Solutions Manual to Accompany

Chemistry *for Accelerated Students*

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Contents

Chapter 1

1.

$$\lambda = 543\ \text{nm} \cdot \frac{1\ \text{m}}{1\times10^{9}\ \text{nm}} = 5.43\times10^{-7}\ \text{m}$$

$$E = \frac{hv}{\lambda} = \frac{6.626\times10^{-34}\ \text{J}\cdot\text{s}\cdot 2.9979\times10^{8}\ \frac{\text{m}}{\text{s}}}{5.43\times10^{-7}\ \text{m}} = 3.66\times10^{-19}\ \text{J}$$

2.

$E = 2.2718\times10^{-19}\ \text{J}$

With 5 sig digs, we need to use constants from Appendix B with at least 5 sig digs:

$$E = \frac{hv}{\lambda} \rightarrow \lambda = \frac{hv}{E} = \frac{6.626\times10^{-34}\ \text{J}\cdot\text{s}\cdot 2.9979\times10^{8}\ \frac{\text{m}}{\text{s}}}{2.2718\times10^{-19}\ \text{J}} = 8.7439\times10^{-7}\ \text{m}\cdot\frac{10^{9}\ \text{nm}}{\text{m}} = 874.39\ \text{nm}$$

The result has 5 sig digs because the given value has 5.

3.

From Figure 1.6, $E = 2.18 \times 10^{-18}$ J

$$E = \frac{hv}{\lambda} \rightarrow \lambda = \frac{hv}{E} = \frac{6.626\times10^{-34}\ \text{J}\cdot\text{s}\cdot 2.9979\times10^{8}\ \frac{\text{m}}{\text{s}}}{2.18\times10^{-18}\ \text{J}} = 9.11\times10^{-8}\ \text{m}\cdot\frac{10^{9}\ \text{nm}}{1\ \text{m}} = 91.1\ \text{nm}$$

The result has 3 sig digs because the given value has 3.

4.

The visible spectrum is the Balmer series. From Figure 1.8,

$$\lambda_1 = 410\ \text{nm} \cdot \frac{1\ \text{m}}{1\times10^9\ \text{nm}} = 4.1\times10^{-7}\ \text{m}$$

$$\lambda_2 = 434\ \text{nm} \cdot \frac{1\ \text{m}}{1\times10^9\ \text{nm}} = 4.34\times10^{-7}\ \text{m}$$

$$\lambda_3 = 486\ \text{nm} \cdot \frac{1\ \text{m}}{1\times10^9\ \text{nm}} = 4.86\times10^{-7}\ \text{m}$$

$$\lambda_4 = 656\ \text{nm} \cdot \frac{1\ \text{m}}{1\times10^9\ \text{nm}} = 6.56\times10^{-7}\ \text{m}$$

$$E_1 = \frac{hv}{\lambda} = \frac{6.626\times10^{-34}\ \text{J}\cdot\text{s}\cdot 2.9979\times10^8\ \frac{\text{m}}{\text{s}}}{4.1\times10^{-7}\ \text{m}} = 4.8\times10^{-19}\ \text{J}\ (2\text{ sig digs because 410 has 2})$$

$$E_2 = \frac{hv}{\lambda} = \frac{6.626\times10^{-34}\ \text{J}\cdot\text{s}\cdot 2.9979\times10^8\ \frac{\text{m}}{\text{s}}}{4.34\times10^{-7}\ \text{m}} = 4.58\times10^{-19}\ \text{J}\ (3\text{ sig digs because 434 has 3})$$

$$E_3 = \frac{hv}{\lambda} = \frac{6.626\times10^{-34}\ \text{J}\cdot\text{s}\cdot 2.9979\times10^8\ \frac{\text{m}}{\text{s}}}{4.86\times10^{-7}\ \text{m}} = 4.09\times10^{-19}\ \text{J}\ (3\text{ sig digs because 486 has 3})$$

$$E_4 = \frac{hv}{\lambda} = \frac{6.626\times10^{-34}\ \text{J}\cdot\text{s}\cdot 2.9979\times10^8\ \frac{\text{m}}{\text{s}}}{6.56\times10^{-7}\ \text{m}} = 3.03\times10^{-19}\ \text{J}\ (3\text{ sig digs because 656 has 3})$$

18.

In Table 1.5, the heaviest nuclide listed is U-238.

238 nucleons – 92 protons = 146 neutrons

---

19. a.

$$73.2\ \text{g Cu} \cdot \frac{1\ \text{mol}}{63.55\ \text{g}} \cdot \frac{6.022\times10^{23}\ \text{particles}}{\text{mol}} = 6.94\times10^{23}\ \text{particles (atoms)}$$

---

19. b.

$$1.35\ \text{mol Na} \cdot \frac{6.022\times10^{23}\ \text{particles}}{\text{mol}} = 8.13\times10^{23}\ \text{particles (atoms)}$$

---

19. c.

$$1.5000\ \text{kg W} \cdot \frac{1000\ \text{g}}{1\ \text{kg}} \cdot \frac{\text{mol}}{183.85\ \text{g}} \cdot \frac{6.0221\times10^{23}\ \text{particles}}{\text{mol}} = 4.9133\times10^{24}\ \text{particles (atoms)}$$

