

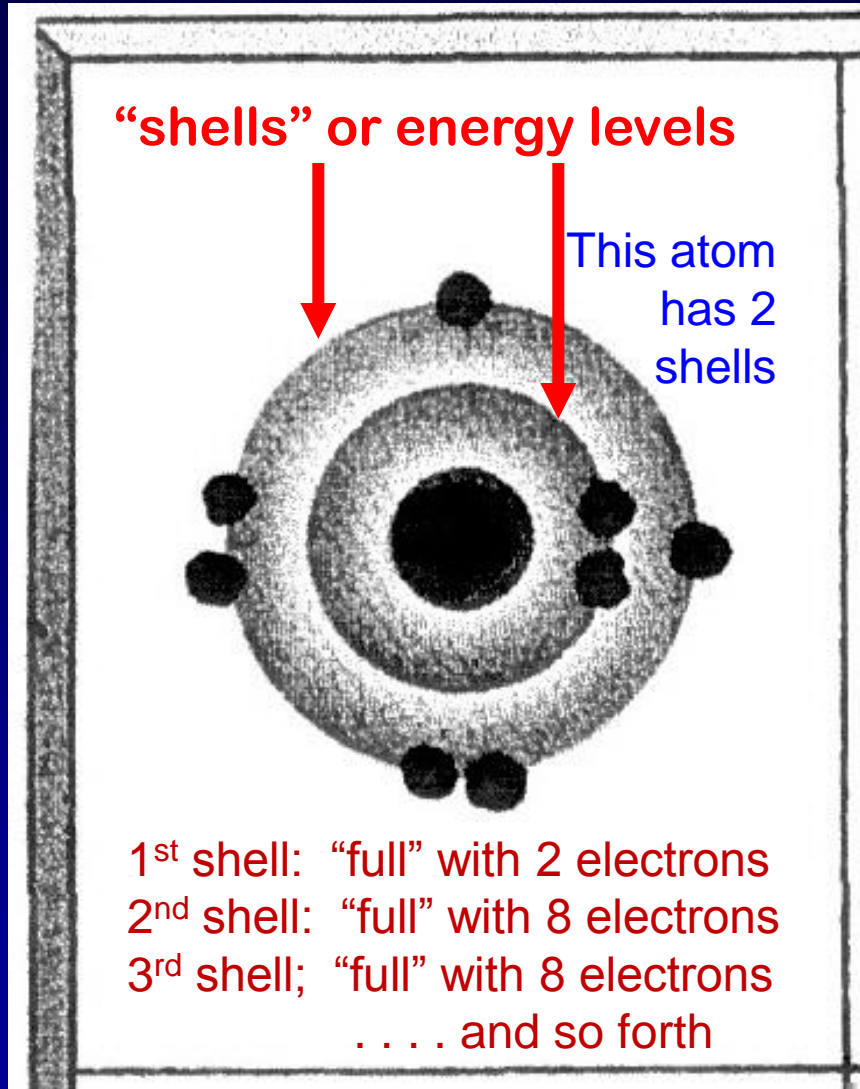
Key points form our last class:

WRAP UP OF TOPIC #3 Part I :

MATTER REVIEW

**What are the key things
you need to know NOW?**

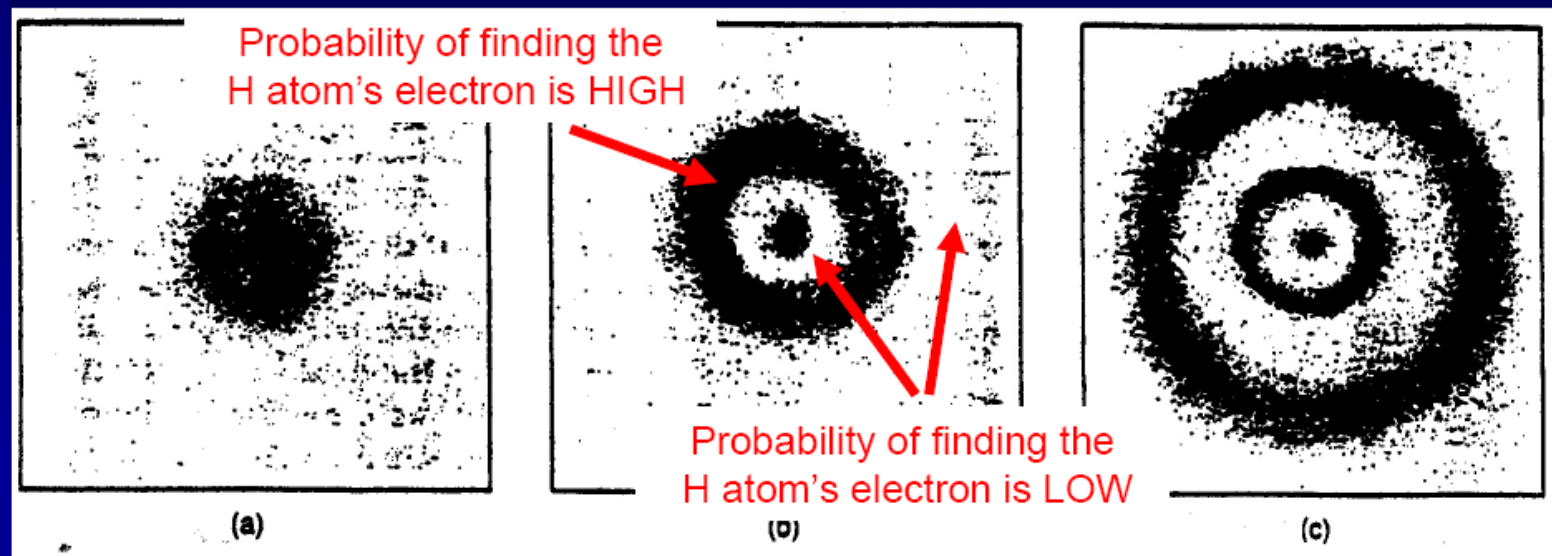
Electron Configuration in Shells (for Elements 1 to 18)



