

[1-6] Classify each of the following as a physical or chemical change. 2.1

- \_ Physical \_** 1. Iron metal is melted.  
**\_ Chemical \_** 2. Wood burns in air.  
**\_ Chemical \_** 3. Iron combines with oxygen to form rust.  
**\_ Physical \_** 4. A rock is broken into small pieces.  
**\_ Chemical \_** 5. Milk turns sour.  
**\_ Physical \_** 6. Steam from your hot shower condenses on a cold mirror.

[7-10] Write the following numbers in scientific notation. 3.1

- \_  $2.38 \times 10^5$  \_** 7. 238,000      **\_  $1.67 \times 10^{-4}$  \_** 9. 0.000167  
**\_  $1.5 \times 10^6$  \_** 8. 1,500,000      **\_  $7.2 \times 10^{-7}$  \_** 10. 0.00000072

11. What are the units for expressing volume? 3.2

**Volume is usually expressed in:  $\text{cm}^3$ , mL (also written as ml), or Liters**

**\* You should know that  $1 \text{ cm}^3$  is the SAME volume as 1 ml. The difference is that  $\text{cm}^3$  is typically used for solids while ml is used for liquids or gases.**

12. The mass of 1 mL of pure water at  $4^\circ\text{C}$  is **\_ 1 gram \_**. The mass of 0.5 L of pure water at  $4^\circ\text{C}$  is **\_ 500 g \_**. (3.4)

**\* You are expected to know that the density of water is 1 g/ml, or  $1 \text{ g/cm}^3$  at temperatures from about  $4\text{-}100^\circ\text{C}$ .**

**\* You also need to know basic conversions like  $1 \text{ L} = 1000 \text{ ml}$  so for the second part here,  $0.5 \text{ L} = 500 \text{ ml}$ . Since  $D = \text{mass}/\text{Volume}$ ,  $1 = m / 500$  and  $\text{mass} = 1(500) = 500 \text{ grams}$ .**

13. If 5.0 mL of a pure liquid substance has a mass of 15.0 g. What is the mass of 2.00 L of the substance? (3.4)

**$D = m/V$   $D = 15 / 5 = 3 \text{ g/ml}$        $D = m/V$   $3 = m / 2000$        $m = 3(2000) = 6000 \text{ g}$**

**\* Note that units in math problems must match up. For the second part here, 2.0 L and the “ml” from 3 g/ml are not alike, so you convert the L to ml before doing the math.**

**\* Note: Since the Density of the liquid does not change, you could also solve this problem by setting the equations “equal to each other” so it works like a proportion.**

**$D_1 = D_2$        $m_1 / V_1 = m_2 / V_2$        $15 / 5 = x / 2000$        $x = (15/5)(2000) = 6000 \text{ g}$**

14. How is the density of a substance calculated? (3.4)

**Density is calculated by dividing the mass of the substance by its volume.**

**The unit of measure for density must always be a combination of mass/volume such as  $\text{g/cm}^3$ , g/L,  $\text{Kg/m}^3$ , g/gal**

