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2 Measurement in Science and Medicine

Chapter 2

End of Chapter Problems with correct answers

2.1 Units of Measurement
LO 1: Report measurements of length, mass, and volume in metric units.

2.01 A nurse in a hospital works with many measurements. Sort each of these measurements into the appropriate category (volume, mass, or length).

(A) The tumor removed from a cancer patient was measured to be 4.3 g. **(Mass)**
(B) A cut along a child's foot was measured to be 6.5 cm. **(Length)**
(C) A urine sample was measured to be 81.5 mL. **(Volume)**

2.02 Match each definition with the appropriate type of measurement (volume, mass, length).

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(A) The amount of matter an object contains. **(Mass)**
(B) The amount of space a substance occupies. **(Volume)**

2.03 How many micrograms are in one gram?

(A) one thousand
(B) one hundred
(C) one million
(D) ten

Answer: C

2.04 Which is a measurement of length?

(A) 11.3 L
(B) 39.2 g
(C) 74.4 m
(D) 96.7 s

Answer: C

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2.05 Identify the types of measurements.

Part A: Which type of measurement is a value of 26.6 mL?

(A) time
(B) volume
(C) length
(D) mass

Answer: B

Part B: Which type of measurement is a value of 17.5 mm?

(A) volume
(B) temperature
(C) mass
(D) length

Answer: D

2.06 Match the correct scientific *metric* unit with the correct measurement type by dragging the appropriate measured unit into each box. One or more of the unit options provided may not qualify to be moved into a category.

(A) **Volume**: liter
(B) **Length:** meter
(C) **Mass**: gram
(D) **None of the above**: pound (non-metric mass), gallon (non-metric volume), hour (time), inch (non-metric length), Celsius (temperature).

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2.07 Classify the type of information in each example.

Part A: A hospital patient is given a 10 mL injection of morphine for pain management. (Options: mass, volume, length, time)
Answer: Volume

Part B: A newborn baby delivered in a clinic is 3.1 kg. (options: length, temperature, time, mass)
Answer: Mass

Part C: A child with a bacterial infection is given 125 mg of the antibiotic, amoxicillin (Options: time, length, mass, volume)
Answer: Mass

2.08 Match the correct scientific *metric* unit abbreviation with the correct measurement type by dragging the appropriate measured unit into each box. One or more of the unit options provided may not qualify to be moved into a category.

(A) **Time**: sec
(B) **Temperature:** °C
(C) **Volume**: L
(D) **None of the above**: kg (mass), lb (non-metric mass), °F (non-metric temperature), m (length), gal (non-metric volume).

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2.09 **Part A**: How many mL are in one L? (options: 0.001, 0.01, 100 1000)
Answer: 1000

Part B: There are _____ grams in one kilogram. (options: 0.001, 0.01, 100 1000)
Answer: 1000

Part C: 100 cm = _____ m (options: 1, 100, 0.1, 0.01)
Answer: 1

2.10 Match each measurement with the correct measurement type. Drag the appropriate measured value into the correct category.

(A) **Mass:** 26 grams, 38 kg
(B) **Length:** 4.1 cm, 3.1 meters
(C) **Volume:** 6.8 milliliters, 2.6 L
(D) **None of the above:** 37 °C (temperature), 68 sec (time), 98.6 °F (temperature), 24 hr (time).

2.11 Select an image that represents each type of measurement and drag it into the correct category

(A) **Mass**



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(B) **None of the above**



(C) **Volume**



(D) **Length**



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2.12 Which sequence correctly ranks the values from smallest to largest?

(A) microgram, gram, milligram, kilogram
(B) milligram, microgram, gram, kilogram
(C) kilogram, gram, milligram, microgram
(D) microgram, milligram, gram, kilogram

Answer: D

2.13 Which sequence correctly ranks the values from smallest to largest**?**

(A) milliliter, microliter, liter, deciliter
(B) microliter, milliliter, deciliter, liter
(C) microliter, milliliter, liter, deciliter
(D) liter, deciliter, milliliter, microliter

Answer: B

2.14 Consider the information given and determine the appropriate answer for the hospital patient in each case.

Part A: A patient is given 2.2×10^2 mg of a drug to help reduce pain. How many grams does this represent?

Answer: **0.22 g**

Solution:
$$\left[\frac{2.2\times10^{2}\ \cancel{\text{mg}}}{1}\right]\times\left[\frac{1\ \text{g}}{1000\ \cancel{\text{mg}}}\right]=0.22\ \text{g}$$

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Part B: A tumor biopsy was taken from a patient and measured to be 4.5×10^{-4} g. How many micrograms (μg) does this represent?

Answer: **450 μg**

Solution:
$$\left[\frac{4.5\times10^{-4}\ \cancel{\text{g}}}{1}\right]\times\left[\frac{1\times10^{6}\ \mu\text{g}}{1\ \cancel{\text{g}}}\right]=450\ \mu\text{g}$$

2.15 **Part A:** During an eye surgery, a patient's retina is injected with 7.5×10^{-5} L of fluid. How many microliters (μL) is this?

