# Class slides for Wed Sep 5th

The first few slides go relate to the brief overview of the Linking-to-Life Part B Assignment

# LINKING-TO-LIFE TERM PROJECT PART B

## "Thinking More Deeply"

Part B is worth 10 points

**"I think science changes the way your mind works, to think a little more deeply about things."**

**~ PZ Meyes, biologist**

**OBJECTIVES**

**This next part of the Linking-To-Life Term Project asks you to "think a little more deeply" on two levels:**

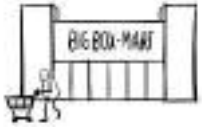
**(1) about science in general -- since you are about to embark on your global change science term project, and**

**(2) about the global change topics we're covering in this class and what question(s) you will pursue for your Linking-to-Life Term Project.**

# POSSIBLE QUESTIONS:

## PROJECT CATEGORIES

*See category choices below or devise your own.*

| PROJECT CATEGORY | Earth's Global Environment | Energy Conservation | Transportation Options | Water Sustainability | Food & the Environment | Artistic Expression / Advocacy | GC-Savvy Consumerism, Sustainability & Business |
|---|---|---|---|---|---|---|---|
| |  |  |  |  |  |  |  |
| **POSSIBLE QUESTIONS**<br><br>*You are encouraged to come up with your OWN question to investigate!*<br><br>*But if you like, you may use one of these suggestions.* | How do human's impact the environment in different parts of the world?<br><br>Are there global examples of sustainable practices?<br><br>What is my response to the "Home" film: "Listen . . .to this extraordinary story and decide what you want to do with it." | Where does my energy come from?<br><br>How can I lower my carbon footprint -- why should I?<br><br>Is solar energy viable for me?<br><br>Will energy policies work?<br><br>Does our local utility have a "green power" program? | Can I find a "dream car" that balances performance, fuel economy, cost, and "crashworthiness"?<br><br>What's the most sustainable form of transportation for my needs?<br><br>What's the most promising type of alternative fuel vehicle?<br><br>What are + and - of travel by plane vs., train, vs. auto? | Where does my water come from?<br><br>What are Tucson & Phoenix water managers doing to address sustainability?<br><br>How is climate change exacerbating the future of water in the arid West -- and the world?<br><br>What's the connection between energy & water supplies? | How does food production impact global change?<br><br>How far does my food travel to get to me?<br><br>Why does meat add so much CO2?<br><br>How are food production and deforestation linked?<br><br>Which Tucson supermarkets provide the most food choices? | Can science and art be linked?<br><br>How can my art, writing, or poetry express my views on the environment?<br><br>What does the SGC textbook cover "say" to me about Global Change?<br><br>Is there an advocacy group that resonates with me? | How can I make "global change savvy" consumer choices?<br><br>Can a business be run sustainably?<br><br>Can Energy Star labels help me find "green" electronics and appliances?<br><br>How can I detect and avoid "greenwashing"? |

# TOPIC # 5
# ELECTROMAGNETIC RADIATION
# &
# THE ELECTROMAGNETIC SPECTRUM

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

Class Notes: pp 25-28

# Objectives for next two classes:

1) Wrap up Topic #4 (Matter & Energy)
2) Start Topic #5 and understand the key aspects of ELECTROMAGNETIC RADIATION that most directly relate to GLOBAL CHANGE!
3) Learn how principles of MATTER & ENERGY tie into this . . . .
4) . . . and relate to one Global Climate Change solution: SOLAR POWER

Home / Business / Local / Local

# Salt River Project activates Arizona's largest solar array

Story (6) Comments Font Size:

Arizona Daily Star Arizona Daily Star | Posted: Wednesday, September 7, 2011 12:00 am | Comments

6 retweet Recommend 11 people recommend this.

The Salt River Project has switched on Arizona's largest solar-energy array, a 144-acre, 20-megawatt installation in Florence.

The Copper Crossing Solar Ranch, on the west side

# Huge Davis Monthan solar project expected to begin soon

By Phil Riske / August 27, 2012 / No Comments

Like Send Sign Up to see what your friends like.

Currently the largest solar array at a military base in at Nellis AFB, Nevada. The Davis Monthan array will be even larger.

*Could provide third of Air Force base's power*

By David Wichner

*Arizona Daily Star*

The Air Force is moving ahead with plans to build a 14.5-megawatt photovoltaic solar array at Davis-Monthan Air Force Base.

## *WRAP UP OF TOPIC #4*

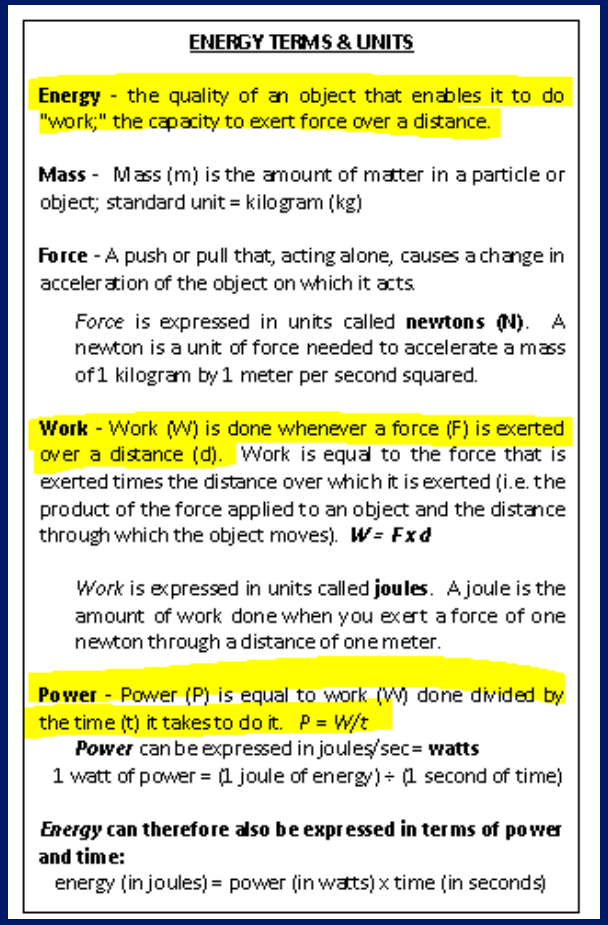
# ENERGY: QUICK REVIEW

***at the end of Friday's class!***

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

**(more will be covered in Topic #8)**

# Re-cap: Energy Terms & Units



**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 x 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)

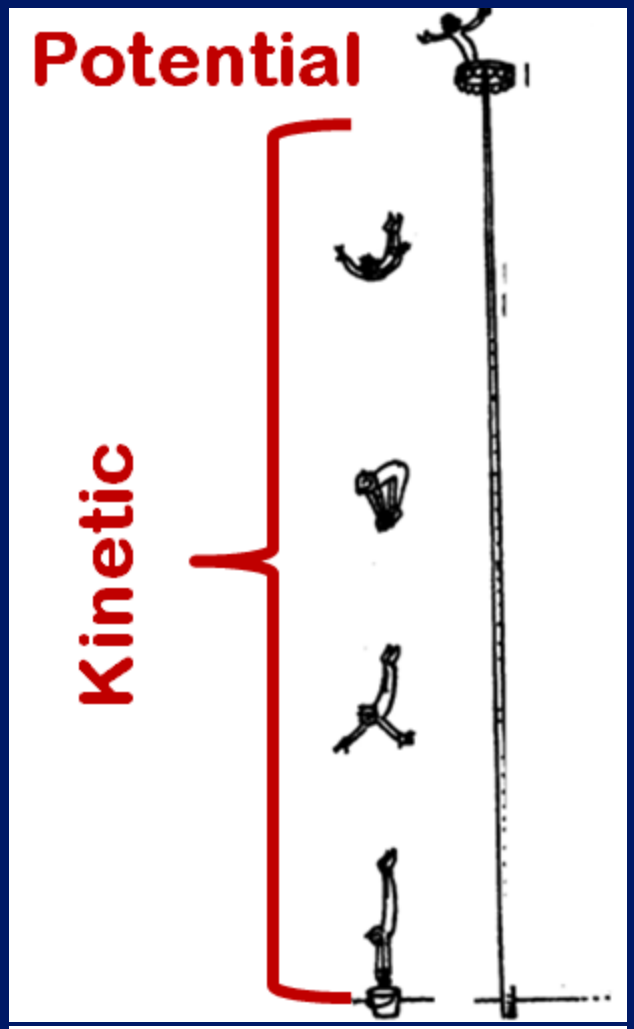
***Energy*** **can therefore also be expressed in terms of power and time:**

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

**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)**

# 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.

# Different forms of POTENTIAL ENERGY

***Review these definitions on your own . . .***

**HERE ARE SOME EXAMPLES →**

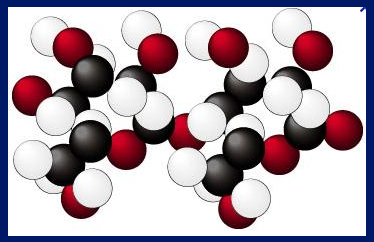
# ENERGY IN OUR EVERYDAY LIVES . . .

