CLASS STARTED WITH TRAINING ON HOW TO GET YOUR CLICKER SET UP:

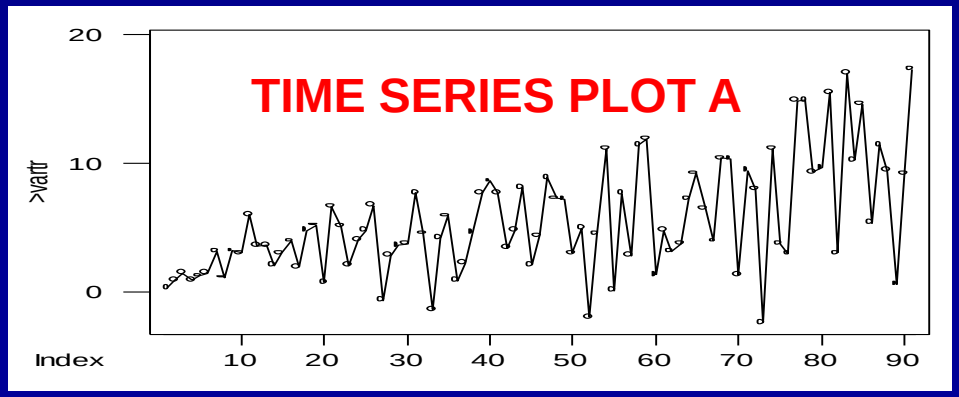
1) Remove plastic strip (if you haven't yet)
2) Press any key to turn it on
3) Select Menu: Change Channel? Y
4) Press #'s for Channel 40
5) Hit ENTER / then hit Menu a couple times
6) Be sure you are in Presentation Mode & Channel 40 / wait for screen to go blank

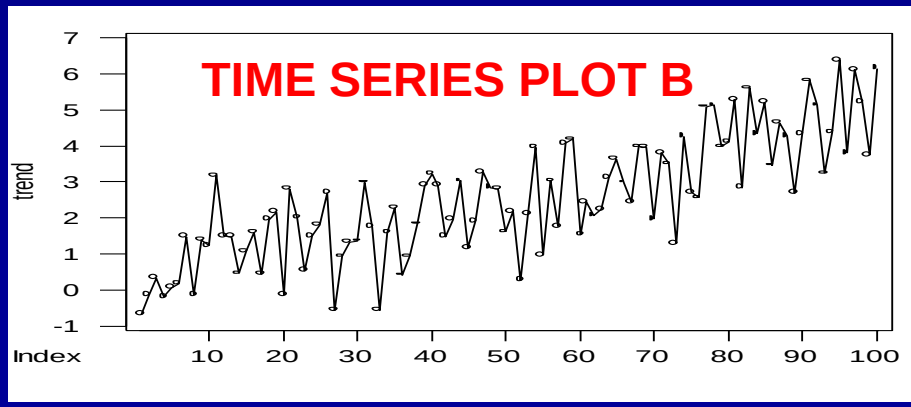
YOU ARE READY TO BEGIN!

Then we had a practice CLICKER Questions based on last Tuesday's class:

Q1. What is the difference between Time Series Plots A & B?

1. Plot A depicts a constant mean over time, but Plot B does not
2. Plot A doesn't depict any trend, but Plot B does
3. Plot A depicts increasing variance over time, but Plot B does not
4. Plot A is periodic but Plot B is not
5. There is no difference – they are both random plots with no trends





The right ANSWER is shown in the RED BOX below:

Q1. What is the difference between Time Series Plots A & B?

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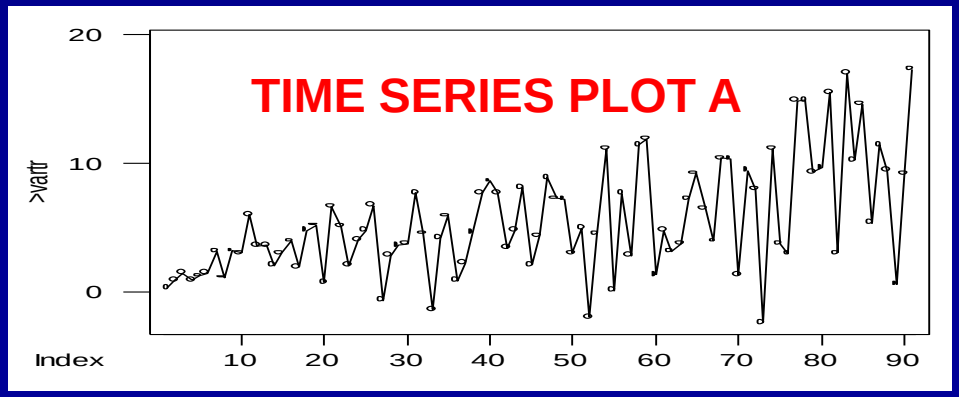
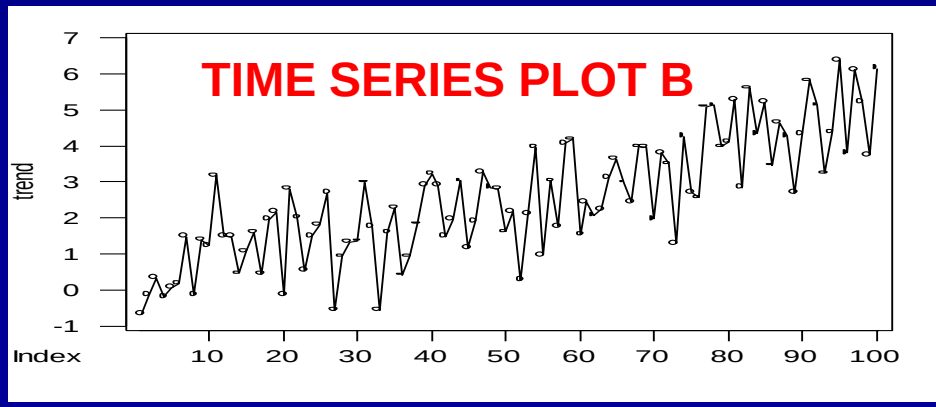
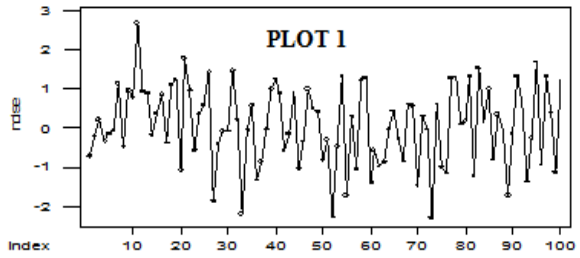
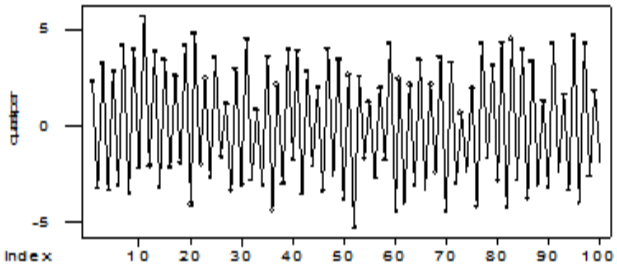




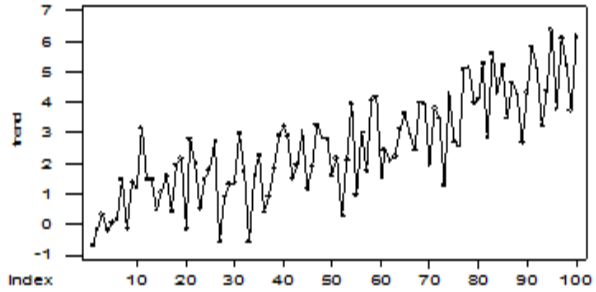
NEED TO REVIEW?

HERE'S A REPEAT OF ANSWERS TO TIME SERIES GRAPHS FROM TUESDAY'S CLASS

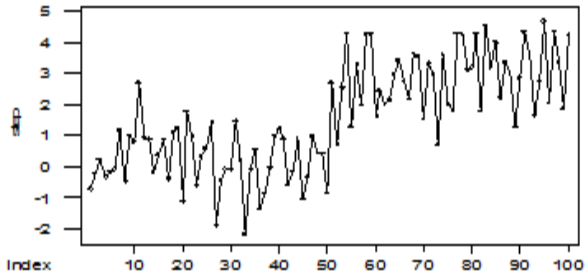




PLOT 2



PLOT 3



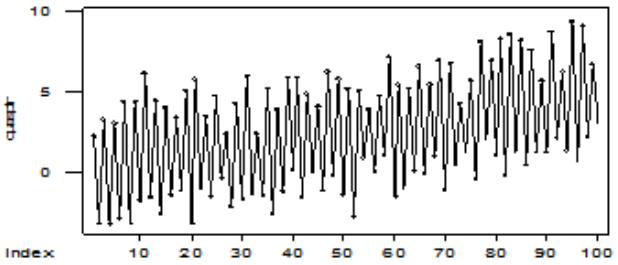
PLOT 4

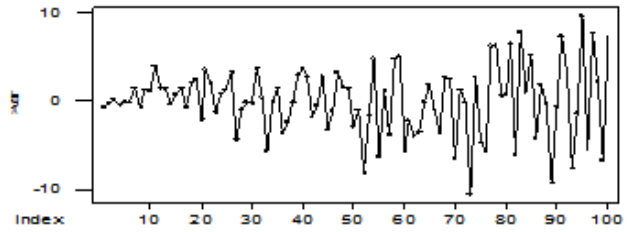
PLOT #1: "White noise" (random fluctuations) but with constant mean and variance [answer given for you]

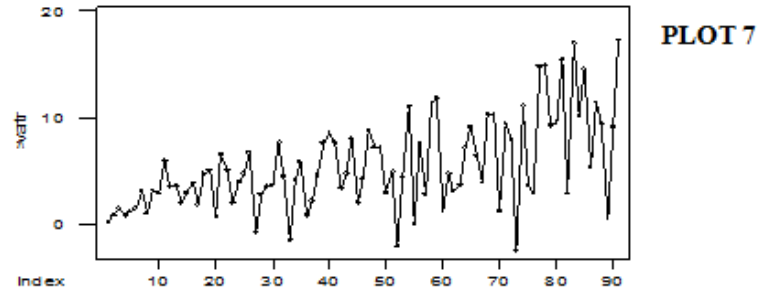
PLOT #2: **"**Quasi-periodic plot" with constant mean and variance. [Graph goes up and down very regularly (periodically); the mean stays the same, the range of fluctuations above and below the mean stays about the same over time.]

