ANSWERS TO UNIT V : THE MOLE CONCEPT

1. Since oxygen is $\frac{88.9\ g}{11.1\ g} = 8$ times heavier than hydrogen (which has a mass of 1), oxygen has a mass of 8. Since nitrogen is $\frac{46.7\ g}{53.3\ g} = 0.876$ times heavier than oxygen, nitrogen has a mass of $0.876 \times 8 = 7$. Finally, since carbon is $\frac{42.9\ g}{57.1\ g} = 0.751$ times heavier than oxygen, carbon has a mass of $0.751 \times 8 = 6$.

2. Since there is 3 times the volume of chlorine gas compared to nitrogen, the reaction involves 3 times as many chlorine molecules as nitrogen molecules. Therefore, the formula is **NCl_3** . The name of the compound is nitrogen trichloride.

3. The volume of oxygen is twice the volume of sulphur so that the product contains twice as many oxygen atoms as sulphur atoms. The formula of the product is SO_2, sulphur dioxide.

4. The volume of fluorine is three times the volume of chlorine so that the formula contains three times as many fluorine atoms as chlorine atoms: ClF_3, chlorine trifluoride.

5. Since the volume of oxygen is five times the volume of unknown gas X, there are five times as many oxygen molecules as gas X molecules; that is, $5 \times 3.0 \times 10^{23} = 1.5 \times 10^{24}$ molecules.

6. (a) 1 N = 1 x 14.0 = 14.0 g
   1 O = 1 x 16.0 = 16.0 g
   molar mass = **30.0 g**

   (b) 2 H = 2 x 1.0 = 2.0 g
   1 O = 1 x 16.0 = 16.0 g
   molar mass = **18.0 g**

   (c) 1 N = 1 x 14.0 = 14.0 g
   3 H = 3 x 1.0 = 3.0 g
   molar mass = **17.0 g**

   (d) 1 C = 1 x 12.0 = 12.0 g
   2 O = 2 x 16.0 = 32.0 g
   molar mass = **44.0 g**

   (e) 1 C = 1 x 12.0 = 12.0 g
   4 H = 4 x 1.0 = 4.0 g
   molar mass = **16.0 g**

   (f) 1 Ag = 1 x 107.9 = 107.9 g
   1 N = 1 x 14.0 = 14.0 g
   3 O = 3 x 16.0 = 48.0 g
   molar mass = **169.9 g**

   (g) 1 Ca = 1 x 40.1 = 40.1 g
   2 O = 2 x 16.0 = 32.0 g
   2 H = 2 x 1.0 = 2.0 g
   molar mass = **74.1 g**

   (h) 1 Al = 1 x 27.0 = 27.0 g
   3 N = 3 x 14.0 = 42.0 g
   9 O = 9 x 16.0 = 144.0 g
   molar mass = **213.0 g**

   (i) 1 Fe = 1 x 55.8 = 55.8 g
   3 Cl = 3 x 35.5 = 106.5 g
   molar mass = **162.3 g**

   (j) 1 Sn = 1 x 118.7 = 118.7 g
   2 C = 2 x 12.0 = 24.0 g
   4 O = 4 x 16.0 = 64.0 g
   molar mass = **206.7 g**

   (k) 1 Sn = 1 x 118.7 = 118.7 g
   4 C = 4 x 12.0 = 48.0 g
   8 O = 8 x 16.0 = 128.0 g
   molar mass = **294.7 g**

   (l) 3 N = 3 x 14.0 = 42.0 g
   12 H = 12 x 1.0 = 12.0 g
   1 P = 1 x 31.0 = 31.0 g
   4 O = 4 x 16.0 = 64.0 g
   molar mass = **149.0 g**

   (m) 2 C = 2 x 12.0 = 24.0 g
   4 H = 4 x 1.0 = 4.0 g
   2 O = 2 x 16.0 = 32.0 g
   molar mass = **60.0 g**

   (n) 4 C = 4 x 12.0 = 48.0 g
   10 H = 10 x 1.0 = 10.0 g
   molar mass = **58.0 g**

