

Chapter 18 Fundamentals of Spectrophotometry

Homework: Due Monday, April 13

Chapter 18:

Problems – 18-1, 18-2, 18-3, 18-4, 18-8, 18-10, 18-12, 18-16, 18-18, 18-22

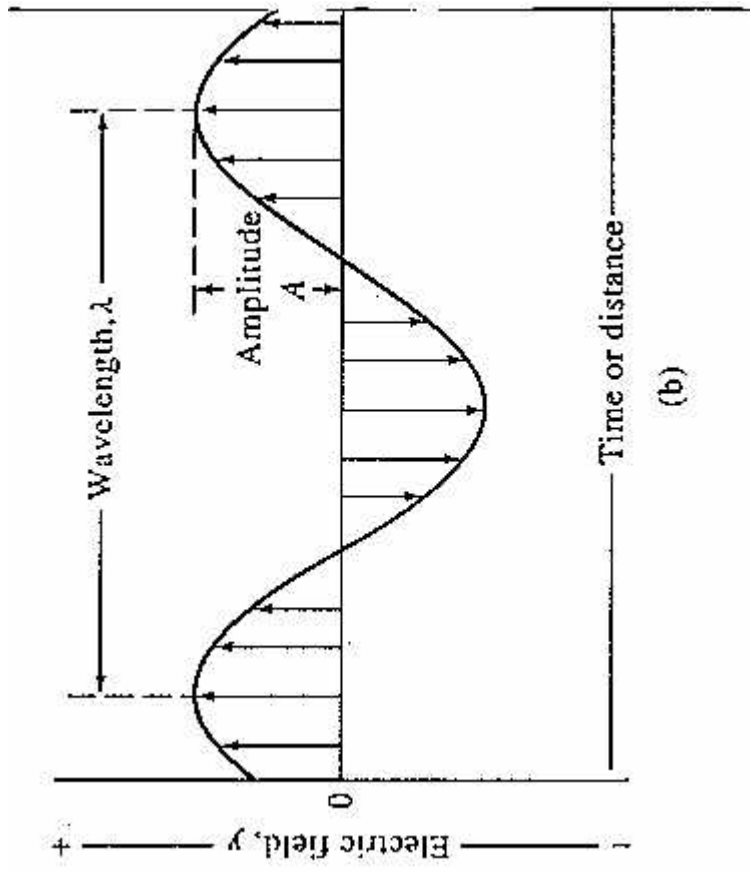
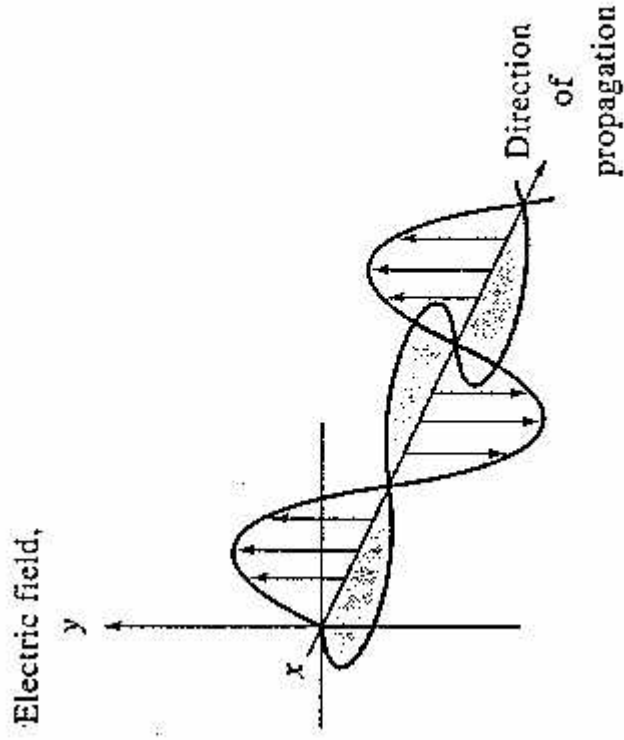
Chapter 20:

