TOPICS FOR TODAY'S CLASS:

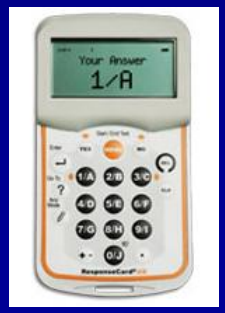
- **Wrap up of Time Series Graphs**
- **Review the basics of**
  MATTER & ENERGY

COURSE LOGISTICS:

Clicker / Response Session Debut!

RESPONSE TIME!

Clicker



Older clicker is OK

ResponseWare Device

Open up your “APP”

or

login to: rwpoll.com

ENTER CHANNEL = 28

ENTER SESSION ID = see above

Q1. I am a . . .

A. FRESHMAN

B. SOPHOMORE

C. JUNIOR

D. SENIOR

E. OTHER

Q2. What is the difference between Time Series Plots A & B?

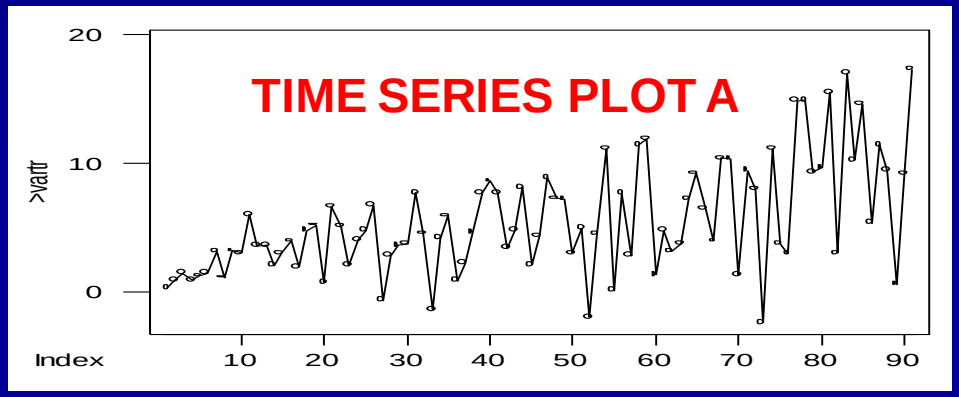
A. Plot A depicts a constant mean over time, but Plot B does not

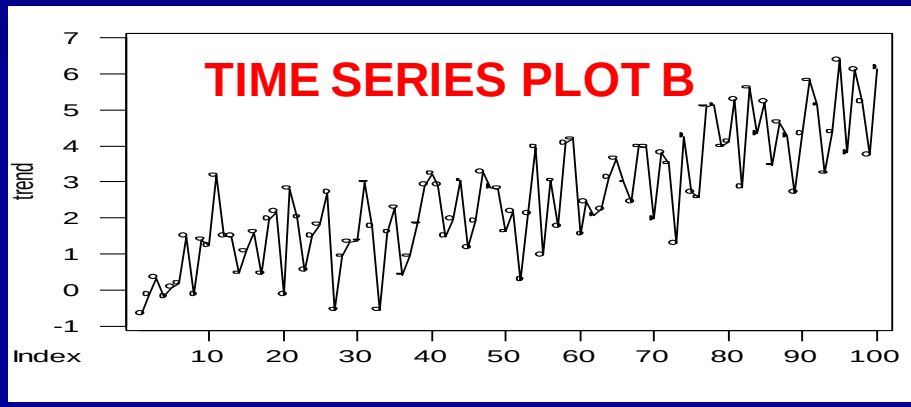
B. Plot A doesn't depict any trend, but Plot B does

C. Plot A depicts increasing variance over time, but Plot B does not

D. Plot A is periodic but Plot B is not

E. There is no difference – they are both random plots with no trends





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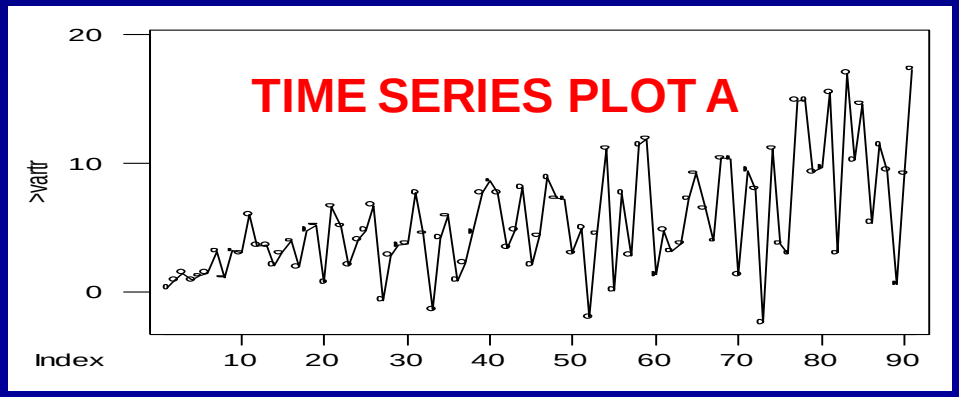
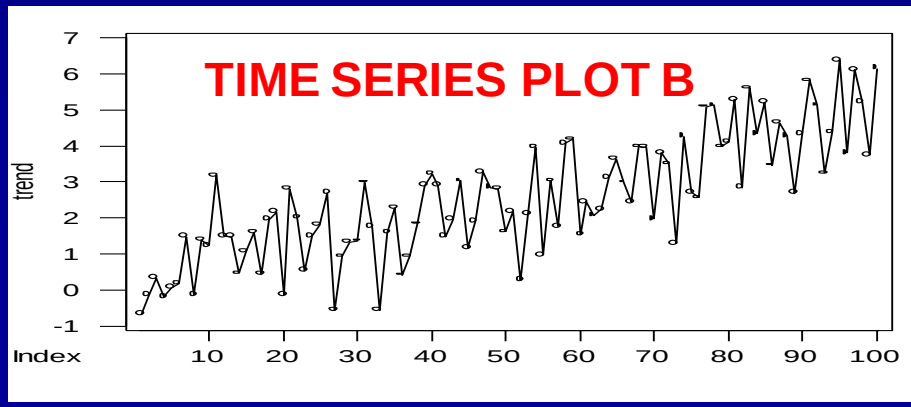
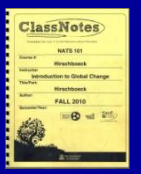


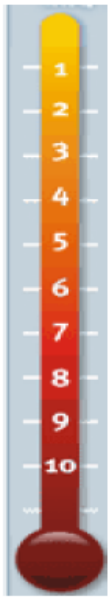


Topic #3
Quantifying Global Change

WRAP-UP . . .

Class Notes page # ➔





INDICATOR INTERLUDE . .

Denier Argument #1:

"Climate's changed before"

Response:

Yes, the climate has changed before – see these times series plots !

Scientists have studied this thoroughly for years and no one disputes this.

Natural climate change in the past PROVES that climate is sensitive to an energy imbalance.

If the planet accumulates heat, global temperatures will go up.

Currently, increased amounts of CO2 are imposing **an energy imbalance** due to the enhanced greenhouse effect.

Past climate change actually provides evidence for our climate's sensitivity to CO2.

To make an incontrovertible case about the role that humans play in global warming, what do scientists need?

1) a long-term temperature record, i.e., centuries
2) over a large part of the globe
3) To be able to say . . . . .

"What's the average been for several hundred years, & is this a significant departure from that?"

"And that's very difficult to do."

(James Trefil, physicist)

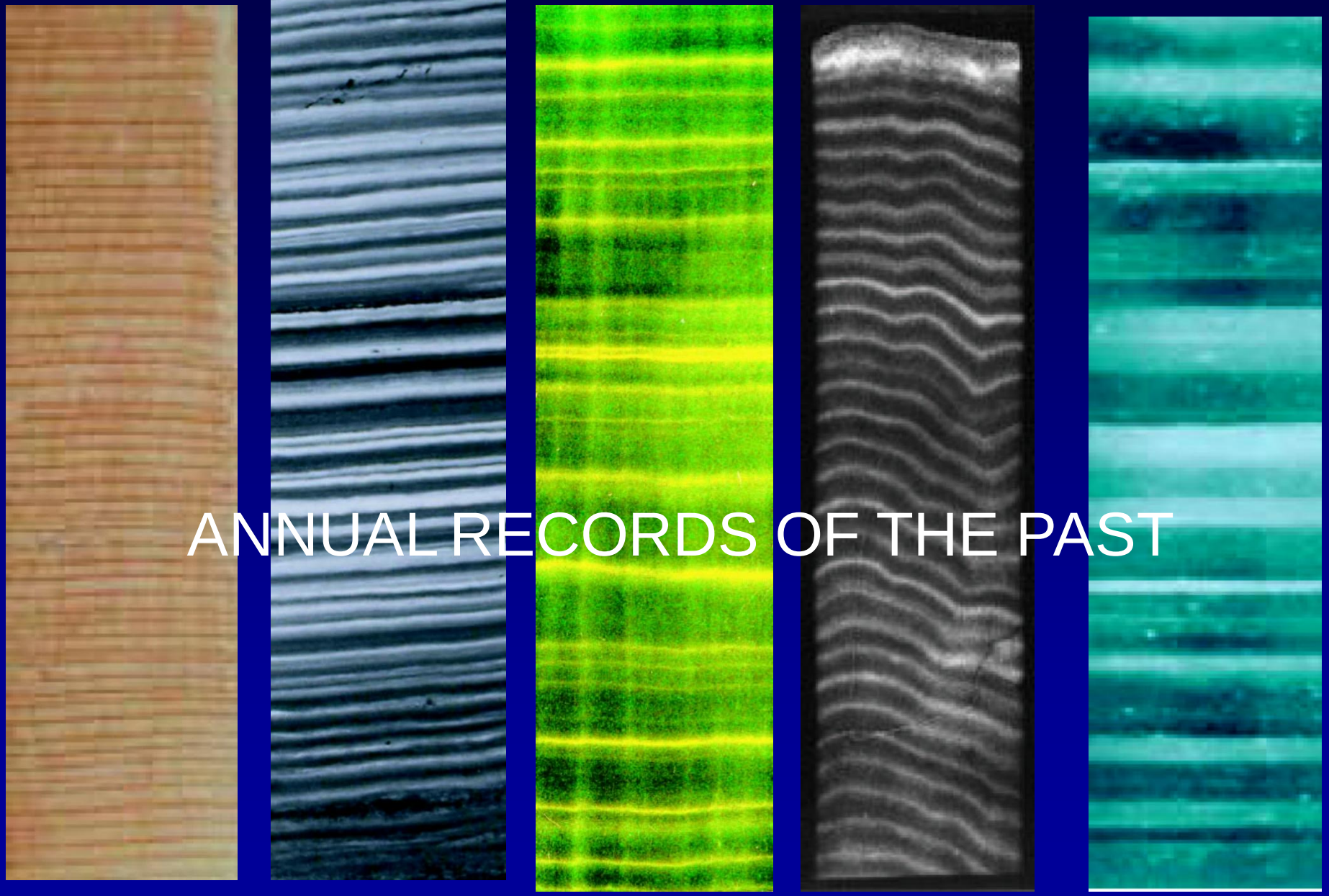
Tree rings

Lake varves (sediments)

Speleothems (from cave)

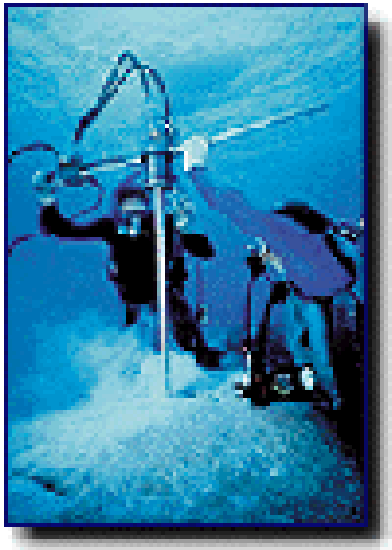
Coral (annual growth)

