

# AP Chemistry

## Summer 2024 Assignment

### Purpose of Assignment:

The purpose of the summer assignment is to ensure that the class can start learning college-level Chemistry as soon as possible. If you take a bit of time to refresh your memory and get organized, the class can be more efficient, and you will have less rushing and less stress during the first two weeks. AP Chemistry is composed of 9 units, as shown in the chart. At W-L, the General and Intensified Chemistry courses include much of Units 1-4, but little to none of the content in Units 5-9. The goal of this summer assignment is to prompt you to review the material from Units 1-4 that you should know from your previous Chemistry course so we can spend more time on the new and higher-level content during the school year.

Units	Exam Weighting
Unit 1: Atomic Structure and Properties	7-9%
Unit 2: Molecular and Ionic Compound Structure and Properties	7-9%
Unit 3: Intermolecular Forces and Properties	18-22%
Unit 4: Chemical Reactions	7-9%
Unit 5: Kinetics	7-9%
Unit 6: Thermodynamics	7-9%
Unit 7: Equilibrium	7-9%
Unit 8: Acids and Bases	11-15%
Unit 9: Applications of Thermodynamics	7-9%

### Estimated Time to Complete Assignment:

This summer assignment is the equivalent of 2 or 3 AP Chemistry homework assignments, between 2-6 hours. The amount of time depends on how well you remember Chemistry.

### Due Date and Method of Assessment:

**Bring the completed problem set (p. 8-9) and your flash cards to class on Monday, August 26, 2024 to be checked off for effort.** I will be looking to see if you are entering the class with an understanding of high school Chemistry, which is a prerequisite. During that first week of school, you will have the chance to ask questions. **The summer assignment will be turned in and graded for correctness on Tuesday, September 3, 2023.** Be kind to yourself and do a nice job on these tasks when you aren't stressed with many other things to do. Start the class in a positive way. AP Chemistry is a rigorous, demanding course. This first assignment and the subsequent test after Unit 1 will help us both determine if this course is a good placement for you in case you need to change your schedule.

### Assignment Overview:

- (1) Refresh your memory of Chemistry using p. 2-7 of this document as a guide. Review the vocabulary, diagrams, and charts. You do not need to submit p. 2-7.
- (2) You may find these websites helpful as additional resources:
  - a. <https://tinyurl.com/APchemsummer1>
  - b. <https://tinyurl.com/APchemsummer2>
- (3) Complete the Problem Set #1-9 (p. 8-9 of this document) on lined paper. Show your work. You will be turning this in for a grade.
- (4) Make flash cards of the polyatomic ions in the chart on p. 9. Put the formula on one side and the name on the other. You will need to memorize these ions this fall.
- (5) Review the naming rules on p. 9. Check out this link for naming review videos and practice: <https://tinyurl.com/APchemsummer3>
- (6) Get a head start on memorizing the selected elements on the Periodic Table on p. 10.

## Atomic Structure

### Key Concepts

- ✓ The atomic number is equal to \_\_\_\_\_
- ✓ The mass number is equal to the \_\_\_\_\_ + \_\_\_\_\_.
- ✓ Isotopes of an element have different numbers of \_\_\_\_\_ and the same number of \_\_\_\_\_. The atomic number of two isotopes is the \_\_\_\_\_ and the mass number of two isotopes is \_\_\_\_\_.
- ✓ What is a charged particle called?
- ✓ How does it acquire a charge?
- ✓ How do you calculate the average atomic mass of two isotopes?
  
- ✓ How do you determine the electron configuration of an atom?
- ✓ What is an energy level? Energy sublevel? Orbital?

- ✓ Fill in the chart:

	Proton	Neutron	Electron
Charge			
Mass			
Location in the atom			

- ✓ Explain the following symbols:  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$

What element has this configuration?

