Name: _____ Period: ____ Date: _____

ATOMIC STRUCTURE NOTES
HONORS CHEMISTRY

Directions: This packet will serve as your notes for this chapter. Follow along with the PowerPoint presentation and fill in the missing information. Important terms / ideas are in all capitals and bolded!

- **ATOM**:

  -_____ are composed of only _____ type of atom

  -_____ formed when _____ or more atoms are _____ bonded to form a new substance

  -Atoms first suggested and named by _____… believed that atoms were _____ and indestructible

  -His ideas were limited because they did not explain _____ and lacked _____ support

  -_____ used experiments to explain Democritus' ideas over 2,000 years later…

- **Dalton's ATOMIC THEORY**

  1) **ALL** elements are made of _____, _____ atoms

  2) Atoms of the **SAME** element are _____… atoms of **DIFFERENT** elements are _____

  3) Atoms can mix together or combine _____ in simple whole number ratios to form _____

  4) Chemical _____ occur when atoms are separated, joined, or rearranged… but atoms are _____ changed into atoms of another _____ as a result

- **LAW OF DEFINITE PROPORTIONS**:

  -Proposed by Joseph _____

  -Known as the Law of _____

  -Ex: _____ or _____

- **LAW OF MULTIPLE PROPORTIONS**:

  -Proposed by John _____

  -Ex: _____ (14:16 = 1:1), _____ (14:32 = 1:2)

- Subatomic Particles

  -Dalton was proved mostly right except… **ATOMS ARE** _____!

  -Three Subatomic Particles

  - **PROTONS**:
  - **NEUTRONS**:
  - **ELECTRONS**:

- Electrons

  -Discovered by _____ in 1897

  -Passed a _____ through gases at low pressure in a vacuum tube, producing a glowing beam or _____

- **CATHODE RAYS**

  -Originate at the _____ end of the electrode

  -Act the _____ regardless of the _____ used

  -Deflected by _____ magnetic fields

- Cathode Ray Experiment

  -The ray is a beam of _____ traveling from the cathode to the anode!

  -When the _____ end of a magnet is applied, the beam is _____…
  ELECTRONS MUST BE _____ CHARGED!!

  -No matter what gas or metals were used, the charge-to-mass ratio remained the _____ …
  _____ ARE PART OF ALL ATOMS!!

- Oil Drop Experiment

  -_____ calculated the charge and mass of the electron

  -Charge: one unit of _____ charge (-1)

  -Mass: 1/1840 the mass of a _____ atom (_____ SUBATOMIC PARTICLE)

- Protons and Neutrons

  -**EUGENE GOLDSTEIN** discovered _____ (1,840 times _____ than an electron)

  -**JAMES CHADWICK** confirmed the existence of _____ (about the same size as a proton)

- Gold Foil Experiment

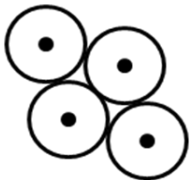
  -**ERNEST RUTHERFORD** shot _____ particles (positively charged) at a thin sheet of _____ foil

  -HYPOTHESIS: alpha particles will pass through the foil _____ changing direction because _____ charged particles spread out in the atoms of the foil will _____ stop or deflect the alpha particles

  -RESULTS: most went straight _____, some _____, and some came straight _____

  -CONCLUSIONS: most of the atom is _____ with a dense, positively charged _____ (protons and neutrons)!!!

  -Use labels / lines to show what happened:



- Models of the Atom

  -Various _____ contributed to our understanding of the atom

  -Discoveries made between _____ shaped the current model

- **Dalton's Model**

  -**1803**: Views atoms as _____ and _____ particles with ____ internal structure

  -Draw it:

- **Thomson's Model**

  -**1897**: Negatively charged particles (_____) are distributed throughout a _____ positive charge

  -"_____" Model

  -Draw it:

- **Rutherford's Model**

  -1911: Small, dense, positively charged _____ with the _____ moving around the nucleus (mostly _____)

  -Did _____ explain the _____ of elements!!

