**Study Guide: Chemistry Semester 1**

Scientific Method & Nature of science

Define:

Hypothesis-

Theory-

Law-

What’s the difference between the three?

Accuracy-

Precision-

What unit expresses volume?

List the SI Units for mass, length, volume, temperature, time, energy, density

What do these prefixes mean? Kilo, centi, milli

Convert 62hm to meters

Convert 800 mg to g

How many sig figs are in each number?

1. 5043 b. 10.01 c. 3.50 d. 7.0200

Put these numbers into scientific notation:

1. 6030000000 b. 0.000000047

Multiply the following numbers and report your answer to correct # of sig figs

12.5 x 3.241

Review the models of the atom and check them off as you go:

a. \_\_\_\_\_Thompson plum pudding, equal distribution of electrons in positive pudding

b. \_\_\_\_\_Rutherford electron cloud is mostly empty space, atom has a dense Positively charged center

c. \_\_\_\_\_Bohr shows electron cloud being made of orbits or energy levels, electron location can be calculated, electrons orbit the nucleus

d. \_\_\_\_\_Quantum electrons move randomly inside if orbitals 90% of the time, Electron location cannot be calculated

Matter

What is the formula for density? \_\_\_\_\_\_\_\_\_\_\_\_\_

What is the density of water ? \_\_\_\_\_\_\_\_\_\_\_\_\_

If equal amounts of water, ethylene glycol (density = 1.11 g/mL, and butane (density = 0.599 g/ml), were mixed in a jar, which would be on top? On bottom?

Be able to calculate density by using the water displacement method to determine volume.

List at least four types of evidence that a chemical change has taken place:

1.

2.

3.

4.

Know the difference between physical properties & chemical properties.

Know the difference between homogeneous vs. heterogeneous

Atomic & Molecular Structure

Atomic number

Atomic structure

1. Draw an atomic model of

***Carbon-13***.

In the drawing include the following:

* *Location* of nucleus & electron cloud.
* *Location* of 3 subatomic particles.
* *Amount* of each subatomic particles.
* *A note* where most of the atom’s mass is found.

1. What is **atomic number**?
2. What is atomic number for the following elements?

|  |  |
| --- | --- |
| Cr | Iron |
| Carbon | Ca |

1. How does atomic number change moving left to right across the periodic table?

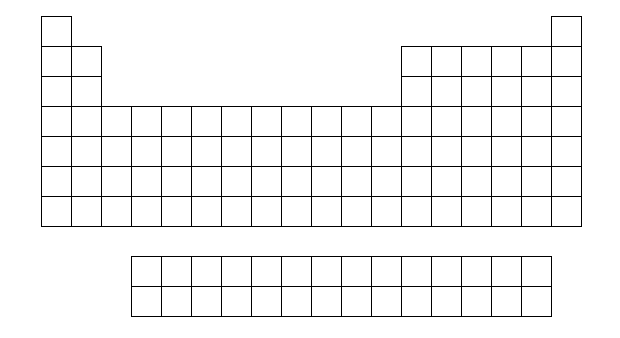
Atomic Weight (Atomic Mass)

1. What is the **atomic mass** for the following elements?

Organization of the Periodic Table

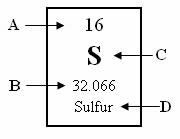
1. Identify on the periodic table below the location of

**The 3 different types of elements.**



1. Where are **groups** on the periodic table?
2. Where are **periods** on the periodic table?

|  |  |
| --- | --- |
| V | Oxygen |
| Beryllium | Mn |

1. It was found that the periodic table was organized by increasing atomic number rather than mass. Give an example of a pair of elements where one element has a larger atomic number but a smaller atomic mass.
2. Identify the letters in the following periodic square:

Atomic Structure (Continued)

Fill out the following chart:

|  |  |  |  |
| --- | --- | --- | --- |
| Subatomic particle | Charge | Relative Mass | Location |
| proton |  |  |  |
| neutron |  |  |  |
| electron |  |  |  |

A positive ion has more \_\_\_\_\_\_\_\_\_\_\_ than \_\_\_\_\_\_\_\_\_\_\_\_.

A negative ion has more \_\_\_\_\_\_\_\_\_\_\_ than \_\_\_\_\_\_\_\_\_\_\_\_.

A neutral atom has an \_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_.

An isotope has the same number of \_\_\_\_\_\_\_\_\_\_\_\_\_ of other isotopes of that element, but it contains a different number of \_\_\_\_\_\_\_\_\_\_\_\_.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Isotope | Atomic Mass | Mass Number | Protons | Neutrons | Electrons |
| U - 240 |  |  |  |  |  |
| U - 238 |  |  |  |  |  |

Helium has two naturally occurring isotopes, helium-3 and helium-4. The atomic mass of helium is 4.003 amu. Which isotope is more abundant in nature?