Answer: **75 μL**

Solution:
$$\left[\frac{7.5\times10^{-5}\ \cancel{\text{L}}}{1}\right]\times\left[\frac{1\times10^{6}\ \mu\text{L}}{1\ \cancel{\text{L}}}\right]=75\ \mu\text{L}$$

Part B: In the clinical laboratory, 0.4 deciliters (dL) of a patient's blood is centrifuged and analyzed. How many milliliters (mL) were analyzed?

Answer: **40 mL**

Solution:
$$\left[\frac{0.4\ \cancel{\text{dL}}}{1}\right]\times\left[\frac{1\ \cancel{\text{L}}}{1\times10^{1}\ \cancel{\text{dL}}}\right]\times\left[\frac{1\times10^{3}\ \text{mL}}{1\ \cancel{\text{L}}}\right]=40\ \text{mL}$$

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2.2 Communicating about Measurements

LO 2: Use scientific notation and significant figures when problem-solving and communicating about measurements.

2.16 Which option has the *fewest* significant figures?

(A) 7.05 cm
(B) 0.075 cm
(C) 7.50 cm
(D) 70.5 cm

Answer: B

2.17 Which option has the *greatest* number of significant figures?

(A) 0.287 mg
(B) 2.14 mg
(C) 61.00 mg
(D) 9100 mg

Answer: C

2.18 Which value has the *greatest* number of significant figures?

(A) 9.8×10^{12} atoms
(B) 8.500×10^{4} atoms
(C) 1.50×10^{23} atoms
(D) 2.05×10^{25} atoms

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Answer: B

2.19 Which value has the *greatest* number of significant figures?

(A) 210.00 mL
(B) 0.800 L
(C) 61.00 mL
(D) 12.5 L

Answer: A

2.20 Determine whether each value is measured or exact.

(A) The volume of an infected kidney is 250 cm^3. **(Measured)**
(B) There are 1000 mL in 1 L. **(Exact)**
(C) A drunk driver had a blood alcohol level of 0.24% (mass/volume). **(Measured)**

2.21 Determine whether each value is measured or exact.

(A) There are 24 pills of medication in a prescription bottle at the pharmacy. **(Exact)**
(B) A newborn baby weighs 3.82 kg. **(Measured)**
(C) A patient's cholesterol level is 265 mg/dL. **(Measured)**

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2.22 Which option shows the measured value 6.0448 mL correctly rounded to three significant figures?

(A) 6.00 mL
(B) 6.045 mL
(C) 6.04 mL
(D) 6.05 mL

Answer: C

2.23 Which option shows the measured value 5.46×10^6 cells correctly rounded to two significant figures?

(A) 5.46×10^6 cells
(B) 5.40×10^6 cells
(C) 5.50×10^6 cells
(D) 5.5×10^6 cells

Answer: D

2.24 Determine the number of significant figures in each value.

(A) 0.0019 **(2 significant figures)**
(B) 902.6 **(4 significant figures)**
(C) 1.011**(4 significant figures)**
(D) 6.27×10^{-3} **(3 significant figures)**
(E) 60.00 **(4 significant figures)**
(F) 2140 **(3 significant figures)**
(G) 2.6×10^3 **(2 significant figures)**
(H) 702.0 **(4 significant figures)**

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2.25 Answer each question about significant figures

Part A: Which number is 806.052 g rounded to four significant figures?
(options: 806.05 g 806.0 g 806.1 g 8060 g)
Answer: 806.1 g

Part B: Which number has three significant figures?
(options: .001 mL .101 mL 1.001 mL 100 mL)
Answer: .101 mL

Part C: Which number is 0.00204 g in scientific notation expressed to two significant figures?
(options: 2.0×10^{-2} g 2.04×10^{-3} g 2.0×10^{3} g 2.0×10^{-3} g)
Answer: 2.0×10^{-3} g

2.26 Answer each question about significant figures

Part A: How many significant figures are in 600.10 mL?
(options: 3 4 5 6)
Answer: 5

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Part B: Which number contains four significant figures?
(options: 0.008 km 200.6 g 5000 mL 7.4×10^4 sec)
Answer: 200.6 g

Part C: Which has the greatest number of significant figures?
(options 6,000 g 1×10^8 g 0.101 g 2.9 g)
Answer: 0.101 g

2.27 Which option correctly shows the measured value 1494.79 grams expressed in scientific notation and rounded to three significant figures

(A) 1.49×10^{-3} g
(B) 1.50×10^3 g
(C) 1.49×10^3 g
(D) 149×10^3 g

Answer: C

2.28 Which correctly shows the measured value 0.000605 meters expressed in scientific notation and rounded to two significant figures?

(A) 6.1×10^{-4} m
(B) 6.0×10^{-4} m
(C) 6.1×10^4 m
(D) 6.05×10^{-4} m

Answer: A

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2.29 A biologist studying ice sheets measured a movement rate of 7.041×10^{-2} m/d. Which is the correct decimal form of the value 7.041×10^{-2} m/d?

