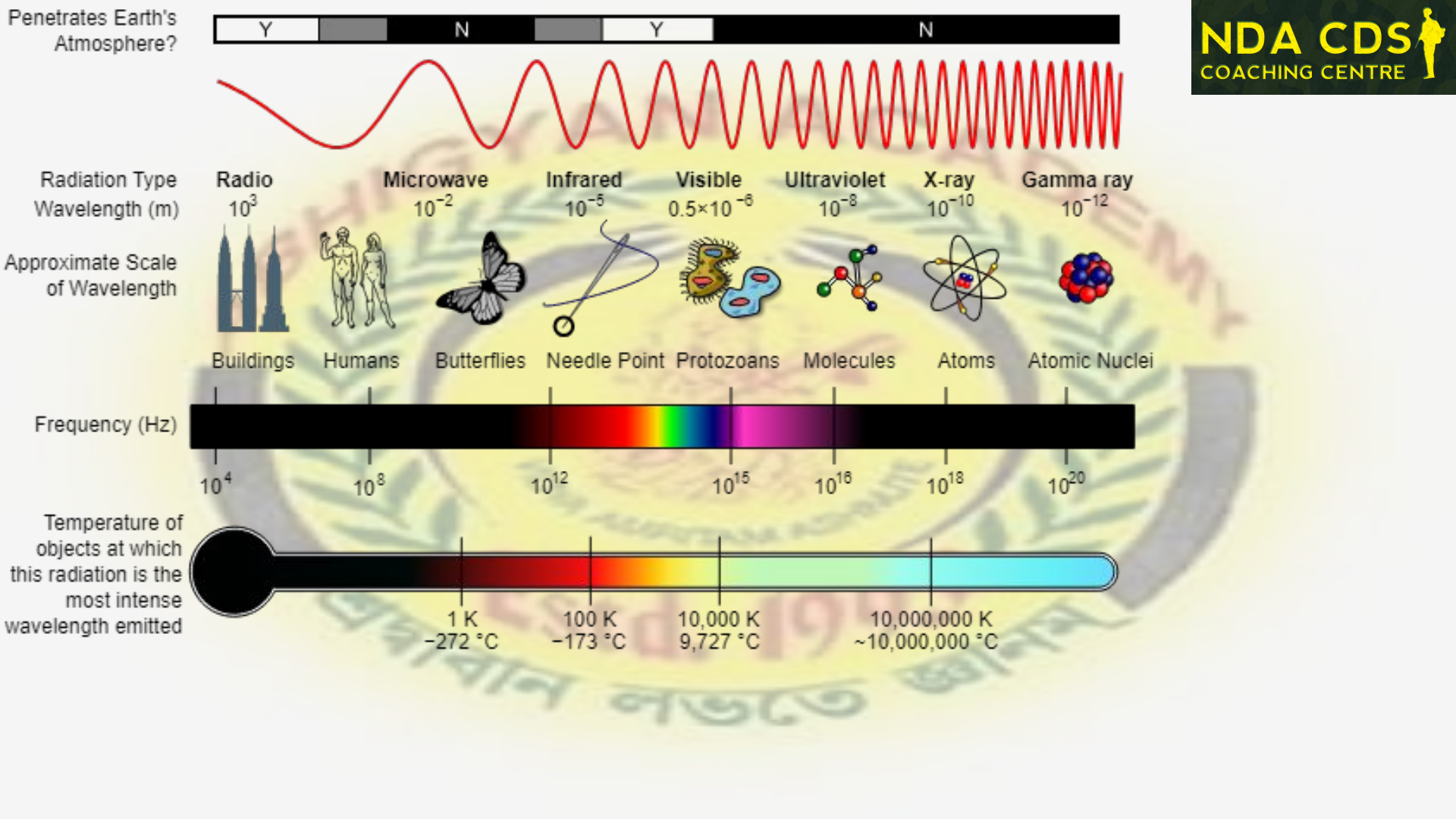
Key Points

- X-rays are a type of invisible light within the electromagnetic spectrum.
- Their wavelength is between 0.01nm and 10nm.
- Their frequency range is between 30 PHz and 30 EHz.
- Their energy ranges from 100eV to 100keV.
- X-rays are known for their ability to penetrate dense materials.
- Discovered by Wilhelm C. Roentgen in 1895.



Electromagnetic Spectrum Overview

- The electromagnetic spectrum includes all types of light, both visible and invisible.
- Waves are categorized based on wavelength, frequency, and energy.
- All electromagnetic waves travel at the speed of light in a vacuum.
- The spectrum, from lowest to highest frequency (and longest to shortest wavelength):
  - Radio waves
  - Microwaves
  - Infrared radiation
  - Visible light
  - Ultraviolet rays
  - X-rays
  - Gamma rays



Properties of X-rays

- X-ray photons carry high energy, capable of ionizing atoms and breaking molecular bonds.
- Shorter wavelength than visible light.
- Hard X-rays can penetrate dense objects with minimal scattering.
- Penetration depth depends on the specific X-ray energy.

Types of X-Rays

- **Hard X-rays:**
  - Energy: 5-10 keV
  - Wavelength: Below 0.1 nm
- **Soft X-rays:**
  - Energy: 100 eV - 5 keV
  - Wavelength: 0.1 nm - 10 nm
- **Key Difference:** Gamma rays originate from the nucleus of an atom, while X-rays originate from the electrons.

Uses of X-rays

1. **Medical Imaging:**
   - Diagnosing broken bones
   - Cancer radiation therapy
2. **Security:** Scanning luggage and people at airports
3. **Art Authentication:** Examining paintings and artifacts to detect forgeries or hidden details

In a Nutshell

- X-rays are high-energy electromagnetic waves.
- They can penetrate various materials, making them valuable in medicine, security, and other fields.
- Different types of X-rays exist, categorized by their energy levels.