

Acc Chemistry Semester 1 Test Review (Units 1-6)

Name: Key Pd: _____

(Formula Sheet) –given to you on the semester test

Element	Reaction
Li Rb K Ba Ca Na	React with cold H ₂ O and acids, replacing hydrogen
Mg Al Mn Zn Fe	React with acids or steam, but usually not liquid water to replace hydrogen
Ni Sn Pb	React with acids but not water to replace hydrogen
H ₂ Cu Hg	React with oxygen to form oxides
Ag Pt Au	Mostly unreactive
F ₂ Cl ₂ Br ₂ I ₂	Listed from most reactive to least

Solubility Rules
NO ₃ ¹⁻ All nitrates are soluble .
Cl ¹⁻ All chlorides are soluble except AgCl, Hg ₂ Cl ₂ , PbCl ₂
NH ₄ ⁺ All Ammoniums are soluble
C ₂ H ₃ O ₂ ⁻ All Acetates are soluble
Group 1 All group one (alkali metals) are soluble
SO ₄ ²⁻ Most sulfates are soluble ; exceptions include: SrSO ₄ , BaSO ₄ , and PbSO ₄ , CaSO ₄ is slightly soluble.
*Assume all other ionic compounds are insoluble

Other information and tips

- There are **85 multiple-choice questions** on the district semester test.
- Test is on the computer.
- There is a **28 point district performance task**
- You will have 50 minutes for the performance task and 90 minutes for the multiple choice test.
- Bring two #2 lead pencils, a good eraser, AND a **calculator**.
- Bring something to study or read after you finish the test
- Try to get a good night's sleep
- Eat a good breakfast. This will help put you in a good mood and help your brain function
- Drink water (H₂O). Avoid caffeine (C₈H₁₀N₄O₂) and sugar (C₁₂H₂₂O₁₁)

Standards	Number of test questions
HS-PS1-1 Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.	11 Multiple Choice & Performance Task
HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction based on the outermost electron states of atoms, trends in the periodic table, and knowledge of the patterns of chemical properties	17 Multiple Choice & Performance Task
HS-PS1-3 Plan and carry out an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles	27 Multiple Choice & Performance Task
HS-PS1-7 Use mathematical representations to support the claim that atoms, and therefore mass, are conserved during a chemical reaction	13 Multiple Choice & Performance Task
HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay	5 Multiple Choice & Performance Task
HS-ESS1-3 Communicate scientific ideas about the way stars, over their life cycle, produce elements	9 Multiple Choice & Performance Task
DD-CHEM1-1 General Scientific Practices (Significant Figures)	3 Multiple Choice Questions & Performance Task

A. Unit 1 & 2 Atomic Structure/Electron Configuration

Be able to:

- differentiate between and determine the number of protons, neutrons, & electrons in an atom
- discuss the history of the atomic theory
- define & determine the atomic #, mass #, and the average atomic mass of different isotopes
- write, interpret, & relate electron configuration orbital notation & electron dot structure based on the location on the periodic table
- relate chemical stability & the octet rule

1. What is the difference between fusion and fission? *fusion - combines fission - splits*
2. What elements are most abundant in the universe? *Hydrogen & Helium*
3. Describe how elements are formed in stars. *Hydrogen & helium fusion*
4. What is an alpha particle? *helium nuclei $\frac{4}{2}\text{He}$*
5. What is a beta particle? *electron ${}_{-1}^0\text{e}$*
6. What type of radiation is the most penetrating: alpha, beta or gamma?
7. Both of the isotopes below are undergoing alpha decay. Complete the reaction.
 - a. ${}_{84}^{210}\text{Po} \rightarrow \frac{4}{2}\text{He} + \frac{206}{82}\text{Pb}$
 - b. ${}_{92}^{238}\text{U} \rightarrow \frac{4}{2}\text{He} + \frac{234}{90}\text{Th}$
8. Both of the isotopes below are undergoing beta decay. Complete the reaction.
 - a. ${}_{6}^{14}\text{C} \rightarrow \frac{0}{-1}\text{e} + \frac{14}{7}\text{N}$
 - b. ${}_{38}^{90}\text{Sr} \rightarrow \frac{0}{-1}\text{e} + \frac{90}{39}\text{Y}$
9. Write the nuclear reaction for the bombardment (fusion) of uranium-232 with an alpha particle. ${}_{92}^{232}\text{U} + \frac{4}{2}\text{He} \rightarrow \frac{236}{94}\text{Pu}$
10. The smallest particle of any element is called a(n) atom.
11. Within an atom, the area of most mass is the nucleus.
12. Within an atom, the area that takes up the most space is the electron cloud.
13. Circle "p" proton, "n" neutron, and/or "e" electron. There may be more than one answer.

