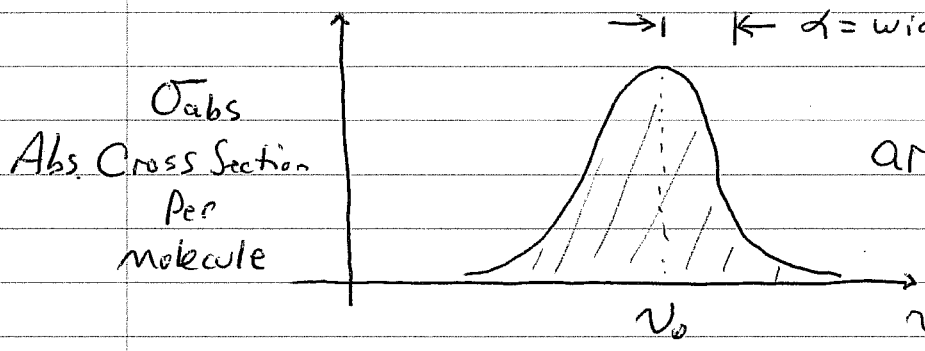
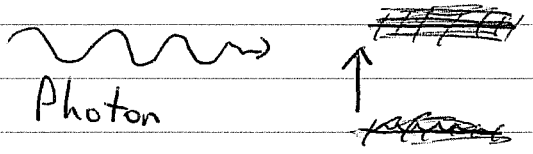
Summary Chapter 2

Good to make your own also, from memory ☺

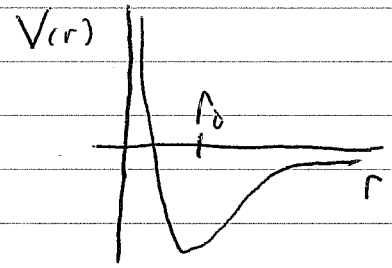




$\nu_0 = \nu_2 - \nu_1$, Energy is Conserved

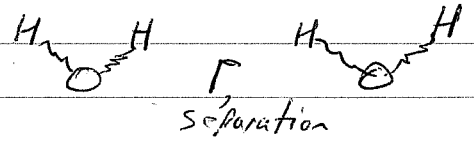
Absorption, photon death, energy levels are smeared out because of pressure broadening [molecules collisions / interactions, wavefunction of molecules interact, atoms in molecules are attracted to the atoms in other molecules.]

Lennard Jones interparticle potential



$F = -dV/dr$

(force between molecules)

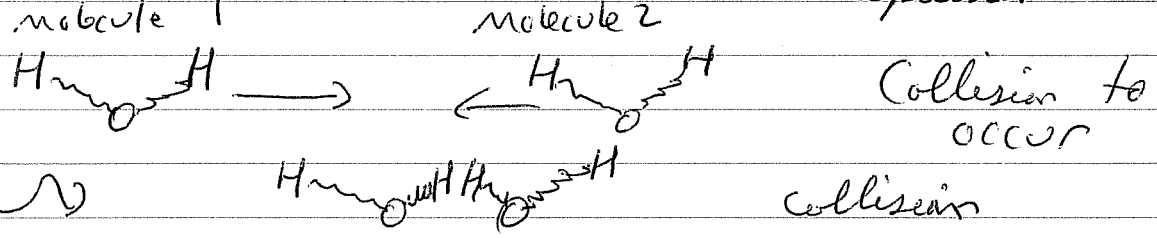


Cases:

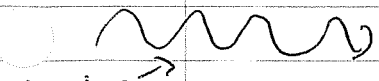
Gases, $r >> r_0$, weak attraction.

Liquid $r \tilde{\approx} r_0$, strong attraction, as r strays

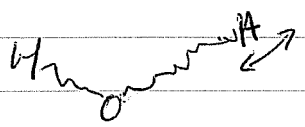
Collision $r < r_0$, strong repulsion.