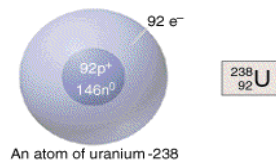
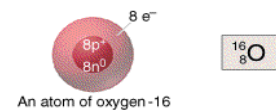
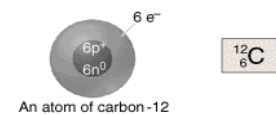
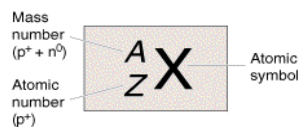
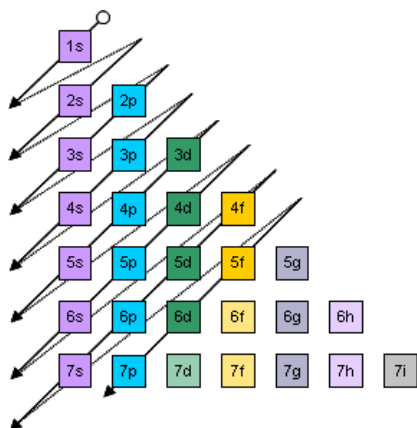
- ✓ Which electrons require the least amount of ionization energy?

### Vocabulary

Isotope  
 Ionization energy  
 Valence electron  
 Orbitals

### Emission Spectra

Flame Tests  
 Anion  
 Cation



## Periodic Table

### Key Concepts

- ✓ Using the Periodic Table describe or color the location of the metals, non-metals, metalloids, transition metals, hydrogen, alkali metals, alkaline earth metals, halogens, and noble gases.

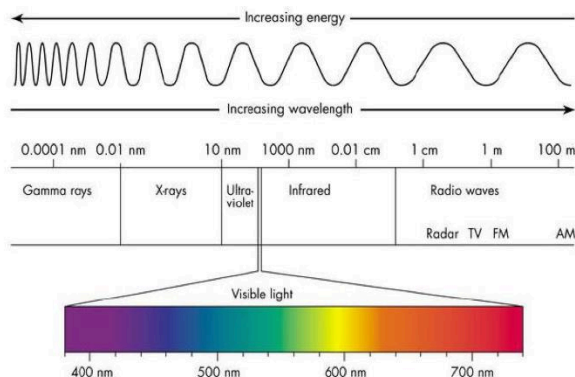
**Periodic Table of the Elements**

1 H																	2 He						
3 Li	4 Be	<div style="display: flex; justify-content: space-between; font-size: 0.8em;"> <div> <p>■ hydrogen</p> <p>■ alkali metals</p> <p>■ alkali earth metals</p> <p>■ transition metals</p> </div> <div> <p>■ poor metals</p> <p>■ nonmetals</p> <p>■ noble gases</p> <p>■ rare earth metals</p> </div> </div>										5 B	6 C	7 N	8 O	9 F	10 Ne						
11 Na	12 Mg																	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr						
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe						
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn						
87 Fr	88 Ra	89 Ac	104 Unq	105 Unp	106 Unh	107 Uns	108 Uno	109 Une	110 Uun														

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

- ✓ Where are the periods? Where are the groups?
- ✓ What does “periodic” mean?
- ✓ What is the pattern that describes elements that have similar properties?
- ✓ How does electronegativity vary within a period?  
Within a group?
- ✓ How does atomic radius vary within a period?  
Within a group?
- ✓ How does ionization energy vary within a period?  
Within a group?
- ✓ How many valence electrons do the elements have in each group?
- ✓ How does the period number relate to the principle energy level of an element?
- ✓ How can the charge of an ion of an element be predicted from the group of the element?



## Bonding

### Key Concepts

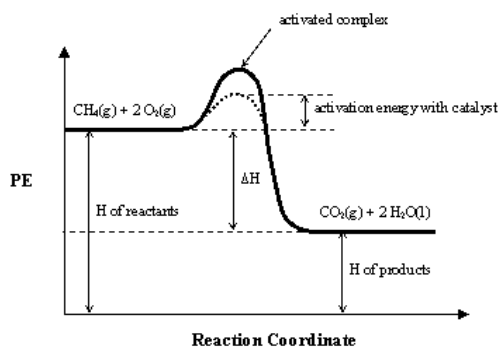
- ✓ Describe an ionic bond.
- ✓ How are ionic substances recognized?
- ✓ How are ionic substances named?
- ✓ Describe a covalent bond (molecular substance).
- ✓ How is a molecular substance recognized?
- ✓ How is a molecular substance named?
- ✓ What is a polyatomic ion?
- ✓ What are the formulas for the following commonly named compounds? Water \_\_\_\_\_, methane \_\_\_\_\_, ammonia \_\_\_\_\_
- ✓ Fill in the table:

Bond Type	Example of Substance	Characteristic Properties
Ionic		
Covalent		
Metallic		

- ✓ Fill in the table:

Intermolecular Force	Strongest (1) to Weakest (3)	Example of Substance	Characteristic Properties
Hydrogen bonding			
Dipole-dipole forces			
Dispersion forces			

- ✓ Does bond breaking absorb or release energy?
- ✓ Exothermic means ?    Endothermic means ?
- ✓ Does bond forming absorb or release energy?
- ✓ Explain the diagram that follows.
- ✓ Is the reaction endo or exothermic?



### Vocabulary

Lewis Dot Diagrams  
Entropy  
Polar bond

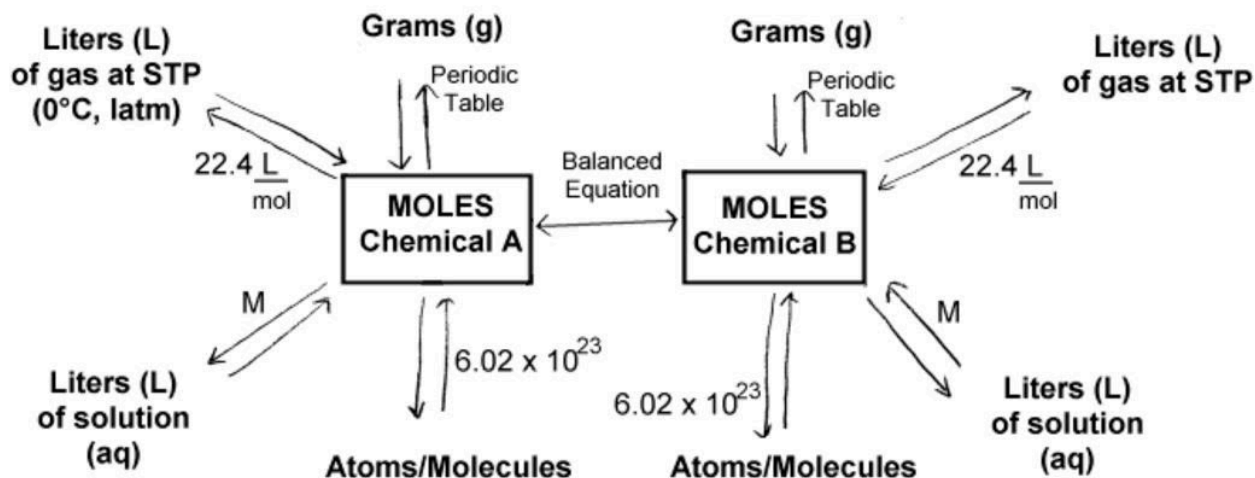
Nonpolar covalent bond  
VSEPR theory  
Structural formula

## Stoichiometry

### Key Concepts

- ✓ What is a mole?
- ✓ How many atoms are in a mole?
- ✓ What is molar mass?
- ✓ Compute the molar mass of sucrose,  $C_{12}H_{22}O_{11}$
- ✓ What is STP?
- ✓ What is the molar volume of an ideal gas at STP?
- ✓ What is an empirical formula?
- ✓ How do you determine an empirical formula if you know the percent composition of a compound?
  
- ✓ How do you determine how many significant figures to report in a measurement?
  
- ✓ Why are all measurements uncertain?
  
- ✓ When performing a calculation with measured data, what are the rules for determining the number of significant figures to report?

### **STOICHIOMETRY ROAD MAP**



- ✓ Describe the following reaction types:
  - o Synthesis
  - o Decomposition
  - o Single Replacement
  - o Double Replacement
  - o Combustion
  - o Oxidation-Reduction
  - o Acid-Base Neutralization
  - o Precipitation

### Vocabulary

Density

Hydrates

Aqueous Solution

Balancing Equations

Molar Ratios

Limiting Reactant

Molarity

Activity Series

## Matter and Energy

### Key Concepts

✓ Distinguish between chemical and physical properties.

