17. 8.18×10^6 mol $NH_3 \times \frac{17.0\ g\ NH_3}{1\ mol\ NH_3} \times \frac{1\ tonne\ NH_3}{1000\ g\ NH_3} = 1.39 \times 10^5$ tonnes NH_3

18. 2.640×10^3 g $(NH_4)PO_4 \times \frac{1\ mol\ (NH_4)PO_4}{47.9\ g\ (NH_4)PO_4} = 55$ mol $(NH_4)PO_4$

19. 5.925 mol $SnCr_2O_7 \times \frac{334.7\ g\ SnCr_2O_7}{1\ mol\ SnCr_2O_7} = 1983$ g $SnCr_2O_7$

3.3 The Wheel Model of Mole Conversions

Warm Up, p. 124

1. 15 g C
2. 1 mol Zn
3. 34 g CH_4

Practice Problems — Two Step Conversions, p. 126

1. 1×10^{18} molecules $SO_2 \times \frac{1\ mol\ SO_2}{\mathbf{6.02 \times 10^{23}}\ molecules\ SO_2} \times \frac{\mathbf{64.1}\ g\ SO_2}{1\ mol\ SO_2} = \mathbf{1 \times 10^{-4}}$ g SO_2

2. 2.1 g Br $\times \frac{1\ mol\ Br}{79.9\ g\ Br} \times \frac{6.02 \times 10^{23}\ atoms\ Br}{1\ mol\ Br} = 1.6 \times 10^{22}$ atoms Br

3. 1 atom Ag $\times \frac{1\ mol\ Ag}{6.02 \times 10^{23}\ atoms\ Ag} \times \frac{107.9\ g\ Ag}{1\ mol\ Ag} = 1.79 \times 10^{-22}$ g Ag

Practice Problems — One-, Two-, and Three-Step Conversions, p. 128

1. a. $\frac{2\ mol\ O}{1\ mol\ SO_2}$ b. $\frac{1\ mol\ C_2H_4}{4\ mol\ H}$

2. 14 g O $\times \frac{1\ mol\ O}{16.0\ g\ O} \times \frac{1\ mol\ KNO_3}{3\ mol\ O} = 0.29$ mol KNO_3

3. 2.5 g $K_2Cr_2O_7 \times \frac{1\ mol\ K_2Cr_2O_7}{\mathbf{294.2}\ g\ K_2Cr_2O_7} \times \frac{\mathbf{7}\ mol\ O}{1\ mol\ K_2Cr_2O_7} \times \frac{6.02 \times 10^{23}\ atoms\ O}{1\ mol\ O}$

   $= 3.6 \times 10^{22}$ atoms O

4. 1.23×10^{24} f.units $Na_2S \times \frac{1\ mol\ Na_2S}{6.02 \times 10^{23}\ f.units\ Na_2S} \times \frac{2\ mol\ Na^+}{1\ mol\ Na_2S} \times \frac{23.0\ g\ Na^+}{1\ mol\ Na^+}$

   $= 94.0$ g Na^+

3.3 Activity: The Evaporation Rate of Water, p. 129

For example:

	Mass of Beaker and H_2O (g)	Time of Day
initial	68.623	8:50
final	68.555	9:20
change	0.068	30 min

1. $0.068\ \text{g } H_2O \times \frac{1\ \text{mol } H_2O}{18.0\ \text{g } H_2O} \times \frac{6.02 \times 10^{23}\ \text{molecules } H_2O}{1\ \text{mol } H_2O} = 2.274 \times 10^{21}\ \text{molecules } H_2O$

2. $30\ \text{min} \times \frac{60\ \text{s}}{1\ \text{min}} = 1800\ \text{s}$

3. $\frac{2.274 \times 10^{21}\ \text{molecules } H_2O}{1800\ \text{s}} = 1 \times 10^{18}\ \text{molecules } H_2O$