15. Calculate the density of 23.50 mL of a liquid that has a mass of 35.062 g. (3.4)  
 $D = m / V = 35.062 / 23.50 = 1.490 \text{ g/ml}$   
*\*note that the final answer is 1.490, not 1.49. This is because of significant digits rules. In a multiply or divide problem, the final answer is rounded to have the same number of significant digits as the least number of digits used in the calculation. 35.062 has 5 sig.fig. 23.50 has 4 sig.fig. so the answer is rounded to four sig. figures. You will need to know the sig.fig. rounding rules.*
16. Calculate the mass of 4.42 cm<sup>3</sup> of platinum. The density of platinum is 22.5 g/cm<sup>3</sup>. (3.4)  
 $D = m / V \quad 22.5 = m / 4.42 \quad m = 22.5(4.42) = 99.5 \text{ g (rounded to 3 sig.fig.)}$   
 Or..  $D = m / V \quad m = D(V) = 22.5(4.42) = 99.5 \text{ g}$
17. When a piece of magnesium with a mass of 3.583 g is placed into a graduated cylinder containing 20.00 mL of water, the water rose to 22.06 mL. Calculate the density of magnesium. (3.4)  
 $D = m / V$  you need mass of Mg and volume of Mg. The mass is given.  
 The challenge here is that you need the volume of the Mg, not the water. The change in water volume is the volume of the Magnesium (because it pushed the water aside making the level rise in the graduated cylinder).  
 $\text{Vol of Mg} = 22.06 - 20.00 = 2.06 \text{ mL.}$   
 $D = 3.583 / 2.06 = 1.74 \text{ g/ml (rounded to 3 sig.fig. because 2.06 has the least number of sigfig)}$
18. Name the scientific theory for which the following scientists are given credit. (Various places.)

a. Bohr	<ul style="list-style-type: none"> <li>Electrons orbiting the nucleus in different levels or “rings”</li> </ul>
b. Mendeleev	<ul style="list-style-type: none"> <li>Organized the periodic table by increasing mass and similar chemical properties.</li> <li>Founder of the first version of the modern periodic table.</li> </ul>
c. Rutherford	<ul style="list-style-type: none"> <li>Proved a small, positive, dense nucleus was at center of atom.</li> <li>The nucleus contains 99.9+% of the atom’s mass</li> </ul>

19. “The Atom”... 4.2

a. What is an atom?

**The smallest particle of an ELEMENT that can still be that element.** (sometimes defined as the smallest particle of matter but “of element” is less confusing because protons and neutrons are “matter” but smaller than an atom)

b. What are the 3 subatomic particles? Size? Location?

Particle	Mass	Location	Charge
Proton	1 amu	Nucleus	Positive +
Neutron	1 amu	Nucleus	None
Electron	0 amu (too small to worry about)	Electron cloud	Negative -

20. Distinguishing Between Atoms... 4.3

a. What distinguishes the atoms of one element from the atoms of another?

**No two elements have the same number of protons in their nucleus. They may have the same number of neutrons or electrons, but proton counts cannot be the same if they are different elements. The number of protons in a nucleus equals the atomic number.**

b. What is the mass number?

**= total number of protons and neutrons in an atom.**

**Mass number must always be a whole number (integer)**

c. How do you calculate the number of neutrons in an atom?

**Neutrons = mass number - atomic number or mass number - number of protons**

d. How do you calculate the number of electrons in an atom?

**In a neutral atom, the number of electrons always = the number of protons**

e. How do isotopes of a given element differ from one another? How are they the same?

**Isotopes are atoms of the same element but having different masses. Their masses differ because they have a different number of neutrons in their nuclei.**

**They are alike in that they have the same number of protons in their nuclei - this is what makes them the same element.**

f. How do you calculate atomic mass?

**Atomic mass is the weighted average of the masses of all known isotopes. It's calculated by multiplying each isotope's mass by its "percent abundance" in nature, and adding up their products. The equation below illustrates the formula.**

**Atomic mass = mass1 x % Abundance1 + mass2 x % Abundance2  
+ mass3 x % Abundance3 + ...**

**NOTES: mass1,2,3 refer to the exact mass of the first isotope, 2nd isotope, 3rd, etc.**

**% Abundance is the % abundance of that isotope expressed in decimal form;**

**a 73% abundance would be 0.73; a 5.6% would be 0.056; etc.**

**Ex: Atomic of element X. X has two isotopes. One weighs 53.4 amu and makes up 87.3% of atoms while the other isotope weighs 52.6 amu and makes up 12.7% of the atoms.**

$$\text{AtMass} = 53.4(.873) + 52.6(.127) = 53.2984 \Rightarrow 53.3 \text{ amu}$$

