Bio Honors # General Chemistry Notes **Name** _____

Directions: Carefully read the following information. Look for the ** *directions in italics* for prompts where you can do some work. Use the information you have reviewed here to help answer questions in your "Chemistry Questions Packet."**

Chemistry is the study of **atoms** and the reactions they undergo to form compounds. Every biological system can be reduced to the chemical level. Therefore, the study of biology must start at the chemical level. **Metabolic processes** like photosynthesis and cellular respiration are composed of a series of chemical reactions which involve the combinations of atoms to form new compounds. An understanding of these atoms and their chemical and physical properties will help in the understanding of the chemical reactions that take place in living things.

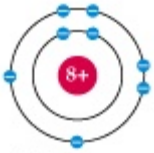
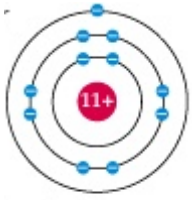
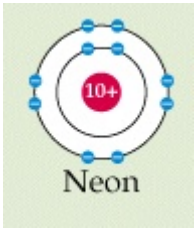
Electrons orbit the nucleus in different **energy levels.** All of these energy levels make up an **electron cloud.** Although the diagrams show electrons orbiting the nucleus in a circular fashion, this is not really accurate. The electrons in the different levels are different distances from the nucleus, but instead of orbiting in a circular track, they occupy a certain space at that distance. This will be explained in much more detail in honors Chemistry next year. Electrons in the different levels possess varying amounts of energy. Electrons that are further from the nucleus have more energy than those closer to the nucleus.

The different **energy levels** can hold different numbers of electrons:

Level 1 – Can hold up to 2 electrons.
Level 2 – Can hold up to 8 electrons.
Level 3 – Can hold up to 18 electrons but it is composed of sublevels. The first sublevel holds up to 8 electrons.

Most important biological elements have fewer than 18 electrons so the first sublevel of the 3rd energy level will be adequate for our studies.

The electron energy levels can be represented in a simple diagram. Hydrogen has 1 electron, oxygen has 8 electrons, sodium has 11electrons and neon has 10. Each can be efficiently illustrated as follows:

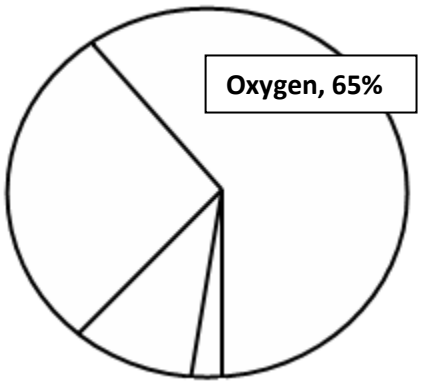
Hydrogen	**Oxygen**	**Sodium**	**Neon**
1p) 1	**8p) 2) 6)**	**11p) 2) 8) 1)**	**10p) 2) 8)**
 Hydrogen	 Oxygen	 Sodium	 Neon

Need some practice with atomic structure?
Try this website:
http://phet.colorado.edu/en/simulation/build-an-atom

The Periodic Table is a chart of the elements found on Earth, both occurring naturally and man-made.

The 4 most abundant elements in living things are:

1. Oxygen 65%
2. Carbon 19%
3. Hydrogen 10%
4. Nitrogen 3%
5. Trace elements like Na, Ca, K, S, P, Cl, Fe, Mg (Trace elements are essential for life but are needed Only in small amounts.)



Label the chart to the left with the elements that each section represents. Oxygen has been done for you. (Trace elements are not represented on the chart.)

Isotopes –are atoms of the same element that have the **same number of protons but a different number of neutrons**. This will cause different isotopes of the same element to have different atomic masses. **The number of protons in an atom will define the element.** An atom of carbon always contains 6 protons. Different isotopes of carbon will contain 6 protons but may contain 6, 8 or 10 neutrons. Since the number of electrons remains the same, the reactivity (the way they combine with other atoms) is also the same for isotopes of the same element.
*(Do not confuse isotopes with ions. **Ions** of the same element will have different numbers of electrons.)*

Most elements have isotopes. Some examples are:

- Carbon- 14 contains 6 protons and 8 neutrons
- Carbon- 12 (most common isotope in nature) contains 6 protons and 6 neutrons
- Oxygen-18 contains 8 protons and 10 neutrons
- Oxygen-16 (common isotope in nature) contains 8 protons and 8 neutrons

Many isotopes are **radioactive**, which means they have an unstable nucleus, which emits radiation, reducing the number of protons or neutrons over time.