**ENERGY:** think of it as "stuff" that can't be created or destroyed, but **can be converted** in form. The form might be:

- **A MOVING MASS** (KE)
  (a large truck going 80 mph)

- **AN ELEVATED MASS** (PE)
  (a boulder poised on a hill)

- **A PARTICULAR CHEMICAL COMBINATION** (PE)

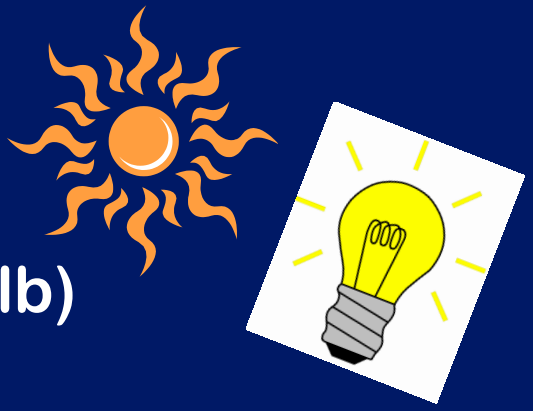


a Glucose molecule

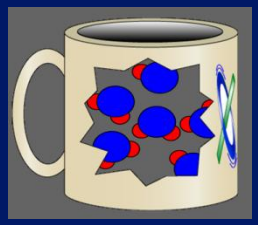
# ENERGY IN OUR EVERYDAY LIVES . . .

- **ELECTRICITY** (PE)
(electrons flowing though a wire)

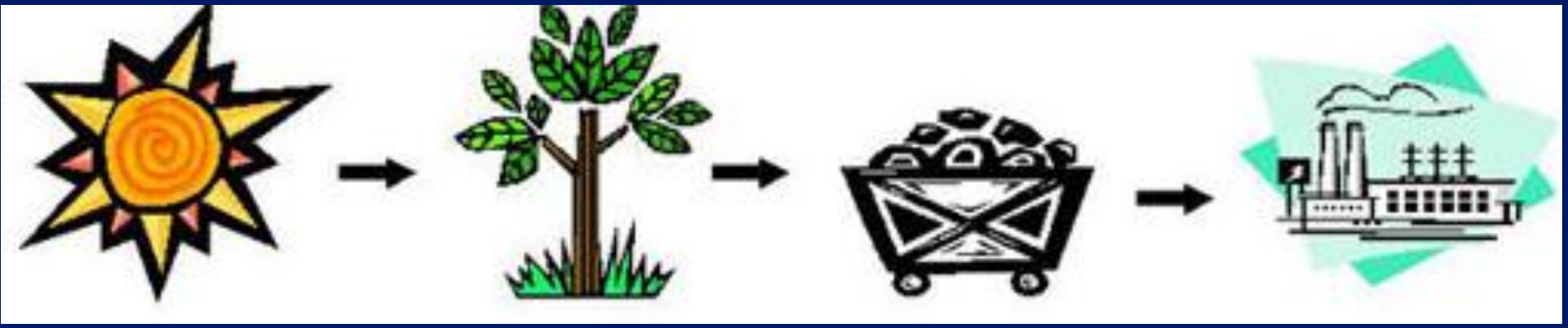
- **LIGHT / ELECTROMAGNETIC ENERGY** (PE)
(solar radiation or light from a bulb)



- **HEAT / THERMAL ENERGY** (PE)
(energetic jiggling molecules in a hot substance)



# KEY POINT:
# ENERGY IS CONVERTED FROM ONE FORM TO ANOTHER



The Sun produces Electro-magnetic Energy

Plants turn the solar energy into Chemical Energy through photosynthesis

Plants are fossilized & compressed (over millions of years) and become Fossil Fuels such as coal and oil

Fossil fuels are burned in power plants to produce Electricity for our homes, businesses & industry

Two of the forms of **POTENTIAL ENERGY** that are central to Global Change issues:

**"LIGHT"**
**Electromagnetic Energy**
(Topic #5)
**&**
**"HEAT"**
**Thermal energy**
(Topic #8)

# LIGHT & HEAT:

## UNITS of Energy & Power in our everyday lives:

CARS & MOTORS: horsepower

LIGHT BULBS: watts

ELECTRICITY: Kwh = kilowatt-hours

NATURAL GAS: therms

AIR CONDITIONERS: tons or BTUs per hour

- Is ENERGY the same as POWER?
- If not, what's the difference?
- How do all of these units relate to each other?

*Remember . . .*

**ENERGY** = the quality of an object that enables it to do **"WORK"**

**POWER** = work done divided by the **TIME** it takes to do it:

**Power = Work / time**

(POWER UNIT = **watts**)

Def on p 22

# A very useful website for sorting out ENERGY & POWER in our everyday lives :

http://www.infinitepower.org/calc_watts.htm

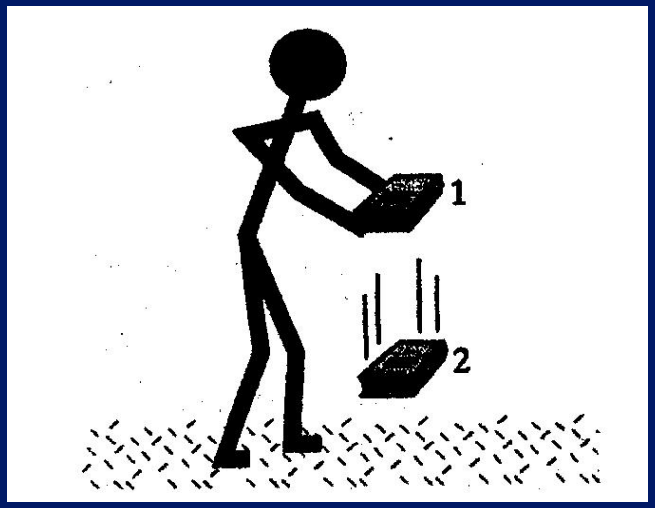
**Power is simply the amount of energy that is "converted" in a unit of time.**

| EnergyTime | | Power | | |
|---|---|---|---|---|
| 13940 | Joules | Energy per Time period | 3.871 Watts | |
| 3.871 | Watt Hours | 1 Hours | 0.003871 Kilowatts | This is the average power in full sunlight falling on a 1 square foot surface, directed toward the sun, and collecting 1 hours each day. |
| 0.003871 | Kilowatt Hours | | 0.005191 Horsepower | |
| 13.22 | BTU | | 13.22 BTU/hr | |
| 0.0001322 | Therms | | 0.001101 tons | |

*Related to upcoming Topic #8:*

# Energy Transformations & Conservation of Energy

*"Everything that happens can be described as energy transformation."*




Potential (PE)

↓

Kinetic (KE)

