My goal for unit 2 is...

What steps will you take to achieve this goal?

Pages...	Due on...

Chemistry

Unit 2:

Atomic Structure & Counting Particles

Name: _____

Class Period: _____

The UNIT 02 TEST is on

_____

Table of Contents

Unit 02: Atomic Structure & Counting Particles Vocabulary

All of the following vocabulary words are relevant to the unit and are found on the Unit 2 Quizlet: bit.ly/3hOVQqs

Vocabulary

Matter - Anything that has mass (grams) and takes up space (volume in mL or cm^3)

Scientific theory - A well-tested explanation for a broad set of observations

Model - A simplified representation of a complex idea that facilitates understanding certain aspects of a real object or process.

Element - A substance that cannot be separated or broken down into simpler substances by chemical means

Chemical Symbol - An abbreviation used to represent the chemical elements listed in the periodic table.

Atom - The smallest unit of an element that maintains the chemical properties of that element

Compound - A substance made up of atoms of two or more elements joined by chemical bonds

Nucleus - The dense, positively charged structure found in the center of the atom. It is composed of protons and neutrons.

Proton - A particle with a positive charge, found in the nucleus of atoms. Has a mass of 1 amu.

Neutron - A particle that does not have a charge, found in the nucleus of atoms. Has a mass of 1 amu.

Electron - A particle with a -1 charge. Electrons move very fast around the outside of the nucleus of atoms. These particles are so small, their mass is negligible (0 amu).

Orbital - A region in an atom where there is high probability of finding electrons.

Law of Definite Proportions - a chemical compound always contains the same elements in exactly the same proportions

Atomic Number - The # of protons in the nucleus of an atom; the atomic number is the same for all atoms of an element.

Mass - A measure of the amount of matter in an object.

Mass Number / Atomic Mass - The sum of the numbers of protons and neutrons in the nucleus of the atom.

Atomic Mass Unit (amu) - A unit used to measure mass of an atom. Protons & neutrons each have a mass of 1 amu.

Average Atomic Mass - The average relative mass of the isotopes of that element.

Percent Abundance - the percentage amount of all naturally occurring isotopes of an element.

Isotope - An atom that has the same number of protons as other atoms of the same element but has a diff. # of neutrons.

Ion - An atom with a charge.

Anion - A negative ion. (gain of electrons)

Cation - A positive ion. (loss of electrons)

Mole (mol) **-** Standard unit of counting in chem. It measures the amount of substance. It is equal to 6.022 x 10^{23} items. Another name for the mole is Avogadro's Number.

Molar Mass - The mass, in grams, of one mole of a substance.

Diatomic Molecules - molecules composed of 2 atoms of the same element.

Molecule - two or more atoms bonded together.

Formulas

Relationship between protons and atomic number: $p^+ = A\#$

Calculate mass number: $M\# = p^+ + n^0$

Calculate # of neutrons in an isotope: $\sim n^0 = AAM - A\#$ Then figure the range of n^0 based on the decimal

Calculate average atomic mass: $$AAM = \left(\frac{M\#_A\,(\%_A) + M\#_B\,(\%_B) + M\#_C\,(\%_C)\ldots..etc....}{100}\right)$$

Calculate # of electrons in a neutral atom: $e^- = A\# = p^+$

Calculate charge of an ion: charge = $p^+ + (-e^-)$

Conversion factor between moles and molar mass: $1\ mol\ X = \#\ g\ X$

 # = molar mass of substance from the periodic table.

X = element symbol from the periodic table

Conversion factor between moles and particles: $1\ mol\ X = 6.02 \times 10^{23}\ particles\ X$

Particles = atoms, ions, isotopes, molecules, and/or formula units

Resources for Unit 2

Common element names and symbols

NAME	***SYMBOL***		***NAME***	***SYMBOL***		***NAME***	***SYMBOL***		***NAME***	***SYMBOL***
Aluminum	Al		Calcium	Ca		Lithium	Li		Phosphorus	P
Argon	Ar		Chlorine	Cl		Magnesium	Mg		Potassium	K
Beryllium	Be		Fluorine	F		Neon	Ne		Silicon	Si
Boron	B		Helium	He		Nitrogen	N		Sodium	Na
Carbon	C		Hydrogen	H		Oxygen	O		Sulfur	S
NAME	***SYMBOL***		***NAME***	***SYMBOL***		***NAME***	***SYMBOL***		***NAME***	***SYMBOL***
Arsenic	As		Cobalt	Co		Krypton	Kr		Titanium	Ti
Bromine	Br		Copper	Cu		Manganese	Mn		Vanadium	V
Chromium	Cr		Iron	Fe		Nickel	Ni		Zinc	Zn
NAME	***SYMBOL***		***NAME***	***SYMBOL***		***NAME***	***SYMBOL***		***NAME***	***SYMBOL***
Barium	Ba		Iodine	I		Silver	Ag		Xenon	Xe
Cadmium	Cd		Lead	Pb		Strontium	Sr		Uranium	U
Gold	Au		Mercury	Hg		Tin	Sn			

Unit 2: Atomic structure and the mole

**These are the resources you will be given on the day of the unit test in addition to the periodic table.*

Average atomic mass

$$AAM = \left(\frac{M\#_A\,(\%_A) + M\#_B\,(\%_B) + M\#_C\,(\%_C)\ .....etc....}{100} \right)$$

Avogadro's number

1 mole X = 6.02×10^{23} particles X

Mass→Moles conversion factor

1 mol X = _#_ grams X (# from periodic table)

Models of the Atom

Name:_____

Chemistry

Date:_____Hour_____

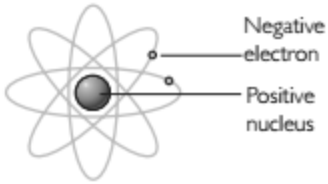
Objective

To compare various models of the atom that have appeared over the past two hundred years.

Part 1: the Five Models of the Atom

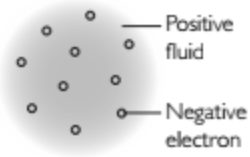
In 1803, John Dalton proposed that atoms were simply solid spheres that were not made up of smaller parts. In the decades that followed, chemists collected a lot of evidence suggesting that there was more to the atom.

