Absorption

$$A = [c]\epsilon l = -\ln\left(\frac{I_S}{I_R}\right)$$

$$A = -\ln T$$

T = Transmittance

$\epsilon \equiv$ extinction coefficient

For systems in thermal equilibrium

The population ratio between E_f and E_i

$$\frac{P(E_i)}{P(E_f)} = \frac{g(E_i)}{g(E_f)} e^{-\frac{E_i - E_f}{k_B T}} \sim e^{\frac{\Delta E}{k_B T}}$$

$$\Delta E = E_f - E_i$$

VIBRATIONS

$$F = -k(L - L_{eq})$$

$$x \equiv L - L_{eq}$$

$$V(x) = \frac{1}{2} k x^2$$

HARMONIC OSCILLATOR

$$H\Psi = -\frac{\hbar^2}{2\mu}\frac{d^2}{dx^2}\Psi + \frac{1}{2} k x^2 \Psi$$

$$\Rightarrow \boxed{E_n = h\nu\left(n + \tfrac{1}{2}\right)} \quad n = 1, 2, 3, \ldots$$

$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{\mu}}$$

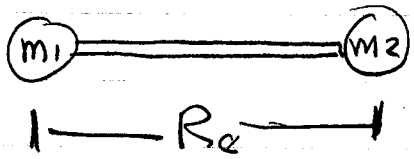
$$\mu = \frac{m_1 m_2}{m_1 + m_2}$$

$$\boxed{E_{n+1} - E_n = h\nu}$$

IR $(2-40)\ kJ\,mol^{-1}$

Room Temp $k_B T \sim 2.5\ kJ\,mol^{-1}$

ROTATIONS



$$I = \mu R_e^2$$

$$\mu = \frac{m_1 m_2}{m_1 + m_2}$$

No radial dependance!

Classical $KE = \frac{1}{2I} L^2$

L = angular momentum

Quantum M. $\boxed{E_J = \frac{h^2}{8\pi^2 I} J(J+1)}$

$J = 0, 1, 2, 3, \ldots$

Selection Rule

$\Delta J = \pm 1$

$$E_{J+1} - E_J = 2\left(\frac{h^2}{8\pi^2 I}\right)(J+1)$$

$$\nu = \frac{E_{J+1} - E_J}{h}$$

$$\boxed{\nu = 2B(J+1)}$$

$$B = \frac{h}{8\pi^2 I}$$

ENERGY IN THE MICROWAVE REGION

MICROWAVE OVENS — 2.45 GHz (12.2cm)

Radiation absorb by water and small molecules WITH SIMILAR MASS AS WATER.

Metals reflect microwaves

Water absorbs — Rot ↑ and, through, collisions give up energy heating up the sample.

Microwave oven — 200 - 1000 W (TOTALLY SAFE)
Mobile phone — 1W max (NOT CLEAR)