**ENERGY IS CONSERVED!**

# The Law of Conservation of Energy:

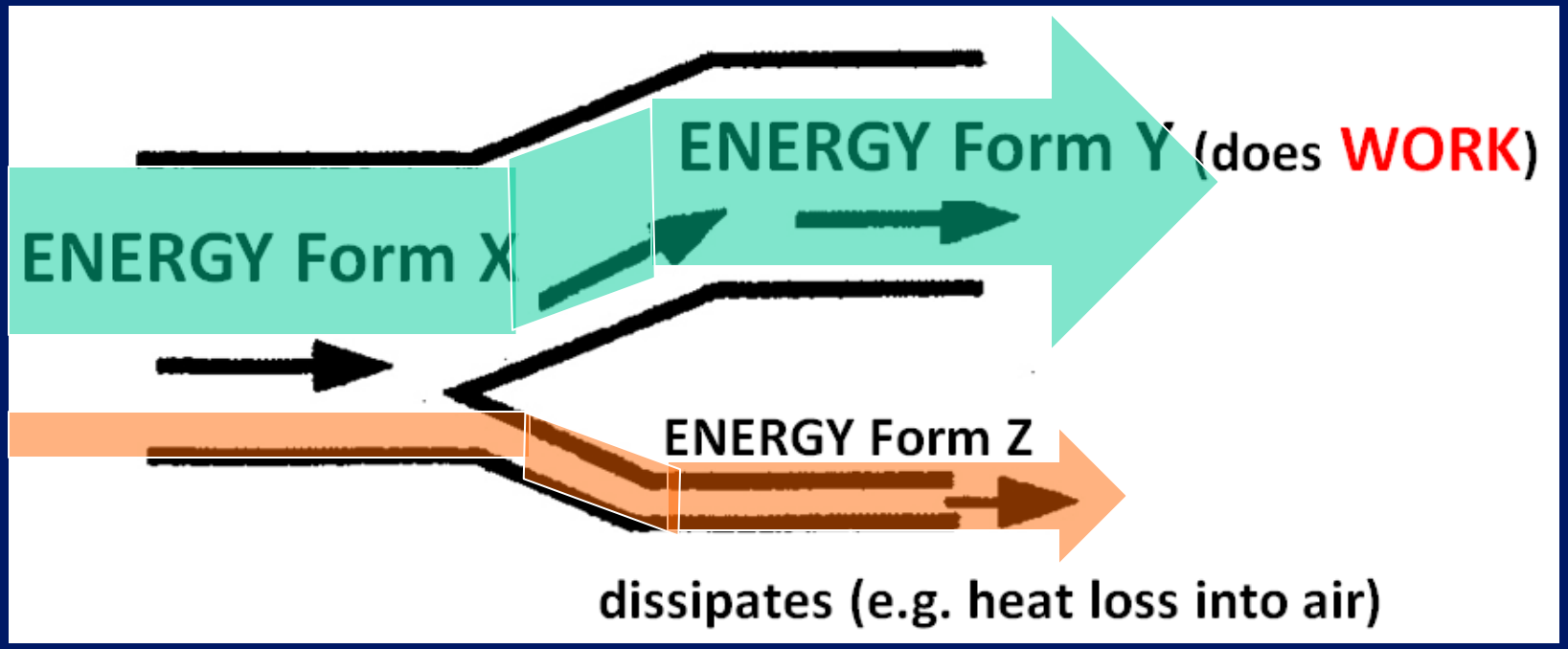
***Energy cannot be created or destroyed.***

*It <u>can</u> be transformed (converted) from one form to another . . . . but*

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

# A KEY POINT:
# IN EVERY ENERGY CONVERSION . . .

- Some of it goes where you want it:




- Some goes elsewhere:
(usually as heat loss or “exhaust”)

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

**i.e., is not easily used or available to do work!**

**Efficiency = work done / energy used**


*This concept is critically important for designing successful **GREEN TECHNOLOGIES** & for mapping out **SOLUTIONS** for addressing climate change*

# LINKING TO LIFE: Typical efficiencies encountered in everyday processes:

- burning fossil fuel for useable heat ~ 40-85%

*Steam turbine plant*

*Gas-fired water heater*

- burning fossil fuel (coal) for electricity ~ 33%

*Coal-fired electric power plant*

- sunlight to electricity in a solar panel ~15-20%

*Photovoltaic (PV) panel*

- hydro power turbines ~85-90%

*Hydroelectric plant*

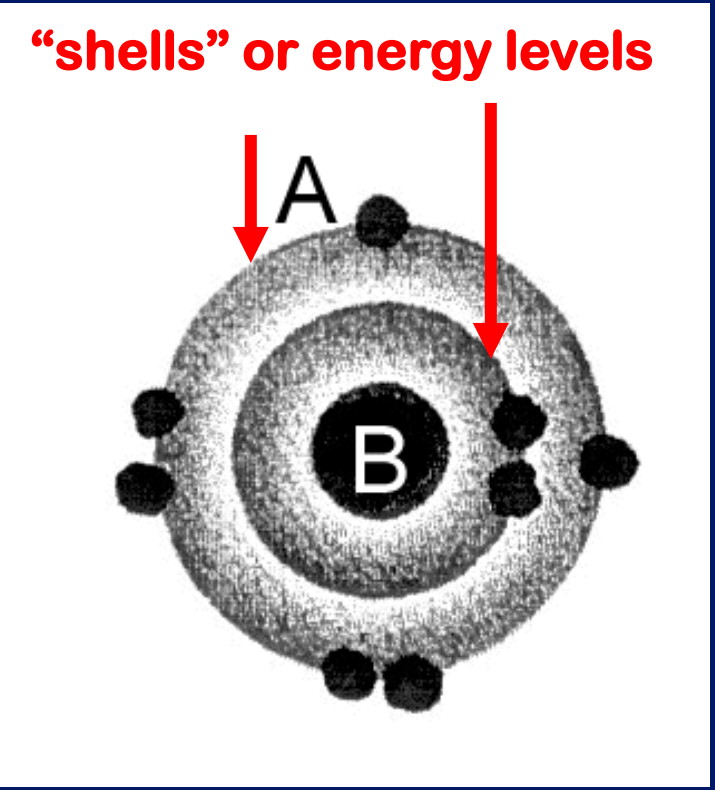
- wind turbines ~30-45%

*Wind farm*

# To wrap up the matter & energy section . . . .


## CLICKER Q's on
## THE PERIODIC TABLE ACTIVITY

# Review: Dot diagram of an OXYGEN ATOM:

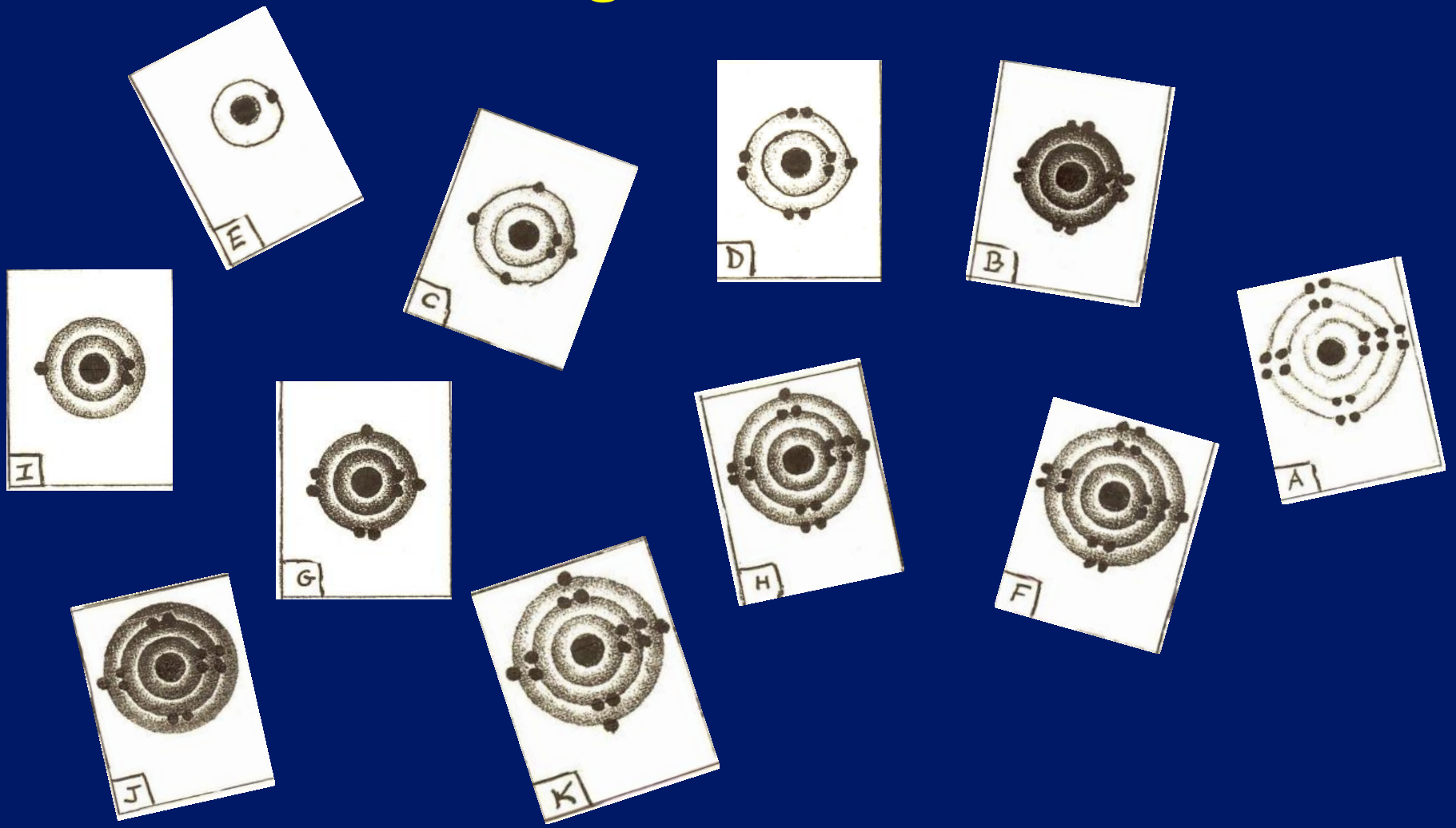



**A = an ELECTRON in outermost shell**

**B = NUCLEUS**

Review p 19

# REVIEW: How is the PERIODIC TABLE OF THE ELEMENTS organized?



# THE PERIODIC TABLE is organized by:

1 electron in outer shell in this column

**Increasing #'s of electrons**
**ROWS = same # of shells / energy levels**
**COLUMNS = same# of electrons in the outer shell**

