The infinite range of frequencies of electromagnetic radiation - an effect of electromagnetism that travels by photon wave particles at the speed of light and carries radiant energy.

### The Electromagnetic Spectrum

<table>
<thead>
<tr>
<th>Waves Type</th>
<th>Frequency Range</th>
<th>Wavelength Range (m)</th>
<th>Notable Experiments/Inventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio Waves</td>
<td>3 Hz - 300 GHz</td>
<td>100 km - 1 m</td>
<td>AM, FM, TV, radar, communications</td>
</tr>
<tr>
<td>Microwaves</td>
<td>300 MHz - 300 GHz</td>
<td>1 m - 1 mm</td>
<td>Wi-Fi, microwave oven, Heinrich Hertz</td>
</tr>
<tr>
<td>Infrared</td>
<td>300 GHz - 400 THz</td>
<td>1 mm - 750 nm</td>
<td>remote, night vision, William Herschel</td>
</tr>
<tr>
<td>Visible Light</td>
<td>400 THz - 770 THz</td>
<td>750 nm - 390 nm</td>
<td>vision, photography, illumination</td>
</tr>
<tr>
<td>Ultraviolet</td>
<td>750 THz - 30 PHz</td>
<td>400 nm - 10 nm</td>
<td>sunburn, dental curing, Johann Ritter</td>
</tr>
<tr>
<td>X-Rays</td>
<td>30 PHz - 30 EHz</td>
<td>10 nm - .01 nm</td>
<td>baggage screen, medical x-ray, Wilhelm Rontgen</td>
</tr>
<tr>
<td>Gamma Rays</td>
<td>&gt;15 EHz</td>
<td>&lt;.02 nm</td>
<td>PET imaging, cosmic rays, Paul Villard, William Henry Bragg, Ernest Rutherford, Edward Andrade</td>
</tr>
</tbody>
</table>

**Roy G. Biv**

- R = red
- O = orange
- Y = yellow
- G = green
- B = blue
- I = indigo
- V = violet

**Formulas:**
- $f = \frac{c}{\lambda}$
- $E = \frac{hc}{\lambda}$
- $E = hf$
- $\lambda = \frac{c}{f}$

**Key Points:**
- **White light** is the combination of all the different wavelengths in the visible range of the spectrum.
- When white light is passed through a prism, it is split into the different colors, as in a rainbow.
- Our perception of the world is based on the eye’s detection of this range of electromagnetic radiation.
- Colors containing only one wavelength are called pure colors.
- Mixes of multiple wavelengths are called unsaturated.
- Objects appear colored because of light absorption, reflection, or emission.
- Redshift indicates that an object is moving away from an observer.
- Blueshift indicates that an object is moving towards an observer.
Visible Light

• The infinite range of frequencies of electromagnetic radiation - an effect of _______________ that travels by _______________ at the speed of _______________ and carries _______________ energy.

• Increasing _______________, _______________, & _______________

• _______________ means an object is moving away from an observer.
• _______________ means an object is moving towards an observer.

ROY G. BIV
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