[21-26] Complete the following table. 4.3

Symbol	Name	Atomic #	Mass #	# Protons	# Neutrons	# Electrons
21. $^{108}_{47}\text{Ag}$	<b>Silver-108</b>	<b>47</b>	<b>108</b>	<b>47</b>	<b>61</b>	<b>47</b>
22. $^{59}_{28}\text{Ni}$	<b>Nickel-59</b>	<b>28</b>	<b>59</b>	<b>28</b>	<b>31</b>	<b>28</b>
23. $^{12}_6\text{C}$	Carbon-12	<b>6</b>	<b>12</b>	<b>6</b>	<b>6</b>	<b>6</b>
24. $^{27}_{13}\text{Al}^{3+}$	<b>Aluminum-27 ion</b>	<b>13</b>	<b>27</b>	<b>13</b>	<b>14</b>	<b>10</b>
25. $^{16}_8\text{O}^{2-}$	<b>Oxygen-16 ion</b>	<b>8</b>	<b>16</b>	<b>8</b>	<b>8</b>	<b>10</b>
26. $^{60}_{20}\text{Ca}^{2+}$	<b>Calcium-60 ion</b>	<b>20</b>	<b>60</b>	<b>20</b>	<b>40</b>	<b>18</b>

27. Compare and contrast the following... atom, ion, cation, anion and compound.

**Atom = smallest particle of an element; neutral in charge**

**Ion = an atom that is no longer neutral in charge because it either lost or gained electrons**

- If electrons lost, becomes positive (+) ion

- If electrons gained, becomes negative (-) ion

**Cation = special name used to indicate a positively charged ion**

**Anion = special name used to indicate a negatively charged ion**

**Compound = any substance made up of two or more different elements that are bonded together**

28. The Periodic Table... 6.1 & 6.2

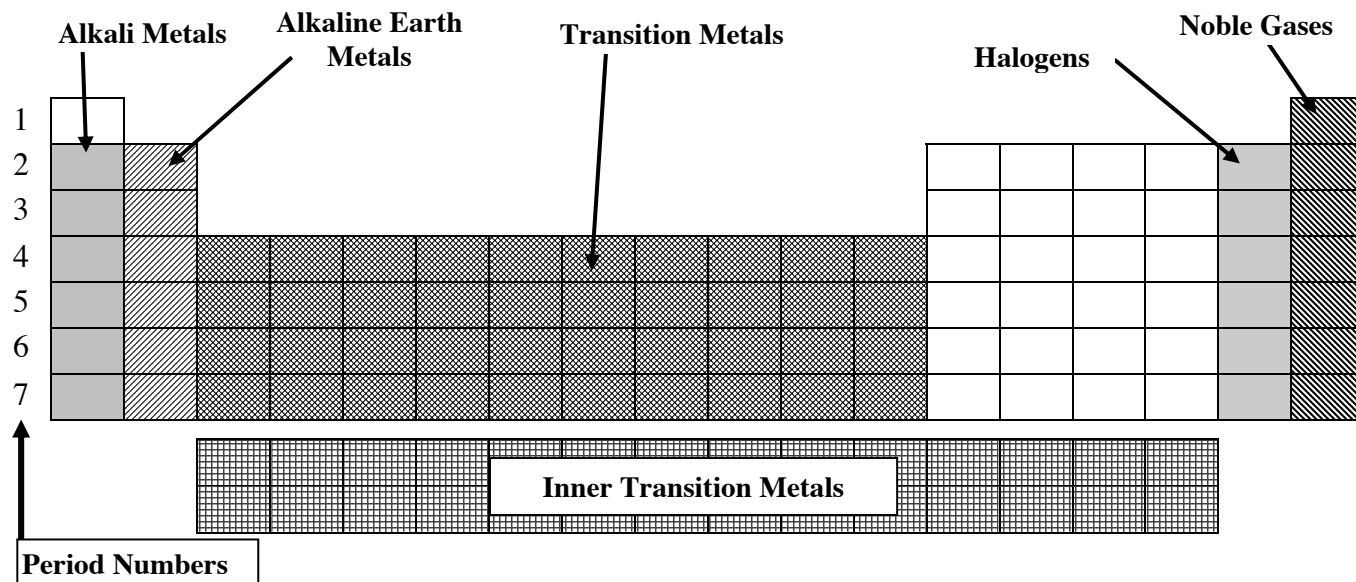
a. What is modern periodic law?