2 electrons

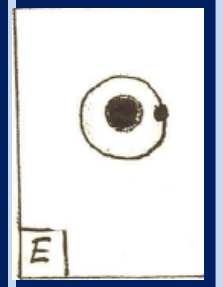
Row 1: 1 shell

4 electrons in outer shell

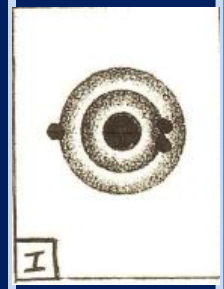
6 electrons in outer shell

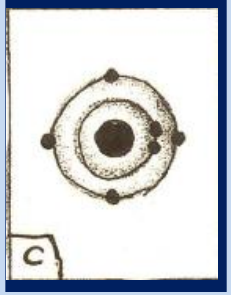
7 electrons

8 ** electrons

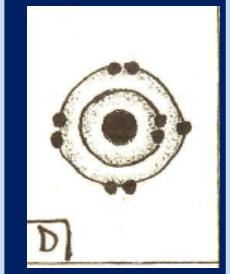


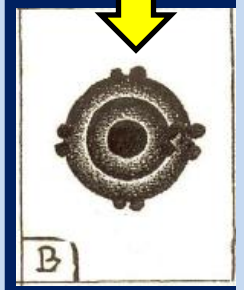

Row 2: 2 shells



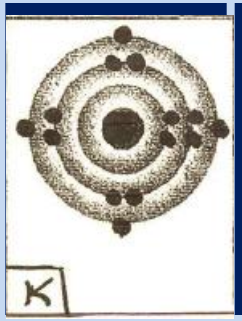





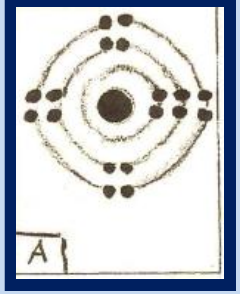



Row 3: 3 shells

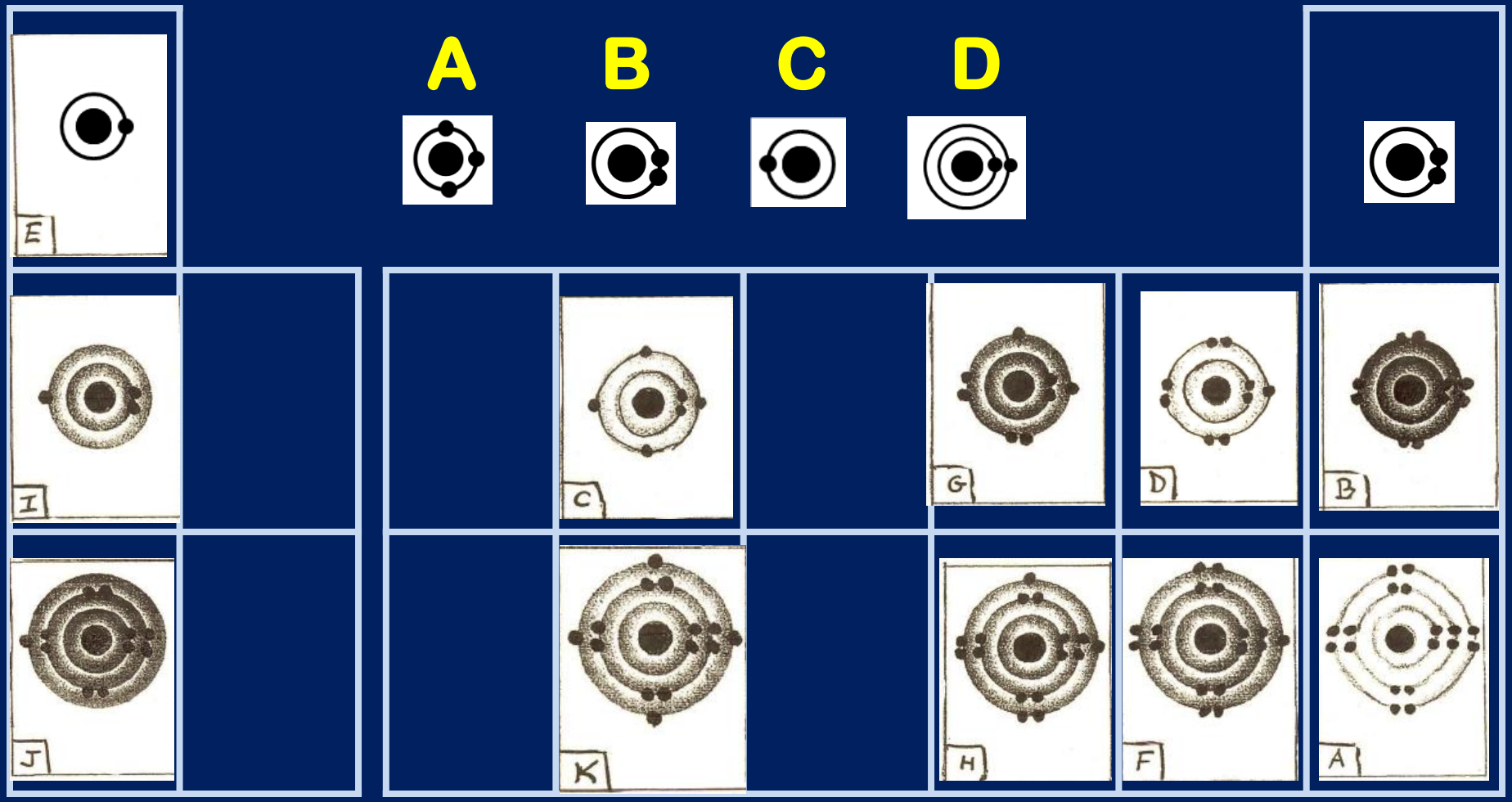






In Row 1 the outer shell is "full" with only 2 electrons in last column **
In Row 2 the outer shell is "full" with 8 electrons in last column
In Row 3 the outer shell is "full" with 8 electrons . . . and so forth

# REVIEW: Which of these is the proper dot diagram for the element in this position?




**B is correct!** The element is Helium (He)


# Q1. Where does Boron fit in the Table?

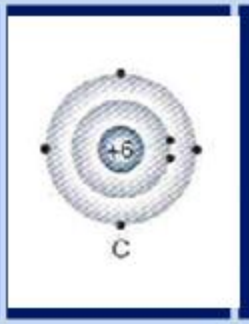
*(Answer with a number from 1 – 7)*

**Hint – see electron configuration table on p 20**


1


2

3

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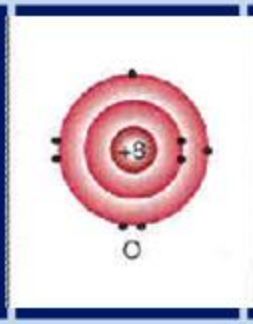
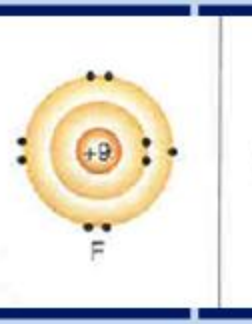
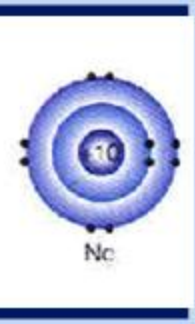
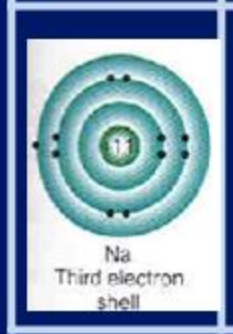