MOLECULES AND COMPOUNDS

A **molecule** is composed of two or more atoms bonded covalently (they share electrons to be stable).

Ex. water **H_2O**, oxygen **O_2** , methane **CH_4** , hydrogen **H_2** , Ozone **O_3**,

A **molecular compound** is a molecule composed of **more than one type** of atom. Some molecules are molecular compounds. Some molecules, like diatomic (N_2) are *not* considered a molecular compound because it only contains N.

Molecules and compounds are represented by **chemical formulas**: (ex. **O_2** **$C_6H_{12}O_6$,** **H_3CO_3,** **N_2**)
The **chemical formula** tells you 1) the **types** of elements present in the molecule or compound
2) the **number** of atoms of each element in the compound.

Look at the following chemical formulas, and determine if they represent a molecule, a compound, or both.

H_2O	**O_2**	**CH_4**	**H_2**	**O_3**
_____	_____	_____	_____	_____

MOLECULES AND BONDING

*****Determine if the following atoms are stable, or unstable. If they are unstable, explain how they can become stable.*****

1. **Carbon 2) 4) -** has 2 electrons in the inner most (1^{st}) energy level and 4 in the valence level. Because the outer level can hold 8 electrons, carbon must share 4 electrons with other atoms to become stable.

2. **Oxygen 2) 6) -** has 2 electrons in the 1^{st} energy level and 6 in the second level. Oxygen must share, gain or lose 2 electrons in order to become stable.

3. **Hydrogen 1) -** will lose an electron to become stable.

4. **Nitrogen 2) 5) -**_____

5. **Neon 2) 8)-**_____

BONDING - The two kinds of chemical bonds you will study are **covalent bonds** and **ionic bonds.** *(ionic bonds will be discussed later in the section on ions).*

CHEMICAL AND STRUCTURAL FORMULAS

Remember, Molecules and compounds can be represented by **chemical formulas. (ex. O_2, $C_6H_{12}O_6$, N_2)**

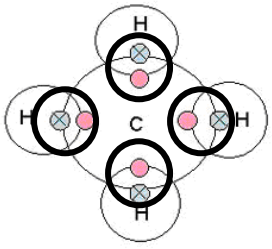
Molecules can also be represented by **structural formulas**. The **structural formula** tells you the **types** and **numbers** as well as the **arrangement of atoms** and the **number of covalent bonds** between atoms in the molecule or compound. Each line between atoms represents one covalent bond or a shared pair of electrons. ***A **single** covalent bond is shown by a single line between the atoms. A **double** covalent bond, where 2 pairs of electrons are shared, is shown by 2 lines*

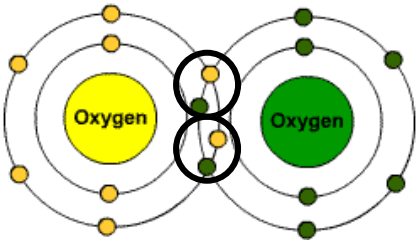
*****Diagram the structural formulas of the two following molecules (water has been done for you):*****

H_2O **CH_4**

H—O—H

*****Diagram how the following molecules are formed by covalent bonding. Show the <u>energy levels</u> in your drawing (Methane and Oxygen have been done for you.) Circle each covalent bond in your diagram:*** **Note**: Oxygen forms a double bond with the other Oxygen atom. This means that they are sharing **two pairs** of electrons. There are also **triple bonds**, where **3 pairs** of electrons are shared. An example of this would be the molecule N_2.**