(A) 704.1 m/d
(B) 7.041 m/d
(C) 07041 m/d
(D) 0.07041 m/d
(E) 70.41 m/d

Answer: D

2.30 An environmental scientist determined that 7.25×10^4 m^3 of soil downstream of an industrial site has become contaminated with arsenic. Which is the correct decimal form of this value?

(A) 72500 m^3
(B) 72500. m^3
(C) 7.25 m^3
(D) 0.000725 m^3
(E) 725104 m^3

Answer: A

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2.31 The Indian city of Delhi is one of the world's largest with a population of over 25 million people. In China however, the government is currently expanding the city of Beijing to become a "super city" called "Jing-Jin-Ji" that is expected to have a population of approximately 130 million people. What is the correct way to express 130 million in scientific notation? (options: 1.3×10^{8} 1.30×10^{-6} 13.0×10^{6} 1.30×10^{6})

Answer: 1.3×10^{8}

2.32 When 161.3 g + 9.2 g + 2.34 g are added, the answer to the correct number of decimal places is _____

(A) 172.84 g
(B) 173 g
(C) 172.8 g
(D) 1.7×10^{2} g

Answer: C

2.33 Which value is correctly rounded for the subtraction sequence: 29.031 mL – 3.8 mL – 4.16 mL?

(A) 21.071 mL
(B) 36.991 mL
(C) 21 mL
(D) 21.1 mL

Answer: D

2.34 What is the correctly rounded answer for this calculation?

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$$8.24 \times 2.2 \times 6.875 \times 0.116 =$$

(A) 14.45708
(B) 14
(C) 14.5
(D) 14.4

Answer: B

2.35 What is the correctly rounded final answer for this calculation?

$$884.6 \div 19.00 \div 0.68 \div 2.00 =$$

(A) 34.2
(B) 34.2337461
(C) 34
(D) 34.23

Answer: C

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2.36 Perform the calculation and report the result in scientific notation with the correct number of significant figures.

Part A: $1.33 \times 0.00234 =$
Answer: $\mathbf{3.11 \times 10^{-3}}$

Part B: $1.09 \div 0.3332 =$
Answer: **3.27**

2.37 Perform the calculation and report the result with the correct number of significant figures.

Part A: $2.3 + 0.0017 + 8.14 =$
Answer: **10.4**

Part B: $24.891 - 0.72 =$
Answer: **24.17**

2.38 What is the correctly rounded final answer for this calculation?

$$\frac{(92.650)(3.710)}{(6.00)} =$$

(A) 57.28
(B) 57.29
(C) 60
(D) 57.289
(E) 57.3

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Answer: E

2.39 **Part A:** A medical technician receives these measurements of a cancerous mole removed from a patient. Perform the calculation shown to determine the volume of the mole. Enter your answer in standard decimal form with the correct number of significant figures and units of mm^3.

$$1.45 \text{ mm} \times 2.0 \text{ mm} \times 3.054 \text{ mm} =$$

Answer: **8.9 mm^3**
Solution: $1.45 \text{ mm} \times 2.0 \text{ mm} \times 3.054 \text{ mm} = 8.8566 \text{ mm}^3 = 8.9 \text{ mm}^3$ when rounded to 2 S.F.

Part B: A nurse helped an average of 24.6 patients per day for 19 consecutive days during a COVID-19 outbreak in 2020. How many total patients did she see during this period of time? Enter your answer in scientific notation with the correct number of significant figures and units of patients.

$$24.6 \frac{\text{patients}}{\text{d}} \times 19 \text{ d} =$$

Answer: **4.7×10^2 patients**
Solution: $24.6 \frac{\text{patients}}{\cancel{\text{d}}} \times 19 \cancel{\text{d}} = 467.4 = 4.7 \times 10^2 \text{ patients}$

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2.40 **Part A:** Perform the calculation shown below for a patient receiving medication through an IV. Enter your answer in scientific notation with the correct number of significant figures and units of mL.

$$2.5\frac{\text{mL}}{\text{min}} \times 135 \text{ min} =$$

Answer: **3.4×10^2 mL**

Solution: $2.5\frac{\text{mL}}{\cancel{\text{min}}} \times 135 \cancel{\text{ min}} = 337.5 = 3.4 \times 10^2 \text{ mL}$

Part B: A doctor recommends her pregnant patient drink at least 7.5 liters of water each day. How many liters of water should she drink each week? Enter your answer in standard decimal form rounded to two significant figures and units of L/wk. For this calculation we are treating 7 d/wk as a perfect conversion that does not impact significant figures.

$$7.5\frac{\text{L}}{\text{d}} \times 7\frac{\text{d}}{\text{wk}} =$$

Answer: **53 L/wk**

Solution: $7.5\frac{\text{L}}{\cancel{\text{d}}} \times 7\frac{\cancel{\text{d}}}{\text{wk}} = 52.5 = 53 \text{ L/wk}$

2.41 Perform the calculation and report the result in standard decimal form with the correct number of significant figures.