- | | |
|--|--|
| <u>p</u> n e 1+ charge | <u>p</u> n <u>e</u> located in "empty space" around nucleus |
| p n <u>e</u> 1- charge | <u>p</u> n e must be the same in an element and its ion |
| p n <u>e</u> changes to gain stability (form an ion) | <u>p</u> n e no charge |
| <u>p</u> n e contributes to most of an element's mass | <u>p</u> n e relatively "big" particle(s) (~1 amu) |
| <u>p</u> n e determines element's identity | <u>p</u> n e same in different isotopes of the same element |
| p n <u>e</u> determines element's reactivity | <u>p</u> n e varies in different isotopes of an element |
| <u>p</u> n e located in nucleus | <u>p</u> n e very small particle(s) (1/1840 amu) |

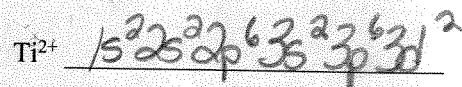
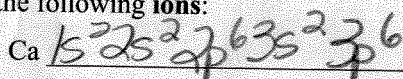
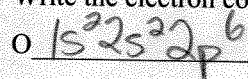
14. Define isotope. *atoms of the same element w/ a different # neutrons*
15. What is another name for the electrons in the outer energy level? *valence e⁻*
16. Fill in the tables with the correct information

Name Notation	Symbol Notation	Protons	Electrons	Neutrons	Mass #	Atomic #
Chromium-53	${}_{24}^{53}\text{Cr}$	24	24	29	53	24
	Complete electron configuration	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$				

Name Notation	Symbol Notation	Protons	Electrons	Neutrons	Mass #	Atomic #	
Potassium-42	${}^{42}_{19}\text{K}$	19	19	23		19	
	Orbital notation	$1s^2$	$2s^2$	$2p^6$	$3s^2$	$3p^6$	$4s^1$

Name Notation	Symbol Notation	Protons	Electrons	Neutrons	Mass #	Atomic #
Potassium-41	${}^{41}_{19}\text{K}$	19	19	22	41	19
	Nobel Gas notation	[Ar] 4s ¹				

17. Write the electron configurations for the following ions:



18. There are 2 isotopes of Boron: Boron-10 and Boron-11. Which isotope is more abundant and why?

Boron-11 because the average atomic mass is closest to 11, not 10.

19. Element X has a mass of 19.90 amu. There are 3 isotopes. X-18, X-19 and X-20. Which isotope is more abundant and why?

X-20 because the average is closer to 20 at 19.90 amu.

B. Unit 2 Periodic Table

Be able to:

- describe the properties of major groups on the periodic table
- identify properties of metals, non-metals, and metalloids
- identify and use the trends on the periodic table (electronegativity, ionization energy, atomic radius, shielding effect, nuclear charge, oxidation number)
- relate electron configuration and ion formation and oxidation number based on the location on the periodic table

Match the family name to the electron configuration

20. b alkali metal a. $1s^2 2s^2 2p^6$
21. e alkaline-earth metal b. $1s^2 2s^2 2p^6 3s^1$
22. d transition metal c. $1s^2 2s^2 2p^5$
23. c halogen d. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$
24. a noble gas e. $1s^2 2s^2 2p^6 3s^2$

25. Circle "m" metal, "md" metalloid, or "nm" nonmetal.

- a. m md nm usually brittle solids and gases f. m md nm malleable and ductile
- b. m md nm forms negative ions g. m md nm poor conductors
- c. m md nm form positive ions h. m md nm semiconductors
- d. m md nm good conductors i. m md nm shiny, hard, dense
- e. m md nm like metals and nonmetals

26. Identify what type of element is present: circle Metal (m), Metalloid (md), or Nonmetal (nm), then identify the family the element belongs to.

a. Fe m md nm transition metals

b. Si m md nm

NA

c. Na m md nm alkali metals
 d. He m md nm noble gases
 e. H m md nm NA

f. U m md nm inner transition
 g. Mg m md nm alkaline earth
 h. Cl m md nm halogens

27. Elements in the same group have similar properties because they have the same # valence e⁻

28. All noble gases are unreactive because they have a full octet (full s and p orbitals)

29. Complete the table concerning Periodic Trends

Trend	Definition	Period Trend	Group Trend	Choose which element has the larger value
Atomic Radius	<u>half the distance between neighboring nuclei</u>	<u>decreases left to right</u>	<u>increases top to bottom</u>	a. <input checked="" type="radio"/> N or <input type="radio"/> O b. Rb or <input checked="" type="radio"/> Fr c. P or <input checked="" type="radio"/> Mg
Ionization Energy	<u>energy required to remove an electron</u>	<u>increases left to right</u>	<u>decreases top to bottom</u>	d. Ca or <input checked="" type="radio"/> Mg e. Mg or <input checked="" type="radio"/> S f. F or <input checked="" type="radio"/> He
Electronegativity	<u>ability to attract electrons in a chemical bond</u>	<u>increases left to right</u>	<u>decreases top to bottom</u>	g. Al or <input checked="" type="radio"/> B h. Fe or <input checked="" type="radio"/> Cu i. Br or <input checked="" type="radio"/> Cl

C. Unit 3 Ionic Compounds

Be able to:

- determine the properties of ionic & metallic bonds
- determine whether if bond is ionic based on the location on the periodic table
- write formulas and names for ions & ionic compound