H_2	**CH_4**
	

O_2	N_2
	

IONS AND IONIC BONDING

Ion- an atom that becomes charged due to the gain or loss of one, two or three electrons. In addition to sharing electrons in covalent bonds, atoms can satisfy the octet rule by becoming **ions**. Some atoms become ions by **gaining** electrons, and therefore become **negatively charged**. Other atoms become ions by **losing** electrons, and therefore become **positively charged.** The charge on the ion is based on how many electrons it gains or loses:

Na: 2)8)1 Loses one electron to become $\mathbf{Na^+}$

Mg: 2)8)2 Loses two electrons to become $\mathbf{Mg^{2+}}$

F: 2)7 Gains one electron to become $\mathbf{F^-}$

O: 2)6 Gains two electrons to become $\mathbf{O^{2-}}$

Ionic Bonds-are formed when two ions of opposite charge (one + and one -) are attracted to each other. There is no sharing of electrons in an ionic bond, just the attraction of two atoms that have gained or lost electrons to one another to become stable. In the process, they are of opposite charges and become attracted to each other.

In the diagram below, the lithium atom has 1 electron in its outer energy level and so will lose that electron in order to become stable. This gives the Li ion a positive charge

Forming an ionic compound.

Ex. lithium and fluorine will combine to form lithium fluoride, and **ionic compound.**
Note: The opposite charges of the Li^+ and the F^- cancel each other out so the compound formed, *lithium fluoride*, is not charged – it is neutral.

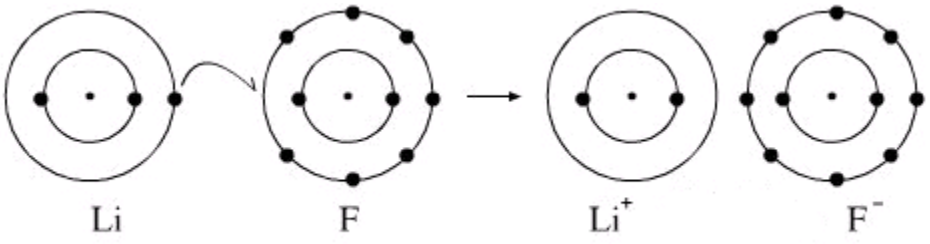


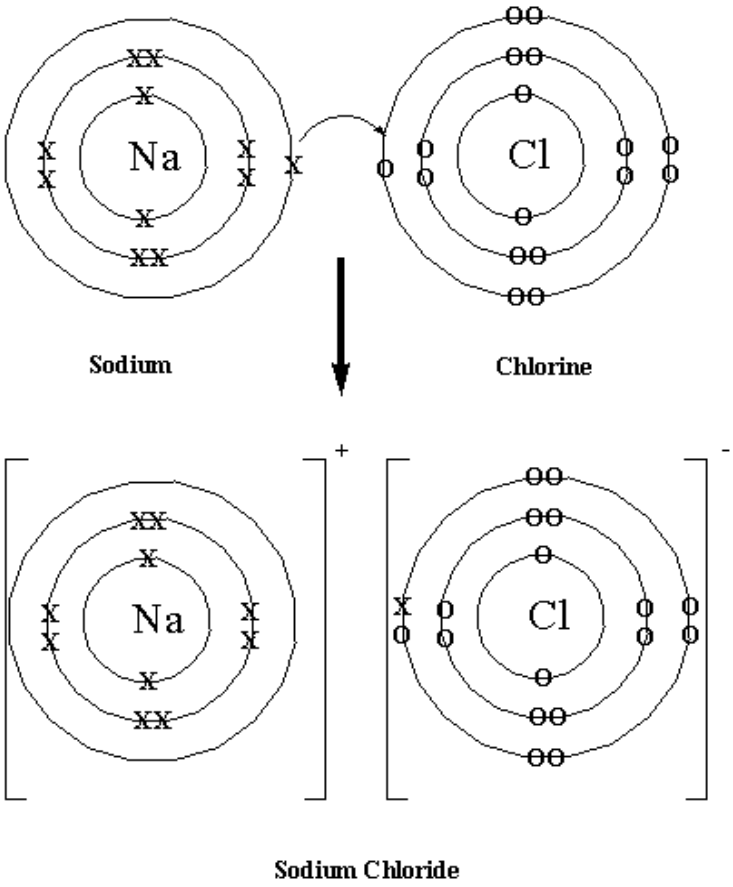
Diagram of a sodium ion and a chloride ion, forming the ionic compound, sodium chloride (NaCl):

(Recall that a sodium <u>atom</u> has 11 protons and 11 electrons. A chloride <u>atom</u> has 17 protons and 17 electrons.)