Write electron configurations for Na, P, Li, F, Ar, Cu

How many principal energy levels are there and how many electrons can each hold?

How many sublevel types are there and how many electrons can each hold?

How does ground state differ from excited state?

If a wavelength of a band of light is known to be 3.45 x 10^-7m, wha tis the frequency of this band?

Periodicity (periodic trends)

|  |  |  |  |
| --- | --- | --- | --- |
| **Group Name** | **Group Number** | **Valence Electrons** | **Solid, liquid, gas?** |
| Alkali metals |  |  |  |
| Halogens |  |  |  |
| Noble gases |  |  |  |
| Chalcogen |  |  |  |
| Alkaline earth metals |  |  |  |

Know the electron configuration for each element of the periodic table.

Ex: F \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Ca \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Which elements are liquids?

Which elements are gases?

Which elements are metalloids?

Metals form \_\_\_\_\_\_\_\_\_\_\_\_ ions

Nonmetals form \_\_\_\_\_\_\_\_\_\_\_\_ions

Give 5 characteristics of a metal:

Give 5 characteristics of a nonmetal:

Describe how electromagnetic radiation is emitted: (know all the steps)

Know the following periodic trends:

|  |  |  |
| --- | --- | --- |
| **Trend** | Across the period | Down a group |
| Atomic radius - |  |  |
| Ionic radius - |  |  |
| Electronegativity - |  |  |
| Ionization energy - |  |  |

What happens to the radius of an atom that becomes a positive ion?

What happens to the radius of an atom that becomes a negative ion?

Atomic Radius

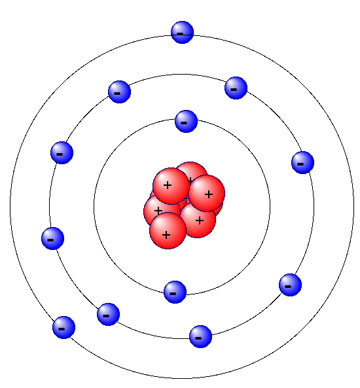
* + Which element has the largest atomic radius?
  + Which element has the smallest atomic radius?

Ionization energy

* + What is Ionization Energy?
  + Which element has the largest ionization energy?
  + Which element has the lowest ionization energy?
  + Why does ionization energy decrease moving down a group?

Electronegativity

* + What is Electronegativity?
  + Which element has the largest electronegativity?
  + Which element has the lowest electronegativity?
  + Why do Noble Gases tend to have no electronegativity?



Valence electrons

1. Why are alkali metals so reactive?
2. Why are halogens so reactive?
3. Identify the amount of valence electrons in each of the following:
4. How many of magnesium atom’s 12 electrons are valence electrons? Circle those electrons.

|  |  |
| --- | --- |
| Na | Phosphorus |
| Argon | He |

Ionic Bonding and Nomenclature

1. Positive ions are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_. Negative ions are called \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
2. Why do chemical bonds form between atoms? (or…Why don’t atoms just stay single?)

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. In an ionic bond, electrons are shared / transferred / connected between atoms. (circle one)
2. Ionic bonds form between \_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_. (metals, nonmetals, metalloids)
3. For the pairs of elements listed below, circle pairs that would likely form ionic bonds.

**C** and **H Na** and **F Hg** and **Ag Mg** and **S N** and **C K** and **O**

1. What is a polyatomic ion? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Circle the ionic compounds listed below.

**CaSO4 CH4 CO2 BaCl2 NH3 KNO3 LiOH**

1. How did you know which compounds in Question 8 above were ionic?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. What are binary ionic compounds? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Binary ionic compounds typically end with the suffix –\_\_\_\_\_.
3. A “formula unit” is the simplest or lowest \_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_ in an ionic compound.
4. How do each of the following atoms achieve a stable octet?

(circle gain or lose and write in a number of electrons)

O will gain / lose \_\_\_ electrons

Li will gain / lose \_\_\_ electrons

N will gain / lose \_\_\_ electrons

1. List the oxidation number (charge) for the following groups of elements.

Group 1 \_\_\_ Group 15 \_\_\_

Group 2 \_\_\_ Group 16 \_\_\_

Group 3 \_\_\_ Group 17 \_\_\_

1. List 3 physical properties of ionic compounds:

1. State: solid / liquid / gas (circle)

2. Melting Point: high / low (circle)

3. Conductor of electricity when \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Determine the total number of **atoms** in each formula listed below.

