

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

- **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

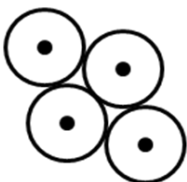
- ERNEST RUTHERFORD** shot _____ particles (positively charged) at a thin sheet of _____ foil

- 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

Model	Atomic Model Info	Draw the Model
DALTON'S	<ul style="list-style-type: none"> 1803: Views atoms as _____ and _____ particles with _____ internal structure 	
THOMSON'S	<ul style="list-style-type: none"> 1897: Negatively charged particles (_____) are distributed throughout a _____ positive charge "_____ " Model 	
RUTHERFORD'S	<ul style="list-style-type: none"> 1911: Small, dense, positively charged _____ with the _____ moving around the nucleus (mostly _____) Did _____ explain the _____ of elements!! 	
BOHR'S	<ul style="list-style-type: none"> 1913: Electrons move in a circular _____ at _____ distances from the nucleus (_____) <p><i>*(BOHR INFO CONTINUED ON NEXT PAGE)*</i></p>	
SCHRODINGER'S	<ul style="list-style-type: none"> 1926: Development of a mathematical equation to determine _____ around the nucleus that would have a high _____ of containing an electron (_____) "_____ " or _____ (current) Protons and neutrons found in the _____ ELECTRON CLOUD: <p>DENSER regions = _____ probability of finding an electron</p>	

- Bohr's Model (CONTINUED)

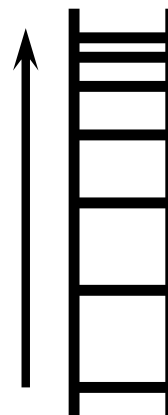
- ENERGY LEVELS (n):

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

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

- o To an **EXCITED** (higher) orbit = _____ energy
- o 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:

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

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

- Distinguishing Among Atoms

- Why are atoms of different elements different?

- o They contain different number of _____
- o _____ 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**

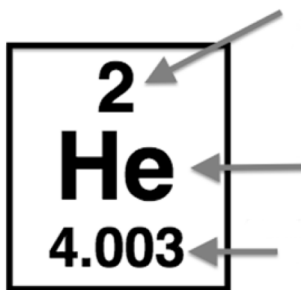
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Ex:

-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

- $n = ___ - ___ \dots$ 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

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

- 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.

-Example: Draw the orbital diagram for _____:

-Example: Draw the orbital diagram for _____:

-Example: Draw the orbital diagram for _____:

- **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... $1^{\text{st}} = 2 e^-$, $2^{\text{nd}} = 8 e^-$, $3^{\text{rd}} = 18 e^-$, 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

Wave Part	Definition / Units (if applicable)	Draw a Wave and Label the Parts
AMPLITUDE:		
WAVELENGTH:		
FREQUENCY:		

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

- Electromagnetic Spectrum

- _____ Regions

-Ranked with respect to their _____

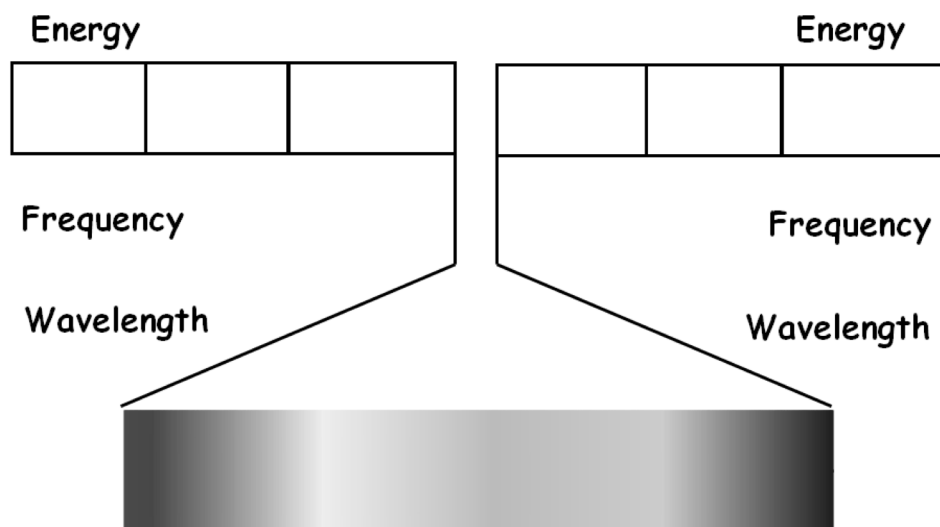
-As the wavelengths become _____ the frequency decreases (_____ relationship)

-Equation to explain this: $c = \lambda \nu$

$c =$ _____ (3×10^8 m/s)

$\lambda =$ _____ (measured in meters)

$\nu =$ _____ (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: _____

$$E = \underline{\hspace{2cm}}$$

$$h = \underline{\hspace{2cm}} = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$\nu = \underline{\hspace{2cm}} \text{ of light wave}$$

-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 _____