Atomic #	Element & Symbol	Number of Electrons in Each Shell			Total # of Electrons
		1st	2nd	3rd	
1	Hydrogen, H	1			1
2	Helium, He	2 (Full)			2
3	Lithium, Li	2	1		3
4	Beryllium, Be	2	2		4
5	Boron, B	2	3		5
6	Carbon, C	2	4		6
7	Nitrogen, N	2	5		7
8	Oxygen, O	2	6		8
9	Fluorine, F	2	7		9
10	Neon, Ne	2	8 (Full)		10
11	Sodium, Na	2	8	1	11
12	Magnesium, Mg	2	8	2	12
13	Aluminum, Al	2	8	3	13
14	Silicon, Si	2	8	4	14
15	Phosphorus, P	2	8	5	15
16	Sulfur, S	2	8	6	16
17	Chlorine, Cl	2	8	7	17
18	Argon, Ar	2	8	8 (Full)	18

There are only certain "allowed orbits" in which an electron can exist for long periods of time without giving off radiation (energy).

- As long as the electron remains at one of these distances, its energy is fixed.

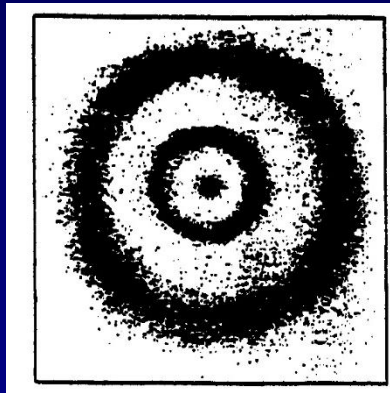


GROUND State

Excited State 1

Excited State 2

-- 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 ENERGY LEVEL
TO ANOTHER???**

That’s today’s topic!

Anyone who says that they can
contemplate quantum mechanics
without becoming dizzy . . .

. . . has not understood
the concept in the least.

~ Niels Bohr

WRAP UP OF TOPIC #3 Part II:

ENERGY REVIEW

**What are the key things
you need to know NOW?**

(more will be covered in Topic #7)

Background: Energy Terms & Units

ENERGY (def) = the quality of an object that enables it to do **“WORK”**

WORK (def) = action of a **FORCE** exerted over a **DISTANCE** ... or **the TRANSFER OF ENERGY** from one object to another (especially to make the second object move in a certain direction)

ENERGY TERMS & UNITS

Energy - the quality of an object that enables it to do "work;" the capacity to exert force over a distance.

Mass - Mass (m) is the amount of matter in a particle or object; standard unit = kilogram (kg)

Force - A push or pull that, acting alone, causes a change in acceleration of the object on which it acts.

Force is expressed in units called **newtons (N)**. A newton is a unit of force needed to accelerate a mass of 1 kilogram by 1 meter per second squared.

Work - Work (W) is done whenever a force (F) is exerted over a distance (d). Work is equal to the force that is exerted times the distance over which it is exerted (i.e. the product of the force applied to an object and the distance through which the object moves). **$W = F \times d$**

Work is expressed in units called **joules**. A joule is the amount of work done when you exert a force of one newton through a distance of one meter.

Power - Power (P) is equal to work (W) done divided by the time (t) it takes to do it. **$P = W/t$**

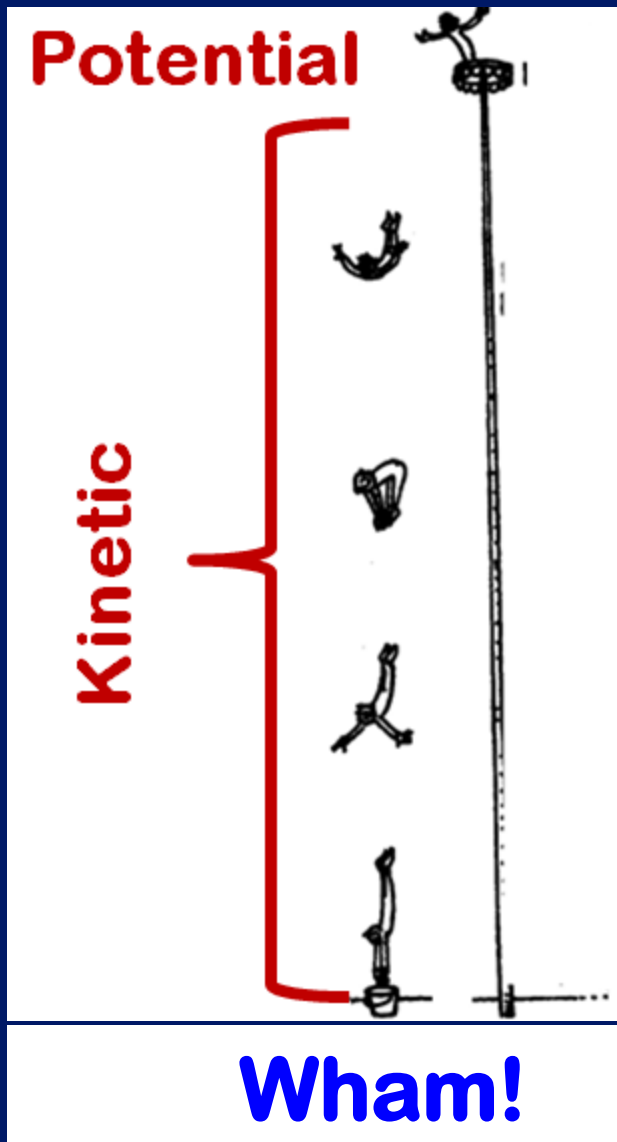
Power can be expressed in joules/sec = **watts**

