Topic #4
ENERGY & MATTER
OVERVIEW - Part II

OBJECTIVES:

To review basic physical concepts of energy and matter and some key ways in which they interact.

CLASS NOTES: pp 19- 24

OBJECTIVES FOR TODAY'S CLASS:

On COURSE TOPICS:

- **Continue our review of the basics of MATTER**
- **Review the basics of ENERGY**
- **Tie Matter & Energy to GLOBAL CHANGE**
- **Share footprint information!**

Isaac Weakens, Leaving Behind Flooding

http://www.nytimes.com/slideshow/2012/08/30/us/20120831-STORM-337.html?ref=us

National Hurricane Center http://www.nhc.noaa.gov/?atlc

CLICKER LOGISTICS!!!

CHANNEL 41

A TRIAL CLICKER QUESTION!

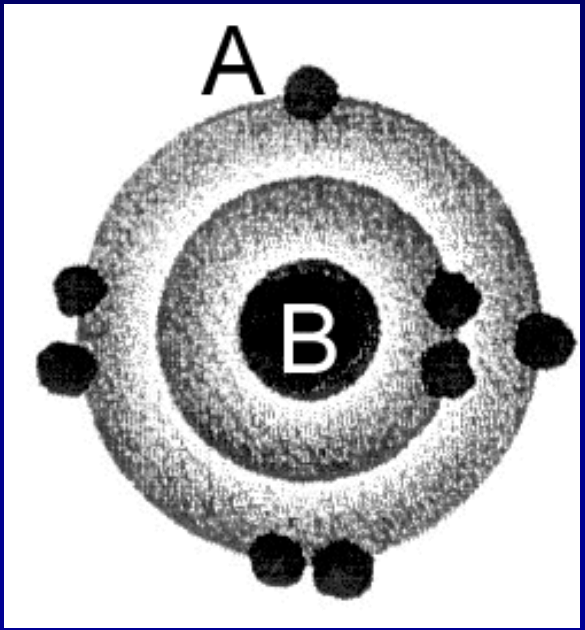
Q1. Will the Wildcats beat Toledo?

A) YES – Decidedly -- Go Cats!
B) YES – but it will be a nail-biter
C) Not sure, but I'm optimistic
D) Not a chance
E) Huh? I haven't a clue!

ATOMIC STRUCTURE:

Electron
Nucleus
Proton
Neutron

Schematic “dot” diagram of an oxygen atom



What is A? electron

What is B? nucleus

 # electrons = 8

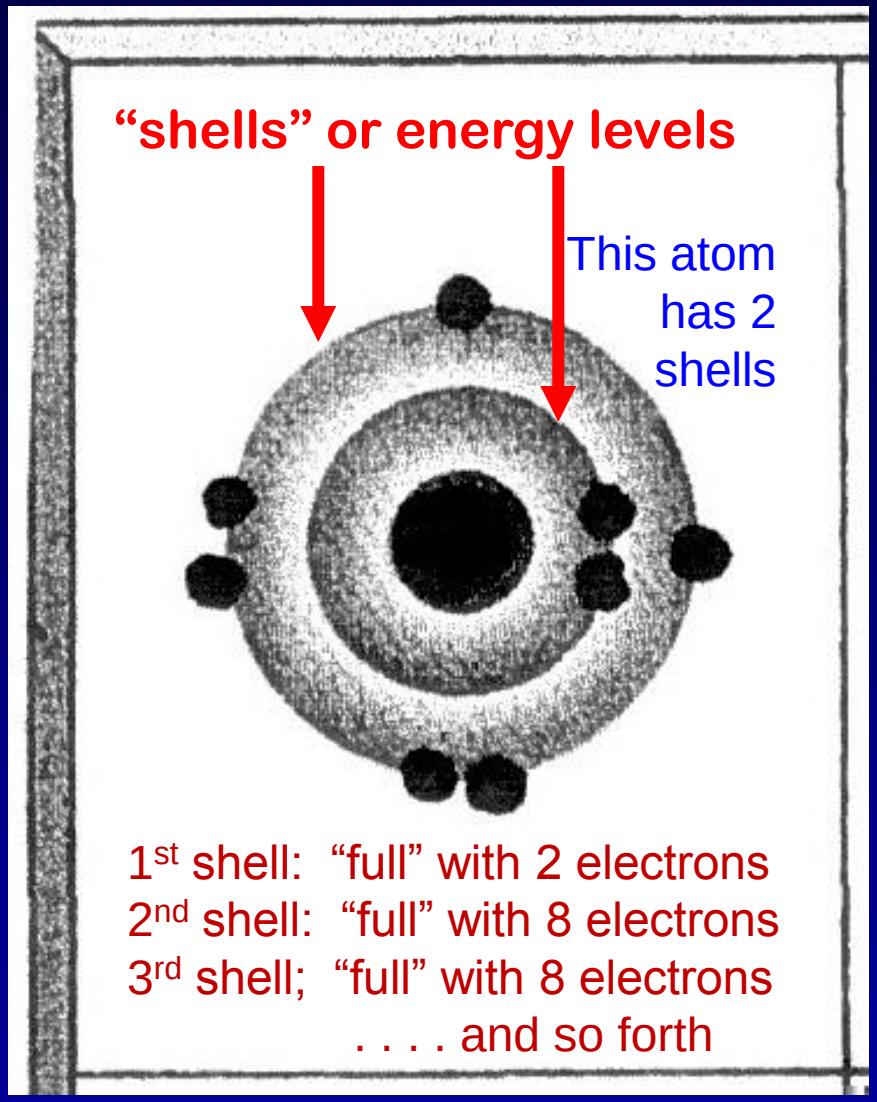
 # protons = 8

 # neutrons = 8

atomic # = 8

mass # = 16

Is ^{18}O [lighter / heavier] than ^{16}O?

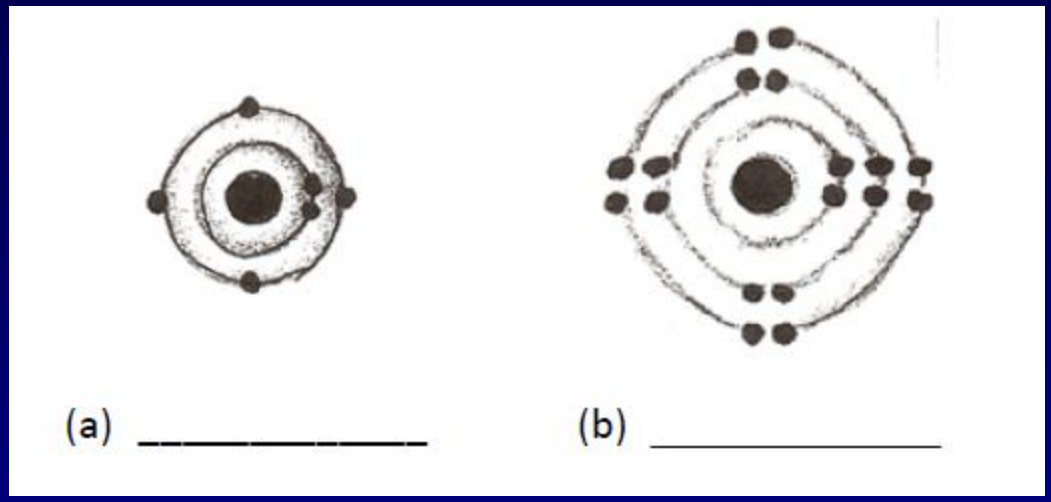


Electron Configuration in Shells
(for Elements 1 to 18)

Atomic #	*Element & Symbol*	Number of Electrons in Each Shell			*Total # of Elec-trons*
		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*

ANOTHER TRIAL CLICKER QUESTION!