PLOT #3: "Trend" plot with the mean increasing over time, but a constant variance. [Graph shows trend of increasing values and increasing mean; the range of fluctuations is about the same.]

PLOT #4: "Step change" plot with an abrupt jump between two series like Plot 1. [Graph shows a "jump" or abrupt change between two different time series, each having a constant mean and variance]







PLOT #5: "Quasi-periodic with upward trend" plot [Graph shows an increasing trend and increasing mean, but has regular periodic ups and downs above and below the increasing mean.]

PLOT #6 "Increasing variance but constant mean" plot. [Graph's mean is constant but the range of fluctuations above and below the mean increases over time.]

PLOT #7 "Trend with increasing mean and increasing variance" plot [Graph had both an increasing mean and an increase in the range of fluctuations above and below the mean over time – the extremes are getting bigger!]

KEELING CURVE QUESTION:

Answer = Plot #5 WHY? The Keeling curve shows an increasing trend with a regular to quasi-periodic oscillation

Plot #3 is the second best answer.)

ASSIGNMENT I-1 FOOTPRINTS & GLOBAL CHANGE (See ASSIGNMENTS in D2L)

PART A is due IN CLASS next TUESDAY Sep 7th

You will turn in a form with the results of YOUR FOOTPRINT CALCULATIONS for:

1) ECOLOGICAL FOOTPRINT
   http://www.footprintnetwork.org/en/index.php/GFN/page/calculators/

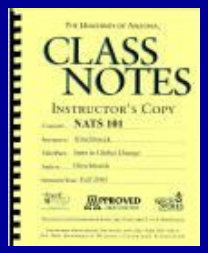
2) CARBON FOOTPRINT
   http://www.nature.org/initiatives/climatechange/calculator/

3) WATER FOOTPRINT
   http://www.waterfootprint.org/?page=files/home

Topic #4
ENERGY & MATTER
OVERVIEW

OBJECTIVES:

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



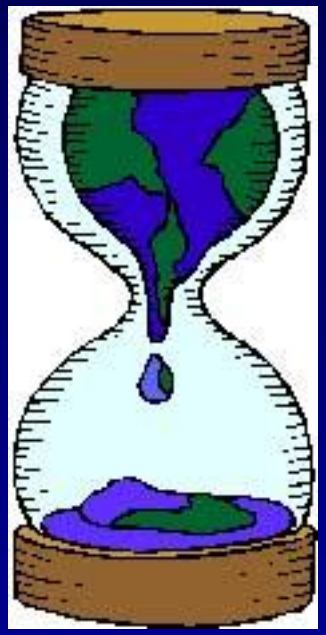
CLASS NOTES: pp 21 - 25

"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

LINK TO GLOBAL CHANGE:



These concepts provide the ‘foundation’ for understanding:

a) the important energy fluxes (transfers) in the Sun-Earth-Atmosphere system, and

b) the important moisture fluxes and phase changes of water (H_2O) at the Earth-Atmosphere interface.

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.

One joule equals the work needed to lift one kilogram (2.2 pounds) ten centimeters off the ground. It can also be used to measure heat energy. One kilocalorie, an older energy unit, equals 4.1868 kilojoules.

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

1 calorie = 4.186 joules

1 calorie per second = 4.186 watts

(1 “calorie” in nutrition context = 1000 calories = 1 kilogram calorie or kilocalorie (Kcal)

HOW MUCH ENERGY IN A HURRICANE?

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

V) is done
) is exerted
Work is
at is exerted
over which it

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
  - Includes: **gravitational, elastic, chemical, electrical, magnetic, nuclear, thermal**

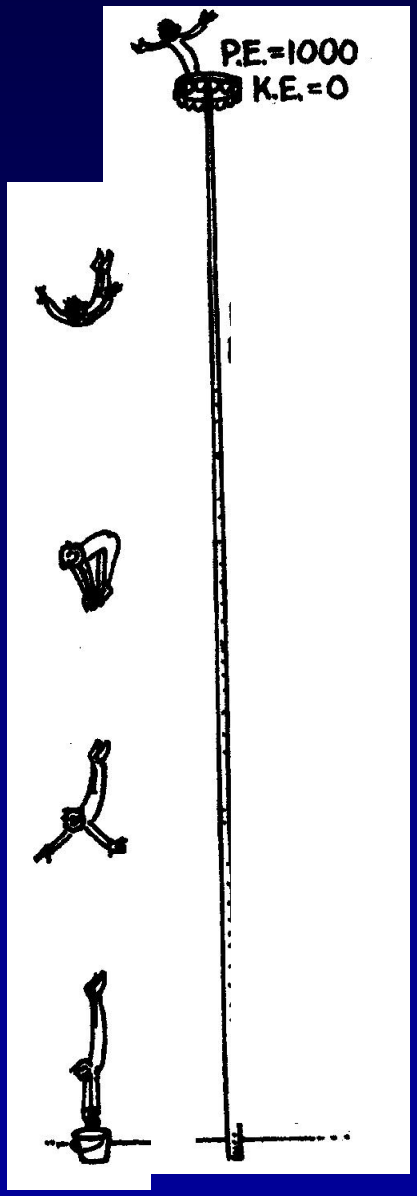
Forms of Energy

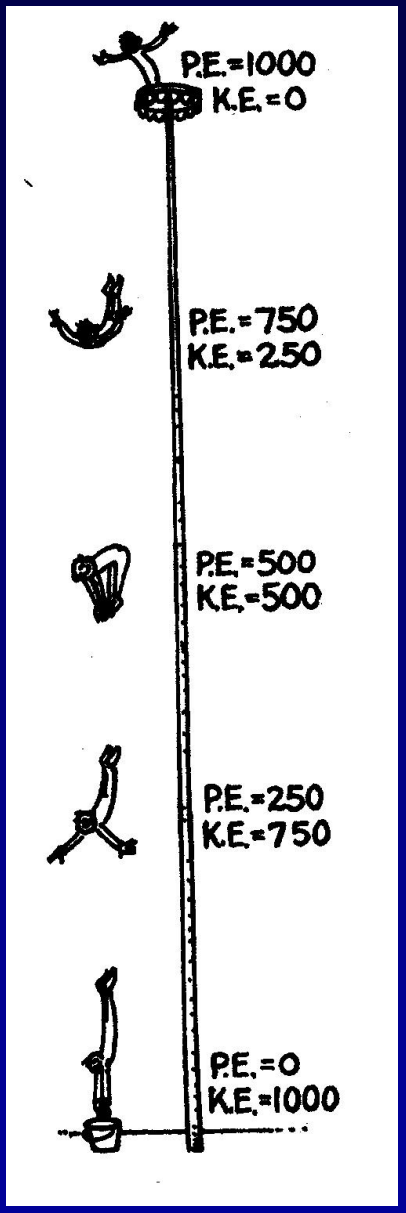
- **Gravitational PE** = energy associated with the position of a mass in a gravitational field, *energy stored by virtue of its position*

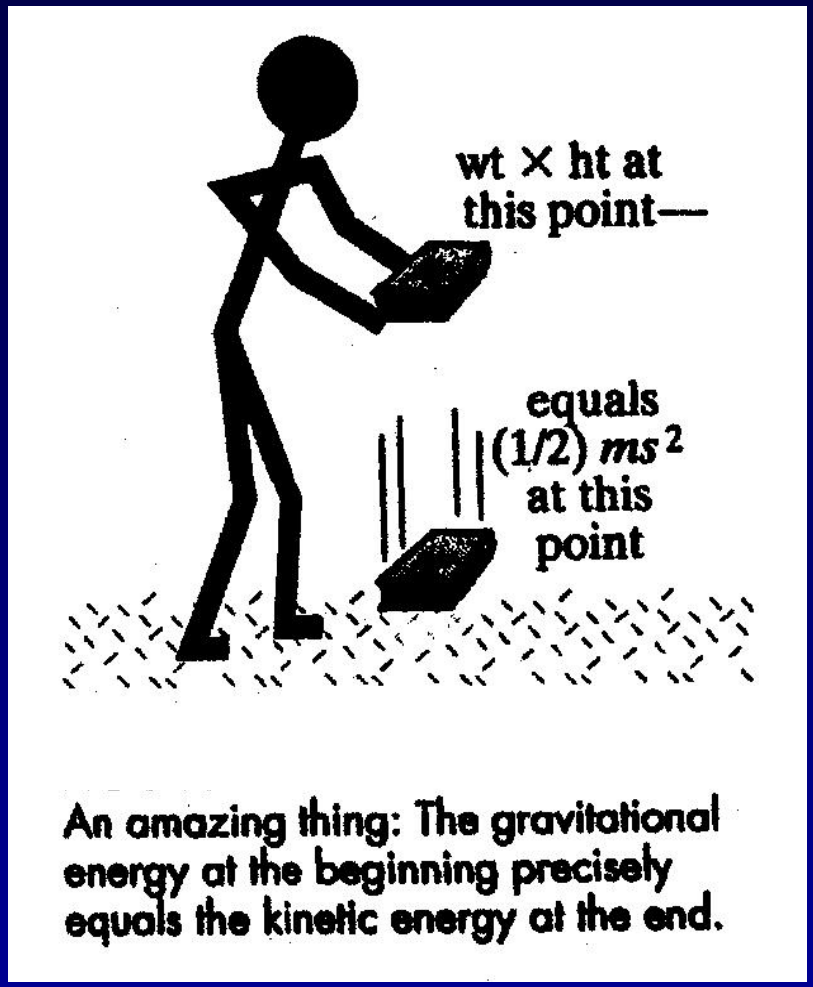
  GravE = weight x height = wt x ht

  Compare with:

