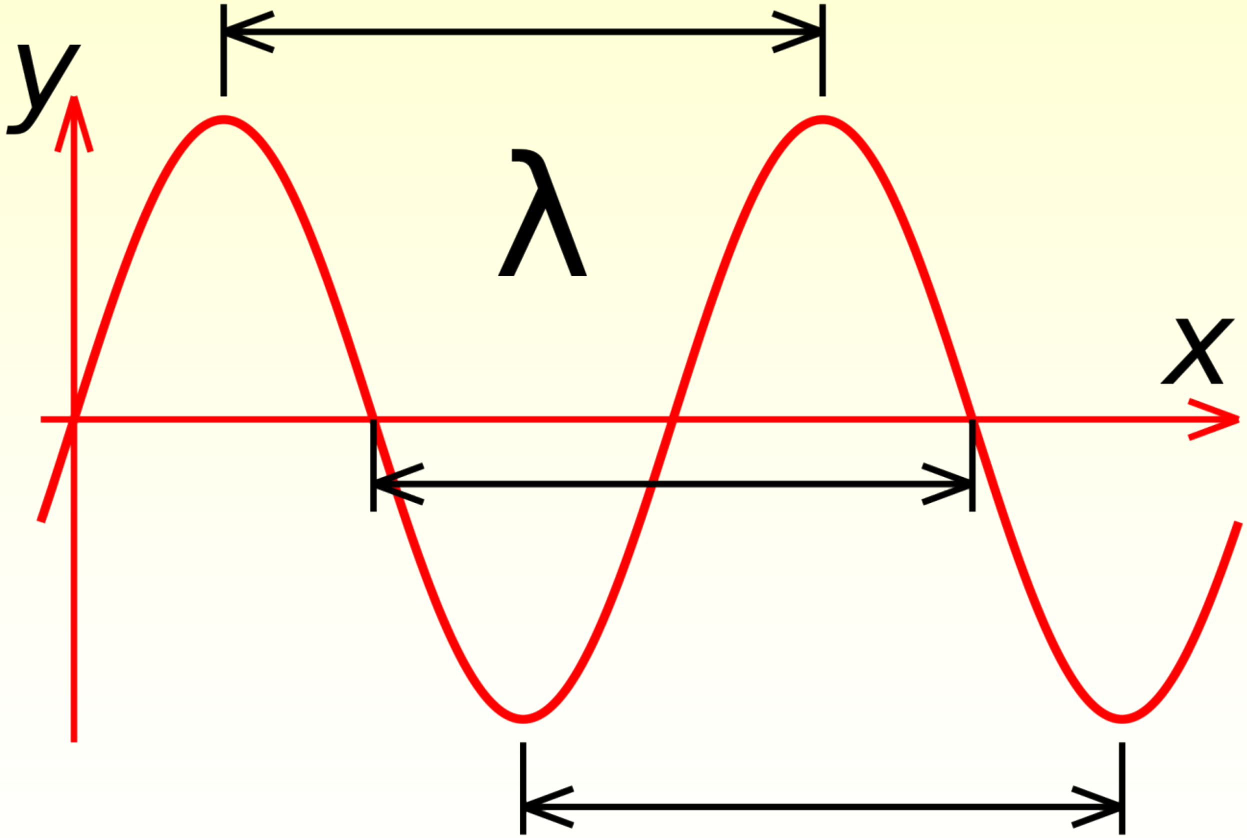
# Spectroscopic methods of analysis

# Spectroscopy

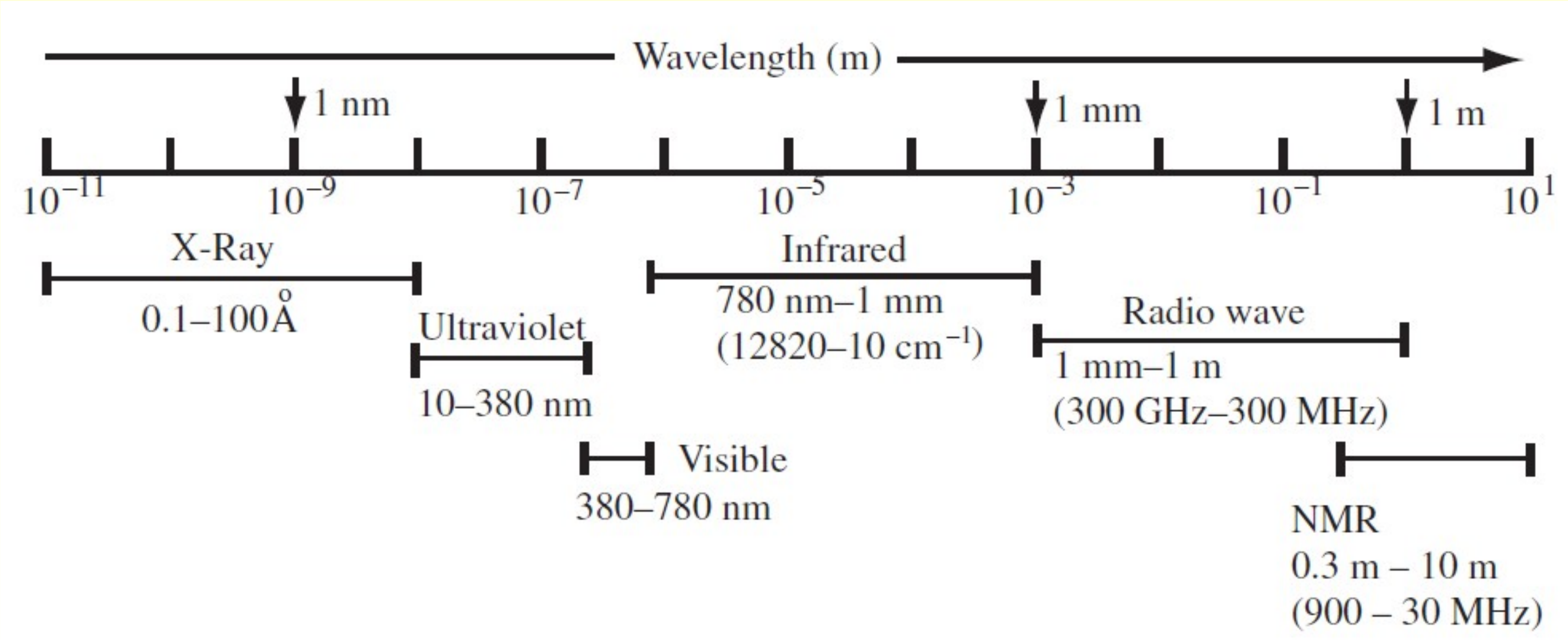
Subject studying interaction of electromagnetic radiation with chemical substance

