Atomic Theory Notes

OB: Students will examine basic structure of the atom, learn what the numbers on the Periodic table mean, and look at electron orbitals. All atoms are made up of three sub-atomic (smaller than atoms) parts. They are the...

1 Parts of the atom	Particle Charge	Symbol	Mass	Location

2. The mass of an electron is NOT REALLY ZERO, but it's so small, about 1/1750 of a proton or neutron, that we will disregard it's mass.
In high school chem the mass of an electron is _____, in real life it is just a very, very small mass.

The nucleus is the _____, _____ center of an atom where the protons + neutrons live.

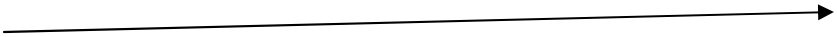
Electrons fly around outside, _____far away.

The mass of all atoms are measured in super tiny masses called ____, or _____.

The approximate masses for the three subatomic particles (approximate)

Protons are _____, Neutrons are _____. Electrons = _____ mass

The periodic table of the elements has a KEY, with the atom carbon as the example.
Let's label these numbers now.

3. 

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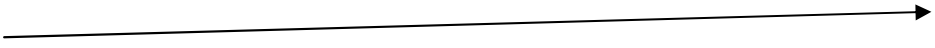
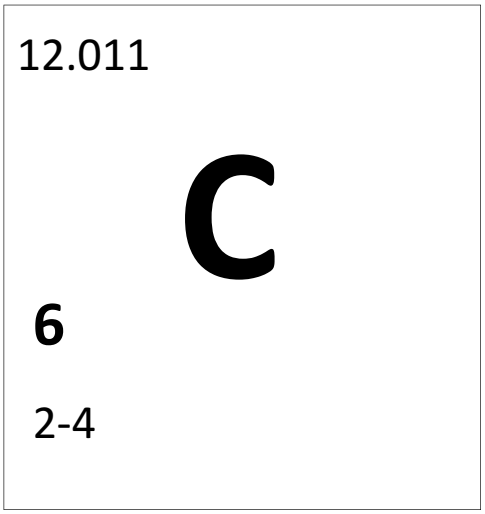
5. 



6,. Atomic Mass Numbers will be rounded to the _____
(they are not really whole numbers, we'll get to that later)

7. Mass Number = mass of _____ + _____

8. The mass of mercury is 201 amu, so mercury has a total of 201 protons plus neutrons.
How many of each??? Let's learn how to figure this out

9. How many protons, neutrons, and electrons in the element TIN?

10. All atoms are electrically neutral, The number of _____ = the number of _____

The positives = the negatives. *Always.*

Every atom is neutrally charged. The positive protons + negative electrons always <u>BALANCE</u>.

11. Determine how many protons, neutrons, and electrons are in these three atoms In, Nb, and Ba.
What are their NAMES too?

In	Nb	Ba

There are several ways to “write” symbols that stand for atoms, here’s another, more formal method.

12. Copy calcium and label the numbers

Ca

14. Write the formal symbols, with the proper numbers, in the RIGHT PLACE, for

mercury chlorine copper

15. Electrons do not fly around the nucleus willy-nilly. They stay in _____,

which are also called _____.

16. The further away from the nucleus, the higher the energy the electrons have. The closer they are the _____ their energy is. The orbitals are named, and they are also sized; they can hold only a certain number of electrons.

17. Orbital (n)	Name of orbital	Fits up to ___ electrons
n = 1	First orbital	

18. What is the symbol for silver, how many electrons does an atom of silver have? _____

9. Find scandium, what is the electron configuration and number of electrons? _____

20. Find S What's the name of this atom, and how many protons does it have? _____

21. Find oxygen, How many neutrons, what is it's symbol? _____

22. For any atom, the atomic number is the _____ = _____.

The electron configuration always adds up to the atomic number. *Examples:*

23. Na #11 has an electron configuration of _____ ___ + ___ + ___ = ____

24. C #6 has an electron configuration of _____ ___ + ___ = ____

25. K #19 has a configuration of _____ ___ + ___ + ___ + ___ = ____

Atomic Theory Class #2

OB: students will review the models of the atom through scientific history, learning how ideas progressed and were dismissed as new information was developed.

26. 2400 years ago, the thinker named Democritus said…

27. In the early 1800's, the English farmer John Dalton said…

28. His model was called the _____ model.

His Atomic theory could be stated in 4 simple statements which you will memorize.

1.

2.

3.

4.

29. Dalton DID NOT KNOW about _____

30. It took almost 100 years, in 1897, for J.J. Thomson (one of the coolest names in all of chemistry) to discover...

31. He used a fancy tool (for 1897) called a _____ _____ _____ to do this.

32. His model was called the _____ named after his...

This can also be thought of like a chocolate chip cookie, where the chips could be the electrons, and the cookie part was the “positively charged” other stuff that the atom was made of. She didn’t make chocolate chip cookies so it’s still called the “plum pudding model”.