✓ Complete the table on the phases of matter:

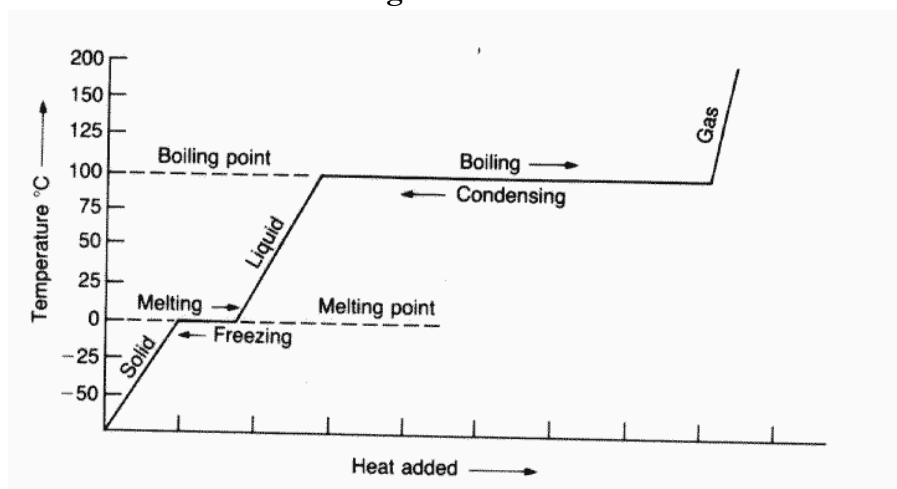
	Solid	Liquid	Gas
Particle distance			
Particle motion			
Particle structure			

✓ Draw three diagrams: solid, liquid and gaseous water at the particle level.

✓ Heat changes with temperature  $q = mc\Delta T$ . (For water,  $c = 4.184 \text{ J/g}^\circ\text{C}$ )

Example: Calculate the amount of heat absorbed when the temperature of 500.g of water increases by  $20.0^\circ\text{C}$ .

### Heating Curve for Water



✓ Phase Changes solid  $\leftrightarrow$  liquid  $\leftrightarrow$  gas

Example : Calculate the heat of fusion of a substance if 12.5 kJ of heat will melt 25 kg of the solid at its melting point. Report the units.

✓ Know the symbol and order of magnitude of each of the metric prefixes: pico \_\_\_\_\_, nano \_\_\_\_\_, micro \_\_\_\_\_, milli \_\_\_\_\_, centi \_\_\_\_\_, deci \_\_\_\_\_, deca \_\_\_\_\_, hecto \_\_\_\_\_, kilo \_\_\_\_\_, mega \_\_\_\_\_, giga \_\_\_\_\_, tera \_\_\_\_\_

### Vocabulary

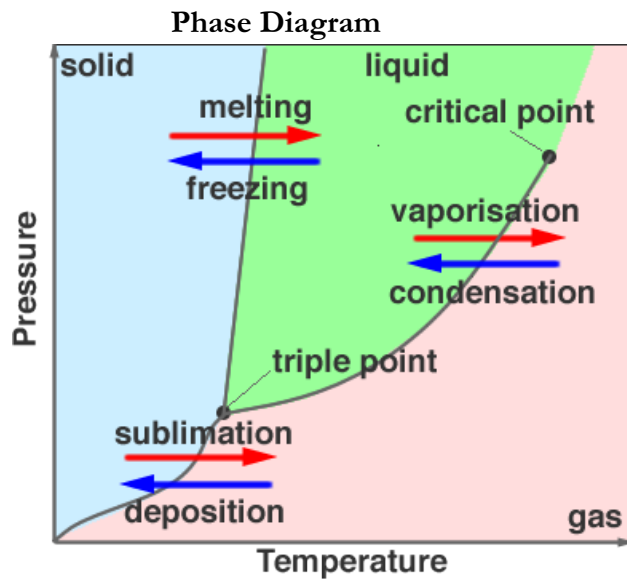
Sublimation  
Heat of fusion  
Vapor pressure