1 watt of power = (1 joule of energy) ÷ (1 second of time)

Energy can therefore also be expressed in terms of power and time:

energy (in joules) = power (in watts) x time (in seconds)

Two Main Kinds of Energy



- **Potential** = energy a system possess if it is capable of doing work, but is *not* doing work now
- **Kinetic** = energy of motion; the ability of a mass to do **WORK** !

POTENTIAL ENERGY (PE) – The energy a system possesses if it is capable of doing work, but is not doing work now.

Quick summary of different forms of potential energy:

Gravitational - Energy associated with the position of a mass in a gravitational field; *energy stored by virtue of its position.*

Elastic - Energy stored in a flexed muscle, a coiled spring, a stretched rubber band, etc.

Chemical - Energy stored in the electrical bonds that bind together the molecules or atoms of a substance.
In any process in which atoms rearrange to form different molecules, a chemical reaction occurs, during which energy is absorbed or released by matter.

Electrical - Energy associated with the position of a charge in an electric field; an electric charge is an excess or deficit of electrons on an object. .

Magnetic - Energy stored in a magnetic field. Magnetic fields can be created by the motion of electrical charges.

Demo of different forms of **POTENTIAL ENERGY** at your TABLES!

*Review these
definitions
on your own . . .*

**HERE ARE SOME
EXAMPLES →**

KEY CONCEPT GC #1:

The Law of Conservation of Energy:

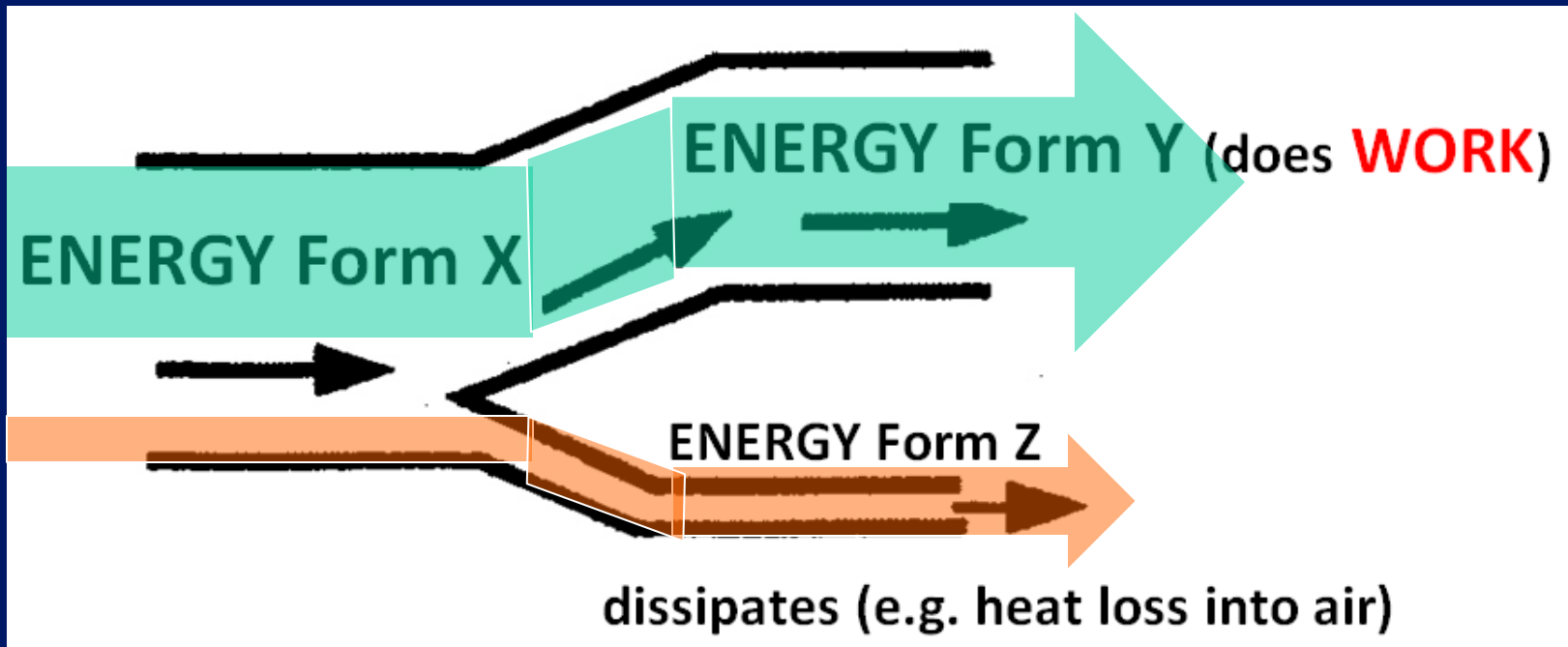
Energy cannot be created or destroyed.

*It can be transformed (converted)
from one form to another but*

**THE TOTAL AMOUNT OF ENERGY
NEVER CHANGES.**

IN EVERY ENERGY CONVERSION . . .

- Some of it goes where you want it:



- Some goes elsewhere

KEY CONCEPT #1 Global Change link . . .

