



# ENGINEERING CHEMISTRY

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Department of Science and Humanities

# ENGINEERING CHEMISTRY

## Module 1- Molecular spectroscopy

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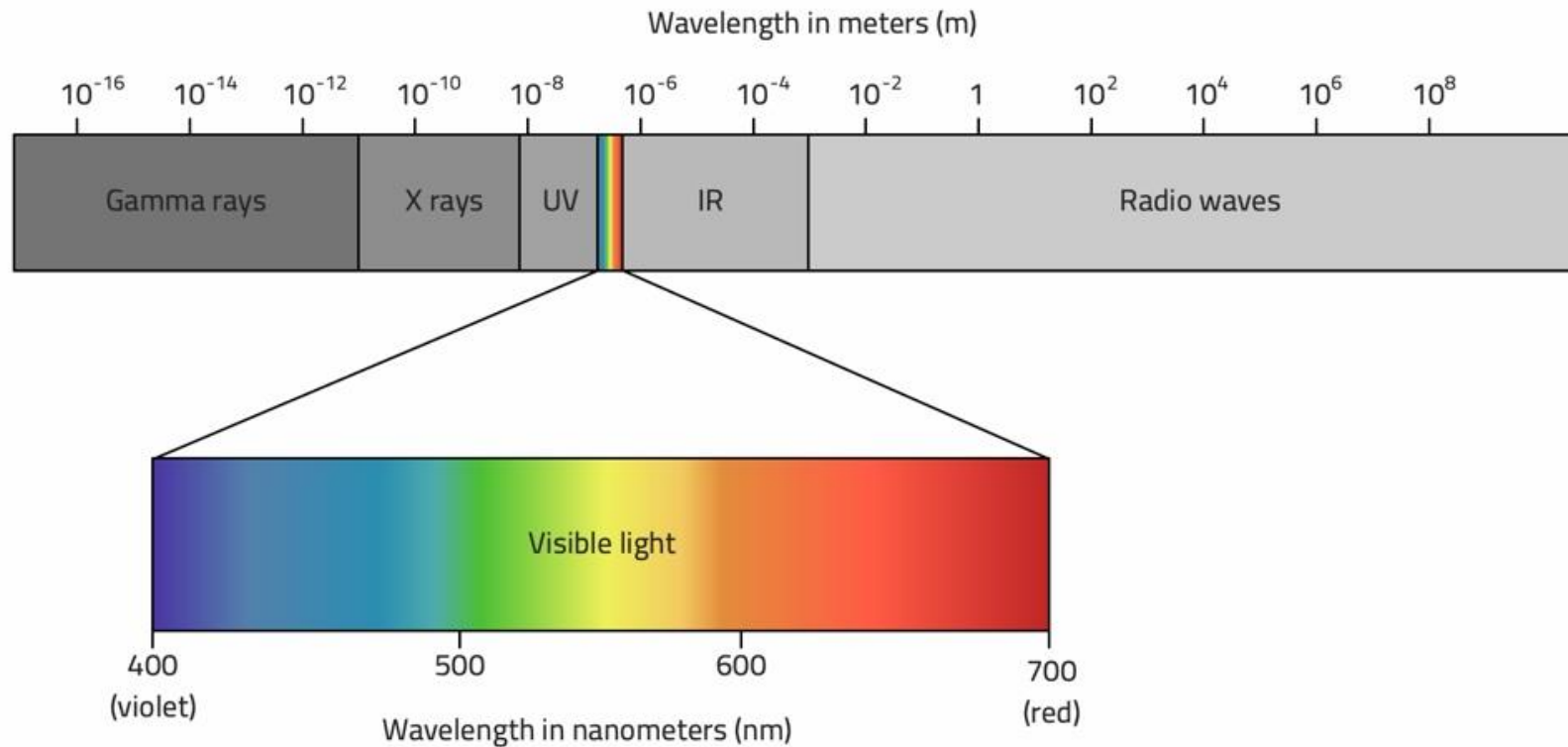
### *Class Content :*

- *Electromagnetic spectrum*
- *Information obtained from each region of the spectrum*

# ENGINEERING CHEMISTRY

## Module I- Molecular Spectroscopy

### Electromagnetic spectrum



Source: <https://www.radio2space.com/components-of-electromagnetic-spectrum/>

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## Module I- Molecular Spectroscopy