**when elements are arranged in order of increasing atomic number, there is a periodic repetition of their physical and chemical properties.**

b. What are the 3 classes of elements? List the properties of each class.

<b>Metals</b>	<b>malleable, ductile, metallic luster, good conductors</b>
<b>Non-metals</b>	<b>brittle, dull, bad conductors</b>
<b>Metalloids</b>	<b>- sometimes called semi-metals - properties of both metals and nonmetals depending on conditions</b>

c. Label the following on the periodic table below... alkali metals, alkaline earth metals, transition metals, inner transition metals, halogens, noble gases and the periods.



d. What is true about the elements in a family on the periodic table?

**They have similar chemical and physical properties; same number of valence electrons**

e. What is true about the elements in a period on the periodic table?

**Have increasing atomic numbers going left-to-right.**



31. Name two elements that have properties similar to those of the element sodium.  
**Elements in the same column: Lithium, potassium, rubidium, cesium, or francium**
32. Arrange these elements in order of decreasing atomic size: sulfur, chlorine, aluminum, and sodium. **sodium, aluminum, sulfur, chlorine**  
 Does your arrangement demonstrate a periodic trend or a group trend?  
**Periodic trend. They are in same period, not same group.**
33. Which element in each pair has atoms with a larger atomic radius? Why?
- sodium**, lithium **has one more level(layer) of electrons**
  - strontium**, magnesium **has two more levels of electrons**
  - carbon, **germanium** **has two more layers of electrons**
  - selenium**, oxygen **has two more levels of electrons**
34. Which element in each pair has a greater first ionization energy? Why?
- lithium, **boron** **greater effective nuclear charge to hold on to the electrons**  
**- B has more protons than lithium and smaller radius**
  - magnesium**, strontium **greater effective nuclear charge to hold on to the electrons,**  
**- strontium is much larger and has more shielding**
  - cesium, **aluminum** **greater effective nuclear charge to hold on to the electrons,**  
**- cesium is much larger and has more shielding**
35. Which element in each pair has a higher electronegativity value? Why?
- Cl, **F** **top of the halogen group and electronegativity increases from bottom to top in a group**
  - C, **N** **is further right in the same period and electronegativity increases as you go left to right across a period**
  - Mg**, Ne **noble gases do not have electronegativity values**
  - As**, Ca **is further right in the same period and electronegativity increases as you go left to right across a period**
36. When elements in each pair are chemically combined, which element in each pair has a greater attraction for electrons? 8.4
- Ca or **O** **(higher Electronegativity values)**
  - O or **F**                      c. H or **O**                      d. K or **S**
37. Identify each element as a metal, metalloid, or nonmetal. 6.1
- gold **Metal**    b. silicon **metalloid**
  - sulfur **nonmetal**    d. barium **metal**
38. Identify each property below as more characteristic of a metal or a nonmetal.