Kelvin Temperature  
Absolute zero  
Specific Heat Capacity

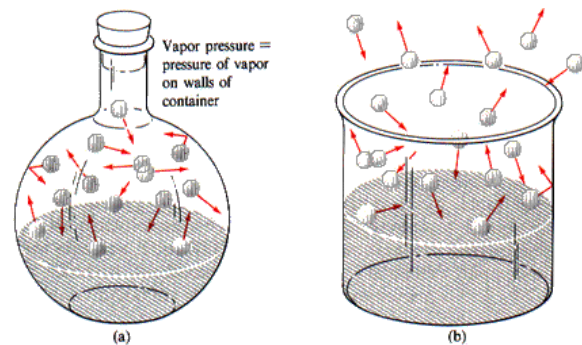
## Phases of Matter & Solutions

### Key Concepts

- ✓ The Gas Laws:
  - o Boyles
  - o Charles
  - o Gay-Lussac
  - o Avogadro
  - o Combined
  - o Ideal Gas Law
  - o Ideal Gas Constant (R)
  - o Dalton's Law of Partial Pressures
- ✓ Describe the postulates of the Kinetic Molecular Theory
- ✓ Standard Temperature in Celsius and Kelvin
- ✓ Standard Pressure in atmospheres (atm), torr, kilopascals (kPa), millimeters of mercury (mmHg)



### **Equilibrium vapor pressure**



### Vocabulary

Solute  
Solvent  
Solution  
Saturated  
Solubility  
Alloy

## Problem Set

**Answer these questions on lined paper. You will be turning this in for a grade. Show all steps of each calculation in a logical order, with units and proper significant figures to receive full credit. This must be your own work. You may use references, but you must answer these specific questions yourself. Copying answers or receiving unauthorized aid is a violation of the school honor code.**

**At the top of the page include this statement: "I pledge that this assignment was completed following the W-L honor code" and sign your name.**

1. Gallium has two naturally occurring isotopes: Ga-69 and Ga-71.
  - a. How many protons, neutrons, and electrons are in neutral atoms of Ga-69 and Ga-71?
  - b. Write the full electron configuration for a neutral gallium atom.
  - c. Write the noble gas electron configuration for a neutral gallium atom.
  - d. Ga-69 has a mass of 68.9256 amu and a natural abundance of 60.11%. Use the atomic mass of gallium from the periodic table to find the mass of Ga-71 to six significant figures.
  
2. Arrange the elements (F, Ne, Na, Cl) in order of...
  - a. Decreasing atomic radius (largest to smallest)
  - b. Decreasing ionization energy (greatest to least)
  - c. Decreasing electronegativity (greatest to least)
  
3. For the following molecules or polyatomic ions: (1) draw the Lewis dot structure and (2) specify the shape the molecule takes according to the VSEPR theory
  - a. Chlorine,  $\text{Cl}_2$
  - b. Oxygen,  $\text{O}_2$
  - c. Nitrogen,  $\text{N}_2$
  - d. Ammonium,  $\text{NH}_4^+$
  - e. Carbonate,  $\text{CO}_3^{2-}$
  - f. Water,  $\text{H}_2\text{O}$
  - g. Phosphorus trichloride,  $\text{PCl}_3$
  - h. Acetylene,  $\text{C}_2\text{H}_2$
  
4. Humulone,  $\text{C}_{21}\text{H}_{30}\text{O}_5$ , is a bitter-tasting molecule that contributes to the flavor of beer. Calculate, showing all work and rounding to the appropriate number of significant figures:
  - a. the molar mass of humulone (round to the hundredths place)
  - b. the number of moles in 275 mg humulone
  - c. the mass of 0.600 moles of humulone, in grams
  - d. the number to atoms of hydrogen in 1.00 pg humulone
  - e. the mass of  $1.000 \times 10^9$  molecules of humulone, in grams
  - f. the mass of one molecule of humulone, in grams
  
5. List the following substances in order of increasing (least to greatest) mass percent of carbon: caffeine,  $\text{C}_8\text{H}_{10}\text{N}_4\text{O}_2$ , sucrose,  $\text{C}_{12}\text{H}_{22}\text{O}_{11}$ , and ethanol,  $\text{C}_2\text{H}_5\text{OH}$ . Show all calculations used to determine the order.



