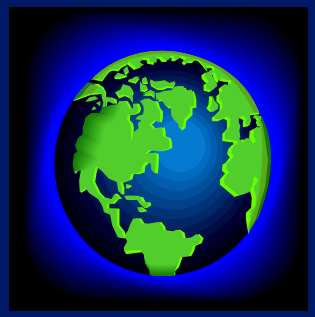
TOPIC # 5
ELECTROMAGNETIC ENERGY

PART 1 of the KEY to unlocking the topics of: OZONE DEPLETION, The GREENHOUSE EFFECT, & GLOBAL WARMING !

Class Notes: pp 27-28

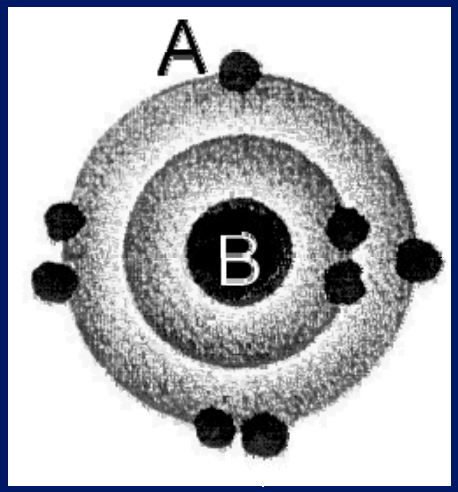
GOAL for this week:

To understand the key aspects of ELECTROMAGNETIC RADIATION and the ELECTROMAGNETIC SPECTRUM that most directly relate to GLOBAL CHANGE!



Two radiating bodies!

Review of last Thursday:



A = ELECTRON

B = NUCLEUS

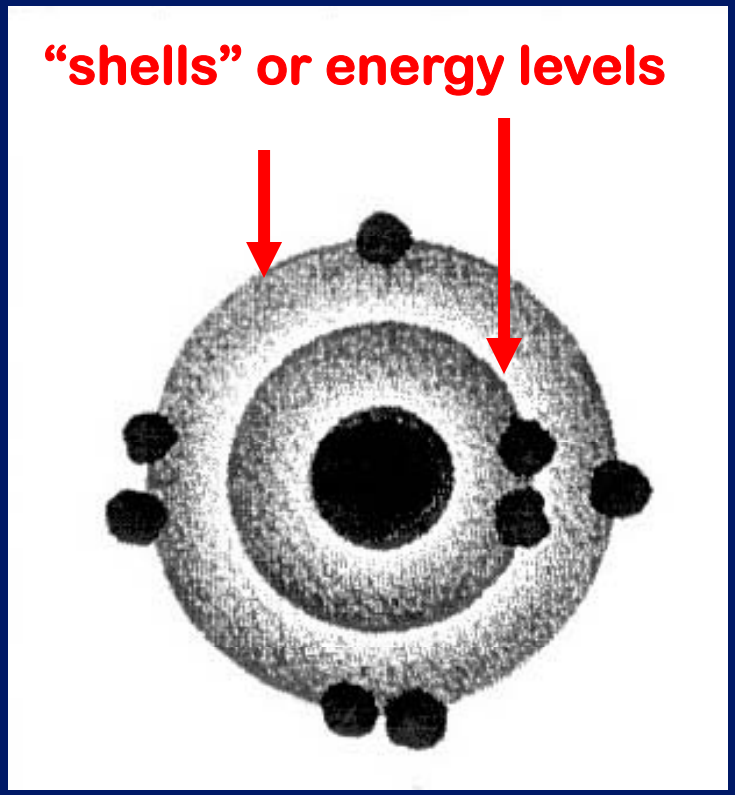
 # electrons = 8

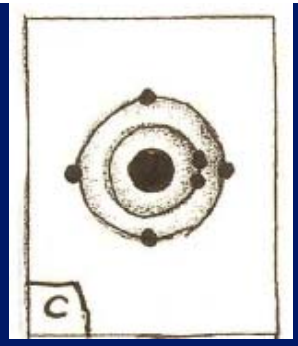
 # protons = 8

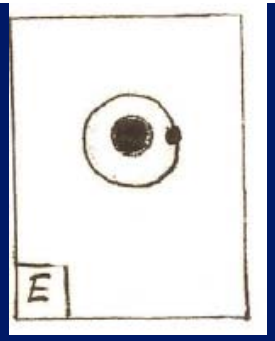
 # neutrons = 8

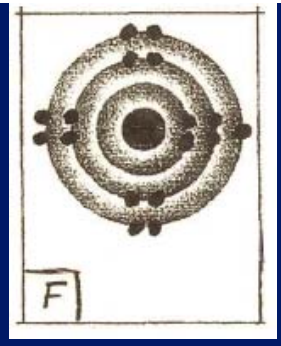
atomic # = 8

Dot diagram of an OXYGEN ATOM:









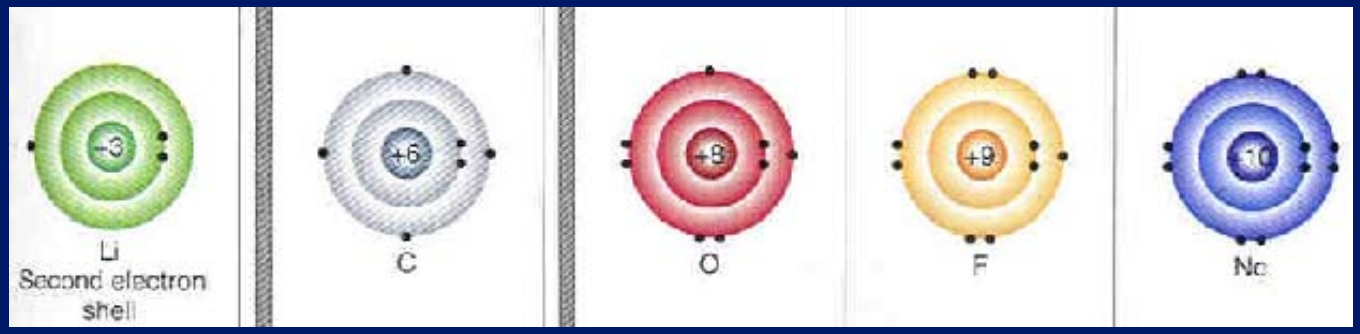
Can you re-arrange these in the proper configuration?
See pp 109-113 in Class Notes Appendix II

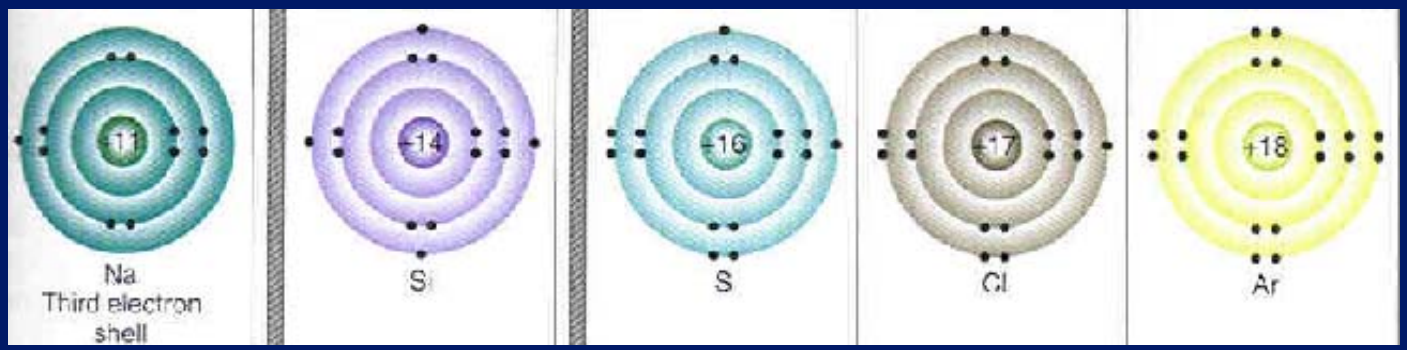
Appendix II p 113

KEY POINT → Because each atom type (element) has a unique set of energy levels,

ANSWER:

each atom type (e.g. H, He, etc.) **will ABSORB over a PARTICULAR SET OF ELECTROMAGNETIC FREQUENCIES & WAVELENGTHS.**



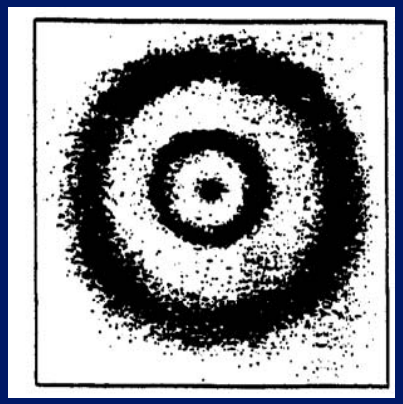


REVIEW:
The Periodic Table is organized by # of shells (**rows**) &
# of electrons in the <u>outer</u> shell (**columns**)

Take notes

Review of last Thursday:

The Bohr Model of the Atom:



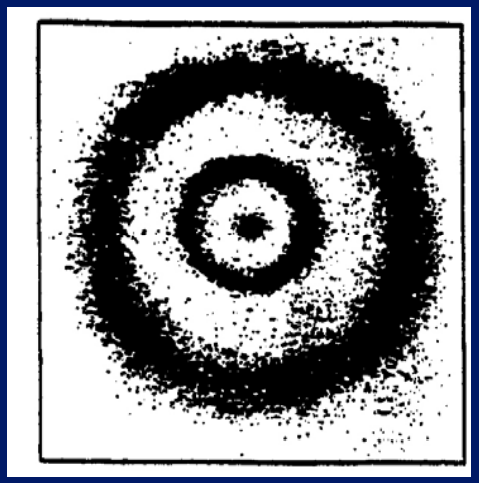
-- The "empty" spaces represent areas with *little likelihood* of finding an electron

-- Dark areas represent places (or energy levels) where electrons are "allowed" to be

. . . but how do they get from one level to another???

