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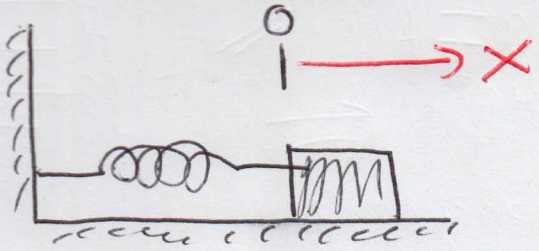
Harmonic Oscillator



force ↓ spring constant ↙

$F = -kx$

$F = m \cdot a$

$a = \Delta v / \Delta t$

$v = \Delta x / \Delta t$

$F = m \cdot a = -kx$

$m \frac{d^2x}{dt^2} = -kx$

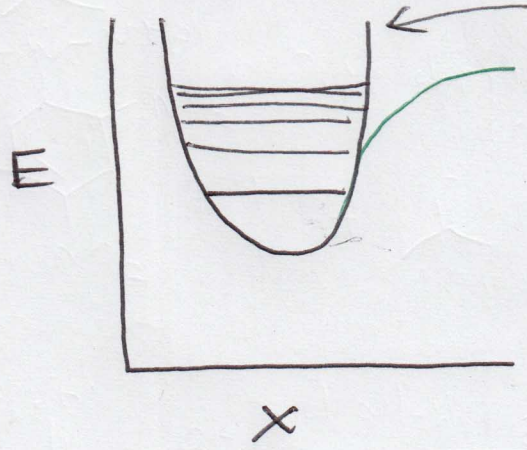
$f(x) = e^{ix}$

$f(x) = \sin \omega x$

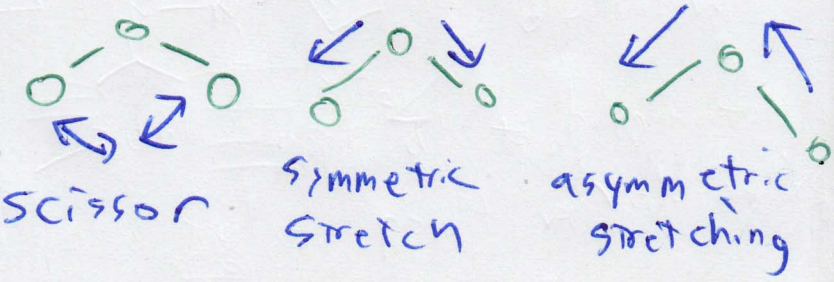
The importance of the above sets of equations is to show that the motion of an idealized spring can be modeled by a periodic function (sine wave). This same model can be applied to the idealized case of two bond atoms vibrating.

* In atomic systems, energy is quantized, so only certain frequencies of vibration are allowed

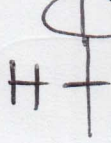
→ vibrational energy states,



Modes of vibration

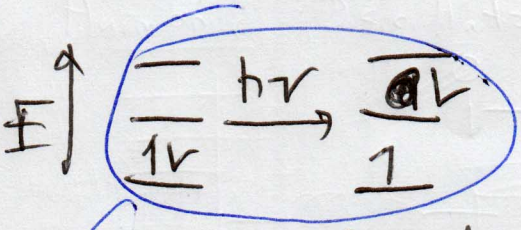


Rotational energy levels



Rotation energy levels are also quantized

Electronic States



Ground state $\Rightarrow S_0$ excited state $\Rightarrow S_1$

When an electron moves between energy levels, there are normally restrictions on how the spin can or can't change as the electron moves between levels ⟶ selection rules

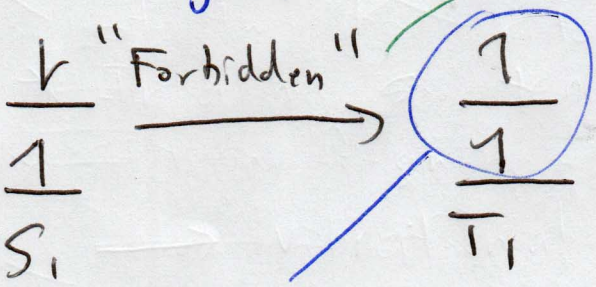
Spin allowed transition – obeys rules of spin

For moving up & down energy levels, a single electron must retain its spin.