Collision to occur



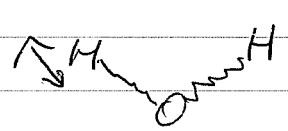
Photon sees



new energy levels

after collision

collision



Induced vibration, later

Summary Ch 2 cont

E_2 O–H ↕ O vibrating, excited state

E_1 O–H Ground State for example

2 Level Example

$P(E_2)$ = Probability molecule is in energy state E_2

$$P(E_2) = \frac{e^{-h\nu_2/k_BT}}{e^{-h\nu_1/k_BT} + e^{-h\nu_2/k_BT}}$$

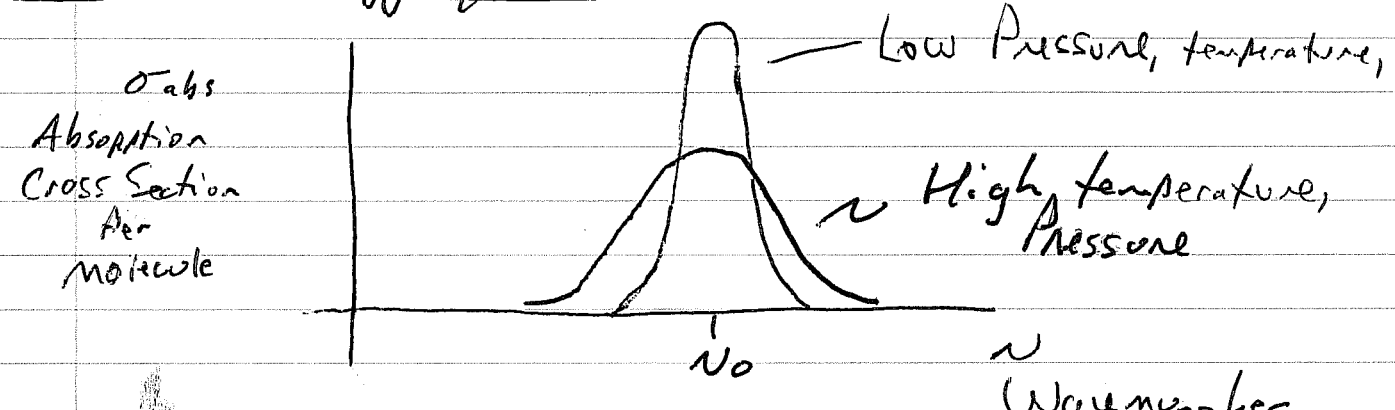
Limits: ① Since $E_2 = h\nu_2 > E_1 = h\nu_1$, when $k_BT >> E_1$,

$P(E_2) \approx 1$. Enough thermal energy to have the molecule in the excited state.

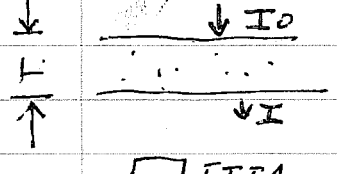
② $k_BT << E_2$,

$P(E_2) \approx 0$, Ground state.

Note: Thermal energy k_BT supplied by the kinetic energy of all the other molecules, not shown.



Area under the curve the same, = S



$\frac{I}{I_0}$ = transmissivity $= e^{-\sigma_{abs}NL}$

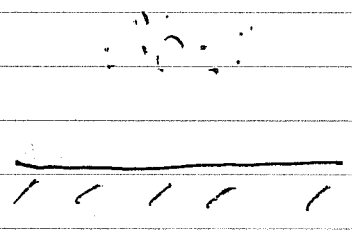
ϵ = emissivity $= (1 - e^{-\sigma_{abs}NL})$

= absorptivity

Summary Ch 2, cont

Keep in Mind

Wavelength Range	Transitions
UV, 200nm - 400nm	Electronic
Visible (400nm - 700nm)	Electronic [exception: Liquid water absorption in visible due to absorption by overtones of vibrational levels
IR (700nm - 50 μm	Vibrational and rotational
Longer	rotational