$$E = h\nu = \frac{hc}{\lambda}$$

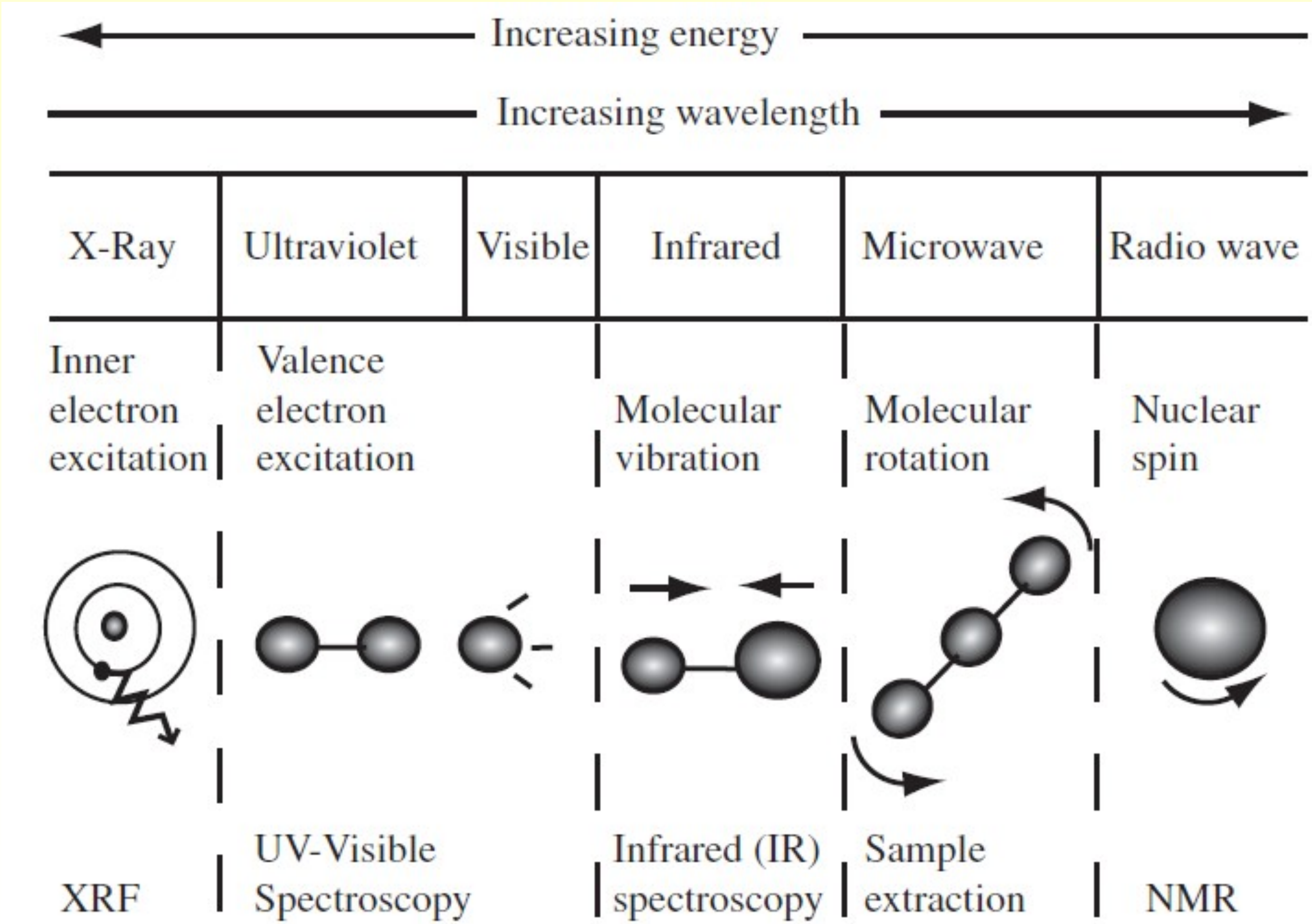
# Wavelength



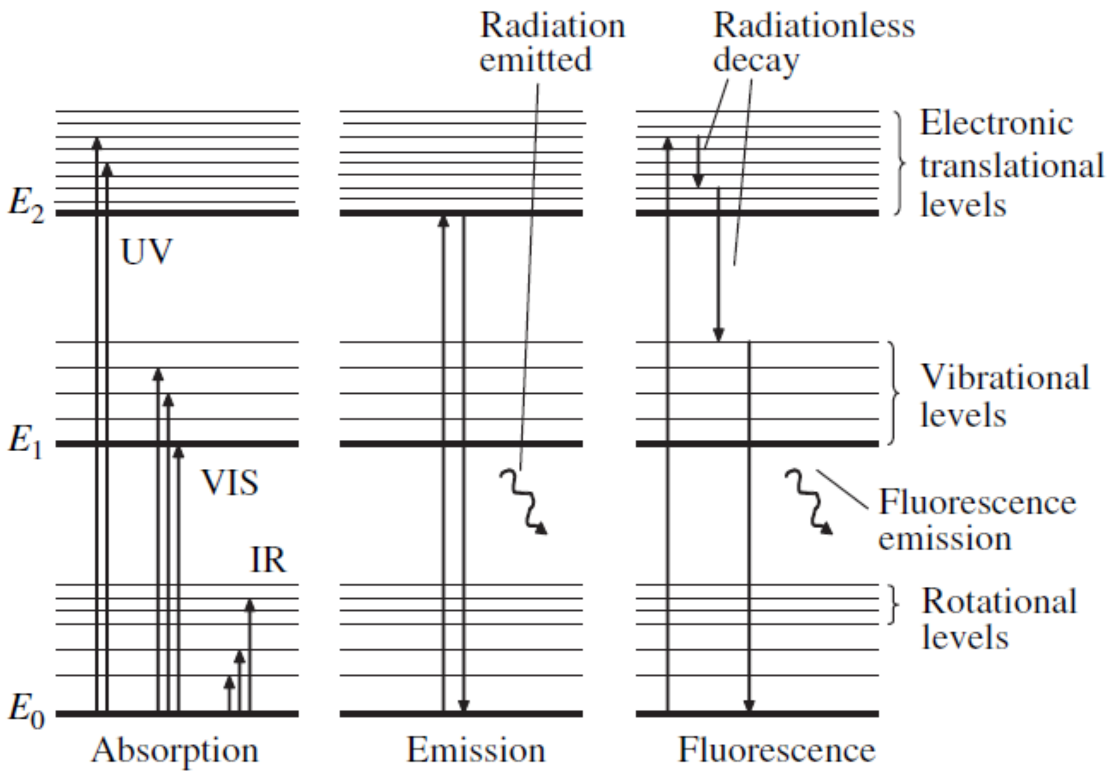
# Classification



# How the radiation affects molecule



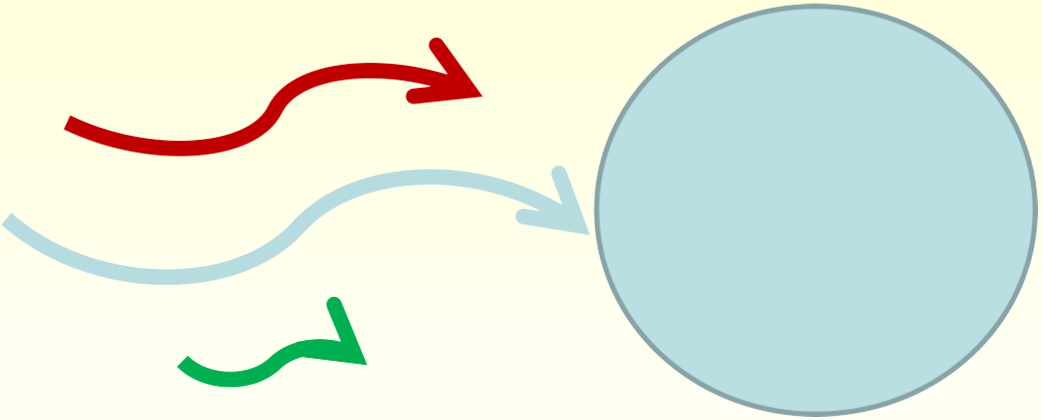