Directions: *Read and annotate (highlight and write in the margins) each of the paragraphs below. Note differences/similarities between models.*



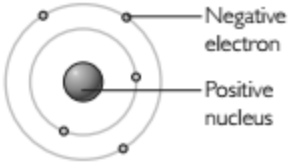
NUCLEAR MODEL: The atom can be divided into a nucleus and electrons. The **nucleus** occupies a small amount of space at the center of the atom. The nucleus is dense and positively charged. The **electrons** circle around the nucleus. The electrons are very tiny and negatively charged. Most of the atom is empty space.

PROTON MODEL: The atom can be divided into a **nucleus** and **electrons**. The nucleus occupies a small amount of space at the center of the atom. The nucleus consists of **protons** that are positively charged. The nucleus also contains **neutrons** which are particles that are neutral in charge. The electrons circle the nucleus. The electrons are tiny and negatively charged. Most of the atom is empty space.



PLUM PUDDING MODEL: The atom can be divided into a fluid (the "pudding") and electrons (the "plums"). The **fluid** spreads out in the atom and is positively charged. The **electrons** are very tiny and negatively charged. Most of the atom is made of fluid.

SOLID SPHERE MODEL: The atom is a **solid sphere** that cannot be divided up into smaller particles or pieces.



SOLAR SYSTEM MODEL: The atom can be divided into a nucleus and electrons. The **nucleus** is at the center of the atom and is positively charged. The **electrons** circle around the nucleus in specific orbits. The electrons are tiny and negatively charged. Different electrons are in orbits at different distances from the nucleus. Most of the atom is empty space.

Part 2: Using Evidence to Evaluate Models

Directions: *Look back at the five models of the atom on the previous page , then use the evidence in each box to evaluate the models.*

EVIDENCE 1: It is possible to remove a negatively charged particle from an atom using electrical forces. (Thomson, 1897)

1) Which model of the atom is best supported by the evidence above? *(circle one)*

solid sphere model *plum pudding model*

Explain your reasoning. Be specific.

EVIDENCE 2: If a tiny particle is shot into the middle of an atom, it hits something dense in the center and bounces back in the direction from which it came. If a tiny particle is shot into the edges of the atom, it goes through. Most tiny particles shot at an atom will go through. (Rutherford, 1911)

2) Which model of the atom is best supported by the evidence above? *(circle one)*

nuclear model *plum pudding model*

Explain your reasoning. Be specific.

EVIDENCE 3: The farther from the center of an atom the negatively charged particles are, the easier they are to remove. (Bohr, 1913)

3) Which model of the atom is best supported by the evidence above? *(circle on**e)***

solar system model *plum pudding model*

Explain your reasoning. Be specific.

Part 3: Interpreting the Evidence

Directions: *Look back at the five models of the atom two pages back, then use the evidence from the previous page to evaluate the models.*

4) Which piece of evidence best supports the existence of negatively charged particles? (*circle one*)

Evidence 1 *Evidence 2* *Evidence 3*

Explain why you selected that piece of evidence. Be specific.

5) Which piece of evidence best supports the existence of a nucleus? (*circle one*)

Evidence 1 *Evidence 2* *Evidence 3*

Explain why you selected that piece of evidence. Be specific.

6) Examine the models and the three pieces of evidence in Part I. In what order do you suppose these models were introduced to the world of science? List them from oldest to newest.

Oldest _____ _____ _____ _____ _____ Newest

7) In 1932, British physicist James Chadwick discovered that the nucleus contained uncharged, or neutral, particles called neutrons, in addition to the protons discovered by Rutherford. How do the three small particles found in the atom differ from one another?

Proton: _____

Neutron: _____

Electron: _____

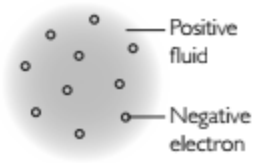
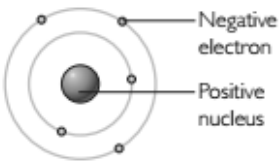
8) A helium atom has two electrons, two protons, and two neutrons.
   a) How many positive charges does the helium atom have? _____
   b) How many negative charges does the helium atom have? _____
   c) What is the net charge (overall charge) on the helium atom? Explain your reasoning.

   d) Examine the models and the three pieces of evidence in Part I. What do you suppose a helium atom would look like? Using the most up-to-date model of the atom, draw your model below and label the small particles.

Atomic Theory Notes Name:_____

Chemistry Date:_____Hour_____

Objective: I can describe and draw an atomic model and explain the evidence that supports the existence of atomic structures.

Who?	When?	Drawing of model	Major contribution(s) to understanding the atom:	Additional info:
Democritus				
		N/A	The Law of Definite Proportions *Define and give examples...*	
				
				Used the gold foil experiment.
Bohr				
				

How are the smallest bits of matter described?

- With _____ particles.

What does the word “subatomic” mean?

- Sub - _____
- Atomic - _____

Create your own definition of the term “subatomic particle”.

Subatomic particles are small, but they still have _____. We measure this using the unit amu.

- amu = _____

  Why do we use amu and not grams?

Subatomic Particle	Proton	Neutron	Electron
Charge			
Location			
Mass			
Symbol	Green 	Blue 	Red 

Using the symbols in the table above, draw a picture of a carbon atom and a helium atom. A carbon atom has 6 protons, 6 neutrons, and 6 electrons. A helium atom has 2 protons, 2 neutrons, and 2 electrons.

Carbon (C) Helium (He)

What is the mass of the carbon atom? What is the mass of the helium atom?

Atomic Structure

Name:_____

Chemistry

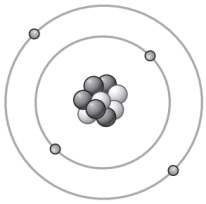
Date:_____Hour_____

Objective

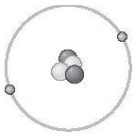
To explore the basic atomic structure of different elements.

Part I: Parts of an Atom

1) Here are simple atomic models of a beryllium atom and a helium atom.
   Label the following in each:
   - (-)Electrons (mass=0 amu)
   - (0) Neutrons (mass=1 amu)
   - (+) Protons (mass=1 amu)
   - Nucleus



Beryllium, Be

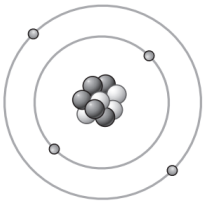


Helium, He

2) Based on the models, why do you think helium is number 2 and beryllium number 4 on the periodic table?

3) The net charge (overall charge) on every atom is zero. Explain why.

4) Why do you think the mass of the beryllium atom shown is 9 atomic mass units (amu)?



Beryllium, Be

Part II: The Numbers

5) Use a periodic table to help you fill in the table below.