   (o) 1 Ni = 1 x 58.7 = 58.7 g
   16 H = 16 x 1.0 = 16.0 g
   2 O = 2 x 16.0 = 32.0 g
   4 N = 4 x 14.0 = 56.0 g
   2 Cl = 2 x 35.5 = 71.0 g
   molar mass = **233.7 g**

   (p) 2 Al = 2 x 27.0 = 54.0 g
   3 S = 3 x 32.1 = 96.3 g
   12 O = 12 x 16.0 = 192.0 g
   molar mass = **342.3 g**

7. (a) 3 Co = 3 x 58.9 = 176.7 g
2 As = 2 x 74.9 = 149.8 g
16 O = 16 x 16.0 = 256.0 g
16 H = 16 x 1.0 = 16.0 g
molar mass = **598.5 g**

(b) 1 Pb = 1 x 207.2 = 207.2 g
4 C = 4 x 12.0 = 48.0 g
12 H = 12 x 1.0 = 12.0 g
7 O = 7 x 16.0 = 112.0 g
molar mass = **379.2 g**

(c) 1 Mg = 1 x 24.3 = 24.3 g
1 S = 1 x 32.1 = 32.1 g
11 O = 11 x 16.0 = 176.0 g
14 H = 14 x 1.0 = 14.0 g
molar mass = **246.4 g**

(d) 1 K = 1 x 39.1 = 39.1 g
1 Al = 1 x 27.0 = 27.0 g
2 S = 2 x 32.1 = 64.2 g
20 O = 20 x 16.0 = 320.0 g
24 H = 24 x 1.0 = 24.0 g
molar mass = **474.3 g**

8. (a) $\text{mass} = 1.00 \text{ mol} \times \frac{53.5 \text{ g}}{1 \text{ mol}} = \mathbf{53.5 \text{ g}}$

(b) $\text{mass} = 4.50 \text{ mol} \times \frac{53.5 \text{ g}}{1 \text{ mol}} = \mathbf{241 \text{ g}}$

(c) $\text{mass} = 3.25 \text{ mol} \times \frac{137.5 \text{ g}}{1 \text{ mol}} = \mathbf{447 \text{ g}}$

(d) $\text{mass} = 0.00355 \text{ mol} \times \frac{142.0 \text{ g}}{1 \text{ mol}} = \mathbf{0.504 \text{ g}}$

(e) $\text{mass} = 0.0125 \text{ mol} \times \frac{207.3 \text{ g}}{1 \text{ mol}} = \mathbf{2.59 \text{ g}}$

(f) $\text{mass} = 2.60 \text{ mol} \times \frac{30.0 \text{ g}}{1 \text{ mol}} = \mathbf{78.0 \text{ g}}$

(g) $\text{mass} = 3.25 \times 10^{2} \text{ mol} \times \frac{17.0 \text{ g}}{1 \text{ mol}} = \mathbf{5.53 \times 10^{3} \text{ g}}$

(h) $\text{mass} = 7.90 \times 10^{-4} \text{ mol} \times \frac{82.1 \text{ g}}{1 \text{ mol}} = \mathbf{0.0649 \text{ g}}$

(i) $\text{mass} = 1.00 \times 10^{-3} \text{ mol} \times \frac{40.0 \text{ g}}{1 \text{ mol}} = \mathbf{0.0400 \text{ g}}$

(j) $\text{mass} = 1.75 \times 10^{-4} \text{ mol} \times \frac{55.8 \text{ g}}{1 \text{ mol}} = \mathbf{9.77 \times 10^{-3} \text{ g}}$

9. (a) $\#\text{ of moles} = 17.0 \text{ g} \times \frac{1 \text{ mol}}{98.1 \text{ g}} = \mathbf{0.173 \text{ mol}}$

(b) $\#\text{ of moles} = 91.5 \text{ g} \times \frac{1 \text{ mol}}{18.0 \text{ g}} = \mathbf{5.08 \text{ mol}}$