Li3PO4 \_\_\_\_ Ba(NO3)2  \_\_\_\_

1. Determine the total number of **ions** in each formula listed below.

Li3PO4  \_\_\_\_ Ba(NO3)2 \_\_\_\_

1. Which of the following compounds contains the Sn4+ ion?

a. Sn2Br

b. SnCI

c. SnI2

d. SnO2

Write the NAME or FORMULA for the following molecular compounds:

13. CS2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

14. CCI4 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

15. S2O6 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

16. triboron monoxide \_\_\_\_\_\_\_

17. tetraphosphorus pentoxide \_\_\_\_\_\_\_

18. arsenic trihydride \_\_\_\_\_\_\_

Describe the following bond types in terms of what happens to the electrons:

Ionic Bonds –

Covalent Bonds –

Metallic Bonds -

Bonding occurs to satisfy the \_\_\_\_\_\_\_\_\_\_ rule. Why?

Write the formula for the following compounds:

Magnesium hydroxide \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Aluminum nitride \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Aluminum nitrate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Aluminum nitrite \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Gold III phosphate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Gold III phosphide \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Gold III phosphite \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Write the formula for the following compounds:

Chloric acid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Sulfuric acid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Hydrosulfuric acid \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dinitrogen pentoxide \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Name the following:

H2CO3 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

SCl6 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

CuNO3 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Ca3(PO4)2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |
| --- |
| **The Mole and Mole Conversions** |

3.  The SI unit used to measure an **amount** is a(n) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

4.  What is molar mass?  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5.  Calculate the molar mass of:

a)  CuSO4     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_                                                    b)  octane     \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6.  a)  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ = 1 mole = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

b)  6.02 x 1023 is called \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

7.  How many moles are in 315 grams of magnesium chloride? \_\_\_\_\_\_\_\_\_\_\_

8.  How many grams are in 7.6 moles of dinitrogen trioxide? \_\_\_\_\_\_\_\_\_\_\_

9.  How many atoms are in 8.40 moles of aluminum (Al)? \_\_\_\_\_\_\_\_\_\_\_

10.  How many molecules are in 88.0 grams of carbon dioxide? \_\_\_\_\_\_\_\_\_\_\_

11.  How many moles are in 7.05 x 1024 atoms of carbon (C)? \_\_\_\_\_\_\_\_\_\_\_

12.  How many grams are in 6.02 x 1023 formula units of LiCl? \_\_\_\_\_\_\_\_\_\_\_

The **periodic table** contains information for every element.

*Define the terms atomic number, atomic weight, and mass number. Identify the atomic number, atomic weight, and mass number for carbon based on the information on your periodic table.*

***Atomic structure***for any element can be determined from the information on the periodic table.

*Describe the three subatomic particles, their charges, sizes, and locations in an atom.*

*Determine the number of protons, neutrons, and electrons for a Boron atom.*

***Bohr Models*** represent the structure of the atom with protons and neutrons in the nucleus and electrons on “rings” outside of the nucleus. Remember the first ring holds 2, the second ring holds 8, and the third ring holds 18.

*Draw the bohr models for Na and Cl and Ar*

***Isotopes*** are atoms of the same element because they have the same number of protons but a different number of neutrons.

*Determine the number of protons, neutrons and electrons in Hydrogen-1, hydrogen-2, and hydrogen-3*

The last digit of an element’s group number is equal to its ***number of valence electrons***.

