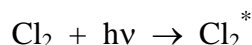


ABSORPTION... a closer look!

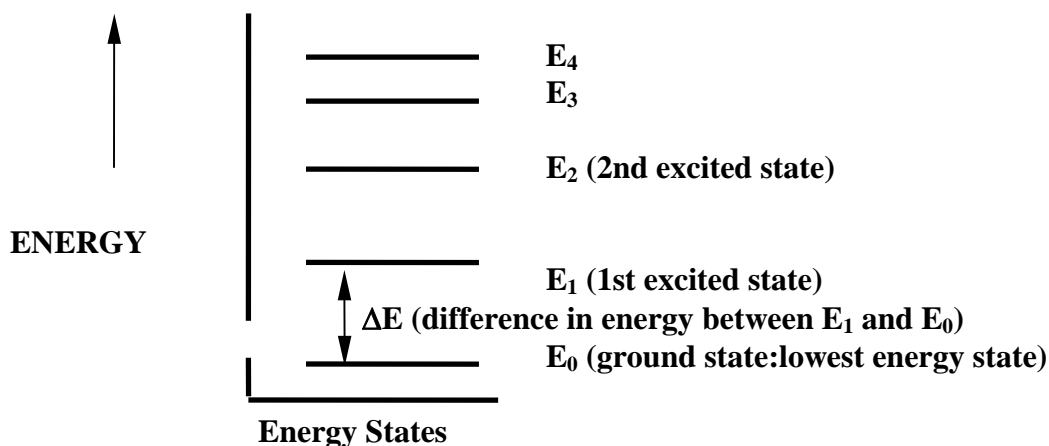
Absorption of light by a substance (e.g., a molecule of Cl_2) means that a photon is absorbed by that substance and that the E of the photon increases the energy content of that substance (atom or molecule).

ABSORPTION MEANS...

- a transfer of energy to the energy framework (system) of a substance
- that the E content of the molecule is increased (just as making a cash deposit to your bank account increases the monetary value of your account).



- the difference in energy between the initial state (Cl_2) and the excited state (Cl_2^*) is the energy transferred when a photon ($h\nu$) is absorbed.
- We can think of the **total energy framework** of a molecule as a series of steps (jumps) and that the difference between each successive step is the difference in E between steps.



KEY POINT

- For a molecule to absorb light (photon) and raise the molecule to a higher energy state, the E of a photon must provide **exactly** the same E as the difference between the E levels.
- **i.e.**, the transition between the lower state (E_0 , ground state) to a higher state (E_1 , 1st excited state) can only occur if a single photon is absorbed whose E is equal to the difference in E of the two states ($\Delta E = E_1 - E_0$).
- Light (photon) of even **slightly less or more** E (than ΔE) won't be absorbed photon won't deliver the **exact** energy required to raise the energy of the molecule from E_0 to the excited state, E_1 .

- Even if two photons **could be** absorbed whose combined E adds up to the difference in E between the two energy states, the transition cannot occur. The transition **must be** brought about by the absorption of a single photon of precisely the difference in E (i.e., ΔE) between the two energy states!

ANALOGIES...

1. Climbing a set of stairs

- There's no intermediate stopping point when climbing a flight of stairs.
- Must take a full step, not partial steps

2. Elevator

- An elevator stops at precisely defined levels (FLOORS)
- Energy levels (E_1 , E_2 , E_3 , etc) are like FLOORS - well defined E states
- The energy of a photon that could take you part way between the "electronic floors" of the molecule will not allow you to reach the next level. This photon will not be absorbed by the molecule.

3. Slot Machine (Las Vegas) - gambling casino

- Putting a dime into a slot machine that will only be activated by quarters means that NOTHING will happen.
- It takes **precisely** a quarter to make the one armed band move.

We call this phenomenon "QUANTIZATION OF ENERGY"

- Energy states in molecules (& atoms) exist at precisely defined levels.
- Transitions between these levels occur only if the exact energy (provided by a photon) is absorbed.
- When a molecule goes from an excited state (E_1) to the ground state (E_0), the **energy released** (emitted) is again precisely the difference between the two states (i.e., $\Delta E = E_1 - E_0$).

Absorption of Light - What does this mean?

- When a molecule "absorbs" light, the light energy increases the energy content of the molecule: We say that "the molecule is raised (promoted) from its normal (ground state) to a higher energy state".
- Analogy:– pollutants absorbed onto aerosol (H_2O) particles are taken within the tiny droplet. The same thing happens when a substance is exposed to and absorbs light: – the E of light (photon) is deposited internally and raises a molecule to a higher state of energy.

We can think of

- Energy states of a molecule/ion as a series of steps and the difference between steps represents the difference in E between these steps (or states).
- For absorption of light to occur the (light) photon must give to the molecule exactly the same E as the difference in energy (i.e., ΔE) between energy states (steps).

- Light of slightly less (or more) E won't be able to cause this change (transition) because the change must be EXACT (no left- over/ deficiency in E)

It's like riding on an elevator, the elevator stops only at precisely defined levels - not in between, but precisely at the level of the floor.

Thus, the absorption of $h\nu$ occurs something like the movement of an elevator - in definite "quantities" - never something in between.

We call this phenomenon the **QUANTIZATION OF ENERGY**

Absorption of light obeys this step to step or state to state rule