Part A: $\dfrac{7.24(1.5 + 6.11 + 0.58)}{4.287} =$

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Answer: **14**

Part B:

$$\frac{(4.28 \times 10^3)(6.879 \times 10^{-5})}{(4.2 - 1.5)} =$$

Answer: 0.11

2.42 Perform the calculation and report the result in standard decimal form with the correct number of significant figures and units.

Part A:

$$2.740 \text{ cm} \times 4.81 \text{ cm} \times 0.692 \text{ cm} =$$

Answer: 9.12 cm^3

Part B:

$$\frac{(8.22 \text{ m})\,(1.285 \text{ m})\,(3.6 \text{ m})}{4.2 \text{ m}^2} =$$

Answer: 9.1 m

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2.3 Units Conversions

LO 3: Use conversion factors to convert between units.

2.43 There are 1000 milliliters (mL) in one liter (L). A nurse administers 400 mL of IV fluids. How many L does this represent?

(A) 40 L
(B) 4 L
(C) 0.4 L
(D) 0.04 L

Answer: C

2.44 Which option shows a correctly written equality and two correctly written conversion factors?

(A) Equality: 10 mm = 1 cm. Conversion factors $\frac{1\text{ mm}}{10\text{ cm}}$ and $\frac{1\text{ cm}}{10\text{ km}}$

(B) Equality: 1 cm = 100 m. Conversion factors $\frac{1\text{ cm}}{100\text{ m}}$ and $\frac{100\text{ m}}{1\text{ m}}$

(C) Equality: 1000 mm = 1 m. Conversion factors $\frac{1000\text{ mm}}{1\text{ m}}$ and $\frac{1\text{ m}}{1000\text{ mm}}$

(D) Equality: 1 m = 10 cm. Conversion factors $\frac{1\text{ cm}}{10\text{ m}}$ and $\frac{10\text{ cm}}{1\text{ m}}$

Answer: C

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2.45 If a piece of pizza contains 450 Calories and a hungry student eats three pieces of pizza while studying for an exam, how many total Calories were in the pizza he ate?

(A) 150 Calories
(B) 135 Calories
(C) 13,500 Calories
(D) 1,350 Calories

Answer: D

2.46 An incision along the chest of a man in surgery is 14.5 inches (in), how many centimeters (cm) is this? There are 2.54 cm/in. Express your answer with three significant figures and in units of cm.

Answer: **36.8 cm**

Solution: $14.5\ \cancel{\text{in}} \times \frac{2.54\text{ cm}}{\cancel{\text{in}}} = 36.83\text{ cm} = 36.8\text{ cm}$ rounded to 3 SF

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2.47 An elderly man takes one heart medication pill each day. His prescription contains 12 pills per bottle. If he will be gone on a 72-day trip to visit his family overseas, how many bottles of heart medication pills does he need to request from his doctor for his trip? Express your answer in units of bottles to the nearest whole number.

Answer: **6 bottles**

Solution: $72 \cancel{\text{ d}} \times \frac{1 \cancel{\text{ pill}}}{\cancel{\text{ d}}} \times \frac{\text{bottle}}{12 \cancel{\text{ pill}}} = 6 \text{ bottles}$

2.48 **Part A**: A sick child received medication in a clinic. Perform the calculation to determine the amount of medication the child received. Enter your answer with the correct number of significant figures and units.

$$\frac{1.5 \text{ mL}}{8.0 \text{ h}} \times \frac{24 \text{ h}}{\text{d}} \times \frac{14 \text{ d}}{1} =$$

Answer: **63 mL**

Solution: $\frac{1.5 \text{ mL}}{8.0 \cancel{\text{ h}}} \times \frac{24 \cancel{\text{ h}}}{\cancel{\text{ d}}} \times \frac{14 \cancel{\text{ d}}}{1} = 63 \text{ mL}$

Part B: A humanitarian agency is delivering 1.5 bags of rice to each family each day during a drought. Each bag contains 525 grams of rice. Perform this calculation to determine how many grams of rice per week the agency should plan to deliver to each family. Enter your answer in scientific notation with two significant figures and units of (g/week).

$$\frac{1.5 \text{ bag}}{\text{d}} \times \frac{7 \text{ d}}{\text{wk}} \times \frac{525 \text{ g}}{\text{bag}} =$$

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Answer: **5.5×10^3 g/wk**

Solution: $\frac{1.5 \cancel{\text{ bag}}}{\cancel{\text{ d}}} \times \frac{7 \cancel{\text{ d}}}{\text{wk}} \times \frac{525 \text{ g}}{\cancel{\text{ bag}}} = 5512.5 \text{ g/wk}$

2.49 A city has a population of 1.3 million people. At one point during an outbreak of the COVID-19 virus, it was estimated that one out of every 28 people had become infected. Which conversion shows the correct setup to approximate the number of people that had become infected at that time in the city?

(A) $1.3 \times 10^6 \text{ people} \times \frac{28 \text{ people}}{1 \text{ infected person}} =$

(B) $28 \text{ people} \times \frac{1 \text{ infected person}}{1.3 \times 10^6 \text{ people}} =$

(C) $1.3 \times 10^6 \text{ people} \times \frac{1 \text{ infected person}}{28 \text{ people}} =$

(D) $\frac{28 \text{ people}}{1 \text{ infected person}} \times \frac{1}{1.3 \times 10^6 \text{ people}} =$

Answer: C

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2.50 You want to convert a measured number of micrometers to meters. Select the conversion factor that is correctly written and does not need to be flipped over in order to be used to solve the problem.