# Absorption, emission, fluorescence



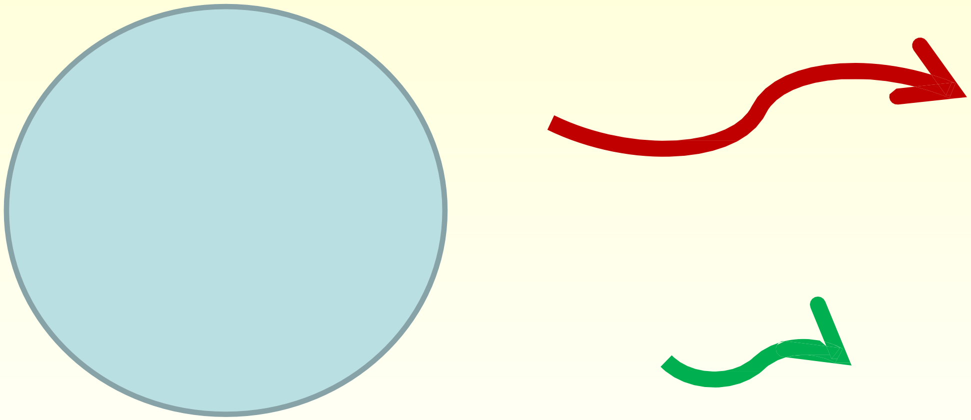

$E_0$ = Ground level; $E_1$, $E_2$ = Excited states

Energy spacing: vibration > rotation >> translation

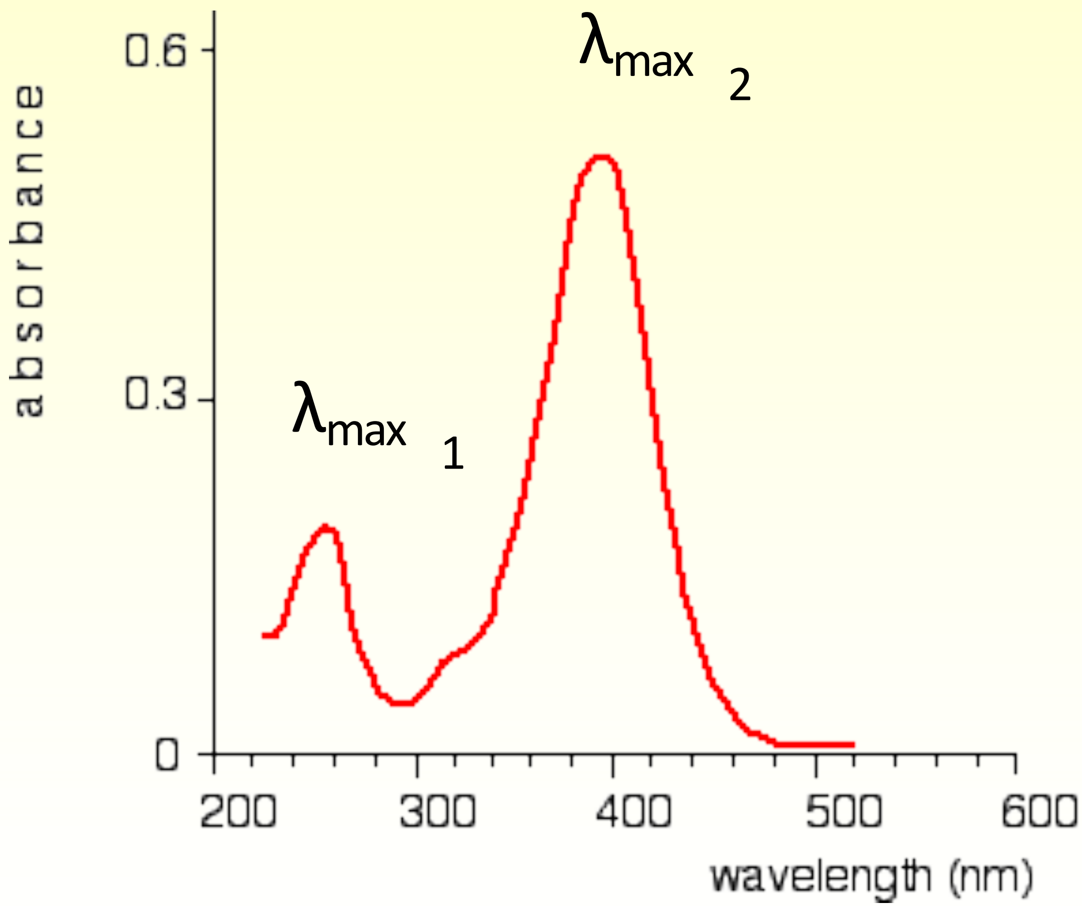
# Light absorption



# Light absorption