Ice Core



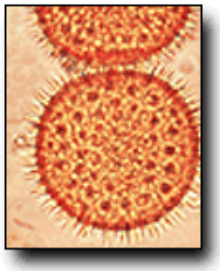
ANNUAL RECORDS OF THE PAST

“PROXY” DATA or NATURAL ARCHIVES of CLIMATE



Corals

Ice cores



Pollen

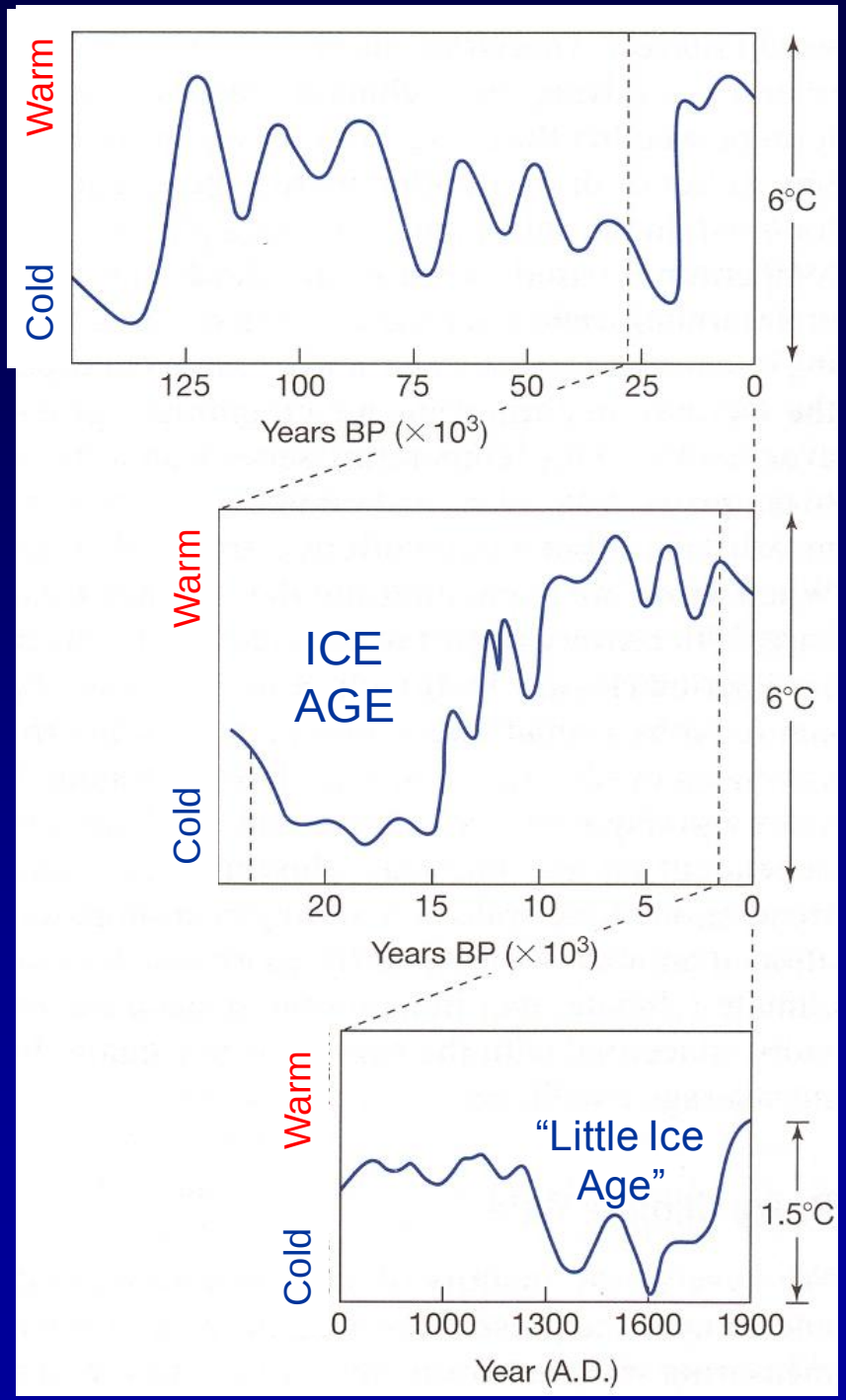
Lake, bog & ocean sediments

WHAT NATURAL ARCHIVES REVEAL:

Over different "Telescoping" Time Scales Of Variability about:

Mean Global Temperature Change

Since The Last Glacial Maximum
(Years BP = "years before present")



Generalized oxygen isotope curve from deep-sea sediments

Generalized estimates from pollen data & alpine glaciers (mid-latitudes of eastern N. America & Europe)

General estimates from historical documents (emphasis on the North Atlantic region)

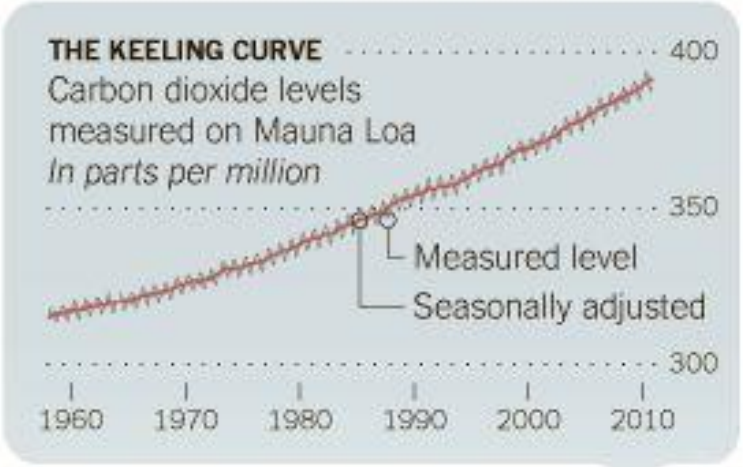
The New York Times

December 22, 2010

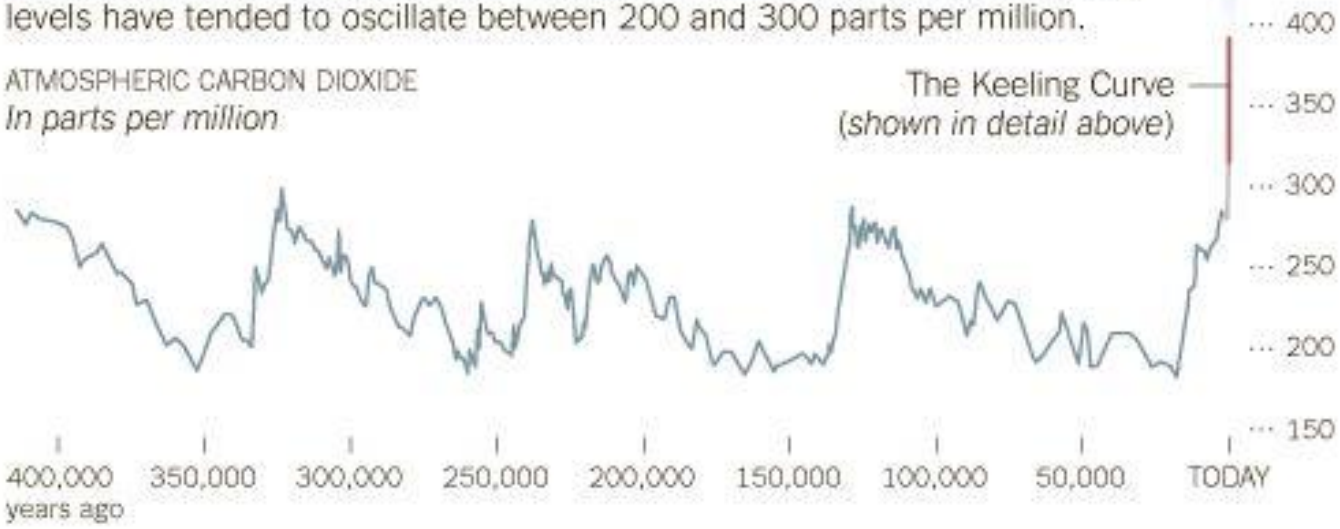
An Ominous Rise

Charles David Keeling began taking precise measurements of carbon dioxide in the atmosphere in the 1950s.

The graph of his findings, known as the Keeling Curve, shows that the amount of carbon dioxide is rising continuously over time.



PAST LEVELS OF CARBON DIOXIDE can be measured in air bubbles trapped in Antarctic ice. Samples dating back nearly half a million years suggest that levels have tended to oscillate between 200 and 300 parts per million.



http://www.youtube.com/watch?v=SXHDwdd7Tf8&lr=1

Topic #4
ENERGY & MATTER
OVERVIEW

OBJECTIVES:

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

"Science shows us that the visible world is neither matter nor spirit;

the visible world is the invisible organization of energy."

Heinz R. Pagels (b. 1939), U.S. Physicist

QUICK
MATTER REVIEW

Matter:

Whatever occupies space & is perceptible to the senses; made up of atoms; matter can be in form of solids, liquids, or gases

Atom:

-- Fundamental building blocks for all matter

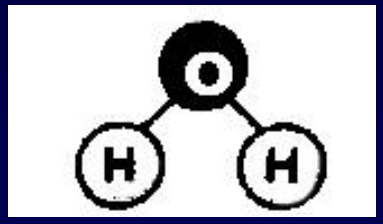
-- the smallest representative sample of an element.

Element:

A chemical substance (material) made from a single type of atom that cannot be broken down any further – and still maintain its identity as that element

. . . as in the *Periodic Table of the Elements*

Molecule:



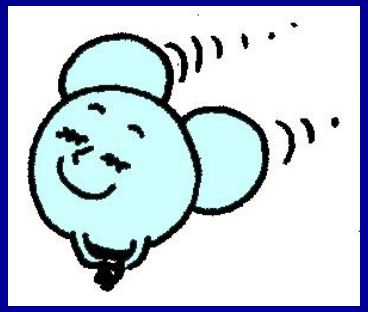
-- Any collection of **two or more atoms bound together**

-- a cluster of atoms bound together

MOLECULES are the basic constituent of different kinds of materials.

-- the smallest part of any substance that **has all the chemical properties of the substance**

e.g., a water molecule = H_2O



STATES OF MATTER

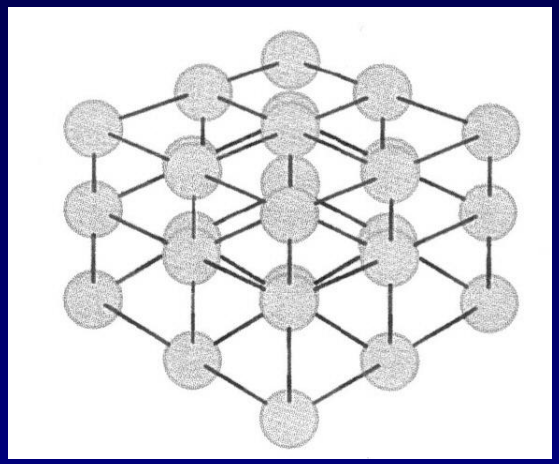
Solid:

-- a substance that resists changes of shape and volume

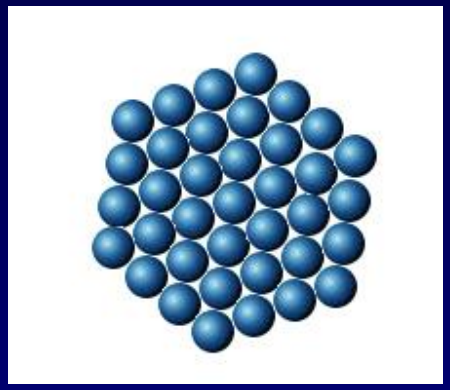
-- characterized by *structure* in the particular order and bonding of atoms that make up the material

Example = a crystal in which the molecules are locked into a strict geometrical order.