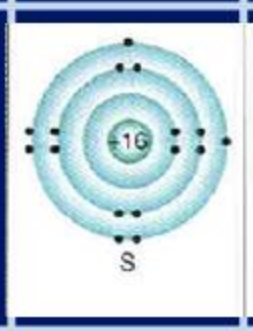



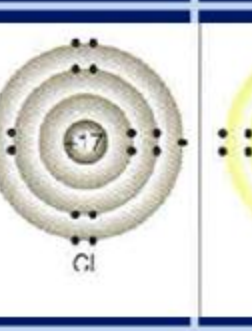




5

6


7



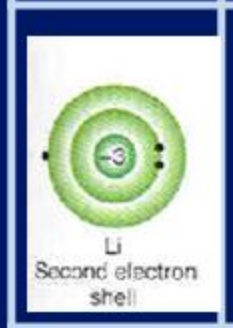


# Q1. Where does Boron fit in the Table?

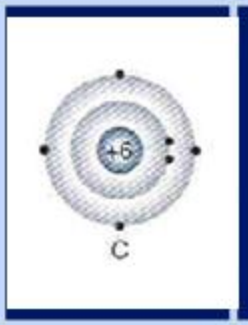
## # 3 is correct!

(2 shells & 3 electrons in the outer shell)


1

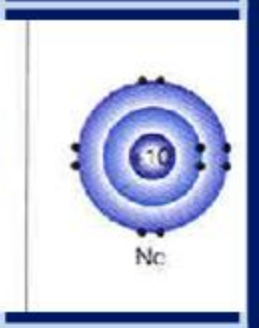


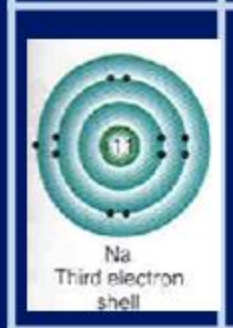

2


4



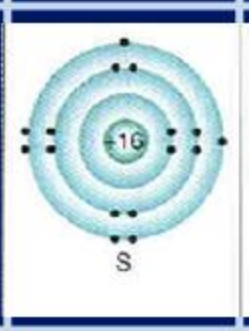


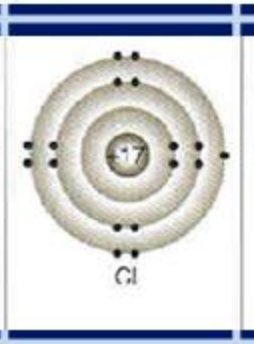



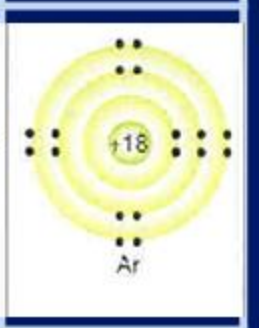

5

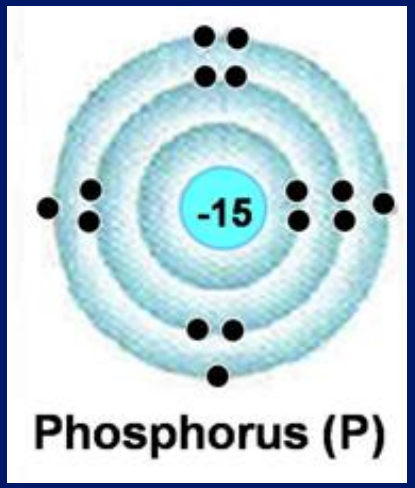
6


7

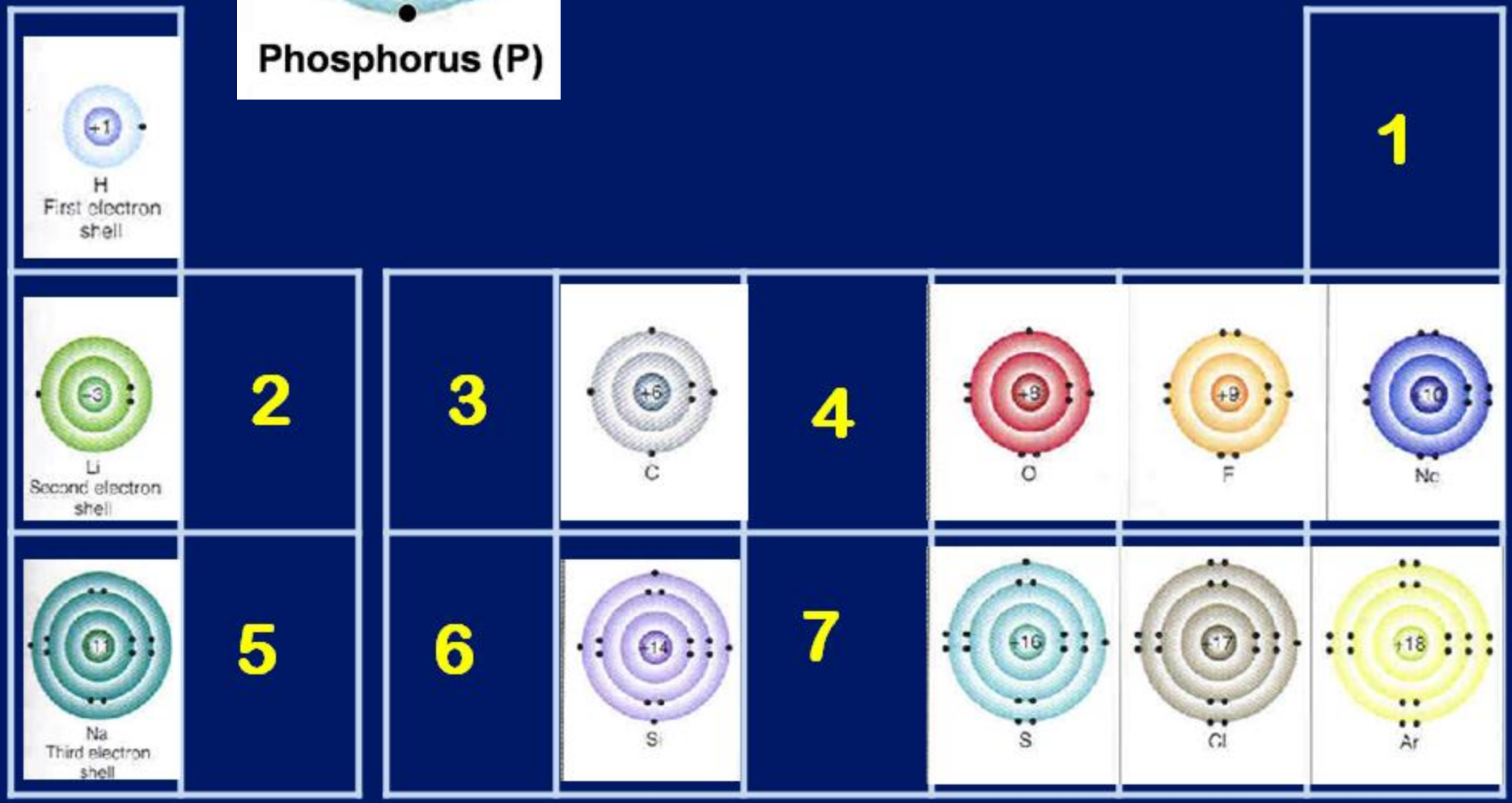


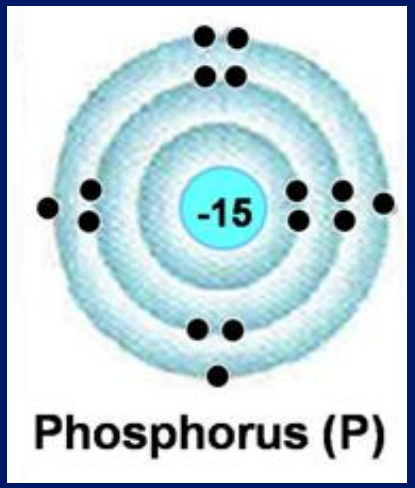






# Q2. Where does Phosphorus fit in the Table?

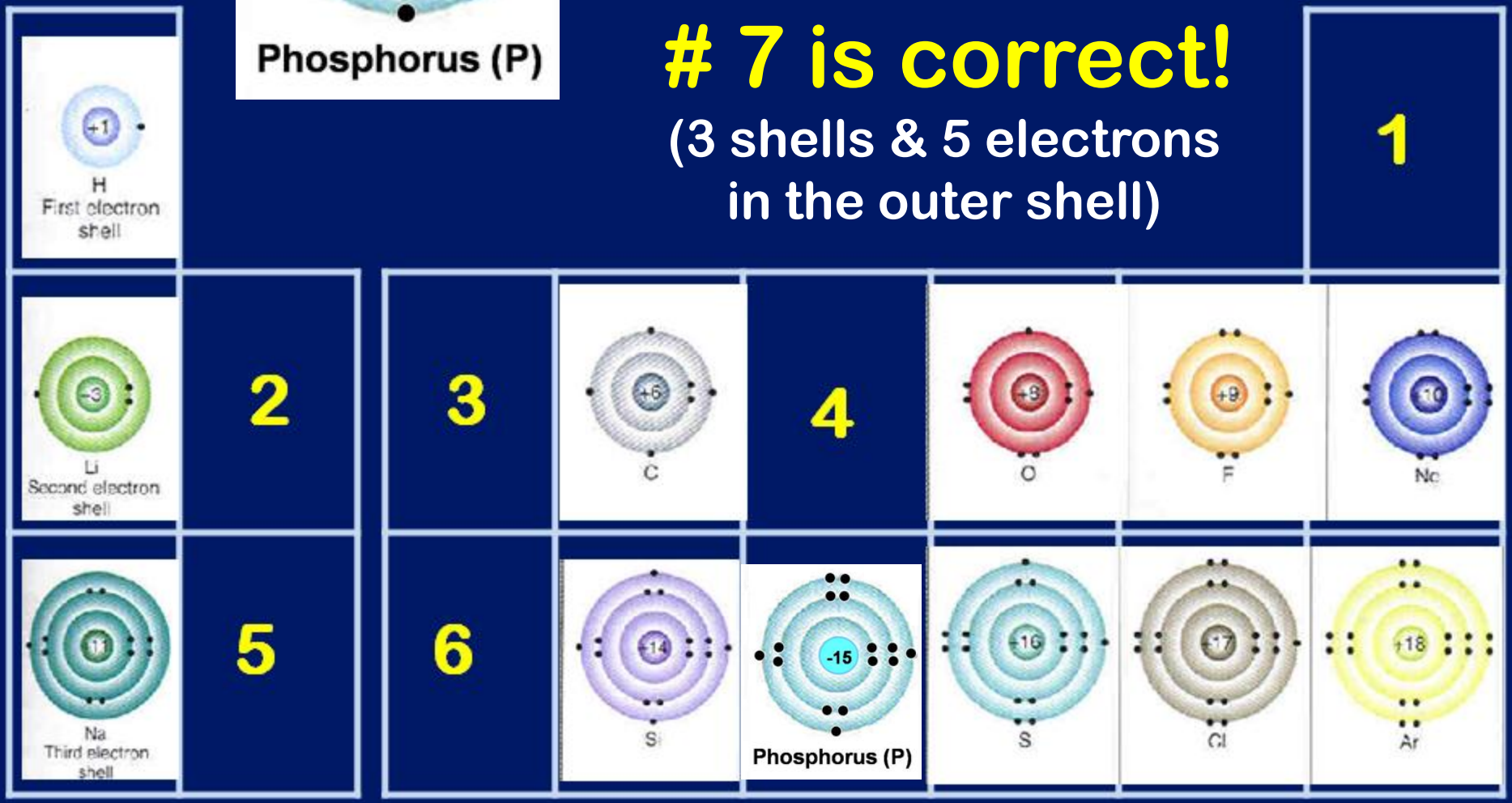





# Q2. Where does Phosphorus fit in the Table?

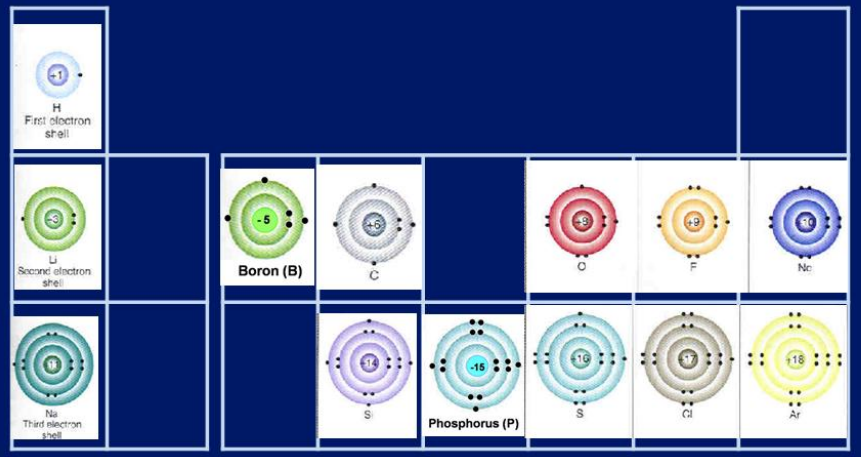
## # 7 is correct!

(3 shells & 5 electrons in the outer shell)



