**Midterm Review**

**Regents Chemistry**

**METRIC**

Using tables on page one of your reference tables you should be able to identify which units are used to measure each quantity and you should be able to convert between units using the prefixes. Locate the prefix assigned to the measurement unit that you are starting with and then find the prefix that you want to convert to. Count the number difference between the factors and then move your decimal that many places.

 a. Identify the unit used for each quantity:

 (1) mass \_\_\_\_\_\_\_\_\_ (4) temperature \_\_\_\_\_\_\_\_\_\_

 (2) volume \_\_\_\_\_\_\_\_\_ (5) length \_\_\_\_\_\_\_\_\_\_

 (3) energy \_\_\_\_\_\_\_\_\_ (6) time \_\_\_\_\_\_\_\_\_\_

 b. Convert the following:

 (1) 780 mL to L \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (4) 50km to m \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 (2) 0.288 g to mg \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (5) 250C to K \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 (3) 6980 mm to km \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (6) 123K to C \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Density** is the measurement of mass divided by volume. A substance’s density can help identify it. For example, water’s density is 1.00g/mL. Substances float in water of they have low densities, and sink when their densities are greater than 1.00 g/mL.

 a. Calculate the density of a 3.6 gram sample of an unknown substance, which has a volume of 6.75mL.

 b. Calculate the mass of a substance with a density of 2.50 g/mL and a volume of 11.0mL.

 c. Calculate the volume of a metal square with a length of 5.0cm.

 d. If the metal in question (d) above is iron, calculate the mass. (Hint: density is on table S)

**SIGNIFICANT FIGURES**

All whole numbers 1-9 count. Preceding zeros never count, trapped zeros always count, and trailing zeros count IF THERES A DECIMAL before the zero. Count the number of significant figures:

 56780 0.09809 0.07845 0.0892

 0.09870 1000 1020 102.986

When rounding, your answer can only be as precise as your least precise measurement. When adding or subtracting numbers, round your answer to the lowest decimal place given. When multiplying or dividing, round your answer to the least number of significant figures. Calculate and round to the correct number of significant figures:

 a. 4.567 + 1.2 = \_\_\_\_\_\_\_\_\_\_\_\_\_ d. 67065/87.2 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 b. 678.345-234.98 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ e. (54.0-32.34)/1.202 = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 c. 45 x789 = \_\_\_\_\_\_\_\_\_\_\_\_\_ f. 3.108\*(98.70-8.20) = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ELEMENTS, COMPOUNDS, AND MIXTURES**

**Matter** is anything that has a mass and takes up space. An **element** is the simplest form of matter, which cannot be broken down any further. Elements are listed on Table S and the periodic table. Their symbols start with an uppercase letter.

 a. Which of the following is not matter? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 heat Hydrogen Salt water Water

 b. Which of the above is an element? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Compounds** are composed of two or more elements. They can only be decomposed chemically. Elements and compounds are also known as **substances**.

 a. Which of the choices in number one was a compound? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 b. How can compound be broken down? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 c. Which of the choices in question one are substances? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Mixtures** are physical combinations of two or more substances (elements and/or compounds). Mixtures can be **homogeneous** (completely mixed, cannot see the parts) or **heterogeneous** (unevenly mixed, can see the parts). Mixtures can be separated by physical means. Homogeneous mixtures with water solvents are labeled (aq). Label each as homogeneous or heterogeneous:

 Bronze: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Milk: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Tap water: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ salad: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Compounds must be separated chemically but mixtures can be separated easily using physical methods.

 a. Match each method with its name.

 Distillation Separated by differences in particle size

 Filtration To pour off the top layer of an uneven mixture

 Decant Separated by differences in boiling point.

 Chromatography Just a test for purity

 b. Which of the above processes only work if the mixture is heterogeneous? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mixtures are composed of **solutes** that dissolve and **solvents** that do the dissolving. The solute should be the smaller quantity.