Element	Chemical symbol	Atomic #	# of protons	# of electrons	# of neutrons	Mass of an atom (amu)	Average atomic mass (amu)
beryllium	Be	4	4	4	5	9	9.01
fluorine					10		
				6		12	
	Cl				18		35.45
lead					126		
		29			36		
	Au		79			197	

6) How did you figure out the number of electrons in each atom?

7) How did you figure out the number of protons in each atom?

8) How did you figure out the number of neutrons in each atom?

9) How did you figure out the mass of each atom?

10) How does the mass of each atom compare to the average atomic mass of the element given in the periodic table? Be specific!

11) Make a drawing of a neutral nitrogen atom, similar to the one given for beryllium in Part I, Question 1. Make a key to show the subatomic particles that are present.

12) If you know the atomic number of an element, what information does it give you about neutral atoms of that element? Remember, all atoms are originally neutral.

13) Explain how you can *estimate* the number of neutrons in the atoms of an element.

14) Examine tellurium (Te) and iodine (I) in the periodic table. Compare their atomic numbers and average atomic masses. Why does iodine have a lower average atomic mass than tellurium? Can you find other examples of this in the periodic table?

Introduction to Isotopes

Name _____

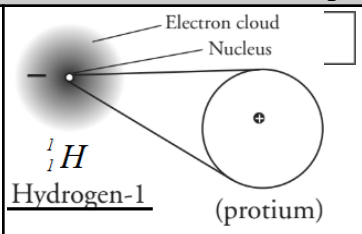
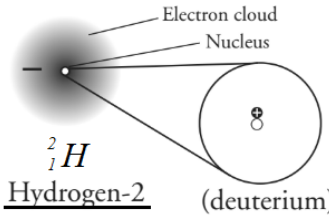
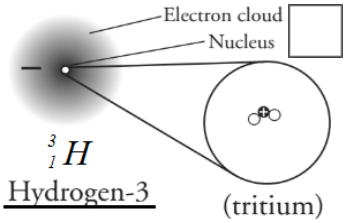
Chemistry

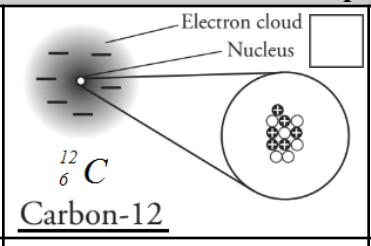
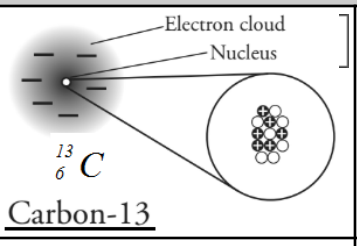
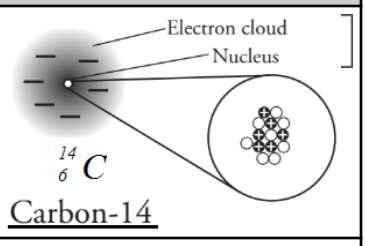
Date _____ Hour _____

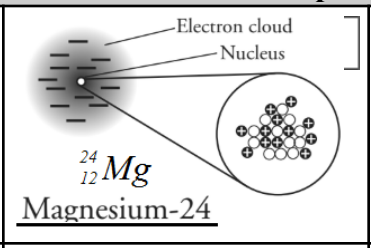
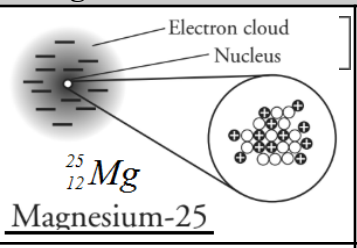
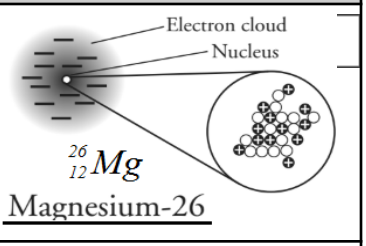
Why?

The following activity will help you learn the important structural characteristics of an atom. Are all atoms of the same element alike? How do we classify atoms? How does the combination of subatomic particles affect the mass and charge of an atom? What are isotopes? This is just a sampling of what we will address. Throughout this activity you will want to keep a **periodic table** handy.

Model 1

Isotopes of Hydrogen			
Atomic Diagram *Isotope Symbol* Isotope Name (Latin name)			
Number of Protons / Neutrons	Protons Neutrons	Protons Neutrons	Protons Neutrons

Isotopes of Carbon			
Atomic Diagram *Isotope Symbol* Isotope Name			
Number of Protons / Neutrons	Protons Neutrons	Protons Neutrons	Protons Neutrons

Isotopes of Magnesium			
Atomic Diagram *Isotope Symbol* Isotope Name			
Number of Protons / Neutrons	Protons Neutrons	Protons Neutrons	Protons Neutrons

1) Refer to **Model 1**.
   a) What does the word subatomic mean?

   b) What subatomic particles do the following symbols represent in the Atomic Diagrams?

   ▬ ⊕ ○

2) Complete the table in **Model 1** by counting the protons and neutrons in each atomic diagram.

3) Find the three elements shown in **Model 1** on your **periodic table**.
   a) Write the whole number shown in **Model 1** for each element that can also be found on the **periodic table** for that element.
      i) Hydrogen - ii) Carbon - iii) Magnesium -

   b) The whole number in each box of the **periodic table** is the atomic number of the element. What does the atomic number of an element represent?

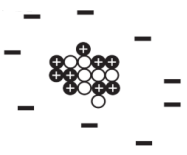
   c) Where is the atomic number located in the *isotope symbol*? (*circle one)* TOP BOTTOM

4) Use **Model 1** to help you, but also refer to your **periodic table**.
   a) How many protons are in all chlorine (Cl) atoms? _____
   b) A student says "I think that some chlorine atoms have 16 protons." Explain why this student is not correct.

5) Refer again to **Model 1**. In the *isotope symbol* of each atom, there is a superscripted (top) number. This number is also used in the <u>isotope name</u> (i.e., carbon-12). It is called the mass number.
   a) How is the mass number determined?

   b) Why is this number called a "mass" number?

Model 2

		Atom 1 	**Atom 2** 
Question 6	Number of Protons		
	Number of Neutrons		
	Mass Number		
Question 8	*Isotope Symbol*		
	<u>Isotope Name</u>		

6) Use **Model 1** to fill in the <u>FIRST</u> <u>3</u> <u>ROWS</u> of the table in **Model 2** for each atom.

