Chapter 18 Fundamentals of Spectrophotometry

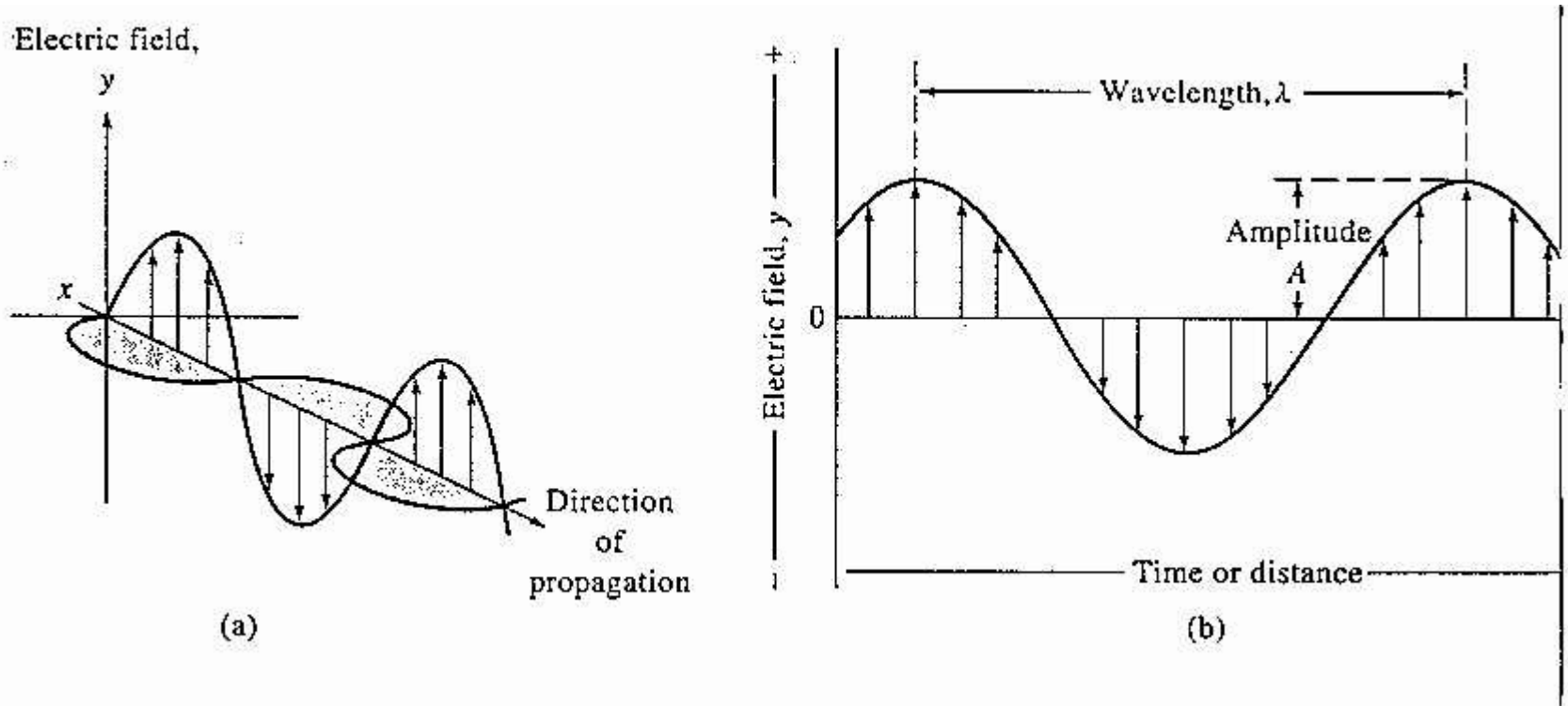
Homework: Due Wednesday, April 19

Problems – 18-1, 18-2, 18-4, 18-8, 18-10, 18-12, 18-16, 18-22

The nature of light

1. **Light as a wave:** light is described as a **periodically oscillating electric and magnetic field,** with perpendicular electric and magnetic field components
2. **Light as a particle:** light energy is transmitted as discrete **"quanta"** or packets called **"photons"**

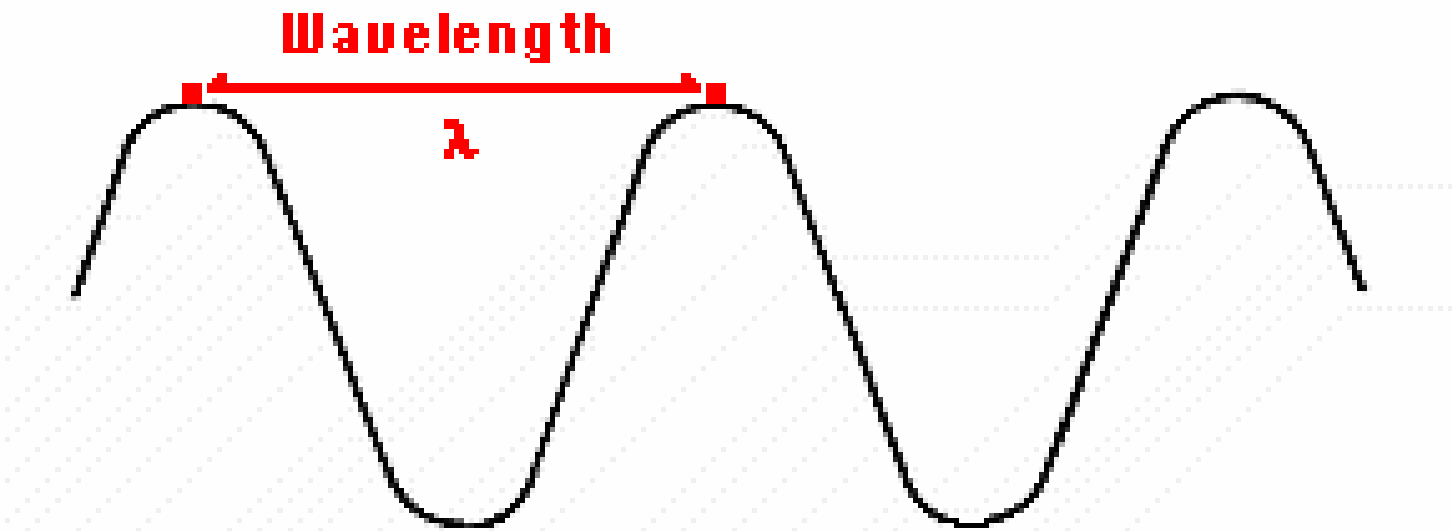
- **Plane-polarized electromagnetic radiation of wavelength λ, propagating along the x axis.**
- **The electric field of the plane-polarized light is confined to a single plane.**
- **Ordinary, unpolarized light has electric field components in all planes.**