The **quantum model** of the atom states that:

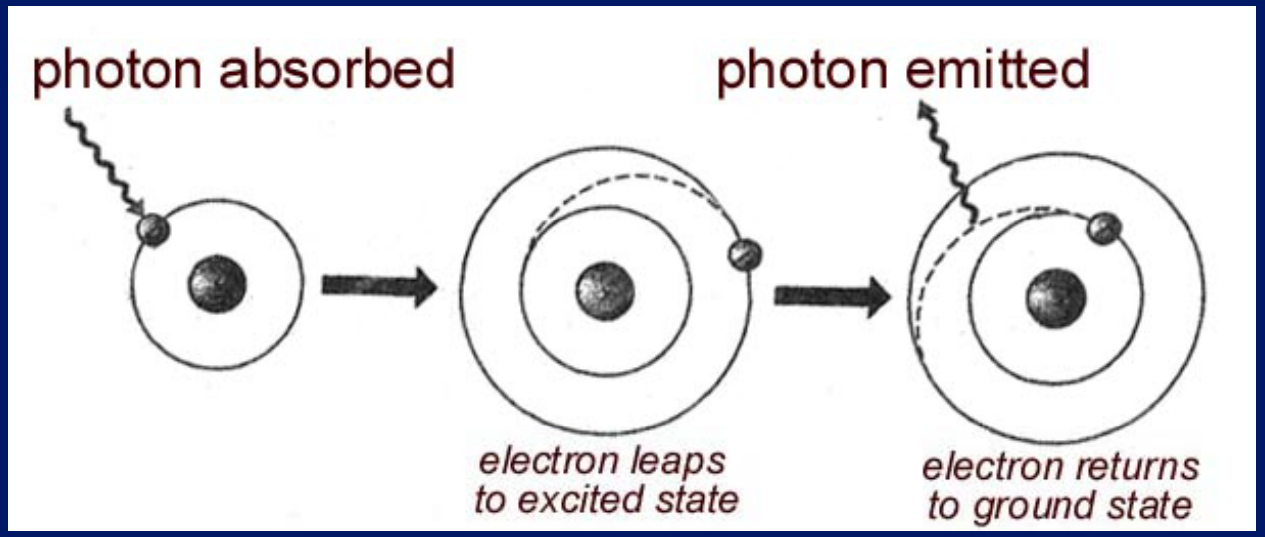
electrons can exist only in discrete allowed places within shells (or energy levels) and not in between.



The electrons move -- NOT according to Newtonian laws of motion

-- but according to

quantum mechanics.

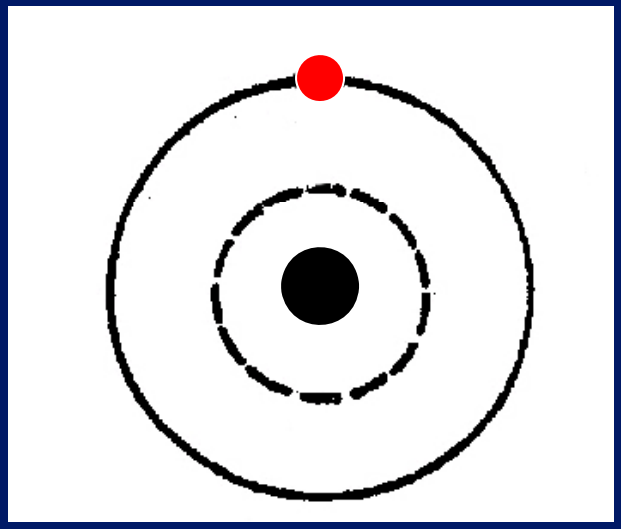


Not only is the universe stranger than we imagine, it is stranger than we can imagine.
~Arthur Eddington

An electron moves between shells or energy levels by “quantum leaps,”

i.e., it disappears from one energy level and reappears in another without ever traversing any of the positions in between!

What causes the “leap” ?



- Electrons can be promoted to higher energy levels or even knocked free from their atoms in a variety of ways . . .

One way is critical to global change processes:

it involves a packet of energy called PHOTON

Frequency, Wavelengths & Energy of Photons

Energy emitted from the sun
(i.e, electromagnetic radiation)
exhibits both a wave-like
(electromagnetic wave)
and
particle-like (photon) nature.

Energy in the form of PHOTONS is absorbed or emitted as electrons change energy levels within the structure of an atom.

Photons, NOT protons!