7) Refer to **Model 1**.
   a) Where is the mass number located in the *isotope symbol*? (*Circle one)* TOP BOTTOM
   b) How is the mass number of an isotope expressed (written) in the <u>isotope name</u>?

8) Use **Model 1** and your **periodic table** to fill in the table in **Model 2** for each of the atoms.

Model 3

9) Use your **periodic table** and **Model 1** to help you fill in the table for **Model 3** below:

Isotope Symbol	$^{40}_{19}K$	$^{18}_{9}F$		
Isotope Name				Boron - 11
Atomic Number			16	
Mass Number				
Number of Protons				
Number Neutrons			15	

10) Consider the examples in **Model 1**.

a) Do all isotopes of an element have the same atomic number? (*Circle one*) YES NO

b) Give at least one example from **Model 1** that supports your answer.

c) Do all isotopes of an element have the same mass number? (*Circle one*) YES NO

d) Give at least one example from **Model 1** that supports your answer.

11) Considering your answers to Question 10, write a definition of isotope using a grammatically correct sentence.

12) Consult the following list of *isotope symbols*: $^{204}_{82}Pb,\ ^{82}_{35}Br,\ ^{78}_{35}Br,\ ^{208}_{82}Pb,\ ^{204}_{78}Pt,\ ^{205}_{82}Pb$

a) Sort the atoms represented by these *isotope symbols* into groups.

b) Which part(s) of the *isotope symbol* did you use to group the atoms?

Isotopes, Percent Abundance and AAM

Name:_____

Chemistry

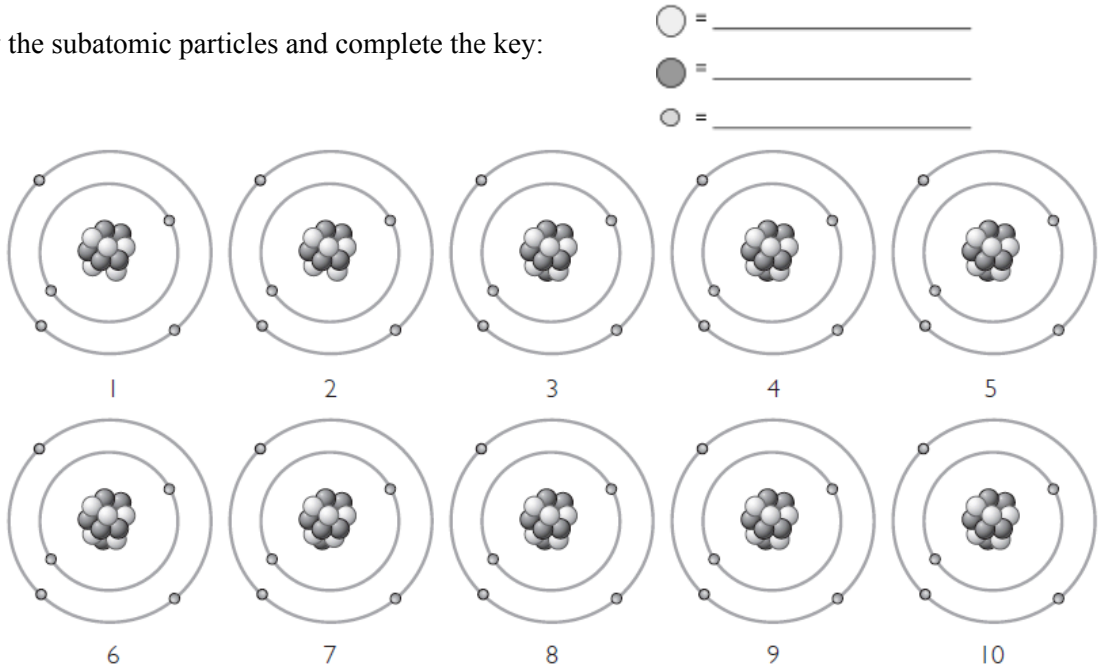
Date:_____Hour_____

Purpose: To investigate the isotopes and the average atomic mass of a naturally occurring sample of atoms.

Part I: The Average Boron Atom

We have discovered that atoms of the same element can exist as **isotopes**. The images below represent a naturally occurring sample of boron. Complete the following questions after examining the sample of boron atoms.

1) Identify the subatomic particles and complete the key:



2) Use the naturally occurring sample of boron atoms above, to fill in the table below.

Boron Atom	1	2	3	4	5	6	7	8	9	10
# of protons										
# of neutrons										
# of electrons										
Mass number										

3) There are 2 types of naturally occurring isotopes represented in this sample. Identify them by completing the table. *Percent abundance is the percentage of each isotope. Include your calculation in the table.*

	Boron isotope 1	Boron isotope 2
Isotope Name		
Isotope Symbol		
Percent abundance		

4) What is the average atomic mass of the ten atoms? How does this answer compare to the average atomic mass of boron listed in the periodic table?

5) Imagine that you could examine a randomly chosen sample of 100 boron atoms. What isotopes would you expect to find? How many of each? Express your answers as percentages.

Part II: The Number of Neutrons

Consider the samples of naturally occurring isotopes of other elements presented in the table below.

6) The first row has been completed for your. Complete the rest of the table.

Element	Element Symbol	A #	AAM	# of p^+	# of e^- (neutral)	Possible # of n^0	Possible isotope symbol(s)	Possible isotope name(s)
boron	***B***	***5***	***10.81***	***5***	***5***	***5 or 6***	***$^{10}_{5}B$ or $^{11}_{5}B$***	***Boron-10 Boron-11***
chlorine				17				
lithium			6.94 amu					
	V	23						

7) How many possible isotopes does chlorine have? How do you know?

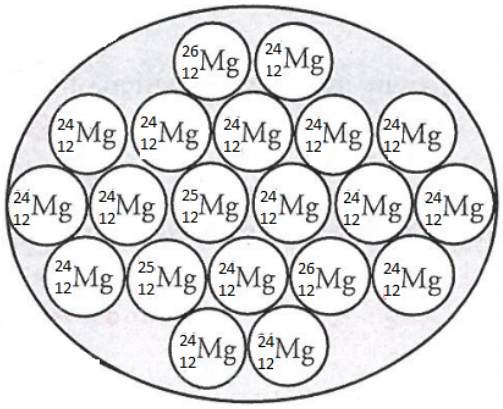
8) Which isotope of chlorine must be most common? Explain your reasoning.