Various Representations of Molecules arranged in a SOLID

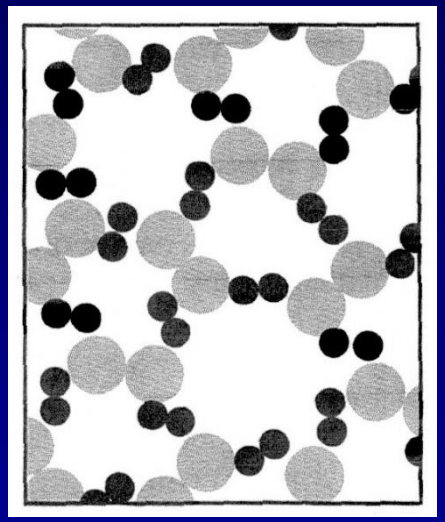


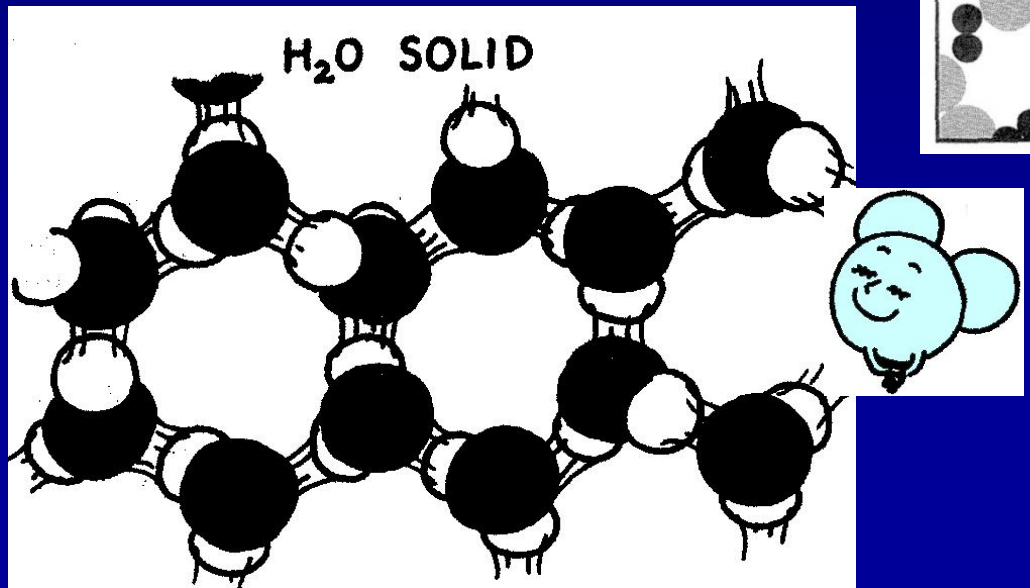
3-D view of a solid crystal structure



"top down" view of a Neon crystal

"top down" view of water (H_2O) arranged in solid (ice) form





Liquid:

-- a substance that flows freely in response to unbalanced forces

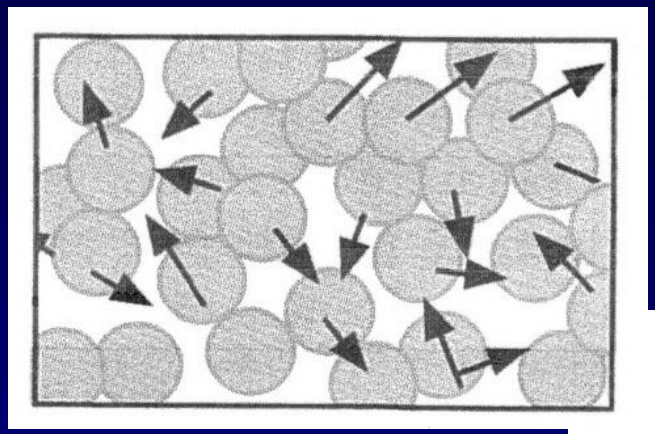
-- molecules more or less move freely past one another as individuals or small groups
-- are not confined to fixed positions (as in solids)

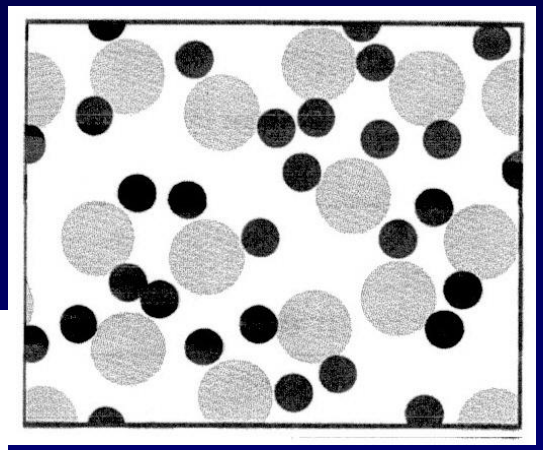
-- LIQUIDS CAN EXHIBIT PRESSURE

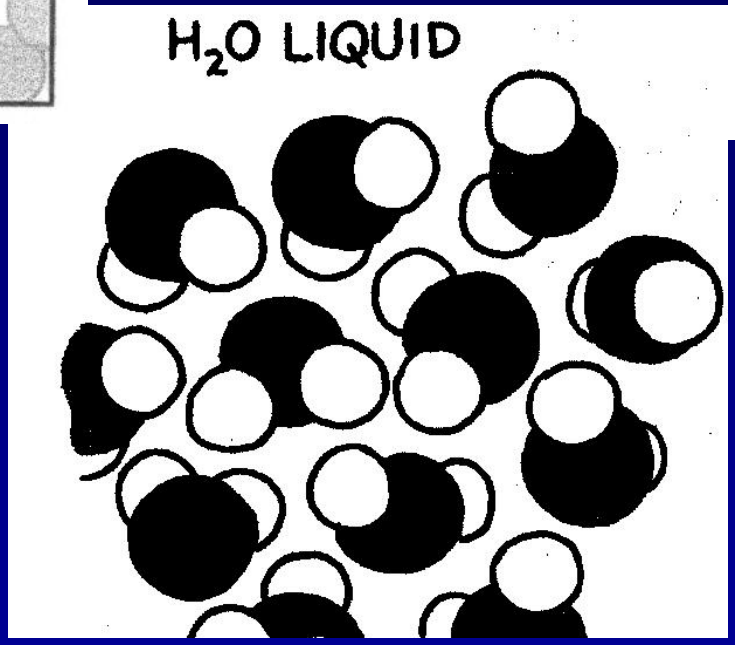
(pressure = a force per unit area)

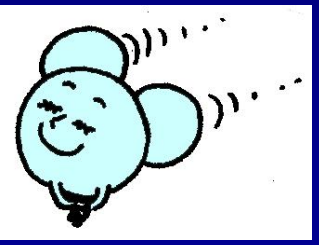
. . . and will take the shape of the container they are in.

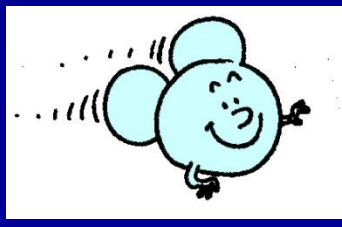
Various Representations of Molecules arranged in a LIQUID











Gas:

-- a substance that expands (and contracts) easily, rapidly, and indefinitely

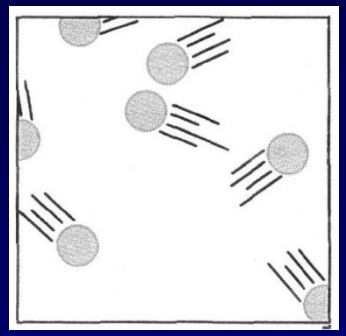
-- fills all space available to it

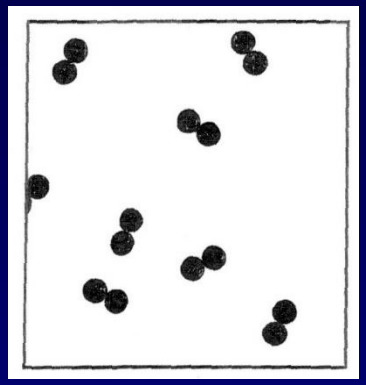
-- takes the shape of its container

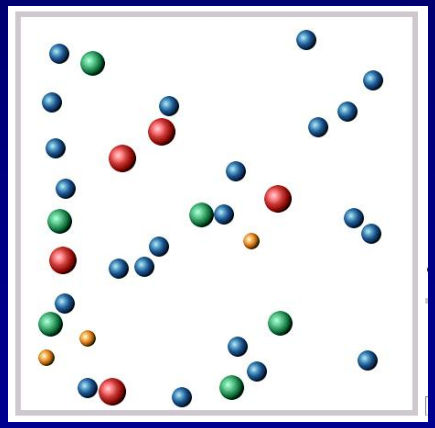
- -- the distance between molecules is such that no cohesive forces exist
- -- atoms or molecules are in high speed motion
- -- many collisions and rebounds occur

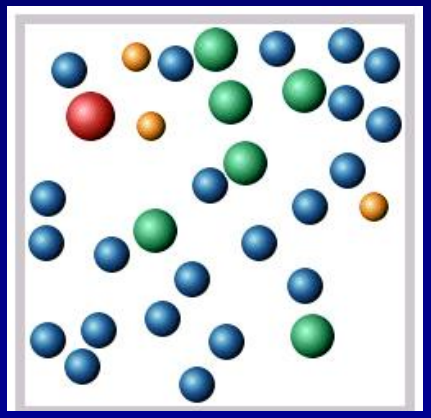
-- GASES ALSO EXHIBIT PRESSURE

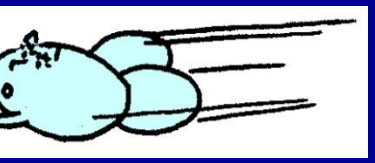
Various Representations of Molecules arranged in a GAS

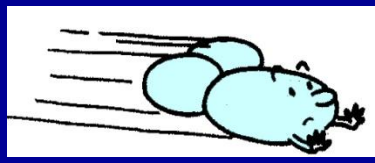








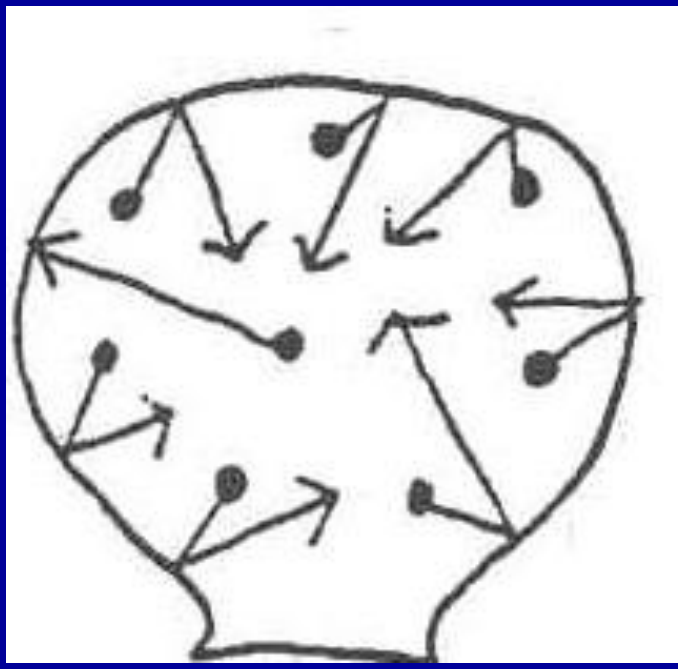


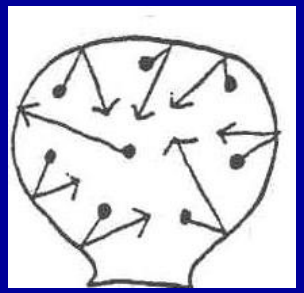


Heat added = increase in total energy + work done against outside pressure

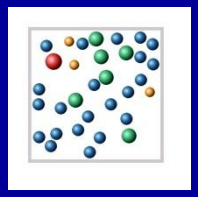
With increasing T (temperature)

