

## Chemistry 105, Chapter 3 Exercises

### Isotopes

1. Strontium has four isotopes with the following masses: 83.9134 amu (0.56%), 85.9094 amu (9.86%), 86.9089 amu (7.00%), and 87.9056 amu (82.58%). Calculate the atomic mass of strontium. Ans. 87.62 amu
2. Oxygen consists of three isotopes with atomic masses 16.00, 17.00, and 18.00 amu. Their abundances are 99.76%, 0.04%, and 0.20%, respectively. What is the atomic mass of oxygen? Ans. 16.00 amu
3. Naturally occurring europium (Eu) consists of two isotopes. One of the isotopes has a mass of 150.960 amu and 48.03% abundance. What is the atomic mass of the other isotope? Ans. 152.9 amu
4. Naturally occurring boron has only two isotopes. B-10 has an atomic mass of 10.0129 amu and an abundance of 19.9%. What is the atomic mass of the second isotope, B-11? Ans. 11.0 amu
5. Oxygen (atomic mass = 15.9994 amu) has three isotopes with masses 15.9949 amu, 16.9993 amu, and 17.9992 amu the abundance of the last isotope is 0.204%. Estimate the abundance of the other two isotopes. Ans. 99.76% O-16, 0.04% O-17

### Mole, Molar Mass, Counting by Weighing, etc.

6. Calculate the mass of  $3.0 \times 10^{12}$  (3 trillion) nickel atoms. Ans.  $2.9 \times 10^{-10}$  g
7. Calculate the mass of 1 tungsten (W) atom. Ans.  $3.05 \times 10^{-22}$  g
8. Calculate the number of atoms in 0.57 g of nickel. Ans.  $5.8 \times 10^{21}$  atoms
9. Calculate the number of atoms in  $10^{-12}$  g (1 picogram) of tungsten (W). Ans.  $3.27 \times 10^9$  atoms
10. Calculate the mass of 0.357 mole of gold. Ans. 70.3 g
11. Calculate the number of moles in 10.0 g of silicon. Ans. 0.356 mole
12. Calculate the molar mass of the following:
  - a. gallium, Ga Ans. 69.72 g
  - b. benzoyl peroxide,  $C_{14}H_{10}O_4$  Ans. 242.2 g
  - c.  $Ca_3(PO_4)_2$  Ans. 310.2g
13. Convert 35.00 g of  $CF_2Cl_2$  to moles. Ans. 0.2895 mole
14. Convert 13.00 g of caffeine,  $C_8H_{10}N_4O_2$  to moles. Ans. 0.134 mole
15. Convert 12.5 g of  $SnF_2$  to number of molecules. Ans.  $4.80 \times 10^{22}$  molecules
16. Convert 6.0 g of urea,  $CH_4N_2O$ , to number of molecules. Ans.  $6.0 \times 10^{22}$  molecules
17. Calculate the mass of 17.5 mole of  $N_2$ . Ans. 490. g
18. Calculate the mass of 20.0 mole of  $NH_3$ . Ans. 340. g
19. Calculate the mass of one sucrose molecule,  $C_{12}H_{22}O_{11}$  (molar mass 342. g). Ans.  $5.68 \times 10^{-22}$  g
20. Calculate the number of oxygen atoms in 0.1364 g of citric acid,  $C_6H_8O_7$  (molar mass 192. g).  
Ans.  $2.99 \times 10^{21}$  oxygen atoms
21. Calculate the number of N atoms in 127.2 g of TNT,  $C_7H_5(NO_2)_3$  (molar mass 227. g). Ans.  $1.01 \times 10^{24}$  N atoms
22. Calculate the mass percent of each element in  $Al_2(OH)_5Cl$  (molecular mass 175. amu), the active ingredient in some antiperspirants. Ans. 30.9% Al, 2.9% H, 45.7% O, 20.3% Cl

23. Calculate the mass percent of each element in  $\text{CF}_2\text{Cl}_2$  (molecular mass 121. amu). Ans. 9.9% C, 31.4% O, 58.65% Cl
24. How many grams of Pt are present in 25.0 g of Cisplatin,  $\text{Pt}(\text{NH}_3)_2\text{Cl}_2$  (molar mass 300. g), an antitumor agent. Ans. 16.3 g Pt
25. How many grams of C are in 0.251 g of acetaminophen,  $\text{C}_8\text{H}_9\text{NO}_2$  (molar mass 151. g). Ans. 0.160 g C