(A) $\frac{1\times10^{-6}\ \mu m}{1\ m}$

(B) $\frac{1\times10^{-6}\ m}{1\ \mu m}$

(C) $\frac{1\ m}{1\times10^{-6}\ \mu m}$

(D) $\frac{1\ \mu m}{1\times10^{-6}\ m}$

Answer: B

2.51 A college student is participating in a fund raiser to help provide school supplies for low-income families. A donor agrees to pay \$2.50 for each kilometer (km) that the student runs in a three-week period of time. The student successfully ran 5 kilometers each day for three weeks. Which conversion correctly shows how to calculate the total amount of money she raised in this effort?

(A) $\frac{2.50\ \text{dollars}}{5\ \text{km}}\times\frac{5\ \text{km}}{1\ \text{d}}\times\frac{7\ \text{d}}{1\ \text{wk}}\times\frac{3\ \text{wk}}{1}=$

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(B) $\frac{2.50\ \text{dollars}}{1\ \text{km}}\times\frac{5\ \text{km}}{1\ \text{d}}\times\frac{7\ \text{d}}{1\ \text{wk}}\times\frac{3\ \text{wk}}{1}=$

(C) $\frac{2.50\ \text{dollars}}{1\ \text{km}}\times\frac{5\ \text{km}}{1\ \text{d}}\times\frac{3\ \text{wk}}{1}=$

(D) $\frac{1\ \text{km}}{2.50\ \text{dollars}}\times\frac{1\ \text{d}}{5\ \text{km}}\times\frac{1\ \text{wk}}{7\ \text{d}}\times\frac{1}{3\ \text{wk}}=$

Answer: B

2.52 Vitamin B_{12} is found in a variety of foods and is available as a dietary supplement. It is an essential vitamin, meaning that the body requires vitamin B_{12} to be obtained in the diet in order to function properly. A pregnant woman takes one vitamin B_{12} supplement pill each day during her 40-week pregnancy. Each vitamin B_{12} pill contains 850 micrograms (mcg). Which conversion sequence correctly shows how the total number of grams vitamin B_{12} consumed during the pregnancy is calculated?

(A) $\frac{850\ \text{mcg}}{1\ \text{pill}}\times\frac{1\ \text{g}}{1\times10^{6}\ \text{mcg}}\times\frac{1\ \text{pill}}{1\ \text{d}}\times\frac{7\ \text{d}}{1\ \text{wk}}\times\frac{40\ \text{wk}}{1}$

(B) $\frac{850\ \text{mcg}}{1\ \text{pill}}\times\frac{1\ \text{pill}}{1\ \text{d}}\times\frac{7\ \text{d}}{1\ \text{wk}}\times\frac{40\ \text{wk}}{1}$

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(C) $\frac{850\text{ mcg}}{1\text{ pill}} \times \frac{1\times10^{6}\text{ mcg}}{1\text{ g}} \times \frac{1\text{ pill}}{1\text{ d}} \times \frac{7\text{ d}}{1\text{ wk}} \times \frac{40\text{ wk}}{1}$

(D) $\frac{850\text{ mcg}}{1\text{ pill}} \times \frac{1\text{ g}}{1\times10^{6}\text{ mcg}} \times \frac{1\text{ pill}}{1\text{ d}} \times \frac{1\text{ d}}{7\text{ wk}} \times \frac{40\text{ wk}}{1}$

Answer: A

2.53 An overweight man took his doctor's advice and made adjustments to his lifestyle that included better eating habits and regular exercise. If he lost an average of 2.5 pounds (lbs) each week for 27 weeks, how many pounds did he lose in this period of time? Express your answer in standard decimal form with two significant figures and units of lbs.

Answer: **68 lbs**

Solution: $\frac{2.5\text{ lbs}}{1\ \cancel{\text{week}}} \times \frac{27\ \cancel{\text{week}}}{1} = 67.5\text{ lbs} = 68\text{ lbs rounded to 2 SF}$

2.54 A scientist wants to convert a flow rate of 2.5 liters per hour (L/h) to milliliters per second (mL/s). What is the correct result?

(A) 2.5×10^{3} mL/s
(B) 6.9×10^{-7} mL/s
(C) 1.4 mL/s
(D) 0.69 mL/s

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Answer: D

Solution: $\frac{2.5\ \cancel{\text{L}}}{1\ \cancel{\text{h}}} \times \frac{1\times10^{3}\text{ mL}}{1\ \cancel{\text{L}}} \times \frac{1\ \cancel{\text{h}}}{60\ \cancel{\text{min}}} \times \frac{1\ \cancel{\text{min}}}{60\text{ sec}} = 0.69\frac{\text{mL}}{\text{sec}}$

2.55 Identify any/all correct conversion factors between the units of deciliters and liters. Drag each into the correct category.