9) If you isolate a single atom of lithium, how many neutrons would it probably have in its nucleus? Explain.

10) Explain why the average atomic masses of the elements listed in the periodic table usually are not whole numbers.

Part III: Calculate the Average Atomic Mass

The image to the right represents a naturally occurring sample of magnesium. Consider the image as you answer the questions below.



11) Determine the number of naturally occurring isotopes represented in this sample. How many *different* isotopes did you find?

Identify these isotopes by completing the table. **You will need to create a column for each isotope you identified**. Recall that percent abundance is the percentage of each isotope. Include your calculation in the table.

	CLASS EXAMPLE	**Isotopes of Magnesium from the sample above**		
Isotope Name	Element Name - M#			
Isotope Symbol	$^{M\#}_{A\#}$ Element Symbol			
Percent abundance	$\frac{\#\ atoms\ of\ \ isotope}{total\ \#\ atoms\ in\ sample}$			
Mass of ONE atom ***HINT 4 LAB!***	$\frac{total\ mass\ of\ one\ isotopes}{total\ mass\ of\ \ atoms\ in\ sample}$			

On page 14, we calculated the average atomic mass (AAM) of the boron atoms by adding up their masses and dividing by 10. Since some isotopes are more common than others, we need to calculate AAM by using a special equation. Record the AAM equation in the box below, then use the information about the magnesium isotopes to practice.

Average Atomic Mass Formula (*this will be provided on the test)*

12) Calculate the average atomic mass of magnesium.

Part VI: Average Atomic Mass Word Problems

Calculate the average atomic mass by using the equation we practiced above. A complete answer will show work, include proper units and be rounded to the hundredths place (okay to ignore sig figs for these).

13) The element copper, Cu, has two naturally occurring isotopes: 69.2% of all copper samples consist of atoms with 34 neutrons, and 30.8% of all samples consist of atoms with 36 neutrons. Calculate the average atomic mass of copper atoms.

14) Rubidium is a soft, silvery-white metal that has two common isotopes, rubidium-85 and rubidium-87. If the abundance of rubidium-85 is 72.2% and the abundance of rubidium-87 is 27.8%, what is the average atomic mass of rubidium?

15) Titanium has five common isotopes: titanium-46 (8.0%), titanium-47 (7.8%), titanium-48 (73.4%), titanium-49 (5.5%), titanium-50 (5.3%). What is the average atomic mass of titanium?

16) Naturally occurring chlorine that is put in pools is 75.53 percent chlorine-35 and 24.47 percent chlorine-37. Calculate the average atomic mass.

17) Calculate the average atomic mass of sulfur if 95.00% of all sulfur atoms have a mass of 32 amu, 0.76% has a mass of 33 amu and 4.22% have a mass of 34 amu.

18) Naturally occurring strontium consists of four isotopes, Sr-84, Sr-86, Sr-87 and Sr-88. Below is the data concerning strontium:

Sr-84	Sr-86	Sr-87	Sr-88
0.56%	9.86%	7.00%	82.58%

What is the average atomic mass of strontium?

19) *Challenge* Uranium is used in nuclear reactors and is a rare element on Earth. This element has three common isotopes, and has an average atomic mass of 237.98 amu. The abundance of uranium-234 is 0.01% and the abundance of uranium-235 is 0.71%. What is the mass of the third isotope if its abundance is 99.28%?

Ions Notes

Name _____

Chemistry

Date _____ Hour _____

Essential Question: How can atoms of the same element be different in relation to the arrangement of their electrons?

I can…

- *...explain where the charge on an ion is derived from.*
- *...determine the charge on an ion based on an atom's placement in the periodic table*
- *...write in isotopic notation and include the charge of the ion.*

Write about it…

- What happens when we change the number of protons in an atom?

- What happens when we change the number of neutrons?

- What do you think happens when we change the number of electrons in an atom?

Ions

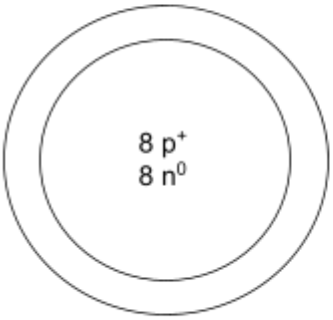
- Ion - An atom (or group of atoms) that has a _____ or _____ charge because it has _____ or _____ electrons.
  - *Review: Protons are positively charged. Neutrons are neutral (no charge) Electrons are negatively charged*
- If plucked off of the p-table, atoms are naturally _____.
  - *Because the number of p+ is equal to the number of e-*
- What if an atom plucked from the p-table loses or gains e-?
  - The atom becomes _____. Charged atoms are called _____.
- There are 2 types of ions:
  - Cation
    - A _____ charged ion
    - Formed when an atom _____ electrons *(losing negative charges = becoming more positive!)*
    - Protons _____ electrons
    - Memory Trick I liked:

  - Anion
    - A _____ charged ion
    - Formed when an atom _____ electrons *(gaining negative charges = becoming more negative!)*
    - Protons _____ electrons
    - Memory Trick I liked.

EdPuzzle Video / In-Class Examples

The oxygen atom

BEFORE moving electrons…



charge chart

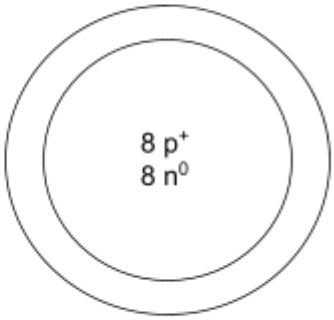
+	-

Calculation: _____

Name:

Symbol:

AFTER moving electrons…



charge chart

+	-

Calculation: _____

Name:

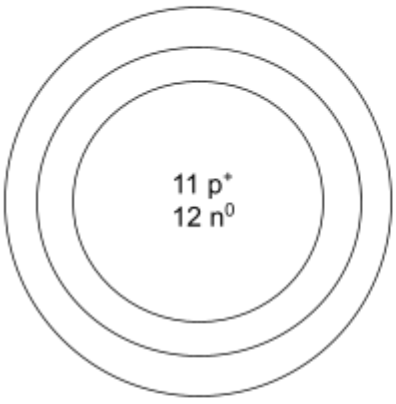
Symbol:

This ion *gained* / *lost* electrons

This is a(n) *cation* / *anion* .