# Absorbance spectrum



# Transmission

$$T = \frac{P}{P_0}$$

$$T = \frac{P_{\text{sample}}}{P_{\text{blank}}}$$

# Absorbance

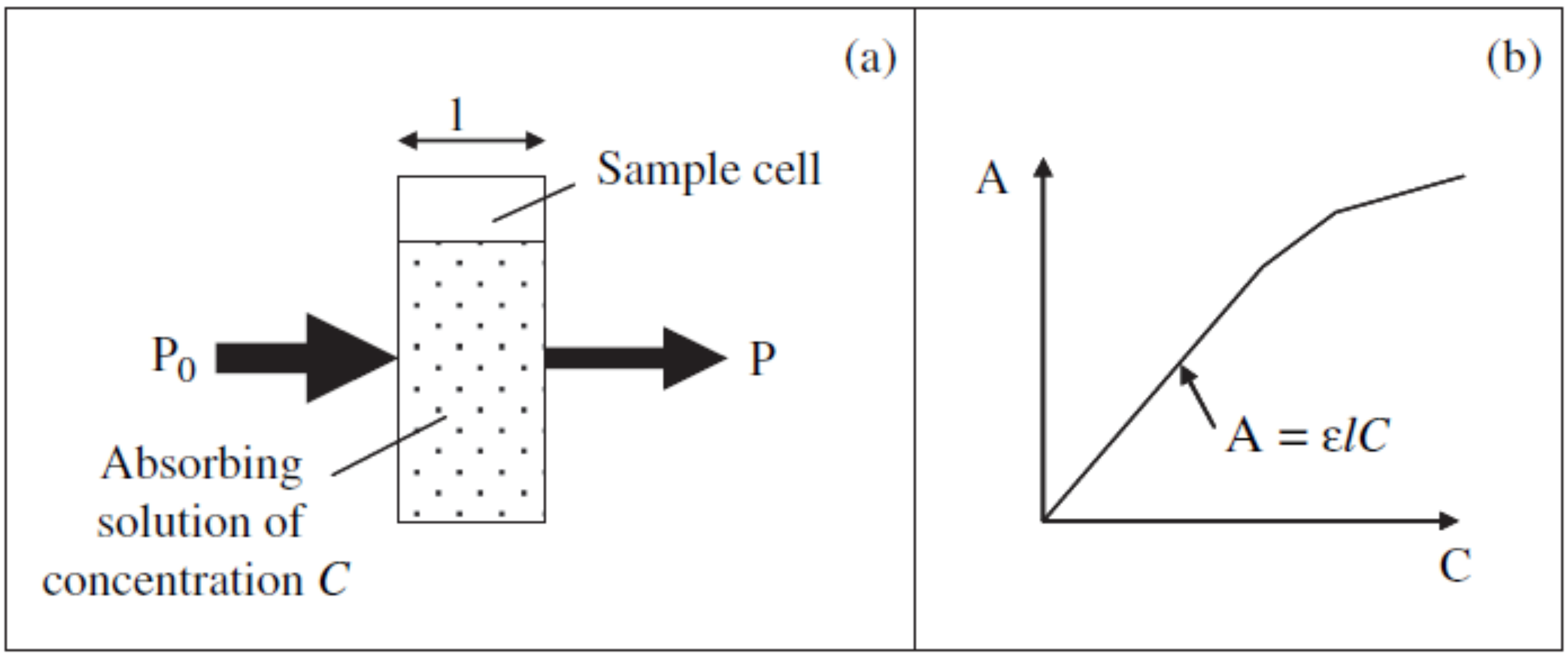
$$A = \log \frac{P_{\text{blank}}}{P_{\text{sample}}} = \log \frac{1}{T}$$