  -Draw it:

- **Bohr's Model**

  -1913: Electrons move in a circular _____ at _____ distances from the nucleus (_____)

  -Draw it:

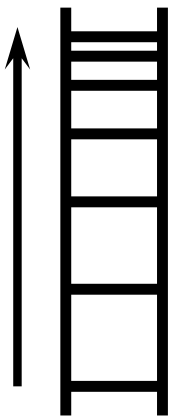
  -**ENERGY LEVELS (n)**:

  -Positive nucleus "_____" the electrons so they stay in orbit

  -Electrons absorb or emit energy as they _____ between levels:

  - To an **EXCITED** (higher) orbit = _____ energy
  - Return to **GROUND** (lower) orbit = _____ energy

  -Imagine the fixed energy levels are like the _____: lowest rung is _____ in energy, can move rung to rung, you _____ stand between the rungs just like _____ can't be in between levels, and to climb you need the right amount of energy

  -Levels are **NOT** _____ apart, so electrons gain or lose different amounts energy

  -Higher energy levels are _____ together… it takes _____ energy to move from one to the next near the top!

  *Ladder with _____ spaced rungs is actually a better representation of the model!!

- Bohr Equation

  -Bohr model only works for _____ small atoms (ex: _____)

  -Calculate the energy absorbed or emitted by electron using the equation:

  $$\Delta E = -2.18 \times 10^{-18} \text{ J } (1/n^2_f - 1/n^2_i)$$

  -Example: What is the energy of a photon when an electron moves from n = ___ to n = ___? Is the energy absorbed or emitted?

- **Schrodinger's Model**

  -**1926**: Development of a mathematical equation to determine _____ around the nucleus that would have a high _____ of containing an electron (_____)

  -"_____" or _____ (current)

  -Draw it:

  -Protons and neutrons found in the _____

  -**ELECTRON CLOUD**:

  DENSER regions = _____ probability of finding an electron

- Distinguishing Among Atoms

  -Why are atoms of different elements different?

  - They contain different number of _____
  - _____ tell you which element is which

- **ATOMIC NUMBER**:

  -Use the _____ to determine

  -Ex: all Hydrogen atoms have _____ proton, so the atomic # of hydrogen is ____

  -What is the Atomic Number for each: Li, Pb, Au, Br?:

- Electrons

  ***Since atoms are electrically _____, the # of protons must _____ the # of _____!!**

  -Atoms with _____ numbers of protons and electrons are _____ (charged particles)

  -Only the _____ can _____ or _____ to give ions, NOT the _____… **WHY?:**

  -Positive (+) charge = _____ electrons, while Negative (-) charge = _____ electrons… number of charge indicates how many!

  -Examples:

- **MASS NUMBER**:

  Mass # =

  # of Neutrons =

  -Example: If an element has an atomic number of _____ and a mass number of 78 what is the…
  Number of protons?
  Number of neutrons?
  Number of electrons?
  Symbol for this element?

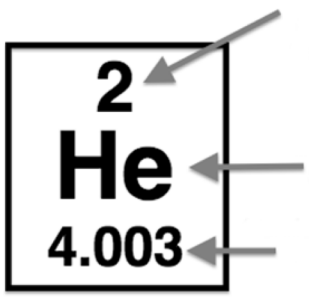
- Atomic Symbols

  X Ex:

  -Example: If an element has _____ protons and 140 neutrons what is the…
  Atomic number?
  Mass number?
  Number of electrons?
  Atomic Symbol for this element?

- Reading the Periodic Table

  -Round the _____ to get the MASS # of the most common isotope!!!



- Problems

  -Determine the number of PROTONS, NEUTRONS, and ELECTRONS for each:

  - _____:
  - _____:
  - _____:
  - _____:

- **ISOTOPES**:

  -_____ is different because there are more or less _____

  -_____ is still the _____… otherwise the _____ would change!

  -Naming: put the _____ after the element name

  -Ex:

  -Example: Determine the number of each subatomic particle for _____.

- **ATOMIC MASS**:

  -Reflects both the _____ and relative _____ of the isotopes as they occur in nature

  -**NOT** a _____ because it is an average

  -Given on the _____

  -Measured in _____ (**amu**)… 1 amu = 1/12 the mass of a _____ atom

- Calculating Avg. Atomic Mass

  Average Atomic Mass =

  -Example: Calculate the average atomic mass of copper if copper has two isotopes. 69.1% of copper has a mass of ____ amu and 30.9% has a mass of ____ amu.

-Example: The element Gallium has two stable isotopes, Ga-69 and Ga-71. The average atomic mass of Gallium is _____ amu. Find the percent abundance of each isotope of the element.

- Quantum Mechanics

  -There are _____ quantum numbers that represent the address of an electron (n, l, m_l, and m_s)

  -The first three describe an _____

- **PRINCIPAL QUANTUM NUMBER (n)**:

  -Regions in space around the _____ that contain _____

  -Tell you how _____ an electron is to the nucleus

  -n = ___-___… with 1 being the _____ in energy and _____ to the nucleus

  -**GROUND STATE** (_____ energy) is _____

  -**EXCITED STATES** (_____ energy) are _____.