Problems - 20-1, 20-3, 20-4, 20-6, 20-9, 20-27

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.**



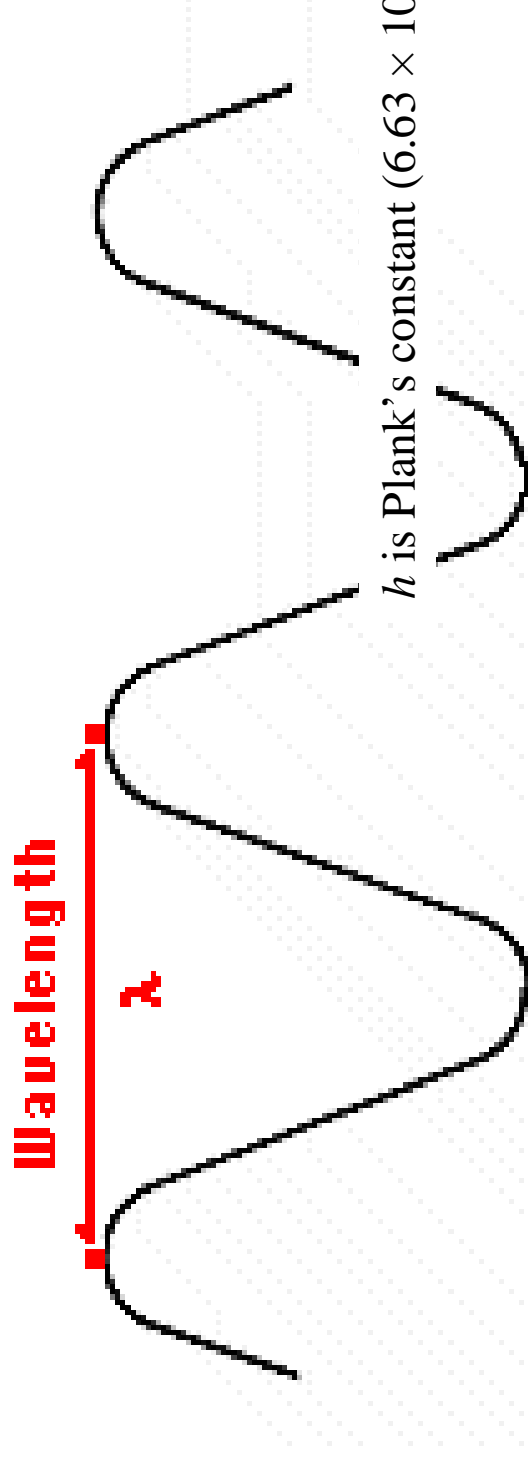
(a)

(b)

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

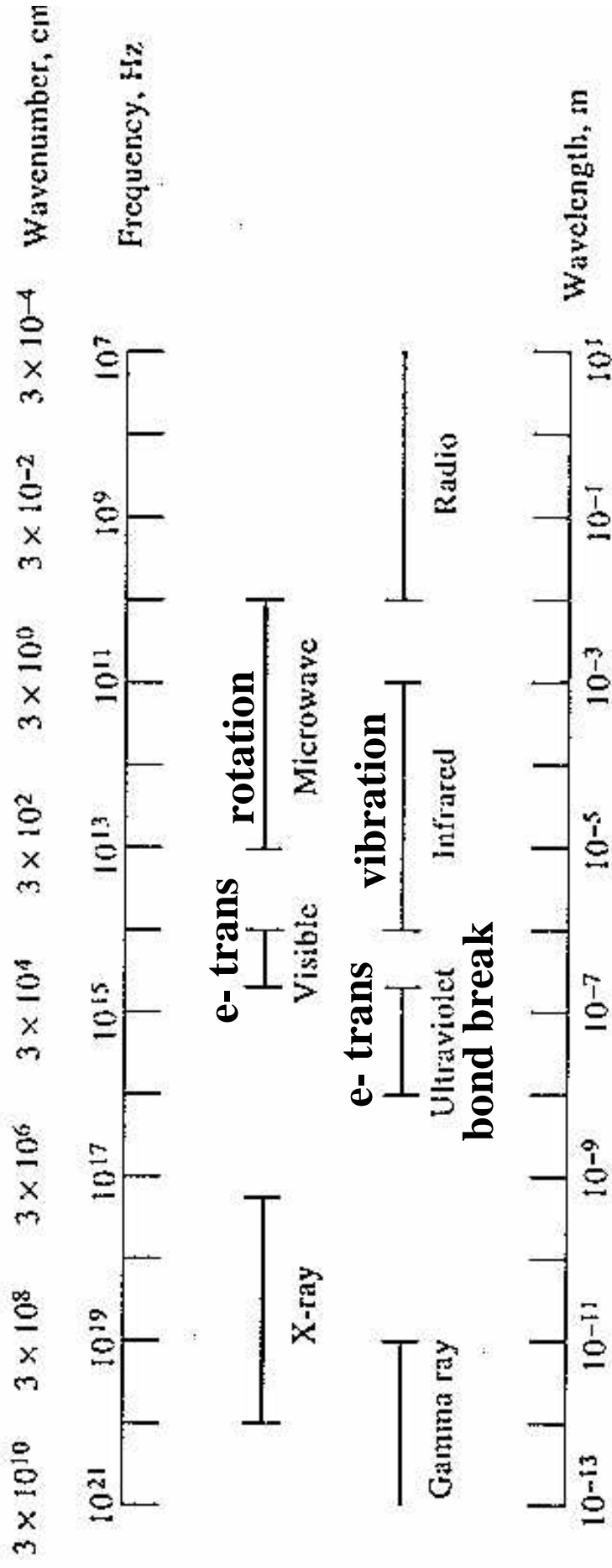
in vacuum, velocity is independent of frequency, maximum value