Correct: (B) $\frac{1\text{ dL}}{10^{-1}\text{ L}}$ and **(D)** $\frac{1\text{ L}}{10\text{ dL}}$

Incorrect: (A) $\frac{1\text{ dL}}{10\text{ L}}$, **(C)** $\frac{1\text{ L}}{10^{-1}\text{ dL}}$, and **(E)** $\frac{10\text{ L}}{1\text{ dL}}$

2.56 Interpreting units in conversion factors.

Part A: Blood glucose levels are often expressed in units of milligrams of glucose per deciliter of blood (mg/dL). How is the amount of glucose expressed in these units?

(A) a mass to mass ratio
(B) a volume to temperature ratio
(C) a volume to volume ratio
(D) a mass to volume ratio

Answer: D

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Part B: If a patient with a blood glucose level of 215 mg/dL has 4.75 L of blood in her body, approximately how many mg of glucose are in her body at the time the measurements were taken? For this calculation, treat the conversion factor 10 dL/L as a perfect conversion that does not impact significant figures. Express your answer in scientific notation with three significant figures and units of mg.

Answer: **1.02×10^4 mg**

Solution: $$4.75 \cancel{\text{L}} \times \frac{10 \cancel{\text{dL}}}{\cancel{\text{L}}} \times \frac{215 \text{ mg}}{\cancel{\text{dL}}} = 10,212.5 \text{ mg} = 1.02 \times 10^4 \text{ mg}$$

2.57 Rank the three hospital patient IV flow rates from least to greatest. Drag each value into the appropriate box. (options: 1.75 mL per minute, 100 mL per hour, 2250 mL per 24-hour day)

Answer: Slowest flow rate: 2250 mL per 24-hour day
Medium flow rate: 100 mL per hour
Fastest flow rate: 1.75 mL per minute

Solution: $$\left[\frac{2250 \text{ mL}}{\cancel{\text{d}}}\right]\left[\frac{\cancel{\text{d}}}{24 \text{ h}}\right] = 93.75 \frac{\text{mL}}{\text{h}} \quad \text{so } 2250 \text{ mL/d} = 93.75 \text{ mL/h}$$

$$100 \frac{\text{mL}}{\text{h}}$$

$$\left[\frac{1.75 \text{ mL}}{\cancel{\text{min}}}\right]\left[\frac{60 \cancel{\text{min}}}{1 \text{ h}}\right] = 105 \frac{\text{mL}}{\text{h}} \quad \text{so } 1.75 \text{ mL/min} = 105 \text{ mL/h}$$

2.58 In the Unit 1 Introduction, we learned that congenital hyperinsulinism (HI) is the most common cause of persistent low blood sugar or hypoglycemia in children. A hypoglycemic child weighing 70 lbs has a blood glucose level of 50 mg/dL. A child of that weight has an estimated total blood volume of 2.4 L. Calculate the total number of milligrams (mg) glucose in the child's blood. Express your answer in scientific notation with two significant figures.

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Answer: **1.2×10^3 mg glucose**

Solution: $$\left[\frac{50 \text{ mg}}{1 \cancel{\text{dL}}}\right] \times \left[\frac{10 \cancel{\text{dL}}}{1 \cancel{\text{L}}}\right] \times \left[\frac{2.4 \cancel{\text{L}}}{1}\right] = 1.2 \times 10^3 \text{ mg glucose}$$

2.59 **Part A:** If a modern train in China travels at an average speed of 225 kilometers per hour, how many hours will it take to travel the 819 miles between the cities of Beijing and Shanghai? Possibly useful conversion factors are given below.

Answer: **5.86 h**

Solution: $$\left[\frac{819 \cancel{\text{mi}}}{1}\right] \times \left[\frac{1.609 \cancel{\text{km}}}{1 \cancel{\text{mi}}}\right] \times \left[\frac{1 \text{ hr}}{225 \cancel{\text{km}}}\right] = 5.85676 = 5.86 \text{ h}$$

Part B: If the train in Part A travels at an average speed of 225 kilometers per hour, how many miles can it travel in 8 hours? Express your answer in scientific notation with three significant figures and units of mi.

Answer: **1.12×10^3 mi**

Solution: $$\left[\frac{8 \cancel{\text{hr}}}{1}\right] \times \left[\frac{225 \cancel{\text{km}}}{1 \cancel{\text{hr}}}\right] \times \left[\frac{1 \text{ mi}}{1.609 \cancel{\text{km}}}\right] = 1118.707272 \text{ mi} = 1.12 \times 10^3 \text{ mi}$$

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2.60 A smoker consumes 2 packs of cigarettes each day for 30 years.

Part A: How many total cigarettes does this represent? Base your calculations on 365 days in a year and 20 cigarettes in each pack. Express your answer in scientific notation with three significant figures and units of cigarettes.

