

$$\begin{aligned}
 19. \quad 14.56 \text{ g NaHSO}_4 &\times \frac{1 \text{ mol NaHSO}_4}{120.1 \text{ g NaHSO}_4} \times \frac{7 \text{ mol atoms}}{1 \text{ mol NaHSO}_4} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol atoms}} \\
 &= 5.11 \times 10^{23} \text{ atoms}
 \end{aligned}$$

3.4 Molar Volume

Warm Up, p. 132

1. thousandth
2. millimoles (mmol)
3. litre
4. 32 mL
5. 0.0112 g

Quick Check, p. 132

- | | |
|--|--------------|
| 1. the volume of the mole of a substance | 3. spacing |
| 2. size, spacing | 4. increases |

Practice Problems — Converting Moles to Volume or Volume to Moles, p. 134

$$1. \quad 1.33 \text{ mol O}_2 \times \frac{22.4 \text{ L O}_2}{1 \text{ mol O}_2} = 29.8 \text{ L O}_2$$

$$2. \quad 9.5 \text{ L SO}_2 \times \frac{1 \text{ mol SO}_2}{22.4 \text{ L SO}_2} = 0.42 \text{ mol SO}_2$$

$$3. \quad 0.39 \text{ mol SiO}_2 \times \frac{22.8 \text{ cm}^3 \text{ SiO}_2}{1 \text{ mol SiO}_2} = 8.9 \text{ cm}^3 \text{ SiO}_2$$

Practice Problems — Conversions: Volume to Number of Items or Mass; Mass to Volume, p. 136

$$1. \quad 17 \text{ g H}_2\text{S} \times \frac{1 \text{ mol H}_2\text{S}}{34.1 \text{ g H}_2\text{S}} \times \frac{22.4 \text{ L H}_2\text{S}}{1 \text{ mol H}_2\text{S}} = 11 \text{ L H}_2\text{S}$$

$$2. \quad 22.4 \text{ L C}_3\text{H}_8, 3 \text{ mol C}, 12.0 \text{ g C} \quad \text{answer } 1.6 \text{ g C}$$

$$\begin{aligned}
 3. \quad 0.200 \text{ L C}_2\text{H}_6\text{O}_2 &\times \frac{1 \text{ mol C}_2\text{H}_6\text{O}_2}{0.0559 \text{ L C}_2\text{H}_6\text{O}_2} \times \frac{6 \text{ mol H}}{1 \text{ mol C}_2\text{H}_6\text{O}_2} \times \frac{6.02 \times 10^{23} \text{ atoms H}}{1 \text{ mol H}} \\
 &= 1.29 \times 10^{25} \text{ atoms H}
 \end{aligned}$$

Practice Problems — Calculating Molar Volume and Density, p. 138

$$1. \quad 1.33 \text{ g Au} \times \frac{1 \text{ cm}^3 \text{ Au}}{19.42 \text{ g Au}} = 639 \text{ cm}^3 \text{ Au}$$

$$2. \quad 12.7 \text{ mL Hg} \times \frac{13.534 \text{ g Hg}}{1 \text{ mL Hg}} = 172 \text{ g Hg}$$

$$3. \quad \frac{46.0 \text{ g C}_2\text{H}_5\text{OH}}{1 \text{ mol C}_2\text{H}_5\text{OH}} \times \frac{1 \text{ mL C}_2\text{H}_5\text{OH}}{0.789 \text{ g C}_2\text{H}_5\text{OH}} = 58.3 \text{ mL/mol C}_2\text{H}_5\text{OH}$$

3.4 Activity: The Atomic Radius of Aluminum, p. 139

$$1. \quad 2.702 \text{ g/cm}^3$$

$$2. \quad \frac{27.0 \text{ g Al}}{1 \text{ mol Al}} \times \frac{1 \text{ cm}^3 \text{ Al}}{2.702 \text{ g Al}} = 9.99 \text{ cm}^3/\text{mol Al}$$

$$3. \quad 0.74 \times \frac{9.99 \text{ cm}^3 \text{ Al}}{1 \text{ mol Al}} = 7.3945 \text{ cm}^3/\text{mol Al}$$

$$4. \quad \frac{7.3945 \text{ cm}^3 \text{ Al}}{1 \text{ mol Al}} \times \frac{1 \text{ mol Al}}{6.02 \times 10^{23} \text{ atoms Al}} = 1.228 \times 10^{-23} \text{ cm}^3/\text{atom Al}$$

$$5. \quad r^3 = \frac{1.228 \times 10^{-23} \text{ cm}^3}{4.1888} = 2.93 \times 10^{-24} \text{ cm}^3 \quad r = 1.43 \times 10^{-8} \text{ cm}$$

$$6. \quad 1.43 \times 10^{-8} \text{ cm} \times \frac{1 \text{ m}}{100 \text{ cm}} \times \frac{1 \times 10^9 \text{ nm}}{1 \text{ m}} = 0.143 \text{ nm}$$