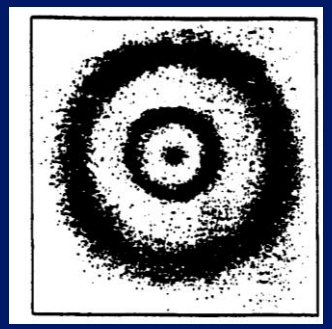
# HOW ARE MATTER & ENERGY RELATED?

Because each element of matter has a **unique set of electron arrangements** within its ENERGY LEVELS . . .




. . . each element is “attuned” to **a unique, discrete set of** ENERGY “PULSES” . . . .

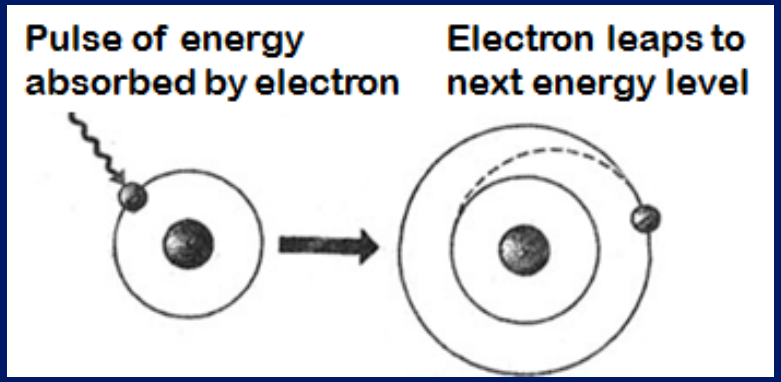
the Bohr model of an atom



# 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

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

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

*~ Niels Bohr*

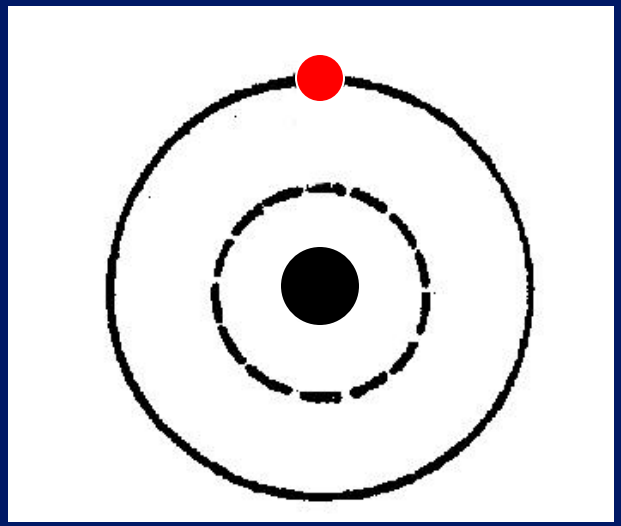
# TOPIC #5 – Part I
# ELECTROMAGNETIC RADIATION

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

# An electron moves between energy levels by "quantum leaps,"

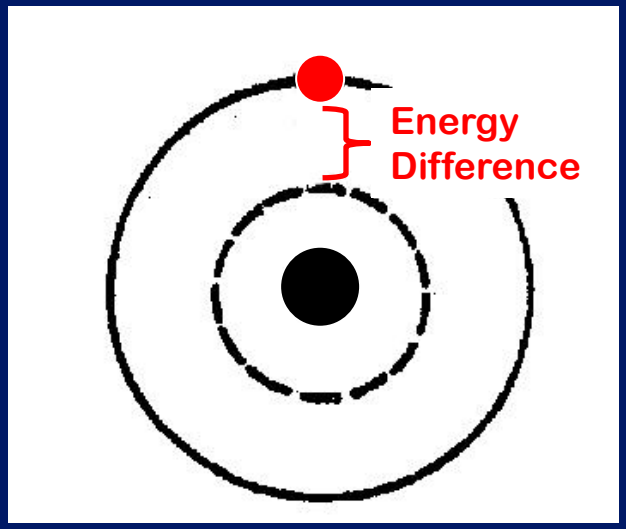
i.e., it disappears from one energy level and reappears in another without ever traversing any of the positions in between!