Answer: **4.38×10^5 cigarettes**

Solution:
$$\frac{2\ \cancel{\text{pack}}}{1\ \cancel{\text{day}}} \times \frac{365\ \cancel{\text{day}}}{1\ \cancel{\text{year}}} \times \frac{30\ \cancel{\text{year}}}{1} \times \frac{20\ \text{cigarettes}}{1\ \cancel{\text{pack}}} = 438{,}000 = 4.38 \times 10^5\ \text{cigarettes}$$

Part B: If there is an average of 12 mg nicotine in each cigarette, how many milligrams (mg) of nicotine are consumed in the 30 years of smoking? Express your answer in scientific notation with three significant figures and units of mg nicotine.

Answer: **5.26×10^6 mg nicotine**

Solution:
$$\frac{2\ \cancel{\text{pack}}}{1\ \cancel{\text{day}}} \times \frac{365\ \cancel{\text{day}}}{1\ \cancel{\text{year}}} \times \frac{30\ \cancel{\text{year}}}{1} \times \frac{20\ \cancel{\text{cigarette}}}{1\ \cancel{\text{pack}}} \times \frac{12\ \text{mg nicotine}}{1\ \cancel{\text{cigarette}}} = 5.26 \times 10^6\ \text{mg nicotine}$$

2.61 If Americans recycle and compost approximately 1.5 pounds of waste per person per day, calculate the number of kilograms of recycled and composted material that a city with a population of 3,500,000 would produce in a week. Express your answer in scientific notation with two significant figures and units of kg/wk.

Answer: **$1.7 \times 10^7\ \dfrac{\text{kg}}{\text{wk}}$**

Solution:
$$\left[\frac{1.5\ \cancel{\text{lb}}}{1\ \cancel{\text{person}}\ \ 1\ \cancel{\text{day}}}\right] \times \left[\frac{1\ \text{kg}}{2.205\ \cancel{\text{lb}}}\right] \times \left[\frac{7\ \cancel{\text{day}}}{1\ \text{wk}}\right] \times \left[\frac{3{,}500{,}000\ \cancel{\text{person}}}{1}\right] = 1.7 \times 10^7\ \frac{\text{kg}}{\text{wk}}$$

2.62 Uric acid is produced during the breakdown of purine, a substance found in many foods. Most uric acid is carried in your blood and passes through your kidneys, where it leaves your body in urine. A high uric acid level, or hyperuricemia, is an excess of uric acid in your blood, and can result in the condition known as gout. If the results of a uric acid blood test for a 48-year-old male patient indicates a level of 13.8 mg/dL, and the total volume of blood in the patient is 5.0 L, how many total grams of uric acid does the patient have in his blood? Express your answer in scientific notation with two significant figures and units of g.

Answer: **6.9×10^{-1} g**

Solution:
$$\left[\frac{13.8\ \cancel{\text{mg}}}{1\ \cancel{\text{dL}}}\right] \times \left[\frac{1\ \text{g}}{1000\ \cancel{\text{mg}}}\right] \times \left[\frac{10\ \cancel{\text{dL}}}{1\ \cancel{\text{L}}}\right] \times \left[\frac{5.0\ \cancel{\text{L}}}{1}\right] = 0.69\ \text{g} = 6.9 \times 10^{-1}\ \text{g}$$

2.63 **Part A**: If the average heart rate of a woman is 78 beats per minute, how many beats will her heart pump in one 365-day year? Express your answer in scientific notation with two significant figures and units of beats/yr.

Answer: **4.1×10^7 beats/year**

Solution:
$$\left[\frac{78\ \text{beats}}{\cancel{\text{min}}}\right] \times \left[\frac{60\ \cancel{\text{min}}}{1\ \cancel{\text{hr}}}\right] \times \left[\frac{24\ \cancel{\text{hr}}}{1\ \cancel{\text{d}}}\right] \times \left[\frac{365\ \cancel{\text{d}}}{1\ \text{yr}}\right] = 4.1 \times 10^7\ \frac{\text{beats}}{\text{yr}}$$

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Part B: If a man's heart is pumping 3.92 gallons of blood per minute on average throughout the day, how many liters (L) will his heart pump in a 7-day week? Express your answer in scientific notation with two significant figures and units of L/wk.

Answer: **1.5×10^5 L/wk**

Solutions:
$$\left[\frac{3.92\ \cancel{\text{gal}}}{\cancel{\text{min}}}\right]\times\left[\frac{60\ \cancel{\text{min}}}{1\ \cancel{\text{hr}}}\right]\times\left[\frac{24\ \cancel{\text{hr}}}{1\ \cancel{\text{d}}}\right]\times\left[\frac{7\ \cancel{\text{d}}}{1\ \text{wk}}\right]\times\left[\frac{3.785\ \text{L}}{1\ \cancel{\text{gal}}}\right]=1.5\times10^5\ \frac{\text{L}}{\text{wk}}$$

2.4 Dosage Calculations

LO 4: Apply ratio and proportion conversion factors for medical dosage calculations.

2.64 A dosage for an antibiotic is 400 mg per 50 kg of body weight. Select the conversion sequence that determines the dosage needed for a patient weighing 85 kg.