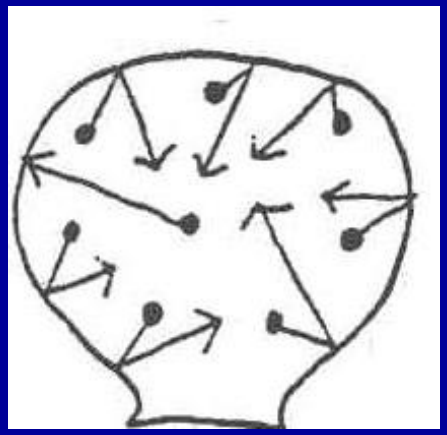
➔ Volume increases &
Density decreases



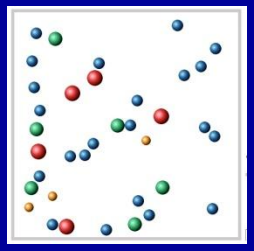


COLD

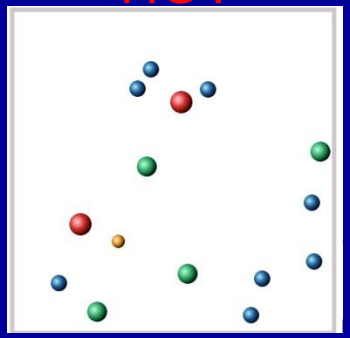


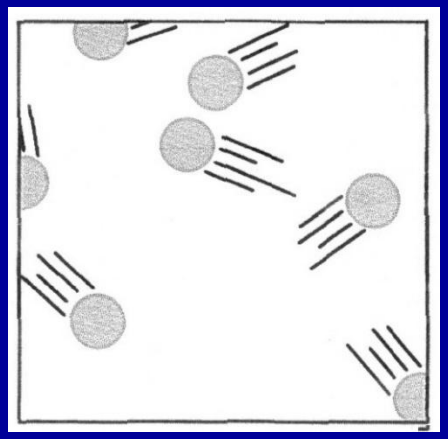


WARM



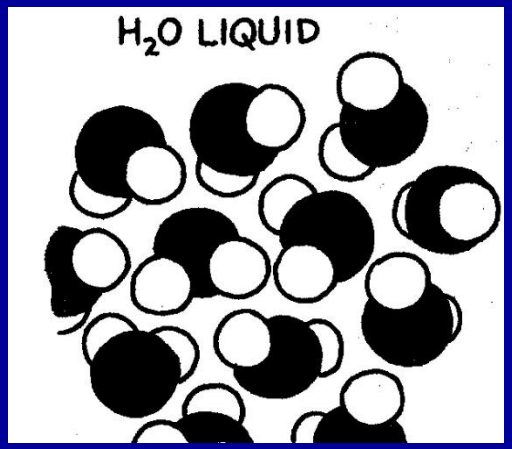
HOT



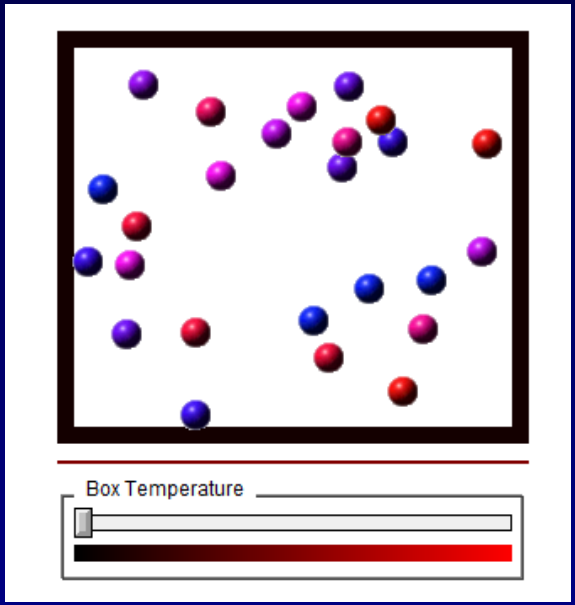


At higher air temperatures, H_2O molecules collide & rebound more frequently, leading to expansion of the air & the water vapor in the air.

At lower air temperatures as air gets more dense, H_2O molecules are more likely to bond so that a phase change to liquid water or even solid ice can occur.



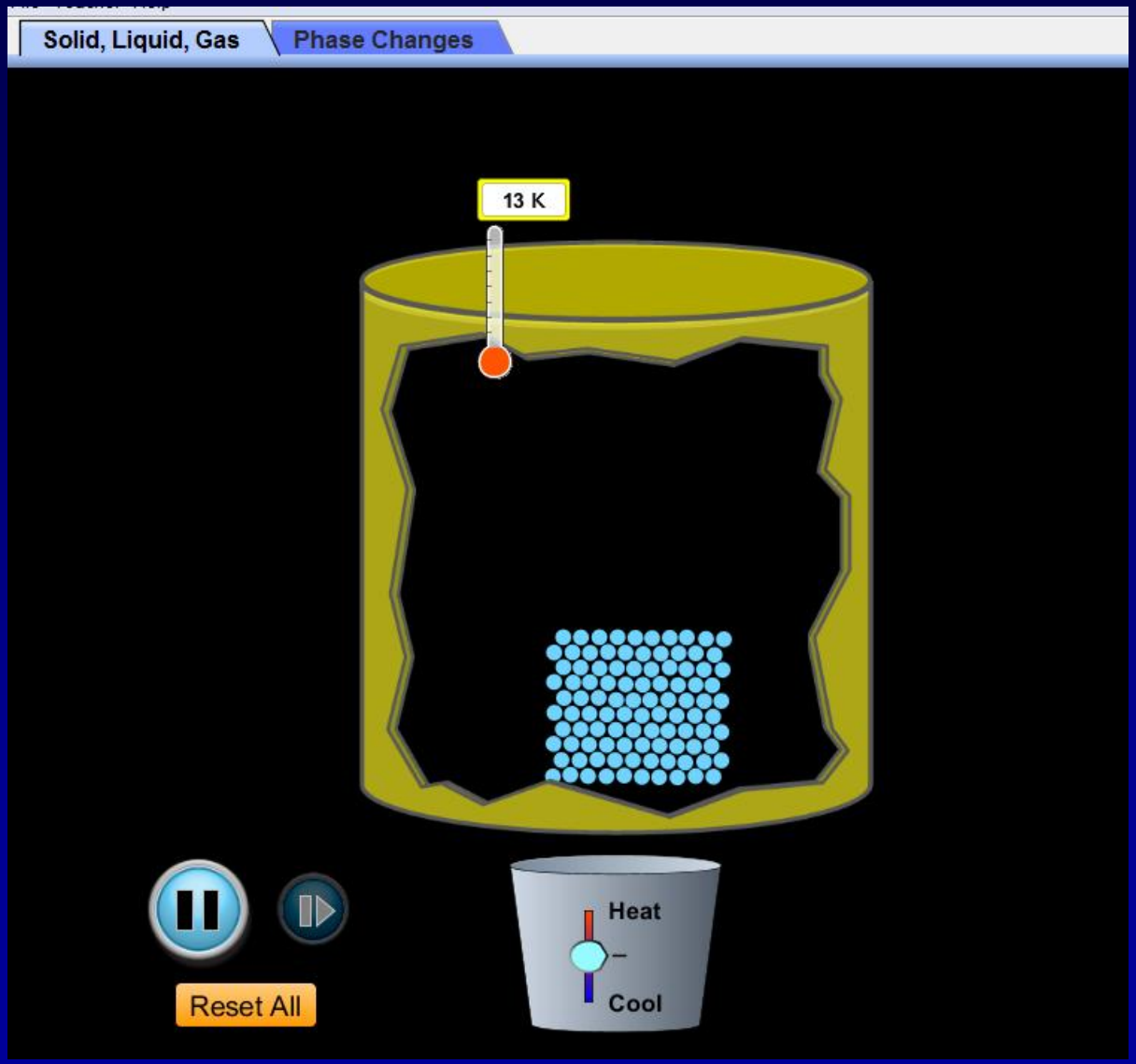
A Simple Demo :

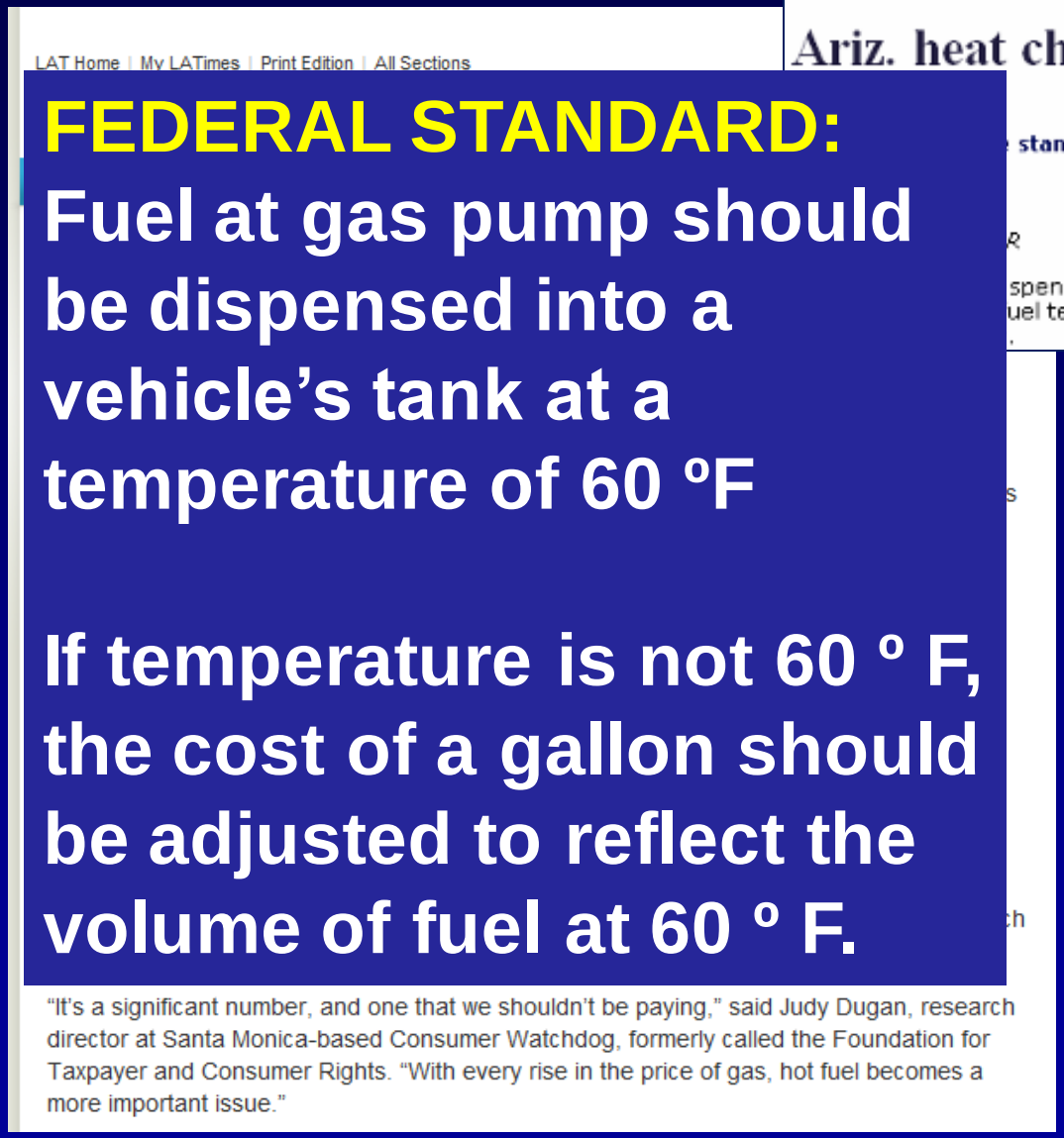


http://www.colorado.edu/physics/2000/bec/temperature.html

WHAT DOES THIS HAVE TO DO WITH GLOBAL CHANGE & MY DAILY LIFE ?????

A better demo:





The U.S. government defined volume of a gallon of gas:

At 60 degrees, a gallon is 231 cubic inches.

But when fuel is warmer than 60 degrees, the liquid expands, yielding less energy per gallon.

http://articles.latimes.com/2008/may/23/business/fi-hotfuel23

Laws of physics cost us money !!

Basic physics!

Depending on the temperature, the difference can amount to a few cents per gallon . . . .

. . . . But it adds up to big money — coming straight out of consumers' pockets.

Now let’s review the atoms themselves and their internal structure . . .


I'VE DONE IT– I'VE FOUND THE MOST BASIC PARTICLE!
I'VE FOUND THE PARTICLE THAT MAKES UP THAT BASIC PARTICLE!
I'VE FOUND THE PARTICLES THAT MAKE UP THE PARTICLES...


I found the Higgs Boson !!

What's Next?

Lecture Break!

http://www.symphonyofscience.com/videos.html

"We Are All Connected"

ATOMIC STRUCTURE:

Electron
Nucleus
Proton
Neutron

ELECTRON: tiny, - charged, very low mass

circles in orbits around a positively charged nucleus of an atom

NUCLEUS: small & massive
(contains protons, neutrons . . .)

central part of an atom;
made up of elementary particles
that are even smaller ➔

PROTON: +charged, in nucleus
(mass > an electron)

NEUTRON: neutral charge, in nucleus,
(approximately equal in mass to a proton).

The # of neutrons can vary → ISOTOPES . . . .