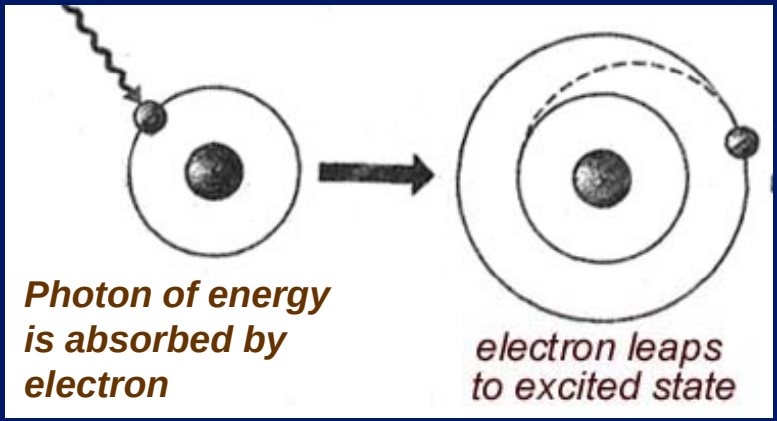
Photon =

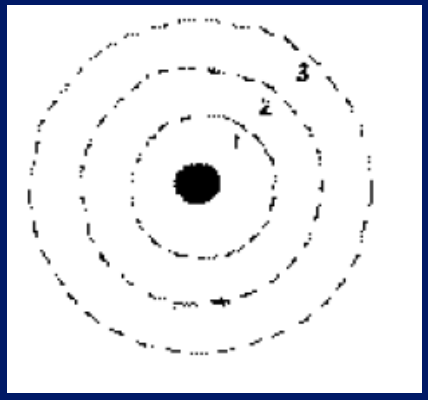
A particle-like unit of electromagnetic energy (light), emitted or absorbed by an atom when an electrically charged electron changes state.

= also the form of a single packet of ELECTROMAGNETIC ENERGY

WHAT HAPPENS WHEN ELECTRONS CHANGE LEVELS:

As an electron receives & absorbs electromagnetic energy (in form of a photon), it jumps from a Lower → Higher energy state (level).





Sketch it yourself ←

WHAT HAPPENS WHEN ELECTRONS CHANGE LEVELS:

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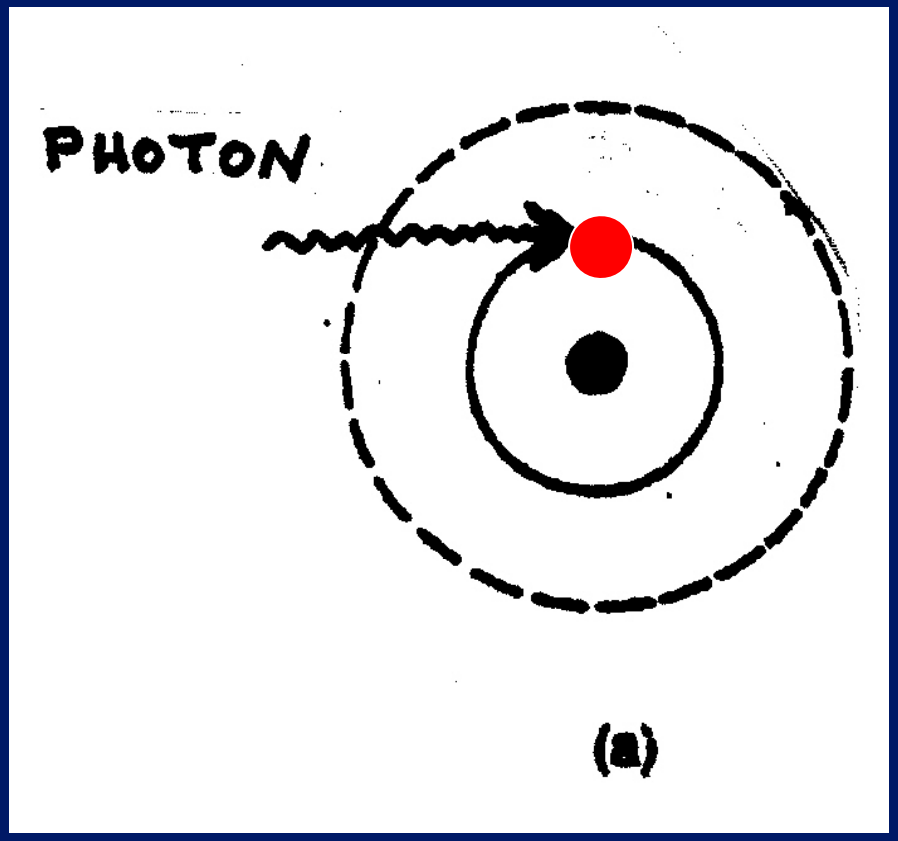
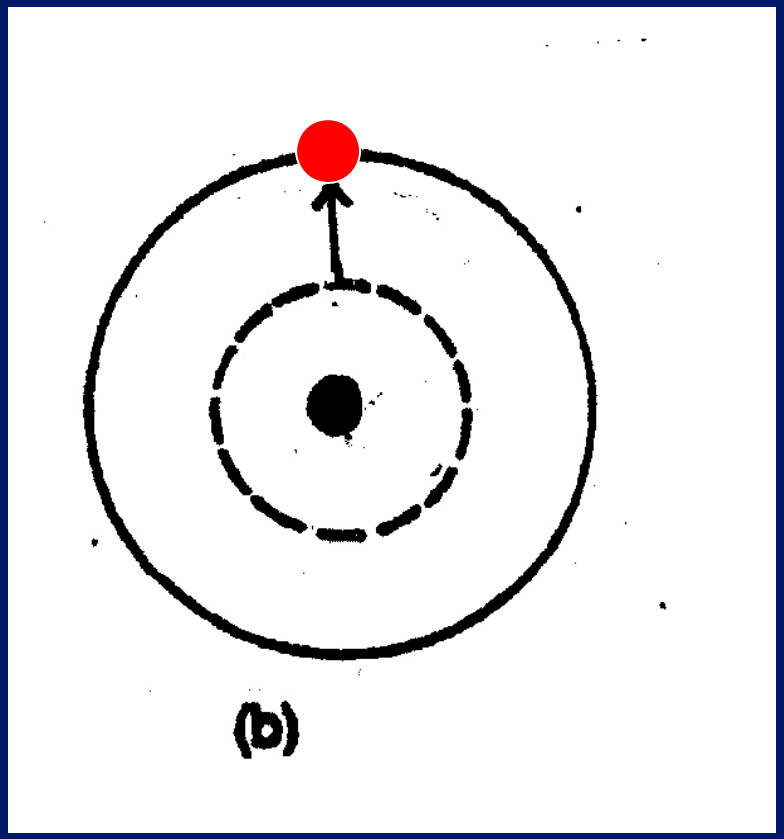