1) A sodium <u>atom</u> loses an electron 'X' and becomes **positive in charge** because it now has 11 protons and only 10 electrons. This forms a **Na^+ <u>ion</u>.**
When Na loses the electron it will have 8 electrons in its outer energy level.

2) A chlorine <u>atom</u> gains the electron lost by sodium and becomes **negative in charge** because it now has 18 electrons and only 17 protons. This forms a **Cl^- <u>ion</u>.**
When Cl gains the electron it will have 8 electrons in its outer energy level.

3) The opposite charges of the resulting ions causes the ions to be attracted to each other forming an **ionic bond**.



Sodium Chloride

Diagram magnesium (Mg) ion and an oxygen ion, and show how they form the ionic compound Magnesium oxide.*

***Diagram a magnesium (Mg) ion and a chloride (Cl) ion, and show how they form the ionic compound Magnesium chloride.**

Note: You will need to use more than one chloride ion to form this ionic compound!

Diagram a calcium (Ca) ion and an chloride (Cl) ion, and show how they form the ionic compound Calcium chloride.* You will have to decide how many of each ion is necessary to form this ionic compound!

Diagram a potassium (K) ion and an chlorine ion, and show how they form the ionic compound Potassium chloride.* You will have to decide how many of each ion is necessary to form this ionic compound!

Need some practice with building molecules?
Try this website: https://phet.colorado.edu/en/simulation/build-a-molecule

Balancing Equations:

In a chemical reaction, bonds in the reactants break and the atoms are rearranged. New bonds form to make new molecule (product). At no time during the reaction are both reactants and products present at the same time! The reactants are used to make the products.
Chemical reactions are said to be **balanced**. A balanced reaction can be identified by counting the numbers and types of atoms in the reactants and products. If an equation is balanced, they will be equal. When balancing reactions, remember that **the numbers and types of atoms in the reactants must be equal to the numbers and types of atoms in the product. You cannot change a subscript when balancing a reaction but you may change a coefficient.**

Review what you learned during 8th grade chemistry and balance the following reactions by changing the coefficients of the molecules involved in the reaction.*

____H_2S + ____O_2 → ____H_2SO_4

____Al + _____ O_2 → ____Al_2O_3

____H_2O_2 → ____ H_2O + ____O_2

____C_3H_8 + _____ O_2 →____ CO_2 + ____H_2O

____$C_6H_{12}O_6$ + _____ O_2 →____ CO_2 + ____H_2O

____P_2O_5 + ____ H_2O →____ H_3PO_4

Need some practice with balancing equations?
Try this website:

https://phet.colorado.edu/sims/html/balancing-chemical-equations/latest/balancing-chemical-equations_en.html

Honors Biology

General Chemistry Questions Name _____

Most of the following questions are review from what you learned in Chemistry last year. Use your notes from last year and the "General Chemistry Notes" you were given to help answer questions. Circle your answer for each question!

1. Which four elements make up approximately 97% _____ of living matter?

   A. Carbon, hydrogen, nitrogen, oxygen

   B. Carbon, sulfur, phosphorus, hydrogen

   C. Oxygen, hydrogen, calcium, sodium

   D. Carbon, sodium, chlorine, magnesium

   E. Carbon, oxygen, sulfur, calcium

2. Each *element* is unique and different from other elements because of its

   A. number of neutrons

   B. number of protons

   C. mass number.

   D. only A and B are correct.

   E. A, B, and C are correct.

3. An oxygen atom has an atomic number of 8. Therefore, it must have

   A. 8 protons.

   B. 8 electrons.

   C. 16 neutrons.

   D. Only A and B are correct.

   E. A, B, and C are correct.

4. If you are solving for the number of neutrons in an atom, which of the following would you use?

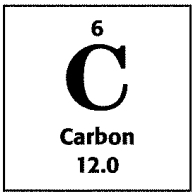
   A. the mass number minus the number of energy levels.