speed of light $\Rightarrow c = \nu\lambda = 2.998 \times 10^8 \text{ m/s}$



$$\text{Energy} \Rightarrow E = h\nu = hc/\lambda = hc\nu$$

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



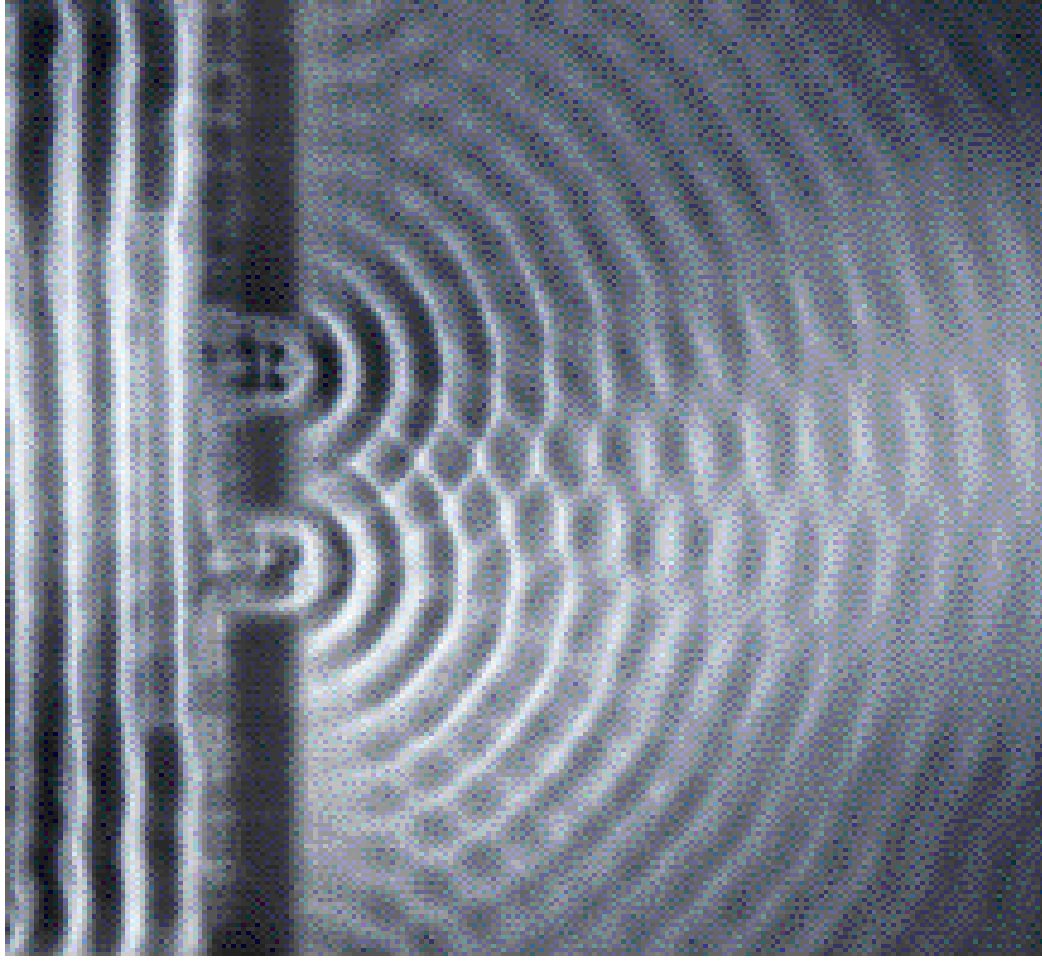
Colors of Visible Light

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

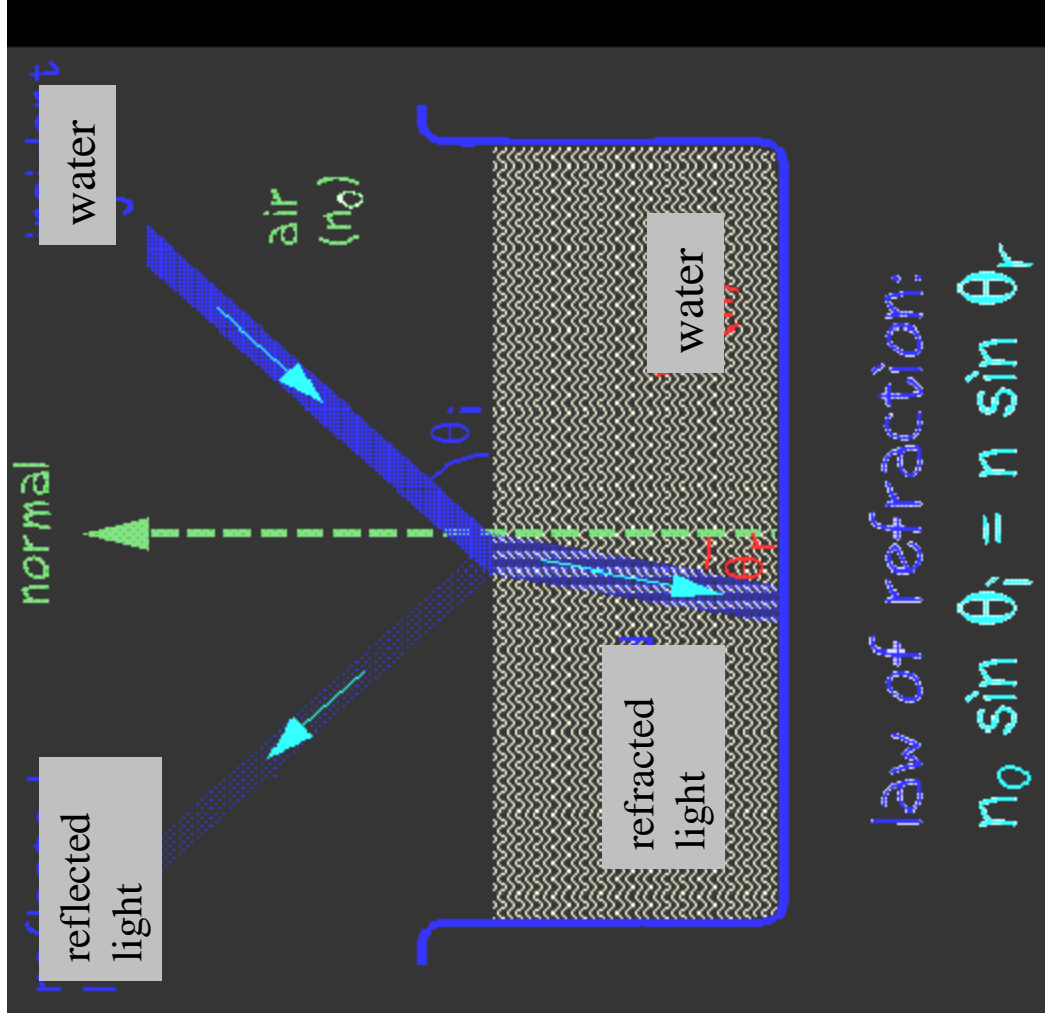
Nine properties of electromagnetic radiation