30. An ionic bond is between a metal and a nonmetal element.

31. What is a cation? positively charged an anion? negatively charged

Determine if the property describes Ionic, Covalent or Metallic Bonding

- | | | | |
|---|---|--|--|
| 32. <input checked="" type="radio"/> I <input type="radio"/> C <input type="radio"/> M | Created through the transfer of electrons | 42. <input checked="" type="radio"/> I <input type="radio"/> C <input type="radio"/> M | Attraction of + and - ions |
| 33. <input type="radio"/> I <input checked="" type="radio"/> C <input type="radio"/> M | Created through the sharing of electrons | 43. <input type="radio"/> I <input checked="" type="radio"/> C <input type="radio"/> M | Conducts electricity when dissolved in water |
| 34. <input type="radio"/> I <input type="radio"/> C <input checked="" type="radio"/> M | Conductor of electricity in the solid state | 44. <input type="radio"/> I <input checked="" type="radio"/> C <input type="radio"/> M | Individual molecules |
| 35. <input type="radio"/> I <input type="radio"/> C <input checked="" type="radio"/> M | Malleable, ductile and lustrous | 45. <input type="radio"/> I <input type="radio"/> C <input checked="" type="radio"/> M | Combination of a metal and a nonmetal |
| 36. <input checked="" type="radio"/> I <input type="radio"/> C <input type="radio"/> M | Hard yet brittle solids | 46. <input type="radio"/> I <input checked="" type="radio"/> C <input type="radio"/> M | Never conducts electricity |
| 37. <input checked="" type="radio"/> I <input type="radio"/> C <input type="radio"/> M | High melting and boiling points | | |
| 38. <input type="radio"/> I <input checked="" type="radio"/> C <input type="radio"/> M | Low melting and boiling points | | |
| 39. <input type="radio"/> I <input checked="" type="radio"/> C <input type="radio"/> M | Poor conductor of heat | | |
| 40. <input checked="" type="radio"/> I <input type="radio"/> C <input checked="" type="radio"/> M | Always solids at room temperature | | |
| 41. <input type="radio"/> I <input checked="" type="radio"/> C <input type="radio"/> M | All states of matter at room temperature | | |



47. What is the basic structure of all ionic compounds? crystal lattice (see the picture above for a hint)

D. Unit 3 & 4 Covalent Bonding

Be able to:

- determine the properties of covalent bonds
- use Lewis Structures to determine shapes of molecules (including expanded octets)
- use Lewis Structures to determine polarity
- use electronegativity to determine the bond type
- Determine the orbital hybridization, sigma and pi bonding in covalent compounds

- determine the type of bond based on electronegativity differences

- write formulas and names for covalent molecules

48. In covalent compounds, electrons are shared in order to complete the atom's octet.
49. Covalent bonds normally form between 2 nonmetals elements.
50. Another name for covalent compounds is molecular compound.

Fill in the chart with the correct name of the substance

<u>Name</u>	<u>Formula</u>
nitrogen trioxide	51. NO_3
calcium nitrate	52. $\text{Ca}(\text{NO}_3)_2$
trisulfur heptoxide	53. S_3O_7
54. <u>ammonium chloride</u>	NH_4Cl
55. <u>diphosphorus pentoxide</u>	P_2O_5
ammonium oxide <u>$\text{NH}_4^+ \text{O}^{2-}$</u>	56. $(\text{NH}_4)_2\text{O}$
57. <u>sodium sulfate</u>	Na_2SO_4
58. <u>potassium phosphate</u>	K_3PO_4
zinc hydroxide	59. $\text{Zn}(\text{OH})_2$
iron (II) chloride	60. FeCl_2
61. <u>manganese (II) carbonate</u>	MnCO_3
62. <u>tin (IV) hydrogen carbonate or bicarbonate</u>	$\text{Sn}(\text{HCO}_3)_4$
Silver nitrite	63. AgNO_2
Nickel (III) sulfite	64. NiSO_3
65. <u>Carbon dioxide</u>	CO_2
66. <u>nitrogen trihydride</u>	NH_3
67. <u>Carbon tetrahydride</u>	CH_4
Aluminum acetate	68. $\text{Al}(\text{C}_2\text{H}_3\text{O}_2)_3$

69. Which elements need Roman numerals included in the name? transition metals + Sn, Pb, Sb
70. What does a Roman numeral in a name represent? the charge of the metal (cation)
71. Describe the difference between a polar bond and a nonpolar bond. polar bonds have an unequal sharing of e^- while nonpolar bonds share e^- equally
72. Between covalent and ionic compounds, which has the higher boiling point? ionic
73. Between covalent and ionic compounds, which will most likely be gases at room temperature? covalent
74. Determine if the following bonds are nonpolar, polar or ionic.
- i. H-H nonpolar
- ii. Na-F ionic
metal nonmetal
- iii. H-Cl polar

75. Ionic bonds are always between a metal and a nonmetal.
76. What are the requirements for a nonpolar molecule? needs to be symmetrical
77. Which shapes could fit the above requirements? linear, trigonal planar, tetrahedral
78. What are the requirements for a polar molecule? polar bond type + asymmetrical
79. What shapes could fit the above requirements? bent, trigonal pyramidal, maybe linear or tetrahedral
80. Complete the chart below

Formula Name the substance	Lewis Structure(s) Include resonance structures if necessary.	Shape Name	Polar or Nonpolar Molecule? (If the compound is polar, please draw in the δ^+ & δ^-)
N_2 $5+5 = \frac{10}{2} = 5 \text{ pairs}$	$:N \equiv N:$	linear	nonpolar
CO_2 $4+2(6) = \frac{16}{2} = 8 \text{ pairs}$	$O = C = O$	linear	nonpolar
SCl_2 $6+2(7) = \frac{20}{2} = 10 \text{ pairs}$	$\begin{array}{c} \delta^- \quad \delta^+ \quad \delta^- \\ :Cl - S - Cl: \\ \cdot\cdot \quad \cdot\cdot \quad \cdot\cdot \end{array}$	bent	$3, 16 - 2, 58 = \text{polar bond}$ asymmetrical, so Polar
SO_3 $6+3(6) = \frac{24}{2} = 12 \text{ pairs}$	$O = S - \ddot{O} \leftrightarrow \ddot{O} = S - \ddot{O} \leftrightarrow \ddot{O} - S = \ddot{O}$	trigonal planar	nonpolar
NF_3 $5+3(7) = \frac{26}{2} = 13 \text{ pairs}$	$\begin{array}{c} \delta^- \quad \delta^+ \quad \delta^- \\ :F - N - F: \\ \cdot\cdot \quad \cdot\cdot \quad \cdot\cdot \\ \\ :F: \\ \cdot\cdot \end{array}$	trigonal pyramidal	polar bond + asymmetrical so Polar
CH_4 $4+4(1) = \frac{8}{2} = 4 \text{ pairs}$	$\begin{array}{c} H \\ \\ H - C - H \\ \\ H \end{array}$	tetrahedral	nonpolar

