## Chapter 3 Questions

## Section 3.1 \& 3.2

1a) The atomic weight of zirconium is reported as 91.22 , however no atom has a mass of 91.22 amu . Explain. b) The element magnesium consists of three naturally occurring isotopes with masses of 23.98504, 24.98584 and 25.98259 amu . The abundance of each of these isotopes are $78.70 \%, 10.13 \%$ and $11.17 \%$ respectively. From this data, calculate the average atomic mass of magnesium.

2) To the right is a mass spectra for boron. Explain what each line means in terms of isotope mass and abundance. Also explain why there are only two lines.
3) To the right is a mass spectra taken for an unknown element. Determine the average atomic mass of the element and determine the identity of the element using the periodic table.

## Sections 3.3 \& 3.4

4) Determine the formula weights of each of the following compounds:
a) $\mathrm{N}_{2} \mathrm{O}_{5}$
b) $\mathrm{FeCO}_{3}$
c) $\left(\mathrm{NH}_{4}\right)_{3} \mathrm{PO}_{4}$
d) disilicon hexabromide
e) sodium nitrate
f) dichromic acid
g) $\mathrm{Ca}\left(\mathrm{C}_{2} \mathrm{H}_{3} \mathrm{O}_{2}\right)_{2}$
h) magnesium hydroxide
i) copper (II) sulfate
j) molybdenum (III) sulfite
5) Calculate the percentage by mass of oxygen in the following compounds
a) dinitrogen tetraoxide
b) $\mathrm{CH}_{3} \mathrm{COOCH}_{3}$
c) chromium (III) nitrate
d) ammonium carbonate

6a) What is the relationship between the formula weight of a substance and its molar mass?
b) What is the mass, in grams, of a mole of ${ }^{12} \mathrm{C}$ ?
c) How many atoms are present in a mole of ${ }^{12} \mathrm{C}$ ?
d) What is the mass, in grams, of a single ${ }^{12} \mathrm{C}$ ?
7) If Avogadro's number of pennies is divided equally among the 319 million people in the United States, how many dollars would each receive?
8) The molecular formula of allicin, the compound responsible for the characteristic smell of garlic, is $\mathrm{C}_{6} \mathrm{H}_{10} \mathrm{OS}_{2}$.
a) What is the molar mass of allicin?
b) How many moles of a1licin are present in 5.00 mg of this substance?
c) How many molecules of allicin are in 5.00 mg of this substance?
d) How many S atoms are present in 5.00 mg of allicin?
9) If you had $6.02 \times 10^{23}$ molecules ( 1 mole ) of potassium chromate, how many
a) atoms of each element would be present?
b) grams of each element would be present?
c) total grams of compound would be present?
*10) A sample of glucose, $\mathrm{C}_{6} \mathrm{H}_{12} \mathrm{O}_{6}$ contains $2.03 \times 10^{21}$ atoms of carbon
a) How many atoms of hydrogen does it contain?
b) How many molecules of glucose does it contain?
c) How many moles of glucose does it contain?
d) What is the mass of this sample in grams?

## Section 3.6 \& 3.7

11) Give the empirical formula of each of the following compounds if a sample contains
a) $0.0130 \mathrm{~mol} \mathrm{C}, 0.0390 \mathrm{~mol} \mathrm{H}$, and 0.0065 mol O
b) 11.66 g iron and 5.01 g oxygen
c) 40.0 percent $\mathrm{C}, 6.7$ percent H , and 53.3 percent 0 by mass
d) 10.4 percent $\mathrm{C}, 27.8$ percent S , and 61.7 percent Cl
e) 21.7 percent C, 9.6 percent 0 , and 68.7
percent $F$
f) 62.1 percent $C, 5.21$ percent $H, 12.1$ percent
$N$, and 20.7 percent $O$