Although energy may not be destroyed, it can become **INEFFICIENT**

Efficiency = work done / energy used



KEY CONCEPT #2:

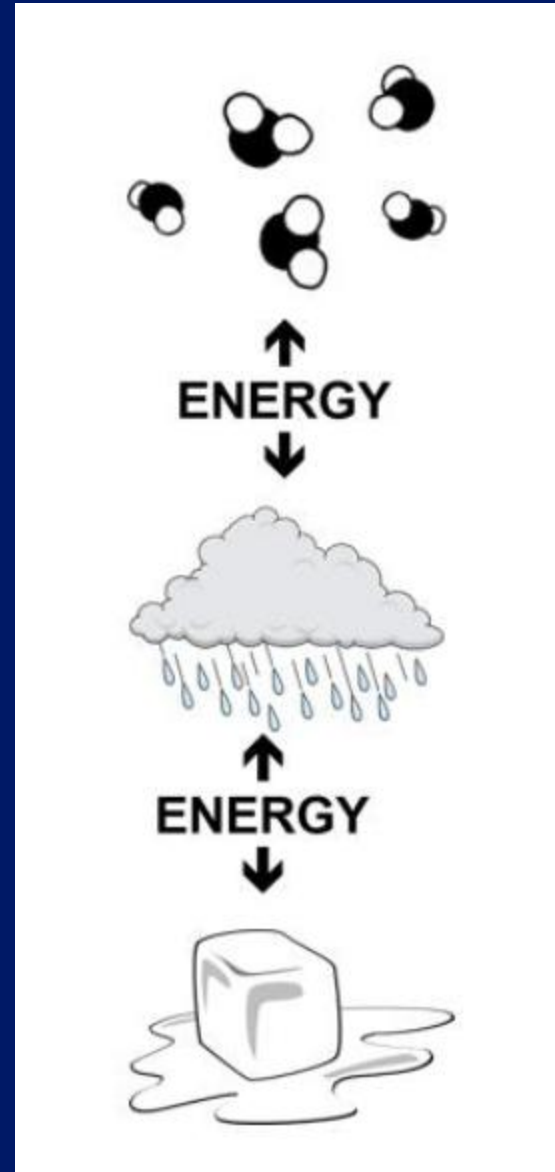
ENERGY & MATTER INTERACT IN PHASE CHANGES

Global Change link . . . ?

WATER VAPOR

LIQUID WATER

ICE



WATER VAPOR

LIQUID WATER

ICE





CHECKPOINT QUESTIONS

30 second TABLE CHAT

What's your most burning question?

TOPIC # 4 ELECTROMAGNETIC RADIATION & THE ELECTROMAGNETIC SPECTRUM

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

Class Notes: pp 19-22



Objectives

- 1) Understand the key aspects of **ELECTROMAGNETIC RADIATION** and the **ELECTROMAGNETIC SPECTRUM** that most directly relate to **GLOBAL CHANGE!**
- 2) Learn how principles of **MATTER & ENERGY** tie into this
- 3) . . . and how they relate to one important Global Climate Change solution:
SOLAR POWER

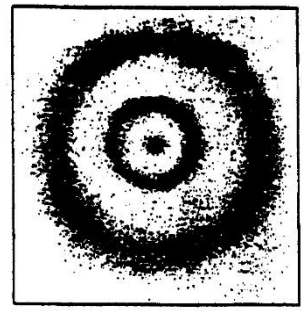
ELECTROMAGNETIC RADIATION

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

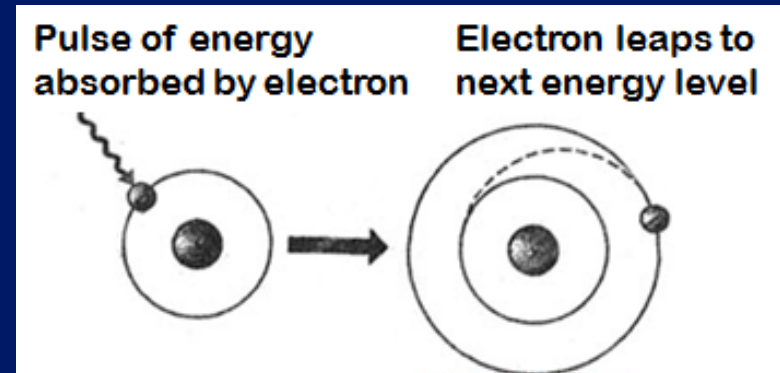
the Bohr
model of
an atom

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

electrons can exist only in discrete allowed energy levels and not in between.



Electrons move not by the “Laws of Motion” defined by Isaac Newton, but by “Quantum mechanics”

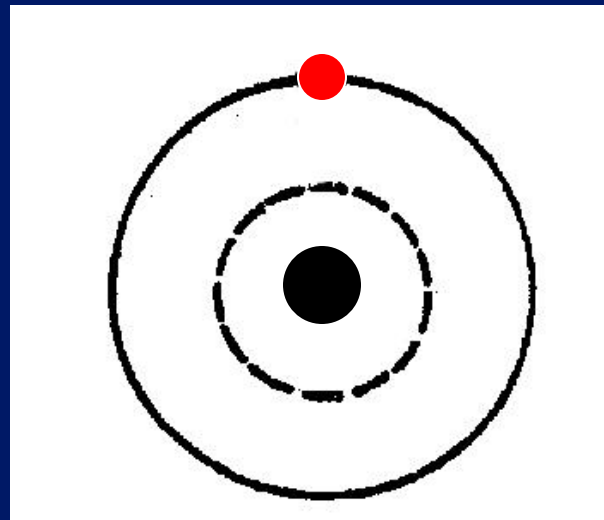


... When an electron **absorbs the exact (discrete) amount of energy** needed for the next energy level, it can make an instantaneous “**quantum leap**” from one energy level to the other