Q2. Using the Table on p 20, figure out which elements these dot diagrams represent:



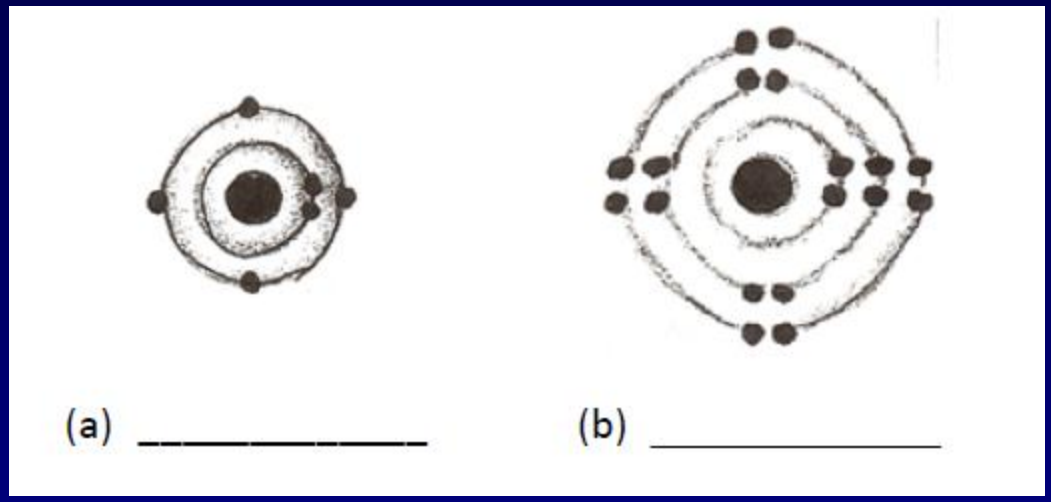
1) a = Beryllium and b = Neon

2) a = Oxygen and b = Sulfur

3) a = Neon and b = Silicon

4) a = Carbon and b = Argon

Q2. Using the Table on p 20, figure out which elements these dot diagrams represent:



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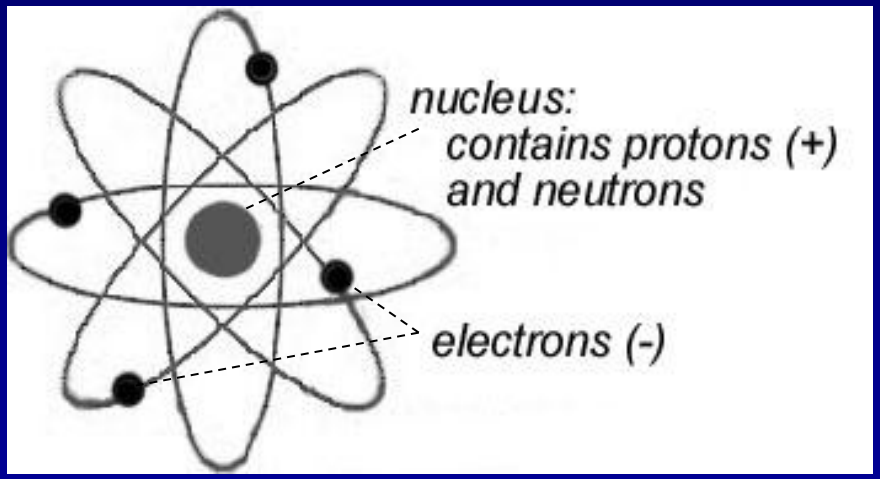
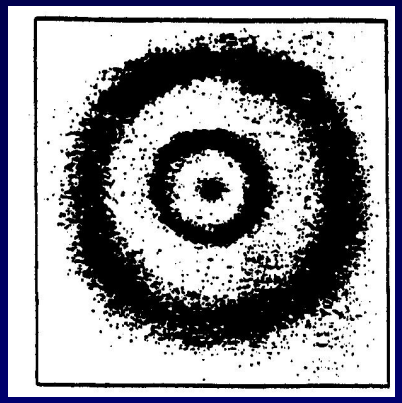
THE EARLY PLANETARY MODEL OF THE ATOM . . . .

Electrons "orbiting" the nucleus



VS. . . . .

The BOHR MODEL OF THE ATOM:



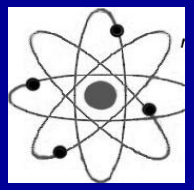
According to Neils Bohr's model of the atom,

electrons circling the nucleus cannot maintain their orbits at just *any* distance from the center of the atom (the early model). . . .

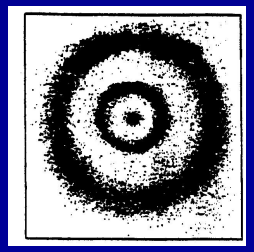
. . . .there are only certain "allowed orbits"

- 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.