# Beer-Lambert Law

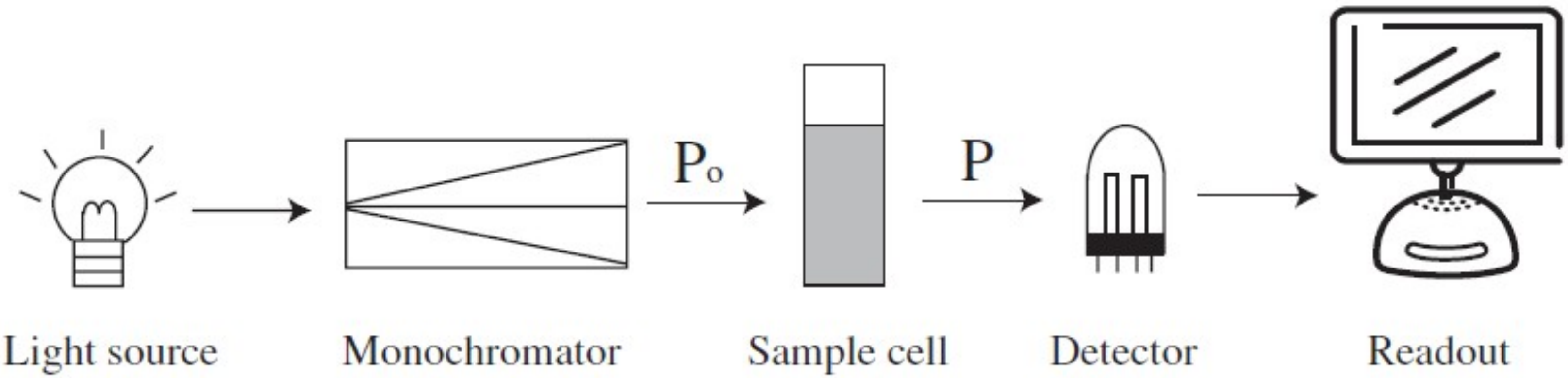
$$A = \epsilon b C$$

b – light path trough sample (cuvette width); C – analyte concentration;
ε– extinction coefficient

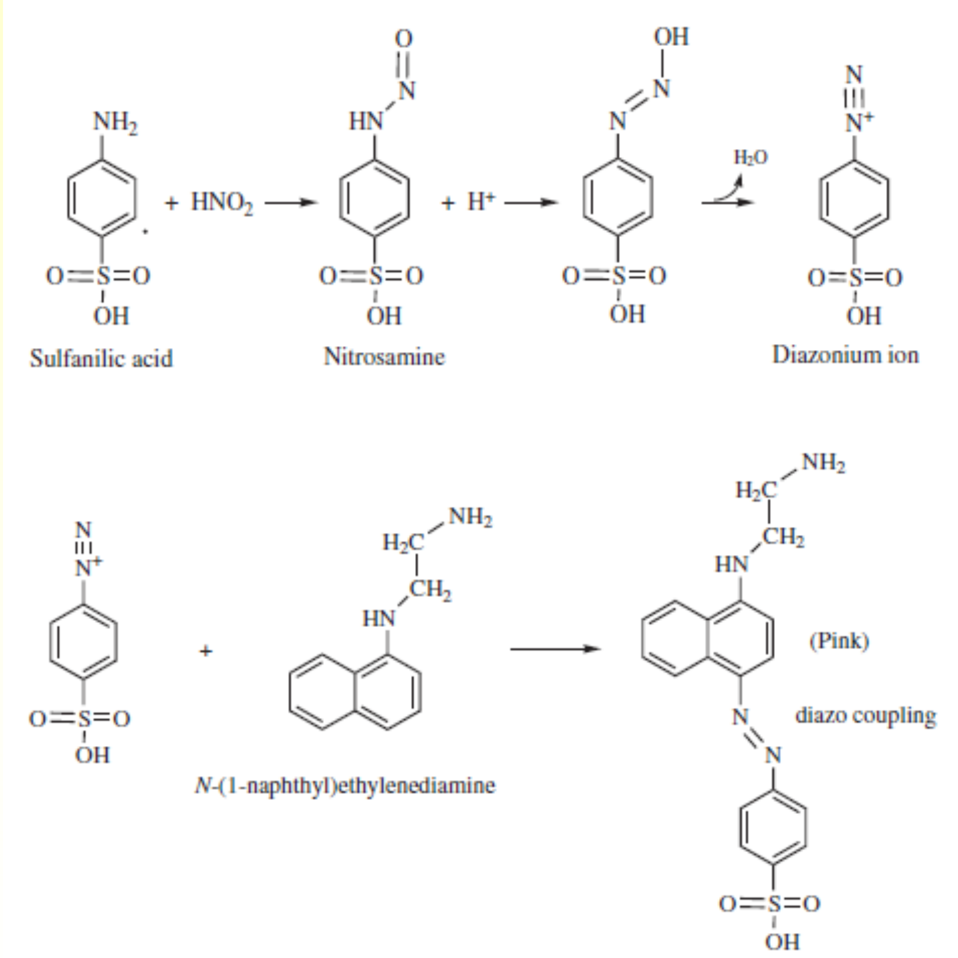
# Quantitative analysis by spectroscopic methods