## Sections 3.8 \& 3.9

13) Rewrite and balance the following equations, and indicate whether they are combustion, combination, or decomposition reactions:
a) $\mathrm{CO}(\mathrm{g})+\mathrm{O}_{2}(\mathrm{~g})-->\mathrm{CO}_{2}(\mathrm{~g})$
b) $\mathrm{N}_{2} \mathrm{O}_{5}(\mathrm{~g})+\mathrm{H}_{2} \mathrm{O}(\mathrm{l})-->\mathrm{HNO}_{3}(\mathrm{aq})$
c) $\mathrm{C}_{3} \mathrm{H}_{6}(\mathrm{~g})+\mathrm{O}_{2}(\mathrm{~g})-->\mathrm{CO}_{2}(\mathrm{~g})+\mathrm{H}_{2} \mathrm{O}(\mathrm{l})$
d) $\mathrm{C}_{7} \mathrm{H}_{8} \mathrm{O}_{2}(\mathrm{l})+\mathrm{O}_{2}(\mathrm{~g})-->\mathrm{CO}_{2}(\mathrm{~g})+\mathrm{H}_{2} \mathrm{O}$ (l)
e) $\mathrm{Li}(\mathrm{s})+\mathrm{N}_{2}(\mathrm{~g})-->\mathrm{Li}_{3} \mathrm{~N}(\mathrm{~s})$
f) $\mathrm{PbCO}_{3}(\mathrm{~s})-->\mathrm{PbO}(\mathrm{s})+\mathrm{CO}_{2}(\mathrm{~g})$
g) $\mathrm{AI}(\mathrm{s})+\mathrm{Cl}_{2}(\mathrm{~g})-->\mathrm{AlCl}_{3}(\mathrm{~s})$
h) $\mathrm{KNO}_{3}(\mathrm{~s})-->\mathrm{KNO}_{2}(\mathrm{~s})+\mathrm{O}_{2}(\mathrm{~g})$
i) $\mathrm{La}_{2} \mathrm{O}_{3}$ (s) $+\mathrm{H}_{2} \mathrm{O}$ (l) --> $\mathrm{La}(\mathrm{OH})_{3}(\mathrm{aq})$
j) $\mathrm{CH}_{3} \mathrm{NH}_{2}(\mathrm{~g})+\mathrm{O}_{2}(\mathrm{~g})-->\mathrm{CO}_{2}(\mathrm{~g})+\mathrm{H}_{2} \mathrm{O}(\mathrm{g})+\mathrm{N}_{2}$
(g)
k) $\mathrm{C}_{2} \mathrm{H}_{4}(\mathrm{~g})+\mathrm{O}_{2}(\mathrm{~g})-->\mathrm{CO}_{2}(\mathrm{~g})+\mathrm{H}_{2} \mathrm{O}(\mathrm{l})$
l) $\mathrm{C}_{5} \mathrm{H}_{10} \mathrm{O}_{2}(\mathrm{l})+\mathrm{O}_{2}(\mathrm{~g})-->\mathrm{CO}_{2}(\mathrm{~g})+\mathrm{H}_{2} \mathrm{O}$ (l)
m) $\mathrm{NH}_{4} \mathrm{NO}_{3}$ (s) --> $\mathrm{N}_{2} \mathrm{O}(\mathrm{g})+\mathrm{H}_{2} \mathrm{O}$ (l)
n) $\mathrm{K}_{2} \mathrm{O}$ (s) $+\mathrm{H}_{2} \mathrm{O}$ (l) --> $\mathrm{KOH}(\mathrm{aq})$
14) What is the molecular formula of each of the following compounds?
a) empirical formula $\mathrm{CH}_{2}$, molar mass $=84$
$\mathrm{g} / \mathrm{mo}$ ]
b) empirical formula $\mathrm{NH}_{2} \mathrm{Cl}$, molar mass $=51.5$

## $\mathrm{g} / \mathrm{mol}$

c) empirical formula $\mathrm{HCO}_{2}$, molar mass $=90.0$
$\mathrm{g} / \mathrm{mol}$
d) empirical formula $\mathrm{C}_{2} \mathrm{H}_{4} \mathrm{O}$, molar mass $=88$
$\mathrm{g} / \mathrm{mol}$
14) Write balanced chemical equations to correspond to each of the following descriptions:
a) Solid calcium carbide, $\mathrm{CaC}_{2}$ reacts with water to form an aqueous solution of calcium hydroxide and acetylene gas, $\mathrm{C}_{2} \mathrm{H}_{2}$.
b) When solid potassium chlorate is heated, it decomposes to form solid potassium chloride and oxygen gas
c) Solid zinc metal reacts with sulfuric acid to form hydrogen gas and an aqueous solution of zinc sulfate
d) When liquid phosphorus trichloride is added to water, it reacts to form aqueous phosphorus acid and aqueous hydrochloric acid, e) When hydrogen sulfide gas is passed over solid hot iron (III) hydroxide, the resultant reaction produces solid iron (III) sulfide and gaseous water.
15) Write a balanced chemical equation for the reaction that occurs when
a) styrene, $\mathrm{C}_{8} \mathrm{H}_{8}$ (1), burns in air
b) $\mathrm{CH}_{3} \mathrm{OC}_{2} \mathrm{H}_{5}$ (l) is combusted in air
c) lithium metal is reacted with bromine gas
d) $\mathrm{GaCl}_{3}(\mathrm{~s})$ is decomposed upon heating
e) $R b$ (s) reacts with solid sulfur
f) the hydrocarbon heptane, $\mathrm{C}_{7} \mathrm{H}_{16}$ (l) is combusted in air