The sodium atom

BEFORE moving electrons…



charge chart

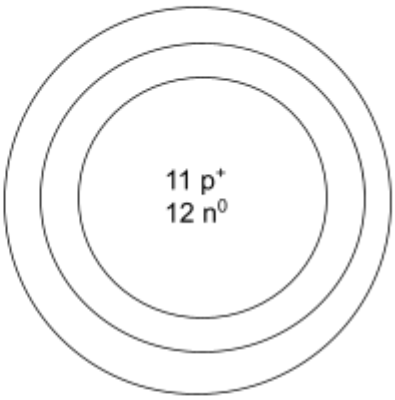
+	-

Calculation: _____

Name:

Symbol:

AFTER moving electrons…



charge chart

+	-

Calculation: _____

Name:

Symbol:

This ion *gained* / *lost* electrons

This is a(n) *cation* / *anion* .

Ions Practice

Name:_____

Chemistry

Date:_____Hour_____

Complete the table below. Use the following formulas to help: A# = p^+ $n^0 + p^+ = M\#$ $p^+ - e^- =$ charge

Element Name	**Atomic #** (A#)	**Mass #** (M#)	**Protons** (p^+)	**Neutrons** (n^0)	**Electrons** (e^-)	**Overall Charge**	**Isotope Symbol with Charge**	**Ion Name** (if neutral, write the **Isotope Name**)
Bromine (example)	***35***	***80***	***35***	***45***	***36***	***-1***	$^{80}_{35}Br^{1-}$	*Bromide*
Aluminum		27	13		10			
Uranium	92			146	87			
	2	4			2		$^{4}_{2}He$	Helium - 4
	53	126			54			Iodide
	3			4	2			
Tungsten		184		110	70			
Xenon		133		79	54			

Element Name	**Atomic #** (A#)	**Mass #** (M#)	**Protons** (p^+)	**Neutrons** (n^0)	**Electrons** (e^-)	**Overall Charge**	**Isotope Symbol with Charge**	**Ion Name** (if neutral, write the **Isotope Name**)
Magnesium	12	24				+2	$^{24}_{12}Mg^{2+}$	
Carbon	6			6		Neutral		
			8	7		-2		Oxide
	7	14				-3	$^{14}_{7}N^{3-}$	
Chlorine		36	17			-1		
	26	56				+3		
Strontium		88				Neutral		Strontium-88
Hydrogen	1	1				Neutral	$^{1}_{1}H$	
			15			-3		Phosphide

The Mole: Notes

Name:_____

Chemistry

Date:_____Hour_____

Essential Question: How do chemists quantify extremely small particles of matter?

Let's look at other common units of counting…

1 pair = ____ objects

1 gross = _____ objects

1 dozen = _____ objects

1 ream = _____ objects

*We use a unit that is appropriate for what we are measuring!

The MOLE is similar to other common units of counting!

Definition: The mole is _____

_____

1 mole = _____ objects or 602, 000, 000, 000, 000, 000, 000, 000
(that's six hundred two *sextillion!)*

The mole is also called _____ _____ .

Molar Mass (MM)

Definition: _____

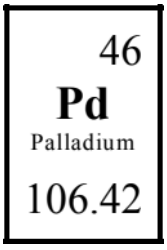
This is considered to be a _____ _____: A unit of measure that combines 2 or more base units.

Molar mass is numerically equal to _____

Unit check…

amu (atomic mass units) measures _____

g/mol (grams per mole) measures _____



Mole Concept Conversion Factors

Moles to Mass

Moles to Particles

- When in doubt, USE PARENTHESES!

- Be careful when typing in powers of ten for scientific notation!
  - Use the ^ key
  - Use the 10^x key (2nd log)
  - Use the EE key

Try it!

3.490×10^{-23}

What it looks like in your calculator:

- Use the ^ key
  - 3.490 * (10^(-23))
- Use the 10^x (2nd log) key
  - $3.490_{10}\hat{}(-23)$
- Use the EE key
  - 3.490E-23

Mole Calculation Practice

Name:_____

Chemistry

Date:_____Hour_____

Useful Conversion Factors:

Avogadro's Number: $1 \text{ mol } X = 6.02 \times 10^{23} \text{ particles } X$

**Particles can be atoms, molecules, ions...etc…*

Molar Mass: $1 \text{ mol } X = \#g\ X$

***Molar mass comes from the periodic table.*

Grams → Moles

Calculate the number of moles in each of the quantities below by using dimensional analysis. Complete answers will include units, the correct number of significant figures, and show all work. ***Box your final answer.***

1) Convert 25.00 g of sodium (Na) to moles. **S**tarting:_____ **U**nknown:_____
Conversion Factor(s): **S**olve:

1.087 mol Na

2) Convert 125 g of hydrogen (H) to moles. **S**tarting:_____ **U**nknown:_____
Conversion Factor(s): **S**olve:

124 mol H

3) Convert 100. g of potassium (K) to moles. **S**tarting:_____ **U**nknown:_____
Conversion Factor(s): **S**olve:

2.56 mol K

4) Convert 255.61 g of chlorine (Cl) to moles. **S**tarting:_____ **U**nknown:_____
Conversion Factor(s): **S**olve:

7.2104 mol Cl

5) Convert 13 g of copper (Cu) to moles. **S**tarting:_____ **U**nknown:_____
Conversion Factor(s): **S**olve:

0.20 mol Cu

6) Convert 46.5 g of silver (Ag) to moles. **S**tarting:_____ **U**nknown:_____
Conversion Factor(s): **S**olve:

0.431 mol Ag

Moles → Grams

Calculate the number of grams in each of the quantities below by using dimensional analysis. Complete answers will include units, the correct number of significant figures, and show all work. ***Box your final answer.***

7) Convert 2.50 moles of aluminum (Al) to grams. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

67.5 g Al

8) Convert 0.50000 moles of sulfur (S) to grams. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

16.035 g S

9) Convert 1.5 moles of manganese (Mn) to grams. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

82 g Mn

10) Convert 0.250 moles of magnesium (Mg) to grams. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

6.08 g Mg

11) Convert 3.20×10^5 moles of chromium (Cr) to grams. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

1.66×10^7 g Cr OR 16,600,000 g Cr

12) Convert 9.801 moles of lithium (Li) to grams. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

68.02 g Li

Moles → Particles

Calculate the number of <u>particles</u> in each of the quantities below by using dimensional analysis. Complete answers will include units, the correct number of significant figures, and show all work. ***Box your final answer.***

13) Convert 2.020 moles of uranium (U) to particles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

1.216×10^{24} particles (atoms) U

14) Convert 1.2 moles of tin (Sn) to particles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