(c) $\#\text{ of moles} = 53.0 \text{ g} \times \frac{1 \text{ mol}}{12.0 \text{ g}} = \mathbf{4.42 \text{ mol}}$

(d) $\#\text{ of moles} = 1.25 \times 10^{-4} \text{ g} \times \frac{1 \text{ mol}}{95.6 \text{ g}} = \mathbf{1.31 \times 10^{-6} \text{ mol}}$

(e) $\#\text{ of moles} = 4.50 \text{ kg} \times \frac{10^{3} \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol}}{16.0 \text{ g}} = \mathbf{281 \text{ mol}}$

(f) $\#\text{ of moles} = 225 \text{ g} \times \frac{1 \text{ mol}}{132.1 \text{ g}} = \mathbf{1.70 \text{ mol}}$

(g) $\#\text{ of moles} = 55.2 \text{ mg} \times \frac{10^{-3} \text{ g}}{1 \text{ mg}} \times \frac{1 \text{ mol}}{71.0 \text{ g}} = \mathbf{7.77 \times 10^{-4} \text{ mol}}$

(h) $\#\text{ of moles} = 128.2 \text{ g} \times \frac{1 \text{ mol}}{64.1 \text{ g}} = \mathbf{2.00 \text{ mol}}$

(i) $\#\text{ of moles} = 2955 \text{ kg} \times \frac{10^{3} \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol}}{107.9 \text{ g}} = \mathbf{2.739 \times 10^{4} \text{ mol}}$

(j) $\#\text{ of moles} = 0.0845 \text{ g} \times \frac{1 \text{ mol}}{158.0 \text{ g}} = \mathbf{5.35 \times 10^{-4} \text{ mol}}$

10. (a) $\text{molar mass} = \dfrac{4.00\text{ g}}{0.250\text{ mol}} = \mathbf{16.0\ g/mol}$

(b) $\text{molar mass} = \dfrac{0.947\text{ g}}{0.00248\text{ mol}} = \mathbf{382\ g/mol}$

(c) $\text{molar mass} = \dfrac{7.76 \times 10^{-3}\text{ g}}{6.47 \times 10^{-4}\text{ mol}} = \mathbf{12.0\ g/mol}$

(d) $\text{molar mass} = \dfrac{74.8\text{ g}}{3.44 \times 10^{-5}\text{ mol}} = \mathbf{2.17 \times 10^{6}\ g/mol}$

11. (a) $\text{volume} = 12.5\text{ mol} \times \dfrac{22.4\text{ L}}{1\text{ mol}} = \mathbf{2.80 \times 10^{2}\ L}$

(b) $\text{volume} = 0.350\text{ mol} \times \dfrac{22.4\text{ L}}{1\text{ mol}} = \mathbf{7.84\ L}$

(c) $\text{volume} = 4.25\text{ mol} \times \dfrac{22.4\text{ L}}{1\text{ mol}} = \mathbf{95.2\ L}$

12. (a) $\#\text{ of moles} = 85.9\text{ L} \times \dfrac{1\text{ mol}}{22.4\text{ L}} = \mathbf{3.83\ mol}$

(b) $\#\text{ of moles} = 375\text{ mL} \times \dfrac{10^{-3}\text{ L}}{1\text{ mL}} \times \dfrac{1\text{ mol}}{22.4\text{ L}} = \mathbf{0.0167\ mol}$

(c) $\#\text{ of moles} = 5.00\text{ mL} \times \dfrac{10^{-3}\text{ L}}{1\text{ mL}} \times \dfrac{1\text{ mol}}{22.4\text{ L}} = \mathbf{2.23 \times 10^{-4}\ mol}$

13. $\#\text{ of seconds in 1 year} = 365 \times 24 \times 60 \times 60 = 3.15 \times 10^{7}\text{ s}$

$\text{amount spent in 1 yr} = 3.15 \times 10^{7}\text{ s} \times \dfrac{\$10^{3}}{1\text{ s}} = \$3.15 \times 10^{10}$