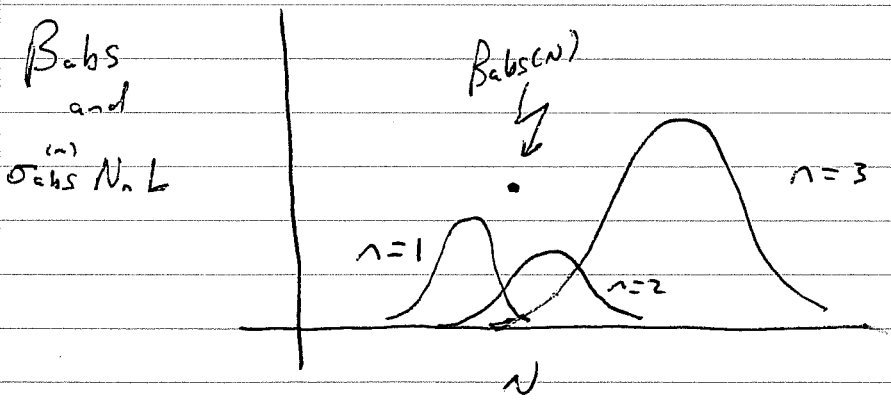


Sky full of things

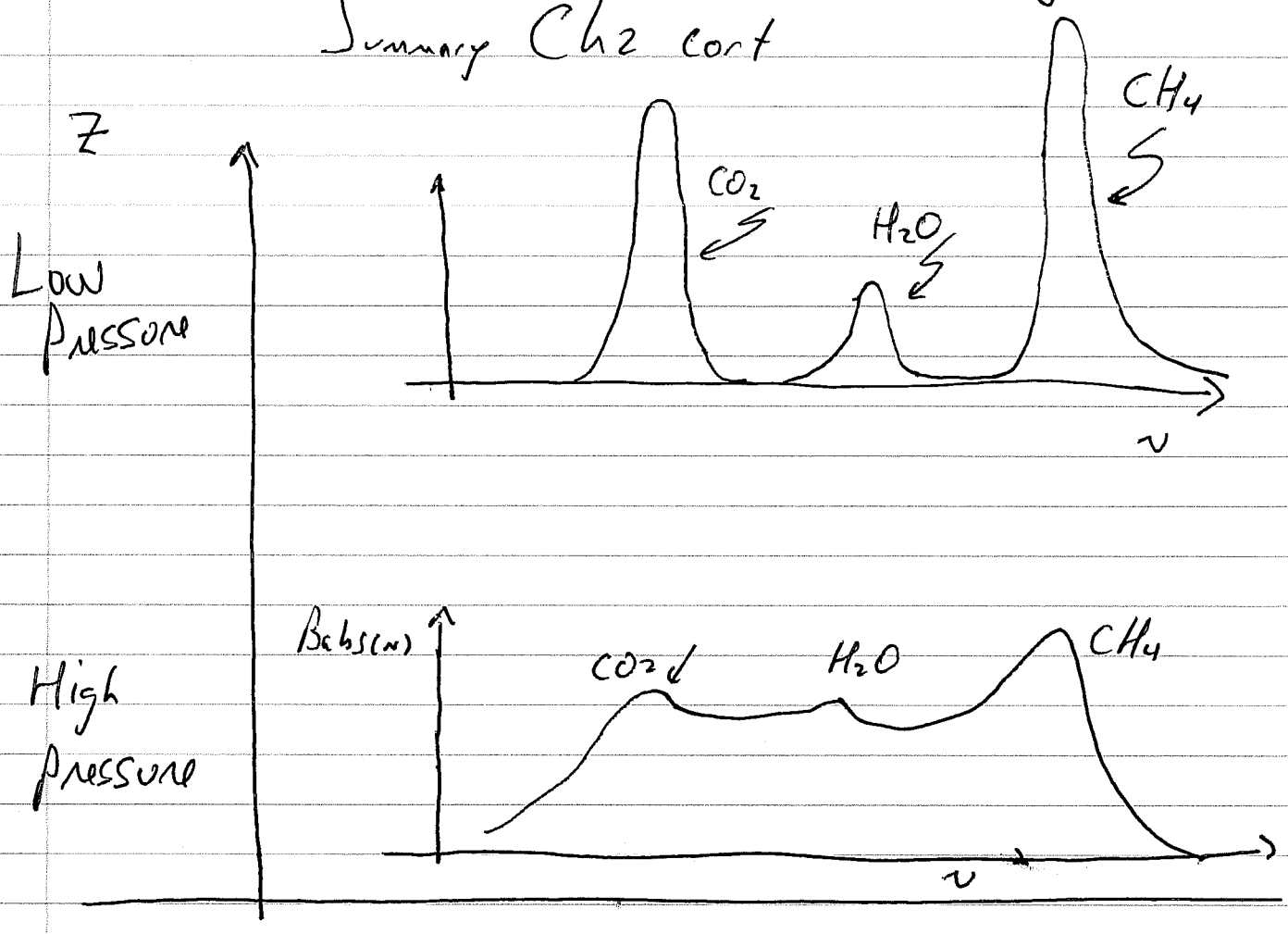
$$\beta_{abs}(\nu) = \sum_{n=1}^{\text{\# types of things}} \sigma_{abs}^{(n)}(\nu)\, N_n$$