1. In salt (aq), what is the solute? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ solvent? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. In air name a solute: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 c. Do all solvents have to be water? Explain. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**SOLIDS, LIQUIDS, AND GASES**

A **solid** has a definite shape and volume. Solids are arranged in a geometric pattern. **Liquids** have a definite volume but take the shape of the container they are in. **Gases** have an indefinite shape and volume; they take the shape and volume of the container. Gases are easily compressed.

 a. Draw particle diagrams for a solid, liquid, and a gas using at least 5 particles:

 b. Which has a definite shape?

 HCl(g) H2O(l)  Cu(s)

 c. Which has a definite volume?

 LiF(g) Br2(l)  Mg(s)

Phase changes occur when heat is given to or taken from a sample. For each of the following, give the phases involved and if it is endothermic or exothermic.

 Evaporation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Melting \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Deposition \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Freezing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Condensation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 Sublimation \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**CHANGES IN THE LAB**

**Physical changes** are changes where the substance retains its properties. **Chemical changes** will make substances change into new substances and change properties.

 a. Label the following as physical (P) or chemical (C) properties:

 Texture \_\_\_\_ flammability \_\_\_\_ boiling point: \_\_\_\_

 Odor \_\_\_\_ color \_\_\_\_ chemical composition: \_\_\_\_

 b. Label the following as physical (P) or chemical (C) changes:

 Corrosion: \_\_\_\_ melting: \_\_\_\_ mixing: \_\_\_\_

 Freezing: \_\_\_\_ cutting: \_\_\_\_ decaying: \_\_\_\_

**MOLES and MOLAR MASS**

The mole represents 6.02x1023 particles such as atoms and molecules of any substance. The Molar Mass (aka gram formula mass or molecular mass) is the mass of one mole of a substance. Element’s molar masses are reported on the periodic table. Using formulas on the last page of your reference tables as well as you periodic table you should be able to calculate the mass or moles of any substance.

1. Calculate the molar mass of the following:

 Li Br2 NaBr

 CaCl2 MgSO4 Sr3(PO4)2

1. Calculate the moles of the following:

12.0 grams Li 19.0 grams of Br2

89.0 grams MgSO4 80.0 grams of Sr3(PO4)2

1. Calculate the mass of the following:

4.00 moles of MgCl2 0.0035 moles of NaBr

2.70 moles of Br2 2.50x10-4 moles of MgSO4

**REACTIONS**

Reactants refer to the substances you start with in a reaction (before the arrow). Products refer to the substances you create in a reaction after the arrow). Coefficients are how many moles of the substance are needed in a reaction. To relate moles of one substance to another, simply create a proportion.

1. Identify the reactants and products in the reaction: **Li2CO3 + 2Cu 🡪 2CuCO3 + Li**
2. If 2.0 moles of Cu react with excess lithium sulfate, how many moles of lithium are formed?
3. If 7.25 moles of CuCO3 are formed, how many moles of copper are used?
4. 100.0 grams of Li2CO3 react with 40.0 grams of Cu and form 70.0 grams of Li, how many grams of CuCO3 were formed?

**BALANCING and TYPES OF REACTIONS**

In a reaction, atoms and molecules cannot appear or disappear. Mass must stay constant from the beginning to the end of the reaction. This is known as conservation of mass. In addition, charge and energy must also be conserved. Balance the following and identify the type of reaction:

1. \_\_\_\_ Na + \_\_\_\_Mg(NO3)2 🡪\_\_\_\_ NaNO3 +\_\_\_\_ Mg \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_ Sr(OH)2 + \_\_\_\_LiCl 🡪 \_\_\_LiOH + \_\_\_\_\_SrCl2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_H2 + \_\_\_\_O2 🡪 \_\_\_\_H2O  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_ H2O2 🡪 \_\_\_\_H2 + \_\_\_\_O2 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Types of Reactions include:

Synthesis: A + 2B 🡪 AB2

Decomposition: AB2🡪 A + 2B

Combustion: CH4 + O2🡪 CO2 + HO

Single Replacement: AB + C 🡪 CB +A

Double Replacement: AB + CD 🡪 AD + CB

**FORMULAS**

Empirical formula refers to any molecular formula in its reduced form. Molecular Formulas are some multiple of the empirical formula. To find molecular formulas: Find the mass of the empirical formula. Divide the mass given by the empirical mass. Distribute your answer through the empirical formula.