Total angular momentum = 0 ⇓ multiplicity of spin states

$m = 2S+1$ (total spin)

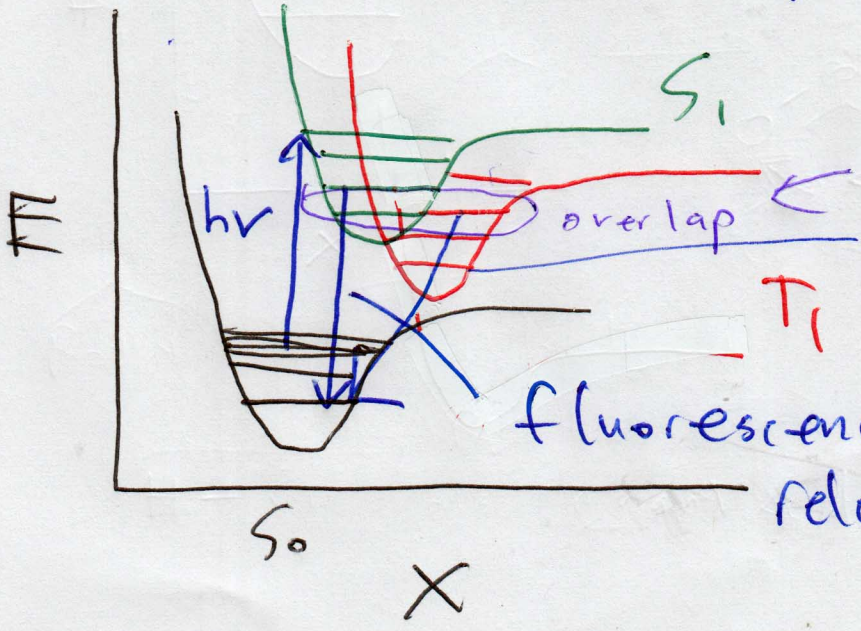
singlet



Spin forbidden – Spin changes in a way that is normally, not physically possible.

total angular moment = 1 $\quad 2(1)+1 = 3$

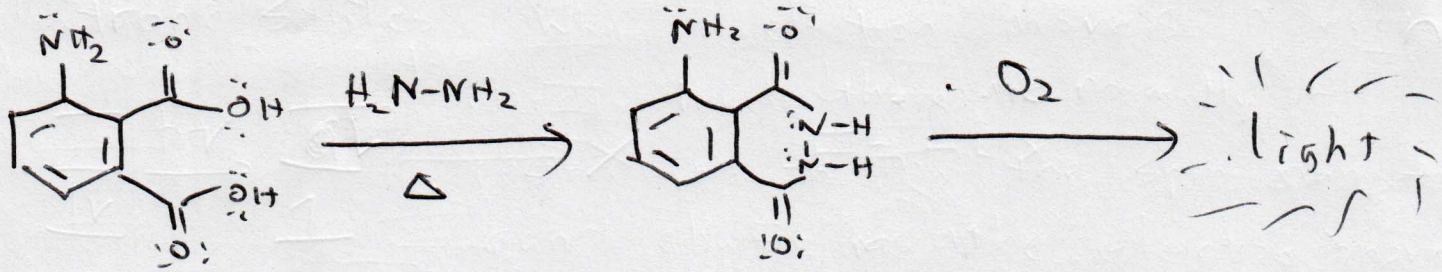
triplet



ISC – inter-system crossing

phosphorescence – spin-forbidden photon release

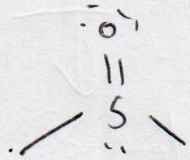
fluorescence – spin-allowed release of a photon



3-amino phthalic acid

luminol

The reaction of luminol causes an intermediate with the exactly correct energy + structure to allow that energy to be released in the form of a photon (radiative decay). ⟶ chemiluminescence



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