$\text{amount given to each person} = \dfrac{\$6.02 \times 10^{23}}{4.5 \times 10^{9}} = \$1.34 \times 10^{14}$

$\text{percentage spent} = \dfrac{\$3.15 \times 10^{10}}{\$1.34 \times 10^{14}} \times 100\,\% = \mathbf{0.0236\ \%}$

14. $\#\text{ of pennies/layer} = \dfrac{1\text{ penny}}{3.61\text{ cm}^2} \times \dfrac{10^{10}\text{ cm}^2}{1\text{ km}^2} \times 1.49 \times 10^{8}\text{ km}^2 = 4.13 \times 10^{17}$

$\text{thickness} = 6.02 \times 10^{23}\text{ pennies} \times \dfrac{1\text{ layer}}{4.13 \times 10^{17}\text{ pennies}} \times \dfrac{1.50\text{ mm}}{1\text{ layer}} \times \dfrac{10^{-3}\text{ m}}{1\text{ mm}} \times \dfrac{1\text{ km}}{10^{3}\text{ m}} = \mathbf{2.19\ km}$

15. (a) $\#\text{ of moles} = 10.6\text{ L} \times \dfrac{1\text{ mol}}{22.4\text{ L}} = \mathbf{0.473\ mol}$

(b) $\#\text{ of moles} = 7.50 \times 10^{21}\text{ molecules} \times \dfrac{1\text{ mol molecules}}{6.02 \times 10^{23}\text{ molecules}} = \mathbf{0.0125\ mol}$

(c) $\#\text{ of moles} = 425\text{ mg} \times \dfrac{10^{-3}\text{ g}}{1\text{ mg}} \times \dfrac{1\text{ mol}}{74.1\text{ g}} = \mathbf{5.74 \times 10^{-3}\ mol}$

(d) $\#\text{ of moles} = 4.25 \times 10^{12}\text{ molecule} \times \dfrac{1\text{ mol molecules}}{6.02 \times 10^{23}\text{ molecules}} = \mathbf{7.06 \times 10^{-12}\ mol}$

(e) $\#\text{ of moles} = 0.950\text{ kg} \times \dfrac{10^{3}\text{ g}}{1\text{ kg}} \times \dfrac{1\text{ mol}}{40.0\text{ g}} = \mathbf{23.8\ mol}$

(f) $\#\text{ of moles} = 25.0\text{ mL} \times \dfrac{10^{-3}\text{ L}}{1\text{ mL}} \times \dfrac{1\text{ mol}}{22.4\text{ L}} = \mathbf{1.12 \times 10^{-3}\ mol}$

(g) $\#\text{ of moles} = 5.50 \times 10^{25}\text{ molecules} \times \dfrac{1\text{ mol molecules}}{6.02 \times 10^{23}\text{ molecules}} = \mathbf{91.4\ mol}$

(h) # of moles = $0.120\ \text{L} \times \frac{1\ \text{mol}}{22.4\ \text{L}} = \mathbf{5.36 \times 10^{-3}\ mol}$

16. (a) volume = $0.235\ \text{mol} \times \frac{22.4\ \text{L}}{1\ \text{mol}} = \mathbf{5.26\ L}$

(b) volume = $9.36\ \text{mol} \times \frac{22.4\ \text{L}}{1\ \text{mol}} = \mathbf{2.10 \times 10^{2}\ L}$

(c) volume = $2.55 \times 10^{3}\ \text{mol} \times \frac{22.4\ \text{L}}{1\ \text{mol}} = \mathbf{5.71 \times 10^{4}\ L}$

17. (a) mass = $0.125\ \text{mol} \times \frac{44.0\ \text{g}}{1\ \text{mol}} = \mathbf{5.50\ g}$

(b) mass = $5.48\ \text{mol} \times \frac{162.3\ \text{g}}{1\ \text{mol}} = \mathbf{889\ g}$

(c) mass = $6.54 \times 10^{-4}\ \text{mol} \times \frac{27.0\ \text{g}}{1\ \text{mol}} = \mathbf{0.0177\ g}$

