Chapter 4 – Problem Solving in Chemistry – Answer Key

Chapter 4: 1 – 5, 7, 9 – 17, 19, 22 – 24, 26 – 29, 33, 34, 38, 40, 51, 52, 56, 70 (30 total)

Practice Problems

1. The density of silicon is 2.33 g/ cm^3. What is the volume of a piece of silicon that has a mass of 62.9 g? Rearrange d = m/ V to V = m/ d; V = 62.9 g/ 2.33 g/ cm^3; V = 26.9 cm^3

2. Helium has a boiling point of 4 K. This is the lowest boiling point of any liquid. Express this temperature in degrees Celsius.

Use °C = K – 273. °C = 4 K – 273; Answer is -269°C

Section Review 4.1

3. List three useful problem-solving skills.

a. Write out any problem, list things that are known and things unknown.
b. Draw diagrams, pictures, and maps, if necessary.
c. Collect as much data as possible, from the problem.
d. Allow yourself plenty of time, don't wait until the last minute to complete homework.

4. State in your own words the three suggested step for solving word problems.

a. Analyze the problem first – list what is known and what is unknown.
b. Calculate – set up the problem mathematically – solving for unknowns.
c. Evaluate – ask yourself if the answer makes any sense.

5. Identify the statements that correctly complete the sentence: Good problem solvers

a. read a problem only once.

<u>b. check their work.</u>

<u>c. break complex problems down into one or more simpler problems.</u>

<u>d. look for relationships among pieces of information.</u>

7. Calculate normal body temperature (37℃) on the Kelvin scale.

Wanted: temperature in kelvins. Given: body temperature in degrees Celsius.

Equation: K = °C + 273; Solve: 37 + 273 = 310 K

Practice Problems

9. An experiment requires that each student use an 8.5-cm length of magnesium ribbon. How many students can perform the experiment if there is a 570-cm length of magnesium ribbon available?

$$\# \ students = (570 \ cm)((1 \text{ student})/(8.5 \text{ cm})) = 67 \ students$$

10. A 1.00-degree increase on the Celsius scale is equivalent to a 1.80-degree increase on the Fahrenheit scale. If a temperature increases by 48.0℃, what is the corresponding temperature increase on the Fahrenheit scale?

Consider the ratio or conversion factor provided, of 1.00 ˚C/ 1.80 ˚F

$$(48.0^{\circ}C)\left(\frac{1.80\ ^{\circ}\mathrm{F}}{1.00\ ^{\circ}\mathrm{C}}\right) = 86.4\ ^{\circ}\mathrm{F}$$

Practice Problems

11. Using tables from Chapter 3, convert the following.

a. 0.044 km to meters $(0.044\ km)\left(\frac{1{,}000\ m}{1\ km}\right) = 44\ m$

b. 4.6 mg to grams $(4.6\ mg)\left(\frac{1\ gram}{1000\ mg}\right) = 0.0046\ g$

c. 8.9 m to decimeters $(8.9\ m)\left(\frac{10\ decimeters}{1\ m}\right) = 89\ dm$

d. 0.107 g to centigrams $(0.107\ g)\left(\frac{100\ cg}{1\ g}\right) = 10.7\ cg$

12. Convert the following.

a. 15 cm^3 to liters $(15\ cm^3)\left(\frac{1\ mL}{1\ cm^3}\right)\left(\frac{1\ L}{1000\ mL}\right) = 0.015\ L$

b. 7.38 g to kilograms $(7.38\ g)\left(\frac{1\ kg}{1000\ g}\right) = 0.00738\ kg$

c. 0.67 s to milliseconds $(0.67\ s)\left(\frac{1000\ ms}{1\ s}\right) = 670\ s$

d. 94.5 g to micrograms $(94.5\ g)\left(\frac{1{,}000{,}000\ \mu g}{1\ g}\right) = 9.45\ x\ 10^7\ \mu g$

Practice Problems

13. Use dimensional analysis and the given densities to make the following conversions.

a. 14.8 g of boron (B) to cubic centimeters of boron. The density of boron is 2.34 g/ cm^3.

$$(14.8\ g\ B)\left(\frac{1\ cm^3}{2.34\ g\ B}\right) = 6.32\ cm^3\ B$$

b. 2.8 L of argon (Ar) to grams of argon. The density of argon is 1.78 g/ L

$$(2.8\ L\ Ar)\left(\frac{1.78\ g\ Ar}{1\ L}\right) = 5.0\ g\ Ar$$

c. 4.62 g of mercury (Hg) to cubic centimeters. The density of mercury is 13.5 g/ cm^3.

$$(4.62\ g\ Hg)\left(\frac{1\ cm^3}{13.5\ g\ Hg}\right) = 0.342\ cm^3\ Hg$$

Practice Problems

14. Rework the preceding problems on your calculator by applying the equation: density = mass/ volume, in order to check your answers.