3.4 Review Questions, p. 140

$$1. \quad 0.250 \text{ mol C}_8\text{H}_{18} \times \frac{82.4 \text{ mL C}_8\text{H}_{18}}{1 \text{ mol C}_8\text{H}_{18}} = 20.6 \text{ mL C}_8\text{H}_{18}$$

$$2. \quad 2.4 \text{ L air} \times \frac{1 \text{ mol air}}{22.4 \text{ L air}} = 0.11 \text{ mol air}$$

$$3. \quad 2.75 \text{ L N}_2 \times \frac{1 \text{ mol N}_2}{22.4 \text{ L N}_2} = 0.123 \text{ mol N}_2$$

$$4. \quad 5.0 \text{ L air} \times \frac{21 \text{ L O}_2}{100 \text{ L air}} \times \frac{1 \text{ mol O}_2}{22.4 \text{ L O}_2} = 0.047 \text{ mol O}_2$$

$$5. \quad 2.57 \text{ L P}_2\text{O}_5 \times \frac{1 \text{ mol P}_2\text{O}_5}{22.4 \text{ L P}_2\text{O}_5} \times \frac{142.0 \text{ g P}_2\text{O}_5}{1 \text{ mol P}_2\text{O}_5} = 16.3 \text{ g P}_2\text{O}_5$$

$$6. \quad \frac{0.935 \text{ g}}{525 \text{ mL}} \times \frac{22400 \text{ mL}}{1 \text{ mol}} = 39.9 \text{ g/mol (Argon)}$$

$$7. \quad 1400 \text{ L C}_2\text{H}_2 \times \frac{1 \text{ mol C}_2\text{H}_2}{22.4 \text{ L C}_2\text{H}_2} \times \frac{6.02 \times 10^{23} \text{ molecules C}_2\text{H}_2}{1 \text{ mol C}_2\text{H}_2} = 3.8 \times 10^{25} \text{ molecules C}_2\text{H}_2$$

$$8. \quad 5 \times 10^{19} \text{ molecules PH}_3 \times \frac{1 \text{ mol PH}_3}{6.02 \times 10^{23} \text{ molecules PH}_3} \times \frac{22.4 \text{ L PH}_3}{1 \text{ mol PH}_3} = 0.002 \text{ L PH}_3$$

$$0.002 \text{ L PH}_3 \times \frac{1000 \text{ mL}}{1 \text{ L}} = 2 \text{ mL PH}_3$$

$$9. \quad 9100 \text{ g C}_3\text{H}_8 \times \frac{1 \text{ mol C}_3\text{H}_8}{44.0 \text{ g C}_3\text{H}_8} \times \frac{22.4 \text{ L C}_3\text{H}_8}{1 \text{ mol C}_3\text{H}_8} = 4600 \text{ L C}_3\text{H}_8$$

$$10. \quad (3.7) 0.355 \text{ L CO}_2 \times \frac{1 \text{ mol CO}_2}{22.4 \text{ L CO}_2} \times \frac{44.0 \text{ g CO}_2}{1 \text{ mol CO}_2} = 2.6 \text{ g CO}_2$$

$$11. \quad 83.9 \text{ L NH}_3 \times \frac{1 \text{ mol NH}_3}{22.4 \text{ L NH}_3} \times \frac{3 \text{ mol H}}{1 \text{ mol NH}_3} = 11.2 \text{ mol H}$$

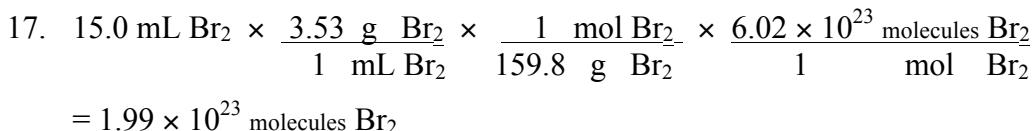
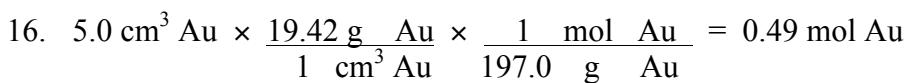
$$12. \quad 3.84 \text{ L N}_2\text{O} \times \frac{1 \text{ mol N}_2\text{O}}{22.4 \text{ L N}_2\text{O}} \times \frac{2 \text{ mol N}}{1 \text{ mol N}_2\text{O}} \times \frac{14.0 \text{ g N}}{1 \text{ mol N}} = 4.80 \text{ g N}$$

$$13. \quad 27.2 \text{ L N}_2\text{O}_4 \times \frac{1 \text{ mol N}_2\text{O}_4}{22.4 \text{ L N}_2\text{O}_4} \times \frac{4 \text{ mol O}}{1 \text{ mol N}_2\text{O}_4} \times \frac{6.02 \times 10^{23} \text{ atoms O}}{1 \text{ mol O}}$$

$$= 2.92 \times 10^{24} \text{ atoms O}$$

$$14. \quad 15 \text{ mL C}_4\text{H}_{10} \times \frac{0.601 \text{ g C}_4\text{H}_{10}}{1 \text{ mL C}_4\text{H}_{10}} = 9.0 \text{ g C}_4\text{H}_{10}$$

$$15. \quad \frac{200.6 \text{ g Hg}}{1 \text{ mol Hg}} \times \frac{1 \text{ mL Hg}}{13.546 \text{ g Hg}} = 14.81 \text{ mL/mol Hg}$$



3.5 Composition Analysis — Determining Formulas

Warm Up, p. 142

1. 72 u
2. 29u
3. For example: more ways of creating the fragment
For example: weaker bonds are broken to create fragment

Practice Problems — Determining Percentage Composition, p. 143

