

Chapter 3

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Section 3.3 – Average Atomic Mass

1. Find the average atomic mass.

Isotope	Relative Mass	Percent Abundance
^{20}Ne	19.992 u	90.92
^{21}Ne	20.994 u	2.57
^{22}Ne	21.991 u	8.82

2. Two isotopes of chlorine exist in nature. 75.77% of chlorine is ^{35}Cl with a mass of 34.96885 amu. What is the mass of the other isotope of chlorine?

Section 3.4 – Mole Conversions

THE MOLE MAP!!!!!!

Notes - Introduction to Moles: One and Two Step Mole Calculations

Formula mass - (also called gram formula mass, molecular mass, gram molecular mass, formula weight, gram formula weight, molecular weight, gram molecular weight, molar mass, and molar weight): the mass of one mole of a compound, atom or ion.

Find the formula mass of each of the following:

sodium chloride

arsenic trichloride

potassium sulfate

ammonium phosphate

Measuring Matter: There are three ways to measure matter: by counting representative particles (typically molecules or formula units), by mass (in grams), or by volume (in liters for gases). The method used is usually chosen by the ease of each method and the information needed. Once a measurement has been made, it is possible to convert between the units for the other methods.

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1 mole of a compound fm (in g) compound
1 mole of an element 6.02×10^{23} atoms of that element
1 mole of a compound 6.02×10^{23} representative particles (molecules or formula units)

The mole is the link between grams, the number of representative particles and liters. For neutral compounds, the representative particle is either the molecule (covalent) or the formula unit (ionic). However, to simplify matters we will just use the term particle for both.

One Step Conversions

Remember to show all work using dimensional analysis and to keep significant figures in mind.

1. How many moles are in 18.0 grams of sugar ($C_6H_{12}O_6$)?
2. What is the weight of 4.50 moles of barium sulfide?
3. How many molecules are in 28.6 mole of nitrogen gas?
4. How many moles are in 3.90×10^{23} molecules of methane (CH_4)?
5. How many atoms of oxygen are in 2.5 moles of oxygen gas?

Two and three step conversions: You are now familiar with conversions between grams, moles, and molecules. We can combine these in to two-step or even three-step problems to find more information such as the number of atoms of an individual element in a compound.

Two-Step and Three-Step Problems

1. How many molecules are in 198.5 grams of sodium chloride?
2. How many molecules are in 937 g of calcium acetate?
3. How many grams are in 3.21×10^{24} molecules of potassium hydroxide?

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- How many atoms of aluminum are in 2.00 moles of aluminum fluoride?
- How many atoms of chlorine are in 654.5 grams of calcium chloride?
- How many moles of carbon are in 1.00×10^{20} molecules of propane, C_3H_8 ?
- How many grams of magnesium are in 5.55×10^{26} molecules of magnesium sulfide?
- How many grams of strontium are in 9.76×10^{28} molecules of silicon dioxide?

9. Complete the following table:

Formula	Molar mass (g/mol) <i>M</i>	Mass of sample (g) <i>m</i>	Moles of sample (mol) <i>n</i>	Number of particles <i>N</i>
H_2SO_4	98.0	0.825		
Cr_2O_3				9.63×10^{23}
unknown		56.8	0.476	
Mo			62.8	

Do work below:

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Section 3.6 – % Composition

1. Determine the percent composition of each element in $\text{Ni}_3(\text{PO}_4)_2$.

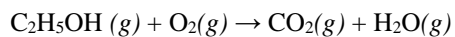
Section 3.7 – Empirical and Molecular Formulas

1. Determine the empirical and molecular formulas for a compound that gives the following percentages on analysis: 71.65% Cl, 24.27% C, 4.07% H. The molar mass is known to be 98.96 g/mol.

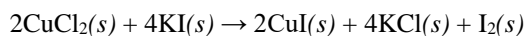
2. Determine the empirical formula for a compound which is 26.6 % potassium, 35.4 % chromium and 38.1 % oxygen. The compound has a molecular weight of 294.2 g/mol. What is the molecular formula?