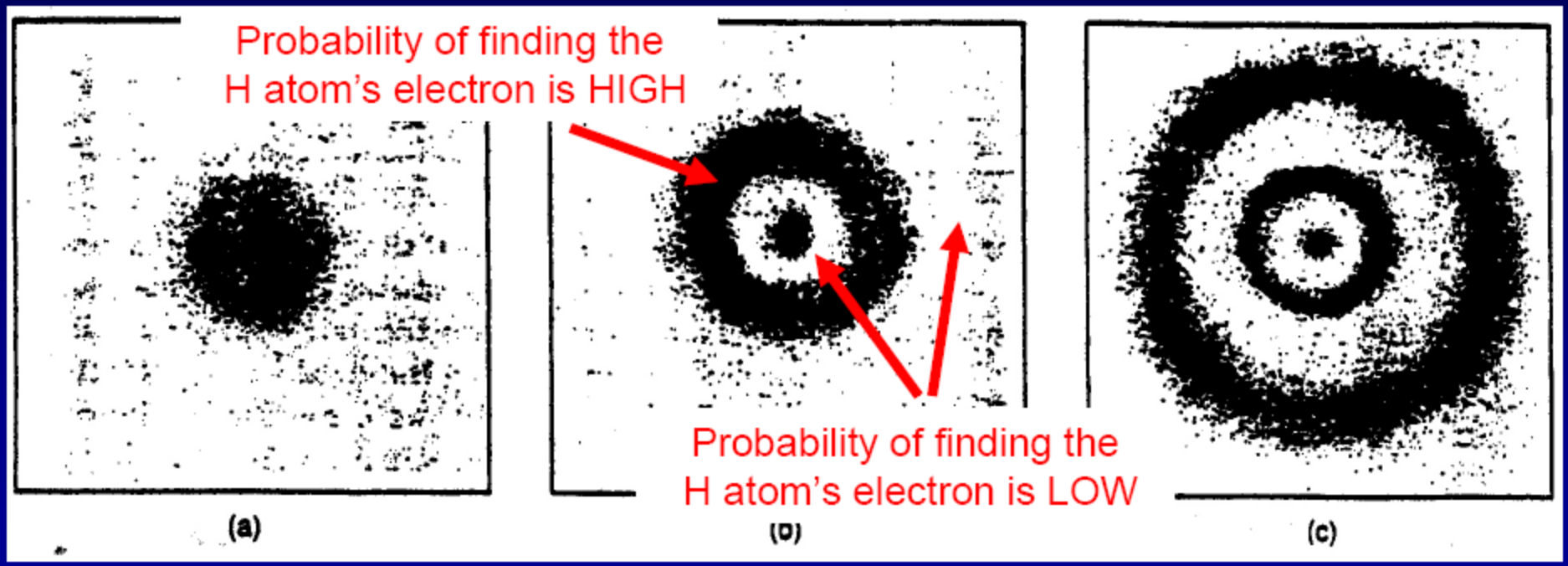


vs.



Schematic Diagrams representing ELECTRON ENERGY STATES (Shells) for Hydrogen H in the Bohr model :

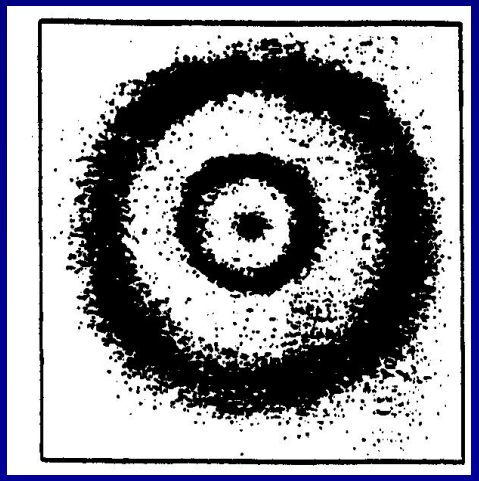
REMEMBER: HYDROGEN has only ONE electron!

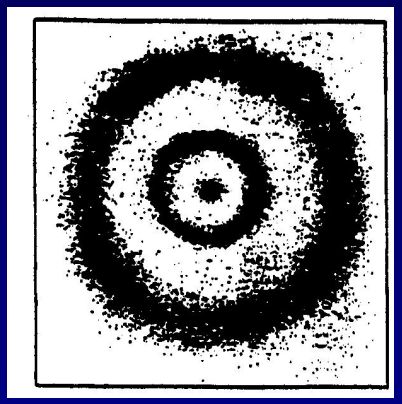


GROUND State **Excited State 1** **Excited State 2**

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 “empty” spaces represent areas with *little likelihood* of finding an electron

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

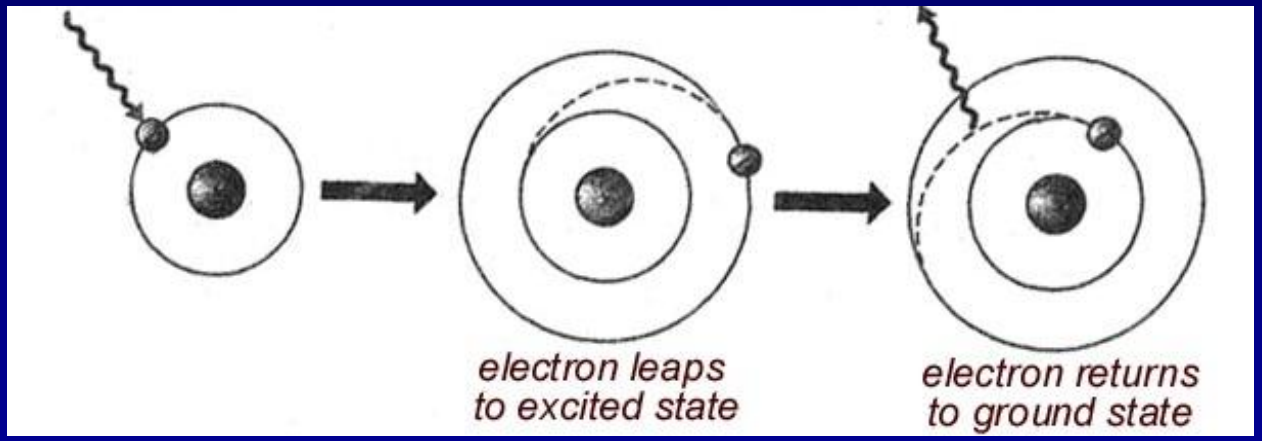
. . . BUT HOW DO THEY GET FROM ONE ENERGY LEVEL TO ANOTHER???

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

-- but according to

quantum mechanics.

Energy Absorbed → Energy Released

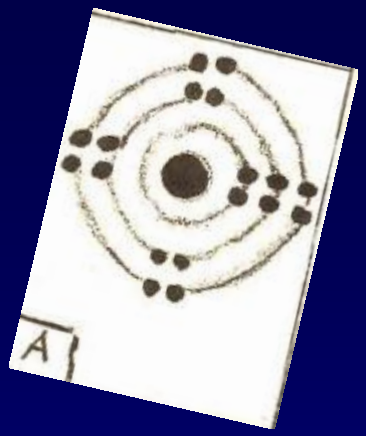


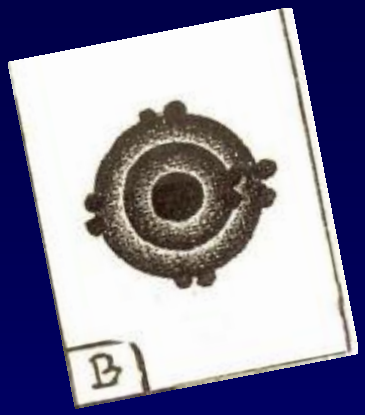
MORE on how this happens and what it has to do with GLOBAL CLIMATE CHANGE in upcoming lectures!!

A little rusty on atoms, elements, shells, and the Periodic Table?