Energy of light can be described by its wavelength (λ, nm), wavenumber (ύ, cm^{-1}), and frequency (ν, sec^{-1})

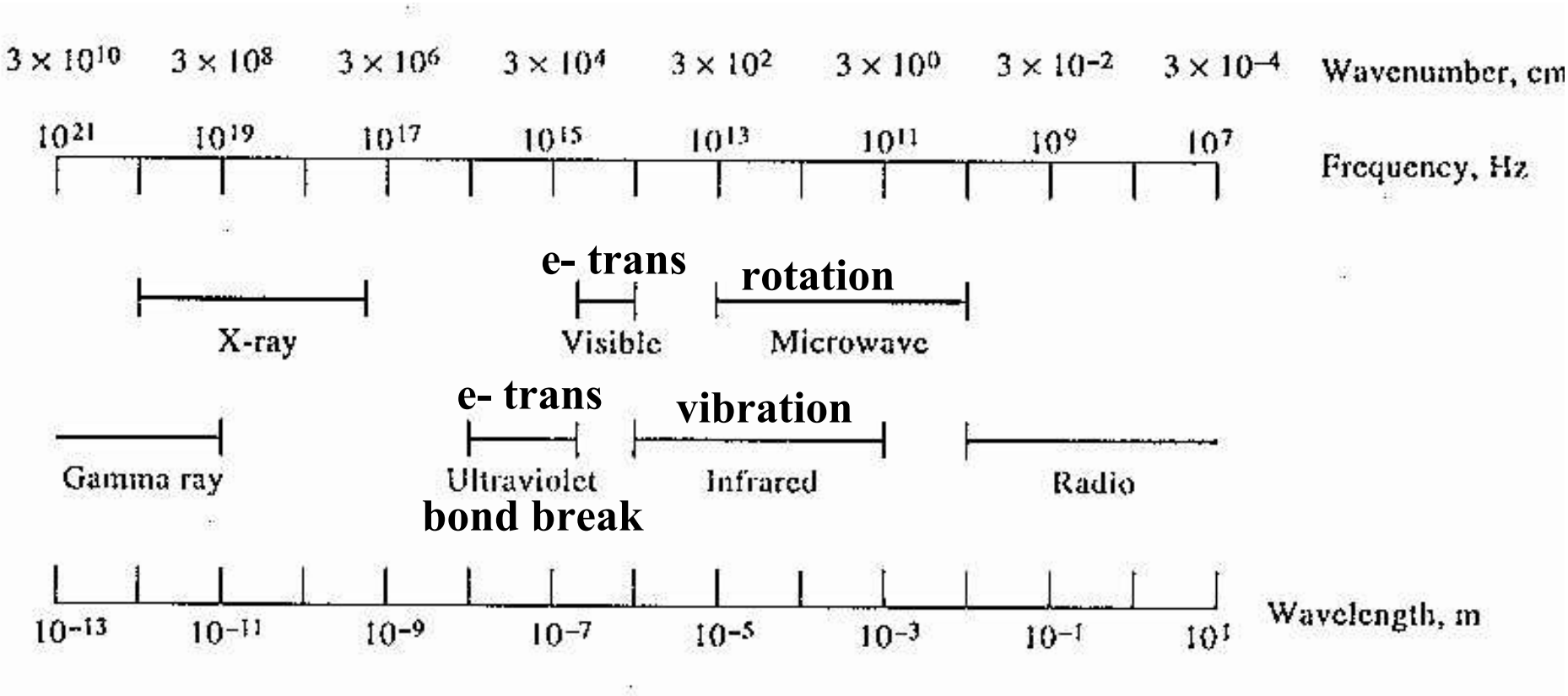
in vacuum, velocity is independent of frequency, maximum value

speed of light => c = $\nu\lambda$ = 2.998 X 10^8 m/s



Energy => $E = h\nu = hc/\lambda = hc\acute{\upsilon}$

Each region of the electromagnetic spectrum serves as the basis for one or more important spectrometric techniques in chemical analysis.