7.2×10^{23} particles (atoms) Sn

15) Convert 0.750 moles of helium (He) to particles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

4.52×10^{23} particles (atoms) He

16) Convert 15.0×10^{4} moles of gold (Au) to particles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

9.03×10^{28} particles (atoms) Au

17) Convert 0.00450 moles of iron (Fe) to particles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

2.71×10^{21} particles (atoms) Fe

18) Convert 3.090×10^{-3} moles of phosphorus (P) to particles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

1.860×10^{24} particles (atoms)

Particles → Moles

Calculate the number of moles in each of the quantities below by using dimensional analysis. Complete answers will include units, the correct number of significant figures, and show all work. ***Box your final answer.***

19) Convert 3.50×10^{25} atoms of lead (Pb) to moles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

58.1 moles Pb

20) Convert 2.405×10^{26} atoms of krypton (Kr) to moles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

399.5 moles Kr

21) Convert 1.5×10^{20} atoms of boron (B) to moles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

2.5×10^{-4} moles B OR 0.00025 moles B

22) Convert 3.497×10^{26} atoms of strontium (Sr) to moles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

580.9 moles Sr

23) Convert 6.00×10^{14} atoms of zinc (Zn) to moles. **S**tarting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

9.97×10^{-10} moles Zn

24) Convert 500. atoms of cobalt (Co) to moles. **S**tarting:_____ **U**nknown:_____

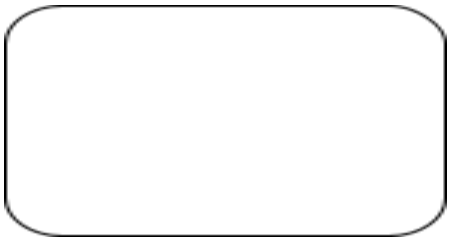
Conversion Factor(s): **S**olve:

8.31×10^{-22} moles Co

2-Steppers and Diatomics

Use dimensional analysis to convert the following quantities. Complete answers will include units, the correct number of significant figures, and show all work. ***Box your final answer.***

The diatomics are...



25) How many grams are there in 4.3×10^{25} atoms of mercury (Hg)?

Starting:_____ **U**nknown:_____

Conversion Factor(s): **S**olve:

14,000 g Hg OR $1.4x10^4$ g Hg

26) How many moles of iodine gas (I_2) are in 500. grams of gas?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

1.97 mol I_2

27) How many atoms are there in 1.2337×10^{-3} grams of calcium (Ca)?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

$1.8530x10^{19}$ atoms Ca

28) How many grams of nitrogen gas (N_2) are in 4.00 moles of gas?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

112.08 → 112 grams of N_2

29) A 5.00 gram sample of cadmium (Cd) is in a container. How many atoms of cadmium (Cd) are in the container?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

$2.68x10^{22}$ atoms Cd

30) What if the container from the previous question contained nickel (Ni)? How many atoms of nickel (Ni) would be in the container?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

$5.13x10^{22}$ atoms Ni

31) How many grams of oxygen gas (O_2) are in 3.500 moles of gas?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

112.0 g O_2

32) How many grams are in 5.203×10^{26} atoms of arsenic (As)?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):
Solve:

64,750 g As

33) How many grams of bromine gas (Br_2) are in 7.28×10^{28} molecules of gas?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):
Solve:

19,300,000 OR 1.93×10^{7} mol Br_2

34) How many grams of fluorine gas (F_2) are in 1.405×10^{24} molecules of gas?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):
Solve:

88.69 g F_2

35) How many atoms are there in a 75.0 gram sample of barium (Ba)?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):
Solve:

3.29×10^{23} atoms Ba

36) How many phosphide ions (P^{3-}) are there in 20.3 grams of phosphide ions?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):
Solve:

3.95×10^{23} P^{3-} ions

37) Determine the number of calcium ions (Ca^{2+}) found in 687g of calcium ions.

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):
Solve:

1.03×10^{25} ions Ca^{2+}

38) How many moles of molecular hydrogen gas (H_2) are in 12.0300×10^{25} molecules of gas?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):
Solve:

199.834 moles H_2

39) What is the mass of a 6.321×10^{24} atom sample of nickel (Ni)?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

616.2 g Ni

40) If you have 88.624 moles of silver (Ag), how many grams are in the sample?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

9,560.0g Ag OR 9.5600×10^{3}g Ag

41) How many molecules are in 4.67 grams of molecular chlorine (Cl_2)

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

3.97×10^{22} molecules of Cl_2

42) How many moles are equal to 0.1360 g Tin (Sn)?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

0.001146 mol Sn OR 1.146×10^{-3} mol Sn

43) How many atoms are in 17,000 moles if Zirconium (Zr)? **pay attention to sig figs here!**

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

1.0×10^{28} atoms Zr

44) What is the mass of 37.0 moles of Boron (B)?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

400. g B OR 4.00×10^{2} g B

45) How many moles are equal to 5.13×10^{27} ions of Sulfide (S^{2-})?

Starting:_____ **U**nknown:_____ **C**onversion Factor(s):

Solve:

8,520 moles S^{2-} OR 8.52×10^{3} moles S^{2-}

Unit 2 Review - Atomic Structure & Counting Particles

Name:_____

Chemistry

Date:_____Hour_____

Match the vocabulary terms with the definitions below. Write the correct term on the line provided.

Matter	Element	Atom	Proton	Ion
Diatomic Molecule	Nucleus	Neutron	Electron	Mole
Atomic Number	Mass Number	Isotope	Average Atomic Mass	Molar Mass
	Anion	Cation	Atomic Mass Unit	

_____ 1. Anything that has mass and takes up space.

_____ 2. The smallest unit of an element that maintains the chemical properties of that element.

_____ 3. A substance that cannot be separated or broken down into simpler substances by chemical means.

_____ 4. The sum of the numbers of protons and neutrons in the nucleus of an atom.

_____ 5. A subatomic particle that has a negative charge.

_____ 6. Atoms of the same element with the same number of protons, but different number of neutrons.

_____ 7. A subatomic particle with a positive charge and can be found in the nucleus of an atom.

_____ 8. An atom's central region, which is made up of protons and neutrons.

_____ 9. A value on the periodic table that represents the number of protons in the nucleus.

_____ 10. A positively charged ion.

_____ 11. An atom that has lost or gained electrons and has a negative or positive charge.

_____ 12. SI base unit used to measure the amount of a substance.The number of particles is 6.022×10^{23}

_____ 13. A subatomic particle that has no charge and that is located in the nucleus of an atom.

_____ 14. The weighted average of all the isotopes that exist for an element.

_____ 15. Because the mass of a proton and neutron is so small, scientists created this unit to make the mass of an atom easier to understand and compare.