ISOTOPE:

atoms of a given element that have different numbers of neutrons in their nuclei (hence slightly different masses)

e.g. carbon-12 (^{12}C) & carbon-13 (^{13}C)

ATOMIC NUMBER = # of protons in nucleus

Atom is neutral (no charge) when:

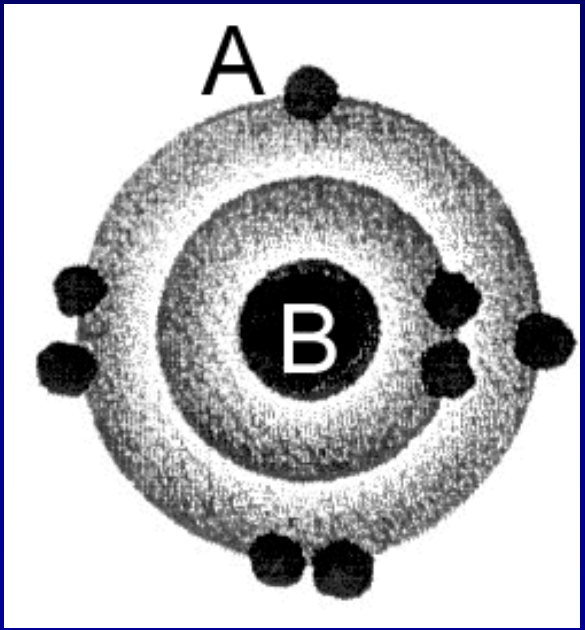
protons (+) = # of electrons (-)

ION: if the atom has a charge (+ or -) it is an **ION**

protons (+) ≠ # neutrons (-)

MASS NUMBER = # protons + # neutrons in the nucleus

Schematic “dot” diagram of an oxygen atom



What is A? _____

What is B? _____

 # electrons = _____

 # protons = _____

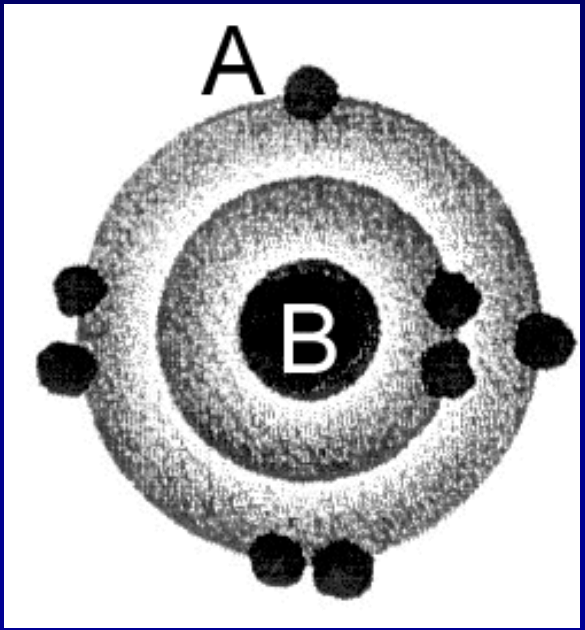
 # neutrons = _____

atomic # = _____

mass # = _____

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

Schematic "dot" diagram of an oxygen atom



What is A? electron

What is B? nucleus

 # electrons = 8

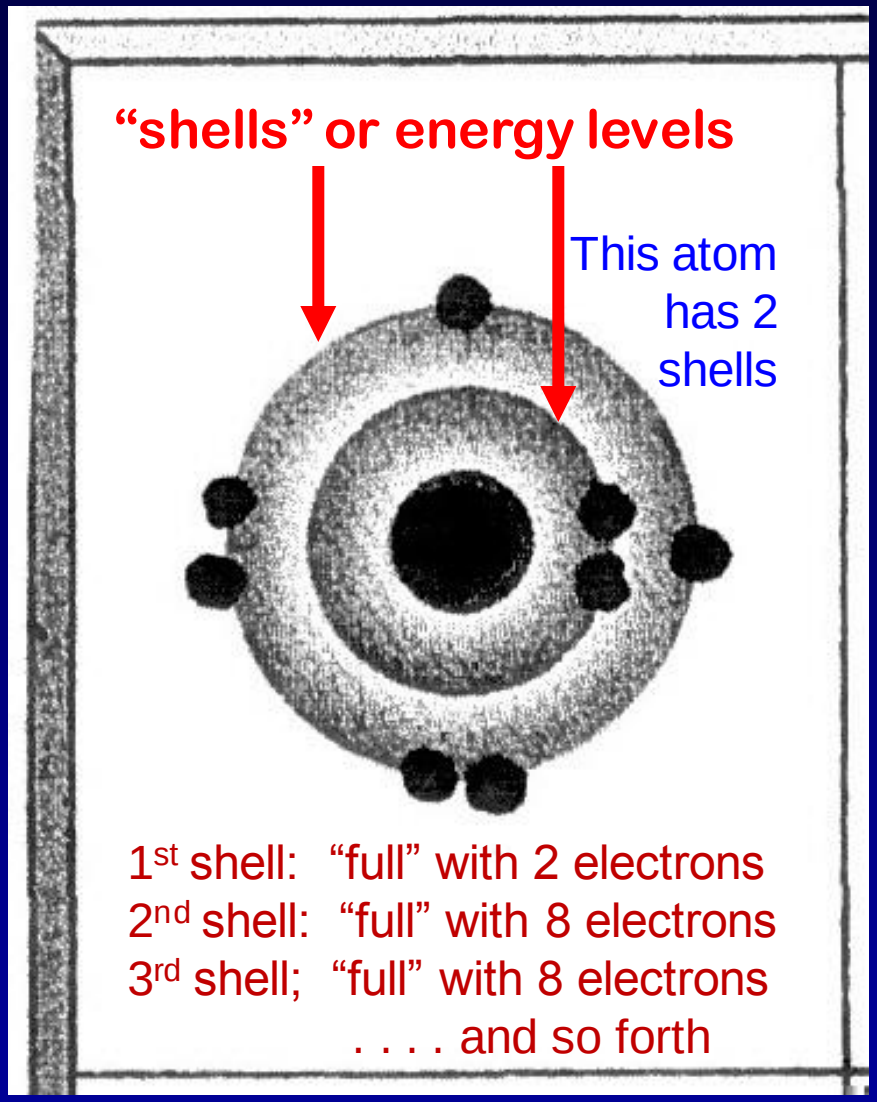
 # protons = 8

 # neutrons = 8

atomic # = 8

mass # = 16

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

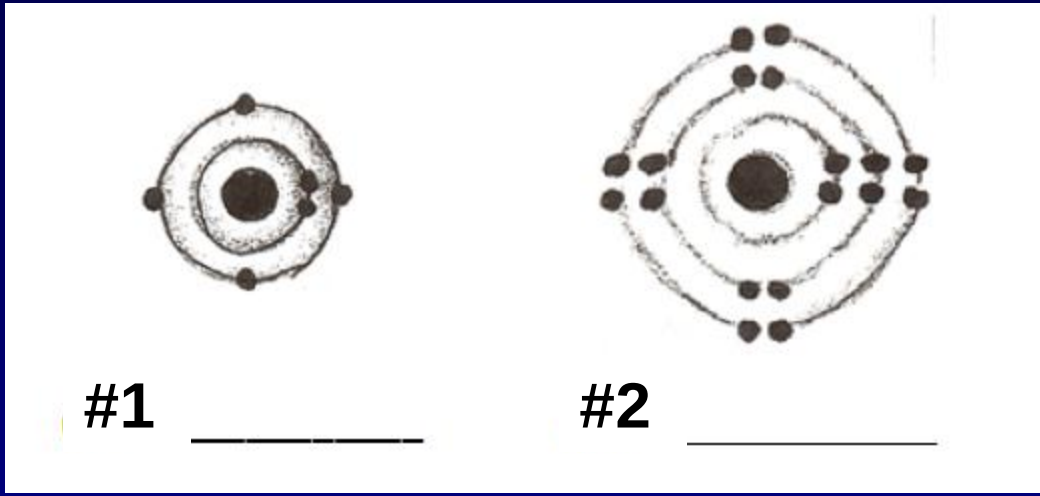


Electron Configuration in Shells
(for Elements 1 to 18)

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 CLICKER QUESTION . . .

Q3. Using the Table on p 20, figure out which elements these dot diagrams represent:



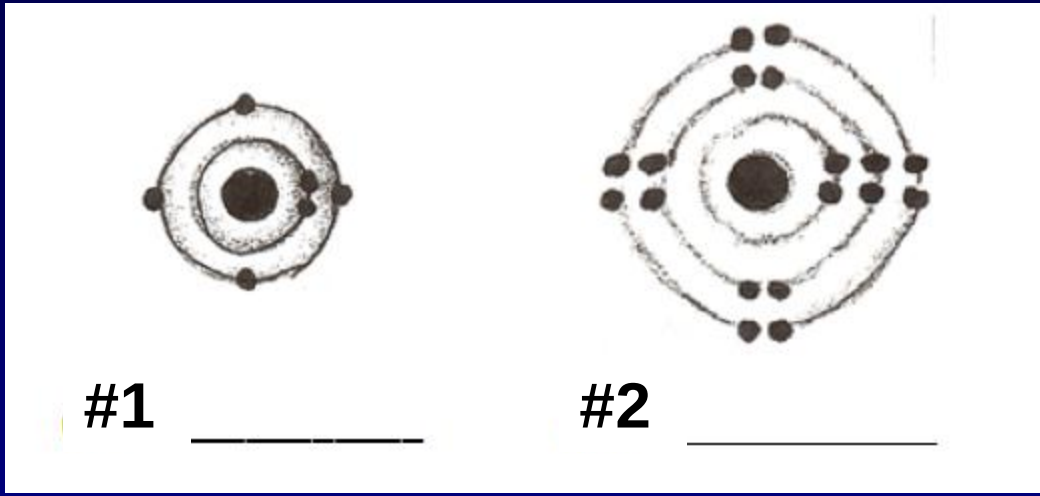
A) 1 = Beryllium and 2 = Neon

B) 1 = Oxygen and 2 = Sulfur

C) 1 = Neon and 2 = Silicon

D) 1 = Carbon and 2 = Argon

Q3. Using the Table on p 20, figure out which elements these dot diagrams represent:



A) 1 = Beryllium and 2 = Neon

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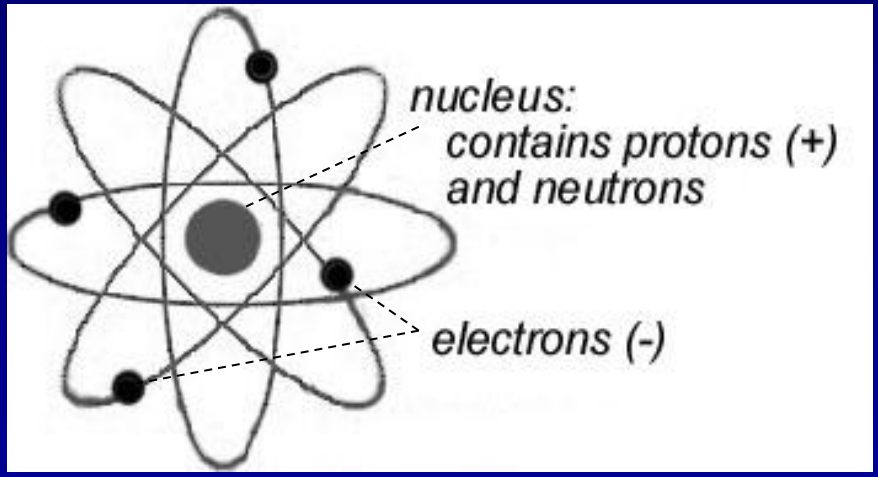
C) 1 = Neon and 2 = Silicon

D) 1 = Carbon and 2 = Argon

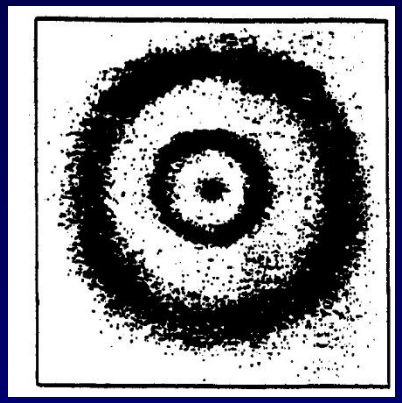
THE EARLY PLANETARY MODEL OF THE ATOM . . . .

Electrons "orbiting" the nucleus



VS. . . . .