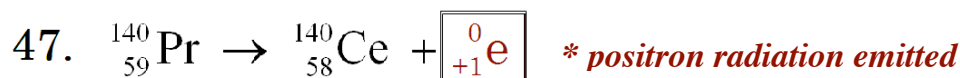
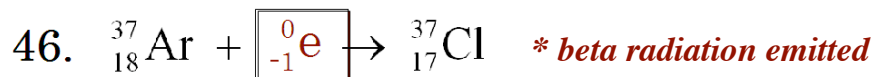
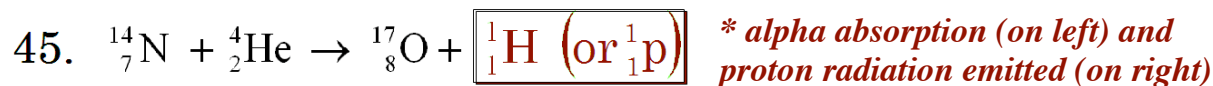
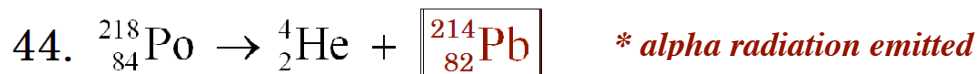
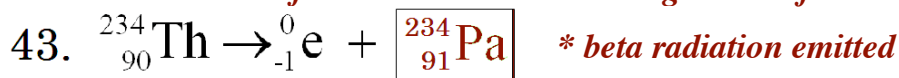
a. a gas at room temperature	<b>Nonmetal</b>
b. brittle	<b>Nonmetal</b>
c. malleable	<b>Metal</b>
d. poor conductor of electric current	<b>Nonmetal</b>
e. shiny	<b>Metal</b>

39. Half-life is **the time it takes half of a sample of a radioactive isotope to decay** 25.2
40. Phosphorus-32 has a half-life of 14.3 days.  
Starting with 5.00 g of  $^{32}\text{P}$  how much will be left after 71.5 days?  
1) **how many half-lives will pass?**  $71.5 / 14.3 = 5$  halflives  
2) **Divide the starting amount by 2, 5 times:**  
 $5/2 = 2.5$   $/2 = 1.25$   $/2 = 0.625$   $/2 = 0.3125$   $/2 = 0.15625 \sim \underline{0.156 \text{ grams}}$   
**Or just divide consecutively on your calculator 5 times:**  
 $5/2/2/2/2/2 = \underline{0.156 \text{ g}}$  will be left after 71.5 days.
41. Iodine-131 has a half-life of 8.0 days. How many grams of an original 160 mg sample will remain in 40 days?  
1) **how many half-lives will pass?**  $40 / 8 = 5$  halflives  
2) **Divide the starting amount by 2, 5 times:**  
 $160/2/2/2/2/2 = \underline{5 \text{ mg}}$  will be left after 40 days.
42. Carbon-14 has a half-life of 5715 years. It is used to determine the age of ancient objects. How many half-lives have elapsed if an original 0.48 mg sample now contains 0.060 mg of carbon-14?  
1) **Since don't know time, must divide starting amount in half as many times as it takes to reach a value of 0.060. This tells how many halflives have passed.**  
 $0.48/2 = 0.24$   $/2 = 0.12$   $/2 = 0.06$  **← three times to reach final value so 3 halflives**  
**Total time = length of halflife x number of halflives**  
**=  $5715 \times 3 = \underline{17145 \text{ years}}$**

[43-47] Complete and balance the equations for the following nuclear transmutations.

*hint: total on top left side = total on top right side.*

*Total on bottom left side = total on bottom right side of arrow.*



48. What is an ionic bond? List 3 properties of an ionic compound. 7.2  
**occurs when a metal gives up electrons to a nonmetal. The metal becomes positively charged (a cation), the nonmetal becomes negatively charged (an anion). The two ions "stick" together because they are oppositely charged (we say there is an electrostatic attraction)**  
**Properties: Conducts electricity when dissolved in water, has a crystal structure in solid form, has a relatively high melting point.**

49. What is a covalent bond? List 3 properties of a covalent compound. 8.1

**A covalent bond is the sharing of pairs of electrons between two nonmetals to create a bond.**

**Properties: Usually gases or liquids at room temperature, lower melting and boiling points than ionic compounds, nonmetal bonded to a nonmetal.**