---

20. a

$$6.022\times10^{23}\ \text{atoms K} \cdot \frac{\text{mol}}{6.022\times10^{23}\ \text{atoms}} \cdot \frac{39.098\ \text{g}}{\text{mol}} = 39.10\ \text{g}$$

(4 sig digs because the given value has 4)

---

20. b.

$$100 \text{ atoms Au} \cdot \frac{\text{mol}}{6.022 \times 10^{23} \text{ atoms}} \cdot \frac{196.9665 \text{ g}}{\text{mol}} = 3 \times 10^{-20} \text{ g}$$

(1 sig dig because the given value has 1)

---

20. c.

$$0.00100 \text{ mol Xe} \cdot \frac{131.29 \text{ g}}{\text{mol}} = 0.131 \text{ g}$$

(3 sig digs because the given value has 3)

---

20. d.

$$2.0 \text{ mol Li} \cdot \frac{6.941 \text{ g}}{\text{mol}} = 14 \text{ g}$$

(2 sig digs because the given value has 2)

---

20. e.

$$4.2120 \text{ mol Br} \cdot \frac{79.904 \text{ g}}{\text{mol}} = 336.56 \text{ g}$$

(5 sig digs because the given value has 5)

---

20. f.

$$7.422 \times 10^{22} \text{ atoms Pt} \cdot \frac{\text{mol}}{6.022 \times 10^{23} \text{ atoms}} \cdot \frac{195.08 \text{ g}}{\text{mol}} = 24.04 \text{ g}$$

(4 sig digs because the given value has 4)

---

21. a.

$$25 \text{ g Ca(OH)}_2 \cdot \frac{\text{mol}}{74.09 \text{ g}} = 0.34 \text{ mol}$$

---

21. b.

$$286.25 \text{ g Al}_2\text{(CrO}_4\text{)}_3 \cdot \frac{\text{mol}}{401.944 \text{ g}} = 0.71216 \text{ mol}$$

---

21. c

$$2.111 \text{ kg KCl} \cdot \frac{1000 \text{ g}}{1 \text{ kg}} \cdot \frac{\text{mol}}{74.551 \text{ g}} = 28.32 \text{ mol}$$

---

21. d.

$$47.50 \text{ g LiClO}_3 \cdot \frac{\text{mol}}{90.39 \text{ g}} = 0.5255 \text{ mol}$$

---

21. e.

$$10.0\text{ g }O_2 \cdot \frac{\text{mol}}{32.0\text{ g}} = 0.313\text{ mol}$$

---

21. f.

$$1.00\text{ mg }C_{14}H_{18}N_2O_5 \cdot \frac{1\text{ g}}{1000\text{ mg}} \cdot \frac{\text{mol}}{294.307\text{ g}} = 3.40\times10^{-6}\text{ mol}$$

22.

Using data from Tables 1.5 and 1.6:

92 protons	$92 \cdot 1.007276\text{ u} = 92.66939\text{ u}$
146 neutrons	$146 \cdot 1.008665\text{ u} = 147.2651\text{ u}$
92 electrons	$92 \cdot 0.0005486\text{ u} = 0.05047\text{ u}$

$$\begin{array}{r} 92.66939\text{ u} \\ 147.2651\text{ u} \\ +\ \ 0.05047\text{ u} \\ \hline 239.9850\text{ u} \end{array}$$

$$\begin{array}{r} 239.9850\text{ u} \\ -\ 238.0508\text{ u} \\ \hline 1.9342\text{ u} \end{array}$$

$$1.9342\text{ u} = 1.9342\ \frac{\text{g}}{\text{mol}} \cdot \frac{\text{mol}}{6.022142\times10^{23}\text{ atoms}} = 3.2118\times10^{-24}\ \frac{\text{g}}{\text{atom}}$$

23.

Sig digs in all products are determined by the factor with the lowest precision. Sig digs in all sums are determined according to the addition rule.

silicon

$27.9769\text{ u} \cdot 0.92223 = 25.801\text{ u}$

$28.9765\text{ u} \cdot 0.04685 = 1.358\text{ u}$

$29.9738\text{ u} \cdot 0.03092 = 0.9268\text{ u}$

$$\begin{array}{r} 25.801\text{ u} \\ 1.358\text{ u} \\ +\ \ 0.9268\text{ u} \\ \hline 28.086\text{ u} \end{array}$$

calcium

$39.9626\text{ u} \cdot 0.96941 = 38.740\text{ u}$

$41.9856\text{ u} \cdot 0.00647 = 2.72\text{ u}$

$$\begin{array}{r} 38.740\text{ u} \\ +\ \ 0.272\text{ u} \\ \hline 39.012\text{ u} \end{array}$$

---

iron

$53.9396\ \text{u} \cdot 0.05845 = 3.153\ \text{u}$

$55.9349\ \text{u} \cdot 0.91754 = 51.323\ \text{u}$

$56.9354\ \text{u} \cdot 0.02119 = 1.206\ \text{u}$

$57.9333\ \text{u} \cdot 0.00282 = 0.163\ \text{u}$

$$\begin{array}{r} 3.153\ \text{u} \\ 51.323\ \text{u} \\ 1.206\ \text{u} \\ +\ \ 0.163\ \text{u} \\ \hline 55.822\ \text{u} \end{array}$$

uranium

$235.0439\ \text{u} \cdot 0.007204 = 1.693\ \text{u}$

$238.0508\ \text{u} \cdot 0.992742 = 236.323\ \text{u}$

$$\begin{array}{r} 1.693\ \text{u} \\ +\ \ 236.323\ \text{u} \\ \hline 238.016\ \text{u} \end{array}$$