The BOHR MODEL OF THE ATOM:



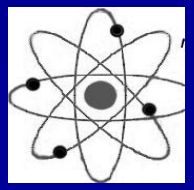
According to Neils Bohr's model of the atom,

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

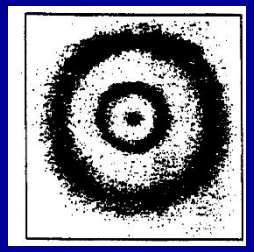
. . . .there are only certain "allowed orbits"

- 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.

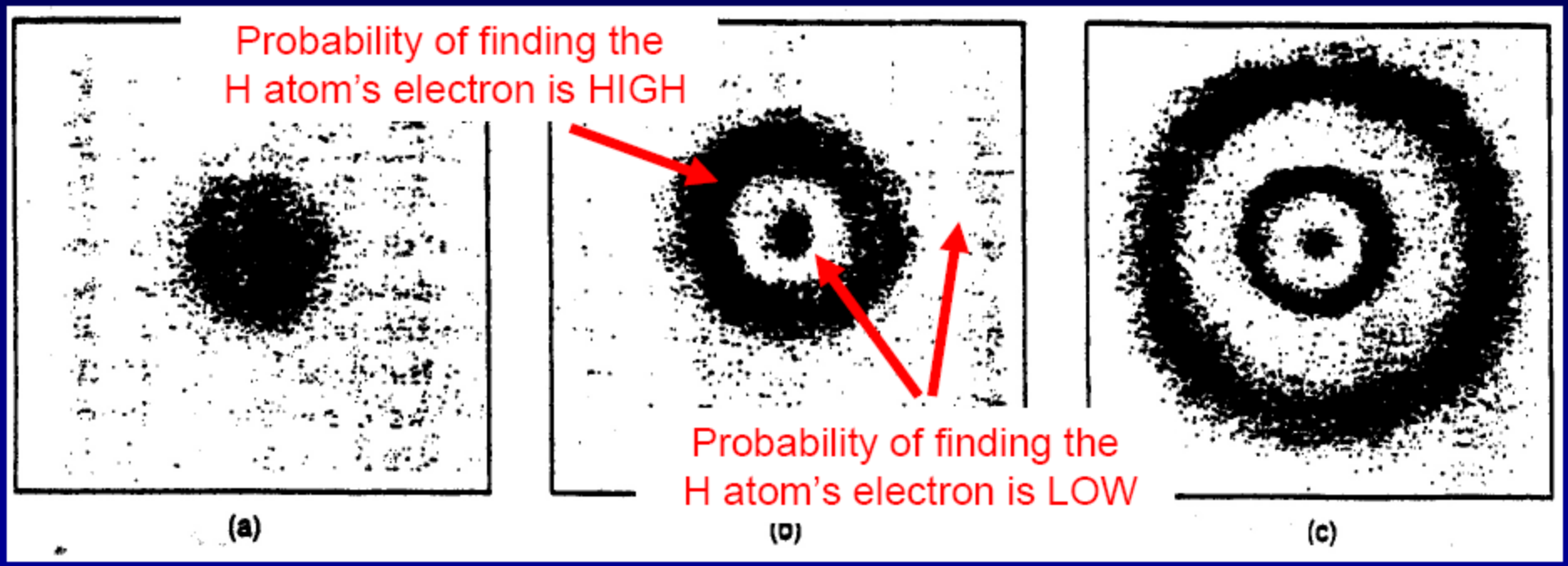


vs.



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

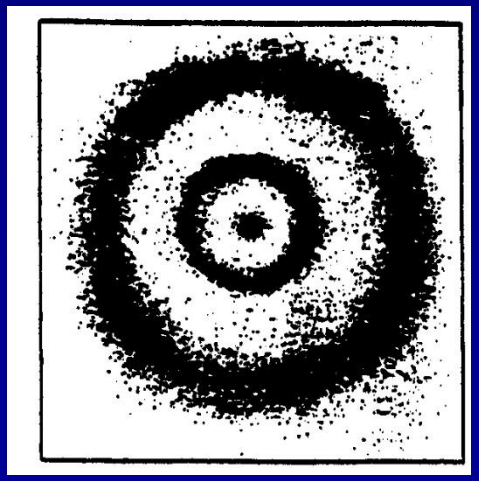
REMEMBER: HYDROGEN has only ONE electron!

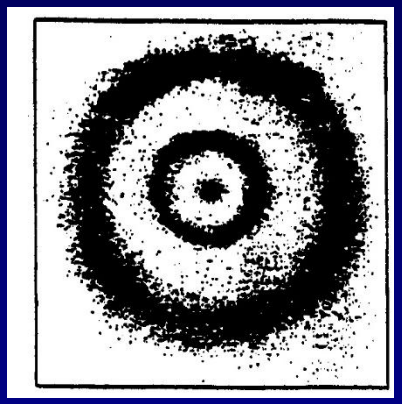


GROUND State **Excited State 1** **Excited State 2**

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

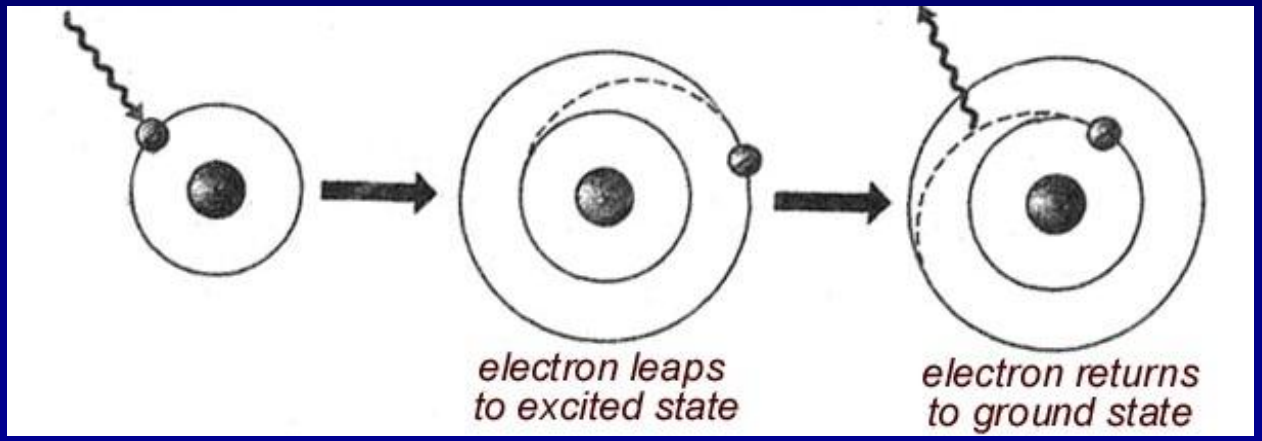
. . . BUT HOW DO THEY GET FROM ONE ENERGY LEVEL TO ANOTHER???

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

-- but according to

quantum mechanics.

Energy Absorbed → Energy Released

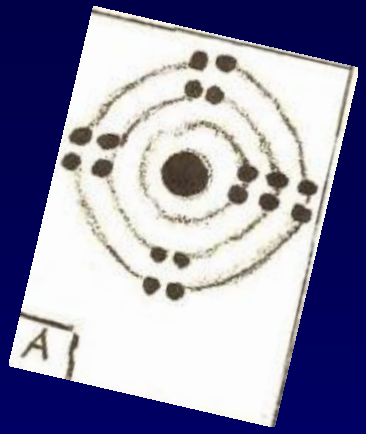


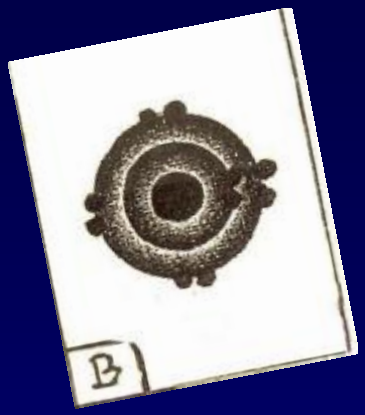
MORE on how this happens and what it has to do with GLOBAL CLIMATE CHANGE in upcoming lectures!!

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

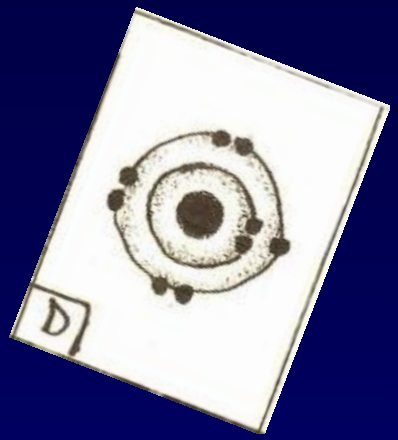
"HANDS ON"
LEARNING ACTIVITY

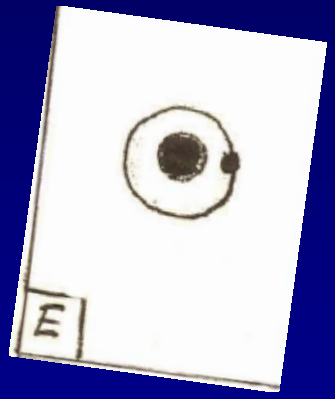
Go to the Class Notes Appendix pp 111 - 115

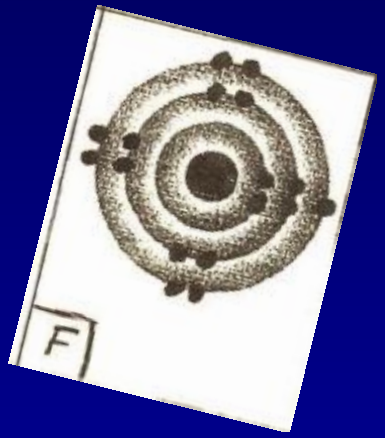

A

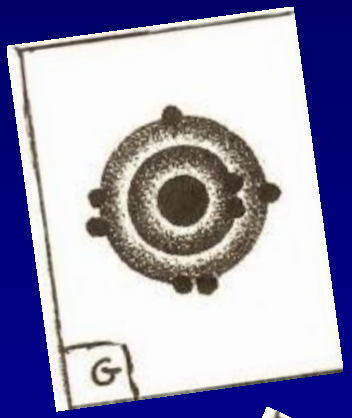

B


C

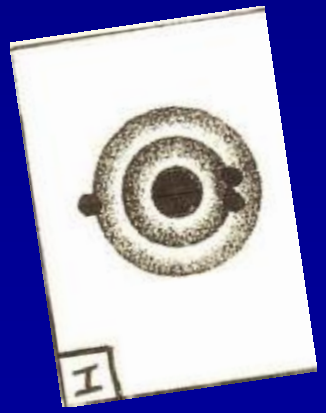

D


E

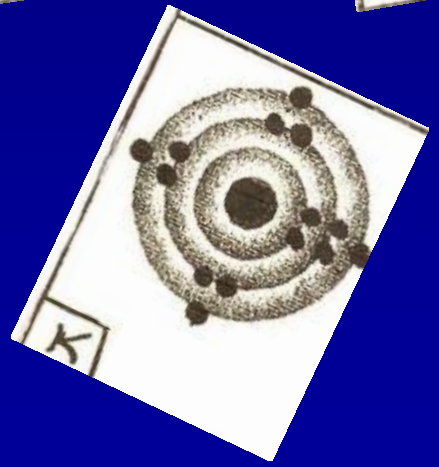

F


G


H


I


J


K

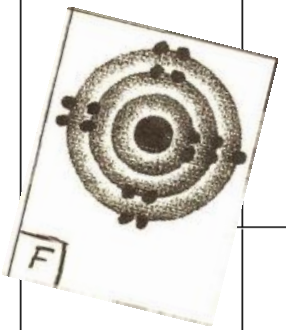
PLACE THE ATOMS ON THE BLANK PERIODIC TABLE in the right location,

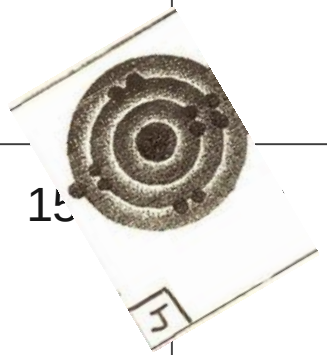
then answer the rest of the questions on p 111

GAP

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

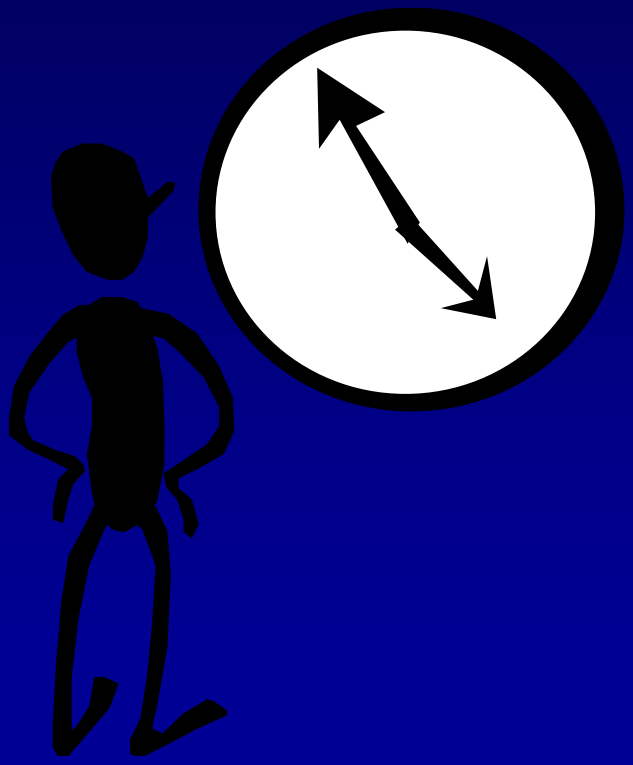
Pair up with one or two classmates & arrange your atoms!





