Sim Pack 4:

Ultraviolet-Visible Absorption Spectroscopy & the Beer Lambert Law
Learning Outcomes:

After reading these notes you will learn about the following terms

- Wave particle duality
- Absorption spectrum
- Ultraviolet - visible absorption spectrometer
- Beer Lambert Law
The complete electromagnetic spectrum is shown below:

**Figure 2: Electromagnetic Spectrum**

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Radio</th>
<th>Microwave</th>
<th>Infrared</th>
<th>Visible</th>
<th>Ultraviolet</th>
<th>Vacuum Ultraviolet</th>
<th>X-rays</th>
<th>Gamma Rays</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.0 x 10^9 Hz</td>
<td></td>
<td>3.0 x 10^12 Hz</td>
<td></td>
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<tr>
<td>4.3 x 10^14 Hz</td>
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<tr>
<td>7.9 x 10^14 Hz</td>
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<tr>
<td>3.0 x 10^15 Hz</td>
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<tr>
<td>3.0 x 10^17 Hz</td>
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<tr>
<td>3.0 x 10^19 Hz</td>
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<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wavelength</th>
<th>&gt; 10 cm</th>
<th>10 cm</th>
<th>0.01 cm</th>
<th>700 nm</th>
<th>380 nm</th>
<th>100 nm</th>
<th>1 nm</th>
<th>0.01 nm</th>
<th>&lt; 0.01 nm</th>
</tr>
</thead>
</table>

- Long wavelength  
- Low frequency  
- Low energy  

- Short wavelength  
- High frequency  
- High energy  

\[ E = h \nu = \frac{hc}{\lambda} \]
Figure 7: An absorption spectrum showing rotational & vibrational transitions & associated fine structure
UV-Visible Absorption Spectrometer

We will now look at a typical uv-visible absorption spectrometer (see Figure 9) which is used to measure a molecule’s absorption spectrum or absorption at a single \( \lambda \).

![Figure 9: uv-visible absorption spectrometer](image)
Since this form of spectroscopy is concerned with outer electron shell transitions it can provide information about the electronic structure of molecules.

Absorption spectroscopy is also important in chemical analyses: we can identify how much of a species is present in a sample by running its absorption spectrum.

This is as a result of the Beer-Lambert Law.

**Beer – Lambert Law**

The absorption of a beam of light by homogeneous absorbing systems can be formally described by the Beer-Lambert Law. The principle of the measurement is shown in Figure 10.