Section 3.9 – Balancing and Stoichiometry

1. Balance the following equation and draw a particulate diagram of all reactants and products.



2. Determine the amount of iodine produced when 145 g of KI react with excess copper (II) chloride.



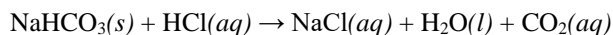
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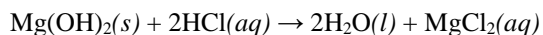
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3. Baking soda (NaHCO_3) is often used as an antacid. It neutralizes excess hydrochloric acid secreted by the stomach:

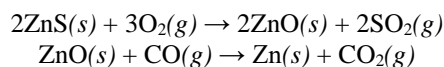


Milk of magnesia, which is an aqueous suspension of magnesium hydroxide, is also used as an antacid:



Which is the more effective antacid per gram, NaHCO_3 or $\text{Mg}(\text{OH})_2$?

4. An industrial method for the production of elemental zinc from its ore is to ‘roast’ the crude ore in oxygen and then react it with CO. The following reactions describe the chemical process,



5. A 10.0 kg sample of an ore containing ZnS was chemically treated according to the reactions described above producing 2.85 kg of Zn. Determine the percentage of ZnS contained in the original sample of the ore.

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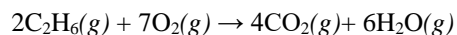
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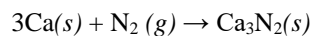
3.11 Limiting Reactant and % yield

1. For the reaction:



determine the moles of C_2O and H_2O formed when 2.00 moles of ethane are reacted with 10.0 moles of oxygen.

2. Calculate the mass of calcium nitride formed when 50.0 g of calcium reacts with 50.0 g of nitrogen according to the reaction.



3. Methanol (CH_3OH), also called methyl alcohol, is the simplest alcohol. It is used as a fuel in race cars and is a potential replacement for gasoline. Methanol can be manufactured by combining gaseous carbon monoxide and hydrogen. Suppose 68.5 kg $\text{CO}(g)$ is reacted with 8.60 kg $\text{H}_2(g)$. Calculate the theoretical yield of methanol. If 3.57×10^4 g CH_3OH is actually produced, what is the percent yield of methanol?

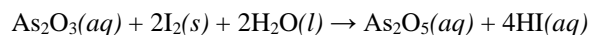
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4. A common laboratory method for determination of arsenic is described in the reaction:



- a. If 2.50 g of As_2O_3 , 4.50 g of I_2 and 4.00 g of H_2O are mixed, and the reaction proceeds to completion, which reactant is the limiting reagent?
- b. Calculate the mass of As_2O_5 which is theoretically possible.
- c. If only 1.80 g of As_2O_5 is actually produced, determine the percent yield in the reaction.
5. A 0.00300 g sample of naphthalene, a compound containing only carbon and hydrogen, was burned in excess oxygen to give 0.0103 g of CO_2 . Determine the empirical formula of naphthalene. The formula weight of naphthalene is 128 u, determine the molecular formula.

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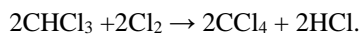
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Extra Practice Problems

1. The reaction of 11.9 g of CHCl_3 with excess chlorine produced 12.6 g of CCl_4 , carbon tetrachloride:



What is the percent yield?

- a. 100% b. 27.4% c. 82.2% d. 113% e. 46.2%
2. When 20.0 g C_2H_6 and 60.0 g O_2 react to form CO_2 and H_2O , how many grams of water are formed?
- a. 14.5 g b. 18.0 g c. 58.0 g d. 20.0 g e. none of these
3. Consider the following reaction: $\text{CH}_4(g) + 4\text{Cl}_2(g) \rightarrow \text{CCl}_4(g) + 4\text{HCl}(g)$
What mass of CCl_4 will be formed if 1.20 moles of methane react with 1.60 moles of chlorine?
- a. 229 g b. 171 g c. 114 g d. 61.5 g e. 17.1 g
4. SO_2 reacts with H_2S as follows: $2\text{H}_2\text{S} + \text{SO}_2 \rightarrow 3\text{S} + 2\text{H}_2\text{O}$
When 7.50 g of H_2S reacts with 12.75 g of SO_2 , which statement applies?
- a. 6.38 g of sulfur are formed.
b. 10.6 g of sulfur are formed.
c. 0.0216 moles of H_2S remain.
d. 1.13 g of H_2S remains.
e. SO_2 is the limiting reagent.