*Which contains the greatest number of valence electrons?*

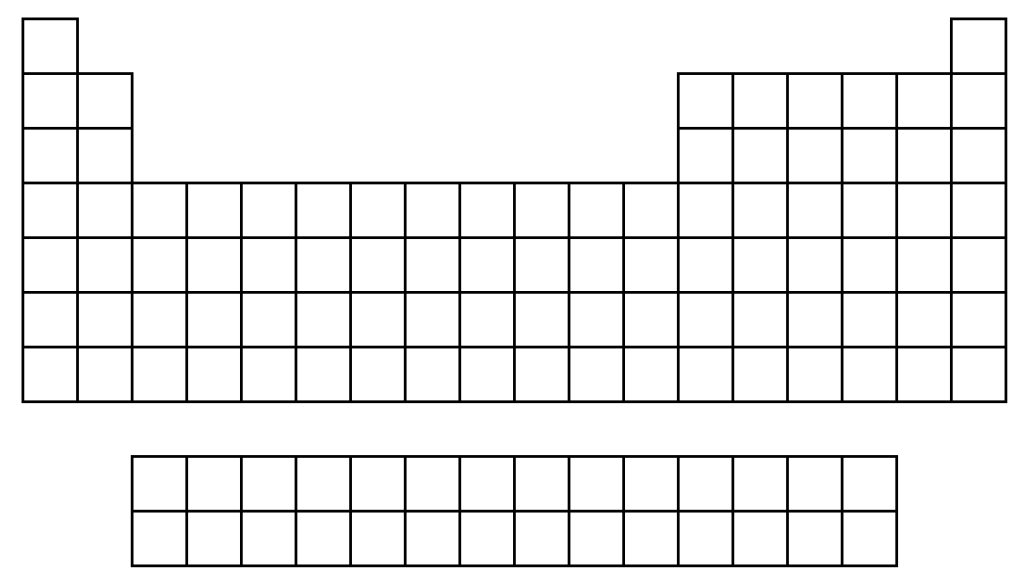
*Ca Ge Se Kr*

Draw one dot for each valence electron when drawing an element’s or ion’s ***Lewis electron dot diagram***.

*Which dot model would contain the fewest dots as valence electrons?*

*Ca Ge Se Kr*

There are various trends that can be found on the periodic table. Define **atomic radius, electronegativity, ionization energy,** and **electron affinity**. Identify their trends using arrows and the words “increasing” or “decreasing” on the periodic table below.



The three classes of elements on the periodic table are **metals, nonmetals,** and **metalloids.** Describe their general characteristics. Color all of the metals green, the metalloids red, and the nonmetals blue on the table above.

Atoms are most stable when they have 8 valence electrons (an ***octet***) and tend to form ions to obtain such a

configuration of electrons.

*Predict the charge of the ions formed by these elements*

*Li F Na Cl*

**Chemical formulas** are written so that the charges of **cations** and **anions** neutralize (cancel) one another.

*calcium phosphate*: Ca2+ PO43- = ………… (criss-cross)

When naming **binary ionic compounds**, write the name of the positive ion (cation) first,

followed by the name of the negative ion (anion) with the name ending in “-ide.”

*CaCl2 …………….. MgS ……………..*

When naming compounds containing **polyatomic ions**, keep the name of the

polyatomic ion the same as it is written on your reference sheet.

*NH4Cl ………. copper (I) nitrate ……….*

**Roman numerals** are used to show the positive oxidation number of the cation if it has more than

one positive oxidation number

*FeO: ……………………. Nickel (III) sulfate: ……………..*

***Ionic bonds*** form when one atom ***transfers*** an electron to another atom when

forming a bond with it.

*Which substance exhibits ionic bonding rather than covalent bonding?*

###### CO2 N2O4 SiO2 CaBr2 C6H12O6

Substances containing mostly covalent bonds are called ***molecular substances***.

They are attracted to each other by sharing electrons

*Which of the following is a molecular substance?*

*Lithium chloride carbon monoxide sodium nitrate aluminum oxide*

When naming a **binary molecular compound,** the first element is named using the name of the element.

The second element always end in “–ide.” Indicate the number of atoms using the prefix…

1 mono 2 di 3 tri 4 tetra 5 penta 6 hexa 7 hepta 8 octa 9 nona 10 deca

If the first element has only one atom, don’t use the mono.

*What is the name of the following molecular compounds?*

*CO2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ N2O­­­­­­­­­­­­­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*

Complete and memorize this table

|  |  |
| --- | --- |
| Substance Type | Properties |
| **Ionic** |  |
| **Covalent (Molecular)** |  |

***Physical changes*** do not form new substances.

They merely change the appearance of the original material. (The melting of ice) H2O (s) 🡪 H2O (l)

***Chemical changes*** result in the formation of new substances or the product(s) of a ***chemical reaction***.

*Which process is an example of a chemical change?*

*the melting of ice the electrolysis of water the boiling of water*

The gram formula mass (**molar mass**) of a substance is the sum of the atomic masses of all the atoms in it. H2SO4 = \_\_\_\_\_\_ g/mole

2 x H = 2 x ………g = ………g

1 x S = 1 x ………g = ………g

4 x O = 4 x………g = ………g

Use the **mole** ***map*** to help you solve conversions

What is the mass in grams of 3.6x1021 molecules of sugar? C12H22O11

What is the mass in grams of NaCl that was dissolved in 3.2 L to create a 1.6M solution?

Covalently bonded substances form **molecules**. Molecular compounds are made up of nonmetals only.

*Which of the following are molecular compounds? H­2O CH4 NaCl CuSO4  CO2*

The formula of a **molecular compound** represents one molecule of the substance, also one mole of

molecules and the number of atoms for each nonmetal element making up the molecule.

*The formula for methane gas, CH4, tells us the make-up of one molecule of methane is 1 carbon atom and 4 hydrogen atoms covalently bonded together. We can also figure out the molar mass or the mass in one mole of methane*. *What is the molar mass of CH4? 47 g/mol 24 g/mol 16 g/mol 10 g/mol*