3.3 Review Questions, p. 130

1. $1.0 \times 10^3\ \text{atoms Ag} \times \frac{1\ \text{mol Ag}}{6.02 \times 10^{23}\ \text{atoms Ag}} \times \frac{107.9\ \text{g Ag}}{1\ \text{mol Ag}} = 1.8 \times 10^{-19}\ \text{g Ag}$

2. $106.0\ \text{g C} \times \frac{1\ \text{mol C}}{12.0\ \text{g C}} \times \frac{6.02 \times 10^{23}\ \text{atoms C}}{1\ \text{mol C}} = 5.32 \times 10^{24}\ \text{atoms C}$

3. $1\ \text{atom Cl} \times \frac{1\ \text{mol Cl}}{6.02 \times 10^{23}\ \text{atoms Cl}} \times \frac{35.5\ \text{g Cl}}{1\ \text{mol Cl}} = 5.90 \times 10^{-23}\ \text{g Cl}$

4. $72.6\ \text{g } C_3H_8 \times \frac{1\ \text{mol } C_3H_8}{44.0\ \text{g } C_3H_8} \times \frac{6.02 \times 10^{23}\ \text{molecules } C_3H_8}{1\ \text{mol } C_3H_8} = 9.93 \times 10^{23}\ \text{molecules } C_3H_8$

5. a. $31.1\ \text{g Au} \times \frac{1\ \text{mol Au}}{197.0\ \text{g Au}} \times \frac{6.02 \times 10^{23}\ \text{atoms Au}}{1\ \text{mol Au}} = 9.50 \times 10^{22}\ \text{atoms Au}$

   b. $\frac{9.50 \times 10^{22}\ \text{atoms Au}}{1.3 \times 10^5\ \text{cents}} = 7.3 \times 10^{17}\ \text{atoms Au per cent}$

6. a. $\frac{4\ \text{mol O}}{1\ \text{mol } N_2O_4}$ b. $\frac{1\ \text{mol } NO_2}{1\ \text{mol N}}$

7. $2.3 \text{ mol } CO_2 \times \frac{2 \text{ mol O}}{1 \text{ mol } CO_2} = 4.6 \text{ mol O}$

8. $52.4 \text{ mg } CaC_2O_4 \times \frac{1 \text{ g } CaC_2O_4}{1000 \text{ mg } CaC_2O_4} = 0.0524 \text{ g } CaC_2O_4$

$0.0524 \text{ g } CaC_2O_4 \times \frac{1 \text{ mol } CaC_2O_4}{128.1 \text{ g } CaC_2O_4} \times \frac{2 \text{ mol C}}{1 \text{ mol } CaC_2O_4} = 8.18 \times 10^{-4} \text{ mol C}$

9. $6.80 \times 10^{24} \text{ f.units } Na_3PO_4 \times \frac{1 \text{ mol } Na_3PO_4}{6.02 \times 10^{23} \text{ f.units } Na_3PO_4} \times \frac{3 \text{ mol } Na^+}{1 \text{ mol } Na_3PO_4}$

$= 33.9 \text{ mol } Na^+$

10. $1.4 \text{ mol O} \times \frac{1 \text{ mol } H_2SO_4}{4 \text{ mol O}} \times \frac{98.1 \text{ g } H_2SO_4}{1 \text{ mol } H_2SO_4} = 34 \text{ g } H_2SO_4$

11. $0.85 \text{ mol } C_8H_9NO_2 \times \frac{8 \text{ mol C}}{1 \text{ mol } C_8H_9NO_2} \times \frac{6.02 \times 10^{23} \text{ atoms C}}{1 \text{ mol C}} = 4.1 \times 10^{24} \text{ atoms C}$

12. $100.0 \text{ g } HgCl_2 \times \frac{1 \text{ mol } HgCl_2}{271.6 \text{ g } HgCl_2} \times \frac{1 \text{ mol } Hg^{2+}}{1 \text{ mol } HgCl_2} \times \frac{6.02 \times 10^{23} \text{ ions } Hg^{2+}}{1 \text{ mol } Hg^{2+}}$