## Sections 3.10 \& 3.11

16) Hydrofluoric acid, HF (aq), cannot be stored in glass bottles because compounds called silicates in the glass are attacked by the $\mathrm{HF}(\mathrm{aq})$. For example, sodium silicate, $\mathrm{Na}_{2} \mathrm{SiO}_{3}$ reacts in the following way:
$\mathrm{Na}_{2} \mathrm{SiO}_{3}(\mathrm{~s})+8 \mathrm{HF}(\mathrm{aq})-->\mathrm{H}_{2} \mathrm{SiF}_{6}(\mathrm{aq})+2 \mathrm{NaF}$ (aq) $+3 \mathrm{H}_{2} \mathrm{O}$ (l)
a) How many moles of HF are required to dissolve 0.50 mol of $\mathrm{Na}_{2} \mathrm{SiO}_{3}$ ?
b) How many grams of NaF form when 0.300 mol of HF reacts in this way?
c) How many grams of $\mathrm{Na}_{2} \mathrm{SiO}_{3}$ can be dissolved by 0.300 g of HF?
17) Aluminum sulfide reacts with water to form aluminum hydroxide and hydrogen sulfide.
a) Write the balanced chemical equation for this reaction.
b) How many grams of aluminum hydroxide are obtained from 10.5 g of aluminum sulfide?
18) The complete combustion of octane, $\mathrm{C}_{8} \mathrm{H}_{18}$ (1), a component of gasoline, proceeds as follows:
$2 \mathrm{C}_{8} \mathrm{H}_{18}(\mathrm{l})+25 \mathrm{O}_{2}(\mathrm{~g})-->16 \mathrm{C} \mathrm{O}_{2}(\mathrm{~g})+18 \mathrm{H}_{2} \mathrm{O}$ (1)
a) How many moles of $\mathrm{O}_{2}$ are needed to burn 1.50 mol of $\mathrm{C}_{8} \mathrm{H}_{18}$ ?
b) How many grams of $\mathrm{O}_{2}$ are needed to burn 1.50 g of $\mathrm{C}_{8} \mathrm{H}_{18}$ ?
*c) Octane has a density of $0.692 \mathrm{~g} / \mathrm{mL}$ at 20
${ }^{\circ}$ C. How many grams of $\mathrm{O}_{2}$ are required to burn 1.00 gal of $\mathrm{C}_{8} \mathrm{H}_{18}$ ?
19) A manufacturer of bicycles has 5050 wheels, 3013 frames, and 2455 handlebars. a) How many bicycles can be manufactured using these parts?
b) How many parts of each kind are left over?
c) Which part is like a limiting reactant in that it limits the production of bicycles?
20) The fizz produced when an Alka-Seltzer tablet is dissolved in water is due to the reaction between sodium bicarbonate, $\mathrm{NaHCO}_{3}$, and citric acid, $\mathrm{H}_{3} \mathrm{C}_{6} \mathrm{H}_{5} \mathrm{O}_{7}$ : $3 \mathrm{NaHCO}_{3}(\mathrm{aq})+\mathrm{H}_{3} \mathrm{C}_{6} \mathrm{H}_{5} \mathrm{O}_{7}(\mathrm{aq})-->3 \mathrm{CO}_{2}(\mathrm{~g})+$ $3 \mathrm{H}_{2} \mathrm{O}$ (1) $+\mathrm{Na}_{3} \mathrm{C}_{6} \mathrm{H}_{5} \mathrm{O}_{7}$ (aq)
In a certain experiment 1.00 g of sodium bicarbonate and 1.00 g of citric acid are allowed to react.
a) Which reactant is the limiting reactant?
b) How many grams of carbon dioxide form?
*c) How much of the excess reactant remains after the limiting reactant is completely consumed?
*21) Solutions of sodium carbonate and silver nitrate react to form solid silver carbonate and a solution of sodium nitrate. A solution containing 5.00 g of sodium carbonate is mixed with one containing 5.00 g of silver nitrate. After the reaction is complete, the solutions are evaporated to dryness, leaving a mixture of salts. How many grams of sodium carbonate, silver nitrate, silver carbonate and sodium nitrate are present after the reaction is complete?