  KinE = (1/2) mass x speed ^{2}


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

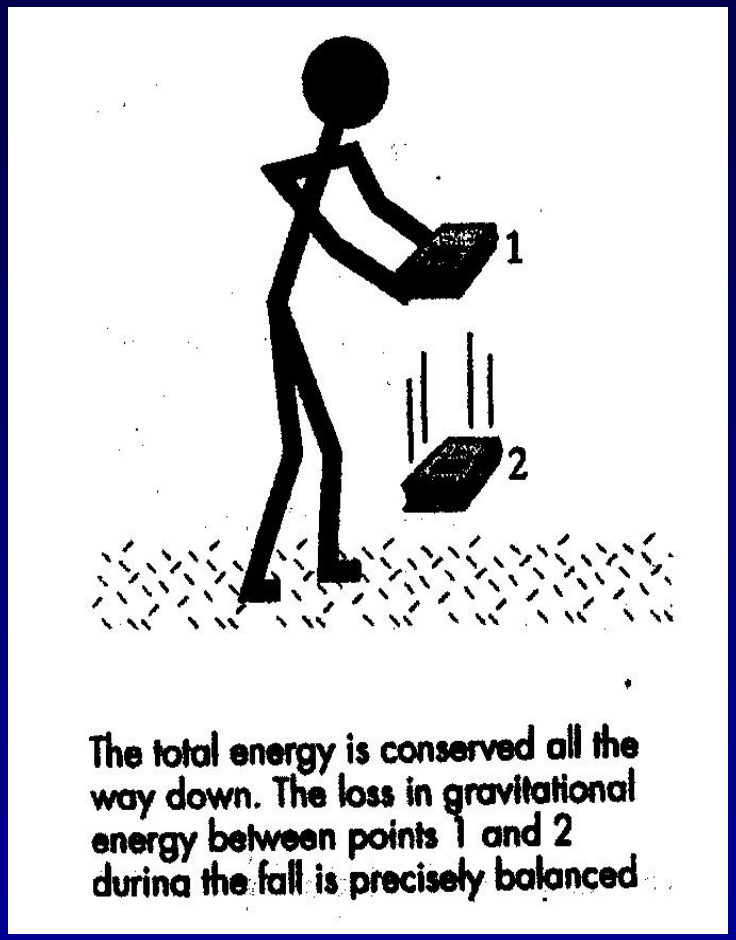

P.E.=1000
K.E.=0
P.E.=750
K.E.=250
P.E.=500
K.E.=500
P.E.=250
K.E.=750
P.E.=0
K.E.=1000



An amazing thing: The gravitational energy at the beginning precisely equals the kinetic energy at the end.

GravE

KinE

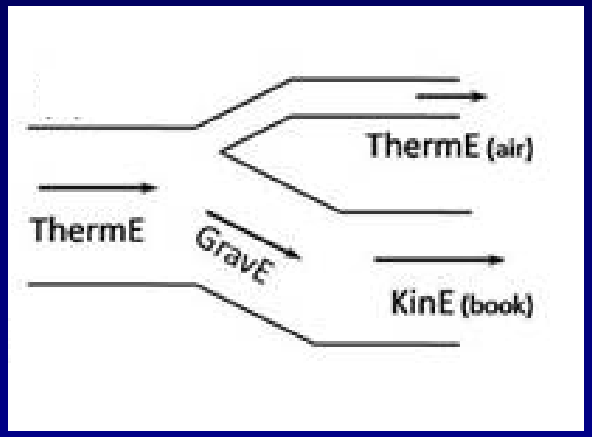


The total energy is conserved all the way down. The loss in gravitational energy between points 1 and 2 durina the fall is precisely balanced

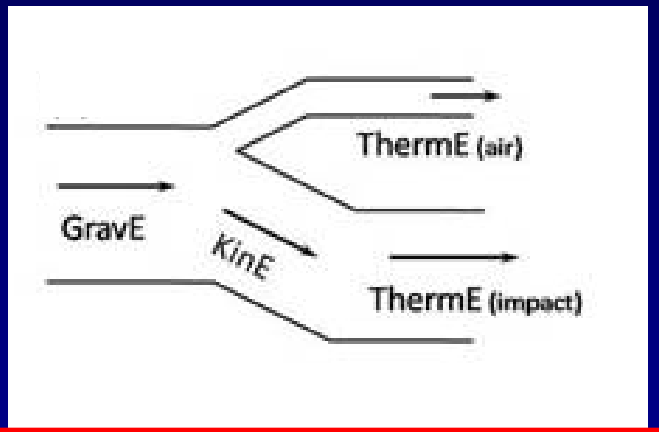
ENERGY IS CONSERVED!

Which figure below depicts an energy flow diagram that properly illustrates the energy transformations that occur with a falling book?

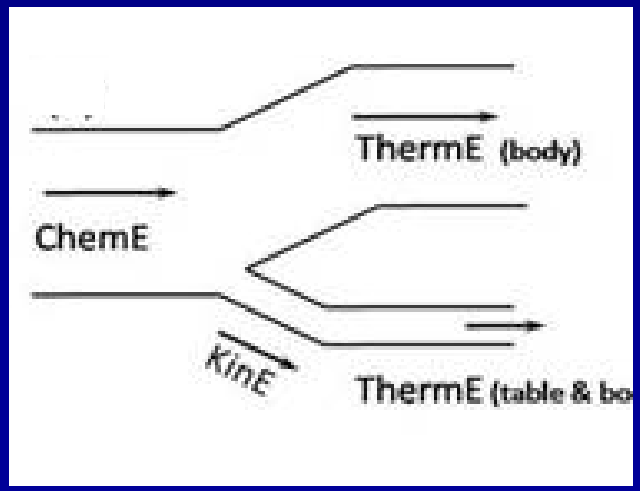
A



B



C



THERMAL ENERGY

Thermal energy (internal energy) =

The TOTAL ENERGY (kinetic + potential) of the particles that make up a substance.

Atoms and **molecules** are constantly "jiggling" in some sort of back-and-forth vibratory motion

*(i.e., they have **kinetic energy, KE**)*

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."

Efficiency:

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

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

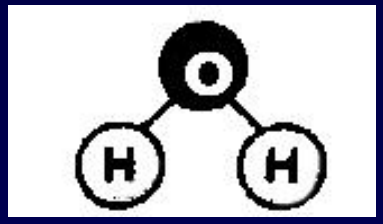
-- the smallest representative sample of an element.

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:



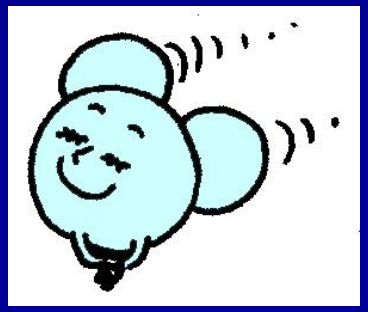
-- Any collection of two or more atoms bound together

-- 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

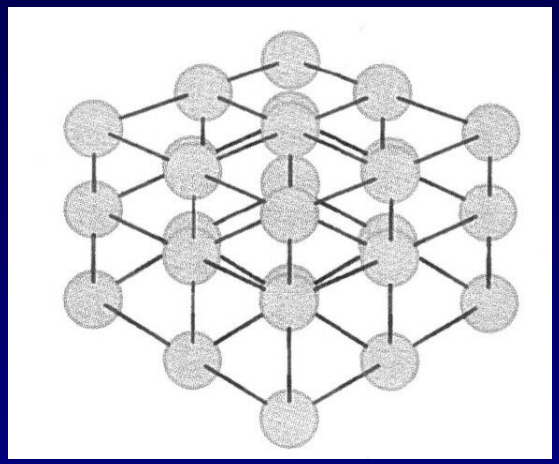
Solid:

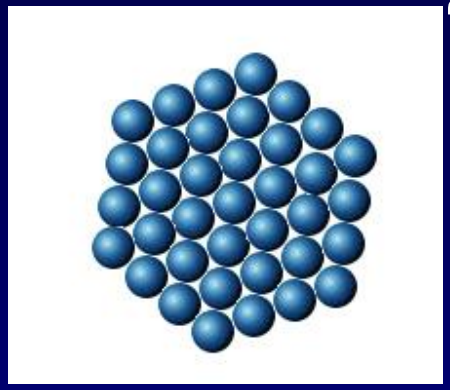
-- a substance that resists changes of shape and volume

-- 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.