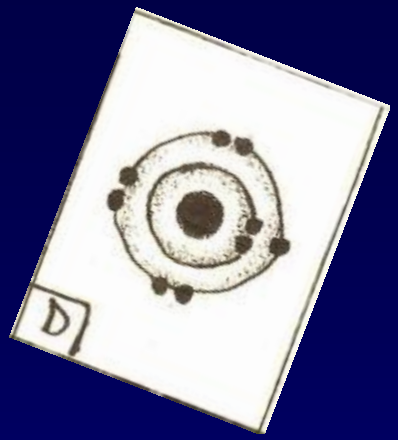
"HANDS ON"
LEARNING ACTIVITY

Go to the Class Notes Appendix pp 107-111


A


B


C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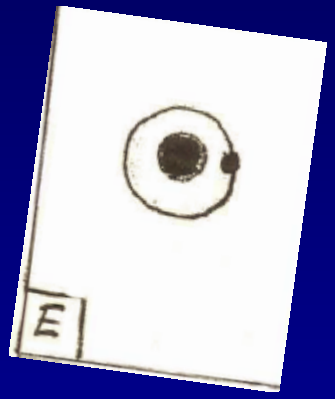
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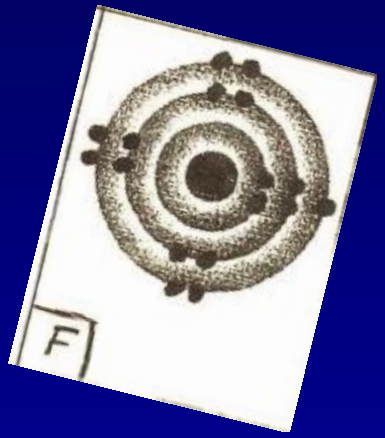
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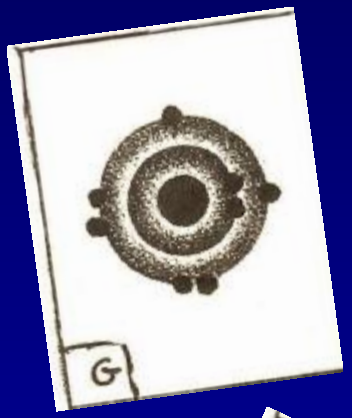
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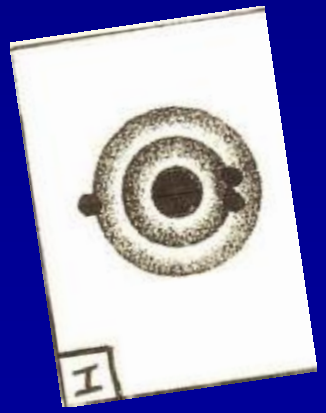
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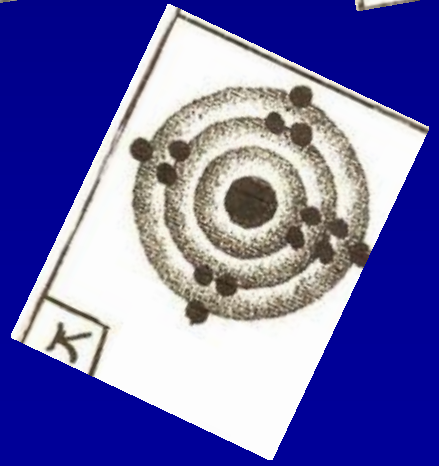
J

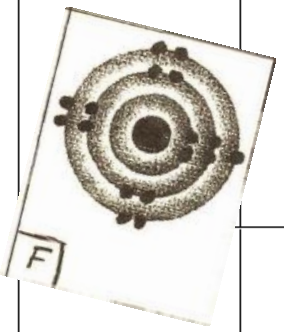

K

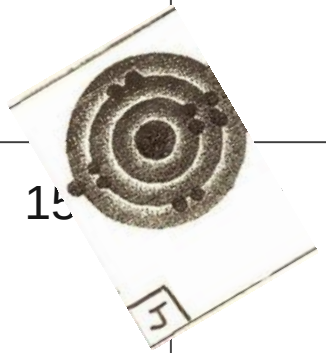
PLACE THE ATOMS
ON THE BLANK PERIODIC TABLE
in the right location,
then answer the rest of the questions on p 107

GAP

1							2
3	4	5	6	7	8	9	10
11	12		14	15		17	18

PEASE DO NOT WRITE ON THE ATOMS THEY ARE USED AGAIN!





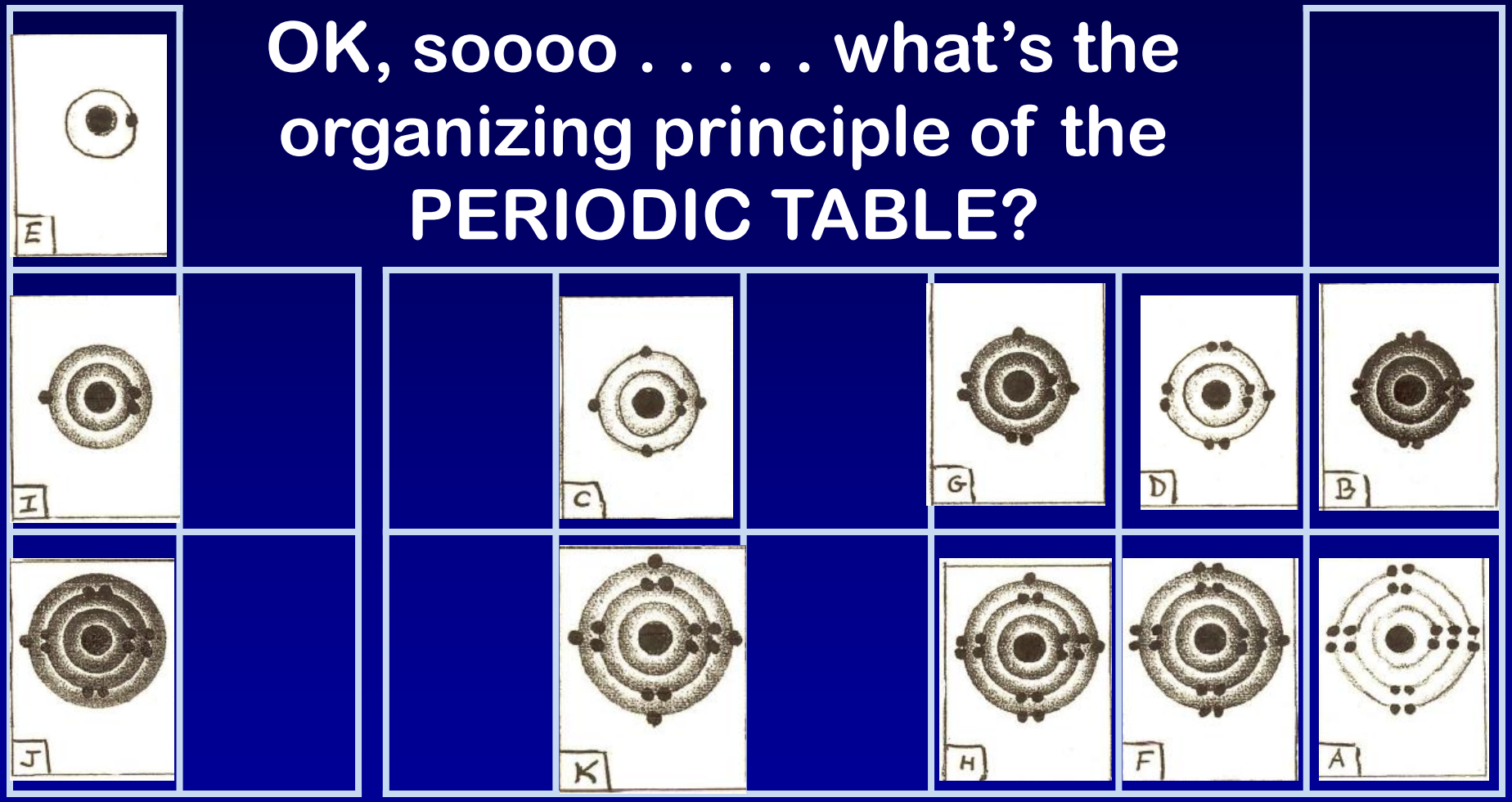
Page 157

BEFORE YOU GO TO THE NEXT SLIDE (with the ANSWER on it) . . . Try to do this on your own (see Class Notes pp 107-111) and **BE SURE YOU KNOW HOW TO DO THIS ACTIVITY ON YOUR OWN!**

Questions related to this activity will appear on upcoming tests . . . .