---

24. a. For all items in problem 24, sig digs are determined as in problem 23.

$$1 \cdot 14.0067\ \frac{\text{g}}{\text{mol}} = 14.0067\ \frac{\text{g}}{\text{mol}}$$

$$3 \cdot 1.0079\ \frac{\text{g}}{\text{mol}} = 3.0237\ \frac{\text{g}}{\text{mol}}$$

$$\begin{array}{r} 14.0067\ \text{g/mol} \\ +\ \ 3.0237\ \text{g/mol} \\ \hline 17.0304\ \text{g/mol} \end{array}$$

---

24. b.

$$1 \cdot 12.011\ \frac{\text{g}}{\text{mol}} = 12.011\ \frac{\text{g}}{\text{mol}}$$

$$2 \cdot 15.9994\ \frac{\text{g}}{\text{mol}} = 31.9988\ \frac{\text{g}}{\text{mol}}$$

$$\begin{array}{r} 12.011\ \text{g/mol} \\ +\ \ 31.9988\ \text{g/mol} \\ \hline 44.010\ \text{g/mol} \end{array}$$

---

24. c.

$$2 \cdot 35.4527\ \frac{\text{g}}{\text{mol}} = 70.9054\ \frac{\text{g}}{\text{mol}}$$

---

24. d.

$$1 \cdot 63.546\ \frac{\text{g}}{\text{mol}} = 63.546\ \frac{\text{g}}{\text{mol}}$$

$$1 \cdot 32.066\ \frac{\text{g}}{\text{mol}} = 32.066\ \frac{\text{g}}{\text{mol}}$$

$$4 \cdot 15.9994\ \frac{\text{g}}{\text{mol}} = 63.9976\ \frac{\text{g}}{\text{mol}}$$

$$\begin{array}{r} 63.546\ \text{g/mol} \\ 32.066\ \text{g/mol} \\ +\ \ 63.9976\ \text{g/mol} \\ \hline 159.610\ \text{g/mol} \end{array}$$

---

24. e.

$$1 \cdot 40.078\ \frac{\text{g}}{\text{mol}} = 40.078\ \frac{\text{g}}{\text{mol}}$$

$$2 \cdot 14.0067\ \frac{\text{g}}{\text{mol}} = 28.0134\ \frac{\text{g}}{\text{mol}}$$

$$4 \cdot 15.9994\ \frac{\text{g}}{\text{mol}} = 63.9976\ \frac{\text{g}}{\text{mol}}$$

$$\begin{array}{r} 40.078\ \text{g/mol} \\ 28.0134\ \text{g/mol} \\ +\ \ 63.9976\ \text{g/mol} \\ \hline 132.089\ \text{g/mol} \end{array}$$

---

24. f.

$$12 \cdot 12.011\ \frac{\text{g}}{\text{mol}} = 144.13\ \frac{\text{g}}{\text{mol}}$$
$$22 \cdot 1.0079\ \frac{\text{g}}{\text{mol}} = 22.174\ \frac{\text{g}}{\text{mol}}$$
$$11 \cdot 15.9994\ \frac{\text{g}}{\text{mol}} = 175.993\ \frac{\text{g}}{\text{mol}}$$

$$\begin{array}{r} 144.13 \text{ g/mol} \\ 22.174 \text{ g/mol} \\ +\ 175.993 \text{ g/mol} \\ \hline 342.29 \text{ g/mol} \end{array}$$

---

24. g.

$$2 \cdot 12.011\ \frac{\text{g}}{\text{mol}} = 24.022\ \frac{\text{g}}{\text{mol}}$$
$$6 \cdot 1.0079\ \frac{\text{g}}{\text{mol}} = 6.0474\ \frac{\text{g}}{\text{mol}}$$
$$1 \cdot 15.9994\ \frac{\text{g}}{\text{mol}} = 15.9994\ \frac{\text{g}}{\text{mol}}$$

$$\begin{array}{r} 24.022 \text{ g/mol} \\ 6.0474 \text{ g/mol} \\ +\ 15.9994 \text{ g/mol} \\ \hline 46.068 \text{ g/mol} \end{array}$$

---

24. h.

$$3 \cdot 12.011\ \frac{\text{g}}{\text{mol}} = 36.033\ \frac{\text{g}}{\text{mol}}$$
$$8 \cdot 1.0079\ \frac{\text{g}}{\text{mol}} = 8.0632\ \frac{\text{g}}{\text{mol}}$$

$$\begin{array}{r} 36.033 \text{ g/mol} \\ +\ 8.0632 \text{ g/mol} \\ \hline 44.096 \text{ g/mol} \end{array}$$

---

24. i.

$$1 \cdot 28.0855\ \frac{\text{g}}{\text{mol}} = 28.0855\ \frac{\text{g}}{\text{mol}}$$
$$2 \cdot 15.9994\ \frac{\text{g}}{\text{mol}} = 31.9988\ \frac{\text{g}}{\text{mol}}$$

$$\begin{array}{r} 28.0855 \text{ g/mol} \\ +\ 31.9988 \text{ g/mol} \\ \hline 60.0843 \text{ g/mol} \end{array}$$