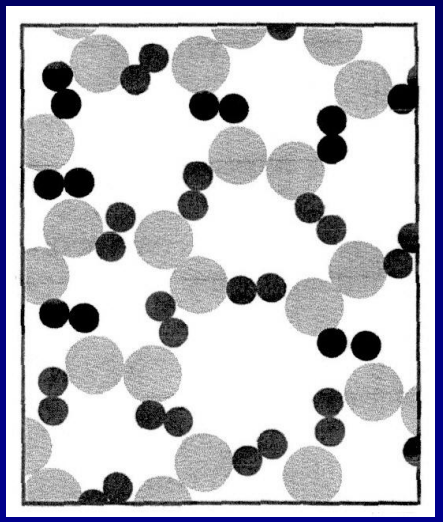
Various Representations of Molecules arranged in a SOLID



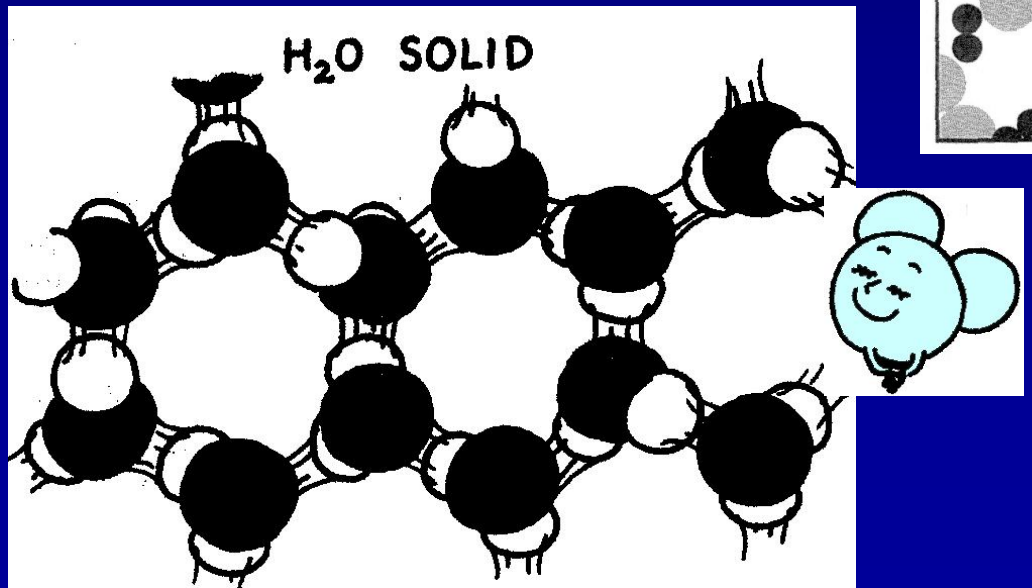


"top down" view of water (H_2O) arranged in solid (ice) form

"top down" view of a Neon crystal



3-D view of a solid crystal structure



Liquid:

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

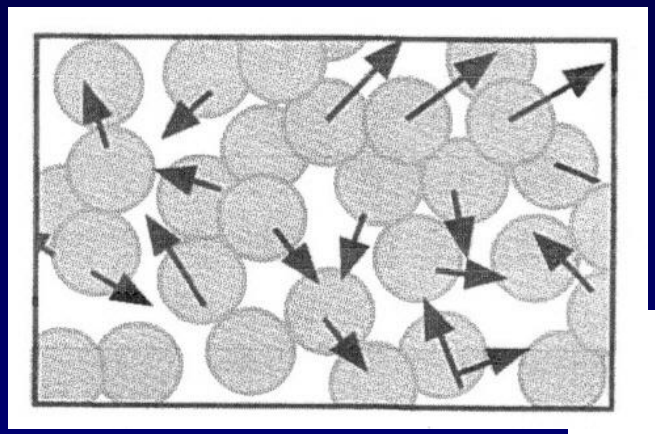
-- molecules more or less move freely past one another as individuals or small groups
-- are not confined to fixed positions (as in solids)

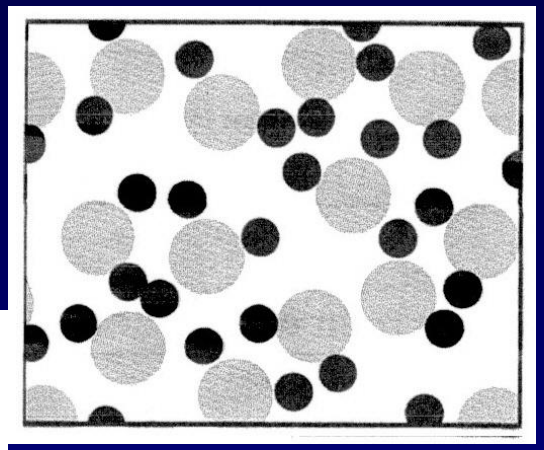
-- LIQUIDS CAN EXHIBIT PRESSURE

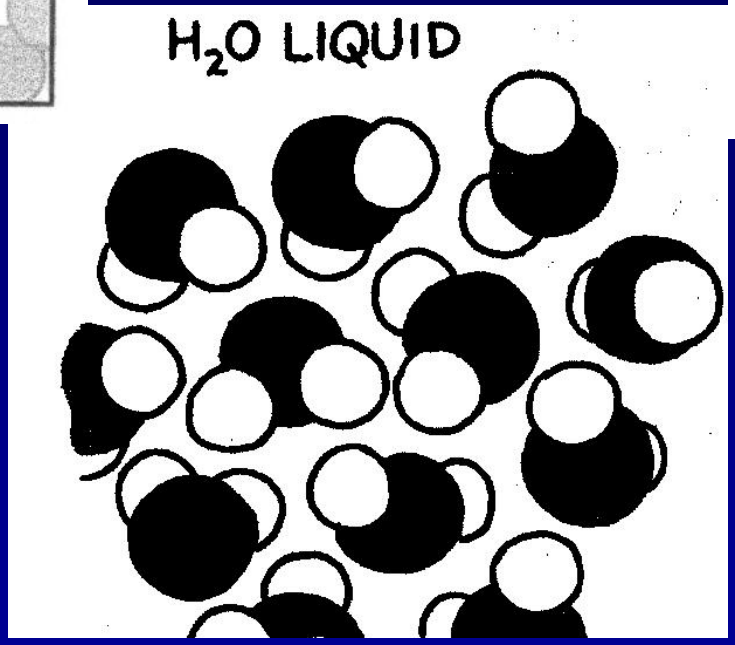
(pressure = a force per unit area)

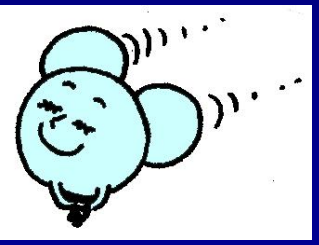
. . . and will take the shape of the container they are in.

Various Representations of Molecules arranged in a LIQUID









Gas:

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

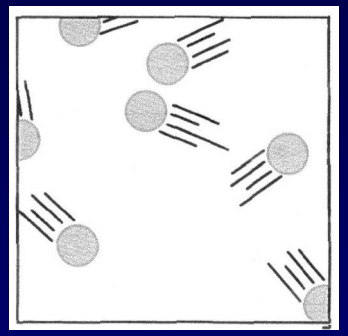
-- fills all space available to it

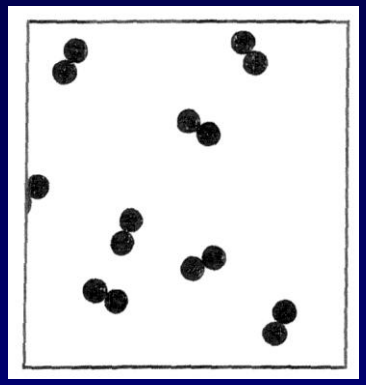
-- takes the shape of its container

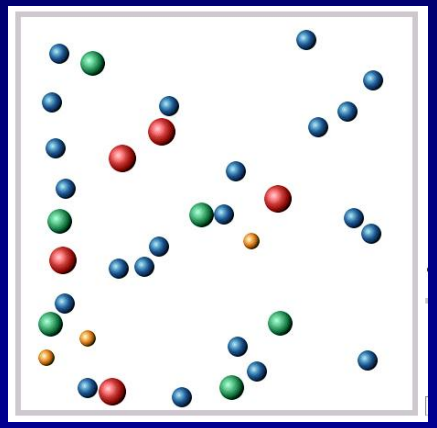
- -- the distance between molecules is such that no cohesive forces exist
- -- atoms or molecules are in high speed motion
- -- many collisions and rebounds occur

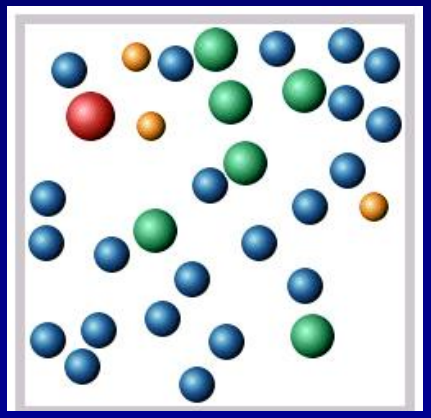
-- GASES ALSO EXHIBIT PRESSURE

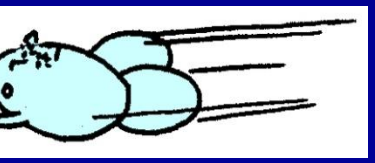
Various Representations of Molecules arranged in a GAS

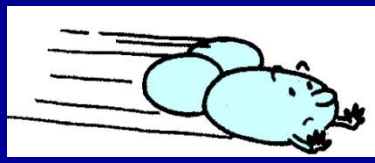








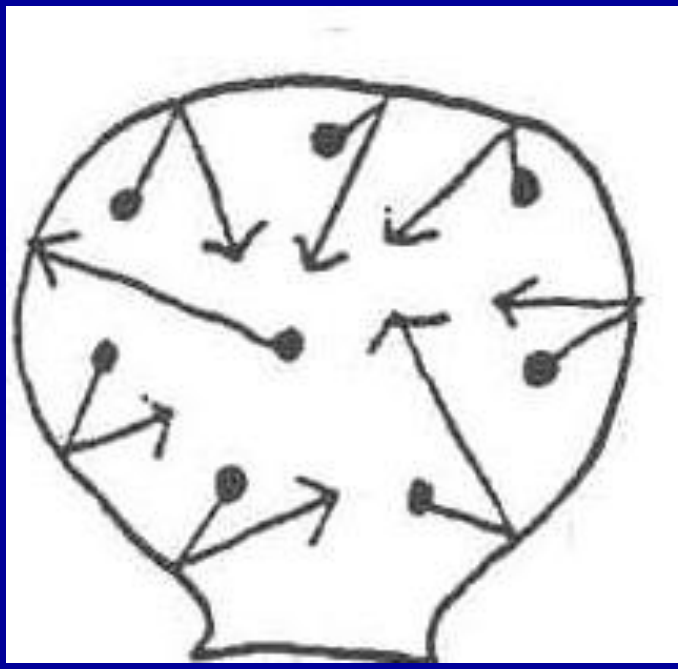


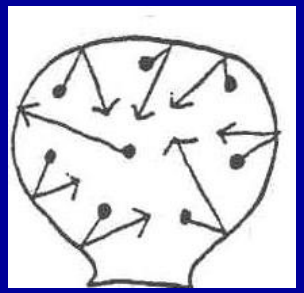


Heat added = increase in total energy + work done against outside pressure

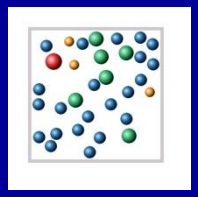
With increasing T (temperature)