_____ 16. A negatively charged ion.

_____ 17. The mass in grams of one mole of a substance.

_____ 18. A molecule consisting of two atoms.

Answer questions #19-25 using the words/symbols: <u>proton</u> (p^+), <u>neutron</u> (n^0), and/or <u>electron</u> (e^-).

19. Which particle(s) in the center of the atom? _____
20. Which particle(s) go around the center of the atom? _____
21. What can you add to the atom to change its identity? _____
22. What can you add to the atom to change its mass number? _____
23. What can you add to the atom to change its net charge? _____
24. Which particle(s) is/are "heavy"? _____
25. Which particle(s) is/are "light"? _____

In questions #26-29 you are given a pair of elements. Use the information given to decide if the pair of elements are isotopes, ions, or different elements. Write your answer on the line.

26. Element A has 6 protons, 7 neutrons, and 6 electrons.
    Element B has 7 protons, 7 neutrons, and 7 electrons. _____

27. Element C has 27 protons, 32 neutrons, and 27 electrons.
    Element D has 27 protons, 33 neutrons, and 27 electrons. _____

28. Element E has 17 protons, 18 neutrons, and 17 electrons.
    Element F has 18 protons, 17 neutrons, and 18 electrons. _____

29. Element G has 56 protons, 81 neutrons, and 57 electrons.
    Element H has 56 protons, 81 neutrons, and 56 electrons. _____

Use your periodic table and your vocabulary notes to draw a model of the atom described in #30 and #35.

30. Draw a model of an atom that has the following components:

    3 protons (p^+) **4 neutrons (n^0)** **3 electrons (e^-)**

31. What element is represented from the model in #30? _____

32. What is the mass number (*M#*) of the atom from the model in #30?_____

33. What is the net charge of the atom from #30? If applicable, name the ion. _____

34. If you add 1 proton and 1 neutron to the atom from the model in #30:
    Will the element change? *Yes / No* If so, **circle** the new element on the periodic table below
    Will the mass change? *Yes / No* If so, what is the new mass of the atom? _____
    Will the charge change? *Yes / No* If so, what is the new charge of the atom?_____

35. Draw a model of an atom that agrees with the isotope symbol below:

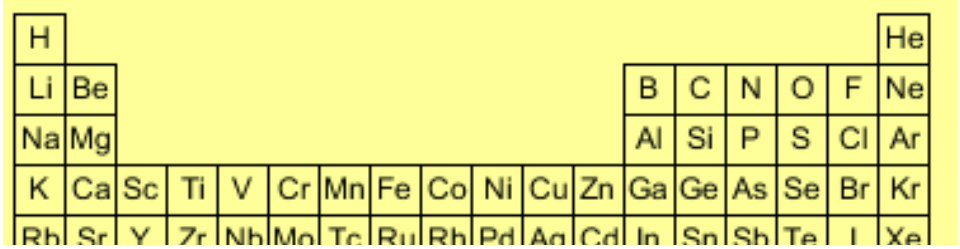
    $^{15}_{7}N^{3-}$ **protons (p^+)** **neutrons (n^0)** **electrons (e^-)**

36. What element is represented from the model in #35? _____

37. What is the mass number (*M#*) of the atom from the model in #35? _____

38. What is the net charge of the atom from #35? If applicable, name the ion. _____

39. If you add 1 proton and 1 neutron to the atom from the model in question 35:
    Will the element change? *Yes / No* If so, **box** the new element on the periodic table below
    Will the mass change? *Yes / No* If so, what is the new mass of the atom? _____
    Will the charge change? *Yes / No* If so, what is the new charge of the atom?_____



40. *Match the following models of the atom to their contribution to the development of the atom.*

_____ The Plum Pudding Model	a. Experiment that proved electrons are removable particles.
_____ The Law of Definite Proportions	b. Negatively charged particles in a positively charged fluid
_____ The Gold Foil Experiment	c. H_2O will always have 2 hydrogens and 1 oxygen
_____ The Cathode Ray Tube	d. Discovered the dense nucleus in the center of the atom

Use this space (and potentially a separate sheet of paper!) to review the Models of an Atom Worksheet. Remember, you do not need to know the names of the people, or the dates of the models.You should be prepared to answer questions about the following:

- *How each of the five atomic models were developed (the experiments)*
- *What each atomic model contributed to our overall understanding of the atom.*

Perform the following mole concept calculations. A complete answer will show work using dimensional analysis, have an answer rounded according to the rules of significant figures, and will include a unit.

41) Calculate the number of molecules of hydrogen found in a 16.09 mole sample of hydrogen gas (H_2).

Answer_____

42) Calculate the number of atoms found in 15.0 grams of nickel (Ni).

Answer_____

43) Calculate the mass of a sample containing 1.90×10^{24} molecules of fluorine (F_2).

Answer_____

The following elements are capable of becoming anions. Write the ion name next to the element listed

44. Nitrogen _____	47. S^{2-} _____
45. O^{2-} _____	48. P^{3-} _____
46. Bromine _____	49. Chlorine _____

Perform the following average atomic mass calculations. A complete answer will show work (use equation to the right), have an answer rounded according to the directions below, and will include a unit.

$$\frac{\text{M\#(\%)} + \text{M\#(\%)} + \text{M\#(\%)...etc}}{100} = \text{AAM}$$

50) Use the information in the table to show the average atomic mass of neon. Round your answer to the hundredths place (two places after the decimal point) and show all work.

ISOTOPE	% ABUNDANCE
Neon-20	90.48
Neon-21	0.27
Neon-22	9.25

51) Gallium, which has two isotopes, has an average atomic mass of 69.72 amu. Gallium-69 makes up 60.1% of all gallium isotopes. The other isotope of gallium is equal to 39.9%. What is the mass number for the less abundant gallium isotope? Round to the nearest whole number.

Complete the table below.

Element Name	**Isotope Symbol w/ Charge**	**Atomic Number**	**Mass Number**	**# of Protons**	**# of Neutrons**	**# of Electrons**	**Charge**
52. Hydrogen		1	1				1+
53.		2			2	2	
54.		2	5			2	
55. Lithium		3	7			2	
56. Carbon				6	8		1-
57. Carbon		6			6		4-
58.		12	24				2+
59.			28	12		12	