Which elements go in which row + column?

OK, soooo . . . . . what's the organizing principle of the PERIODIC TABLE?



[Table is on p 109 of Class Notes Appendix]

How is the PERIODIC TABLE organized?

1 electron in outer shell in this column

The Periodic Table is organized by:

# of shells (rows)

# of electrons in the outer shell (columns)

2 electrons

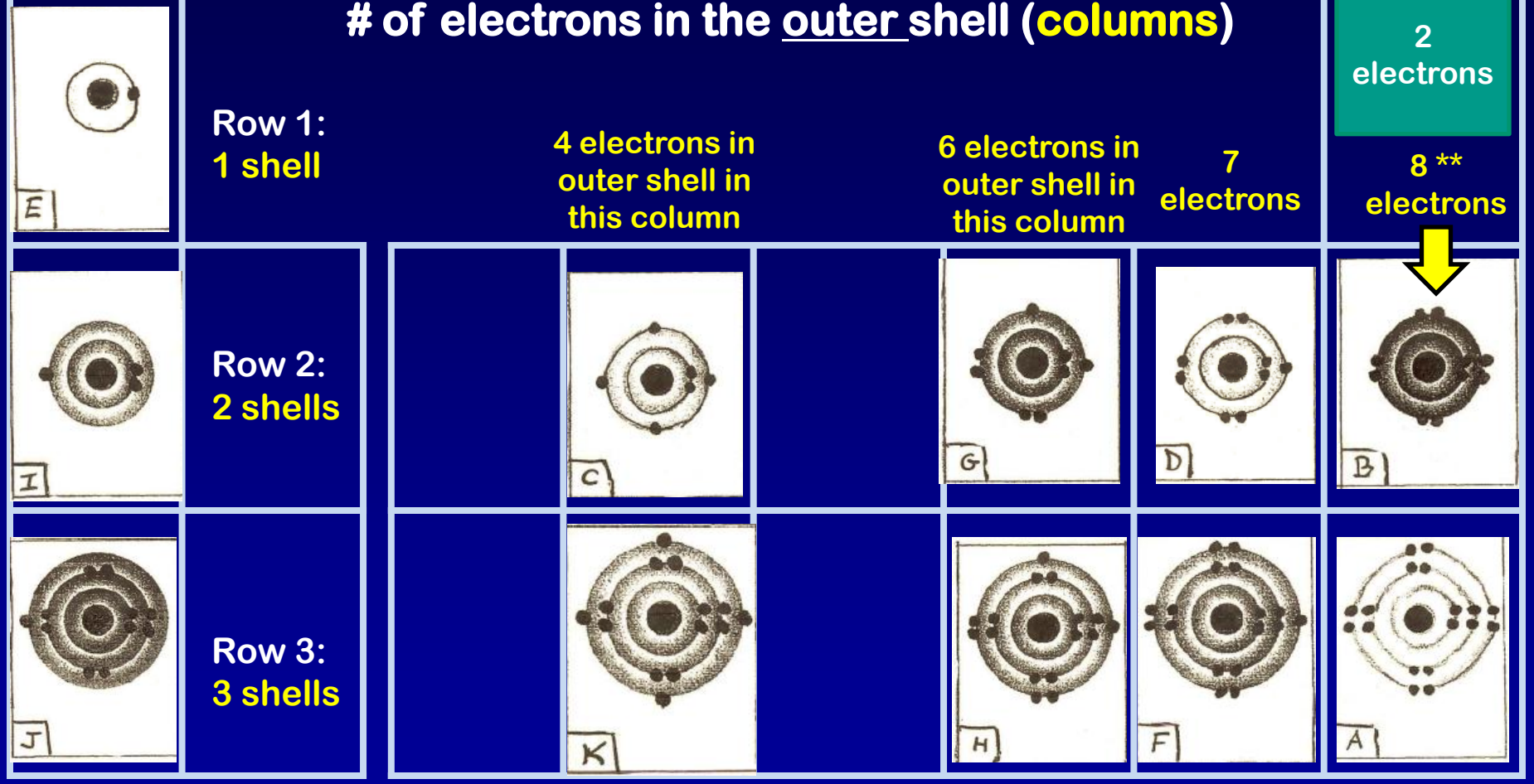
Row 1: 1 shell

4 electrons in outer shell in this column