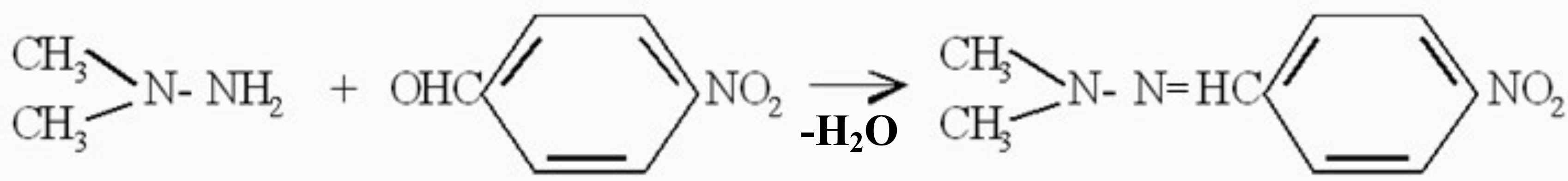
# Electron spectroscopy



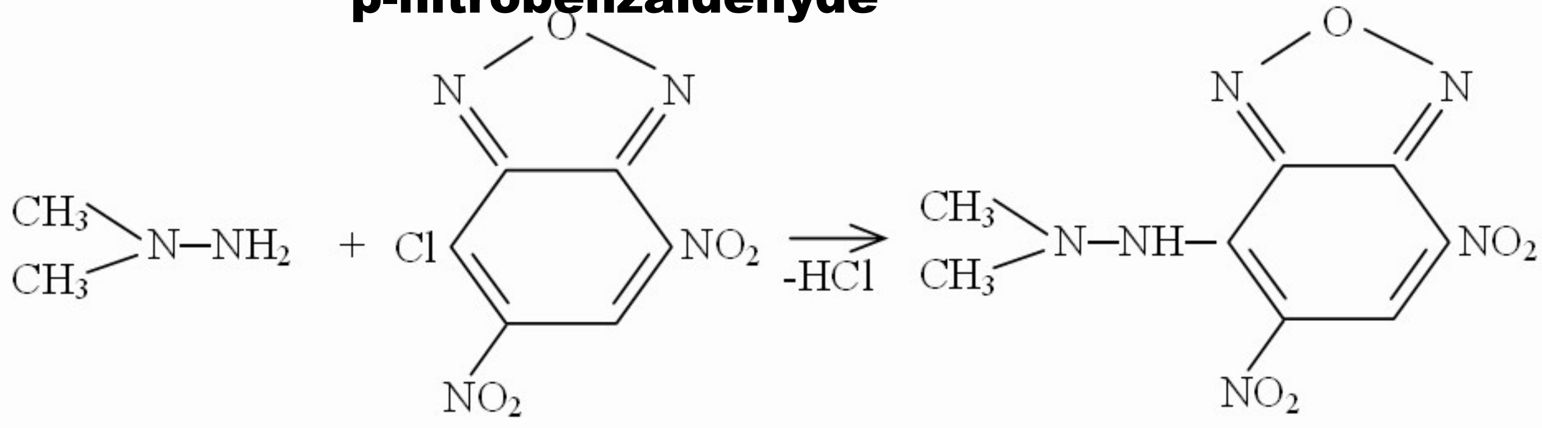
# Derivatization: example



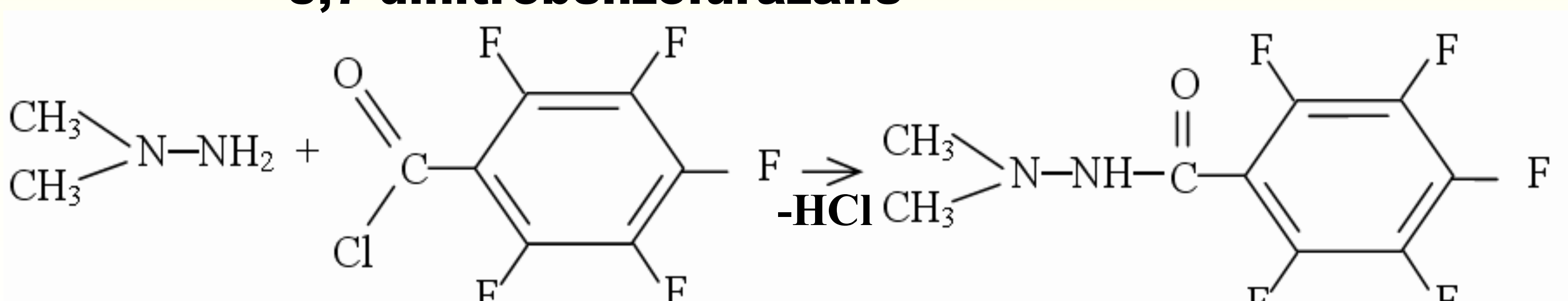
# Derivatization of 1,1-dimethylhydrazine



**p-nitrobenzaldehyde**



**5,7-dinitrobenzofurazane**



**dancyl chloride**

# Advantages of electron spectroscopy

Simple and inexpensive equipment