$\sigma_{abs}^{(n)}(\nu)$: Absorption Cross Section per thing

N_n: # of things of type n per volume



Summary Ch2 cont



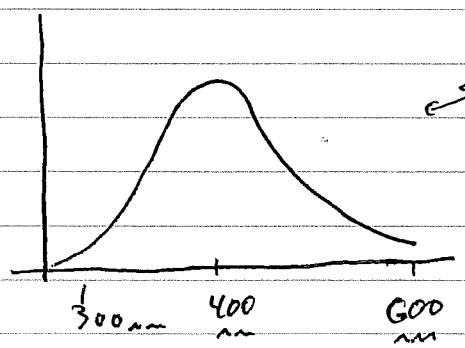
Low Pressure, can more easily do spectroscopy (find out how much H_2O) for example

Key Points ① $\lambda < 340nm$, UV Photons absorbed by Ozone (O_3)

Energetic enough to break molecules

$O_3 + h\nu \rightarrow O_2 + O + KE$

② B_{abs} NO_2



NO_2 Broad spectrum in the visible, contributes to brownness of polluted skies

Summary Ch2 Cont

Earth is a cool Place

$P(\nu) \sim e^{-h\nu/k_BT}$ Probability Photon mingle with gases @ k_BT

Small T, need small ν
so that $P(\nu)$ is not so small.
IR photons mingle with molecules having vibrational, rotational Modes to put energy into.

Sun Hot

k_BT is much larger,
$h\nu$ can be much larger and still get reasonable $P(\nu)$

Visible, UV, Xray photons mingle with atoms, molecules having electronic modes to exchange energy with.

Major Major Point

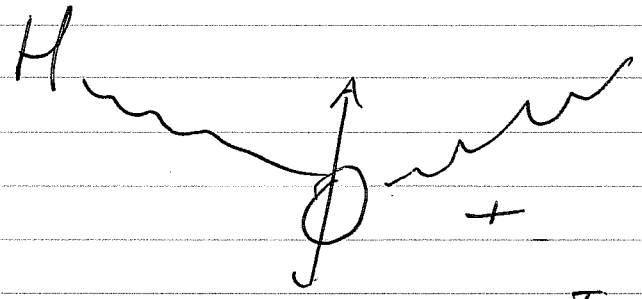
$O_2 \sim 21\%$ by volume
$N_2 \sim 79\%$ by Volume
(Atmosphere Composition)

O=O N≡N

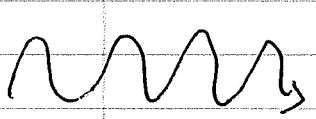
No vibrational transitions that involve photons
[If there were we would have a mega greenhouse]

Summary CH2 cont

Why no vibrational modes that eat or emit photons for N_2, O_2 ??



Polar Molecule with dipole moment: Induced or permanent



$F = qE = e^- E$

Accelerated Charges are the source of electromagnetic radiation

No dipole moment, no radiation.

Modes that create Changes in dipole moments give transitions

Nothing to break the Symmetry when the O_2 vibrate so that Charge distribution can Create dipole moments, radiation.

(Homonuclear Molecule
Same atoms in the ↗)