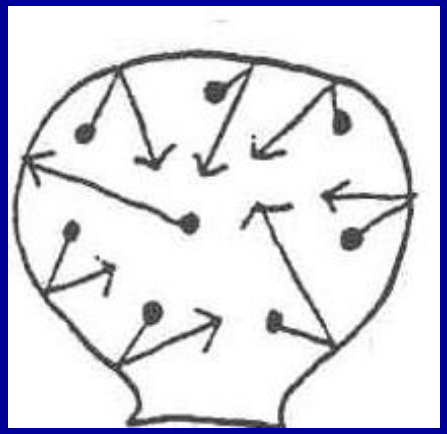
➔ Volume increases &
Density decreases



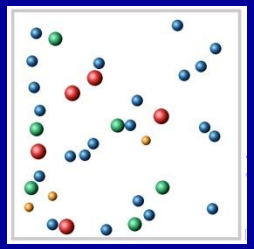


COLD

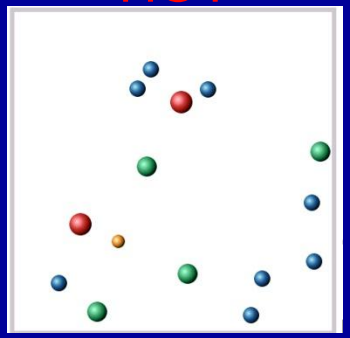


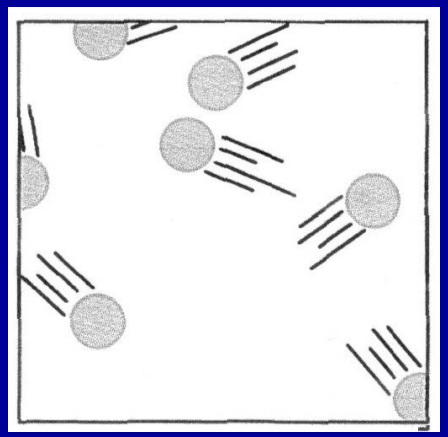


WARM



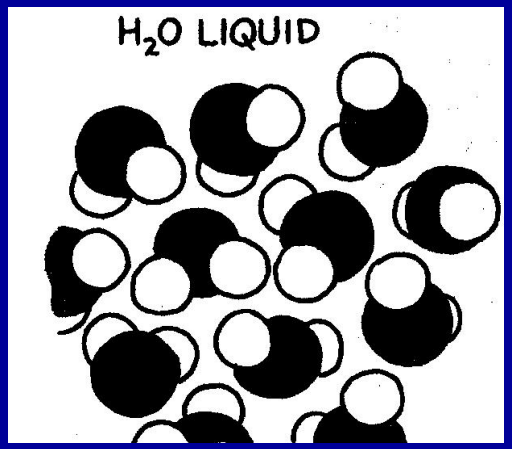
HOT



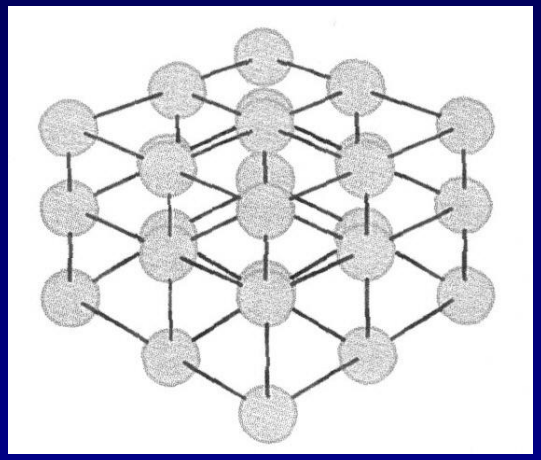


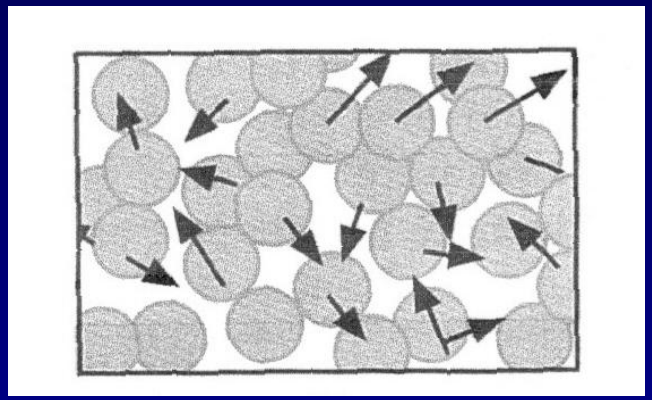
At higher air temperatures, H_2O molecules collide & rebound more frequently, leading to expansion of the air & the water vapor in the air.

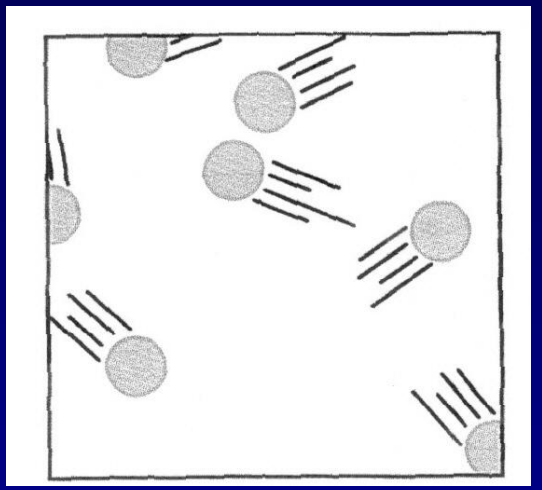
At lower air temperatures as air gets more dense, H_2O molecules are more likely to bond so that a phase change to liquid water or even solid ice can occur.



SUMMARY:







SOLID LIQUID GAS

KEY CONCEPT #1:

ENERGY & MATTER INTERACT

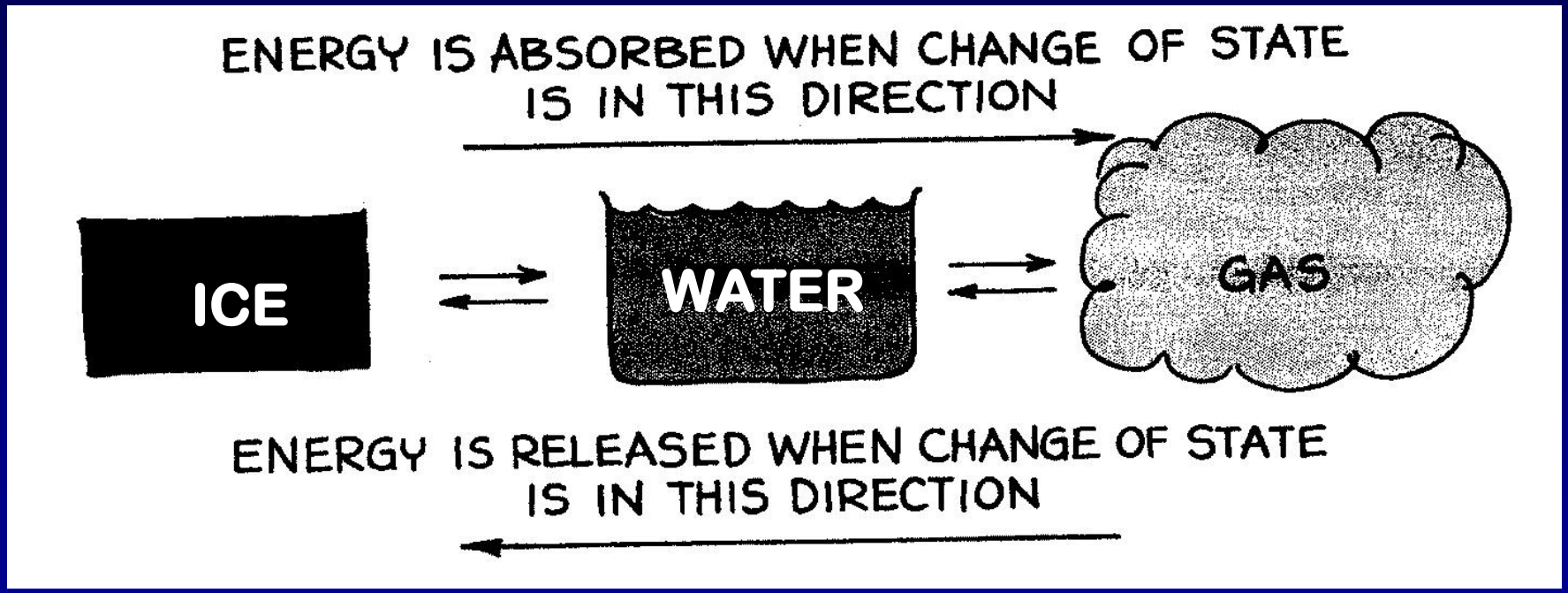
The change in the state of a substance
- **from a solid to a liquid form, or**
- **from a liquid to a gaseous form,**

(or vice versa)

is called a CHANGE OF STATE or PHASE CHANGE.