   B. the atomic number minus the number of electrons.

   C. the valence electron number minus the number of protons

   D. the mass number minus the atomic number

   E. the atomic mass minus the number of valence electrons.



5. The image above indicates that

   A. carbon has 12 electrons

   B.. carbon has 12 neutrons

   C. the atomic mass of carbon is 6

   D. carbon has 12 protons

   E. the atomic mass of carbon is 12

6. An atom of magnesium with an atomic number of 12, and an atomic weight of 24.3 would have

A. 12 neutrons

B. 11 electrons

C. an atomic mass of 12

D. a mass number of 12

E. one electron in its valence shell

7. Oxygen as an ion has a -2 charge, means that an atom

A. gained 2 electrons to become stable
B. gained 2 protons to become stable
C. lost 2 electrons to become an ion
D. lost 2 neutrons to become an ion
E. lost 2 protons to become stable

8. A covalent bond differs from an ionic bond in that

A. Covalent bonds occur when atoms share electrons while ionic bonds occur when atoms gain or lose electrons.

B. Covalent bonds make atoms stable while ionic bonds make atoms more reactive

C. Ionic bonds occur when atoms share electrons while covalent bonds occur when atoms gain or lose electrons.

D. Covalent bonds do not involve valence electrons while ionic bonds do.

9. What type of bond will lithium most likely form with another atom?

A. an ionic bond by gaining electrons

B. an ionic bond by losing electrons

C. a covalent bond by sharing electrons

D. a covalent bond by losing electrons

E. a hydrogen bond

10. What determines how an atom will react with other atoms?

A. the number of protons in the nucleus

B. the number of electrons in the outermost energy level

C. the number of neutrons in the nucleus

D. the atomic mass of the atom

11. What are the chemical properties of atoms whose valence shells are filled with 8 electrons? (Valence= outermost energy level).

A. They form ionic bonds in aqueous solutions.

B. They form covalent bonds in aqueous solutions.

C. They are stable and unreactive.

D. They exhibit similar chemical behaviors.

E. Both C and D are correct.

12. Based on electron configuration which of these elements would exhibit the **same** chemical behavior (reactivity) as that of **oxygen**?

A. C D. S

B. H E. P

C. N

13. What is the maximum number of **covalent bonds** an element with atomic number 6 can make with hydrogen?

A. 1 B. 2 C. 3 D. 4 E. 5

14. If atom ^{6}X (atomic number 6) were allowed to react with hydrogen, the molecule formed would be:

A. *X*-H

B. H-*X*-H

C.
H-*X*-H
|
H

D.
H
|
H -*X*- H
|
H

E. H = *X* = H

15. The ionic bond of sodium chloride is formed when

A. chlorine gains an electron from sodium.

B. sodium and chlorine share an electron pair.

C. sodium and chlorine both lose electrons from their outer valence shells.

D. sodium gains an electron from chlorine.

E. chlorine gains a proton from sodium.

16. How many bonds will Phosphorus (P) form to become stable and non-reactive?

A. 1 C. the same number as N

B. 2 D. the same number as C

17. A **chemical formula** indicates which of the following?

A. the arrangement of atoms in the molecule

B. the types of atoms in the molecule

C. the numbers of each atom in the molecule

D. the number of bonds between each atom

E. B and C

18. Since all atoms are neutral, which **<u>THREE</u>** of the following are always equal in an atom?

A. the number of protons

B. the number of electrons

C. the number of neutrons

D. atomic mass

E. atomic number

19. Which of the following is a molecule but not a molecular compound? (**<u>choose two by filling in two answers on the same Scantron line.</u>**)

A. H_2 B. H_2SO_4 C. SO_2 D. O_3

20. What coefficients must be placed in the blanks to balance the chemical reaction?

$C_6H_{12}O_6 \rightarrow$ ____ C_2H_6O + ____ CO_2

A. 1;2

B. 2;2

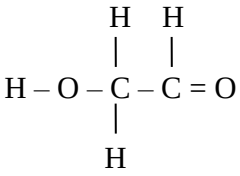
C. 1;3

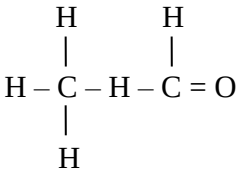
D. 1;1

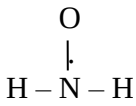
E. 3;1

21. Review the valences of carbon, oxygen, hydrogen, and nitrogen, and then determine which of the following molecules is most likely to exist.