---

25. a. For all items in problem 25, sig digs are determined as in problem 23.

$$1 \cdot 24.3050 \text{ u} = 24.3050 \text{ u}$$
$$2 \cdot 35.4527 \text{ u} = 70.9054 \text{ u}$$

$$\begin{array}{r} 24.3050 \text{ u} \\ +\ 70.9054 \text{ u} \\ \hline 95.2104 \text{ u} \end{array}$$

---

25. b.

$$1 \cdot 40.078 \text{ u} = 40.078 \text{ u}$$
$$2 \cdot 14.0067 \text{ u} = 28.0134 \text{ u}$$
$$6 \cdot 15.9994 \text{ u} = 95.9964 \text{ u}$$

$$\begin{array}{r} 40.078 \text{ u} \\ 28.0134 \text{ u} \\ +\ 95.9964 \text{ u} \\ \hline 164.087 \text{ u} \end{array}$$

---

25. c.

$$1 \cdot 32.066 \text{ u} = 32.066 \text{ u}$$
$$4 \cdot 15.9994 \text{ u} = 63.9976 \text{ u}$$

$$\begin{array}{r} 32.066 \text{ u} \\ +\ 63.9976 \text{ u} \\ \hline 96.064 \text{ u} \end{array}$$

---

25. d.

$$\begin{array}{ll} & 63.546\text{ u} \\ 1\cdot 63.546\text{ u} = 63.546\text{ u} & 32.066\text{ u} \\ 1\cdot 32.066\text{ u} = 32.066\text{ u} & \underline{+\ 63.9976\text{ u}} \\ 4\cdot 15.9994\text{ u} = 63.9976\text{ u} & 159.610\text{ u} \end{array}$$

25. e.

$$\begin{array}{ll} & 10.811\text{ u} \\ 1\cdot 10.811\text{ u} = 10.811\text{ u} & \underline{+\ 56.9952\text{ u}} \\ 3\cdot 18.9984\text{ u} = 56.9952\text{ u} & 67.806\text{ u} \end{array}$$

25. f.

$$\begin{array}{ll} & 12.011\text{ u} \\ 1\cdot 12.011\text{ u} = 12.011\text{ u} & \underline{+\ 141.811\text{ u}} \\ 4\cdot 35.4527\text{ u} = 141.811\text{ u} & 153.822\text{ u} \end{array}$$

26.

$$2.25\text{ mol AgNO}_3 \cdot \frac{169.8731\text{ g}}{\text{mol}} = 382\text{ g}$$

(3 sig digs because the given value has 3)

27. a.

$$2.25\text{ kg CCl}_4 \cdot \frac{1000\text{ g}}{\text{kg}} \cdot \frac{\text{mol}}{153.822\text{ g}} = 14.6\text{ mol}$$

(3 sig digs because the given value has 3)

27. b.

$$14.63\text{ mol} \cdot \frac{6.022\times 10^{23}\text{ particles}}{\text{mol}} = 8.81\times 10^{24}\text{ particles}$$

For CCl_4, particles = molecules, and each molecule contains 1 carbon atom, giving 8.81×10^{24} carbon atoms. (Computing moles in step 1 was an intermediate calculation for this one, thus an extra digit was retained to get 14.63.)

27. c.

From Table 1.5, 1.078% of carbon atoms are carbon-13. This gives $8.81 \times 10^{24} \cdot 0.01078 = 9.50 \times 10^{22}$ atoms of carbon-13.

28. a.

$$1.00\ \text{gal}\cdot\frac{3.785\ \text{L}}{1\ \text{gal}}\cdot\frac{1000\ \text{mL}}{1\ \text{L}}=3785\ \text{mL}$$

$$\rho=\frac{m}{V}\rightarrow m=\rho V=1.000\ \frac{\text{g}}{\text{mL}}\cdot 3785\ \text{mL}=3785\ \text{g}$$

$$3785\ \text{g}\cdot\frac{\text{mol}}{18.02\ \text{g}}=2.10\times10^{2}\ \text{mol}$$

(Result written in scientific notation in order to show 3 sig digs.)

---

28. b.

$$210.0\ \text{mol}\cdot\frac{6.022\times10^{23}\ \text{particles}}{\text{mol}}=1.264\times10^{26}\ \text{particles}$$

Particles = molecules, and there are 2 H atoms in each molecule. Doubling and rounding to 3 sig digs gives 2.53×10^{26} H atoms.

---

28. c.

From Table 1.5, H-2 is 0.0115% of all hydrogen. $2.53\times10^{26}\cdot 0.000115 = 2.91\times10^{22}$ atoms of H-2.

29.