1. Find the empirical formula of the following:

NO2 N2O4 C4H16 P2O6

1. Find the molecular formula of a substance with a mass of 65.0 grams and an empirical formula of CH.

**PERCENT COMPOSITION**

Percent composition formula is on the last page of the reference tables.

1. Find the percent of C in the following:

C4H8 C6H12O6

**NAMING COMPOUNDS**

When naming, always name the positive, cation first and then the negative, anion last. The elements are named in the same order they appear on the periodic table. When compounds have more than 2 elements, it contains a polyatomic ion. Use Table E on page 2 of your reference tables. Transition Metals are in the middle group of the periodic table. Nonmetals are on the right side of the staircase. They have multiple charges or oxidation numbers and so you must show which charge you are using with roman numerals. Polyatomic ions are a group of 2 or more atoms that are bonded very strongly and act as one ion. Name the following:

CaF2 NaCl LiOH MgSO4

NiI2 NiI3 Fe(OH)2 CrCl3

To write a formula, write the two ions separately showing their charges. Charges are on the periodic table. Then, swap the two numbers and drop the sign. Write the formula for the following:

 Sodium phosphide Lithium hydroxide

 Silver (I) phosphate Strontium sulfate

 Copper(II) iodide Manganese (VII) iodide

**SCIENTIFIC THEORIES**

**Dalton** theorized that atoms were the smallest particle and could not be divided. Atoms can bond with one another in whole number ratios to form compounds but cannot be created or destroyed. Atoms of the same element are identical. Dalton’s model is known as the **hard sphere model**.

1. According to Dalton, what is inside the atom? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What part of Dalton’s theory has been disproven? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Thompson** worked with the cathode ray tube and discovered a ray of light travelling to the positive plate in the tube. This particle was the **electron** which must have a negative charge. Because atoms are neutral, Thompson assumed there must be invisible positively charged particles as well. These discoveries lead to Thompson’s **plum pudding model**.

1. Draw the plum pudding model:
2. Explain why Thompson didn’t find protons, but knew they were there.

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

**Rutherford** shot alpha particles at gold foil in an effort to disprove either Dalton or Thompson’s theory. If Dalton were right, the alpha particle would deflect, if Thompson were right the alpha particle would go straight through. 99% of the alpha particles went straight through. Rutherford concluded the atom was mostly empty space with a dense positive **nucleus** containing **protons** and **neutrons**. His model is known as the **nuclear model**.

1. Draw the nuclear model:
2. How did Rutherford know the atom had empty space?

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

**Bohr** used complicated mathematics to organize electrons into **orbits** around the nucleus with specific energies. His model is known as the **planetary model**.

 a. Draw the planetary model:

 b. Why did Rutherford’s model need to be revised?

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

**SUBATOMIC PARTICLES**

Atoms are neutral and contain subatomic particles. **Protons** are positively charged particles located in the nucleus**. Neutrons** are neutral particles located in the nucleus. **Electrons** are negatively charged particles found in orbit around the nucleus. Protons and neutrons both weigh 1 amu and the electron’s mass in negligible.

 a. Fill in the chart below:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Charge | Mass | Location |
| Proton |  |  |  |
| Neutron |  |  |  |
| Electron |  |  |  |

1. What is an amu?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What are orbitals?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. If atoms are neutral, then the number of protons \_\_\_\_\_\_\_\_\_ the number of electrons because\_\_\_\_\_\_\_\_\_\_\_

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

The **atomic number** is the identity of an element. The periodic table and table S are arranged according to the atomic number. It tells you how many protons an atom has.