### Information obtained from different regions of electromagnetic spectrum

Radiofrequency region	Wavelength (10m-1cm) NMR, ESR Nuclear and electron spin reversal
Microwave region	Wavelength (1cm-100 $\mu$ m) Rotational spectroscopy Rotational transitions
Infra Red region	Wavelength (100 $\mu$ m-1 $\mu$ m) Vibrational spectroscopy Vibrational transitions

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## Module I- Molecular Spectroscopy



### Information obtained from different regions of electromagnetic spectrum

Visible and Ultra-Violet region	Wavelength ( $1\mu\text{m}$ - $10\text{nm}$ ) UV-Visible spectroscopy Electronic states Change in electronic distribution of valence electrons
X-ray region	Wavelength ( $10\text{nm}$ - $100\text{pm}$ ) X-ray spectroscopy Change in electronic distribution of inner electrons
$\gamma$ - ray region	Wavelength ( $100\text{pm}$ - $1\text{pm}$ ) $\gamma$ - ray spectroscopy Rearrangement of nuclear particles

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## Module I- Molecular Spectroscopy

### Raman Spectroscopy: scattering of light

When monochromatic radiation is passed through a transparent medium:

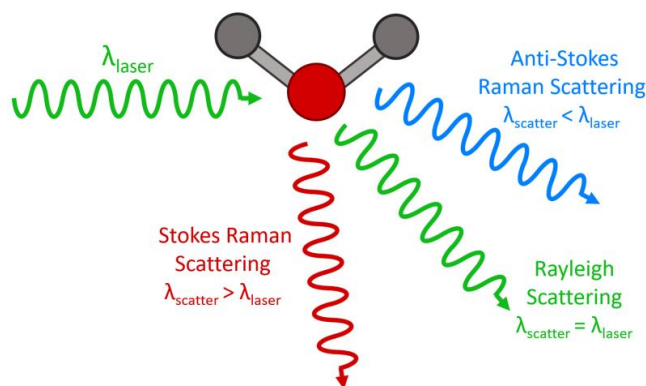
Most of the scattered radiation consists of radiation of incident wavelength –

**Rayleigh scattering**

Some of the scattered radiation consists of radiation with different wavelength from incident wavelength – **Raman scattering**

When the wavelength of scattered radiation is more than that of incident radiation – **Stokes lines**

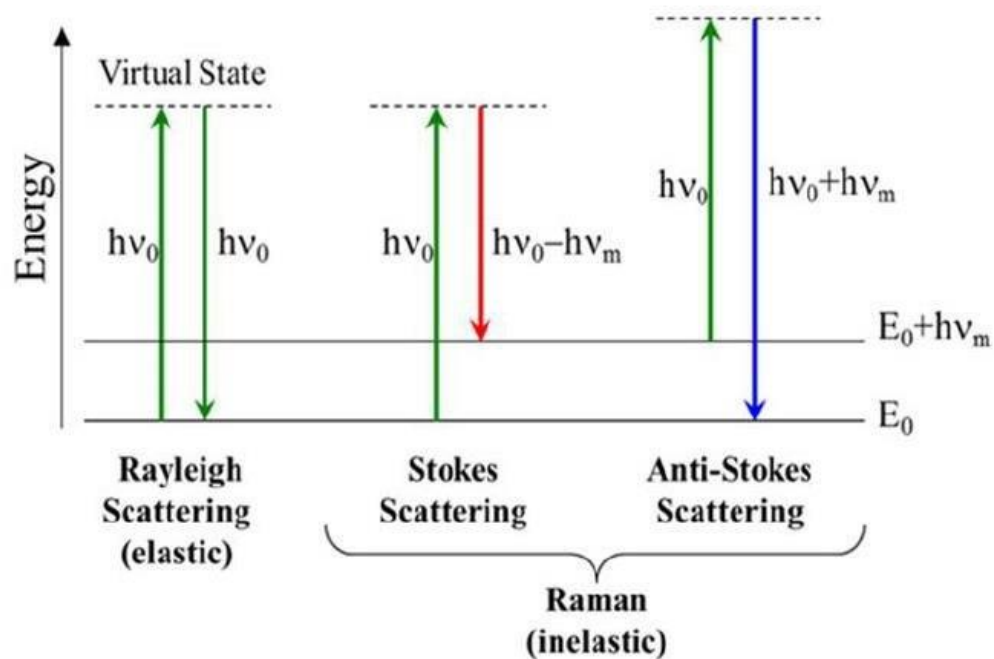
When the wavelength of scattered radiation is less than that of incident radiation – **anti-Stokes lines**