Assuming a 100-gram sample:

$$38.7\ \text{g C}\cdot\frac{\text{mol}}{12.011\ \text{g}}=3.222\ \text{mol C}\quad(3.222/3.222=1)$$

$$9.7\ \text{g H}\cdot\frac{\text{mol}}{1.0079\ \text{g}}=9.62\ \text{mol H}\quad(9.62/3.222=2.99\approx3)$$

$$51.6\ \text{g O}\cdot\frac{\text{mol}}{15.9994\ \text{g}}=3.225\ \text{mol O}\quad(3.225/3.222\approx1)$$

These ratios give an empirical formula of CH_3O.

$$1\cdot12.011\ \text{u}+3\cdot1.0079\ \text{u}+1\cdot15.9994\ \text{u}=31.0\ \text{u}$$

$$62.1\ \text{u}\,/\,31.0\ \text{u}\approx2$$

Applying the factor of 2 to the empirical formula gives a molecular formula of $C_2H_6O_2$.

---

30. a.

$$\text{C: }\frac{43.910\ \text{g}}{47.593\ \text{g}}=0.92261=92.261\%\ \text{C}$$

$$\text{H: }\frac{3.683\ \text{g}}{47.593\ \text{g}}=0.07739=7.739\%\ \text{H}$$

---

30. b.

Assuming a 100-gram sample:

$$92.261 \text{ g C} \cdot \frac{\text{mol}}{12.011 \text{ g}} = 7.68 \text{ mol} \quad (7.68/7.68 = 1)$$

$$7.739 \text{ g H} \cdot \frac{\text{mol}}{1.0079 \text{ g}} = 7.68 \text{ mol} \quad (7.68/7.68 = 1)$$

These ratios give an empirical formula of CH.

---

30. c.

$$1 \cdot 12.011 \text{ u} + 1 \cdot 1.0079 \text{ u} = 13.019 \text{ u}$$

$$78.11 \text{ u}/13.019 \text{ u} = 6$$

Applying the factor of 6 to the empirical formula gives a molecular formula of C_6H_6.

31.

$$125.0 \text{ g } HClO_3 \cdot \frac{\text{mol}}{84.459 \text{ g}} \cdot \frac{6.022 \times 10^{23} \text{ particles}}{\text{mol}} = 8.913 \times 10^{23} \text{ particles}$$

(molecules)

---

32. a.

$$1 \cdot 22.9898 \text{ u} + 1 \cdot 1.0079 \text{ u} + 1 \cdot 12.011 \text{ u} + 3 \cdot 15.9994 \text{ u} = 84.007 \text{ u}$$

$$22.9898/84.007 = 0.27367 \rightarrow 27.367\% \text{ Na}$$

$$1.0079/84.007 = 0.011998 \rightarrow 1.1998\% \text{ H}$$

$$12.011/84.007 = 0.14298 \rightarrow 14.298\% \text{ C}$$

$$(3 \cdot 15.9994)/84.007 = 0.57136 \rightarrow 57.136\% \text{ O}$$

The sig digs in the formula mass are limited by the decimals in the mass of carbon. When this value came out with 5 sig digs, all percentages after that had 5 sig digs.

---

32. b.

$$2 \cdot 22.9898 \text{ u} + 1 \cdot 15.9994 \text{ u} = 61.9790 \text{ u}$$

$$(2 \cdot 22.9898)/61.9790 = 0.741858 \rightarrow 74.1858\% \text{ Na}$$

$$(1 \cdot 15.9994)/61.9790 = 0.258142 \rightarrow 25.8142\% \text{ O}$$

---

32. c.

$$2 \cdot 55.847 \text{ u} + 3 \cdot 15.9994 \text{ u} = 159.692 \text{ u}$$

$$(2 \cdot 55.847)/159.692 = 0.69943 \rightarrow 69.943\% \text{ Fe}$$

$$(3 \cdot 15.9994)/159.692 = 0.300567 \rightarrow 30.0567\% \text{ O}$$

The sig digs in the formula mass are limited by the decimals in the mass of iron. The atomic mass of iron also limits the iron percentage to 5 sig digs.

---

32. d.

$1 \cdot 107.8682 \text{ u} + 1 \cdot 14.0067 \text{ u} + 3 \cdot 15.9994 \text{ u} = 169.8731 \text{ u}$

$(1 \cdot 107.8682)/169.8731 = 0.6349928 \rightarrow 63.49928\%$ Ag

$(1 \cdot 14.0067)/169.8731 = 0.0824539 \rightarrow 8.24539\%$ N

$(3 \cdot 15.9994)/169.8731 = 0.282553 \rightarrow 28.2553\%$ O

---

32. e.

$1 \cdot 40.078 \text{ u} + 4 \cdot 12.011 \text{ u} + 6 \cdot 1.0079 \text{ u} + 4 \cdot 15.9994 \text{ u} = 158.167 \text{ u}$

$(1 \cdot 40.078)/158.167 = 0.25339 \rightarrow 25.339\%$ Ca

$(4 \cdot 12.011)/158.167 = 0.30375 \rightarrow 30.375\%$ C

$(6 \cdot 1.0079)/158.167 = 0.038234 \rightarrow 3.8234\%$ H

$(4 \cdot 15.9994)/158.167 = 0.404620 \rightarrow 40.4620\%$ O

The sig digs in the formula mass are limited to the third decimal by Ca and C. In the results, the sig digs for Ca, C, and H are limited by the atomic masses to 5. O has 6 sig digs in the mass, thus 6 in the result.

---

32. f.