1. Which element has 35 protons? \_\_\_\_\_\_\_\_\_\_\_\_\_
2. How many protons does sulfur have? \_\_\_\_\_\_\_\_\_\_\_

The **mass number** of an element is a whole number equal to the number of protons and neutrons. Every atom has it’s own mass number.

1. Why aren’t electrons counted in the mass number? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 b. How many electrons does B-10 have? \_\_\_\_\_\_\_\_ Ca-40? \_\_\_\_\_\_\_\_\_\_\_ Ne-20? \_\_\_\_\_\_\_\_\_\_

**IONS**

**Ions** represent atoms that have either gained or lost electrons forming anions and cations. A list of allowable charges is listed on the top right corner of every element box on the periodic table.

1. How are positive ions formed? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. How are negative ions formed? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. What are negative ions called? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. What are positive ions called? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. A sample has 18 protons and 18 electrons. Give the element symbol and charge. \_\_\_\_\_\_\_
6. A sample has 1 protons and 0 electrons. Give the element symbol and charge. \_\_\_\_\_\_
7. A sample has 16 protons and 18 electrons. Give the element symbol and charge. \_\_\_\_\_\_\_

**ISOTOPES**

**Isotopes** are atoms of the same element with the same number of protons. But they have different number of neutrons and a different mass.

1. What do isotopes have in common? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. How are isotopes different? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Which of the following are isotopes?

 126C 157N 146C 157N 125B

The **atomic mass** of an element is the weighted average mass of the naturally occurring isotopes.

1. Explain how mass number and atomic mass are different. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What the atomic mass of Calcium? \_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. If there are two isotopes of carbon, Ca-40 and Ca-39 which is more abundant? \_\_\_\_\_\_\_\_\_\_
4. Calculate the atomic mass of a sample of element X which contains 25% X-122 and the rest is X-123.

**ELECTRONS, BOHR, AND SPECTRA**

Neils **Bohr** organized the electrons into energy levels. Electrons closer to the nucleus have less energy than electrons further from the nucleus. The first level holds only 2 electrons. The second level holds 8, third holds 18 and fourth 32. These numbers are reported on the periodic table. Each element’s box has an **electron configuration** in the **ground state** showing how many electrons are in each level.

1. What is the electron configuration of Lithium? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the electron configuration of Neon? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Which element has the ground state electron configuration 2-8-1? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Draw the Bohr diagram of the following:

Mg-24+2

F-19

Ca-40

The last level contains **valence** electrons that can be lost or gained to form ions involved in bonding. **Cations** are positive ions that have lost electrons, therefore having more positive protons than negative electrons. **Anions** are negative ions that have gained electrons and then have fewer protons than electrons.

1. How many valence electrons does Lithium have? \_\_\_\_\_\_\_\_
2. How many valence electrons does Chlorine have? \_\_\_\_\_\_\_\_
3. Draw the lewis diagram of the following:

 Ne P Ca+2 I-

When energy is added to the atom, electrons can move up to higher energy levels, in the excited state. The excited state is unstable. When the electrons return to the ground state they release energy in the form of light called a spectra. Every atom has a different spectrum.

1. Energy is \_\_\_\_\_\_\_\_\_\_\_\_\_ when electrons move from higher to lower energy levels.
2. Energy is \_\_\_\_\_\_\_\_\_\_\_\_\_ when electrons move from lower to higher energy levels.
3. Spectra is observed when electrons move from \_\_\_\_\_\_\_\_\_ to \_\_\_\_\_\_\_\_\_\_ energy levels.
4. Why can you identify atoms by their spectra? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 e. Identify which two gases (A, B, C, or D) are in the unknown mixture: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_



**THE PERIODIC LAW**

The **Periodic Law** states that when elements are arranged in order of increasing atomic number, repetitious trends can be seen. **Mendeleev’s** periodic table was arranged in order of increasing atomic mass. He then arranged columns in order to have elements with similar properties align in columns. The **modern** table is arranged by atomic number.