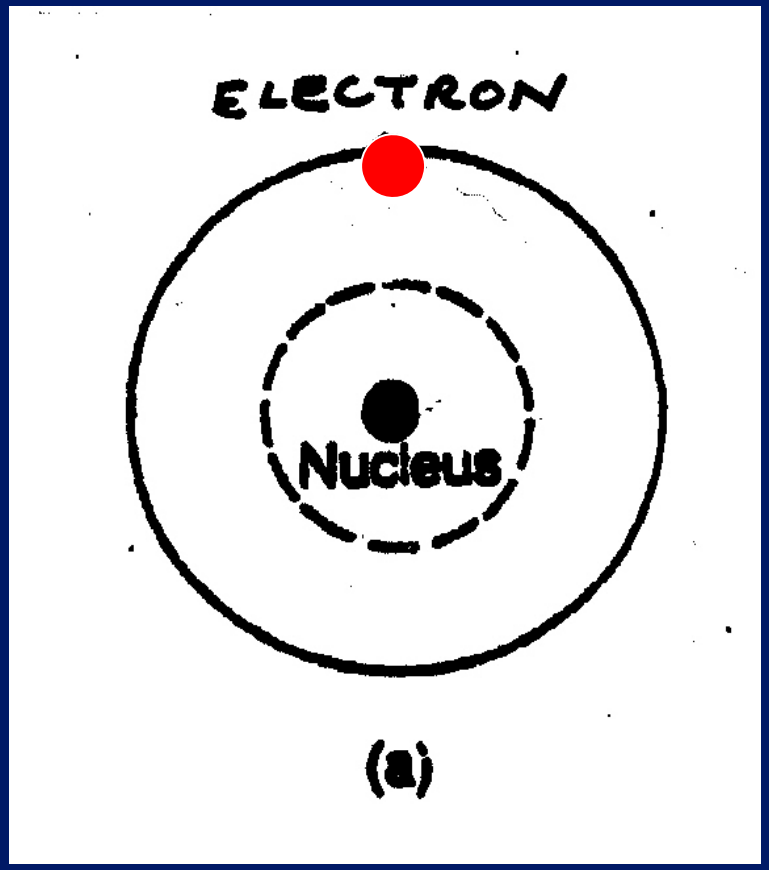
(a) An electron in its ground state, about to absorb a photon