A. O = C – H

B.


C.


D.


22. In the reaction NaOH + HCl → NaCl + H_2O, the total mass of NaCl and H_2O is _____ the total mass of HCl and NaOH.

A. greater than C. the same as

B. less than D. a fraction of

23. The mass number of an atom is

A. the number of protons in the nucleus

B. the number of neutrons in the nucleus

C. the number of protons plus the number of neutrons in the nucleus.

D. the number of protons and electrons in the nucleus.

24. One difference between carbon-12 and its isotope carbon-14 is that carbon-14 has

A. 2 more protons than carbon 12.

B. 2 more electrons than carbon 12.

C. 2 more neutrons than carbon 12.

D. Only A and B are correct.

E. A, B, and C are correct.

25. How many total electrons would Potassium (K) **ion** have?

A. 20 B. 19 C. 18 D. 17 E.16

26. What is the correct charge on the K ion?

A. +1 B. -1 C.+2 D. -2

27. A formula that shows the arrangement of atoms in a molecule and the location and number of covalent bonds between atoms is called a(n) _____ formula.

A. simple C. structural

B. chemical D. organic

28. Hydrogen cyanide has a chemical formula of HCN. The structural formula for HCN is

A. H-C=N C. N≡C-H

B. H=C=N D. C≡H-N

29. The **total number** of atoms in $6NaHCO_3$ is

A. 24 B. 28 C. 36 D. 40

30. The chemical formula $6H_2O$ contains

A. six atoms of hydrogen

B. twelve molecules of H_2

C. six atoms of oxygen

D. six molecules of O

31. How many covalent bonds will the element Phosphorus (P) form to become stable?

A. 1 B. 2 C. 3 D. 4 E. 0

32. When Magnesium fluoride, an ionic compound, is formed from Magnesium and Fluorine ions, Its chemical formula will be:

A. Mg_2F B. MgF C. MgF_2 D. Mg_2F_3

33. Atoms X and Y easily combine together to form an ionic compound. Atom X has an atomic number of 13, and atom Y has an atomic number of 17. Which of the following molecules would they form?

A. XY D. XY_2

B. X_3Y E. XY_3

C. X_2Y_3

Use the following equation to answer the next two questions:

$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

34. How many **atoms** of oxygen are there in the **product(s)**?

A. 2 B. 3 C. 4 D. 5 E. 6

35. How many **molecules** of oxygen are there in the **reactant(s)**?

A. 2 B. 3 C. 4 D. 5 E. 6

36. Which of the following are TRUE statements concerning the two atoms below? ***(fill in ALL possible answers)***

Atom 1	Atom 2
6 protons	6 protons
6 neutrons	8 neutrons
6 electrons	6 electrons

A. They have the same atomic mass.

B. They have the same atomic number

C. They are isotopes.

D. They are the same element

37. The number of covalent bonds in CH_3ON is: (you can draw the molecule several different ways and still get the same answer) *(A double covalent bond would be considered 2 bonds)*

A. 3 B. 4 C. 5 D. 6 E.7

38. The atomic number of sulfur is 16. Sulfur combines with hydrogen by covalent bonding to form a compound, hydrogen sulfide. Based on the electron configuration of sulfur, we can predict that the molecular formula of the compound will be

A. HS B. HS_2 C. H_2S D. H_3S_2 E. H_4S

Name_____

CHEMISTRY PRACTICE PROBLEMS

#1 Periodic Table

Use the following terms to fill in the blanks for questions 1-8:

protons mass number neutrons energy levels nucleus symbol electrons atomic number