1. What subatomic particle decides the order of the modern periodic table? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 b. Explain how Mendeleev’s table is only slightly different than the modern table. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**METALS, NONMETALS, AND METALLOIDS**

**Metals** are elements on the left side of the staircase on the periodic table. They have 1-2 valence electrons, which they tend to lose to form cations. Metals are **lustrous**, **malleable**, **ductile**, and good conductors of heat and electricity.

1. Define lustrous. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Define malleable. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Define ductile. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 d. Circle the metal: H P Cu S

**Nonmetals** are elements on the right side of the staircase on the periodic table. They have 4-8 valence electrons, which they tend to gain to form anions and fill their octet. Nonmetals are dull, brittle, and poor conductors of heat and electricity.

 a. Circle the nonmetal: C Mg Na Au

1. Why is hydrogen considered to be a nonmetal? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Metalloids** are elements that touch the staircase on the periodic table. They have properties of both metals and nonmetals.

1. Most elements on the periodic table can be classified as metal, nonmetal, or metalloid?

 b. Circle the metalloid: S Si Se Sr

 c. Circle the element that is lustrous: Na N Rn Ne

 d. Circle the element that is malleable: Mg C Ar H

 e. Circle the element that is dull: S Sc Sr Sn

 f. Circle the best conductor: C Cl Cu He

 g. Circle the element that has properties of both metals and nonmetals: Ge Ga

**GROUPS AND PERIODS**

**Periods** are the horizontal rows on the periodic table. Elements in the same period have the same number of electron levels in the Bohr diagram.

 a. Draw Bohr diagrams of Na, Si, Li and C and show how you can tell which are in the same period.

1. How many energy levels will an atom in the second period have? \_\_\_\_\_\_\_\_ Third period? \_\_\_\_\_\_\_\_\_\_

**Groups** (or families) are the vertical columns on the periodic table. Elements in the same group have the same number of valence electrons and often have similar properties.

1. How many valence electrons do the following atoms have?

 Na: \_\_\_ Mg: \_\_\_ Al: \_\_\_ Si: \_\_\_ P: \_\_\_ S: \_\_\_ Cl: \_\_\_

 b. Which two have the same number of valence electrons? Ca S Mg

Group 1 elements are the **Alkali Metals**, which have 1 valence electron and are very reactive (explode in water). Group 2 elements are the **Alkaline Earth Metals**, which have 2 valence electrons and are still very reactive (not as much as alkali). Groups 3-12 are the **Transition Metals**, which form colored compounds and solutions. Group 17 elements are the **Halogens**, which have 7 valence electrons and are the most reactive nonmetals. Group 18 are the **Noble Gases**, which have 8 valence electrons and are not reactive.

1. Why are the noble gases not reactive? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

 b. Which element may be blue in solutions? C Cu Ca Cl

 c. Which element is a halogen? C Cu Ca Cl

 d. Which element is an alkaline earth metal? C Cu Ca Cl

 e. Which element is a noble gas? H F Cs Rn

 f. Which element is the most reactive metal? H F Cs Rn

 g. Which element is the most reactive nonmetal? H F Cs Rn

**ATOMIC RADIUS**

The **atomic radius** is the size of an atom. You can look up the atomic radius on Table S of the reference tables.

 a. Record the atomic radius of: Li \_\_\_\_\_\_\_\_ Be \_\_\_\_\_\_\_\_ B \_\_\_\_\_\_\_\_ C \_\_\_\_\_\_\_\_

 N \_\_\_\_\_\_\_\_ O \_\_\_\_\_\_\_\_ F \_\_\_\_\_\_\_\_ Ne \_\_\_\_\_\_\_\_

1. As you go across a period the atomic radius \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

 c. Record the atomic radius of: Na \_\_\_\_\_\_\_\_ Li \_\_\_\_\_\_\_\_ K \_\_\_\_\_\_\_\_ Rb \_\_\_\_\_\_\_\_ Cs \_\_\_\_\_\_\_\_