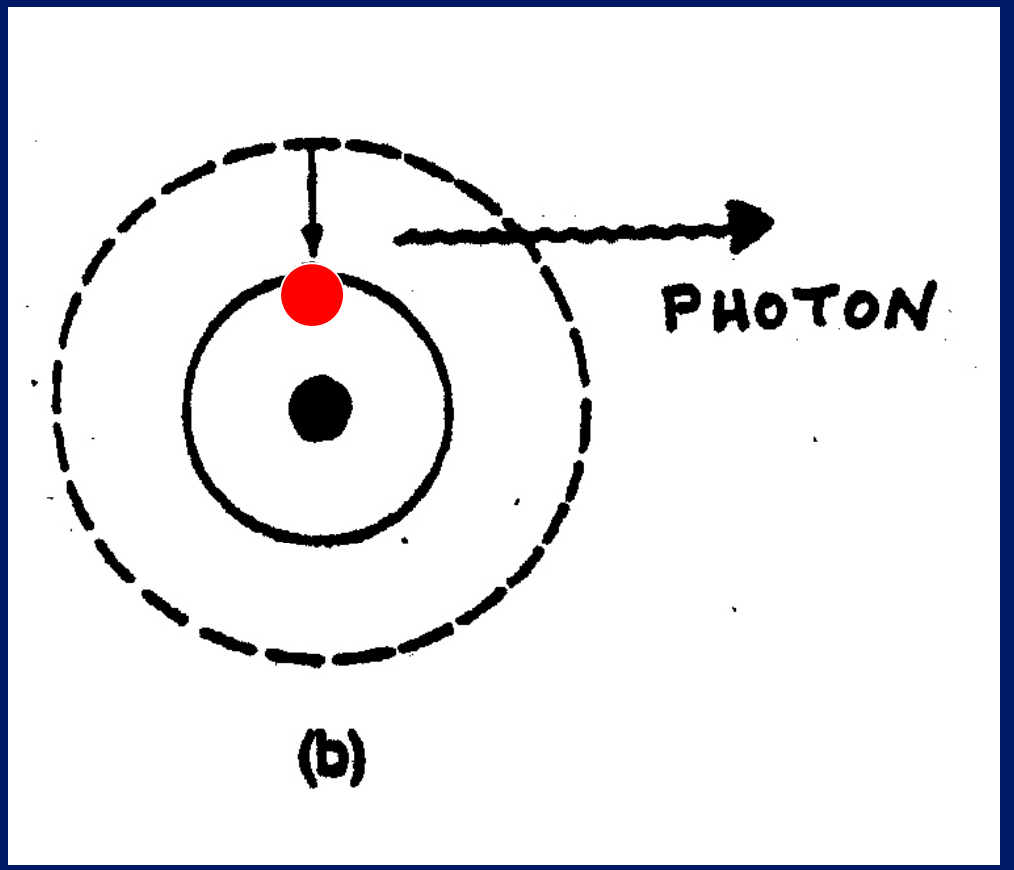
(b) The electron leaps to a higher level as the photon is absorbed

WHAT HAPPENS WHEN ELECTRONS CHANGE LEVELS:

As an electron emits or "gives off" electromagnetic energy (in form of a photon),

it jumps from a Higher $\rightarrow$ Lower energy state (level)





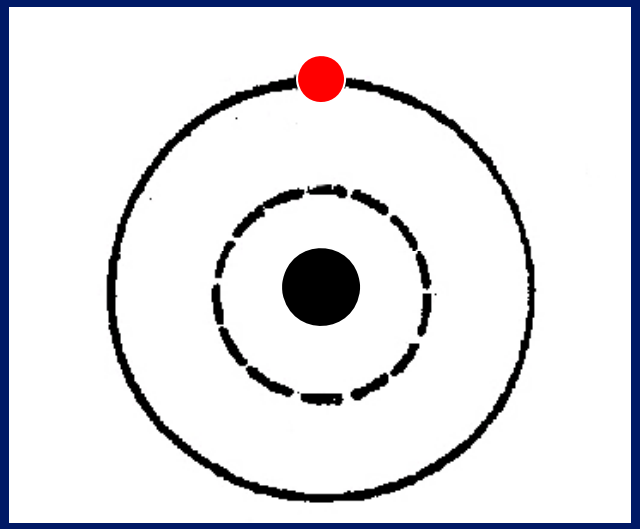
(a) An electron in an excited state.

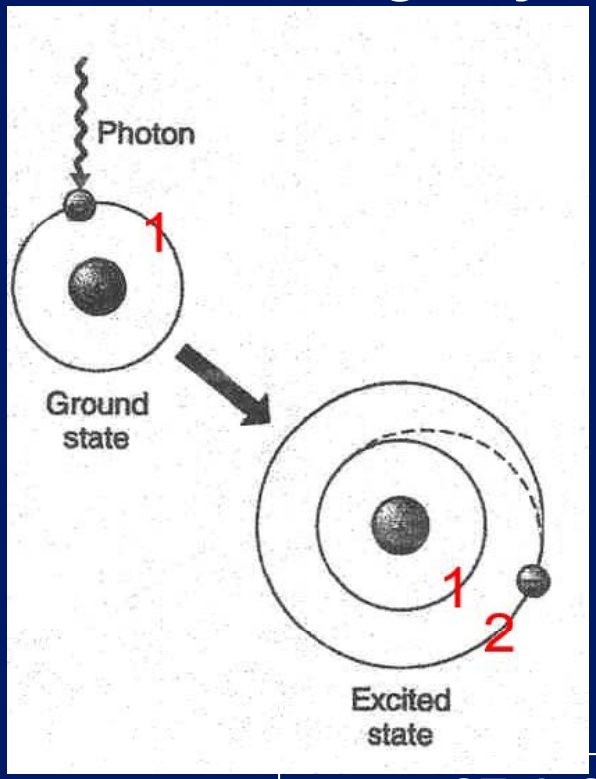
(b) When the electron drops to a lower level, a photon is emitted.