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

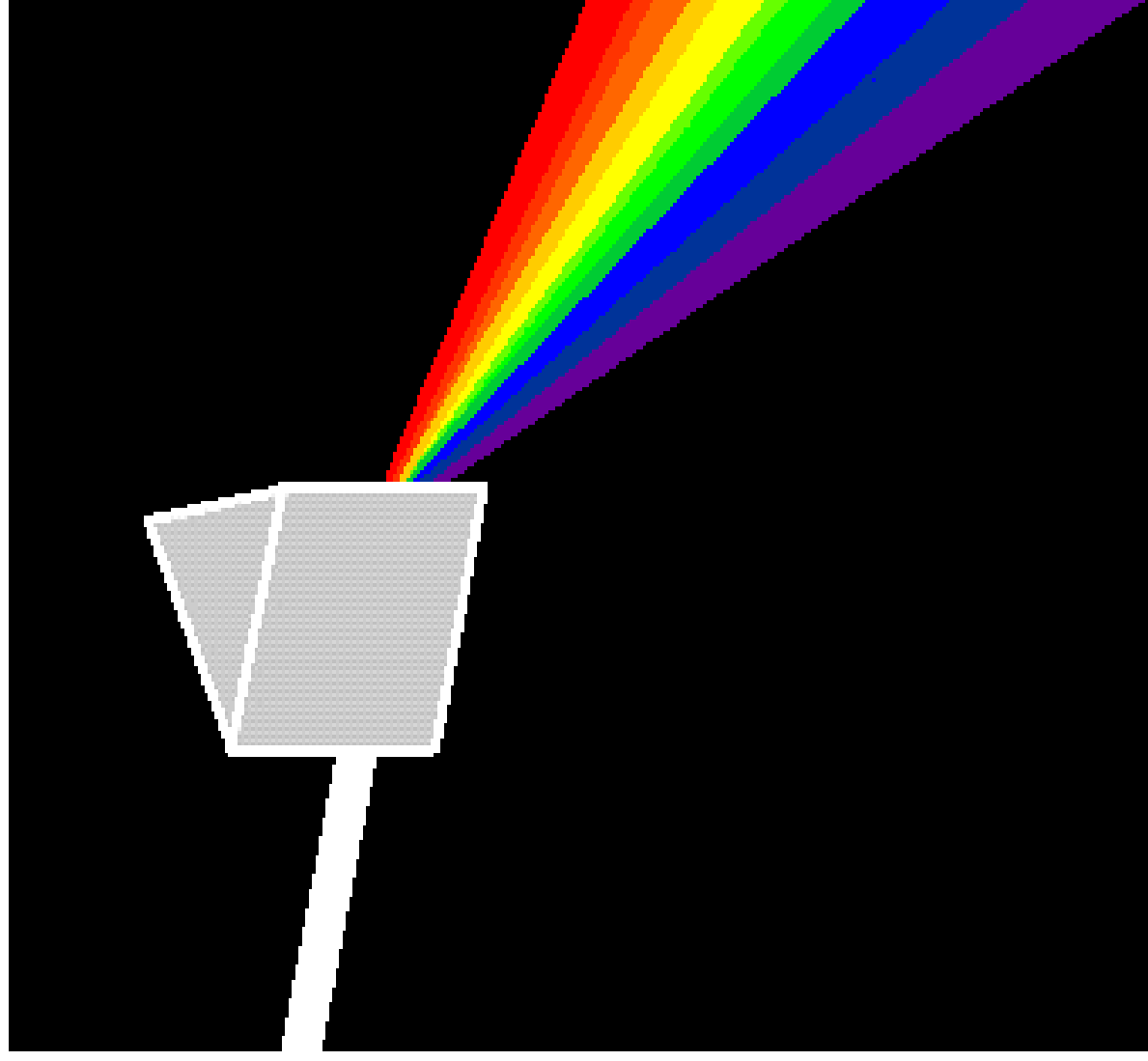
Diffraction refers to the constructive and destructive interference pattern that is formed when light passes through an opening of size d which is \sim same order as λ ,