Page 157

p 113

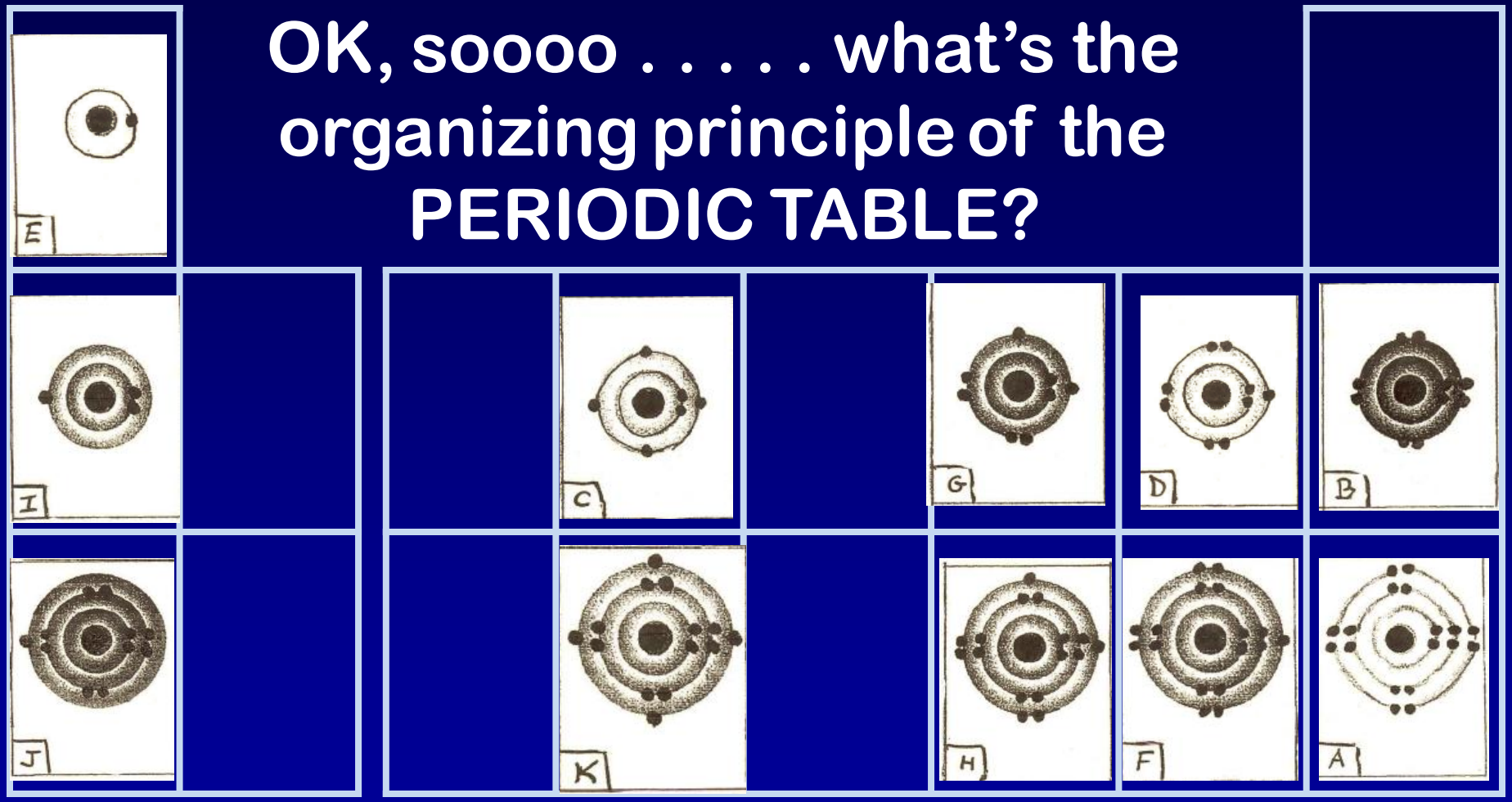


IT'S TIME TO END YOUR DISCUSSION . . .

PLEASE WRAP IT UP AND QUIET DOWN.

Which elements go in which row + column?

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



[Table is on p 113 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

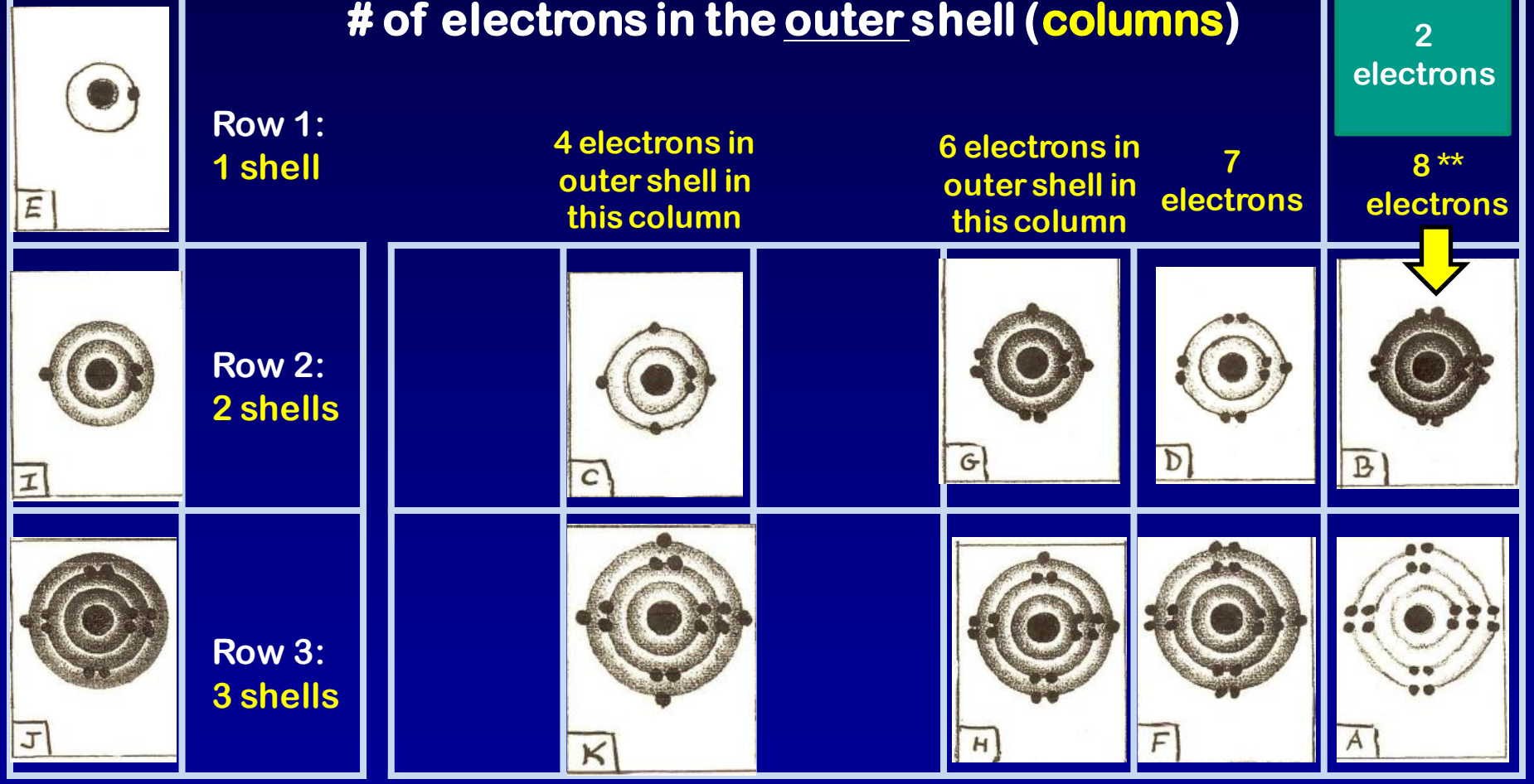
Row 1: 1 shell

4 electrons in outer shell in this column

6 electrons in outer shell in this column

7 electrons

8 ** electrons



Row 2: 2 shells

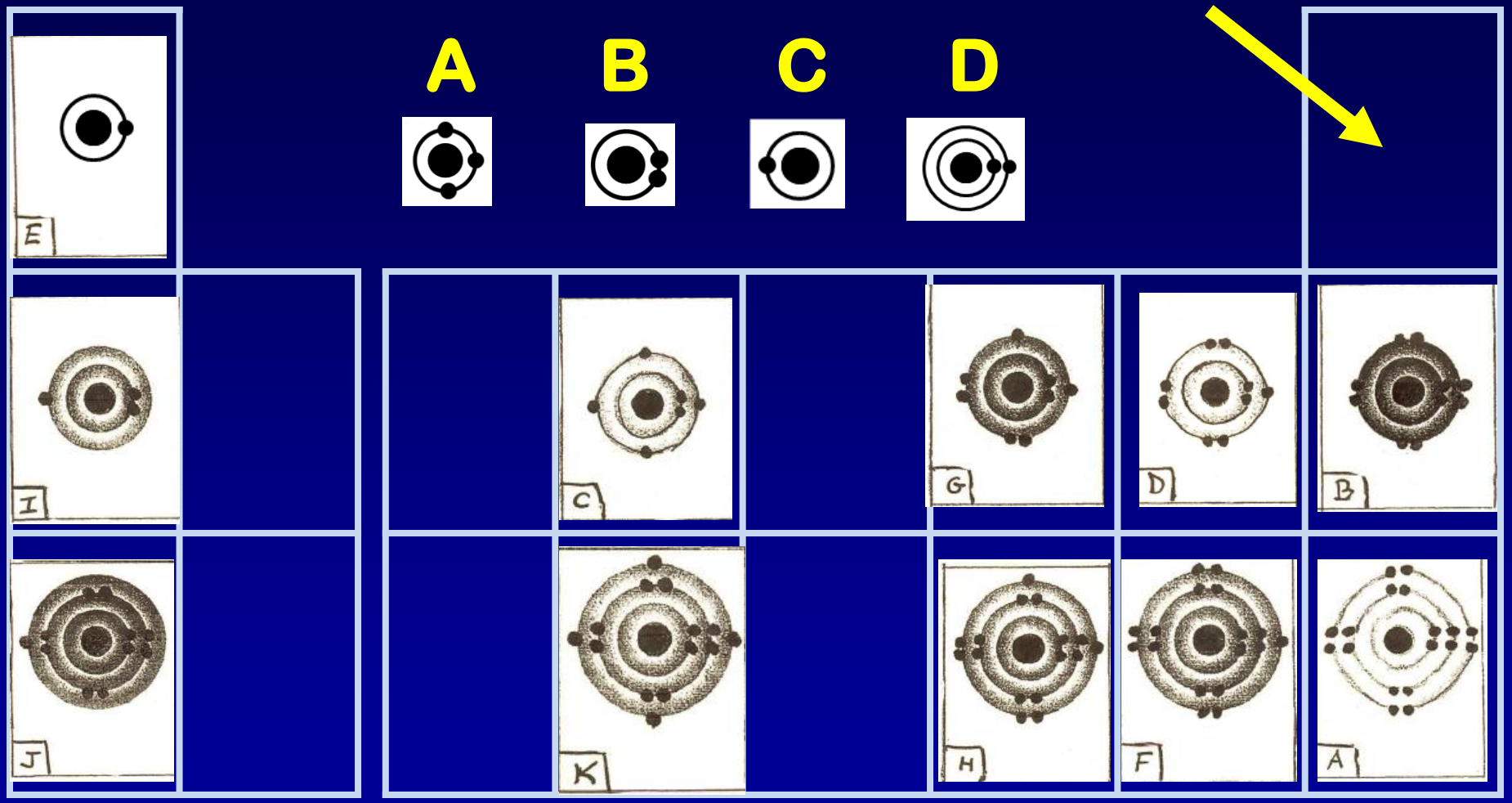
Row 3: 3 shells

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

Q4. Which of these is the proper dot diagram for the element in this position?