33. In 1908, MY CHEMISTRY HERO, Earnest Rutherford, from Australia, did one of the most important experiments in science ever, called the

_____ experiment.

34. Draw that now.

35. What does this gold foil experiment prove?

1. Atoms are mostly _____ (since most of the alpha particles pass though the foil like it's not really there.)
2. He knew that atoms are neutral so the nucleus must be dense and _____ charged (since the alpha particles which are positive didn't stick, and they dinged off of something much bigger than themselves every once in a while)
3. Neutral atoms must therefore have electrons _____ of the nucleus, flying around outside (maybe like the planets going around the Sun)

But there were serious PROBLEMS with this new theory, even though he was RIGHT.

36. Problems with this new theory of Rutherford's

Atoms are mostly empty space. Really?

So these negatively charged electrons fly around this positively charged nucleus, and they just aren't attracted together? They just keep flying? They never use up their energy? Ever? Wow!

How far away are these electrons and do they just fly willy-nilly? No system?

He just couldn't figure it all out, but he was **right**.

He took lots of flack for this, until his student, the chemist with the plural first name, saved his theory and helped prove him correct.

37. In 1913, Niels Bohr is able to mathematically PROVE for _____ that Rutherford is correct. He shows that for this one atom, the electron can fly around the nucleus at a certain distance and be held to the nucleus without being pulled in to it. He proved that the electron will not lose energy if it stays in this orbit (which is strange), but it doesn't, so it won't slow down and be pulled inward, or fly away.

Even though he earns a Nobel Prize for how smart he is, he couldn't (no one yet can) prove this true for atoms larger than hydrogen because the math is too hard, but since atoms exist, they don't collapse, it sort of MUST BE TRUE FOR ALL ATOMS even if the math is too hard to explain.

38. Niels Bohr determines that…

1. The electrons are in _____
   (which we know is a little wrong now, they're in _____)

2. He determines that these are also _____ _____, and that the electrons have lower or higher energy, depending upon which orbit they are in.
3. Electrons could gain a specific amount of energy, an amount called a _____ of energy, which would enable them to "jump" up to a _____ energy level or orbit.

4. Since every atom was unique (different numbers of protons and had different electron configurations) it took unique amounts of energy to make these upward "jumps" possible.

5. The electrons, in this new _____ state, were less stable than when they were in the normal _____ state, they would revert back to the ground state only when they released this SPECIFIC AMOUNT OF ENERGY, and that energy would be SEEN by your eyes (literally) as a unique color (a unique amount of energy is measurable, even by your eyes).

6. He wins the Noble Prize for this work with electrons, and the SPECTRA (colors we see when electrons return to the ground state from the excited state). Each atom emits unique, measurable spectra. We will measure this IN OUR LAB soon. You can do this, you can see this, it's way cool.

39. The Modern Model of the Atom has been developed by many scientists over a long period of time.

It's called the Modern Model, or the _____ - _____ model, because

40. The electrons sometimes act as _____ of energy, or as _____ bits of matter. Electrons don't act the way you would suppose, they are truly weird and act differently on different days.

41. This modern model concerns itself more with the _____ probability of finding an electron's location most of the time, not knowing where it is EXACTLY at any one time.

Atomic Theory Class #3

OB: patterns of the electron orbitals as related to the Periodic Table, ground & excited states, and Spectra

Using your Periodic tables, write the electron configurations of the following:

	Group 1	Group 2	Group 15	Group 16	Group 17	Group 18
42	lithium	beryllium	nitrogen	oxygen	fluorine	neon
43	sodium	magnesium	phosphorous	sulfur	chlorine	argon
44	rubidium	strontium	antimony	tellurium	iodine	xenon

45. The 1st orbital holds up to _____electrons The 2nd orbital holds up to _____ electrons

46. While the 3rd orbital holds up to _____ (or _____) electrons

47. The 4th orbital holds up to _____ (or _____) electrons

48. All electron configurations on the periodic table are in the LOWEST ENERGY state, also called the

_____

Electrons are found in the ground state normally, but if they gain energy (heat, electricity, or even radiation) one or more electrons can jump up to higher orbitals. Fill in POSSIBLE excited state configurations for these atoms (KISS)

	ground state	A possible excited state	Total # electrons in ground or in excited state
49	Lithium 2-1	Lithium	
50	Silicon 2-8-4	Silicon	
51	Potassium 2-8-8-1	Potassium	
52	Aluminum 2-8-3	Aluminum	
53	Boron 2-3	Boron	

54. Ground + Excited State electron configurations have the _____,

they are just in _____ places.

55. What is KISS? _____

And that means what here?

56. How do electrons get excited? They absorb energy in _____ _____ and release it as

_____ light, called _____.

	Atom	Number of protons in nucleus with positive charge pulling on the electrons	Ground State	Possible Excited State
57	Sodium Na	_____ protons	2-8-1	2-7-2
58	Magnesium Mg	_____ protons	2-8-2	2-7-3

Why is the spectra different for Na and Mg if they both move 1 electron from 2nd to 3rd orbital?