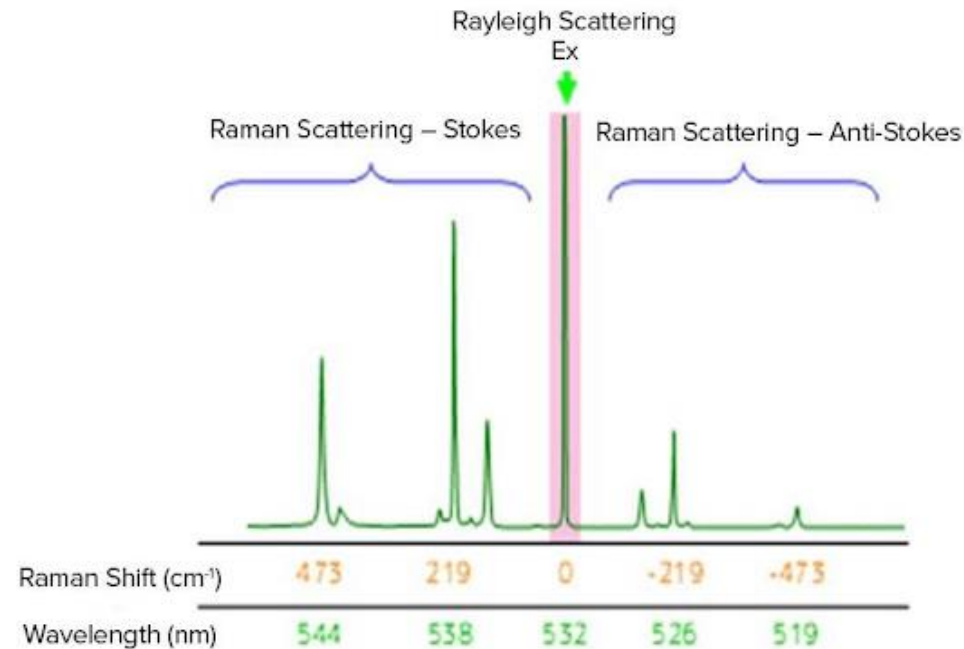
<https://www.edinst.com/blog/what-is-raman-spectroscopy/>

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## Module I- Molecular Spectroscopy



Source: [https://www.researchgate.net/figure/A-simplified-diagram-of-energy-transitions-for-Rayleigh-and-Raman-scattering\\_fig7\\_327321311](https://www.researchgate.net/figure/A-simplified-diagram-of-energy-transitions-for-Rayleigh-and-Raman-scattering_fig7_327321311)



Source: <https://www.jasco-global.com>

**Exchange of energy** between the molecules and radiation  
**Homonuclear diatomic molecules** which are microwave and  
Infra-red inactive are Raman active

# ENGINEERING CHEMISTRY

## Module I- Molecular Spectroscopy

### Information obtained from different regions of electromagnetic spectrum

Spectral region	VHF	UHF	Microwave	Infrared	Visible	Ultraviolet	X-rays	$\gamma$ -rays
Common usage	NMR	EPR	rotational transitions	vibrational transitions	electronic transitions		ionisation	nuclear effects
Frequency (Hz)	$5 \times 10^8$	$3 \times 10^{10}$	$3 \times 10^{11}$	$3 \times 10^{13}$	$6 \times 10^{14}$	$1.2 \times 10^{15}$	$3.0 \times 10^{17}$	$1.5 \times 10^{19}$
Wavelength	0.6 m	1 cm	1 mm	10 $\mu$ m	500 nm	250 nm	1 nm	20 pm
Wavenumber ( $\text{cm}^{-1}$ )	0.017	1.0	10.0	1000	20,000	40,000	$1.0 \times 10^7$	$5.0 \times 10^8$

Source: <http://photobiology.info/Visser-Rolinski.html>





# THANK YOU

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