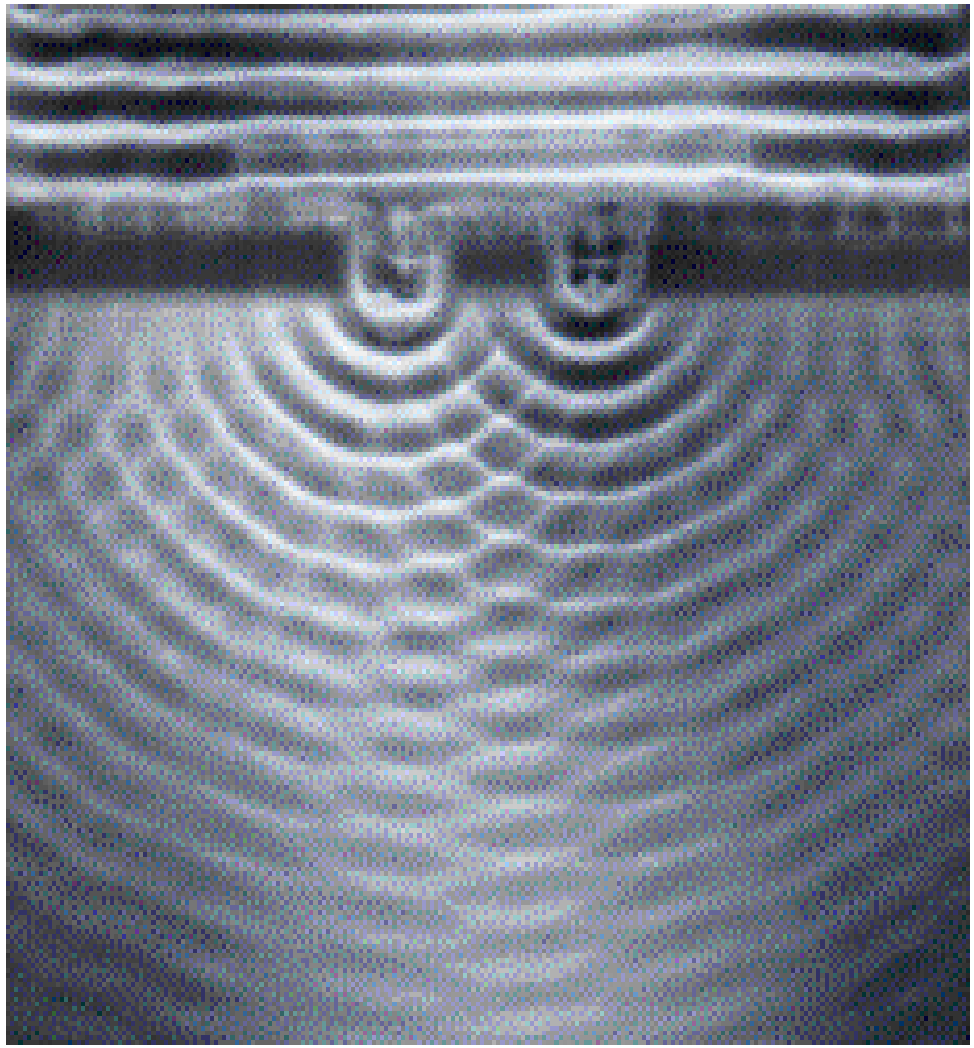
Colors of Visible Light

Wavelength	Absorbed	Observed
380-420	violet	green-yellow
420-440	violet-blue	yellow
440-470	blue	orange
470-500	blue-green	red
500-520	green	purple
520-550	yellow-green	violet
550-580	yellow	violet-blue
580-620	orange	blue
620-680	red	blue-green
680-780	purple	green

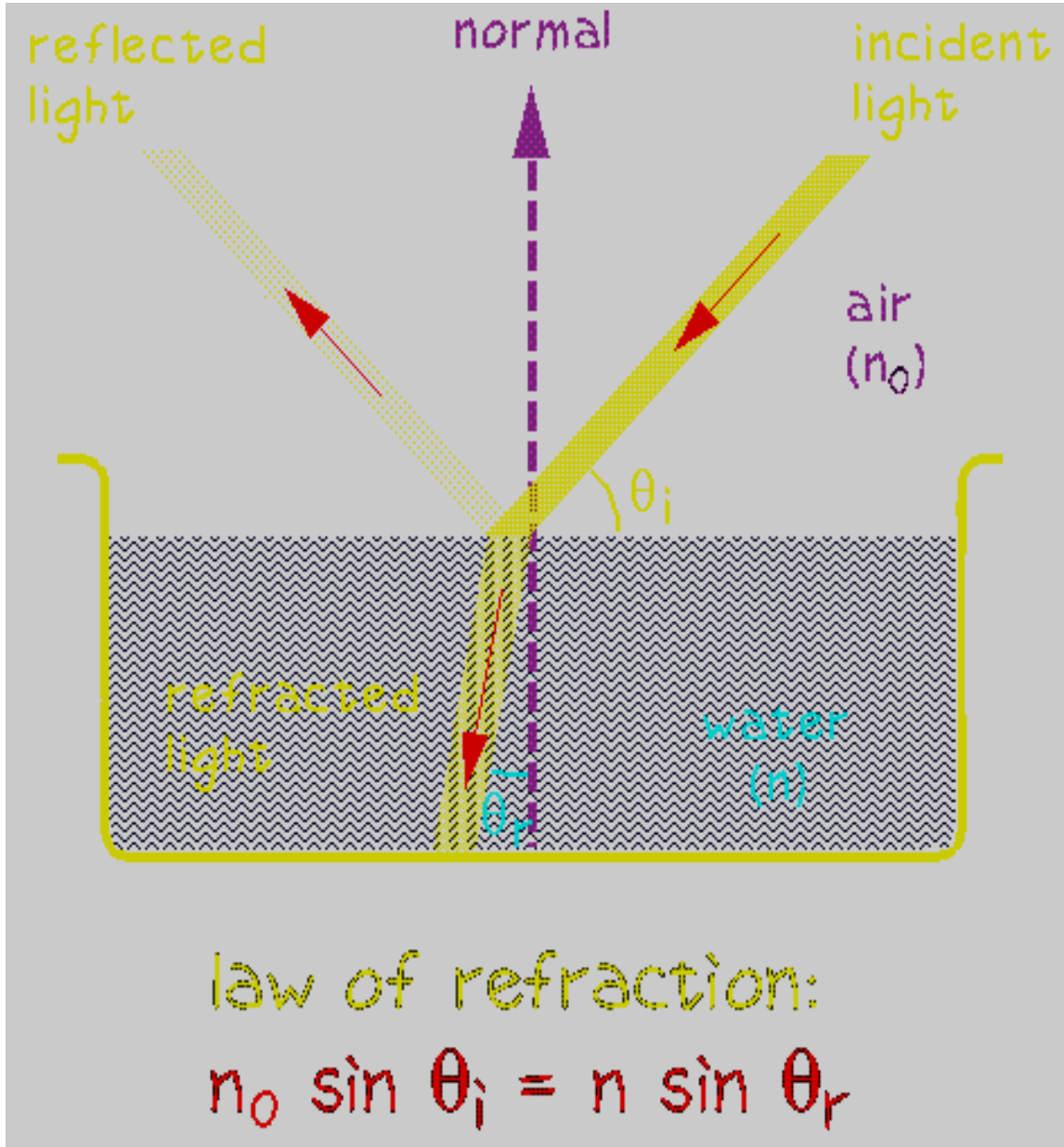
Nine properties of electromagnetic radiation