$= 2.22 \times 10^{23} \text{ ions } Hg^{2+}$

13. $8.3 \text{ g } CuCl_2 \times \frac{1 \text{ mol } CuCl_2}{134.5 \text{ g } CuCl_2} \times \frac{2 \text{ mol } Cl^-}{1 \text{ mol } CuCl_2} \times \frac{35.5 \text{ g } Cl^-}{1 \text{ mol } Cl^-} = 4.4 \text{ g } Cl^-$

14. $4.8 \times 10^{26} \text{ molecules } C_2H_5OH \times \frac{1 \text{ mol } C_2H_5OH}{6.02 \times 10^{23} \text{ molecules } C_2H_5OH} \times \frac{2 \text{ mol C}}{1 \text{ mol } C_2H_5OH} \times \frac{12.0 \text{ g C}}{1 \text{ mol C}}$

$= 1.9 \times 10^4 \text{ g C} = 19 \text{ kg C}$

15. $3.9 \times 10^{27} \text{ molecules HF} \times \frac{1 \text{ mol HF}}{6.02 \times 10^{23} \text{ molecules HF}} \times \frac{20.0 \text{ g HF}}{1 \text{ mol HF}} \times \frac{1 \text{ kg HF}}{1000 \text{ g HF}}$

$= 1.3 \times 10^2 \text{ kg HF}$

16. $1.44 \times 10^8 \text{ g } NO_2 \times \frac{1 \text{ mol } NO_2}{46.0 \text{ g } NO_2} \times \frac{2 \text{ mol O}}{1 \text{ mol } NO_2} \times \frac{6.02 \times 10^{23} \text{ atoms O}}{1 \text{ mol O}}$

$= 3.77 \times 10^{30} \text{ atoms O}$

17. $1.000 \times 10^{-3} \text{ g } CCl_4 \times \frac{1 \text{ mol } CCl_4}{154.0 \text{ g } CCl_4} \times \frac{6.02 \times 10^{23} \text{ molecules } CCl_4}{1 \text{ mol } CCl_4}$

$= 3.91 \times 10^{18} \text{ molecules } CCl_4$

18. $4.5 \text{ mol } C_3H_5(OH)_3 \times \frac{8 \text{ mol H}}{1 \text{ mol } C_3H_5(OH)_3} \times \frac{6.02 \times 10^{23} \text{ atoms H}}{1 \text{ mol H}} = 2.2 \times 10^{25} \text{ atoms H}$

19. $14.56 \text{ g } NaHSO_4 \times \frac{1 \text{ mol } NaHSO_4}{120.1 \text{ g } NaHSO_4} \times \frac{7 \text{ mol atoms}}{1 \text{ mol } NaHSO_4} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol atoms}}$

$= 5.11 \times 10^{23}$ atoms

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
2. size, spacing
3. spacing
4. increases

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

1. $1.33 \text{ mol } O_2 \times \frac{22.4 \text{ L } O_2}{1 \text{ mol } O_2} = 29.8 \text{ L } O_2$

2. $9.5 \text{ L } SO_2 \times \frac{1 \text{ mol } SO_2}{22.4 \text{ L } SO_2} = 0.42 \text{ mol } SO_2$

3. $0.39 \text{ mol } SiO_2 \times \frac{22.8 \text{ cm}^3 SiO_2}{1 \text{ mol } SiO_2} = 8.9 \text{ cm}^3 SiO_2$

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

1. $17 \text{ g } H_2S \times \frac{1 \text{ mol } H_2S}{34.1 \text{ g } H_2S} \times \frac{22.4 \text{ L } H_2S}{1 \text{ mol } H_2S} = 11 \text{ L } H_2S$

2. 22.4 L C_3H_8, 3 mol C, 12.0 g C answer 1.6 g C