### Empirical and Molecular Formulas

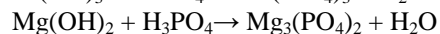
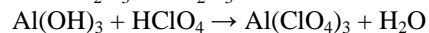
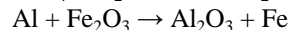
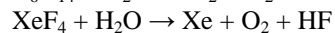
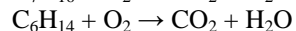
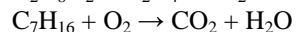
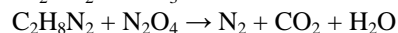
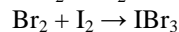
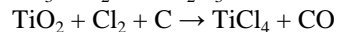
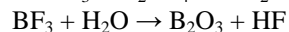
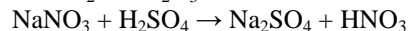
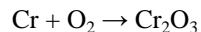
26. Assume that 1.587 g of As reacts with 3.755 g of chlorine. What's the empirical formula for the compound?  
Ans.  $\text{AsCl}_5$
27. Assume that 7.35 g of Cr reacts with oxygen to form 10.74 g of metal oxide. What's the empirical formula for the compound? Ans.  $\text{Cr}_2\text{O}_3$
28. Saccharin has the composition 45.90% C, 2.75% H, 26.20% O, 17.50% S and 7.65% N. What's the empirical formula?  
Ans.  $\text{C}_7\text{H}_5\text{O}_3\text{SN}$
29. Allicin, the compound that give garlic its odor has the composition 6.21% H, 44.4% C, 9.86% O, and 39.51% S. What's the empirical formula? Ans.  $\text{C}_6\text{H}_{10}\text{S}_2\text{O}$
30. Ibuprofen is made of carbon, hydrogen, and oxygen atoms. When a 5.000 g sample is burned in oxygen 13.86 g of  $\text{CO}_2$  and 3.926 g of water are obtained. What's the empirical formula? Ans.  $\text{C}_{13}\text{H}_{18}\text{O}_2$
31. Sevin, a plant insecticide, is made of C, H, N, and O atoms. A 10.94 g sample of sevin burned in oxygen gives 28.73 g of  $\text{CO}_2$  and 5.386 g of  $\text{H}_2\text{O}$ . Another experiment determines that the insecticide contains 6.963% nitrogen by mass. What's the empirical formula? Ans.  $\text{C}_{12}\text{H}_{11}\text{NO}_2$
32. Dimethylhydrazine, the fuel used in the Apollo lunar descent modules, is made of carbon, hydrogen, and nitrogen atoms. The combustion of 2.859 g of the material in oxygen gives 4.190 g of  $\text{CO}_2$  and 3.428 g  $\text{H}_2\text{O}$ . What is the empirical formula? If the molar mass is 60.10 g, what is the molecular formula?  
Ans.  $\text{CH}_4\text{N}$   $\text{C}_2\text{H}_8\text{N}_2$

### Hydrates

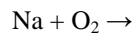
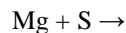
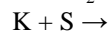
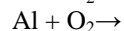
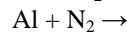
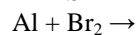
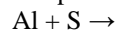
33. A certain hydrate of potassium aluminum sulfate (alum) has the formula  $\text{KAl}(\text{SO}_4)_2 \cdot x\text{H}_2\text{O}$ . When a hydrate sample weighing 5.459 g is heated to remove all the water, 2.583 g of  $\text{KAl}(\text{SO}_4)_2$  remains. What is the mass percent of water in the hydrate? What is x? Ans. 52.68%,  $x = 16$
34. Epsom salts are hydrates of magnesium sulfate. The formula for Epsom salts is  $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ . A 7.834 g sample is heated until all the water has evaporated off. What is the mass of anhydrous magnesium sulfate? What percentage of the hydrate is water? Ans. 51.1%, 3.83 g

### Balancing Chemical Equations

35. Balance the following equations. Answers are at the end of the exercise sheet.

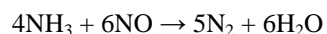


36. Complete and balance the following equations. To complete these equations you must determine the formula for the compound that forms when the metal and nonmetal react. Answers are at the end of the exercise sheet.