- **Diffraction**
- **Refraction**
- **Dispersion**
- **Reflection**
- **Scattering**
- **Polarization**
- **Transmission**
- **Absorption**
- **Emission**

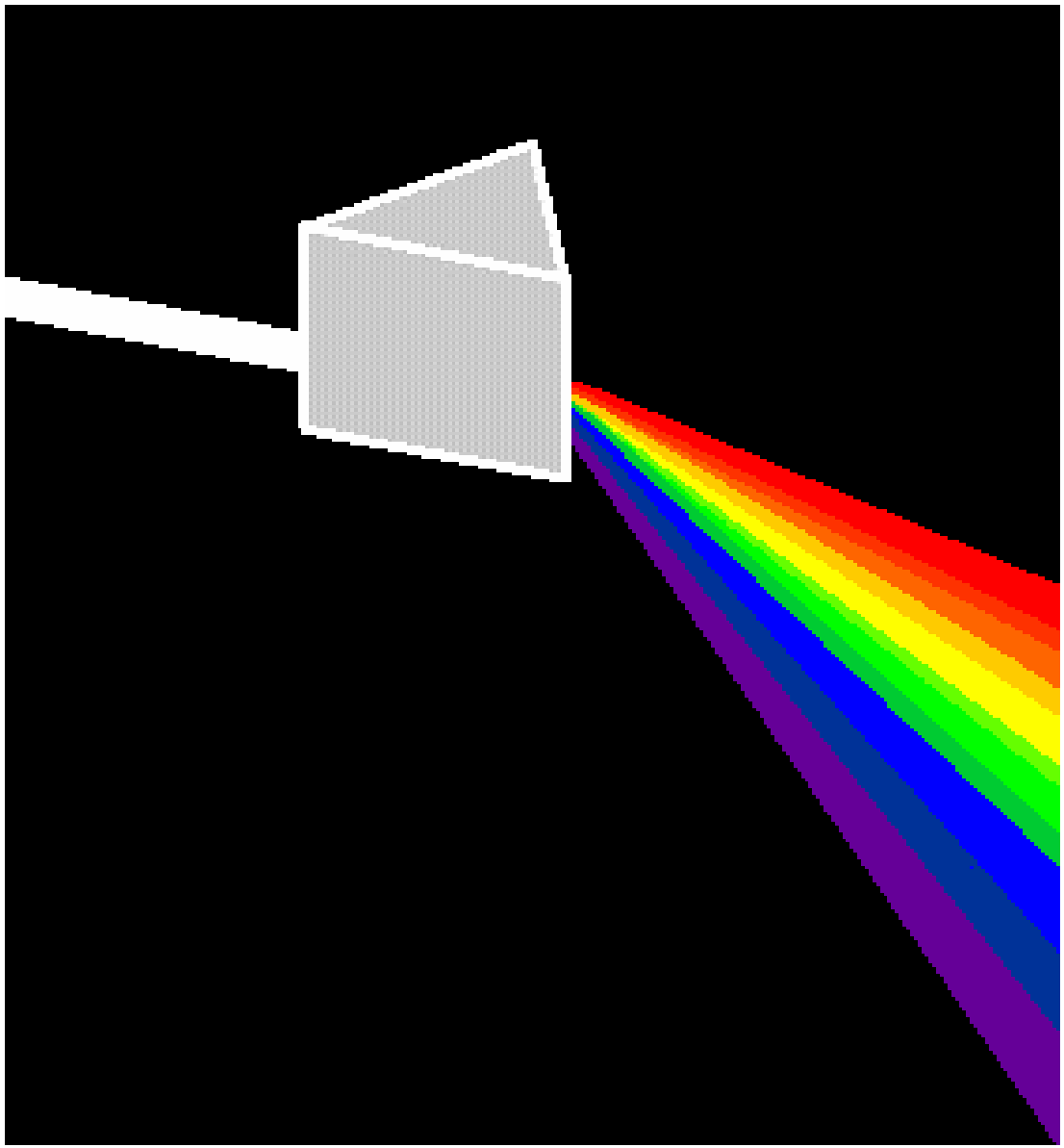
Diffraction refers to the constructive and destructive interference pattern that is formed when light passes through an opening of size d which is ~ same order as λ,