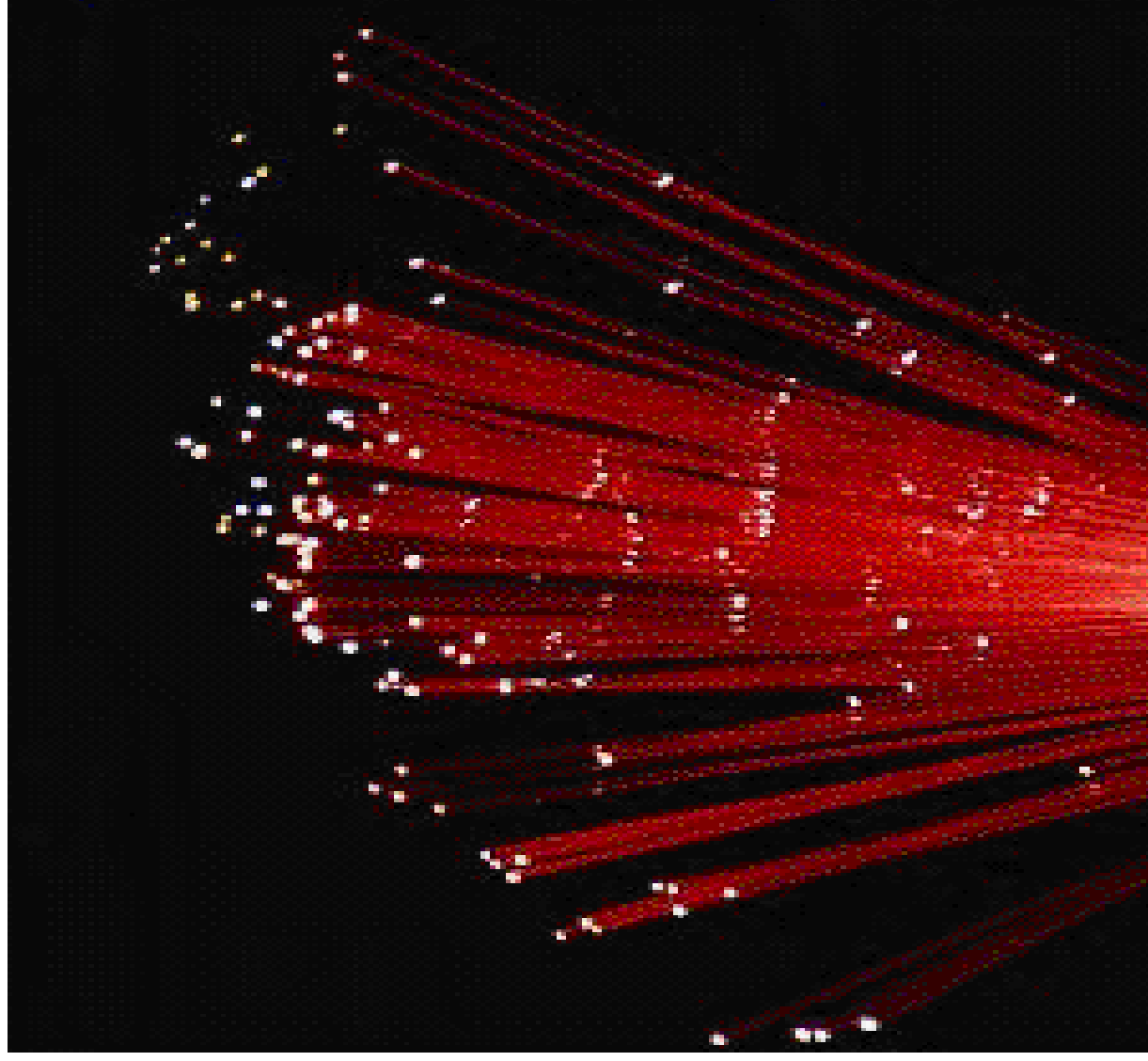
Refraction is the change of direction which occurs when light passes from one medium to another.