**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 <u>exactly the energy difference</u>** 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**

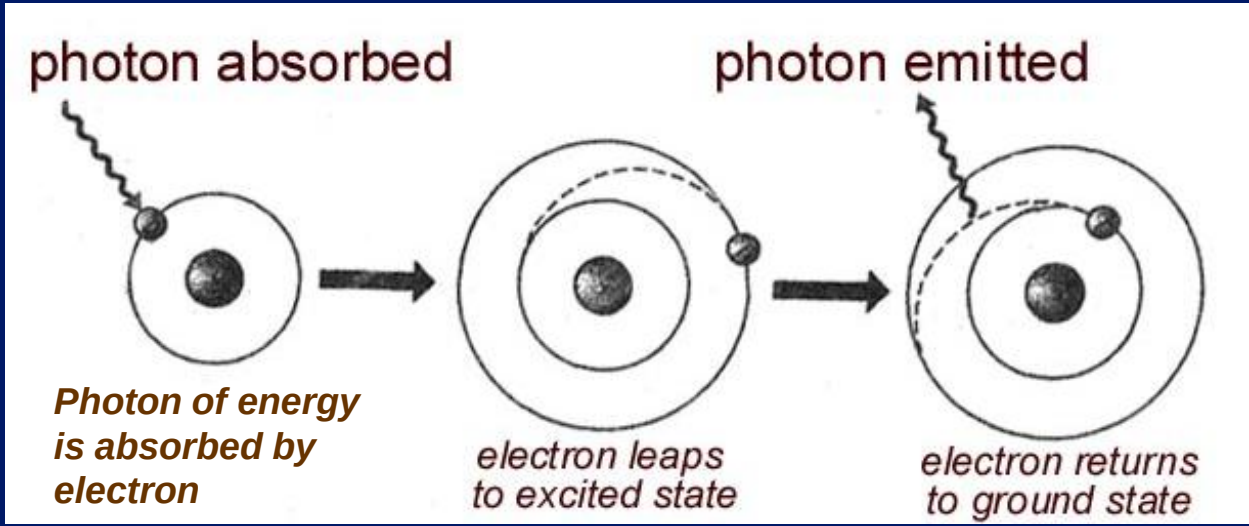
# PHOTON =

**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 ]

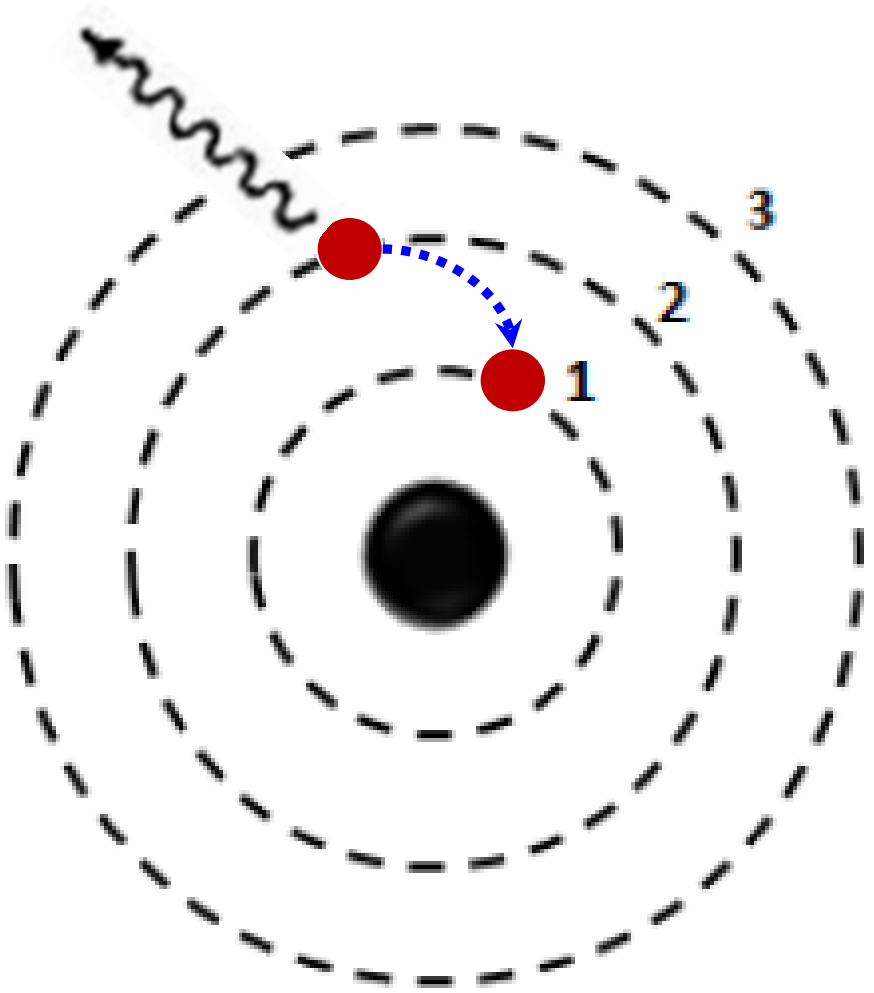
***Photons, NOT protons!***

# The Quantum Behavior of Electrons in Atoms produces Electromagnetic Energy

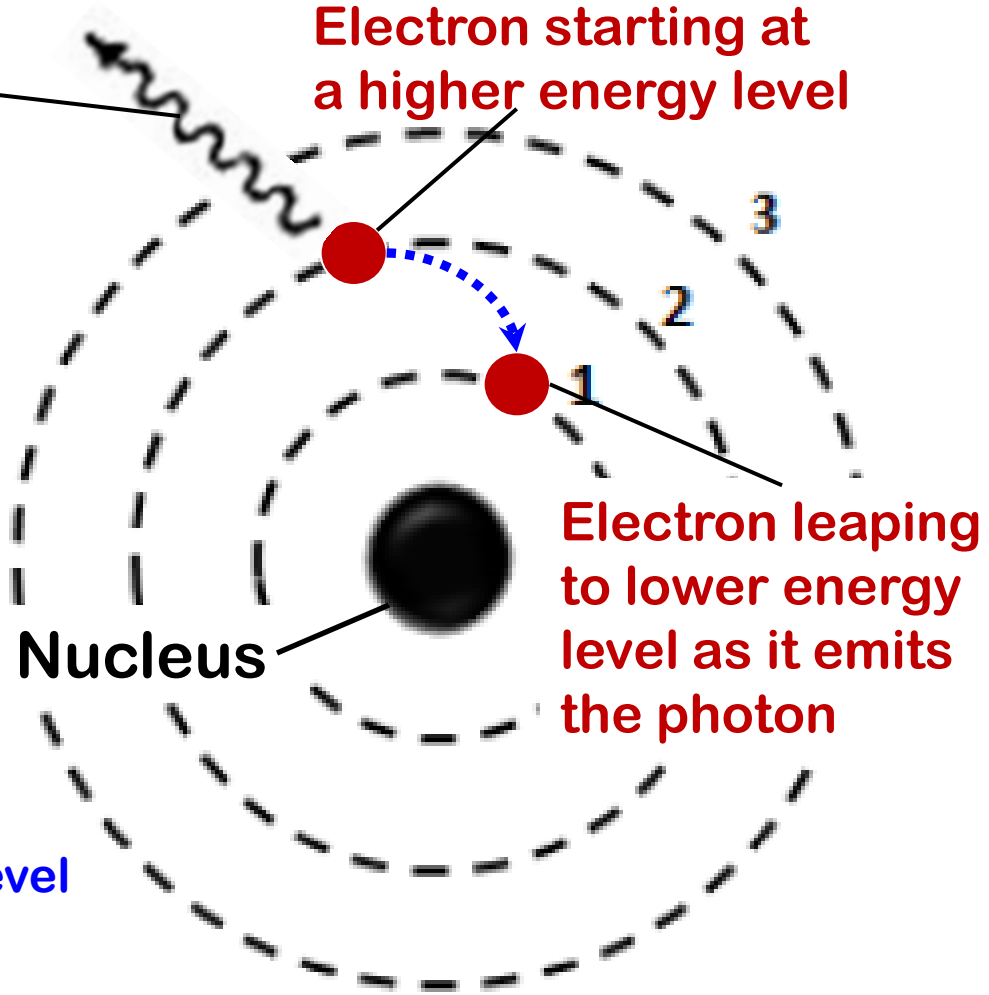


Illustrate the **photon behavior** and **electron behavior** that takes place **when a photon is *emitted* (given off) by an electron:**