Colored substances may be detected visually (by eye)

Many derivatization reagents available

Many sensors and field equipment is based on this method

# Disadvantages

Poor selectivity

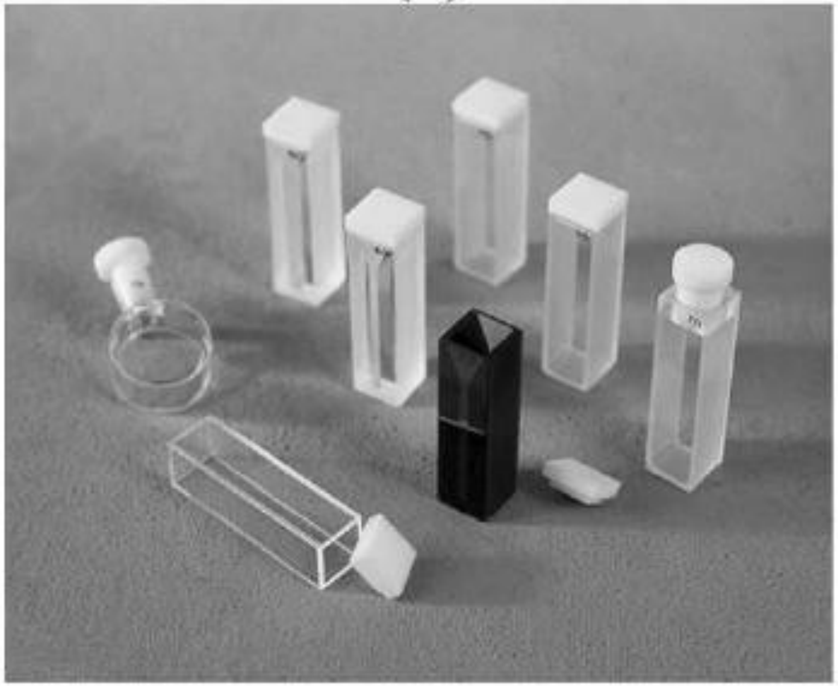
Complex sample preparation when derivatization is needed

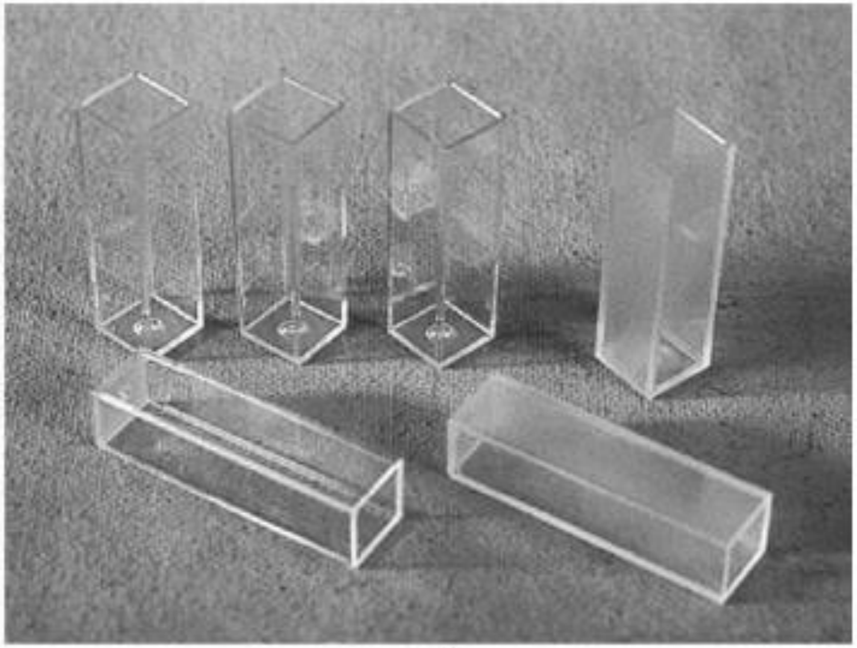
Low detection limits are difficult/impossible to achieve