$9 \cdot 12.011 \text{ u} + 8 \cdot 1.0079 \text{ u} + 4 \cdot 15.9994 \text{ u} = 180.160 \text{ u}$

$(9 \cdot 12.011)/180.160 = 0.60002 \rightarrow 60.002\%$ C

$(8 \cdot 1.0079)/180.160 = 0.044756 \rightarrow 4.4756\%$ H

$(4 \cdot 15.9994)/180.160 = 0.355226 \rightarrow 35.5226\%$ O

33.

$1 \cdot 65.39 \text{ u} + 1 \cdot 32.066 \text{ u} + 4 \cdot 15.9994 \text{ u} + 14 \cdot 1.0079 \text{ u} + 7 \cdot 15.9994 \text{ u} = 287.56 \text{ u}$

$14 \cdot 1.0079 \text{ u} + 7 \cdot 15.9994 \text{ u} = 126.1064 \text{ u}$

$126.1064 / 287.56 = 0.43854$ (43.854%)

34.

Assuming a 100-gram sample:

$$22.65 \text{ g S} \cdot \frac{\text{mol}}{32.066 \text{ g}} = 0.7064 \text{ mol} \quad (0.7064/0.7064 = 1)$$

$$32.38 \text{ g Na} \cdot \frac{\text{mol}}{22.9898 \text{ g}} = 1.408 \text{ mol} \quad (1.408/0.7064 \approx 2)$$

$$44.99 \text{ g O} \cdot \frac{\text{mol}}{15.9994 \text{ g}} = 2.812 \text{ mol} \quad (2.812/0.7064 \approx 4)$$

These ratios give an empirical formula of SNa_2O_4. As we see later, this is actually Na_2SO_4.

35.

$$1 \cdot 12.011 \text{ u} + 2 \cdot 1.0079 \text{ u} + 1 \cdot 15.9994 \text{ u} = 30.026 \text{ u}$$

$$120.12 / 30.026 \approx 4$$

Applying the factor of 4 to the empirical formula gives a molecular formula of $C_4H_8O_4$.

36. a.

Assuming a 100-gram sample:

$$49.5 \text{ g C} \cdot \frac{\text{mol}}{12.011} = 4.12 \text{ mol} \quad (4.12/1.03 = 4)$$

$$5.15 \text{ g H} \cdot \frac{\text{mol}}{1.0079} = 5.11 \text{ mol} \quad (5.11/1.03 \approx 5)$$

$$28.9 \text{ g N} \cdot \frac{\text{mol}}{14.0067} = 2.06 \text{ mol} \quad (2.06/1.03 = 2)$$

$$16.5 \text{ g O} \cdot \frac{\text{mol}}{15.9994} = 1.03 \text{ mol} \quad (1.03/1.03 = 1)$$

These ratios give an empirical formula of $C_4H_5N_2O$. We get the multiplier factor from the empirical formula mass:

$$4 \cdot 12.011 \text{ u} + 5 \cdot 1.0079 \text{ u} + 2 \cdot 14.0067 \text{ u} + 1 \cdot 15.9994 \text{ u} = 97.096 \text{ u}$$

$$195 / 97.096 \approx 2$$

This factor gives a molecular formula of $C_8H_{10}N_4O_2$.

36. b.

Assuming a 100-gram sample:

$$75.69 \text{ g C} \cdot \frac{\text{mol}}{12.011} = 6.302 \text{ mol} \quad (6.302/0.9694 \approx 6.5) \rightarrow (6.5 \cdot 2 = 13)$$

$$8.80 \text{ g H} \cdot \frac{\text{mol}}{1.0079} = 8.73 \text{ mol} \quad (8.73/0.9694 \approx 9) \rightarrow (9 \cdot 2 = 18)$$

$$15.51 \text{ g O} \cdot \frac{\text{mol}}{15.9994} = 0.9694 \text{ mol} \quad (0.9694/0.9694 = 1) \rightarrow (1 \cdot 2 = 2)$$

The values are all doubled to obtain whole number ratios. These ratios give an empirical formula of $C_{13}H_{18}O_2$. We get the multiplier factor from the empirical formula mass:

$$13 \cdot 12.011 \text{ u} + 18 \cdot 1.0079 \text{ u} + 2 \cdot 15.9994 \text{ u} = 206.284 \text{ u}$$

$$206 / 206.284 \approx 1$$

The factor of 1 indicates that the empirical and molecular formulas are the same.

36. c.

Assuming a 100-gram sample:

$$81.71 \text{ g C} \cdot \frac{\text{mol}}{12.011} = 6.803 \text{ mol} \quad (6.803/6.803 = 1) \rightarrow (1 \cdot 3 = 3)$$

$$18.29 \text{ g H} \cdot \frac{\text{mol}}{1.0079} = 18.15 \text{ mol} \quad (18.15/6.803 \approx 2.668) \rightarrow (2.668 \cdot 3 \approx 8)$$

The values are all tripled to obtain whole number ratios. These ratios give an empirical formula of C_3H_8. We get the multiplier factor from the empirical formula mass:

$$3 \cdot 12.011 \text{ u} + 8 \cdot 1.0079 \text{ u} = 44.096 \text{ u}$$

$$44.096 / 44.096 = 1$$

The factor of 1 indicates that the empirical and molecular formulas are the same.

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36. d.