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

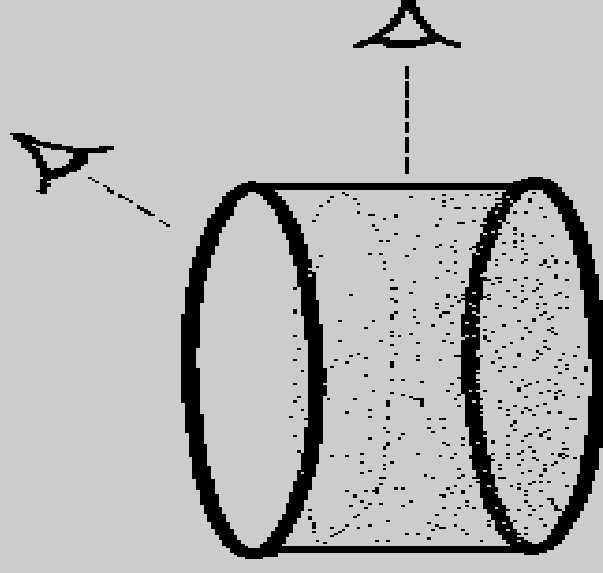


- **Reflection** is obvious, but is importantly exploited in optical fibers which work based upon “total internal reflection”



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

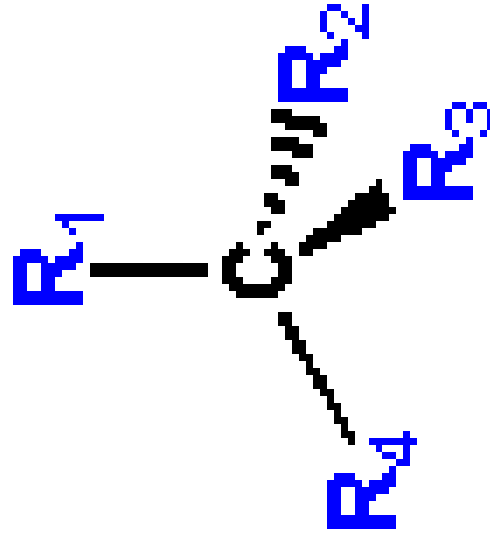
Scattering

RAYLEIGH SCATTERING

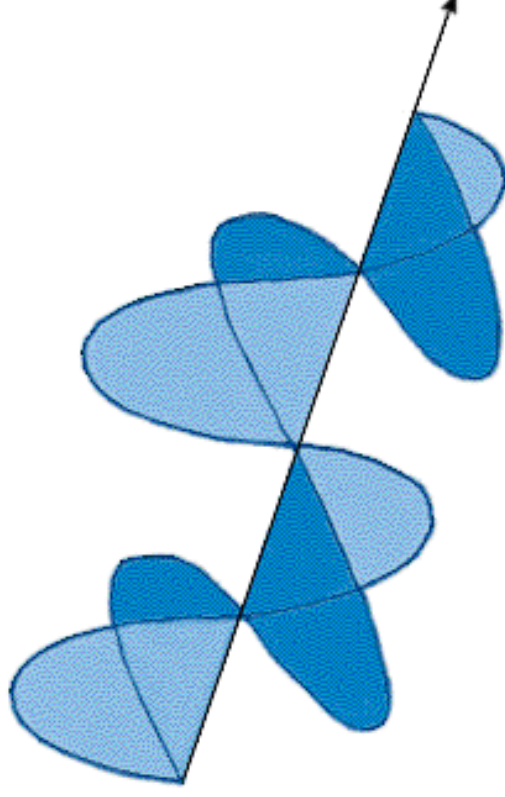
A few drops of milk in water illuminated by an overhead projector demonstrate scattering. The liquid looks blue, while the light emerging from the liquid looks red.