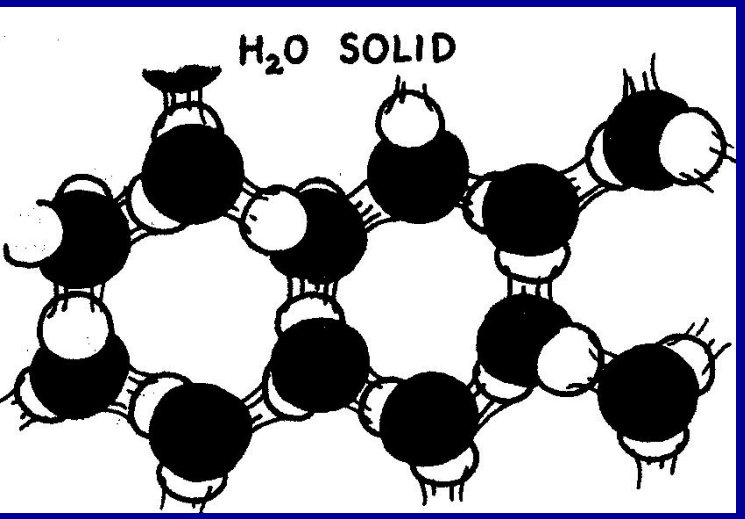
***Thermal energy* is involved in phase changes.**

PHASE CHANGES in H_2O



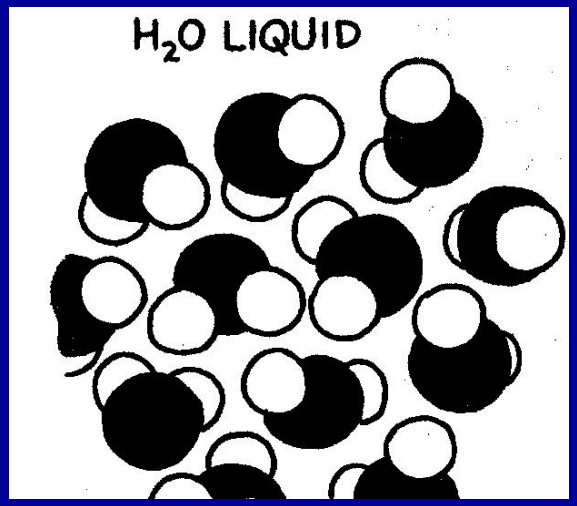
(more on this later in the semester)

H_2O's UNIQUE EXCEPTION at ~ 0º-4 ºC to "rule" of: heating → expansion cooling → contraction



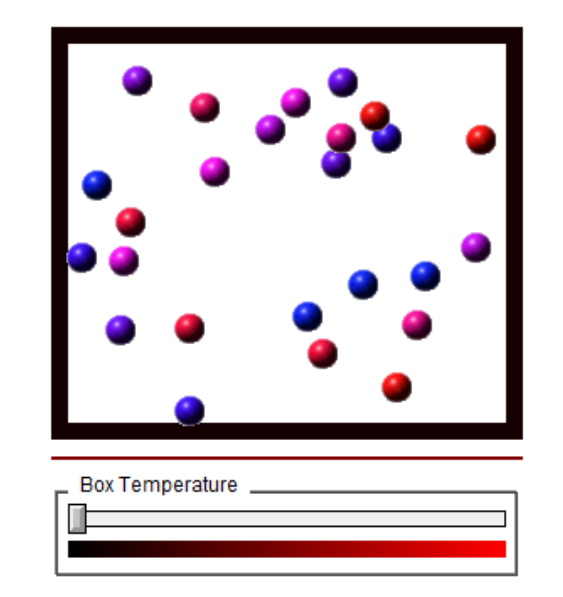
ice → water

PHASE CHANGE



Volume decreases upon heating (in a short range of temperatures) when the phase change occurs from ice to liquid water (due to collapsing ice crystals)

A Simple Demo :



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

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


Arizona Daily Star®
www.dailystar.com® www.azstarnet.com®
Published: 09.31.2006

Ariz. heat cheats drivers at gas pump

standard not enforced, costing $115M yearly in state, study says

spending about $115 million more a year on gasoline and diesel fuel
uel temperatures were regulated to the federal standard, according to

LAT Home | My LATimes | Print Edition | All Sections

"It's a significant number, and one that we shouldn't be paying," said Judy Dugan, research director at Santa Monica-based Consumer Watchdog, formerly called the Foundation for Taxpayer and Consumer Rights. "With every rise in the price of gas, hot fuel becomes a more important issue."

FEDERAL STANDARD:

Fuel at gas pump should be dispensed into a vehicle's tank at a temperature of 60 ºF

If temperature is not 60 º F, the cost of a gallon should be adjusted to reflect the volume of fuel at 60 º F.

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

Rules 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.

THE ATOMIC MICROSCOPE / MOLECULAR DYNAMICS DEMO!

Now let’s focus on 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...

ATOMIC STRUCTURE:

Electron
Nucleus
Proton
Neutron

ELECTRON:

Tiny negatively charged particles that circle in orbits around a positively charged nucleus of an atom.

The electron is an atomic particle with a negative charge and very low mass.

NUCLEUS:

The small, massive central part of an atom; it is made up of elementary particles that are even smaller →

PROTON: Positively charged nuclear particle.

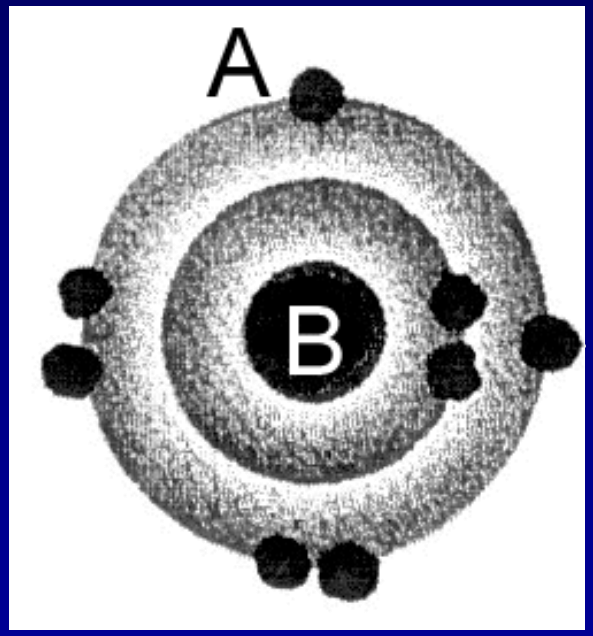
The *atomic number* of an atom is the number of protons, or units of positive charge, in the nucleus. If the atom is neutral -- the atomic number is also equivalent to the number of electrons.

NEUTRON: Electrically neutral nuclear particle, approximately equal in mass to a proton.

(Both protons and neutrons have much greater relative mass than electrons.)

The *mass number* of an atom is the total number of protons and neutrons in the nucleus of the atom.