E. Unit 5 Chemical Reactions Be able to:

- distinguish between the five types of chemical reactions
- write and balance chemical reactions
- interpret the law of conservation of mass
- apply the rules of solubility for writing net ionic equations

81. List the 7 diatomic elements. $H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2$
82. We balance chemical equations because mass cannot be created or destroyed according to the law of conservation of mass.
- When a reaction is balanced, the number of atoms are the same on the reactants side and the product side.
 - When balancing a reaction, only the coefficients can be changed.

83. What is another name for the solid created during a double replacement reaction? precipitate
84. List the 4 states of matter used during a chemical reaction. Solid, liquid, gas, aqueous
85. What are the 5 indicators of a Chemical Change? change in color, odor, temperature formation of gas or precipitate

Matching - What type of reaction is shown?

86. d $A + BY \rightarrow AY + B$ a. combustion
87. b $A + B \rightarrow AB$ b. synthesis
88. e $AY + BX \rightarrow AX + BY$ c. decomposition
89. a $C_xH_x \text{ (hydrocarbon)} + O_2 \rightarrow CO_2 + H_2O$ d. single displacement
90. c $AB \rightarrow A + B$ e. double displacement

Balance and identify the type of reaction for each of the following:

91. 1 C + 1 O₂ → 1 CO₂ Synthesis + Combustion
92. 2 C₄H₁₀ + 13 O₂ → 8 CO₂ + 10 H₂O Combustion
93. 2 H₂O₂ → 2 H₂O + 1 O₂ decomposition
94. 1 Pb + 1 Hg₂SO₄ → 1 PbSO₄ + 2 Hg Single replacement
95. 1 NaCl + 1 AgNO₃ → 1 AgCl + 1 NaNO₃ double replacement
96. 2 Cr + 1 SnCl₄ → 1 Sn + 2 CrCl₂ Single replacement

Predict the products for the following reactions and balance them correctly. If there is no reaction, write NR.

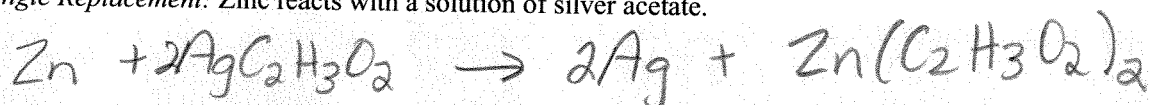
97. Combustion: Propane gas (C₃H₈) combusts.



98. Synthesis: The synthesis of potassium bromide KBr.



99. Single Replacement: Zinc reacts with a solution of silver acetate.



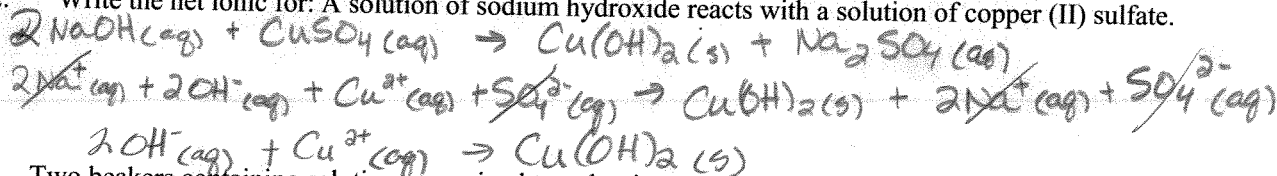
100. Single Replacement: $NaCl + F_2 \rightarrow$



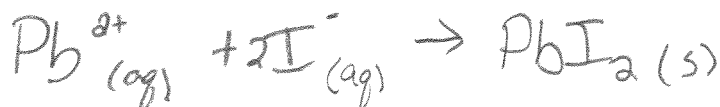
101. Double Replacement: The reaction of barium chloride solution and sodium carbonate solution.



102. Write the net ionic for: A solution of sodium hydroxide reacts with a solution of copper (II) sulfate.



103. Two beakers containing solutions are mixed together in an empty beaker. If lead (II) iodide precipitates out (it's yellow), write the net ionic equation that shows the creation of lead (II) iodide.



F. Unit 6- Data Analysis

Be able to:

- Identify the correct significant digits within a number
- Round a number to correct significant digits
- Convert a number into correct scientific notation
- Use a graph to determine density

- Use the density formula to solve for mass or volume
- Determine if a dimensional analysis problem has been solved correctly

104. Turn the following numbers into the correct scientific notation format

a. 0.000909 meters 9.09×10^{-4}

b. 12,000,000 liters 1.2×10^7

c. 96.56 grams 9.656×10^1

d. 0.000,000,000,000657 kg 6.57×10^{-13}

Determine the number of significant digits in each number.

105. 3.204 4

107. 0.000001 1

109. 0.10100 5

106. 1,000 1

108. 101.010 6

110. 89.250 5

Round each number to the specified significant digits.