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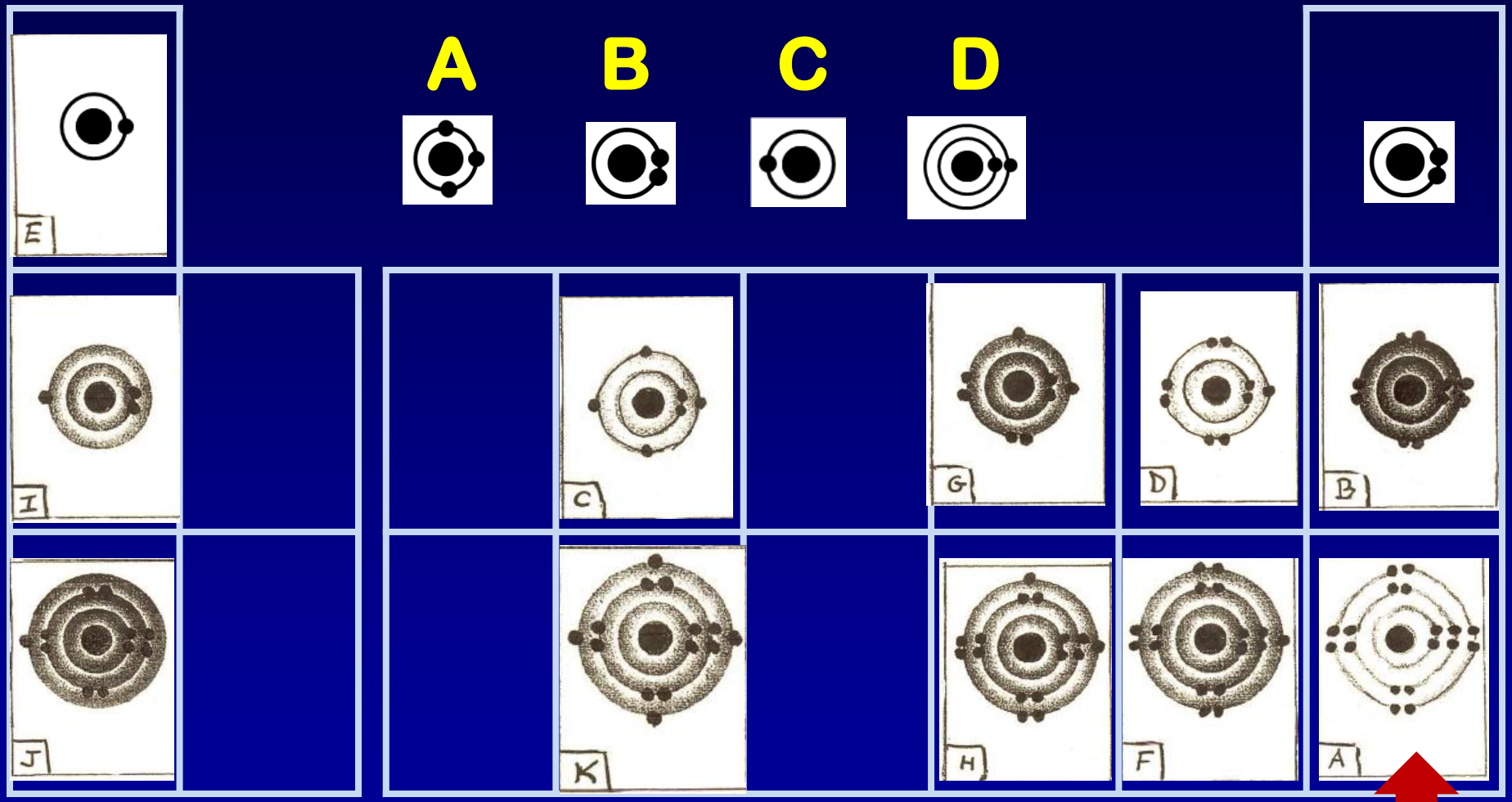


B is correct! Helium (He)

Noble Gases (stable)

QUICK
ENERGY REVIEW

Energy Terms & Units

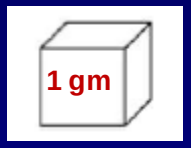
Energy (def) = the quality of an object that enables it to do “work;” the ability to do work.

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

HUGE AMOUNTS OF ENERGY ARE 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!

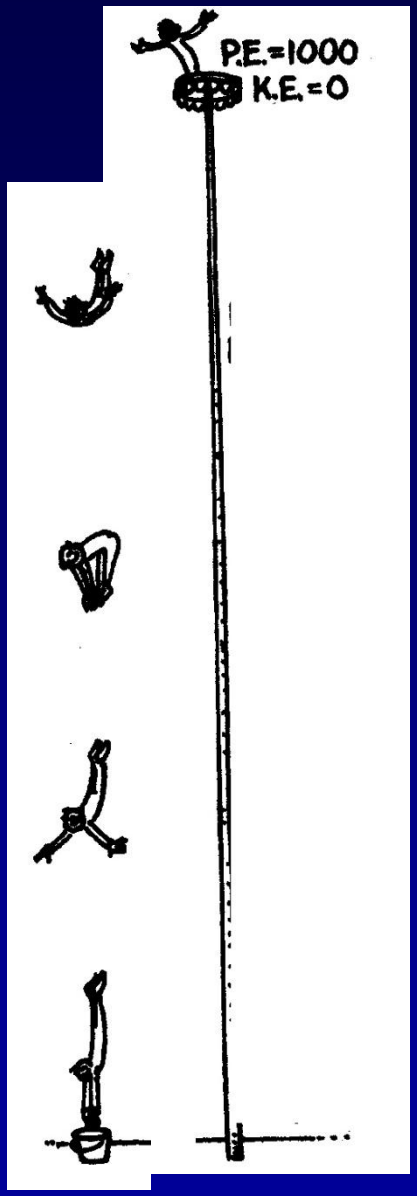
http://www.nhc.noaa.gov/

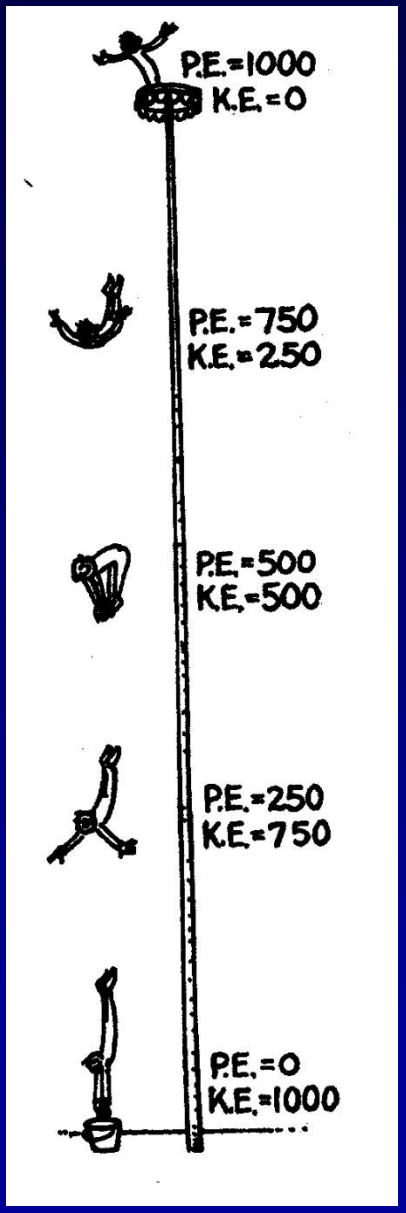
Different Forms of Energy

- **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 . . .

Especially important for THIS class are:

ELECTROMAGNETIC & THERMAL ENERGY

Especially important for THIS class are . . .

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:***

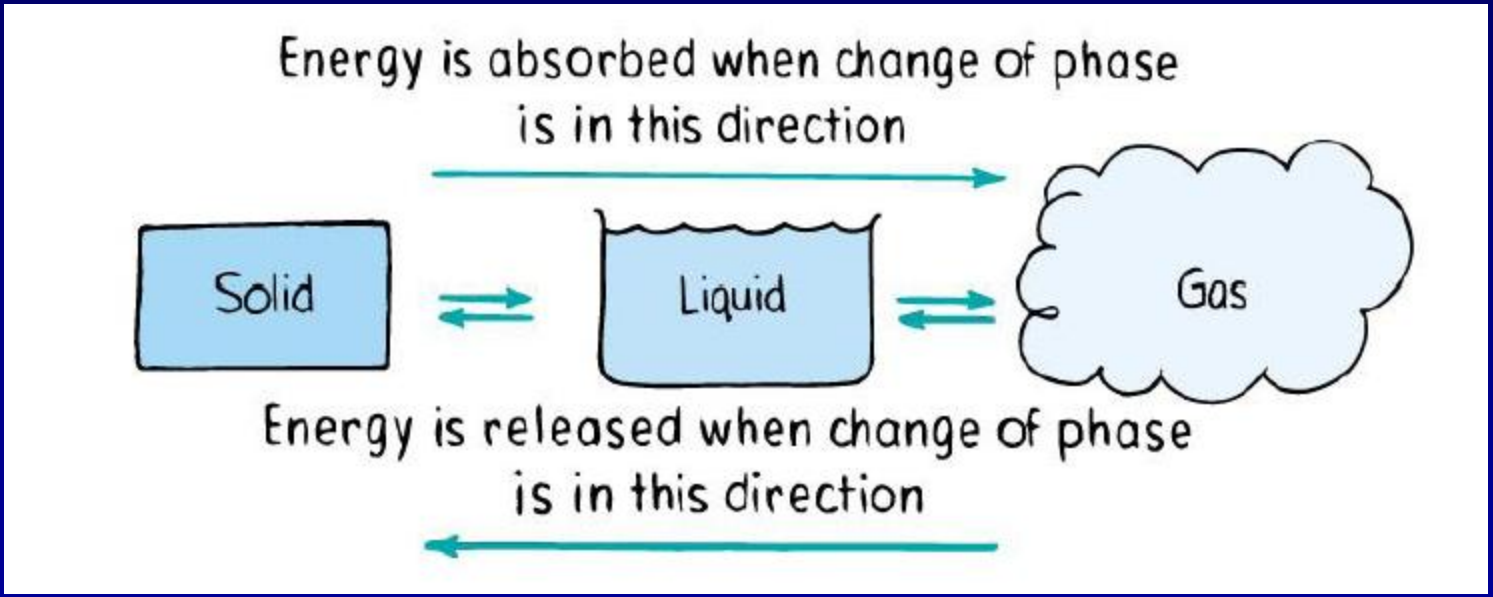
Although energy may not be destroyed, it can become **INEFFICIENT**

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



Recap of ANNOUNCEMENTS

- **REMINDER:** Online Quiz **RQ-1** was cutoff 30 minutes before class today!

  Didn't make the deadline?? **FAQ #22**

- **ASSIGNMENT:** Linking-to-Life Project Part A (Ecological Footprint) due in the DROPBOX next TUESDAY, SEP 10th 30 minutes before class

- ON Tuesday, please bring your FOOTPRINT RESULTS WITH YOU to class – we'll be discussing them. If you want to bring them on a TABLET or LAPTOP (instead of hard paper copy) on Tuesday, the ban on electronic devices will be lifted temporarily.

Have a great weekend!

GO CATS!