JR

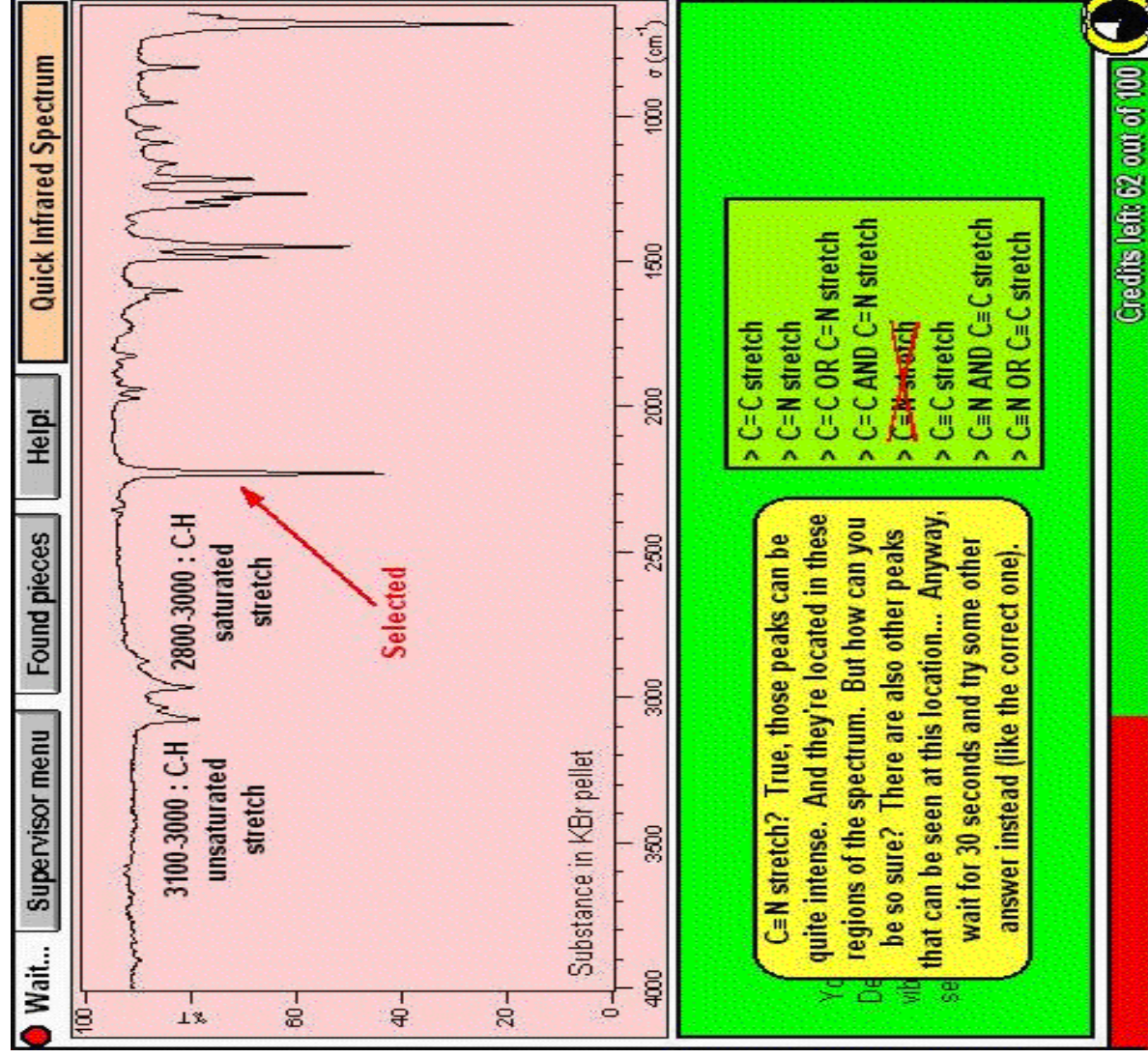
Polarized light is used
in observing the
properties of optically
active compounds.



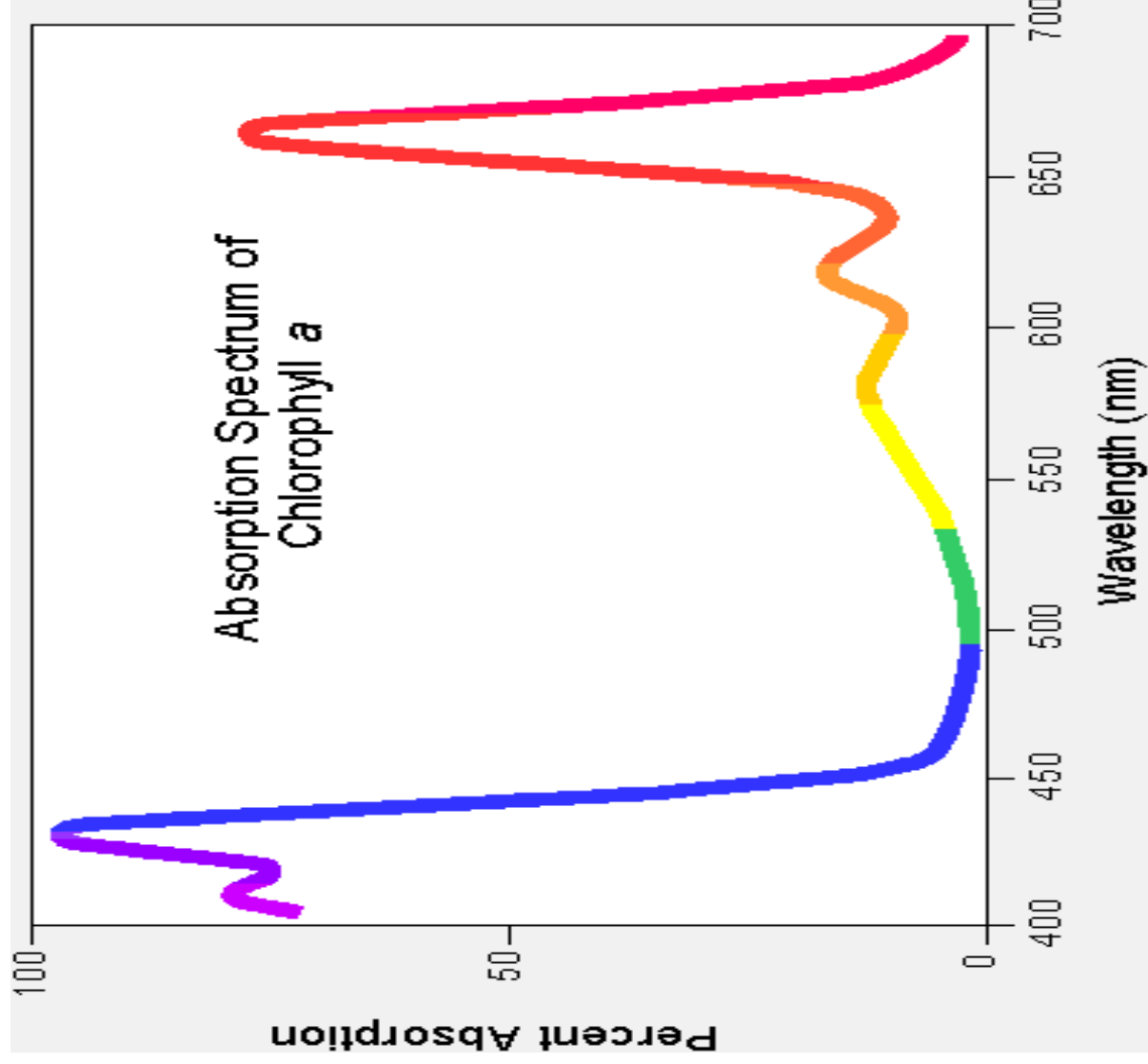
**Plane polarized and
unpolarized light**