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

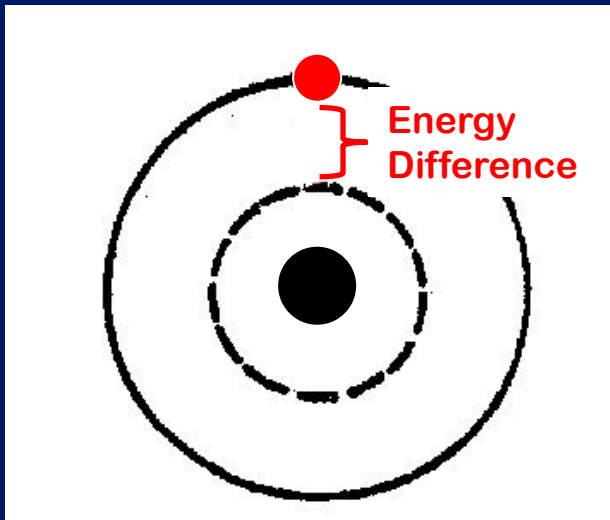
i.e., it disappears from one energy level and reappears in another without ever traversing any of the positions in between!

What causes the “leap” ?



Electrons make transitions (leaps) between the orbits (or energy levels) by:

absorbing or emitting energy



BUT: the energy absorbed or emitted has to be equivalent to exactly the energy difference

between the orbits for that atom!

The energy involved in the electron leaps
is called

ELECTROMAGNETIC ENERGY

It can be viewed either as:

pulses of energy traveling in **WAVES**
(of a specified wavelength and speed)

OR

as bundles of **particle-like energy**
called **PHOTONS**



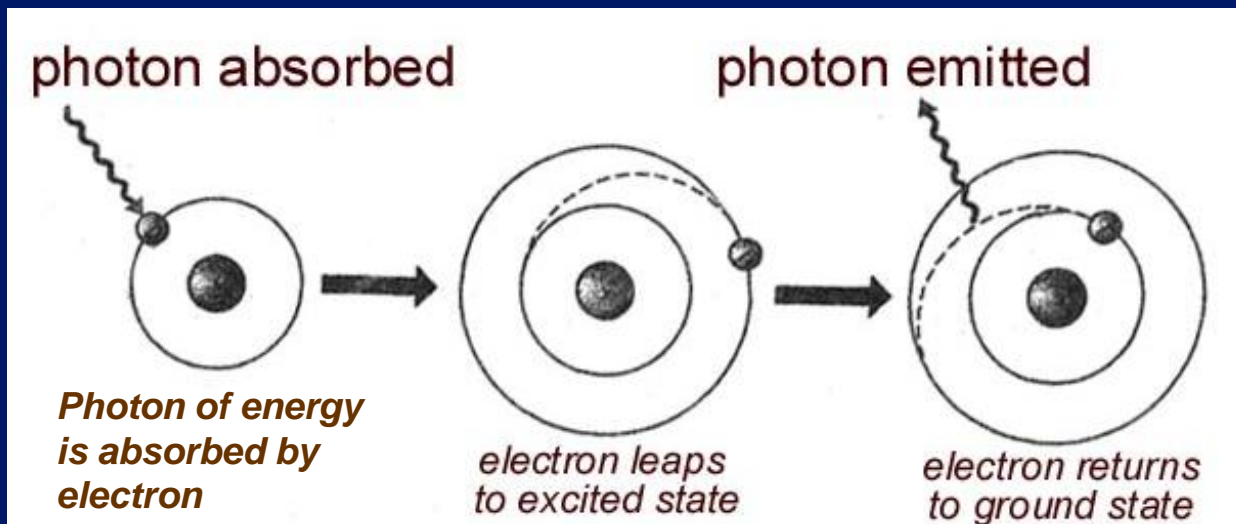
PHOTON =

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

[can also be described as the form in which a single packet of **ELECTROMAGNETIC ENERGY** travels]

Photons, NOT protons!

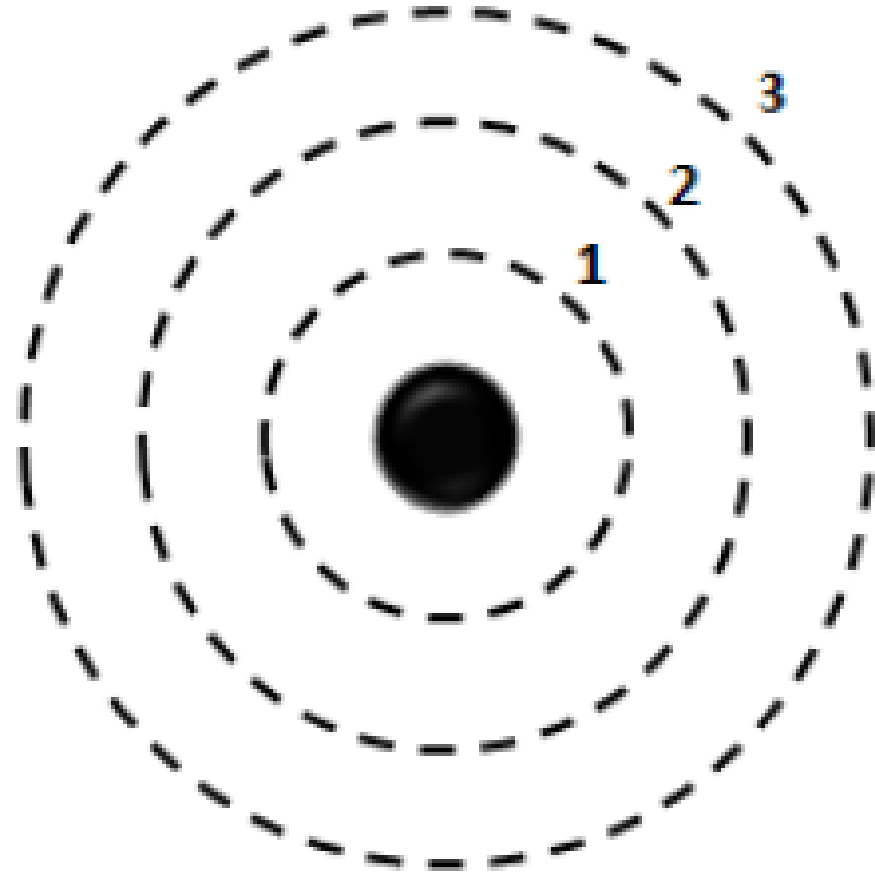
The Quantum Behavior of Electrons in Atoms produces Electromagnetic Energy