111. 569 \rightarrow 1 sig. dig. 600

112. 0.02509 \rightarrow 2 sig. dig. 0.025

113. 865,900 \rightarrow 3 sig. dig. 866,000

114. 100.0023 \rightarrow 4 sig. dig. 100.0

Adding with Significant Digits

115. Three students had peanuts and placed them in a jar after measuring the mass of their sample. What is the total mass of the peanuts in the jar? Student 1: 15.23 g, Student 2: 16.2 g and Student 3: 17 g.

$15.23 + 16.2 + 17 = 48.43 = \boxed{48g}$

Adding smallest # of sig. figs after the decimal so the last sample is nothing so we round to 0 sig. figs = 48g

Dimensional analysis - error recognition - Find the error in the dimensional analysis problem, then fix the error and come up with the correct answer.

116. How many kilograms are equal to 9.65 oz?

9.65 oz	28.35 g	1000 kg	$= 2.74 \times 10^2 \text{ kg}$
	1 oz	1 g	$= 274 \text{ kg}$

117. How many liters are equal to 10.32 cm³?

10.32 cm ³	1 mL	1000 mL	$= 10320 \text{ L}$
	1 cm ³	1 L	$= 0.01032 \text{ L}$

G. Unit 6-The Mole

Be able to:

- Using the mole and molar mass, make conversions between moles, mass, and number of particles
- Use molar mass to calculate percent composition, empirical, and molecular formulas

118. 1 mole Fe = 6.02×10^{23} atoms Fe = 55.847 grams Fe

119. Calculate the number of atoms in a gold sample containing 333 grams.

$\frac{333g \text{ Au}}{196.967g \text{ Au}} \times \frac{1 \text{ mol Au}}{1 \text{ mol Au}} \times \frac{6.02 \times 10^{23} \text{ atoms Au}}{1 \text{ mol Au}} = 1.02 \times 10^{24} \text{ atoms Au}$

120. Calculate the mass (g) of 1.34×10^{25} atoms of Lead.

$1.34 \times 10^{25} \text{ atoms Pb} \times \frac{1 \text{ mol Pb}}{6.02 \times 10^{23} \text{ atoms Pb}} \times \frac{207.2g \text{ Pb}}{1 \text{ mol Pb}} = 4.61 \times 10^3 \text{ or } 4610 \text{ g Pb}$

121. Determine the mass (g) of 1.17×10^{25} formula units of ammonium dichromate (NH₄)₂Cr₂O₇.

$1.17 \times 10^{25} \text{ fu (NH}_4)_2\text{Cr}_2\text{O}_7 \times \frac{1 \text{ mol (NH}_4)_2\text{Cr}_2\text{O}_7}{6.02 \times 10^{23} \text{ fu (NH}_4)_2\text{Cr}_2\text{O}_7} \times \frac{252.06472g \text{ (NH}_4)_2\text{Cr}_2\text{O}_7}{1 \text{ mol (NH}_4)_2\text{Cr}_2\text{O}_7} = 4.9 \times 10^3 \text{ g}$

122. Circle the empirical formulas, square the molecular formulas.

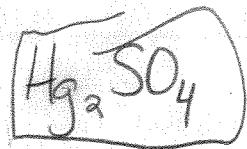
123. C₆H₁₂O₆ - This compound contains 6 atoms of carbon, 12 atoms of hydrogen and 6 atoms of oxygen.

124. If the molecular compound is $C_6H_{14}O_6$, what is the empirical formula? $C_3H_7O_3$
125. Determine the empirical formula for a compound having 80.68% mercury, 6.45% sulfur, and 12.87% oxygen.

$$\frac{80.68g \text{ Hg}}{200.59g \text{ Hg}} = \frac{402 \text{ mol Hg}}{201} = 2$$

$$\frac{6.45g \text{ S}}{32.06g \text{ S}} = \frac{201 \text{ mol S}}{201} = 1$$

$$\frac{12.87g \text{ O}}{16.00g \text{ O}} = \frac{804 \text{ mol O}}{201} = 4$$



126. Caffeine is a compound that was found to have the empirical formula $C_4H_5N_2O$. If its molar mass is 194.19 g/mol calculate its molecular formula.

$$4(12.011) + 5(1.00794) + 2(14.0067) + 15.9994 = 97.0969$$

$$\frac{194.19}{97.0969} = 2(C_4H_5N_2O) = \boxed{C_8H_{10}N_4O_2}$$

127. Determine the molecular formula for a compound that has an empirical formula of CH_2O and a molar mass of 180 g/mol.

$$\frac{180}{30.02638} = 6(CH_2O) = \boxed{C_6H_{12}O_6}$$

128. Calculate the percent composition of Lead (II) chloride $PbCl_2$.

$$\%Pb = \frac{207.2}{278.106} \times 100 = 74.5\% Pb$$

$$\%Cl = \frac{70.906}{278.106} \times 100 = 25.5\% Cl$$

$$207.2 + 2(35.453) = 278.106$$

H. Unit 6-Stoichiometry

Objectives

- Use stoichiometry to convert between substances in chemical reactions
- Identify the limiting reactant (reagent) and be able to solve problems based upon it
- Calculate the theoretical and percent yield of a chemical reaction

129. For the reaction: $2KClO_3 \rightarrow 2KCl + 3O_2$ How many grams of $KClO_3$ must be decomposed to yield 30.0 grams of oxygen.