(d) mass = $15.4\ \text{mol} \times \frac{92.7\ \text{g}}{1\ \text{mol}} = \mathbf{1.43 \times 10^{3}\ g}$

18. (a)
2 Na = 2 x 23.0 = 46.0 g
4 B = 4 x 10.8 = 43.2 g
17 O = 17 x 16.0 = 272.0 g
20 H = 20 x 1.0 = 20.0 g
molar mass = **381.2 g**

(b) mass of 1 mol of grannies = $6.02 \times 10^{23} \times 52\ \text{kg} = \mathbf{3.1 \times 10^{25}\ kg}$

(c) mass of 1 mol = $3.52 \times 10^{-22}\ \text{g} \times 6.02 \times 10^{23} = \mathbf{212\ g}$

(d) mass of 1 mol of electrons = $6.02 \times 10^{23} \times 9.1 \times 10^{-28}\ \text{g} = \mathbf{5.5 \times 10^{-4}\ g}$

(e)
3 Cu = 3 x 63.5 = 190.5 g
8 O = 8 x 16.0 = 128.0 g
2 H = 2 x 1.0 = 2.0 g
2 C = 2 x 12.0 = 24.0 g
molar mass = **344.5 g**

(f) mass of 1 mol of books = $6.02 \times 10^{23} \times 1.34\ \text{kg} = \mathbf{8.07 \times 10^{23}\ kg}$

19. mass of 1 mol of unknown = $6.02 \times 10^{23} \times 1.18 \times 10^{-22}\ \text{g} = 71.0\ \text{g}$

molar masses of known gases: SO_3 = 80.1 g
CH_4 = 16.0 g
NF_3 = 71.0 g (this is the unknown)
C_2H_2 = 26.0 g

20. (a) # of drumsticks = $2\ \text{mol} \times \frac{6.02 \times 10^{23}\ \text{chickens}}{1\ \text{mol chickens}} \times \frac{2\ \text{drumsticks}}{1\ \text{chicken}} = \mathbf{2.41 \times 10^{24}\ drumsticks}$

(b) each chicken has 2 drumsticks + 2 wings + 2 thighs = 6 "parts"

# of parts = $2\ \text{mol} \times \frac{6.02 \times 10^{23}\ \text{chickens}}{1\ \text{mol chickens}} \times \frac{6\ \text{parts}}{1\ \text{chicken}} = \mathbf{7.22 \times 10^{24}\ parts}$

21. (a) 8 (b) 6 (c) 10 (d) 15 (e) 46 (f) 23

22. (a) mass = $2 \times 10^{6}\ \text{molecules} \times \frac{1\ \text{mol}}{6.02 \times 10^{23}\ \text{molecules}} \times \frac{28.0\ \text{g}}{1\ \text{mol}} = \mathbf{9 \times 10^{-17}\ g}$

(b) mass = $1.25\ \text{L} \times \frac{1\ \text{mol}}{22.4\ \text{L}} \times \frac{17.0\ \text{g}}{1\ \text{mol}} = \mathbf{0.949\ g}$

(c) mass = $5 \times 10^{14}\ \text{molecules} \times \frac{1\ \text{mol}}{6.02 \times 10^{23}\ \text{molecules}} \times \frac{28.0\ \text{g}}{1\ \text{mol}} = \mathbf{2 \times 10^{-8}\ g}$

(d) $\text{mass} = 1 \text{ molecule} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{56.1 \text{ g}}{1 \text{ mol}} = \mathbf{9.32 \times 10^{-23} \text{ g}}$

(e) $\text{mass} = 125 \text{ atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{4.0 \text{ g}}{1 \text{ mol}} = \mathbf{8.3 \times 10^{-22} \text{ g}}$

(f) $\text{mass} = 1 \text{ atom} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{107.9 \text{ g}}{1 \text{ mol}} = \mathbf{1.79 \times 10^{-22} \text{ g}}$

(g) $\text{mass} = 4.15 \times 10^{15} \text{ molec} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{16.0 \text{ g}}{1 \text{ mol}} = \mathbf{1.10 \times 10^{-7} \text{ g}}$