1. As you go down a group the atomic radius \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

1. Which element is the largest? \_\_\_\_\_\_\_\_\_\_\_\_ The smallest? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**ELECTRONEGATIVITY**

The **electronegativity** of an atom is its ability to gain an electron. You can look up the electronegativity on Table S of the reference tables.

 a. Record the electronegativity of: Li \_\_\_\_\_\_\_\_ Be \_\_\_\_\_\_\_\_ B \_\_\_\_\_\_\_\_ C \_\_\_\_\_\_\_\_

 N \_\_\_\_\_\_\_\_ O \_\_\_\_\_\_\_\_ F \_\_\_\_\_\_\_\_ Ne \_\_\_\_\_\_\_\_

1. As you go across a period the electronegativity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

 c. Record the electronegativity of: Na \_\_\_\_\_\_\_\_ Li \_\_\_\_\_\_\_\_ K \_\_\_\_\_\_\_\_ Rb \_\_\_\_\_\_\_\_ Cs \_\_\_\_\_\_\_\_

1. As you go down a group the electronegativity \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

1. Why don’t noble gases have electronegativity values? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

1. Which element has the highest electronegativity? \_\_\_\_\_\_\_\_\_\_\_\_

**IONIZATION ENERGY**

The last level contains **valence** electrons that can be lost or gained to form ions involved in bonding. **Cations** are positive ions that have lost electrons, therefore having more positive protons than negative electrons. **Anions** are negative ions that have gained electrons and then have fewer protons than electrons.

1. How many valence electrons does Sodium have? \_\_\_\_\_\_\_\_
2. How many valence electrons does fluorine have? \_\_\_\_\_\_\_\_
3. If an atom has 8 protons and 10 electrons, what is the charge? \_\_\_\_\_\_\_ What type of ion is it? \_\_\_\_\_\_\_
4. If an atom has 12 protons and 10 electrons, what is the charge? \_\_\_\_\_\_ What type of ion is it? \_\_\_\_\_\_\_

The **ionization energy** of an atom is how much energy is required to remove an electron from the valence. You can look up the ionization energies on Table S of the reference tables.

 a. Record the ionization energies of: Li \_\_\_\_\_\_\_\_ Be \_\_\_\_\_\_\_\_ B \_\_\_\_\_\_\_\_ C \_\_\_\_\_\_\_\_

 N \_\_\_\_\_\_\_\_ O \_\_\_\_\_\_\_\_ F \_\_\_\_\_\_\_\_ Ne \_\_\_\_\_\_\_\_

1. As you go across a period the ionization energies \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_

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

 c. Record the ionization energies of: Na \_\_\_\_\_\_\_\_ Li \_\_\_\_\_\_\_\_ K \_\_\_\_\_\_\_\_ Rb \_\_\_\_\_\_\_\_ Cs \_\_\_\_\_\_\_\_

1. As you go down a group the ionization energies \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ because \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

 e. Which element has the highest ionization energy? \_\_\_\_\_\_\_\_\_\_\_\_ The lowest? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**INTRODUCTION TO BONDING**

Elements are the simplest form of matter and cannot be decomposed. Compounds can be formed between two or more elements. They can be decomposed chemically.

 a. Which of the following is a compound? Ne H2O Be F

 b. Which of the following cannot be decomposed by chemical means?