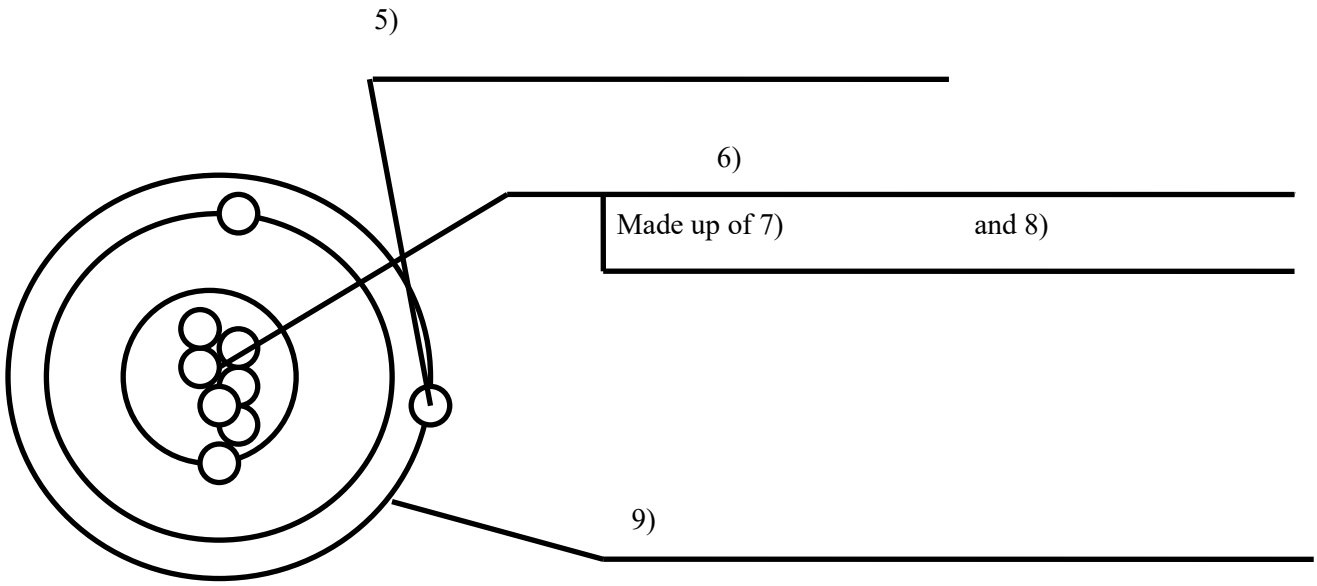
1) The periodic table is arranged in general order of increasing a) _____,
b) _____ and, c) _____.

2) Each element in the table has a different a) _____, b) _____,
c) _____, and d) _____.

3) The number of protons in the nucleus of an atom is the same as the a) _____, and
b) _____.

4) The large letter(s) that represent each element is called a _____.

Complete the diagram by labeling all the parts.



12) **Complete the following table by placing a check in each box that makes the statement true:**

Characteristic	Electron	Proton	Neutron
Has nearly no mass			
Positively charged			
Found in the nucleus			
Moves in energy levels			
Added together to make the mass number or atomic mass (weight)			
Does not have an electrical charge			
Negatively charged			

13) **Use the Periodic Table of the Elements to complete the following table.**

Note: Add the names and information for THREE elements of your own choosing:

ELEMENT	SYMBOL	ATOMIC NUMBER	MASS NUMBER *	NUMBER OF PROTONS	NUMBER OF ELECTRONS
CARBON			**12**		
HYDROGEN	**H**		**1**		
OXYGEN				**8**	
NITROGEN		**7**	**14**	**7**	**7**
PHOSPHORUS		**15**			
SULFUR					**16**
Pick 3 more elements:					

***Note:** Remember to *round off* the atomic weight to obtain the mass number or atomic mass.

Fill in the blanks:

In any neutral atom, the number of _____ is always equal to the number of _____.

#2 Electrons and the Reactivity of Atoms

Directions: Place the answer to the following questions on the line provided.