Boron = 14.8 g B/ 6.32 cm^3 = 2.34 g/ cm^3 Argon = 5.0 g Ar/ 2.8 L = 1.78 g/ L

Mercury = 4.62 g Hg/ 0.342 cm^3 = 13.5 g Hg/ cm^3

Section Review 4.2

15. What conversion factor would you use to convert between these pairs of units?

a. minutes to hours 1 hour/ 60 min

b. grams of water to cubic centimeters of water 1 cm^3 H_2O/ 1 g H_2O

c. grams to milligrams 10^3 mg/ 1 g

d. cubic decimeters to milliliters 10^3 mL/ 1 dm^3

16. Make the following conversions. Express your answers in scientific notation.

a. 36 cm to meters $(36\ cm)\left(\frac{1\ m}{100\ cm}\right) = 0.36\ m, or\ 3.6\ x\ 10^{-1}$

b. 14.8 g to micrograms $(14.8\ g)\left(\frac{1{,}000{,}000\ \mu g}{1\ g}\right) = 14{,}800{,}000\ \mu g\ or\ 1.48\ x\ 10^7\ \mu g$

c. 1.44 kL to liters $(1.44\ kL)\left(\frac{1000\ L}{1\ kL}\right) = 1{,}440\ L\ or\ 1.44\ x\ 10^3\ L$

16. (continued)

d. 68.9 m to decimeters $(68.9\ m)\left(\frac{10\ dm}{1\ m}\right) = 689\ dm, or\ 6.89\ x\ 10^2\ dm$

e. 3.72 x 10^{-3} kg to grams $(3.72\ x\ 10^{-3}\ kg)\left(\frac{1000\ g}{1\ kg}\right) = 3.72\ g\ or\ 3.72\ x\ 10^0\ g$

f. 66.3 L to cubic centimeters $(66.3\ L)\left(\frac{1000\ mL}{1\ L}\right)\left(\frac{1\ cm^3}{1\ mL}\right) = 66{,}300\ cm^3\ or\ 6.63\ x\ 10^4\ cm^3$

g. 0.0371 m to kilometers $(0.0371\ m)\left(\frac{1\ km}{1000\ m}\right) = 0.0000371\ km\ or\ 3.71\ x\ 10^{-5}\ km$

17. A 2.00-kg sample of bituminous coal is composed of 1.30 kg of carbon, 0.20 kg of ash, 0.15 kg of water, and 0.35 kg of volatile (gas-forming) material. Using this information, determine how many kilograms of carbon are in 125 kg of this coal.

$$(125\ kg\ coal)\left(\frac{1.30\ kg\ carbon}{2.00\ kg\ coal}\right) = 81.3\ kg\ carbon, or\ 8.13\ x\ 10^1\ kg\ carbon$$

19. An atom of gold (Au) has a mass of 3.271 x 10^{-22} g. How many atoms of gold are in 5.00 g of gold?

$$(5.00\ g\ Au)\left(\frac{1\ atom\ Au}{3.271\ x\ 10^{-22} g}\right) = 1.53\ x\ 10^{22}\ atoms\ Au$$

Practice Problems

22. How many minutes are there in exactly one week?

$$(1\ week)\left(\frac{7\ days}{1\ week}\right)\left(\frac{24\ hours}{1\ day}\right)\left(\frac{60\ minutes}{1\ hour}\right) = 10{,}080\ minutes, or\ 1.008\ \ x\ 10^4\ minutes$$

23. How many seconds are there in exactly a 40 hour work week?

$$(40\ hours)\left(\frac{60\ minutes}{1\ hour}\right)\left(\frac{60\ s}{1\ minute}\right) = 144{,}000\ seconds, or\ 1.44\ x\ 10^5\ seconds$$

Practice Problems

24. Gold has a density of 19.3 g/ cm^3. What is the density in kilograms per cubic meter?

$$\left(\frac{19.3\ g\ Au}{cm^3}\right)\left(\frac{1\ kg}{1000\ g}\right)\left(\frac{1{,}000{,}000\ cm^3}{1\ m^3}\right) = 19{,}300\frac{kg}{m^3}\ or\ 1.93\ x\ 10^4\ \frac{kg}{m^3}$$

Section Review 4.3

26. How can you solve a complicated problem more easily?

First *analyze* the problem by listing the knowns and unknowns. Then consider conversion factors, ratios, and unit relationships and set up the problem (always including units in intermediate steps), and *calculate*. Finally, *evaluate* your answer, does it make sense?

27. How are complex units dealt with in calculations?

You may want to use many conversion factors. Again, include units always in those intermediate steps, treat units with as much importance as the numbers themselves.