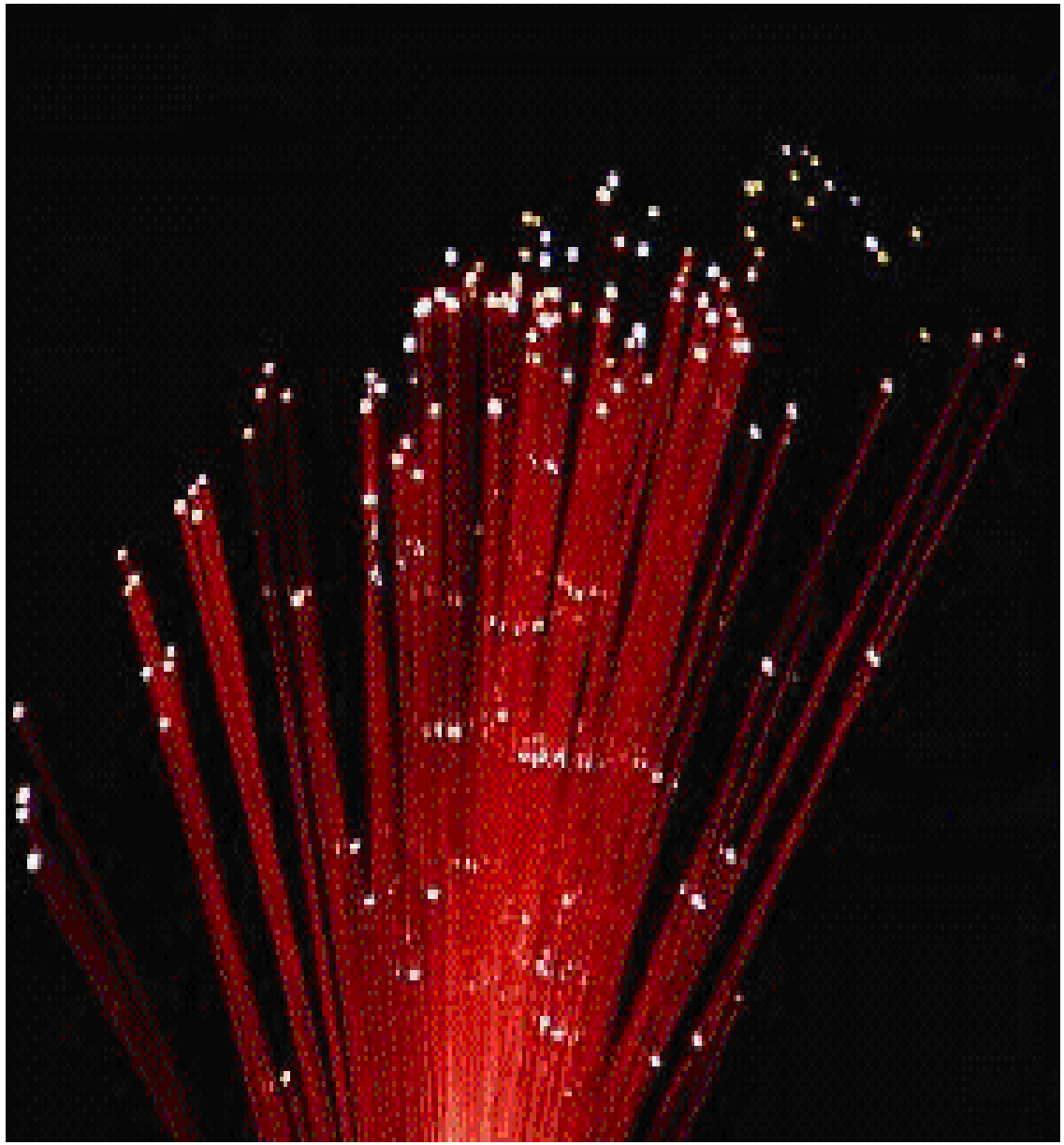
Refraction is the change of direction which occurs when light passes from one medium to another.



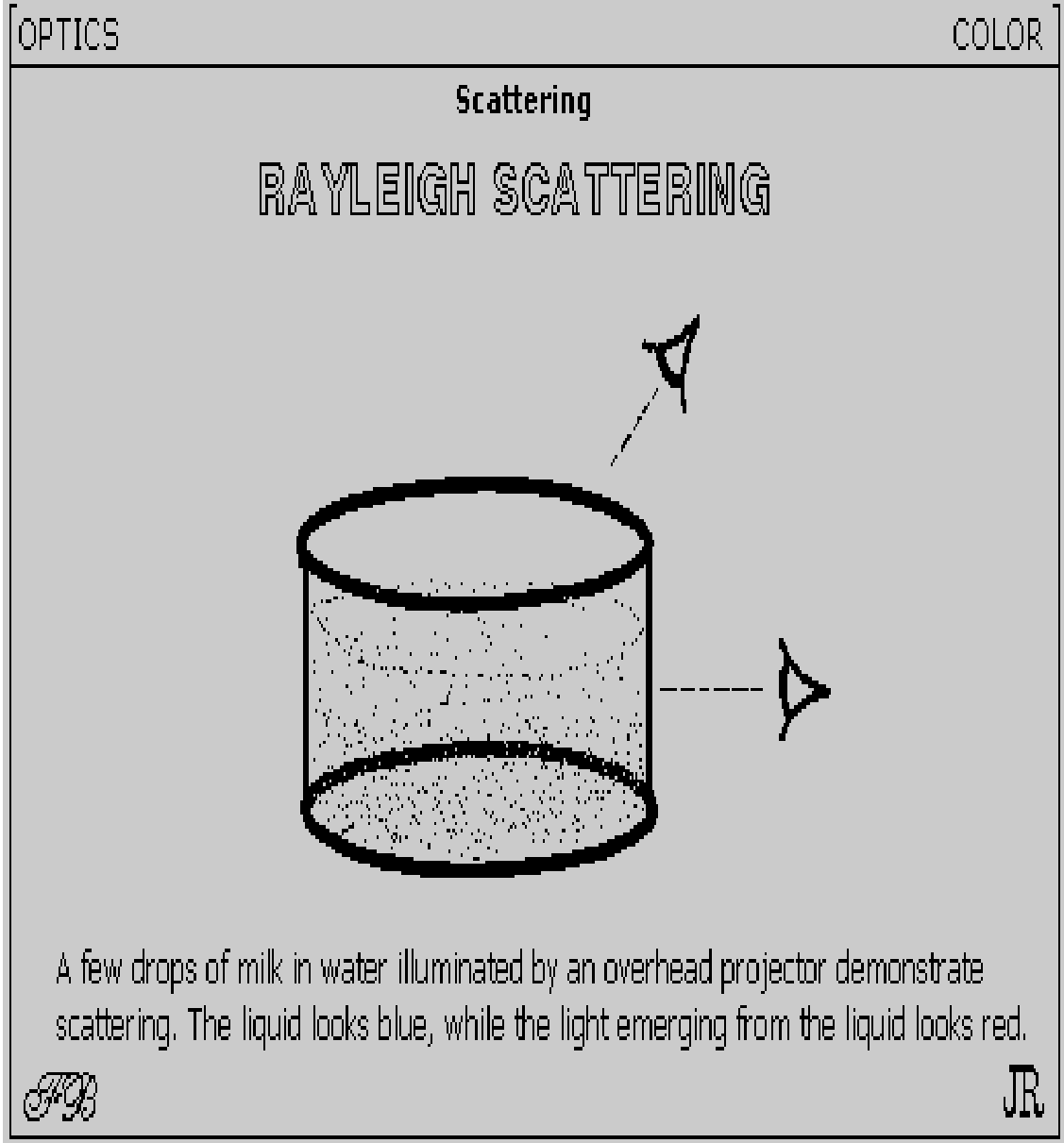
Dispersion refers to the apparent "spreading out" in distance or angle when light is diffracted or refracted.