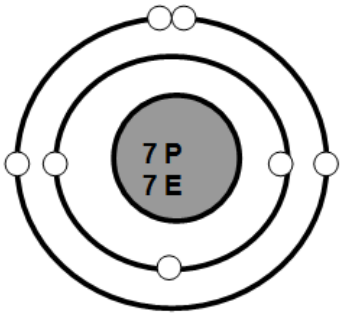
_____1. Energy levels are:
a. the charge of protons
b. the charge of atoms
c. the definite locations of electrons
d. the probable locations of electrons

_____2. If an atom is reactive, how does it become stable?
a. join a water molecule
b. join the nuclei of other atoms
c. form energy levels with other subatomic particles
d. form bonds with other reactive atoms

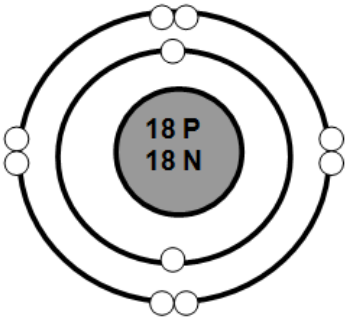
Directions: Smiley Cyrus was a student at Livingston High School. Below are her drawings of Bohr models for atoms of three different elements. **Check Smiley Cyrus's work – each diagram has TWO mistakes. Your task is to fix her errors.**

* P=protons N=neutrons E= Electrons ○ = electrons in energy levels

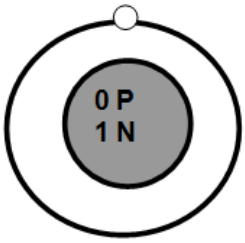
Nitrogen



Argon



Hydrogen



Circle the atom(s) below that are **reactive**. Put a triangle around the atom(s) below that are **nonreactive**.

N Ar H K C O He

How many electron vacancies are in the valence of each of the following atoms?

N_____ Ar_____ H_____ K_____ C_____ O_____ He_____

#3 Counting Atoms

Calculate how many atoms of each element are present in each of the following (as written). The first one is done for you

1. $3NaHCO_3$

   Na = 3 (3 coefficient x 1 atom of Na)
   H = 3 (3 coefficient x 1 atom of H)
   C = 3 (3 coefficient x 1 atom of C)
   O = 9 (3 coefficient x 3 atom of O)

2. $5C_2H_4O_2$

3. $2Mg(OH)_2$

4. $6H_3\ PO_4$

5. $(NH_4)_3PO_4$

#4 Recognizing Balanced Equations

Remember, in a balanced chemical equation, the number of atoms of each element in the reactants will equal the number of atoms of each element in the products.

	EQUATION	**IS IT BALANCED, as written? (Y/N)**
A.	$2C_2H_6 + 5O_2 \rightarrow 2CO_2 + 6H_2O$	
B.	$2H_2O_2 \rightarrow 2H_2O + O_2$	
C.	$Na + O_2 \rightarrow 2Na_2O$	
D.	$N_2 + 3H_2 \rightarrow 2NH_3$	

PERIODIC TABLE OF THE ELEMENTS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1 H Hydrogen 1.008																	2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.179
11 Na Sodium 22.990	12 Mg Magnesium 24.305											13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.06	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.08	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.847	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.922	34 Se Selenium 78.96	35 Br Bromine 79.904	36 Kr Krypton 83.80
37 Rb Rubidium 85.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.94	43 Tc Technetium 97.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.411	49 In Indium 114.82	50 Sn Tin 118.710	51 Sb Antimony 121.757	52 Te Tellurium 127.60	53 I Iodine 126.905	54 Xe Xenon 131.29
55 Cs Cesium 132.905	56 Ba Barium 137.327	57 * La Lanthanum 138.905	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.2	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium 208.982	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89 ** Ac Actinium 227.028	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110	111	112	113	114	115	116	117	118

Lanthanide Series	58 * Ce Cerium 140.12	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.24	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.50	67 Ho Holmium 164.930	68 Er Erbium 167.26	69 Tm Thulium 168.934	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.967
Actinide Series	90 ** Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium 252.083	100 Fm Fermium 257.095	101 Md Mendelevium 258.099	102 No Nobelium 259.101	103 Lr Lawrencium 260.105