**Try it yourself on page 26:**



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



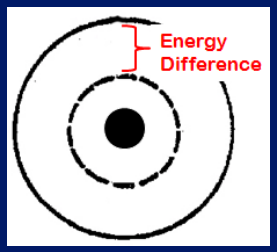

## LABEL your sketch:

- 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

***Could you do the sketch for a photon being absorbed by an electron?***

# RECAP: QUANTUM MECHANICS 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:

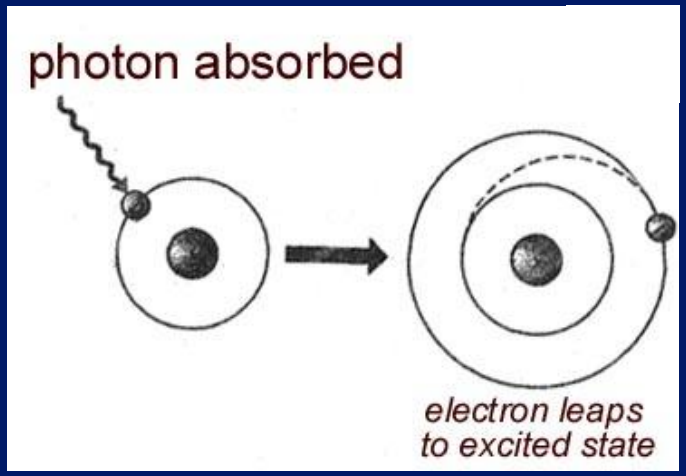



the *difference* in the energy of the ground level & the first excited level,

- the electron **ABSORBS** the photon energy and . . .
- the electron makes a "quantum leap" to Level 2

**Hydrogen atom:**

with electron in ground state (Level 1 shell)

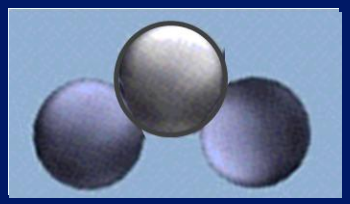


**But what happens if PHOTONS of electromagnetic energy strike an entire MOLECULE ?**

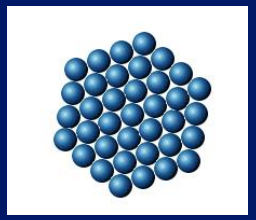
(not just a single atom)

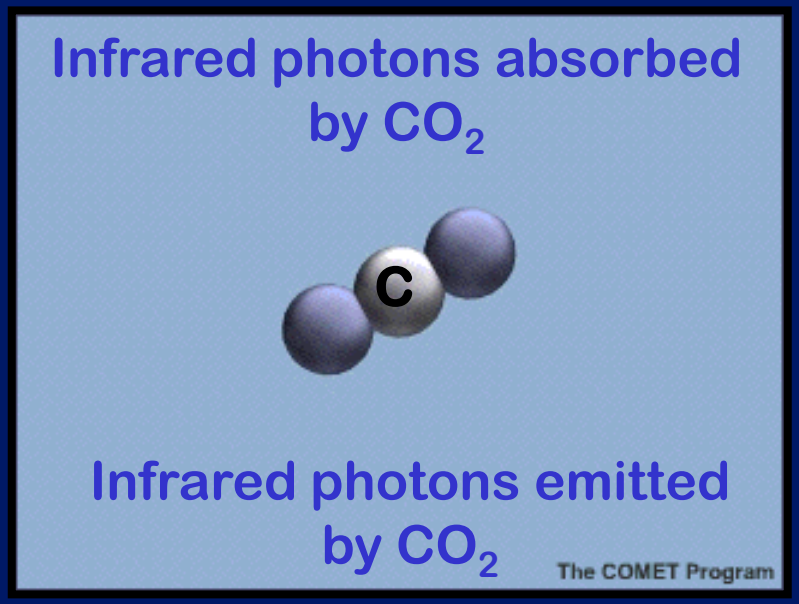
# Quantum theory <u>also</u> involves the ***behavior of molecules*:**

as seen in their molecular-scale motions:

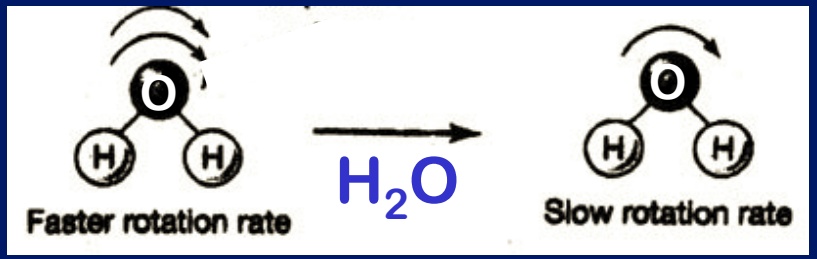


rotation
bending
vibration






Infrared photon is emitted ➔




# LINK TO GLOBAL CHANGE:

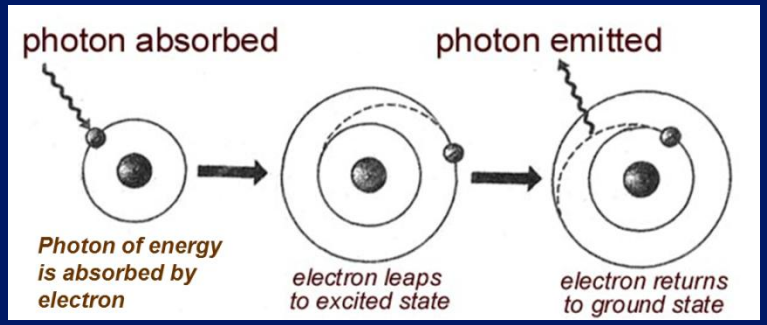
**The type and frequency of molecular motions in gases like CARBON DIOXIDE and WATER VAPOR explain why THEY contribute to The Greenhouse Effect while other gases ($O_2$, $N_2$ . . . ) do not!!**

***(more on this later . . . )***

# *Recap of Key Concept:*

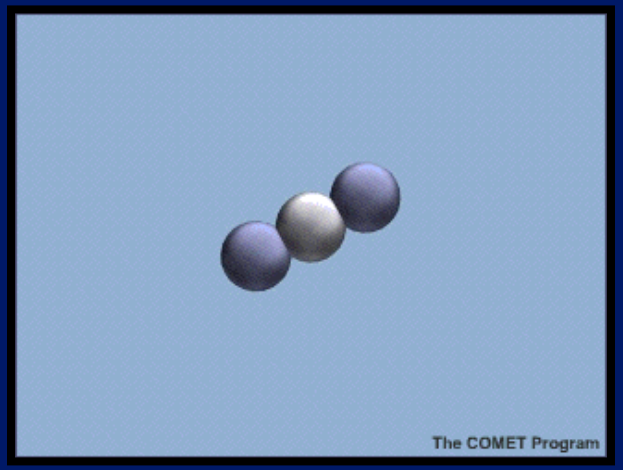
# ENERGY & MATTER INTERACT !!!

**within atoms**



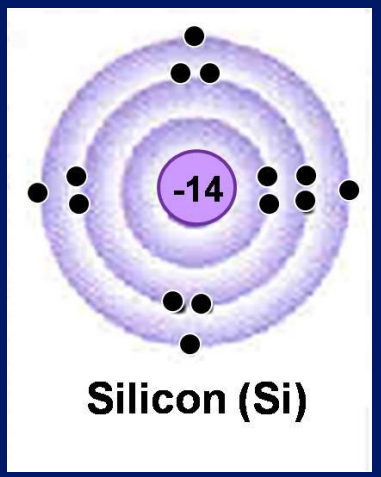

**&**

**within molecules**



# *PRESENTING . . .* A New Feature: The SUSTAINABILITY SEGMENT!!!


Staring:
The SUN
&




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