Illustrate the **photon behavior** and **electron behavior** that takes place when a photon is *emitted* (given off) by an electron:



**Try it yourself
on the
White Boards**



Label what you draw!!

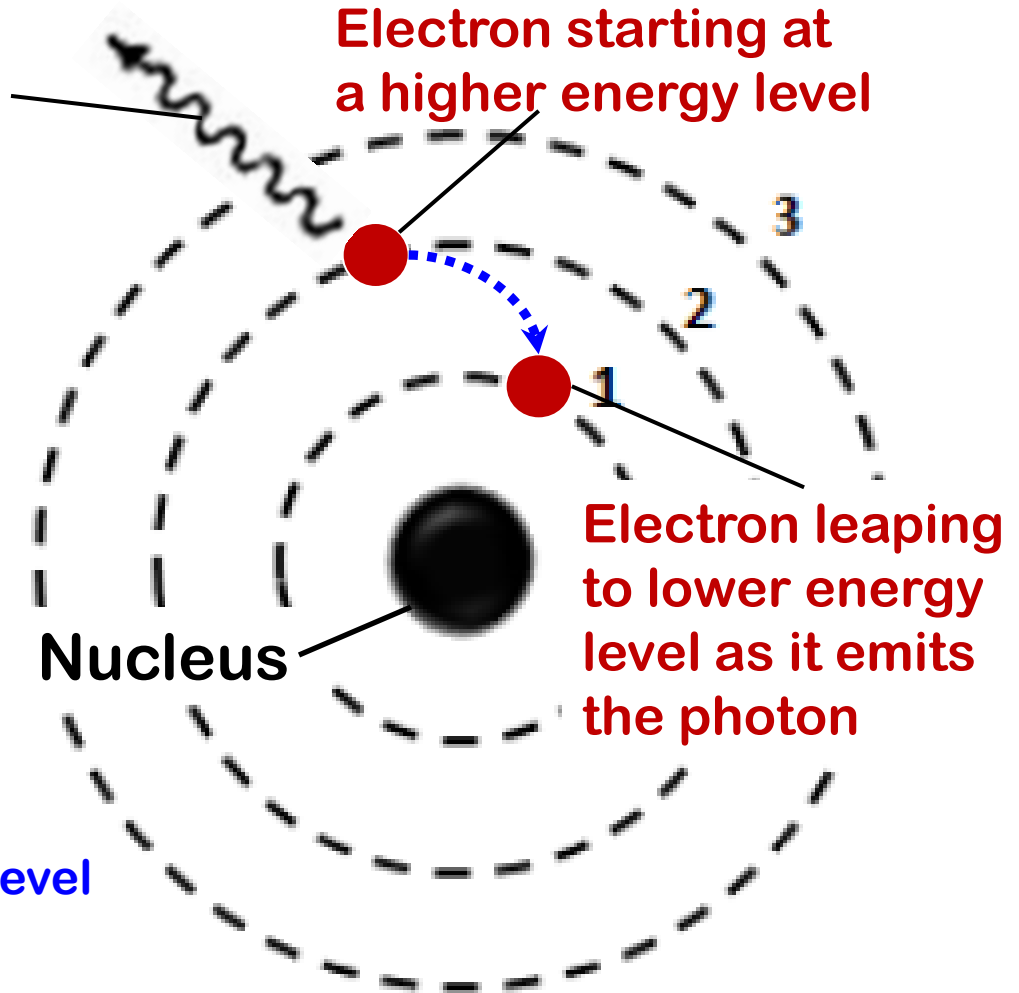
Illustrate the **photon behavior** and **electron behavior** that takes place when a photon is ***emitted*** (given off) by an electron:

Photon being emitted by electron

Electron starting at a higher energy level

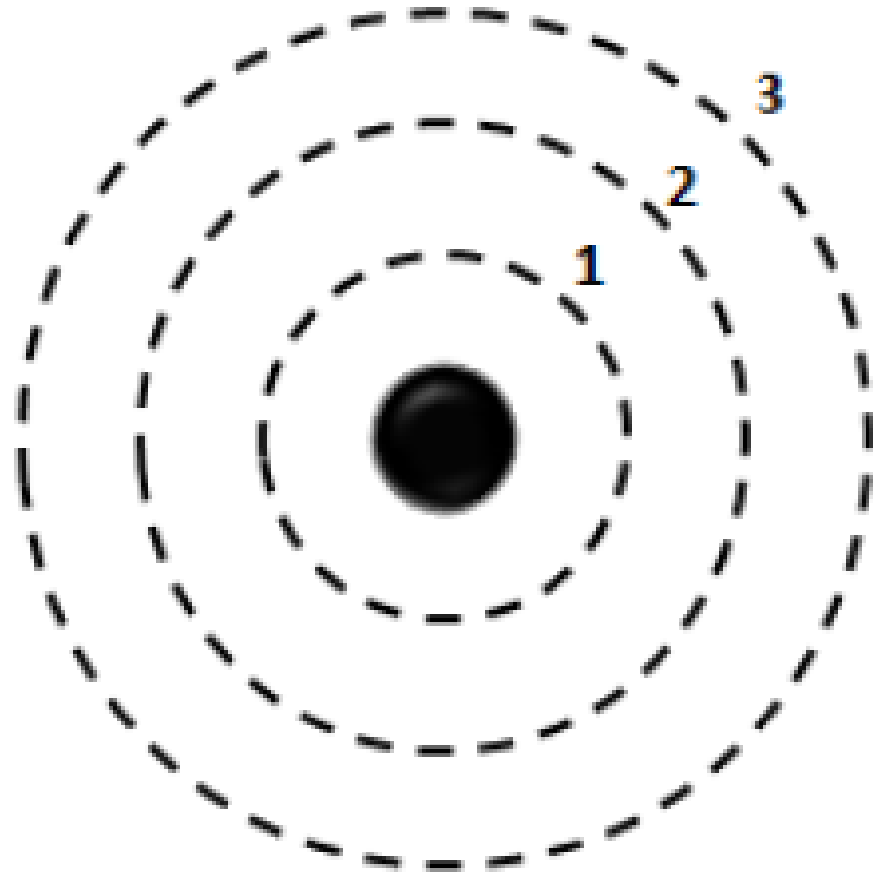
LABEL your sketch:

- Identify the names of the features in your diagram
- Explain what is happening to them:
 - being absorbed
 - being emitted
 - leaping to a lower/higher level



Electron leaping to lower energy level as it emits the photon

NOW do the sketch for a photon being absorbed by an electron:



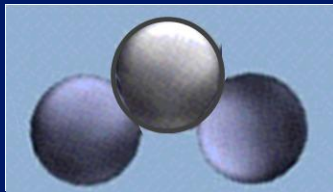


But what happens if **PHOTONS**
of electromagnetic energy
strike an entire MOLECULE ?
(not just a single atom)

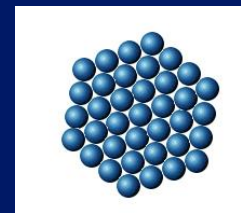


Quantum theory also involves the *behavior of molecules*:


as seen in their **molecular-scale
motions**:



rotation
bending
vibration



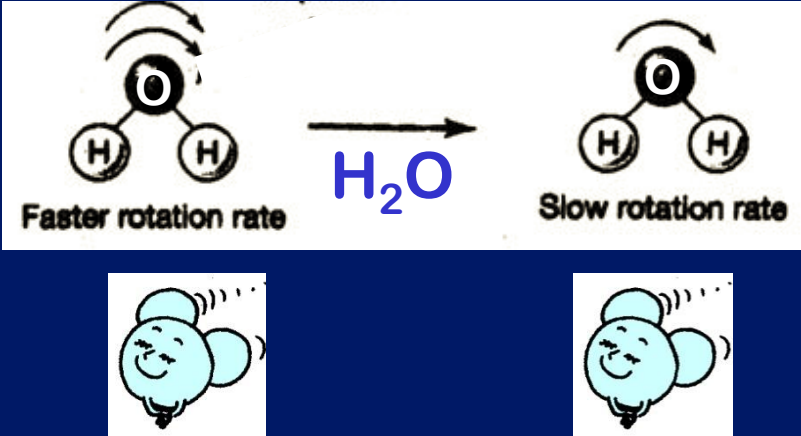
Infrared photons absorbed
by CO_2



Infrared photons emitted
by CO_2

The COMET Program

Infrared photon is emitted →

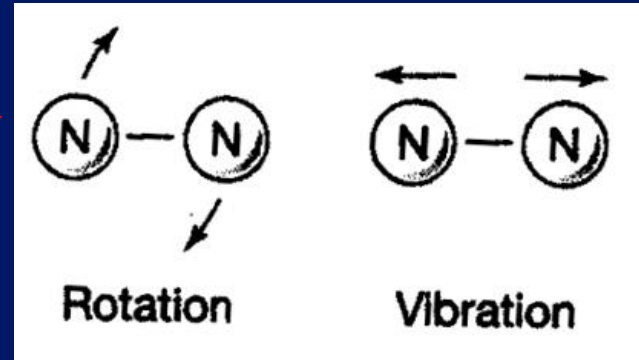


Faster rotation rate H_2O Slow rotation rate

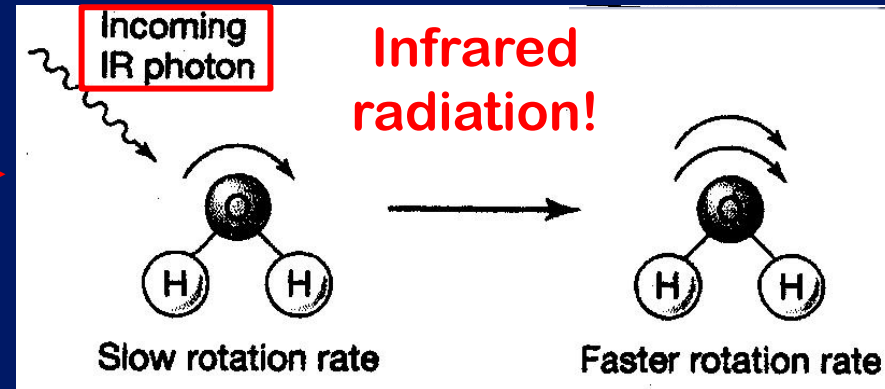
LINK TO GLOBAL CHANGE:

The type and frequency of molecular motions in gases like **CARBON DIOXIDE** and **WATER VAPOR** explain why THEY contribute to **The Greenhouse Effect** while other gases (O_2 , N_2 ...) do not!!