 C12H24 NH3 Li CS2

Atoms bond in order to obtain a stable electron configuration, like noble gases, called the **octet**. Most atoms will gain or lose electrons in order to have eight valence electrons. However, small elements such as H, Li, and Be will settle for two valence electrons. Obtaining an octet makes the atoms more stable and they can release energy. The electrons obtain the octet by sharing or transferring electrons.

 a. Draw the Lewis dot diagram of the following elements:

 Na Mg Al Si

 P S Cl Ar

 b. Draw the Lewis dot diagram of the following ions:

 Na+ Mg+2 Al+3

 P-3 S-2 Cl-

 c. Explain why the metals lost electrons but the nonmetals gained electrons. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

 d. Explain why Ar doesn’t form an ion. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Fill the blanks with **release or absorb**: “When atoms bond they \_\_\_\_\_\_\_\_\_\_\_\_ energy. In order to break a bond, energy must be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**IONIC BONDING**

Compounds that form between a metal and a nonmetal contain **ionic bonds**, transferring electrons. Ionic bonds are strong. Ionic compounds have high melting points, are generally solids at room temperature, and conduct in the liquid phase.

 a. Which of the following has ionic bonds? NaCl NH3 Mg

 b. Which of the following transfers electrons? MgBr2 Li CO2

 c. Which of the following has a higher melting point? Cu C6H12 LiF

 d. Which of the following can conduct in the aqueous phase? NO KI Ne

**COVALENT BONDING**

Compounds that form between two nonmetals have **covalent bonds,** sharing electrons. Covalent bonds are weaker than ionic bonds. Covalent compounds have low melting points, are generally gases, liquids, or powdery solids at room temperature, and never conduct. These are also known as **molecular compounds**.

 a. Which of the following has covalent bonds? HF LiCl Rb

 b. Which of the following shares electrons? H2O Ag CaCl2

 c. Which of the following can never conduct electricity? Kr Rb2O H2O

 d. Which of the following has both ionic and covalent bonds? Li NH3 CaCO3

e. Which of the following is a molecular compound? H2O Mg LiBr

**METALLIC BONDING**

**Metallic Bonds** form when a metal loses their valence electrons and a “sea of mobile electrons” form that allows the metal to conduct electricity in the solid or liquid phase.

 a. Which of the following is metallic? NaCl NH3 Mg

 b. Which of the following has a sea of mobile electrons? Cu C6H12 LiF

 c. Which of the following can conduct in the solid phase? Ne Ag CaCl2

**LEWIS STRUCTURES/GEOMETRY**

Ionic Lewis diagrams show the ions involve in the bond, but no arrangement. Covalent Lewis diagrams show the sharing of electrons with lines representing two electrons. They form shapes such as **linear, bent, pyramidal, and tetrahedral.**

1. Draw the following and give the number of shared pairs, unshared pairs, and the shape if applicable.

LiF NH3

MgF2 CH4

Cl2 H2O

**POLARITY**

Bonds are **polar** when two atoms have different electronegativities and share unevenly. The more electronegative atom has the electrons more of the time. **Nonpolar bonds** form when two atoms have the same electronegativity values and share equally.

1. Label the bonds as polar or nonpolar:

NH3 CH4 Cl2 H2O

Molecules are polar when the molecule is asymmetrical. They are nonpolar if the molecule is symmetrical.

1. Label the bonds as polar or nonpolar (Use your drawing to help you):

NH3 CH4 Cl2 H2O

**INTERMOLECULAR FORCES**

**Intermolecular forces** are what keeps molecules together (not atoms-that’s bonds) and are responsible for phases, phase changes, surface tension and various other properties. Nonpolar molecules have the weakest attractive forces dependent on their size 9the bigger the stronger). Polar molecules have stronger forces dependent on their polarity. **Hydrogen bonds** are a special case of polar forces between H and either F,O, or N. Molecules that are hydrogen bonded have high melting and boiling points, strong surface tension, and have closely packed particles.

1. Which of the following has the highest melting point? \_\_\_\_\_\_

HF HCl HBr HI

1. Which of the above has the lowest boiling point? \_\_\_\_\_\_

**HEAT CURVES**

Heating and cooling curves show the phases and changes they undergo as a sample is heated or cooled. The coldest phase is a solid and the hottest is gas for any substance. Kinetic energy is directly related to the temperature. Potential energy increases as a phase change occurs on a heating curve, and decreases on the cooling curve.