SUMMARY:

An electron moves between shells or energy levels by "quantum leaps,"

i.e., it disappears from one energy level and reappears in another without ever traversing any of the positions in between!



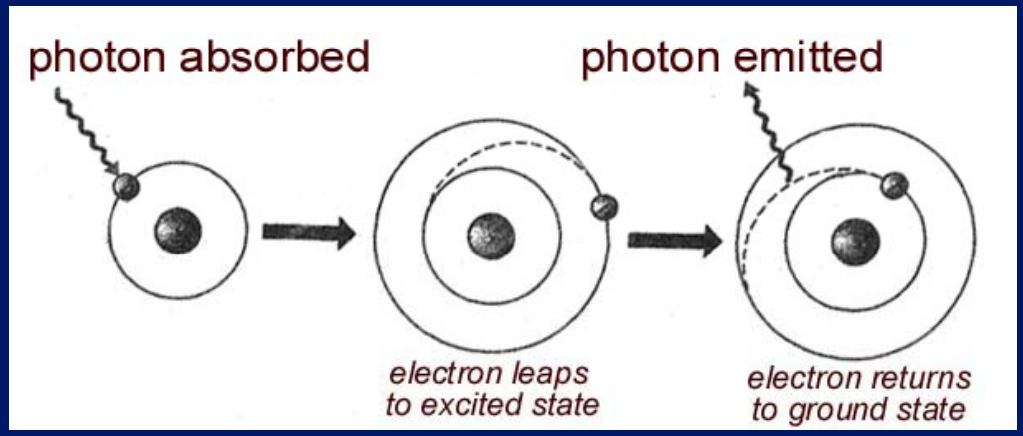


Another depiction ➔

p 27 & 28

RECAP: Electromagnetic Radiation

(under certain higher-energy conditions, e.g. light) exhibits a particle-like nature which we call PHOTONS.



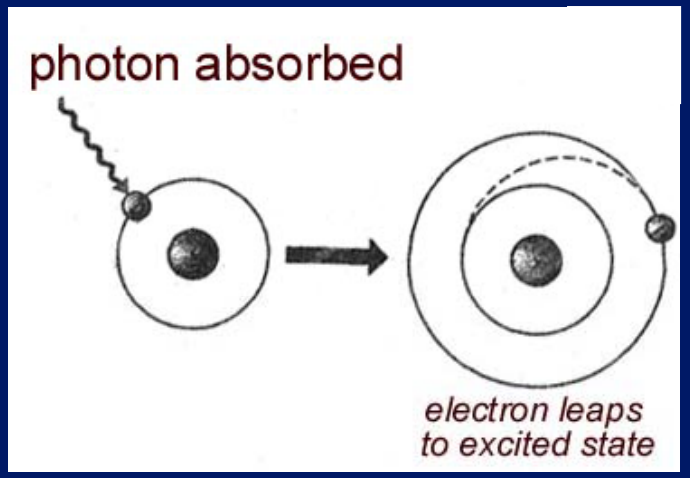
Link to our upcoming topic:
The Electromagnetic Spectrum . . . .

Photons are energy packets having a well-defined wavelength and frequency

QUANTUM MECHANICS & the LINK to ABSORPTION OF ELECTROMAGNETIC ENERGY AT THE SUBATOMIC SCALE

- If a photon of electromagnetic energy strikes an atom,
- and if the **FREQUENCY** of the electromagnetic radiation is such that it is equal to:
  the *difference* in the energy
  of the ground level & the first excited level,
- the electron **ABSORBS** the photon energy and . . .
- the electron is "moved" (quantum leap) to "Level 2"

Hydrogen atom:



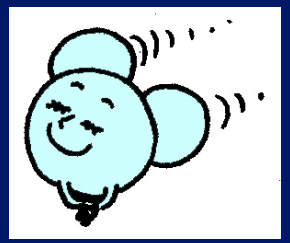
Take notes

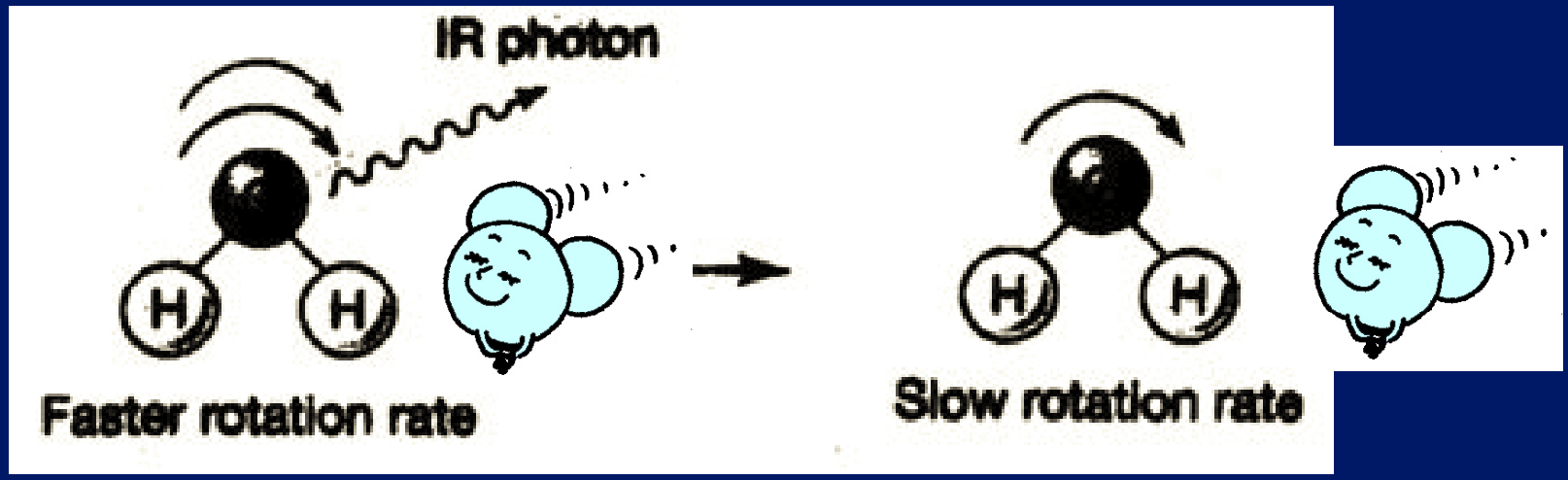
Quantum Behavior of MOLECULES

Quantum leaps of electrons between discrete energy levels (shells) *within atoms* involve photons which are absorbed or emitted, but

Quantum theory also involves the *behavior of molecules*:

the molecular-scale motion (i.e., rotation, bending, & vibration) of molecules!





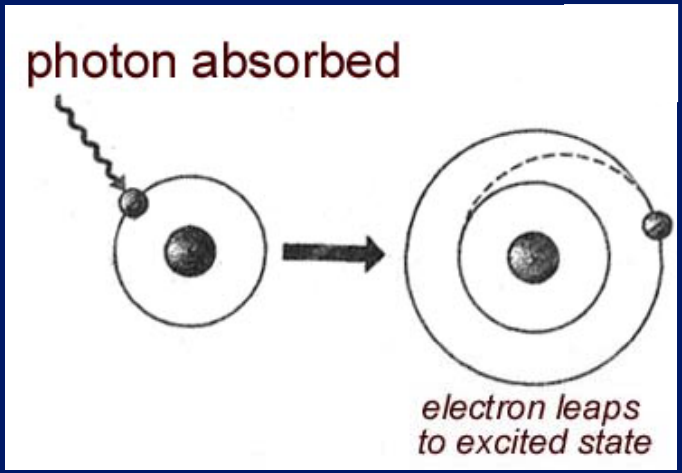
LINK TO GLOBAL CHANGE:

Molecular motions in the gases WATER VAPOR and CARBON DIOXIDE (H_2O and CO_2) explain why some gases (e.g., H_2O, CO_2) contribute to the greenhouse effect and others (e.g., O_2, N_2) do not!!

(more on this later . . .)

Recap of Key Concept:

ENERGY & MATTER INTERACT !!!



PRESENTING:

A SUSTAINABILITY SEGMENT!!!

We watched Chapters 1 & 2 at the link below:

http://www.pbs.org/wgbh/nova/solar/program.html

G-1 GROUP ECOLOGICAL FOOTPRINT

(the class finished up the G-1 activity and graded Assignment I-1 was returned –in your group folder!)

COMPLETING G-1 YOUR GROUP'S ECOLOGICAL FOOTPRINT

- GET GROUP FOLDER
- ON YOUR GROUP PHOTO: DR H will deliver NAME LABELS to each group. Insert your NAME on the photo to identify yourself.
- Pick a NEW GROUP LEADER
- TODAY'S ICEBREAKER: GO AROUND THE CIRCLE (again), INTRODUCE YOURSELF (again) & find out something new:
  (1) where from (2) most exotic place traveled (3) favorite food
- GROUP LEADER appoints a new RECORDER, who makes sure the form is totally filled out.
- Submit your Completed G-1 GROUP FOOTPRINT FORM by leaving it in your group folder. Be sure everyone has signed in at the top of the form – no signature, no credit!

Re-cap of ANNOUNCEMENTS:

- **RQ-2 REMINDER – Cutoff is THURSDAY Sep 10th, 30-minutes before class begins – don't wait until the last minute!!**
- **TEST #1 is a week from TODAY (Sep 15th) ! A "Top Ten Things to Study" guide will be posted near the end of this week.**
- **REMEMBER TO CHECK THE WEEKLY D2L CHECKLIST for announcements of assignments, RQ's TESTS, etc. and when they are due.**
- **The online Textbook Reading & RQ Schedule has been corrected to match the D2L Checklist – please update p 4 in Class Notes with the proper page #s ←**
- **Still without a textbook? Use the PDF password and link in the Text Schedule to access the necessary pages for RQ-2.**