  -Electrons in excited states are _____ from the nucleus, have _____ orbits, and _____ energy!

  -Maximum # of e- in an energy level found using _____

  -_____ on the Periodic Table indicate the energy level!!

- **AZIMUTHAL QUANTUM NUMBER (l)**:

  -Principal energy levels can be divided into energy _____ or _____

  -Each energy level can have _____ sublevels with different _____ (showing where an electron is _____ to be found)

  -Sublevels are denoted by letters: _____

Sublevel	s	p	d	f
l =				
Max # of e-				
Shape Name / Quick Sketch				

- **ORBITALS (m_l)**:

  -Electrons are spinning in _____ directions… "_____"

  -Range of numbers from ____ through ____

  -Each sublevel has a different number of orbitals: s = ___, p = ___, d = ___, and f = ___

  -Since each orbital can hold ___ e-, max # of e- determined by: _____

- **SPIN (m_s)**:

  -Only two possible values: _____ or _____ (indicates that the electrons in the pair have _____ spins)

  -Electrons are shown to have _____ spins when drawing the electron diagrams

- Summary

ENERGY LEVEL (n)	# OF SUBS	# OF ORBS (n^2)	MAX # OF e^- ($2n^2$)
1			
2			
3			
4			

- Electron Configurations: shows distribution of electrons among the orbitals of the atom

  -Three Ways to do this:

  - **Orbital Diagrams** (using _____ with electrons as _____)
  - **SPDF Notation** (_____ and _____ showing levels and electrons)
  - **Kernel Notation** (use _____ and simplified SPDF)

- Rules

  1) **AUFBAU PRINCIPLE**: add electrons one at a time to the orbitals of _____ energy first
  2) **PAULI EXCLUSION**: e- MUST have _____ spins and _____ of 2 e- per orbital (each e- has _____ different quantum #s)
  3) **HUND'S RULE**: each orbital in the sublevel must have one e- _____ pairing begins

     Ex:

- **Orbital Diagrams**

  -How to draw:

  1) Use a box to represent one _____ / Arrows represent _____

  2) Find the # of _____

  3) Start with the _____ energy level first (n = 1) and write down all _____ in each

  4) Follow all _____ (max 2 e- per orbital, correct # of orbitals for spdf, unpaired first, d is one row behind)

  5) Use the _____ to help!

- Practice

  -Example: Draw the orbital diagram for _____. Determine the number of unpaired electrons.

  -_____:

  -_____:

  -_____:

- **SPDF Notation**

  -The electron configuration for _____ using this notation is:

  -**Large numbers** represent the _____

  -**Letters** represent the energy _____

  -**Superscript numbers** indicate the number of _____ in the sublevel

***USE THE _____ TO GUIDE YOU!!**

-Periods (_____) indicate an ENERGY LEVEL (___ sublevels are off by _____) ← WHY?

-Groups (_____) indicate SUBLEVELS

-Example: Write the electron configuration for _____.

- Practice

  Write the electron configurations for _____, _____, _____, and _____ using spdf notation. How many electrons are in the last energy level?

- **Kernel (Shorthand) Notation**

  -Write the symbol of the _____ (FARTHEST RIGHT column on the table) that _____ the element on the Periodic Table and put in [ ]

  -Then write the remaining electrons using spdf notation

  -Example:

  Aluminum:

  Ne:

  So… Al is:

  -Try ___ and ___ on your own:

- Exceptions

  -Some electron configurations will be _____ than what is expected from the rules

  -_____ **OR** _____ **SUBLEVEL CONFIGURATIONS ARE MORE** _____**!!!!**

  -Examples: _____ and _____ (one electron is _____ for added stability)

  ___:

  ___:

- **BOHR DIAGRAMS**:

  -Protons and neutrons are shown in the center, representing the _____

  -Electrons surround the nucleus in the _____

  -How to Draw:

  1) Find the _____ on the Periodic Table to determine the # of _____ you will draw and the # of protons and neutrons in the _____

  2) The _____ determines how many energy levels (**RINGS**) you draw (ex: if the element is in _____, only _____ energy level is needed)

  3) Label the # protons and neutrons in the _____ and put the correct # of energy levels

  4) Draw the electrons as _____ in the energy levels

  5) Watch the _____ that each level can hold… 1^{st} = 2 e-, 2^{nd} = 8 e-, 3^{rd} = 18 e-, etc.