6. A mystery carbohydrate is composed of 25.0% carbon, 8.30% hydrogen, and 66.7% oxygen.
- From this information, calculate the empirical formula of the compound.
  - What is the molecular formula of this mystery carbohydrate, if the molar mass of the compound is experimentally determined to be 145 g/mol
7. Calculate the energy needed to raise the temperature of an 850. gram aluminum tray from 22.8°C to 94.6°C. (The specific heat of Al is 0.9000 J/g°C)
8. A 75.0 mL steel reaction vessel is filled with oxygen gas (O<sub>2</sub>) until the pressure reads 145 atm at 22.0°C. How many moles of oxygen are in the container?
9. A student adds 4.00 g dry ice, CO<sub>2</sub>(s), to an empty balloon. Calculate the volume of the balloon after the dry ice sublimates and comes to STP.
10. Make flash cards of the polyatomic ions in the chart. Put the formula on one side and the name on the other. You will need to memorize these ions this fall. We will have a quiz on these polyatomic ions during the first few weeks of school.

Formula	Name	Formula	Name
H <sub>3</sub> O <sup>+</sup>	Hydronium	CrO <sub>4</sub> <sup>-2</sup>	Chromate
NH <sub>4</sub> <sup>+</sup>	Ammonium	Cr <sub>2</sub> O <sub>7</sub> <sup>-2</sup>	Dichromate
CN <sup>-</sup>	Cyanide	MnO <sub>4</sub> <sup>-</sup>	Permanganate
CO <sub>3</sub> <sup>-2</sup>	Carbonate	NO <sub>2</sub> <sup>-</sup>	Nitrite
ClO <sup>-</sup>	Hypochlorite	NO <sub>3</sub> <sup>-</sup>	Nitrate
ClO <sub>2</sub> <sup>-</sup>	Chlorite	O <sub>2</sub> <sup>-2</sup>	Peroxide
ClO <sub>3</sub> <sup>-</sup>	Chlorate	OH <sup>-</sup>	Hydroxide
ClO <sub>4</sub> <sup>-</sup>	Perchlorate	PO <sub>4</sub> <sup>-3</sup>	Phosphate
CH <sub>3</sub> COO <sup>-</sup>	Acetate	SO <sub>3</sub> <sup>-2</sup>	Sulfite
C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-</sup>		SO <sub>4</sub> <sup>-2</sup>	Sulfate

11. Review naming! You will be expected to go from name to formula and formula to name of compounds with ease in this course. Practice naming and writing formulas for ionic compounds (with and without polyatomic ions) and molecular compounds (covalent bonds). We will learn how to name acids at the beginning of the year.

**Ionic**

**Naming Ionic Compounds**

cation first    anion second

element name    Roman numeral in parenthesis (if more than one possible charge)    -ide ending (if binary compound)    ion name (if polyatomic)

SrCl<sub>2</sub>    strontium chloride  
 CoCl<sub>2</sub>    cobalt(II) chloride  
 Pt<sub>3</sub>(AsO<sub>2</sub>)<sub>4</sub>    platinum(II) arsenate

sciencenotes.org

**Molecular**

Compound Formula

Element to bottom or left on periodic table    N<sub>2</sub> O<sub>3</sub>    Element to right or top of periodic table (more electronegative)

Compound Name

Element name    dinitrogen trioxide    "ide" root

number of atoms prefixes

sciencenotes.org

Prefixes	
1	Mono
2	Di
3	Tri
4	Tetra
5	Penta
6	Hexa
7	Hepta
8	Octa
9	Nona
10	Deca

12. The AP Chemistry Periodic Table does not contain the names of the elements, it only shows their symbols. You will need to get used to using this new Periodic Table. We will have a quiz on the elements and their symbols during the first few weeks of school. Pay attention to spelling! If you want to get a head start on memorizing, these are the elements you will need to know by name:

H	V	Sn
He	Cr	Sb
Li	Mn	Te
Be	Fe	I
B	Co	Xe
C	Ni	Cs
N	Cu	Ba
O	Zn	La
F	Ga	W
Ne	Ge	Pt
Na	As	Au
Mg	Se	Hg
Al	Br	Pb
Si	Kr	Bi
P	Rb	Po
S	Sr	At
Cl	Y	Rn
Ar	Zr	Fr
K	Mo	Ra
Ca	Pd	U
Sc	Ag	Pu
Ti	Cd	