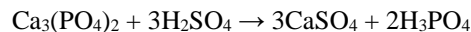
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5. Phosphoric acid can be prepared by reaction of sulfuric acid with "phosphate rock" according to the equation:

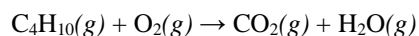


How many oxygen atoms are there in 1.55 ng of $\text{Ca}_3(\text{PO}_4)_2$?

- a. 3.01×10^{12} b. 1.20×10^{13} c. 3.01×10^{18} d. 1.21×10^{16} e. 2.41×10^{13}
6. You take an aspirin tablet (a compound consisting solely of carbon, hydrogen, and oxygen) with a mass of 1.00 g, burn it in air, and collect 2.20 g of carbon dioxide and 0.400 g water. The molar mass of aspirin is between 170 and 190 g/mol. The molecular form of aspirin is _____.

- a. $\text{C}_6\text{H}_8\text{O}_5$ b. $\text{C}_9\text{H}_8\text{O}_4$ c. $\text{C}_8\text{H}_{10}\text{O}_5$ d. $\text{C}_{10}\text{H}_6\text{O}_4$ e. none of these

7. Determine the coefficient for O_2 when the following equation is balanced in standard form (smallest whole number integers)



- a. 4 b. 8 c. 10 d. 13 e. 20
8. Vitamin C contains the elements C, H, and O. It is known to contain 40.9% C and 4.58% H by mass. The molar mass of vitamin C has been found to be about 180. The molecular formula for vitamin C is:

- a. $\text{C}_2\text{H}_3\text{O}_2$ b. $\text{C}_3\text{H}_4\text{O}_3$ c. $\text{C}_4\text{H}_6\text{O}_4$ d. $\text{C}_6\text{H}_8\text{O}_6$ e. none of these

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9. When 125.0 g of ethylene (C_2H_4) burns in oxygen to give carbon dioxide and water, how many grams of CO_2 are formed?

- a. 392.2 g b. 250.0 g c. 57.50 g d. 425.6 g e. 327.0 g

10. A 0.4647 g sample of a compound known to contain only carbon, hydrogen, and oxygen was burned in oxygen to yield 0.8635 g of CO_2 and 0.1767 g of H_2O . What is the empirical formula of the compound?

- a. CHO b. C_2H_2O c. $C_3H_3O_2$ d. $C_6H_3O_2$ e. $C_3H_6O_2$

11. Adipic acid contains 49.32% C, 43.84% O, and 6.85% H by mass. What is the empirical formula?

- a. $C_3H_5O_2$ b. $C_3H_3O_4$ c. C_2HO_3 d. $C_2H_3O_4$ e. C_3HO_3

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12. The characteristic odor of pineapple is due to ethyl butyrate, a compound containing carbon, hydrogen, and oxygen. Combustion of 2.78 g of ethyl butyrate leads to formation of 6.32 g of CO_2 and 2.58 g of H_2O . The properties of the compound suggest that the molar mass should be between 100 and 150. What is the molecular formula? ($\text{C}_6\text{H}_{12}\text{O}_2$)
13. Suppose the reaction $\text{Ca}_3(\text{PO}_4)_2 + 3\text{H}_2\text{SO}_4 \rightarrow 3\text{CaSO}_4 + 2\text{H}_3\text{PO}_4$ is carried out starting with 103 g of $\text{Ca}_3(\text{PO}_4)_2$ and 75.0 g of H_2SO_4 . How much phosphoric acid will be produced?
- a. 74.9 g b. 50.0 g c. 112 g d. 32.5 g e. 97.6 g
14. The hormone epinephrine is released in the human body during stress and increases the body's metabolic rate. Epinephrine, like many biochemical compounds, is composed of carbon, hydrogen, oxygen, and nitrogen. The percentage composition of the hormone is 56.8% C, 6.56% H, 28.4% O, and 8.28% N. Determine the empirical formula. ($\text{C}_8\text{H}_{11}\text{O}_3\text{N}$)