Schematic “dot” diagram of an oxygen atom



Fill in blanks on p 24

A = ELECTRON

B = NUCLEUS

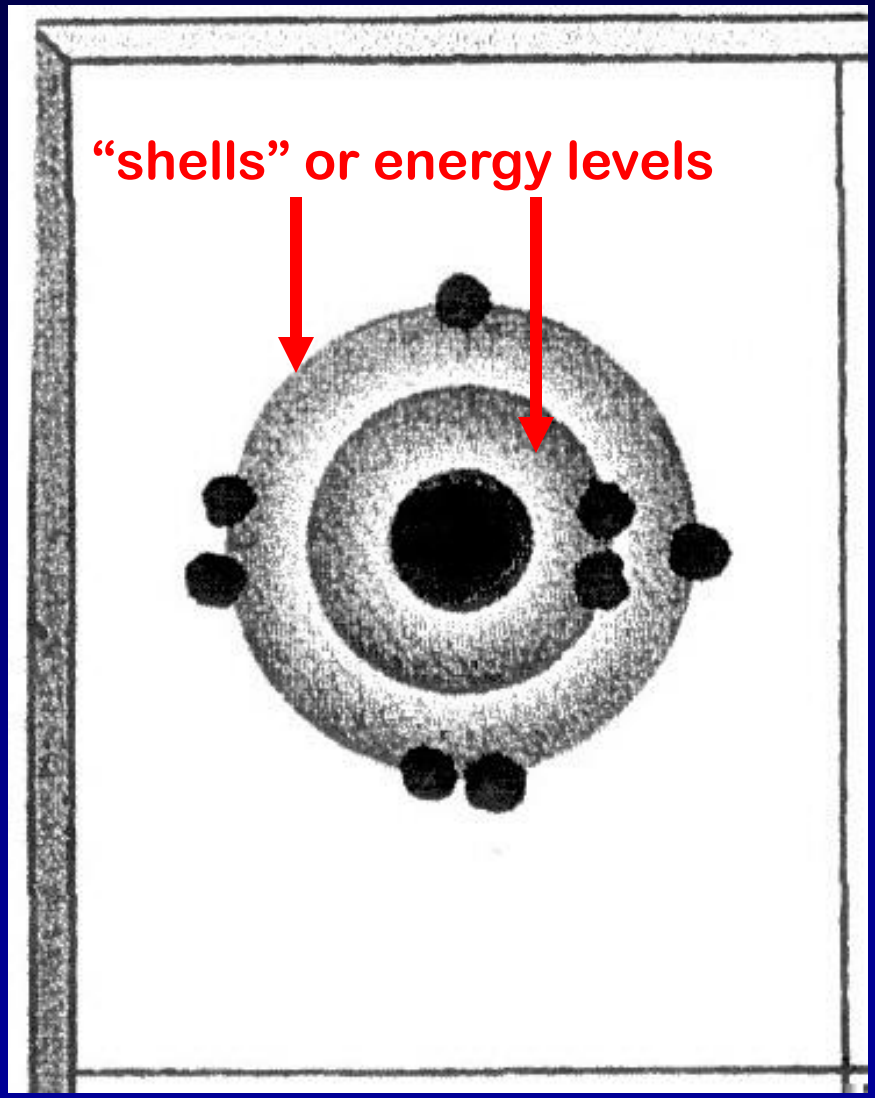
 # electrons = 8

 # protons = 8

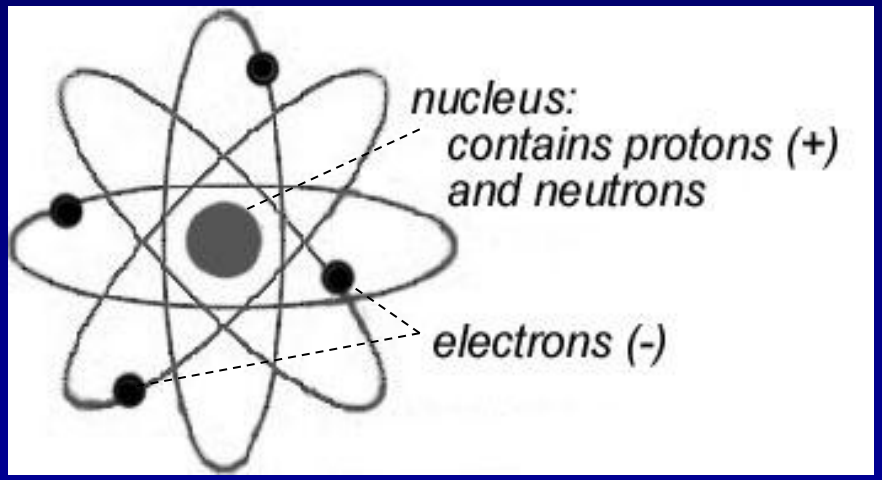
 # neutrons = 8

atomic # = 8

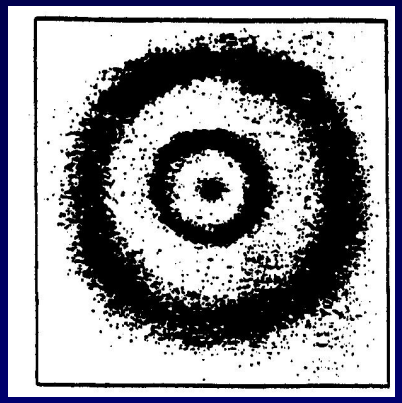
Review the details about “shells” and “energy levels” on p 25 (on your own later if necessary)



THE PLANETARY MODEL OF THE ATOM



The BOHR MODEL OF THE ATOM:



According to Neils Bohr's model of the atom,

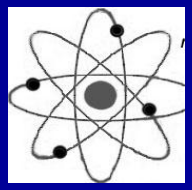
electrons circling the nucleus cannot maintain their orbits at just *any* distance from the center of the atom (the early model).

p 25
(1st bullet)

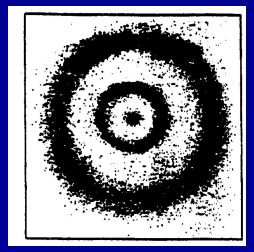
There are only certain "allowed orbits"

- in which an electron can exist for long periods of time without giving off radiation.

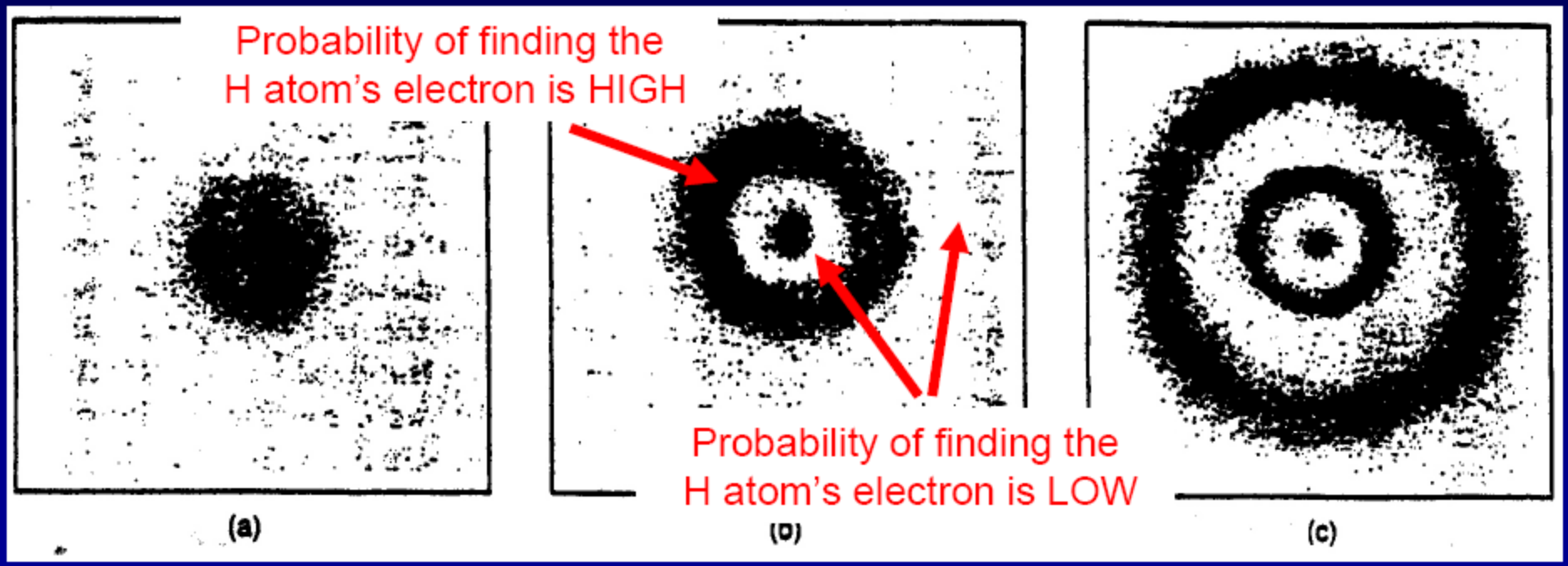
- As long as the electron remains at one of these distances, its energy is fixed.



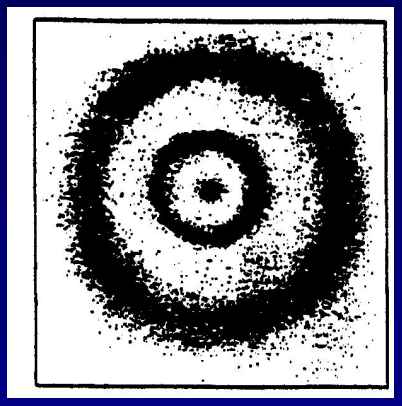
vs.



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



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



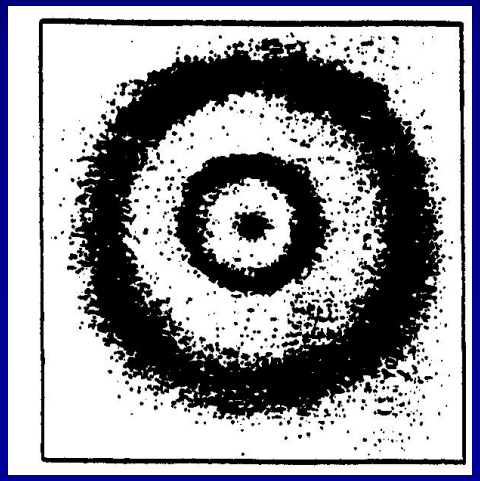
-- The “empty” spaces represent areas with *little likelihood* of finding an electron

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

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

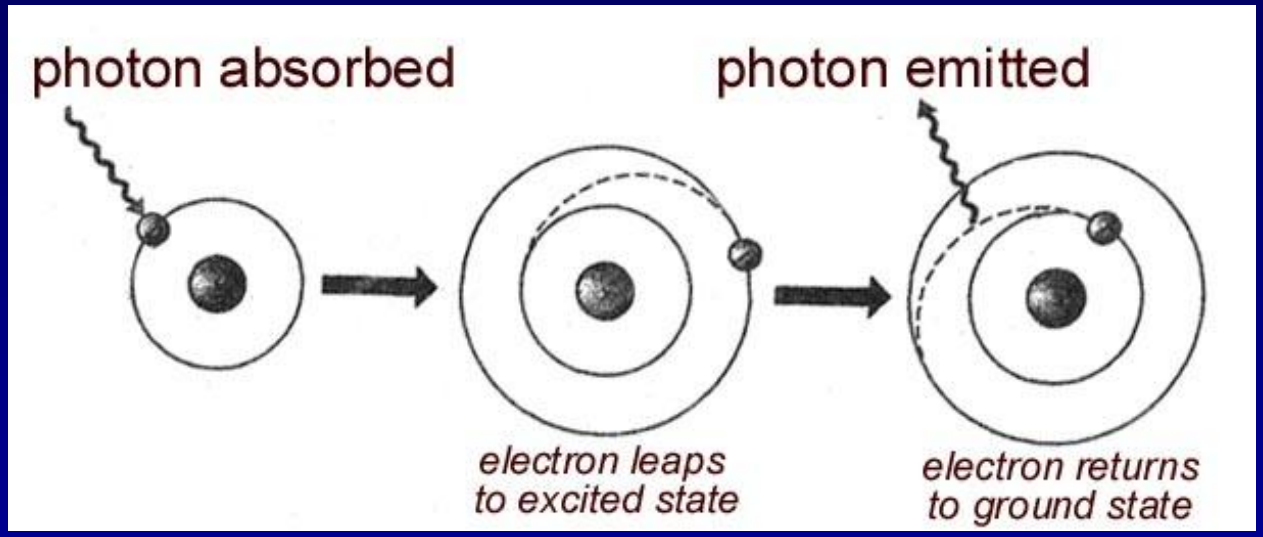
The quantum model of the atom states that:

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

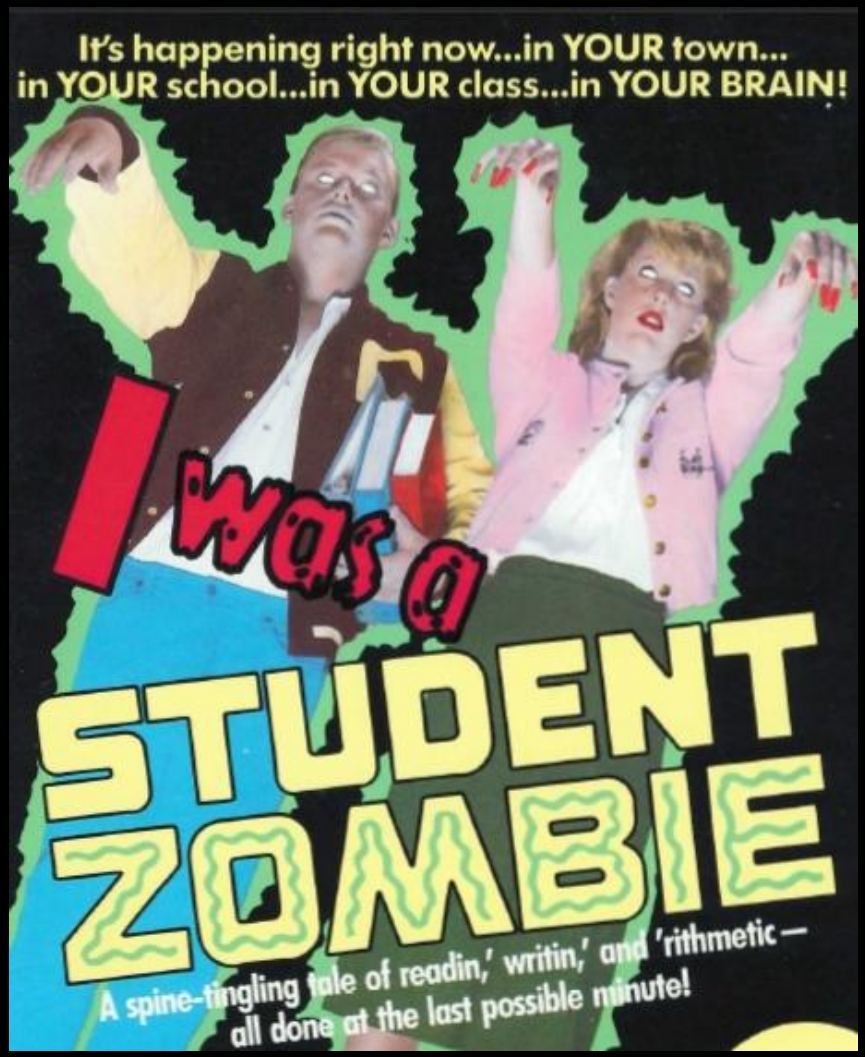


The electrons move -- NOT according to Newtonian laws of motion

-- but according to quantum mechanics.



MORE on how this happens and what it has to do with GLOBAL CLIMATE CHANGE next week!!



ZOMBIE BREAK !

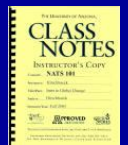
A little rusty on atoms, elements, shells, and the Periodic Table?

"HANDS ON"
LEARNING ACTIVITY

Class Notes Appendix
p 116 - 120

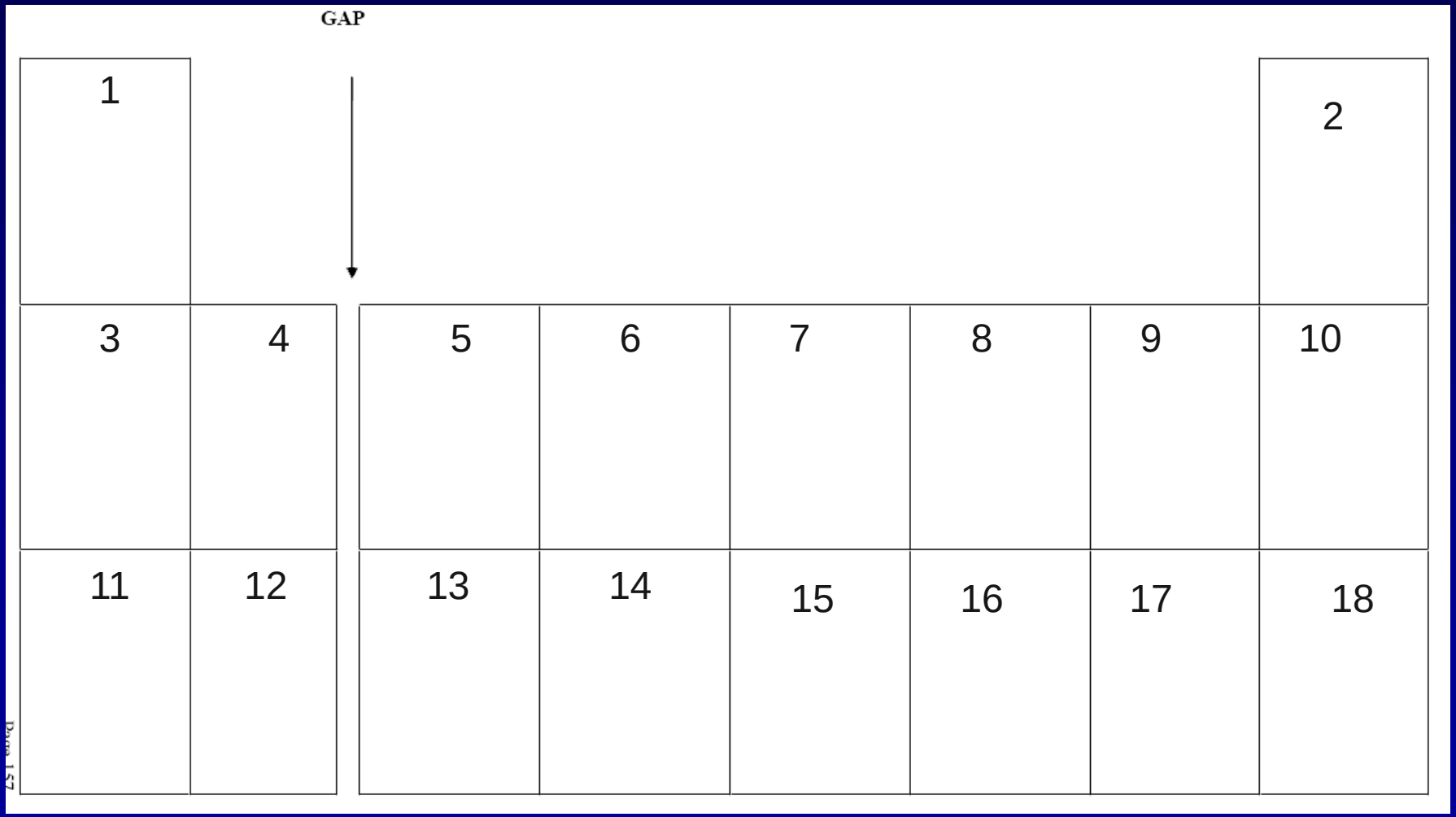
ORGANIZING THE PERIODIC TABLE ACTIVITY

- Create a mini-group of ~ 3 people and introduce yourselves to each other
- During the Zombie Break send one person from your mini-group down to pick up an envelope (contains cutouts of atoms shown on p 120)
- **PLEASE DO NOT WRITE ON THE ATOM CUTOUTS IN THE ENVELOPES !!!! Dr H recycles ☺**
- Together, do the PERIODIC TABLE ACTIVITY p 116-117
- When everyone has their atoms arranged in the proper layout on p 118, you will send your answers via your CLICKERS to get Individual Participation Points for today's class.

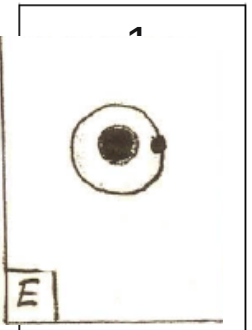


Class Notes Appendix p 116-120

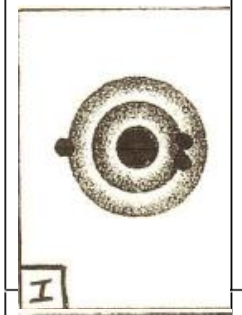
PLACE THE ATOMS ON THE BLANK PERIODIC TABLE –
Do NOT refer to the periodic table in your class notes . . .
Figure it out on your own so that you “get it” !!



GAP



2



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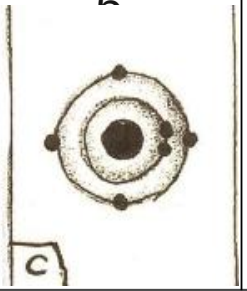
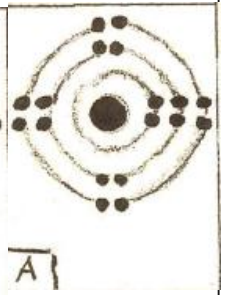


7

12

13

15



RE-CAP of ANNOUNCEMENTS

- **RQ-1 was cutoff at 30 minutes before class TODAY.**
  Missed the cutoff deadline? See FAQ #22

- **Be sure you have submitted the Practice RQ on the Syllabus & FAQ with a perfect score of 7/7 by midnight tonight to earn one point on Assignment I-1**

- **OFFICE HOURS are now in operation for Dr H and the GTA's See the hours on the TEACHING TEAM link.**

- **RQ-2 is due next Thursday (Sep 9) 30 minutes before class begins.**

- **ASSIGNMENT I-1 will be linked tonight: Part A (your Footprint Calculations) will be due IN CLASS next Tuesday Sep 7) Part B (write-up) will be due via D2L Dropbox by midnight a week from tomorrow, Friday Sep 10th)**

Have a Great Weekend . . .