- **Reflection** is obvious, but is importantly exploited in optical fibers which work based upon "total internal reflection"

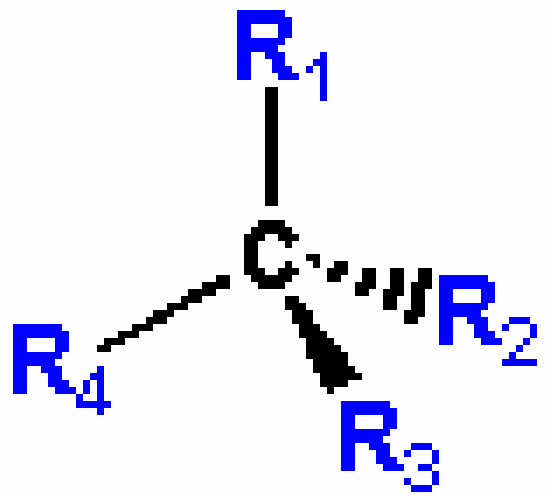


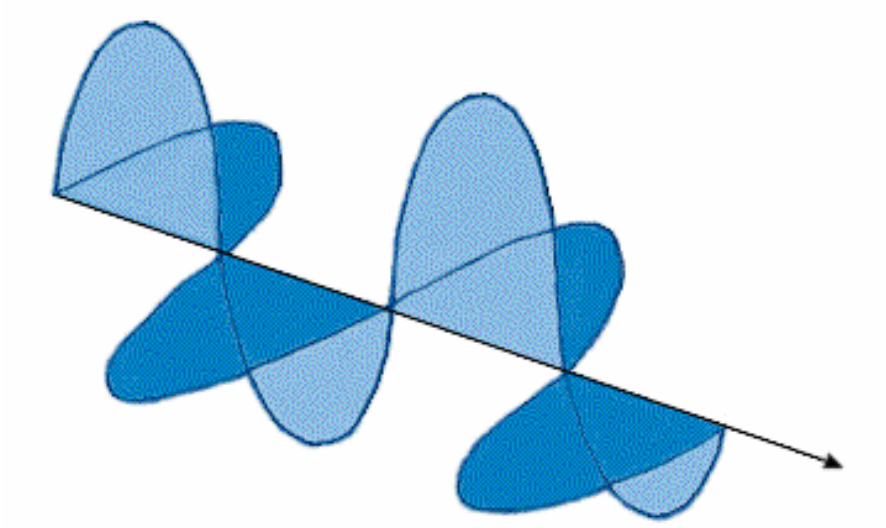
Two types of scattering are of great importance: an "elastic" Rayleigh and an inelastic "Raman" variety