1. Draw a heat curve for Bromine, including all phases and phase changes with temperatures.
2. Draw a cooling curve for water including phase changes with temperatures, and label the parts where kinetic energy is decreasing.

**TABLE I**

Reactions are reported with their net heats of reaction. Exothermic reactions release heat, have a negative value, and become more stable.

1. Which reaction on table I becomes the most stable?
2. What is the heat of reaction for the following:

3CO2 + 4H2O 🡪 C3H8 + 5O2

16Al + 12O2 🡪 8Al2O3

**HEAT EQUATIONS**

If a substances changes temperature, use the q=mcΔT equation. If the substance undergoes evaporation or condensation use q=mHv. If the substance undergoes freezing or melting use q=mHf. Equations are found on table S and values are found on table B.

1. Find the heat needed to change 100.0g of water from 0 to 25C.
2. Find the mass of water that was heated from 250 to 705C by 2500J.
3. Find the temperature change of 150.0g of water heated by the addition of 8778 J.
4. Find the specific heat of a 55.0g substance that changes 35 to 80C with the addition of 1600J.
5. Find the heat needed to vaporize 20.0g of water at 100C.
6. Find the heat needed to melt 120.0g of ice at OC.
7. Find the heat of fusion of a 150.0g substance that melts with the addition of 880J.

**ENTROPY**

The randomness or disorder of a sample is referred to as entropy. Gases at high temperatures have high entropy.

1. Which substance has the highest entropy?

Cu(s) He(g) Br2(l)

1. Which substance has the lowest entropy?

H2O at 0C H2O at 100C

**Kinetic Molecular Theory**

Gases are spread out and constantly moving in random straight line motion. **Ideal gases** have no mass, no volume, and no attractive forces.

1. Give an example of the most ideal gas on the periodic table : \_\_\_\_\_\_\_\_\_\_\_\_\_
2. Under what conditions of temperature and pressure will a gas behave ideally? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Draw five particles of He in the gas phase:

**Combined Gas Law**

**Volume** is the amount of space a substance takes up. **Pressure** is the amount of force that substance has on another object measured in atmospheres or kilopascals. **Temperature** is the measure of kinetic energy a sample has measured in degrees Celsius or Kelvin. Standard temperature and pressures are listed on Table A. The calculation formula is on table T.

1. What are the possible values for standard temperature? \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What are the possible values for standard pressure? \_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. When pressure increases, volume \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
4. When pressure increases, temperature \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
5. When temperature increases, volume \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
6. The pressure of a gas is 2.2 atm at 300K. Calculate the pressure at 150K if the gas is in a rigid container.
7. The volume of a gas at 500K is 70.6L. Calculate the volume at 550K.
8. A 1.0L sample of a gas at 50kPa and 150K is changed to STP. What is the new volume?
9. Sketch graphs to represent the following relationships:
	1. Pressure and volume
	2. Pressure and temperature
	3. Volume and temperature

**Avogadro’s Law** states that two different gases at the same temperature, pressure and volume must have the same number of molecules. (Molecules also could mean moles. Not the same atoms or grams!)

1. Which sample would have the same number of molecules as 11.2L of He (g) at 273K and 202kPa?
2. 11.2L of N2(g) at 300K and 202kPa
3. 22.4L of Ne(g) at 546K and 404K
4. 11.2L of CH4(g) at 273K and 202kPa
5. At what volume will 22.4L of O2 (g) at 303K and 1.2atm have the same number of molecules as Neon gas at 303K and 1.2atm? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Grahams Law** states that light gases diffuse the fastest. Diffuse means to spread out and travel.

* 1. Which gas on the periodic table diffuses the fastest? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	2. Circle the two gases that diffuse at a similar speed: H2O Ne H2  SO2