6 electrons in outer shell in this column

7 electrons

8 ** electrons



Row 2: 2 shells

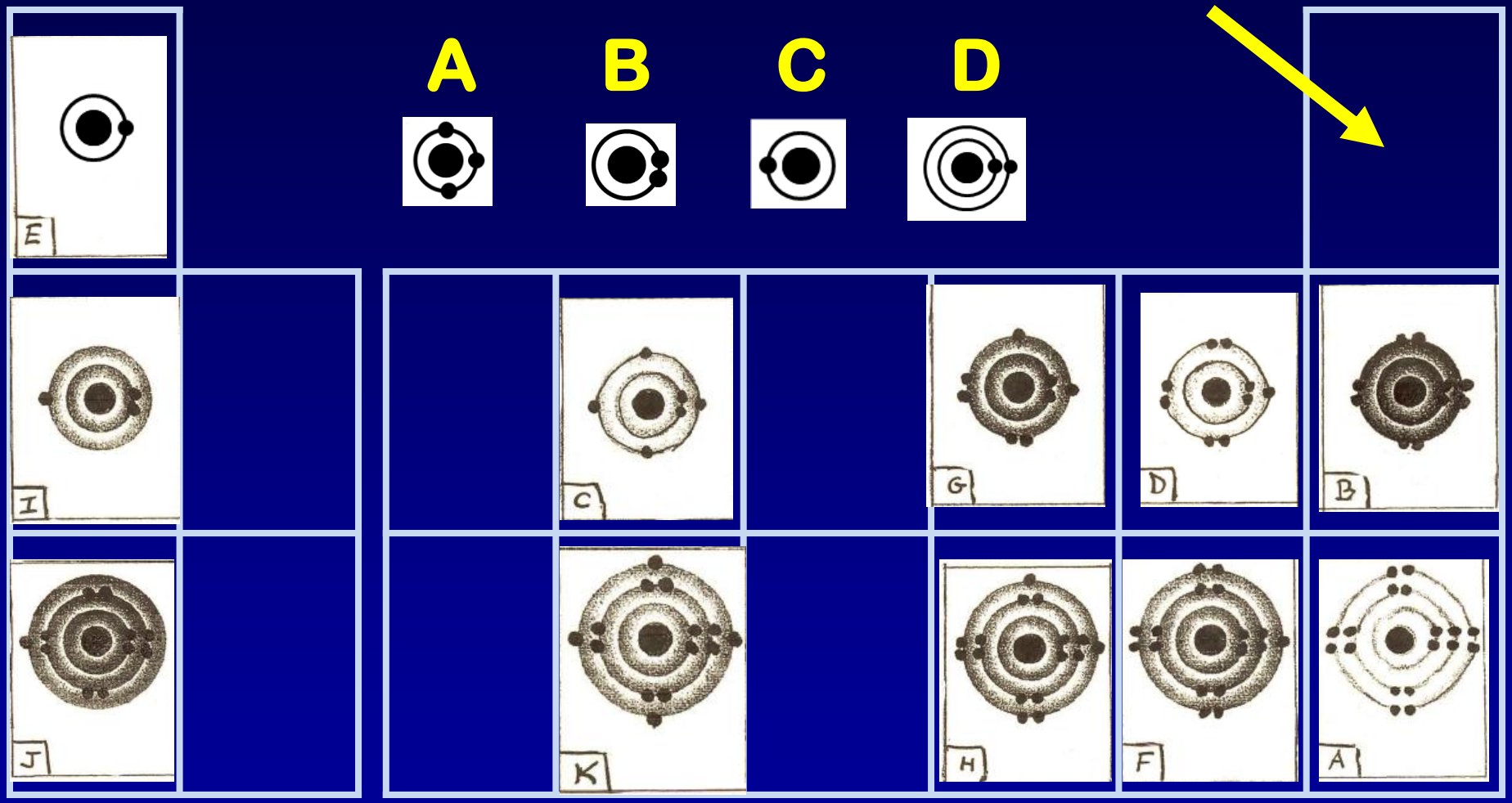
Row 3: 3 shells

In Row 1 the outer shell is "full" with only 2 electrons in last column **

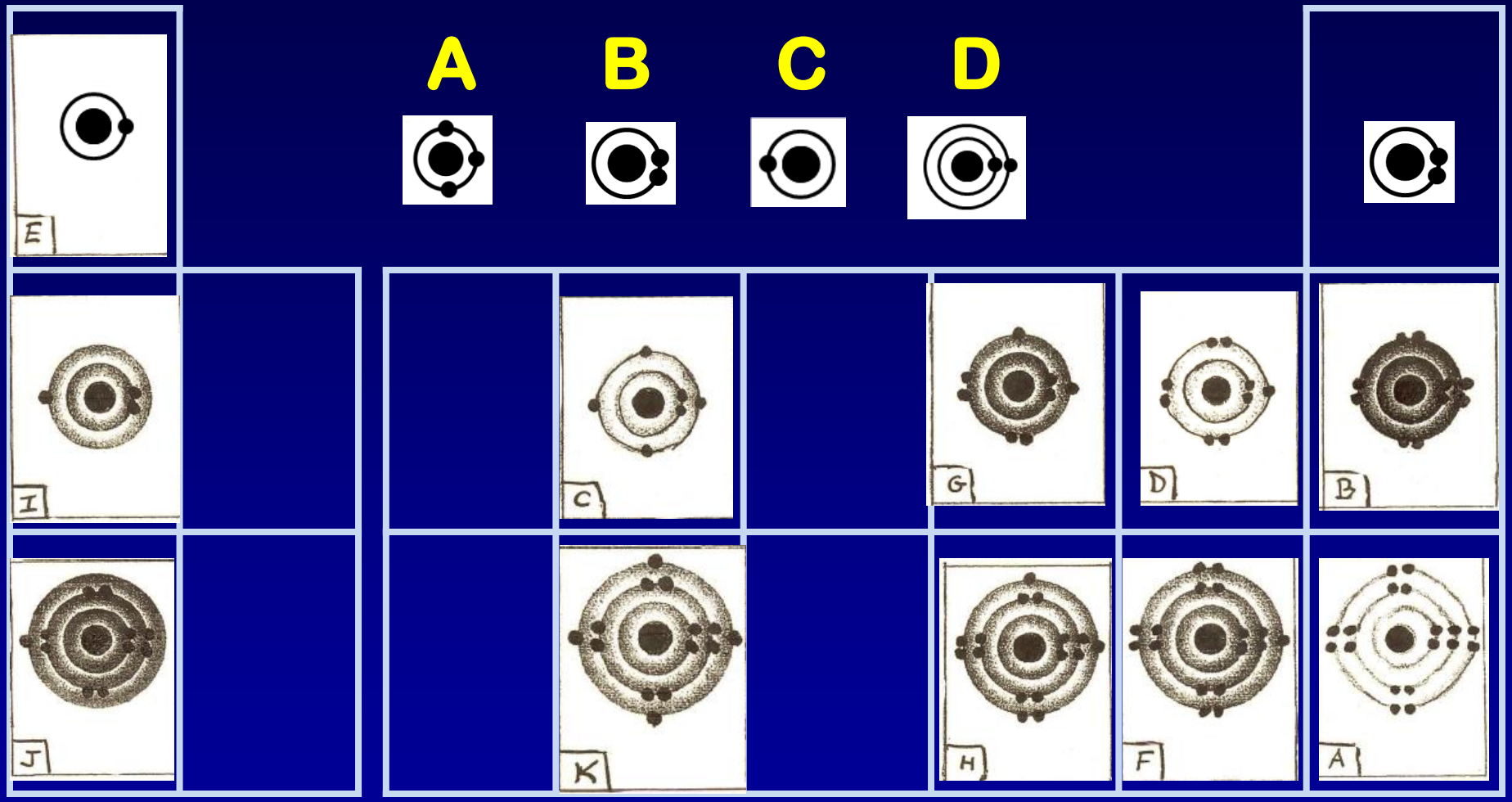
In Row 2 the outer shell is "full" with 8 electrons in last column

In Row 3 the outer shell is "full" with 8 electrons . . . and so forth

Q3. Which of these is the proper dot diagram for the element in this position?