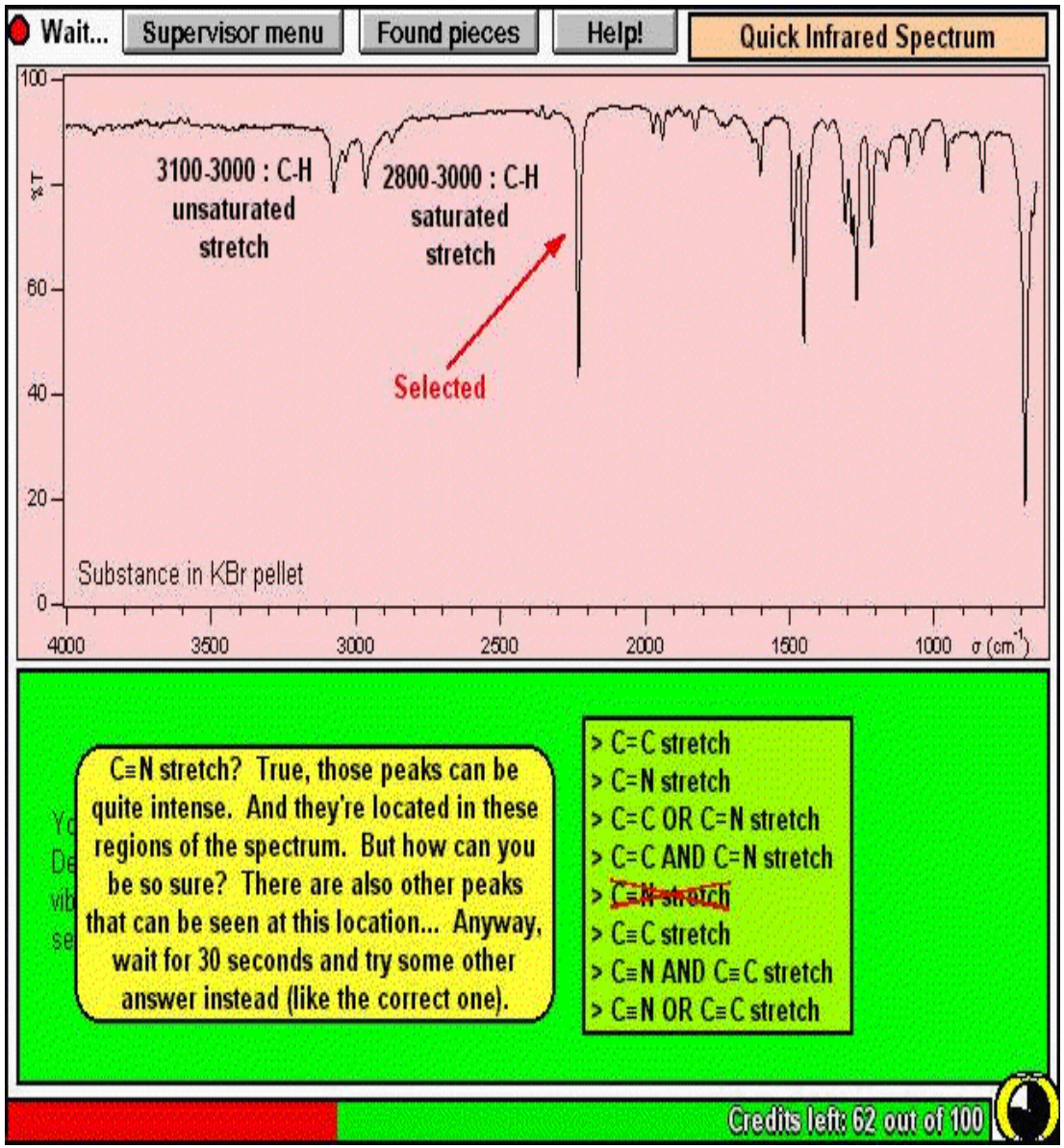
Polarized light is used in observing the properties of optically active compounds.