# Cuvettes for electron spectroscopy

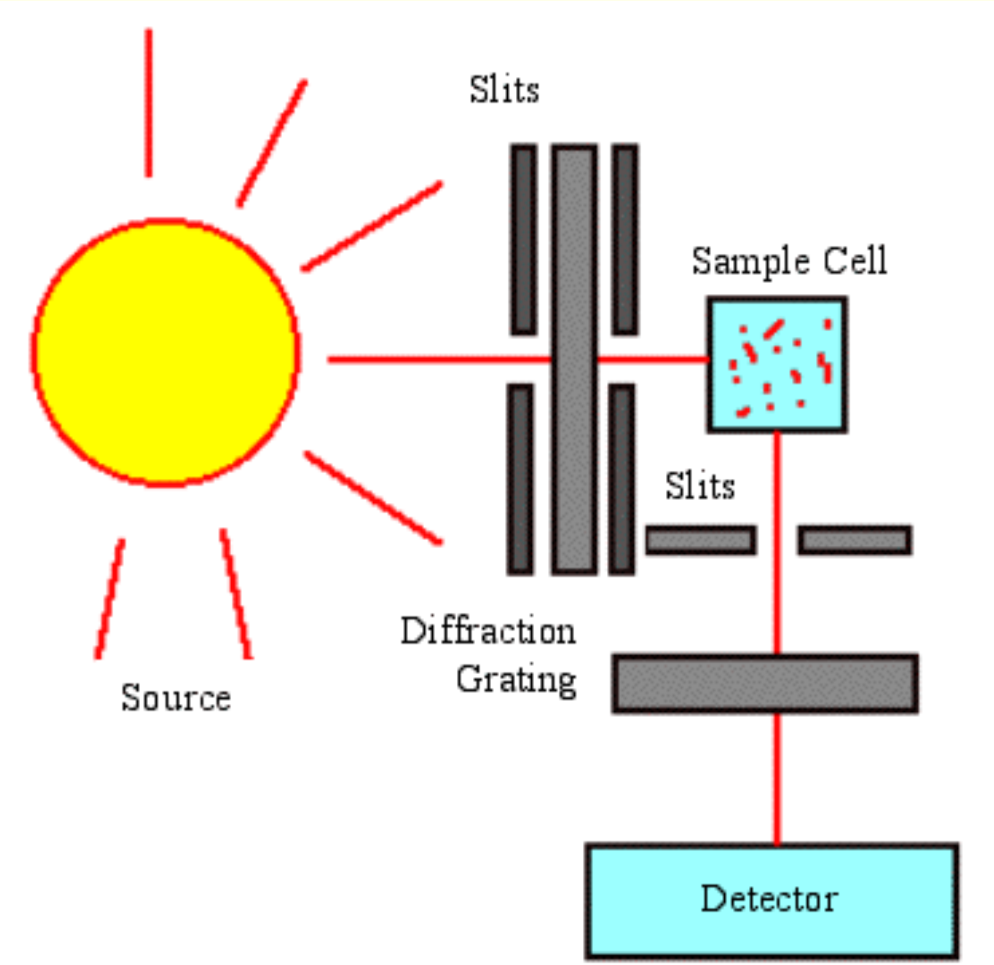
Quartz – for UV and Visual range

Glass – for Visual range only





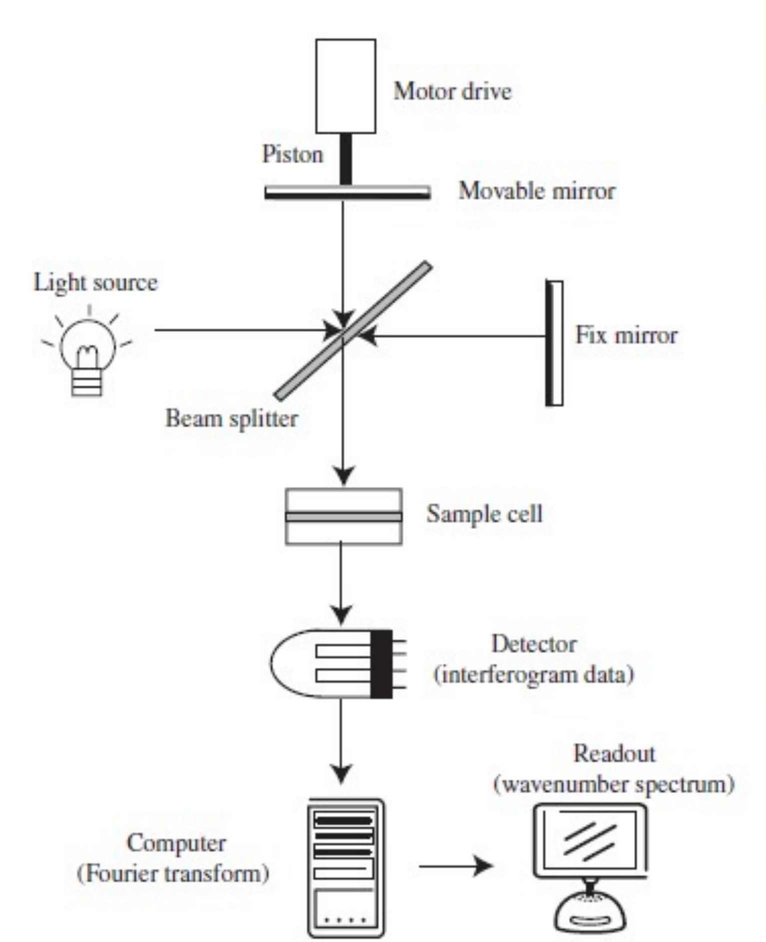
# Fluorescence spectroscopy




Very sensitive and selective method

Popular in biology: fluorescence markers

# Infrared spectroscopy




Ideal for fast identification of pure compounds

Poor sensitivity and selectivity: not suitable for complex mixtures

# Infrared spectrum