$$\frac{30.0g O_2}{31.9988g O_2} \times \frac{2mol KClO_3}{3mol O_2} \times \frac{122.549g KClO_3}{1mol KClO_3} = 76.6g KClO_3$$

130. If 20.5 moles of Zn react with excess H_2SO_4 in the following reaction: $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

a. How many grams of $ZnSO_4$ will be produced?

$$\frac{20.5mol Zn}{1mol Zn} \times \frac{161.4476g ZnSO_4}{1mol ZnSO_4} = 3310g ZnSO_4$$

- b. How many formula units of zinc sulfate will be produced?

$$\frac{20.5mol Zn}{1mol Zn} \times \frac{6.02 \times 10^{23} \text{ atoms ZnSO}_4}{1mol ZnSO_4} = 1.23 \times 10^{25} \text{ atoms ZnSO}_4$$

- c. If the density of hydrogen gas is 0.886 g/L, what volume of hydrogen gas will be produced?

$$\frac{20.5mol Zn}{1mol Zn} \times \frac{1mol H_2}{1mol Zn} \times \frac{2.01588g H_2}{1mol H_2} = 41.3g H_2$$

$$V = \frac{m}{D} = \frac{41.3g}{0.886g/L} = 46.6L$$

131. How many grams of hydrogen gas are formed if 4.21 g of Zinc react with 2.75 g hydrochloric acid according to the following equation: $Zn + 2HCl \rightarrow ZnCl_2 + H_2$

$$\frac{4.21g Zn}{65.39g Zn} \times \frac{2mol HCl}{1mol Zn} \times \frac{36.46094g HCl}{1mol HCl} = 4.69g HCl$$

LR = HCl

$$\frac{2.75g HCl}{36.46094g HCl} \times \frac{1mol Zn}{2mol HCl} \times \frac{65.39g Zn}{1mol Zn} = 2.46g Zn$$

$$\frac{2.46g Zn}{65.39g Zn} \times \frac{1mol H_2}{1mol Zn} \times \frac{2.01588g H_2}{1mol H_2} = 0.75g H_2$$

132. How many grams of ammonium sulfate can be produced if 30.0 mol of H_2SO_4 are reacted with excess NH_3 according to the following equation: $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$

$$\frac{30.0mol H_2SO_4}{1mol H_2SO_4} \times \frac{132.13452g (NH_4)_2SO_4}{1mol (NH_4)_2SO_4} = 3960g (NH_4)_2SO_4$$

133. Describe the following:

- a. Limiting reactant

reactant that gets used up during a reaction
determines how much product can be made

- b. Excess reactant *reactant that has some leftover when the reaction is complete*
- c. Theoretical Yield *calculated amount of product; what should be produced*
- d. Percent Yield *efficiency of a reaction* $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100$

134. For the reaction $\text{NaCl} + \text{AgNO}_3 \rightarrow \text{NaNO}_3 + \text{AgCl}$, if 10.0 grams of both sodium chloride and silver nitrate react:

a. Identify the limiting and excess reactants.

$\frac{10.0 \text{ g NaCl}}{58.44 \text{ g/mol NaCl}} = 0.171 \text{ mol NaCl}$ $\frac{10.0 \text{ g AgNO}_3}{169.87 \text{ g/mol AgNO}_3} = 0.059 \text{ mol AgNO}_3$

$0.059 \text{ mol AgNO}_3 \times 169.87 \text{ g/mol AgNO}_3 = 9.99 \text{ g AgNO}_3$ $0.171 \text{ mol NaCl} \times 58.44 \text{ g/mol NaCl} = 10.0 \text{ g NaCl}$

$169.87 \text{ g AgNO}_3 = 29.1 \text{ g AgNO}_3$ $58.44 \text{ g NaCl} = 3.44 \text{ g NaCl}$

LR = AgNO_3
ER = NaCl

b. How many grams of silver chloride are produced?

$\frac{10.0 \text{ g AgNO}_3}{169.87 \text{ g/mol AgNO}_3} \times 143.32 \text{ g/mol AgCl} = 8.44 \text{ g AgCl}$

135. When you determine actual yield you do a(n) (Experiment/Calculation)? When you determine theoretical yield you do a(n) (Experiment/Calculation)?

136. Which is generally greater, the actual yield or the theoretical yield?

theoretical yield

137. In the production of lead (II) chloride 24.6 grams were produced. It was calculated that the theoretical yield of the reaction was 28.9 g. Calculate the percent yield.

$\frac{24.6 \text{ g}}{28.9 \text{ g}} \times 100 = 85.1\%$

138. What is the percent yield if 9.05 g of zinc react with excess hydrochloric acid to produce 0.259 g hydrogen gas according to the following equation: $2 \text{HCl} (\text{aq}) + \text{Zn} (\text{s}) \rightarrow \text{ZnCl}_2 (\text{aq}) + \text{H}_2 (\text{g})$

$\frac{9.05 \text{ g Zn}}{65.39 \text{ g/mol Zn}} \times 2.01588 \text{ g/mol H}_2 = 0.279 \text{ g H}_2$

$\frac{0.259 \text{ g}}{0.279 \text{ g}} \times 100 = 92.8\%$

139. For the reaction $\text{NaCl} (\text{aq}) + \text{AgNO}_3 (\text{aq}) \rightarrow \text{NaNO}_3 (\text{aq}) + \text{AgCl} (\text{s})$ If 10.0 grams of both sodium chloride and silver nitrate react, identify the limiting and excess reactants. How many grams of silver chloride are theoretically produced? If 8.06 grams of precipitate were collected in the lab after filtration and proper drying time, what is the percent yield?

