

| EM spectrum   | Wavelength/ m<br>(low to high limit)           | Frequency / Hz                              | Method of production   | Method of detection                             | Uses  |   |
|---------------|--|---|--|---|---|---|
| Radio Waves   | $10^{-1}$ to $10^4$ m                          | $3 \times 10^9$ to $3 \times 10^4$ Hz       | Electrons oscillated by electric fields in aerials                                   | Resonance in electronic circuits                | Television, radio, telecommunications, WIFI   | Increasing Frequency/Danger (decreasing wavelength) ↓ |
| Microwaves    | $10^{-4}$ to $10^{-1}$ m                       | $3 \times 10^{12}$ to $3 \times 10^9$ Hz    | Magnetron, klystron oscillators, using electrons to set up oscillations in a cavity. | Heating effect, electronic circuits             | Radar, mobile phones, microwave ovens, satellite navigation                         |   |
| Infra-red     | $7.4 \times 10^{-7}$ to $10^{-3}$ m            | $4 \times 10^{14}$ to $3 \times 10^{11}$ Hz | Oscillation of molecules from all objects above temperature of absolute zero         | Photographic film, thermophile, heating of skin | Heaters, night vision equipment, remote controls                                    |   |
| Visible light | $3.7 \times 10^{-7}$ to $7.4 \times 10^{-7}$ m | $8 \times 10^{14}$ to $4 \times 10^{14}$ Hz | High temperature solids and gases, lasers  | Photographic film, retina of eye                | Sight, communication  |   |
| Ultra-violet  | $10^{-9}$ to $3.7 \times 10^{-7}$ m            | $3 \times 10^{17}$ to $8 \times 10^{14}$ Hz | From high temperature solids and gases, lasers                                       | Photographic film, sunburn, phosphors           | Disco lights, tanning studios, counterfeit detection, by detergents                 |   |
| X-rays        | $10^{-12}$ to $10^{-7}$ m                      | $3 \times 10^{20}$ to $3 \times 10^{15}$ Hz | Bombarding metals with high-energy electrons   | Photographic film, fluorescence                 | Computer-aided tomography (CT) scans, X-ray photography, crystal structure analysis |   |
| Gamma rays    | $10^{-16}$ to $10^{-9}$ m                      | $3 \times 10^{24}$ to $3 \times 10^{17}$ Hz | Nuclear decay or in a nuclear accelerator  | Photographic film, Geiger counter               | Diagnosis and cancer treatment (radiotherapy)                                       |   |