(h) $\text{mass} = 175 \text{ atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{14.0 \text{ g}}{1 \text{ mol}} = \mathbf{4.07 \times 10^{-21} \text{ g}}$

(i) $\text{mass} = 3.45 \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{32.0 \text{ g}}{1 \text{ mol}} = \mathbf{4.93 \times 10^{-3} \text{ g}}$

(j) $\text{mass} = 1.00 \times 10^{8} \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{2.0 \text{ g}}{1 \text{ mol}} = \mathbf{8.93 \times 10^{6} \text{ g}}$

23. (a) $\#\text{ of atoms} = 1.00 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{6 \text{ atoms}}{1 \text{ molecule}} = \mathbf{3.61 \times 10^{24} \text{ atoms}}$

(b) $\#\text{ of atoms} = 2.5 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 \text{ atoms}}{1 \text{ molecule}} = \mathbf{4.5 \times 10^{24} \text{ atoms}}$

(c) $\#\text{ of atoms} = 8.00 \text{ g} \times \frac{1 \text{ mol}}{55.8 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = \mathbf{8.63 \times 10^{22} \text{ atoms}}$

(d) $\#\text{ of atoms} = 15.0 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = \mathbf{4.03 \times 10^{23} \text{ atoms}}$

(e) $\#\text{ of atoms} = 12 \text{ g} \times \frac{1 \text{ mol}}{34.0 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{4 \text{ atoms}}{1 \text{ molecule}} = \mathbf{8.5 \times 10^{23} \text{ atoms}}$

(f) $\#\text{ of atoms} = 55.0 \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 \text{ atoms}}{1 \text{ molecule}}$

$= \mathbf{4.43 \times 10^{21} \text{ atoms}}$

(g) $\#\text{ of atoms} = 40.0 \text{ g} \times \frac{1 \text{ mol}}{39.1 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = \mathbf{6.16 \times 10^{23} \text{ atoms}}$

(h) $\#\text{ of atoms} = 5.0 \text{ g} \times \frac{1 \text{ mol}}{58.5 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{2 \text{ atoms}}{1 \text{ molecule}} = \mathbf{1.0 \times 10^{23} \text{ atoms}}$

(i) $\#\text{ of atoms} = 125 \text{ g} \times \frac{1 \text{ mol}}{50.5 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{5 \text{ atoms}}{1 \text{ molecule}} = \mathbf{7.45 \times 10^{24} \text{ atoms}}$

(j) $\#\text{ of atoms} = 8.30 \times 10^{-4} \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{4 \text{ atoms}}{1 \text{ molecule}}$

$= \mathbf{8.92 \times 10^{16} \text{ atoms}}$

(k) $\#\text{ of atoms} = 6.5 \times 10^{-6} \text{ g} \times \frac{1 \text{ mol}}{83.8 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = \mathbf{4.7 \times 10^{16} \text{ atoms}}$

(l) $\#\text{ of atoms} = 9.5 \times 10^{-3} \text{ g} \times \frac{1 \text{ mol}}{17.0 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{4 \text{ atoms}}{1 \text{ molecule}} = \mathbf{1.3 \times 10^{21} \text{ atoms}}$

24. (a) volume = $16.5\text{ g} \times \frac{1\text{ mol}}{77.9\text{ g}} \times \frac{22.4\text{ L}}{1\text{ mol}} = \mathbf{4.74\ L}$

(b) volume = $5.65 \times 10^{22}\text{ molecules} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\text{ molecules}} \times \frac{22.4\text{ L}}{1\text{ mol}} = \mathbf{2.10\ L}$

(c) volume = $0.750\text{ g} \times \frac{1\text{ mol}}{48.0\text{ g}} \times \frac{22.4\text{ L}}{1\text{ mol}} = \mathbf{0.350\ L}$

(d) volume = $9.04 \times 10^{24}\text{ atoms} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\text{ atoms}} \times \frac{22.4\text{ L}}{1\text{ mol}} = \mathbf{336\ L}$