  -Example: Draw the Bohr Diagram for _____.

  -Example: Draw the Bohr Diagram for _____.

  -Example: Draw the Bohr Diagram for _____.

- **VALENCE ELECTRONS**:

  -Usually _____ energy level ____ **AND** ____ electrons added together

  -Ex:

-More Ex:

- **ELECTRON DOT STRUCTURES**:

  -How to draw:

  1) Determine the # of _____
  2) Write the element _____
  3) Add one ____ at a time to each side of the symbol… show as _____
  4) Until they are forced to _____ (____ e- max)
     - EXAMPLE:

  -More Practice:

- Light

  -Study of light by _____ helped lead to the quantum mechanical model

  -All light exhibits _____ properties

  - **AMPLITUDE**:
  - **WAVELENGTH**:
  - **FREQUENCY**:

  -All light (in a vacuum) moves at the speed of light… _____

- Parts of a Wave (Draw Below)

- Electromagnetic Spectrum

  -____ Regions

-Ranked with respect to their _____

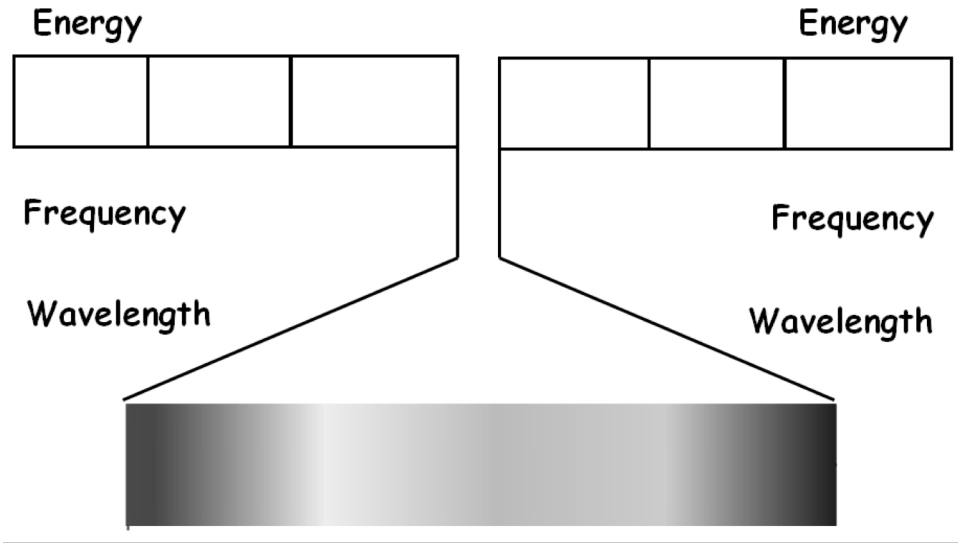
-As the wavelengths become _____ the frequency decreases (_____ relationship)

-Equation to explain this: **$c = \lambda v$**

c = _____ (3×10^8 m/s)

λ = _____ (measured in meters)

v = _____ (measured in hertz or s^{-1})



- Visible Spectrum

  -We are only able to see a very limited portion of the electromagnetic spectrum (_____)

  -Visible light is an example of a **continuous spectrum** (_____)

  -Ranges from _____ (long λ) to _____ (short λ)

- Problems

  -What is the wavelength of radiation with a frequency of _____ Hz?

  -What is the frequency of radiation with a wavelength of _____ nm?

- Prisms

  -White light is made of _____ of the spectrum (**CONTINUOUS**)

  -Colored light only gives _____ (**NOT CONTINUOUS**)…

- **ATOMIC EMISSION SPECTRUM**:

  -Gives a pattern of color that is _____ for each element

  -Adding energy _____ an atom's electrons… so they jump from the _____ (lowest energy) to an _____ (higher energy)

  -When electrons move from a higher energy level back to a lower one, a quantum of energy (_____) is given off that has a frequency _____ to the energy change…

- Energy

  -Energy absorbed or emitted by an atom can be calculated using: _____

  E = _____

  h = _____ = 6.63×10^{-34} J•s

  ν = _____ of light wave

  -Using the $c = \lambda \nu$ equation and substitution, we know that: _____

- Problems

  -What is the energy of blue light with a wavelength of _____ m?

  -What is the _____ of the photon from above?

- **HEISENBERG'S UNCERTAINTY PRINCIPLE**:

  -Does _____ apply to _____ objects (trains, cars, etc.) but critical in finding the position of electrons due to their _____