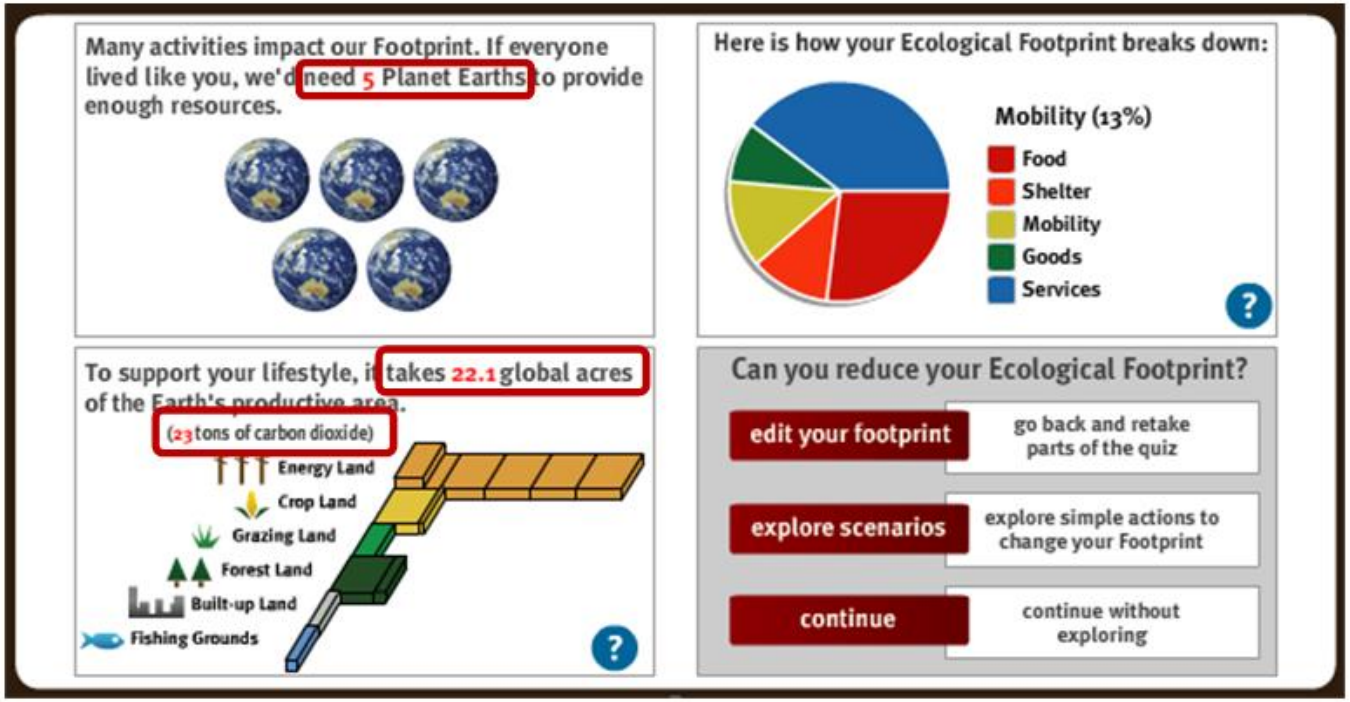
Q1. Which of these is the proper dot diagram for the element in this position?



B is correct! The element is Helium (He)

FOOTPRINT RESULTS!

USA AVERAGE Ecological Footprint (based on 2008 data)

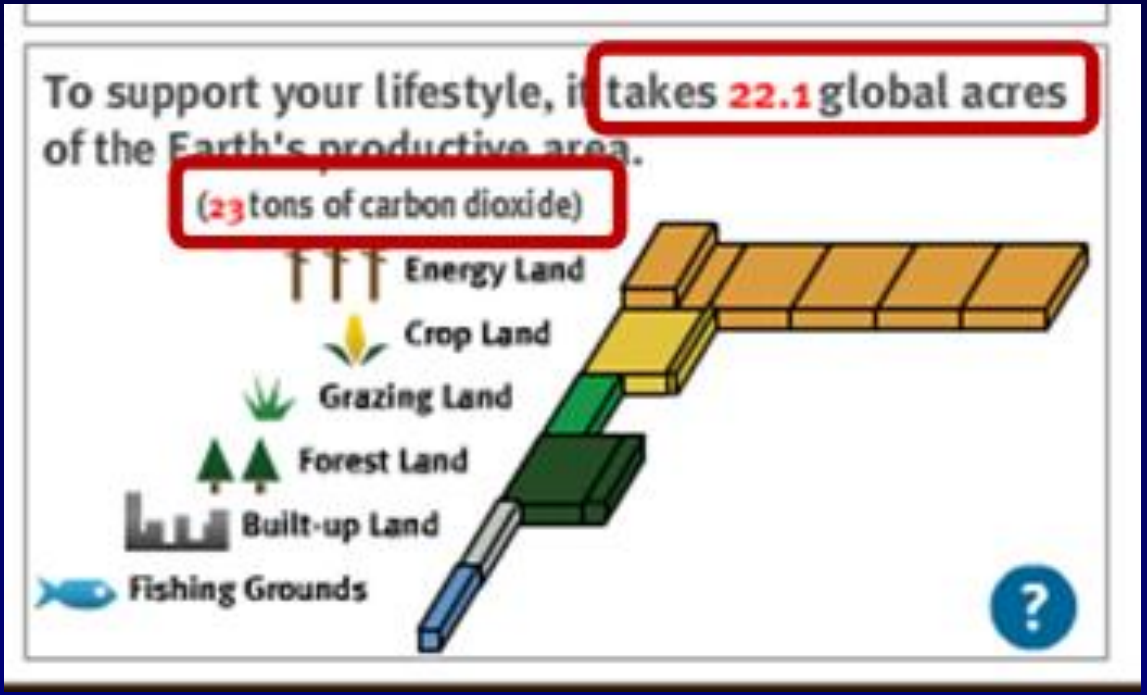


The Ecological Footprint calculator "represents the amount of land and sea area needed to provide the resources a person needs (food, shelter, etc.), and absorb the wastes they create (including carbon dioxide)"

SOURCE: http://www.footprintnetwork.org/en/index.php/GFN/page/footprint_calculator_frequently_asked_questions/

The Ecological Footprint results box:

What does it mean?



The large amount of **'ENERGY LAND'** needed to support the average lifestyle of someone in the United States represents **the global land area** (primarily forest, but also ocean) **needed to "uptake" the CO_2 "waste" emitted** in the USA due to energy use (coal fire plants, auto emissions, etc.)

The **'SERVICES'** category includes **activities "that are not considered personal, but societal.** These areas include (but are not limited to) health care, entertainment, restaurants, real estate, legal services, government and the military.

Everyone taking the quiz has a portion of their nation's "services" Footprint allocated to them.

QUICK
ENERGY REVIEW

Energy Terms & Units

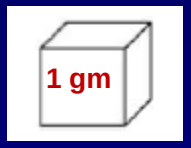
Energy (def) = the quality of an object that enables it to do “work;” the ability to do work.

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

Energy Unit Review

Joule (or J) is the physical measurement for work.

Calorie (def) = the amount of **heat** required to raise 1 gram of room-temperature water 1 degree Celsius in temperature



~ 1 cubic centimeter H_2O

1 calorie = 4.186 joules
1 calorie per second = 4.186 watts

HOW MUCH ENERGY IN A HURRICANE?

http://www.aoml.noaa.gov/hrd/tcfaq/D7.html

1.3×10^{17} Joules / day

ever a force
distance (d).

that is exerted
hich it is exerted:

d

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

$$P = W / t$$

The POWER of A Hurricane!