28. Convert the following. Express your answers in scientific notation.

a. 7.5×10^4 nm to kilometers $(7.5\ x\ 10^4\ nm)\left(\frac{1\ m}{1\ x\ 10^9\ nm}\right)\left(\frac{1\ km}{1{,}000\ m}\right) = 7.5\ x\ 10^{-8}\ km$

b. 3.9×10^5 mg to decigrams $(3.9\ x\ 10^5 mg)\left(\frac{1\ g}{1000\ mg}\right)\left(\frac{10\ dg}{1\ g}\right) = 3.9\ x\ 10^3 dg$

c. 0.764 km to centimeters $(0.764\ km)\left(\frac{1000\ m}{1\ km}\right)\left(\frac{100\ cm}{1\ m}\right) = 7.64\ x\ 10^4 cm$

d. 2.21×10^{-4} dL to microliters $(2.21\ x\ 10^{-4} dL)\left(\frac{1\ L}{10\ dL}\right)\left(\frac{1\ x\ 10^6\ \mu L}{1\ L}\right) = 2.21\ x\ 10^1 \mu L$

29. Light travels at a speed of 3.00×10^{10} cm/ s. What is the speed of light in kilometers per hour?

$$\left(\frac{3.00\ x\ 10^{10} cm}{s}\right)\left(\frac{60\ s}{1\ min}\right)\left(\frac{60\ min}{1\ hr}\right)\left(\frac{1\ m}{100\ cm}\right)\left(\frac{1\ km}{1000\ m}\right) = 1.08\ x\ 10^9\ \frac{km}{hr}$$

Chapter 4 Review

33. A volume of 5.00 mL of mercury (Hg) is added to a beaker that has a mass of 87.3 g. What is the mass of the beaker with the added mercury? 4.1

First calculate the mass of Hg added: $(5.00\ mL)\left(\frac{1\ cm^3}{1\ mL}\right)\left(\frac{13.56\ g\ Hg}{cm^3}\right) = 67.8\ g\ Hg$

Then, add the mass of 67.8 g Hg to that of the beaker: 87.3 g + 67.8 g = 155 g.

34. What is the name given to a ratio of two equivalent measurements? 4.2

Conversion Factor

38. One of the first mixtures of metal used by dentists for tooth fillings consisted of 26.0 g of silver, 10.8 g of tin, 2.4 g of copper, and 0.8 g of zinc. How much silver is in a 25.0 g sample of this amalgam? 4.2

$$(25.0\ g\ Amalgam)\left(\frac{26.0\ g\ silver}{40.0\ g\ Amalgam}\right) = 16.3\ g\ silver$$

40. The density of dry air measured at 25℃ is 1.19×10^{-3} g/ cm^3. What is the volume of 50.0 g of air? 4.2

$$(50.0\ g\ air)\left(\frac{1\ cm^3}{1.19\ x\ 10^{-3}}\right) = 4.20\ x\ 10^4\ cm^3$$

51. Alkanes are a class of molecules that have the general formula C_nH_{2n+2}, where n in an integer. The table below gives the boiling points for the first five alkanes with an odd number of carbon atoms. Using the table, construct a graph with number of carbon atoms on the x-axis.

Boiling Point (℃)	Number of carbon atoms
-162.0	1
-42.0	3
36.0	5
98.0	7
151.0	9

a. what are the approximate boiling points for the C_2, C_4, C_6, and C_8 alkanes?

C_2 = -90 ° C; C_4 = 0 ° C; C_6 = 70 ° C; C_8 = 125 ° C

b. Which of these nine alkanes are gases at room temperature (20℃)?

C_1 through C_4

c. How many of these nine alkanes are liquids at 350K?

three

d. What is the approximate increase in boiling point per additional carbon atom in this series of alkanes?

From C_1 through C_9, the increase is approximately 38° C per additional carbon [-162 + (-151) = 313/ 8 carbons = 39.2]. Over the range C_3 through C_9, the increase is about 32 ° C per additional carbon [-42 + (-151) = 193/ 6 = 32.1].

52. Earth is approximately 1.5 x 10^8 km from the sun. How many minutes does it take light to travel from the sun to Earth? The speed of light is 3.00 x 10^8 m/s.

$$(1.5\ x\ 10^8\ km)\left(\frac{1000\ m}{1\ km}\right)\left(\frac{s}{3.00\ x\ 10^8\ m}\right)\left(\frac{1\ min}{60\ s}\right) = 8.2\ min$$

56. Choose the term that best completes the second relationship.

a. journey: route problem: ____________

(1) unknown (3) known

(2) plan (4) calculate

b. meter: 100 cm gram: _____________

(1) 0.001 kL (3) 1000 mg

(2) 100 cm (4) 100 kg

70. The density of dry air at 20℃ is 1.20 g/ L. What is the mass of air, in kilograms, of a room that measures 25.0 m by 15.0 m by 4.0 m?

First calculate the volume of the room: (25.0 m) (15.0 m) (4.0 m) = 1,500 m^3

$$(1{,}500\ m^3)\left(\frac{1\ x\ 10^6\ cm^3}{1\ m^3}\right)\left(\frac{1\ mL}{1\ cm^3}\right)\left(\frac{1\ L}{1000\ mL}\right)\left(\frac{1.20\ g\ dry\ air}{1\ L}\right)\left(\frac{1\ kg}{1000\ g}\right) = 1.8\ x\ 10^3\ kg$$