No matter how the energy was added in, most of the energy coming out is emitted as visible light, which we can see (you can see).

59. Each unique amount of energy given off is visible as different colors, which we can see with our eyes. This light given off WHEN ELECTRONS RETURN TO THE GROUND STATE IS CALLED THE

_____

60. The spectra is a _____ of light, we see as one color but is made up of _____ colors. Our eyes blend it into one shade. Inexpensive devices (similar to prisms) break up this single color spectra, into what is called a _____-graph. We will see this in lab.

Each line is part of the spectra, and is like a UNIQUE finger print for that atom or compound. Scientists (and you too) will be able to determine what atoms are present by what spectra is emitted by unknown substances. We just compare the spectra measured, to the known spectrographs. This can be used in a lab to do CSI work, or through telescopes - to know what substances exist on other planets. The unique spectra that the same throughout the Universe.

Atomic Theory Class #4 OB: what are isotopes and why are they so important?

John Dalton once said that all atoms of an element are identical, because at that time he could not imagine that there were any subatomic particles. He thought all the differences in atoms were that they had different masses, and that alone accounted for all the different properties. He was the father of modern chemistry, and you already are more educated than him. It turns out he was half right. He should have said that:

All Atoms Of An Element Are Chemically Identical. They all react alike, & they have the same chemical properties. They are not physically identical.

61. There are atoms of each element that have a different mass, they have different numbers of _____.

These "different" atoms are called _____ of each other.

There are 118 types of atoms, but there are almost _____ different kinds of atoms.

62. Each kind of atom comes in a variety of masses, each type of atom forms many different _____.

	ISOTOPE →	Neon-20	Neon-21	Neon-22
63	# protons			
64	# electrons			
65	# neutrons			
66	MASS in amu			

67. These 3 different ISOTOPES of neon are _____ identical but all have different _____.

68. They have the same number of protons + electrons, but _____numbers of neutrons.

69. Only the _____ is affected, not the atoms' chemical _____.

Carbon has 2 isotopes, C-12 and C-14. The carbon 12 is the "normal" carbon, while the carbon 14 is the radioactive kind (which we will discuss in great detail - later in the year).

C-12 makes up 99.45% of all the carbon in the world. C-14 makes up the rest, just 0.55% of the carbon.

70. Together, they make up _____% of the carbon.

71. LOOK UP the ACTUAL average weighted atomic mass of a carbon atom on the periodic table?

It is: _____amu

72. Show how this average atomic mass is calculated

Does this make sense? Yes the rounded mass equals the mass of the MOST COMMON isotope, which here is clearly the 12 amu which makes up more than 99% of all carbon atoms.

Average Weighted Atomic Mass is the mass listed on our periodic tables. They take into account the mass of each isotope AND the proportions that those isotopes make up of all of that kind of atom. Scientists measure these proportions all the time (and sometimes it changes the numbers on the periodic table when they realize that the proportions are a little different than they thought.

73. The mass of an isotope (in HS Chem) is always a WHOLE NUMBER of amu, because they have a whole

number of _____ + _____.
But the PROPORTIONS are funky, which is where the decimals come from.

74. A new element named Arbuiso is discovered (A). It has two isotopes, A-44 and A-45. 95.00% of all Arbuiso has mass of 44 amu, while the rest has mass of 45 amu. What is the weighted average atomic mass of this cool new metallic element? (do math)

75. Unknown element X has three isotopes, X-23, X-24, and X-25. The first isotope makes up 75.00% of all of this element. X-24 makes up 20.0%, while the last isotope X-25 makes up just 5.0% of all this unknown element. What is it's average weighted atomic mass?

Does this make sense? Yes, the rounded average mass is equal to the most common isotope mass. That means it makes up the bulk of the average mass too.

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76. State objective #1 in the NYS Chemistry Curriculum about Atomic Theory:

	Scientist Name	Model Name	Details
77		x	
78			
79			
80		x	
81			
82	many		

83. Four Main Points of Dalton's Atomic Theory:

A

B

C

D

84. Draw the "GOLD FOIL" experiment

85. What did Rutherford DISCOVER, what were the PROBLEMS with this new model?

86. Describe the BOHR MODEL, explain what SPECTRA is and where it comes from.

87. What is the difference between an ORBIT and an ORBITAL? (this is more important than you think)

88. What is the difference between SPECTRA and a SPECTRAGRAPH?

	Atom	Ground state electron configuration	Possible excited state configuration	Number of electrons is always
89	Mg – 12			
90	Al – 13			
91	C – 6			
92	Ca – 20			
93	Fe – 26			

Mark the correct electron configurations OK. Fix any that are wrong and state why they are wrong below.

94	Mg ground state 2-8-2	
95	F ground state2-7	
96	He ground state 2	
97	Ne ground state 2-8-8	
98	Mg excited state 1-9-2	
99	He excited state 1-1	
100	Ne excited state 2-8-7-1	
101	F excited state 2-8	