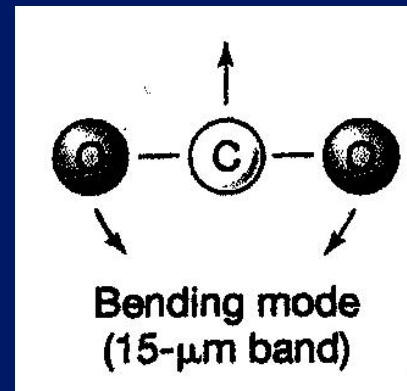
**NITROGEN GAS
MOLECULE**
 N_2



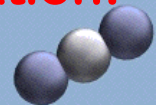
**WATER VAPOR
MOLECULE**
 H_2O



**CARBON
DIOXIDE GAS
MOLECULE**
 CO_2



**Infrared
radiation!**



The COMET Program

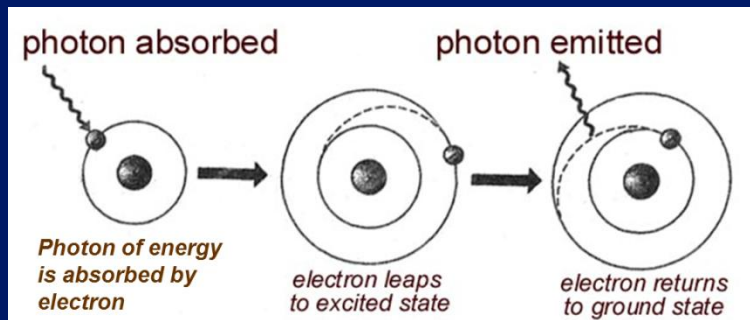
Greenhouse gases!

Figures on p 20

Recap of Key Concept:

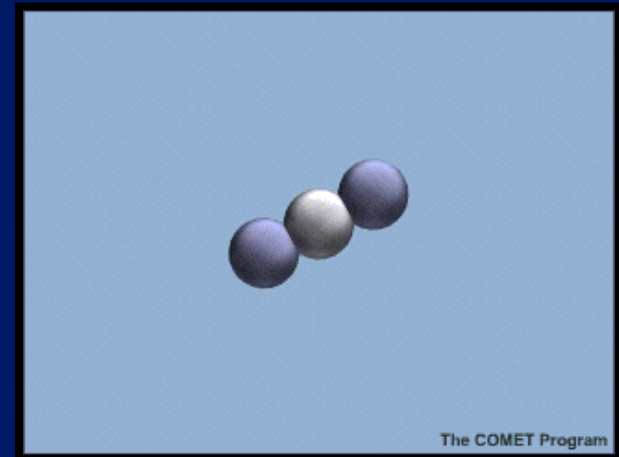
ENERGY & MATTER INTERACT !!!

within atoms



&

within molecules



So what is a Greenhouse Gas?

abbreviation we'll use = GHG

Think & write . . .

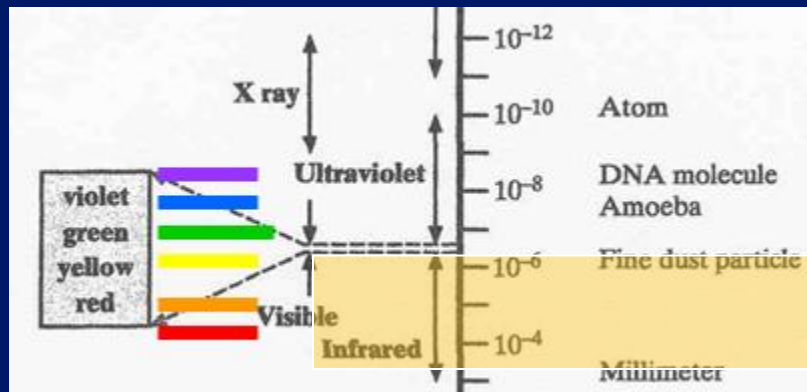




So what is a **Greenhouse Gas**?

abbreviation we'll use = GHG

GHG = a gas than can absorb and emit (re-radiate) **INFRARED** wavelengths of Electromagnetic Radiation



IR
radiation

> 0.7 - 1000 micrometers



KEY POINT:

The QUANTUM BEHAVIOR of
CERTAIN MOLECULES
with respect to
INFRARED RADIATION
is the
REASON THAT **GREENHOUSE**
GASES ARE GREENHOUSE GASES!!


OK, take a **MEDIA MINUTE** !



**Come forth into the
light of things.**

Let nature be your teacher.

~ William Wordsworth



whiteboard

**As a GROUPdraw
the ELECTROMAGNETIC
SPECTRUM in as much
detail as you can FROM
MEMORY!**

No peeking at:

- CLASS NOTES**
- phones or laptops**

**To be
continued . . .**

**No class next
Monday due to
the
LABOR DAY
HOLIDAY**

**See you next
Wednesday**