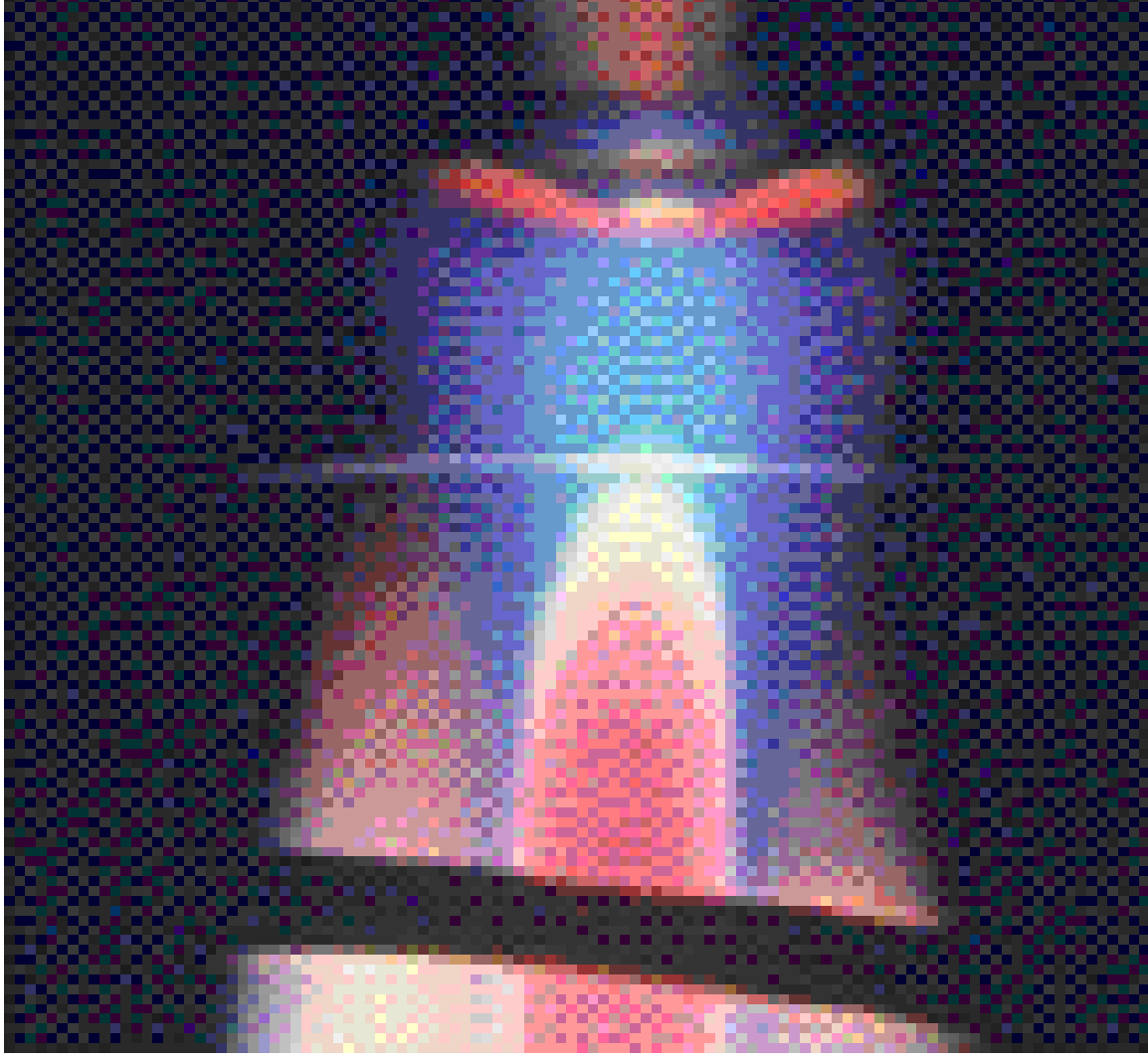
Transmission
refers to
when light
passes
through a
medium
without a
net change.



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.