Plane polarized and unpolarized light

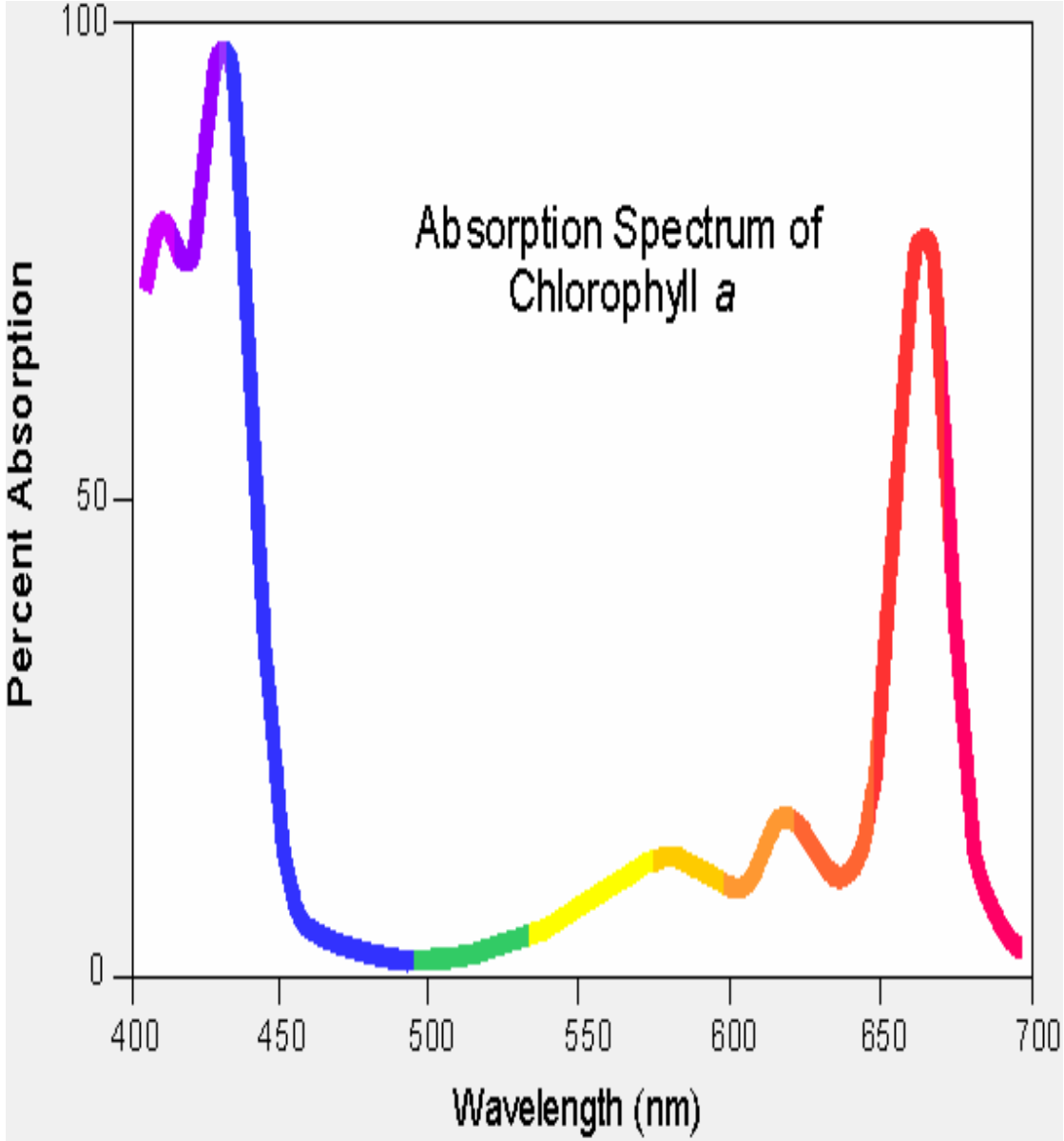




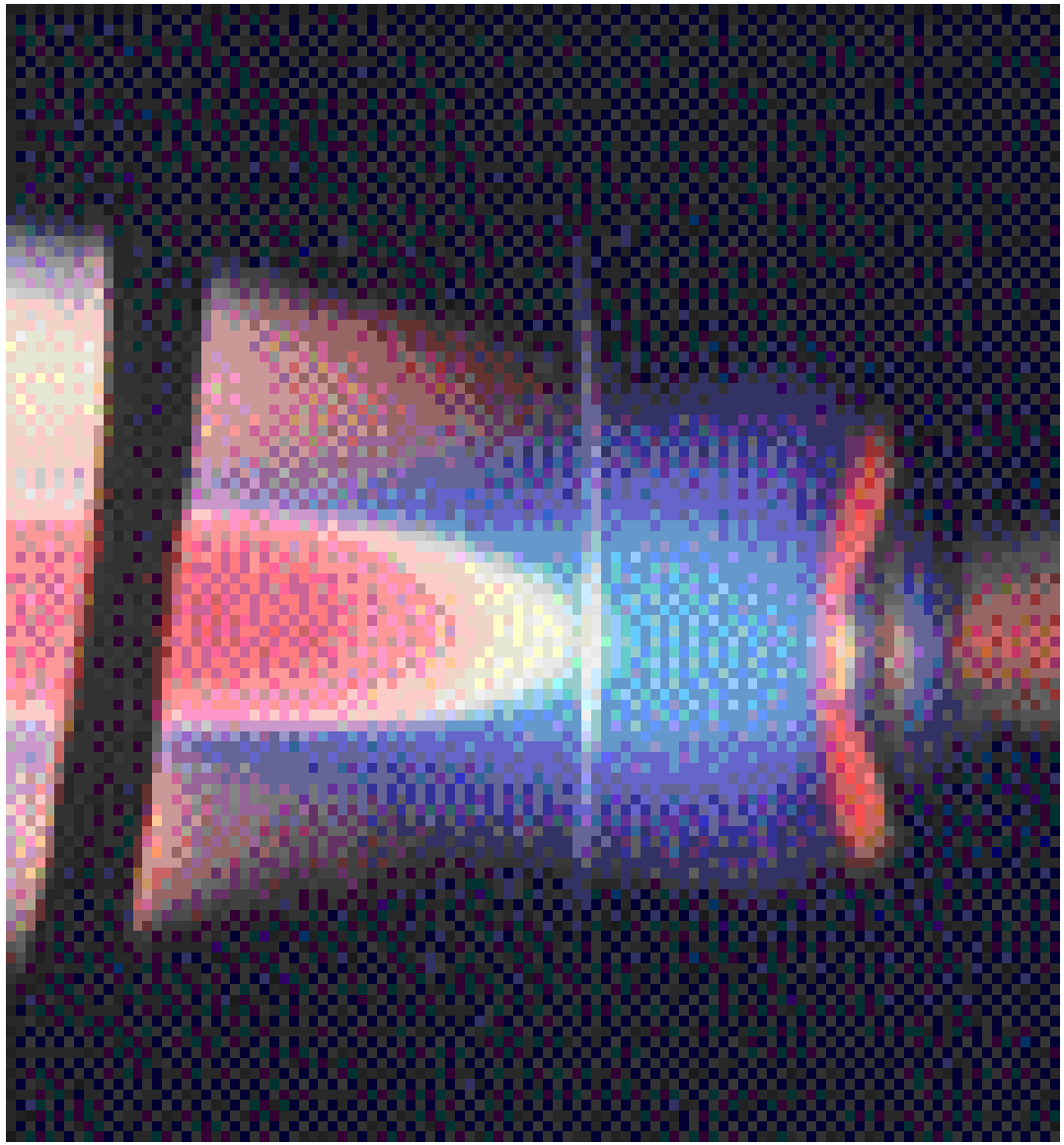
Transmission refers to when light passes through a medium without a net change.



Absorption refers to when the energy of the EMR is transferred to atoms or molecules of the absorbing medium, which subsequently wind up in higher energy states



Emission is the opposite of absorption: an atom or molecule in an excited state gives off a photon and returns to a lower-lying energy state



Absorption, emission, fluorescence

- **Absorption: atom or molecule "absorbs" a photon of specific energy, goes to a higher energy state**
- **Emission: atom or molecule releases a photon of specific energy, goes to a lower energy state; nonradiative excitation**
- **Fluorescence: absorption followed by re-emission**

Ground State: The state of least possible energy in a physical system, as of elementary particles. Also called *ground level.*

Excited State: Being at an energy level higher than the ground state.