(e) volume = $8.65 \times 10^{21}\text{ molecules} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\text{ molecules}} \times \frac{22.4\text{ L}}{1\text{ mol}} = \mathbf{0.322\ L}$

(f) volume = $6.98 \times 10^{15}\text{ atoms} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\text{ atoms}} \times \frac{22.4\text{ L}}{1\text{ mol}} = \mathbf{2.60 \times 10^{-7}\ L}$

(g) volume = $28.4\text{ mg} \times \frac{10^{-3}\text{ g}}{1\text{ mg}} \times \frac{1\text{ mol}}{129.6\text{ g}} \times \frac{22.4\text{ L}}{1\text{ mol}} = \mathbf{4.91 \times 10^{-3}\ L}$

(h) volume = $3.25\text{ kg} \times \frac{10^{3}\text{ g}}{1\text{ kg}} \times \frac{1\text{ mol}}{30.0\text{ g}} \times \frac{22.4\text{ L}}{1\text{ mol}} = \mathbf{2.43 \times 10^{3}\ L}$

25. density of $CO_2(g) = \frac{44.0\text{ g}}{22.4\text{ L}} = \mathbf{1.96\ \frac{g}{L}}$

26. # of N atoms = $30.0\text{ g} \times \frac{1\text{ mol}}{80.0\text{ g}} \times \frac{6.02 \times 10^{23}\text{ molecules}}{1\text{ mol}} \times \frac{2\text{ N–atoms}}{1\text{ molecule}} = \mathbf{4.52 \times 10^{23}\ atoms}$

27. # of molecules = $2.50\text{ L} \times \frac{1.59\text{ g}}{10^{-3}\text{ L}} \times \frac{1\text{ mol}}{154.0\text{ g}} \times \frac{6.02 \times 10^{23}\text{ molecules}}{1\text{ mol}} = \mathbf{1.55 \times 10^{25}\ molecules}$

28. density = $\frac{1.67\text{ g}}{1.35\text{ L}} = 1.237\text{ g/L}$, and mass of 1 mol = $1.237\ \frac{\text{g}}{\text{L}} \times 22.4\text{ L} = \mathbf{27.7\ g}$

29. density = $\frac{30.0\text{ g}}{22.4\text{ L}} = \mathbf{1.34\ \frac{g}{L}}$

30. volume = $8.50 \times 10^{24}\text{ C–atoms} \times \frac{1\text{ molecule}}{6\text{ C–atoms}} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\text{ molecules}} \times \frac{78.0\text{ g}}{1\text{ mol}} \times \frac{1\text{ mL}}{0.877\text{ g}} = \mathbf{209\ mL}$

31. density = $\frac{0.358\text{ g}}{0.2500\text{ L}} = 1.432\text{ g/L}$, and mass of 1 mol = $1.432\ \frac{\text{g}}{\text{L}} \times 22.4\text{ L} = \mathbf{32.1\ g}$

Silane molecules have at least one Si and one H atom. The molar mass of Si is 28.1 g and of H is 1.0 g. Silane has a molar mass of 32.1 g, which is not big enough to allow 2 atoms of Si per molecule. Hence, there is exactly 1 Si per molecule and 32.1 –28.1 = 4.0 H atoms. The formula must be **SiH_4**.

32. volume = $4.50 \times 10^{22}\text{ molecules} \times \frac{1\text{ mol}}{6.02 \times 10^{23}\text{ molecules}} \times \frac{76.2\text{ g}}{1\text{ mol}} \times \frac{1\text{ mL}}{1.26\text{ g}} = \mathbf{4.52\ mL}$

33. molar mass = 60.1 g; volume of 1 mol = $60.1\text{ g} \times \frac{1\text{ mL}}{2.64\text{ g}} = \mathbf{22.8\ mL}$

34. density = $\frac{0.02780\text{ mol}}{0.2836 \times 10^{-3}\text{ L}} \times \frac{197.0\text{ g}}{1\text{ mol}} = \mathbf{1.931 \times 10^{4}\ g/L}$