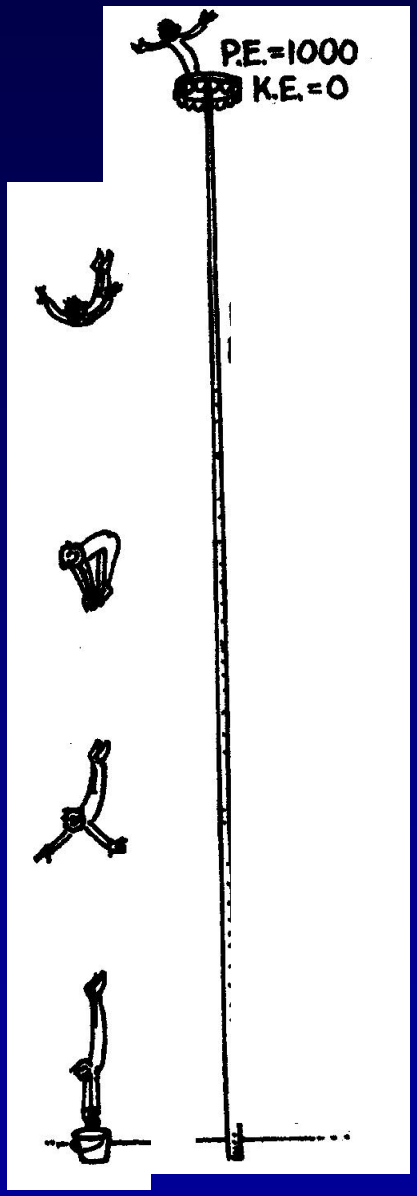
http://www.nhc.noaa.gov/

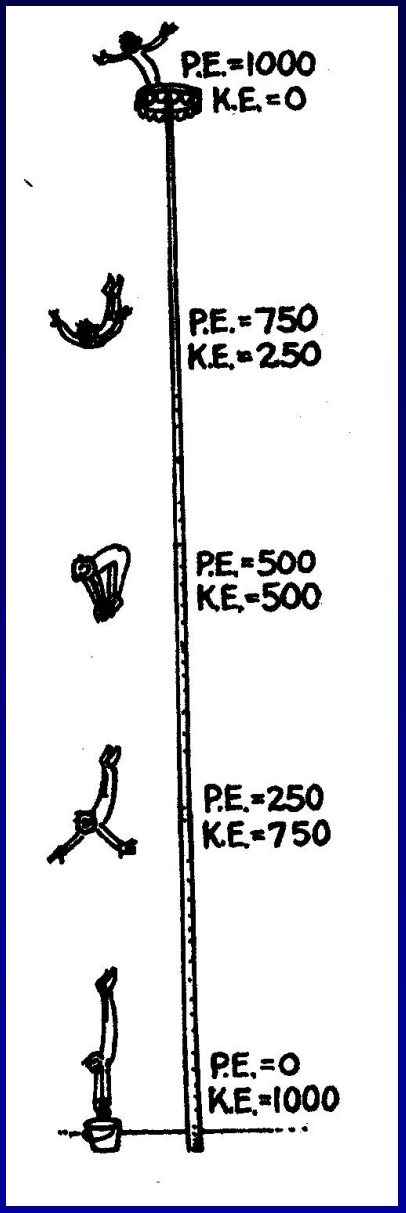
Different Forms of Energy

- **Kinetic** (KE or KinE) = energy of *motion*; the ability of a mass to do work.

  KE = ½ (mass x velocity^2) or KinE = (1/2) ms ^{2}

- **Potential** (PE) = energy a system possess if it is capable of doing work, but is *not* doing work now


P.E.=1000
K.E.=0


P.E.=1000
K.E.=0
P.E.=750
K.E.=250
P.E.=500
K.E.=500
P.E.=250
K.E.=750
P.E.=0
K.E.=1000

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 . . .

Coming up this semester. . . .

2 Important forms of POTENTIAL ENERGY that are keys to Global Change Issues:

Electromagnetic Energy

(Topic #5)

&

Thermal energy

(Topic #8)

Related to Topic #8:

Energy Transformations & Conservation of Energy:

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

ENERGY IS CONSERVED!

The Law of Conservation of Energy:

Energy cannot be created or destroyed.

It can be transformed
from one form to another . . . . but

THE TOTAL AMOUNT OF ENERGY NEVER CHANGES.

Same as : 1st Law of Thermodynamics
(Topic #8)

➔ ***Link to GREEN TECHNOLOGIES & SOLUTIONS for addressing climate change:***

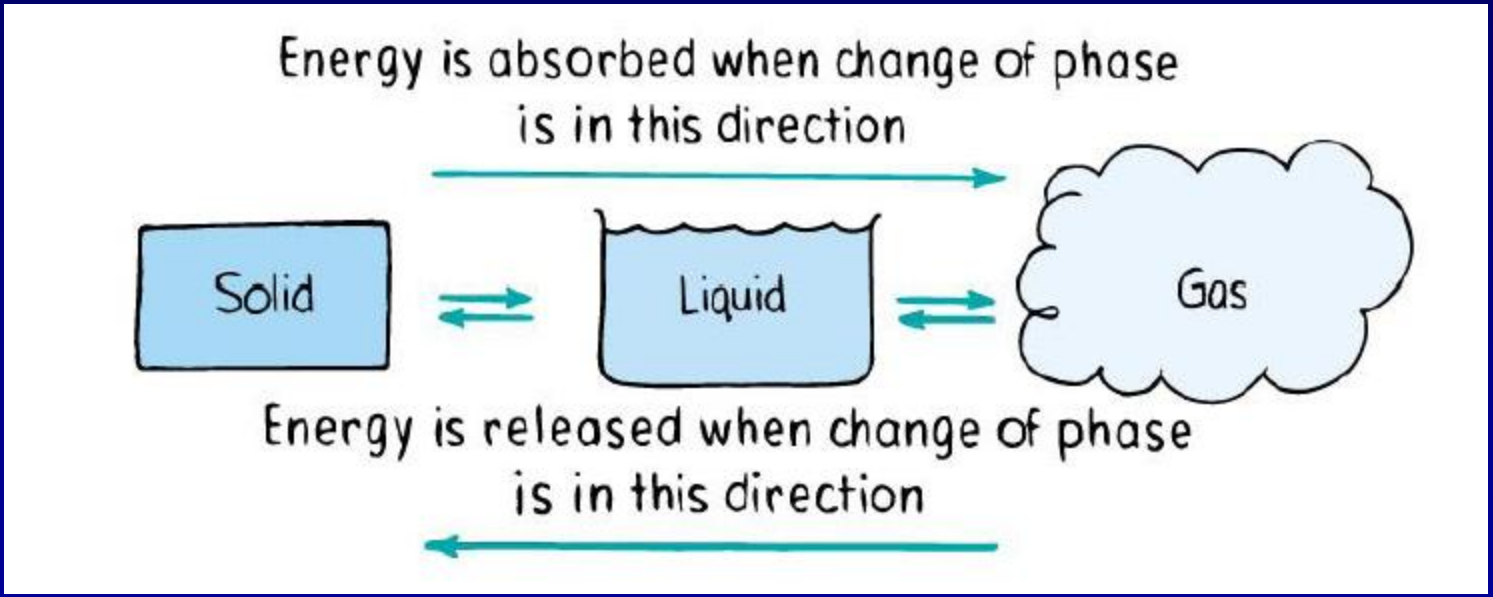
Although energy may not be destroyed, it can become **INEFFICIENT**

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

Efficiency = work done / energy used

Also coming up under Topic #8:

ENERGY & MATTER INTERACT IN PHASE CHANGES



Have a great Labor Day Weekend!

Go CATS!