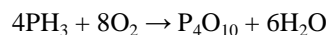
### Stoichiometry

37. One way to remove NO gas from smoke stack emissions is to react it with ammonia,  $\text{NH}_3$ .



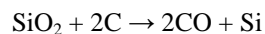
- How many grams of NO will react with 20.0 g of  $\text{NH}_3$ ? Ans. 52.9 g
- How many grams of water are produced when 20.0 g of  $\text{NH}_3$  react? Ans. 31.8 g
- How many moles of  $\text{N}_2$  are produced when 20.0 g of  $\text{NH}_3$  react? Ans. 1.47 moles
- How many grams of  $\text{NH}_3$  are needed to produce 60.0 g of  $\text{H}_2\text{O}$ ? Ans. 37.8 g

38. Consider the following reaction.



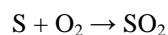
- How many grams of  $\text{PH}_3$  are required to react with 100. g of  $\text{O}_2$ ? Ans. 53.1 g
- How many grams of  $\text{P}_4\text{O}_{10}$  are produced when 100. g of  $\text{O}_2$  react? Ans. 111. g
- How many moles of water are produced when 100. g of  $\text{O}_2$  react? Ans. 2.34 moles
- How many moles of  $\text{PH}_3$  are required to produce 50.0 g of  $\text{P}_4\text{O}_{10}$ ? Ans. 0.704 mole

39. The following equation represents the reaction used to obtain Si from sand. Sand consists mostly of  $\text{SiO}_2$ .



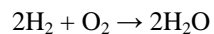
- How many grams of C are needed to react with 1000. g of  $\text{SiO}_2$ ? Ans. 399. g
- How many grams of Si are produced? Ans. 468. g
- How many moles of CO are produced? Ans. 33.3 moles

40. A coal burned in an electrical generating plant contains 1.2% S by mass. When the coal is burned the S is also oxidized.



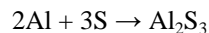
How many liters of  $\text{SO}_2$  ( $d = 2.60 \text{ g/L}$ ) are produced when  $1.00 \times 10^4 \text{ Kg}$  of coal burns at the same temperature and pressure? Ans.  $9.2 \times 10^4 \text{ L}$

41. For the following reaction 8.3 g of  $\text{H}_2$  and 230. g of  $\text{O}_2$  are used.



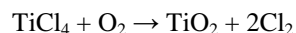
- What's the theoretical yield of  $\text{H}_2\text{O}$ ? Ans. 75. g
- What's the limiting reactant? Ans.  $\text{H}_2$
- How many grams of the excess reactant remains? Ans. 164. g
- If the actual yield is 72.0 g what's the percent yield? Ans. 96. %

42. For the following reaction 32.0 g of Al and 72.0 g of S react.



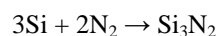
- What's the theoretical yield of  $\text{Al}_2\text{S}_3$ ? Ans. 89.1 g
- What's the limiting reactant? Ans. Al
- How many grams of the excess reactant remains? Ans. 14.9 g
- If the actual yield is 80.0 g what's the percent yield? 89.8 %

43.  $\text{TiO}_2$  is used for the white pigment in paint. It is prepared using the following reaction.



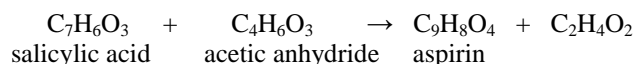
If the reaction is 85.0 % efficient, how much  $\text{TiCl}_4$  must be used to make 175. g of  $\text{TiO}_2$ ? Assume you have excess oxygen. Ans. 489. g

44. Silicon nitride,  $\text{Si}_3\text{N}_4$ , is a ceramic. It made at high temperatures by the following reaction.



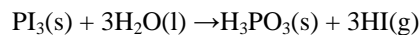
If the reaction is 72.0 % efficient, how much Si must be used to make  $2.0 \times 10^3$  g of  $\text{Si}_3\text{N}_2$ ?  
Ans.  $2.1 \times 10^3$  g

45. Aspirin is prepared by the following reaction.



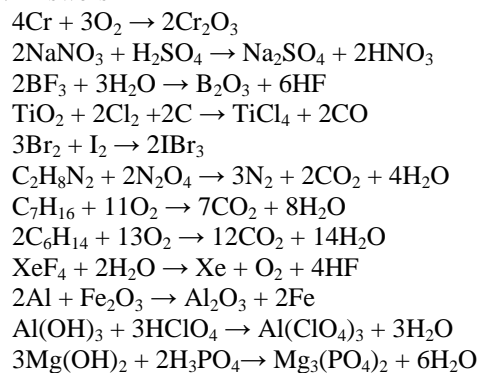
Assume you want to prepare 45.0 g of aspirin. The yield for the reaction is 85.0%. How many grams of salicylic acid must you use? Ans. 40.6 g salicylic acid

46. Phosphorous acid can be prepared by the following reaction.



Assume you want to prepare 400. g of  $\text{H}_3\text{PO}_3$ . The yield for the reaction is 75.0%. How many grams of  $\text{PI}_3$  must you use? Ans.  $2.70 \times 10^3$  g  $\text{PI}_3$

35. Answers



36. Answers