See work in #134 for LR + ER + how much AgCl is produced

$\frac{8.06 \text{ g}}{8.44 \text{ g}} \times 100 = 95.5\%$

140. In a chemical reaction the total mass of the reactants must equal the total mass of the products.

141. In an experiment a student heated 5.00 grams of a compound and recorded the mass of the product to be 3.88 grams. Describe what happened in this reaction and how it appears that mass was lost.

a gas was produced that was released causing the supposed decrease in mass.

I. Multiple Choice Practice Questions for the Semester Test

1. The density of silver is 10.5 g/cm³. A piece of silver that occupies a volume of 23.6 cm³ would have a mass of ___ g.

- a. 248 $D = \frac{m}{V}$ $10.5 = \frac{x}{23.6}$ c. 2.25
b. 0.445 d. 112

$x = 247.8$

2. In which of the following numbers are all the zeros significant?
- a. 100.090090
 b. 0.143290
 c. 0.05843
 d. 1000
3. The correct formula of Iron (III) bromide is ____.
- a. FeBr₂
 b. FeBr₃
 c. FeBr
 d. Fe₃Br
4. The formula for ammonium carbonate is ____.
- a. (NH₄)₂CO₃
 b. NH₄CO₂
 c. (NH₃)₄CO₄
 d. (NH₃)₂CO₃
5. Chromium and chlorine form an ionic compound whose formula is CrCl₃. The name of this compound is ____.
- a. chromium chlorine
 b. chromium (III) chloride
 c. monochromium trichloride
 d. chromium (III) trichloride
6. The formula for aluminum hydroxide is ____.
- a. AlOH
 b. Al₃OH
 c. Al₂(OH)₃
 d. Al(OH)₃
7. The name of the ionic compound (NH₄)₃PO₄ is ____.
- a. ammonium phosphate
 b. nitrogen hydrogen phosphate
 c. tetrammonium phosphate
 d. ammonium phosphide
8. Which formula/name pair is incorrect?
- a. Mn(NO₂)₂ - manganese (II) nitrite
 b. Mg(NO₃)₂ - magnesium nitrate
 c. Mn(NO₃)₂ - manganese (II) nitrate
 d. Mg₃N₂ - magnesium nitrite
9. Which formula/name pair is incorrect?
- a. FeSO₄ - iron (II) sulfate
 b. Fe₂(SO₃)₃ - iron (III) sulfite
 c. FeS - Iron (II) sulfide
 d. Fe₂(SO₄)₃ - iron (III) sulfide
10. The suffix -ide is used ____.
- a. for monoatomic anion names
 b. for polyatomic cation names
 c. for the name of the first element in a molecular compound
 d. for monoatomic cations
11. The formula for the compound formed between aluminum ions and phosphate ions is ____.
- a. Al₃(PO₄)₃
 b. AlPO₄
 c. Al(PO₄)₃
 d. AlP
12. Which metal doesn't require having its charge specified in the name of an ionic compound it forms?
- a. Mn
 b. Fe
 c. Cu
 d. Ca *not a transition metal*
13. The nucleus of an atom contains ____.
- a. electrons
 b. protons, electrons, neutrons
 c. protons and neutrons
 d. protons and electrons
14. The element ____ is the most similar to strontium in chemical and physical properties.
- a. Li
 b. Rb
 c. Ba *both are in the same group*
 d. Cs *alkaline earth metals*
15. Horizontal rows of the periodic table are known as ____.
- a. periods
 b. groups
 c. metalloids
 d. families
16. Vertical columns of the periodic table are known as ____.
- a. metals
 b. periods
 c. groups
 d. octaves
17. Elements in group 1 are known as ____.
- a. chalcogens
 b. alkali metals
 c. alkaline earth metals
 d. halogens