50. What is the difference between a polar covalent bond and a nonpolar covalent bond? 8.4

**In a polar covalent bond, the shared pair of electrons is not shared equally. One of the atoms will have a higher electronegativity value than the other atom. So the atom with the higher value will be able to draw the electrons closer causing that atom to become slightly negative, and the other atom slightly positive.**

**In a nonpolar covalent bond, atoms have the same electronegativity and share the electrons equally.**

[51-56] Complete the following table. 8.4

Reacting elements	Difference in electronegativity	Ionic or covalent?	Molecular formula
51. Na, S	1.6	Ionic	Na <sub>2</sub> S
52. H, O	1.4	Polar Covalent	H <sub>2</sub> O
53. C, Cl	.5	Non-Polar Covalent	CCl <sub>4</sub>
54. Li, Br	1.8	Ionic	LiBr
55. Fe(III), Cl	1.2	Ionic	FeCl <sub>3</sub>
56. H, H	0	Non-Polar Covalent	H <sub>2</sub>

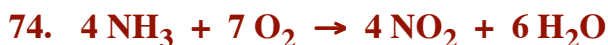
[57-64] Name the following compounds. 9.1 & 9.2

57. As <sub>2</sub> O <sub>3</sub>	diarsenic trioxide	61. KCl	potassium chloride
58. Ni(NO <sub>3</sub> ) <sub>2</sub>	nickel (II) nitrate	62. PbSO <sub>3</sub>	lead (II) sulfite
59. N <sub>2</sub> O <sub>5</sub>	dinitrogen pentoxide	63. SO <sub>3</sub>	sulfur trioxide
60. SiBr <sub>4</sub>	silicon tetrabromide	64. NaClO <sub>3</sub>	sodium chlorate

[65-72] Write the formula for the following compounds. 9.1 & 9.2

65. Ammonium sulfide	(NH <sub>4</sub> ) <sub>2</sub> S	69. Iron (III) oxide	Fe <sub>2</sub> O <sub>3</sub>
66. Diphosphorous pentoxide	P <sub>2</sub> O <sub>5</sub>	70. Calcium chloride	CaCl <sub>2</sub>
67. Aluminum phosphate	AlPO <sub>4</sub>	71. Copper (II) sulfate	CuSO <sub>4</sub>
68. Zinc nitrate	Zn(NO <sub>3</sub> ) <sub>2</sub>	72. Carbon dioxide	CO <sub>2</sub>

[73-78] Balance the following chemical equations. 11.1



79. Calculate the atomic mass of rubidium. The two isotopes of rubidium have atomic masses and % natural abundances of 84.91 amu (72.16%) and 86.91 amu (27.84%). 4.3

**Atomic mass = mass1(Abundance1) + mass2(Abundance2) + ...**

*\*abundance must be decimal equivalent of percentage, not actual percentage value*

**= 84.91 (.7216) + 86.91 (.2784)**

**= 61.271 + 24.196**

**= 85.467 ~ 85.47** when rounded to proper, 4 sig.figs.

**\* NOTE that the atomic mass MUST BE between the smallest and largest masses given.**

80. Find the average atomic mass of copper given the following information. Remember to show your work and include units. 4.3

Isotope	Mass	Percent Abundance
Cu-63	62.93 amu	69.2%
Cu-65	64.93 amu	30.8%

*\* answer should be rounded to 3 sig.figs. because the % values given have 3 figures.*

**Atomic mass = mass1(Abundance1) + mass2(Abundance2) + ...**

**= 62.93 (.692) + 64.93 (.308)**

**= 43.6 + 20.0**

**= 63.6**

81. Name 3 methods of separating mixtures. 2.2

**Filtration, distillation, chromatography**

82. Which method of separating mixtures would you use for each of the following? 2.2

a. liquids from liquids

**Distillation or chromatography**

b. insoluble solids from liquids

**Filtration**