Assuming a 100-gram sample:

$$57.14 \text{ g C} \cdot \frac{\text{mol}}{12.011} = 4.757 \text{ mol} \quad (4.757/0.680 \approx 7) \rightarrow (7 \cdot 2 = 14)$$

$$6.16 \text{ g H} \cdot \frac{\text{mol}}{1.0079} = 6.11 \text{ mol} \quad (6.11/0.680 \approx 9) \rightarrow (9 \cdot 2 = 18)$$

$$9.52 \text{ g N} \cdot \frac{\text{mol}}{14.0067} = 0.680 \text{ mol} \quad (0.680/0.680 = 1) \rightarrow (1 \cdot 2 = 2)$$

$$27.18 \text{ g O} \cdot \frac{\text{mol}}{15.9994} = 1.699 \text{ mol} \quad (1.699/0.680 = 2.5) \rightarrow (2.5 \cdot 2 = 5)$$

The values are all doubled to obtain whole number ratios. These ratios give an empirical formula of $C_{14}H_{18}N_2O_5$. We get the multiplier factor from the empirical formula mass:

$$14 \cdot 12.011 \text{ u} + 18 \cdot 1.0079 \text{ u} + 2 \cdot 14.0067 \text{ u} + 5 \cdot 15.9994 \text{ u} = 294.31 \text{ u}$$

$$294.302 / 294.31 \approx 1$$

The factor of 1 indicates that the empirical and molecular formulas are the same.

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36. e.

Assuming a 100-gram sample:

$$92.26 \text{ g C} \cdot \frac{\text{mol}}{12.011} = 7.681 \text{ mol} \quad (7.681/7.68 \approx 1)$$

$$7.74 \text{ g H} \cdot \frac{\text{mol}}{1.0079} = 7.68 \text{ mol} \quad (7.68/7.68 = 1)$$

These ratios give an empirical formula of CH. We get the multiplier factor from the empirical formula mass:

$$1 \cdot 12.011 \text{ u} + 1 \cdot 1.0079 \text{ u} = 13.019 \text{ u}$$

$$26.038 / 13.019 = 2$$

This factor gives a molecular formula of C_2H_2.

37.

$$9.581/10.5 = 0.912 \rightarrow 91.2\%\ \text{C}$$

$$0.919/10.5 = 0.0875 \rightarrow 8.75\%\ \text{H}$$

Assuming a 100-gram sample:

$$91.2\ \text{g C} \cdot \frac{\text{mol}}{12.011\ \text{g}} = 7.59\ \text{mol} \quad (7.59/7.59 = 1) \rightarrow (1 \cdot 7 = 7)$$

$$8.75\ \text{g H} \cdot \frac{\text{mol}}{1.0079\ \text{g}} = 8.68\ \text{mol} \quad (8.68/7.59 \approx 1.14) \rightarrow (1.14 \cdot 7 = 8)$$

The values are multiplied by 7 to obtain whole number ratios. These ratios give an empirical formula of C_7H_8. We get the multiplier factor from the empirical formula mass:

$$7 \cdot 12.011\ \text{u} + 8 \cdot 1.0079\ \text{u} = 92.140\ \text{u}$$

$$92.140/92.140 = 1$$

The factor of 1 indicates that the empirical and molecular formulas are the same.

Chapter 2

6. a.

$$\frac{1.098\ \text{Å}}{2}+\frac{0.741\ \text{Å}}{2}=0.920\ \text{Å} \qquad \frac{|1.012\ \text{Å}-0.920\ \text{Å}|}{1.012\ \text{Å}}\times 100\%=9.09\%$$

6. b.

$$\frac{1.242\ \text{Å}}{2}+\frac{1.208\ \text{Å}}{2}=1.225\ \text{Å} \qquad \frac{|1.128\ \text{Å}-1.225\ \text{Å}|}{1.128\ \text{Å}}\times 100\%=8.60\%$$

6. c.

$$\frac{1.242\ \text{Å}}{2}+\frac{1.208\ \text{Å}}{2}=1.225\ \text{Å} \qquad \frac{|1.160\ \text{Å}-1.225\ \text{Å}|}{1.160\ \text{Å}}\times 100\%=5.60\%$$

6. d.

$$\frac{1.893\ \text{Å}}{2}+\frac{1.413\ \text{Å}}{2}=1.653\ \text{Å} \qquad \frac{|1.570\ \text{Å}-1.653\ \text{Å}|}{1.570\ \text{Å}}\times 100\%=5.29\%$$

33.

$$\lambda = 94\ \text{nm}\cdot\frac{1\ \text{m}}{1\times 10^{9}\ \text{nm}}=9.4\times 10^{-8}\ \text{m}$$

$$E=\frac{hv}{\lambda}=\frac{6.626\times 10^{-34}\ \text{J}\cdot\text{s}\cdot 2.9979\times 10^{8}\ \dfrac{\text{m}}{\text{s}}}{9.4\times 10^{-8}\ \text{m}}=2.11\times 10^{-18}\ \text{J}\cdot\frac{1\ \text{eV}}{1.60\times 10^{-19}\ \text{J}}=13\ \text{eV}$$

34.

$$E=5.09\times 10^{-19}\ \text{J}$$

$$E=\frac{hv}{\lambda}\rightarrow \lambda=\frac{hv}{E}=\frac{6.626\times 10^{-34}\ \text{J}\cdot\text{s}\cdot 2.9979\times 10^{8}\ \dfrac{\text{m}}{\text{s}}}{5.09\times 10^{-19}\ \text{J}}=3.903\times 10^{-7}\ \text{m}\cdot\frac{1\times 10^{9}\ \text{nm}}{1\ \text{m}}=390\ \text{nm}$$

The result is stated with only 2 sig digs instead of three so we can see it in nanometers and compare it to the visible band of 700–400 nm. Doing so, the light is in the ultraviolet band and would thus not be visible.