18. Potassium is a ___ and chlorine is a ____.
- a. metal, nonmetal
b. metal, metalloid
c. nonmetal, metal
d. nonmetal, metalloid
19. ___ are found uncombined, as monatomic species in nature.
- a. noble gases
b. alkali metals
c. halogens
d. transition metals
20. When a metal and a nonmetal react, the ___ tends to lose electrons to form a(n) ____.
- a. metal, cation
b. nonmetal, cation
c. metal, anion
d. nonmetal, anion
21. When a metal and a nonmetal react, the ___ tends to gain electrons to form a(n) ____.
- a. metal, cation
b. nonmetal, cation
c. metal, anion
d. nonmetal, anion
22. The empirical formula of a compound with molecules containing 14 carbon atoms, 16 hydrogen atoms and 8 oxygen atoms is ____.
- Simplest formula*
a. $C_{14}H_{16}O_8$
b. $C_7H_8O_4$
c. CHO
d. $C_{3.5}H_4O_2$
- $C_{14}H_{16}O_8$ divide by 2
 $C_7H_8O_4$*
23. What is the formula of the compound formed between strontium ions and nitrogen ions?
- a. SrN
b. Sr_3N_2
c. Sr_3N_4
d. SrN₂
- $Sr^{2+} N^{3-}$*
24. The formula of a salt is XCl_2 . The X-ion in this salt has 28 electrons. The metal X is ____.
- a. Ni
b. Fe
c. Zn
d. Pd
- X^{2+} lost $2e^-$ so the original metal had $30e^-$ making it Zn*
25. The charge on the manganese in the salt MnF_3 is ____.
- a. +1
b. -2
c. -1
d. +3
- F⁻ by you have 3, so total is 3⁻
by you have 1 Mn, so # has to be 3⁺*
26. Aluminum reacts with a certain nonmetallic element to form a compound with the general form AlX . Element X is a natural diatomic gas at room temperature. Element X must be ____.
- a. oxygen
b. fluorine
c. sulfur
d. nitrogen
- $Al^{3+} X^{3-}$
N has 3⁻*
27. All atoms of a given element have the same ____.
- a. mass
b. number of protons
c. number of neutrons
d. number of electrons and neutrons
28. Vanadium has two naturally occurring isotopes, ^{50}V and ^{51}V . The percent abundance of ^{50}V is ___ and of ^{51}V is ____.
- a. 6.00%, 94.00%
b. 49.00%, 51.00%
c. 99.00%, 1.00%
d. 25.00%, 75.00%
- $V = 50.9415$ (on PT)
 $50.9415 = 50(x) + 51(1-x)$
 $50.9415 = 50x + 51 - 51x$
 $-0.0585 = -1x$
 $x = 0.0585$*
29. An unknown element is found to have three naturally occurring isotopes with atomic masses of 35.9675 (0.337%), 37.9627 (0.063%) and 39.9624 (99.600%). Which of the following is the known element?
- a. Ar
b. Cl
c. K
d. Ca
- most abundant
 $35.9675(0.00337) + 37.9627(0.00063) + 39.9624(0.99600) = 39.9417$*
30. Of the following, only ___ is not a metalloid.
- a. B
b. Si
c. Al
d. Ge
31. Of the choices below, which one is not an ionic compound?
- a. PCl_5 - 2 nonmetals
b. RbCl
c. $MoCl_6$
d. $PbCl_2$
- metal + nonmetal*
32. Which metal does not form cations of differing charges?
- a. Na
b. Co
c. Cu
d. Fe
- Group 1 alkali metals*
33. Compared to the charge and mass of a proton, an electron has
- a. the same charge and a smaller mass
b. the same charge and the same mass
c. an opposite charge and a smaller mass
d. an opposite charge and the same mass

34. When alpha particles are used to bombard gold foil, most of the alpha particles pass through undeflected. This result indicates that most of the volume of a gold atom consists of

a. deuterons
 b. neutrons
 c. protons
 d. unoccupied space

35. Which symbols represent atoms that are isotopes?

a. C-14 and N-14
 b. O-16 and O-18

Same element but different # of neutrons which means mass # is different

c. I-131 and I-131
 d. Rn-222 and Ra-222

36. Atoms of elements in a group on the Periodic Table have similar chemical properties. This similarity is most closely related to the atoms'

a. number of principal energy levels
 b. number of valence electrons
 c. atomic numbers
 d. atomic masses

37. What is the molar mass of K_2CO_3 ?

a. 138 g/mol
 b. 106 g/mol

$$2(39.0983) + 12.011 + 3(15.9994) =$$

c. 99 g/mol
 d. 67 g/mol

38. What is the total number of atoms contained in 2.00 moles of nickel?

a. 58.9
 b. 118

$$2.00 \text{ mol Ni} \times 6.02 \times 10^{23} \text{ atoms/mol} =$$

c. 6.02×10^{23}
 d. 1.2×10^{24}

39. What is the percent by mass of oxygen in magnesium oxide, MgO?

a. 20%
 b. 40%

$$\%O = \frac{15.9994}{24.305 + 15.9994} \times 100 = 39.7\%$$

c. 50%
 d. 60%

40. What is the mass in grams of 3.0×10^{23} molecules of CO_2 ?

a. 22 g
 b. 44 g

$$3.0 \times 10^{23} \text{ molecules } CO_2 \times \frac{1 \text{ mol } CO_2}{6.02 \times 10^{23} \text{ molecules } CO_2} =$$

$$44.0099 \text{ g } CO_2 = 21.9 \text{ g } CO_2$$

c. 66 g
 d. 88 g

41. Which pair of atoms constitutes a pair of isotopes for the same element?

a. ${}^{14}_6X$ ${}^{14}_7X$
 b. ${}^{17}_9X$ ${}^{17}_8X$

needs the same atomic # (# of protons)

c. ${}^{20}_{10}X$ ${}^{21}_{11}X$
 d. ${}^{14}_6X$ ${}^{12}_6X$

42. The mass number of an atom is equal to:

a. protons + electrons
 b. electrons + neutrons

c. protons + neutrons
 d. protons + neutrons + electrons

43. What term is used to describe the splitting of two nuclei?

a. fusion
 b. fission

c. ionization
 d. deionization

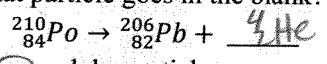
44. Which of the following puts elements in the correct order of increasing atomic radius?

a. Cl, Bi, P
 b. Sr, Mg, Al

small to big
 inc ↓

c. Si, F, Cl
 d. B, Li, K

45. What particle goes in the blank?



a. alpha particle
 b. beta particle

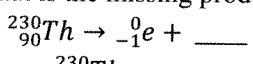
c. gamma ray
 d. beta emission

46. This type of radiation is released when Rn - 224 to Po - 220.

a. alpha particle
 b. beta particle

c. gamma ray
 d. beta emission

47. What is the missing product of the following?



a. ${}^{230}_{91}Th$
 b. ${}^{230}_{89}Ac$

c. ${}^{231}_{89}Ac$
 d. ${}^{230}_{91}Pa$