37.

$$112\ \text{g CO}_2\cdot\frac{\text{mol}}{44.01\ \text{g}}\cdot\frac{6.022\times 10^{23}\ \text{particles}}{\text{mol}}=1.53\times 10^{24}\ \text{particles}$$

For CO_2, the particles are molecules and there is one atom of C in each molecule. Thus, this value is the number of carbon atoms.

38.

$$2 \cdot 1.0079 \text{ u} + 1 \cdot 32.066 \text{ u} + 4 \cdot 15.9994 \text{ u} = 98.079 \text{ u}$$

$$2 \cdot 1.0079 \text{ u} / 98.079 \text{ u} = 0.020553 \rightarrow 2.0553\% \text{ H}$$

$$1 \cdot 32.066 \text{ u} / 98.079 \text{ u} = 0.32694 \rightarrow 32.694\% \text{ S}$$

$$4 \cdot 15.9994 \text{ u} / 98.079 \text{ u} = 0.65251 \rightarrow 65.251\% \text{ O}$$

$$35.0 \text{ g } H_2SO_4 \cdot \frac{\text{mol}}{98.079 \text{ g}} \cdot \frac{6.022 \times 10^{23} \text{ particles}}{\text{mol}} = 2.15 \times 10^{23} \text{ particles}$$

Each particle is a molecule, and each molecule contains 2 H atoms, 1 S atom, and 4 O atoms. Thus, the numbers of atoms are 4.30×10^{23} H atoms, 2.15×10^{23} S atoms, and 8.60×10^{23} O atoms.

40.

The difference in mass between Br-79 and Br-81 is 2 u. The difference between the average mass 79.904 and 79 is 0.904. 0.904/2 = 0.452. If the average were 80, the proportion of each isotope would be 0.5. Instead the proportions are 0.452 and 0.548. Since the average mass of 79.904 is closer to 79 than it is to 81, the proportion of Br-79 is greater, and is 0.548. Thus, the closest of the choices given is 52%.

41.

$$3.00 \text{ mol } CaBr_2 \cdot \frac{199.89 \text{ g}}{\text{mol}} = 599.7 \text{ g}$$

$$40.078 \text{ u} / 199.89 \text{ u} = 0.2005 \text{ (proportion of calcium)}$$

$$0.2005 \cdot 599.7 \text{ g} = 1.20 \times 10^2 \text{ g}$$

The result is stated in scientific notation in order to show 3 sig digs.

42.

Assuming a 100-gram sample:

$$53.64 \text{ g Cl} \cdot \frac{\text{mol}}{35.4527 \text{ g}} = 1.513 \text{ mol} \quad (1.513 / 0.2522 = 6)$$

$$46.36 \text{ g W} \cdot \frac{\text{mol}}{183.85 \text{ g}} = 0.2522 \text{ mol} \quad (0.2522 / 0.2522 = 1)$$

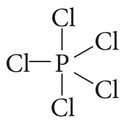
The 6:1 ratio gives an empirical formula of WCl_6.

Chapter 3

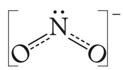
20. a.

The Lewis structure is: S=C=S Each bond is a double bond, so bond number is 2.

20. b.

The Lewis structure is:  Each bond is a single bond, so bond number is 1.

20. c.

The Lewis structure is:  Each bond is composed of one part single bond and one part that is its share of the resonance structure bond. There is one resonance structure bond to be shared by two bonds, so the share of each is 0.5. Adding this to the single bond we get a bond number of 1.5.

22. a.

Be—F: 2.41, O—F: 0.54, C—F: 1.43

22. b.

F—F: 0, B—F: 1.94, S—O: 0.86

22. c.

O—Cl: 0.28, S—Cl: 0.58, C—P: 0.36

24.

$$100.00\text{ g CaCO}_3 \cdot \frac{\text{mol}}{100.057\text{ g}} \cdot \frac{6.02214\times10^{23}\text{ particles}}{\text{mol}} = 6.0187\times10^{23}\text{ particles}$$

In this ionic compound, the particles are formula units. There are 3 O atoms in each formula unit, so the number of O atoms is 1.8056×10^{24}.

25.

$$1\cdot 32.066\text{ u} + 6\cdot 18.9984\text{ u} = 146.056\text{ u}$$

$$1\cdot 32.066\text{ u}/146.056\text{ u} = 0.21955 \rightarrow 21.955\%\text{ S}$$

$$6\cdot 18.9984\text{ u}/146.056\text{ u} = 0.780457 \rightarrow 78.0457\%\text{ F}$$

28.

$$12.00\text{ u}\cdot 0.9893 + 13.0034\text{ u}\cdot 0.01078 = 12.01\text{ u}$$

$$\text{percent difference} = \frac{|12.01\text{ u} - 12.01\text{ u}|}{12.01\text{ u}} \times 100\% = 0.00\%$$