(A) $$\left[\frac{1}{85\ \text{kg patient weight}}\right]\times\left[\frac{400\ \text{mg antibiotic}}{50\ \text{kg patient weight}}\right]$$

(B) $$\left[\frac{85\ \text{kg patient weight}}{1}\right]\times\left[\frac{50\ \text{kg patient weight}}{400\ \text{mg antibiotic}}\right]$$

(C) $$\left[\frac{85\ \text{kg patient weight}}{1}\right]\times\left[\frac{400\ \text{mg antibiotic}}{50\ \text{kg patient weight}}\right]$$

(D) $$\left[\frac{50\ \text{kg patient weight}}{1}\right]\times\left[\frac{400\ \text{mg antibiotic}}{85\ \text{kg patient weight}}\right]$$

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Answer: C

Solution:
$$\left[\frac{85\ \text{kg patient weight}}{1}\right]\times\left[\frac{400\ \text{mg antibiotic}}{50\ \text{kg patient weight}}\right]=680\ \text{mg antibiotic}$$

2.65 A child experiencing pain while recovering from a broken arm is to take 160 mg of ibuprofen each day. If liquid Children's Motrin contains 100 mg of ibuprofen per 5 mL, how many milliliters should the child take each day? Express your answer with one significant figure and units of mL.

Answer: **8 mL**

Solutions:
$$\left[\frac{160\ \text{mg ibuprofen}}{1}\right]\times\left[\frac{5\ \text{mL}}{100\ \text{mg ibuprofen}}\right]=8\ \text{mL}$$

2.66 An elderly woman in the hospital develops a bacterial infection after surgery. She is prescribed 0.6 g of clindamycin added to her IV fluid every 12 hours. If the bottle of clindamycin contains 300 mg/2 mL, which conversion correctly calculates the number of mL of antibiotic that should be added to her IV fluid every 12 hours?

(A) $$\left[\frac{0.6\ \text{g}}{1}\right]\times\left[\frac{1000\ \text{g}}{1\ \text{mg}}\right]\times\left[\frac{2\ \text{mL}}{300\ \text{mg}}\right]$$

(B) $$\left[\frac{0.6\ \text{g}}{1}\right]\times\left[\frac{1000\ \text{mg}}{1\ \text{g}}\right]\times\left[\frac{300\ \text{mg}}{2\ \text{mL}}\right]$$

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(C) $\left[\frac{300\text{ mg}}{2\text{ mL}}\right]\times\left[\frac{1000\text{ mg}}{1\text{ g}}\right]\times\left[\frac{12\text{ h}}{0.6\text{ mg}}\right]$

(D) $\left[\frac{0.6\text{ g}}{1}\right]\times\left[\frac{1000\text{ mg}}{1\text{ g}}\right]\times\left[\frac{2\text{ mL}}{300\text{ mg}}\right]$

Answer: D

Solution: $\left[\frac{0.6\ \cancel{\text{g}}}{1}\right]\times\left[\frac{1000\ \cancel{\text{mg}}}{1\ \cancel{\text{g}}}\right]\times\left[\frac{2\text{ mL}}{300\ \cancel{\text{mg}}}\right]=4\text{ mL every 12 hours}$

2.67 Haldol (haloperidol decanoate) is a medication used to help treat mood and mental disorders such as schizophrenia. A doctor prescribes 2,500 micrograms (written as mcg or μg) injected into a patient monthly. If the bottle of the medication has a concentration of 5 mg/1 mL, which conversion sequence correctly determines the number of milliliters to be injected for a monthly dose?

(A) $\left[\frac{2500\text{ mcg}}{1}\right]\times\left[\frac{1\text{ mg}}{1000\text{ mcg}}\right]\times\left[\frac{1\text{ mL}}{5\text{ mg}}\right]$

(B) $\left[\frac{2500\text{ mcg}}{1}\right]\times\left[\frac{1000\text{ mg}}{1\text{ mcg}}\right]\times\left[\frac{1\text{ mL}}{5\text{ mg}}\right]$

(C) $\left[\frac{2500\text{ mcg}}{1}\right]\times\left[\frac{1\text{ mg}}{1000\text{ mcg}}\right]\times\left[\frac{5\text{ mg}}{1\text{ mL}}\right]$

(D) $\left[\frac{1\text{ mL}}{5\text{ mg}}\right]\times\left[\frac{1\text{ mg}}{1000\text{ mcg}}\right]\times\left[\frac{1}{2500\text{ mcg}}\right]$

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Answer: A

Solution: $\left[\frac{2500\ \cancel{\text{mcg}}}{1}\right]\times\left[\frac{1\ \cancel{\text{mg}}}{1000\ \cancel{\text{mcg}}}\right]\times\left[\frac{1\text{ mL}}{5\ \cancel{\text{mg}}}\right]=0.5\text{ mL}$

2.68 A 143-pound (lb) patient in the hospital has been diagnosed with methicillin-resistant *Staphylococcus aureus* (MRSA). MRSA infections are caused by staph bacteria that have become resistant to many antibiotics. The doctor orders a dose of 15 mg/1 kg of a new antibiotic every 12 hours. The concentration on the drug bottle is 1 g/20 mL. Which conversion sequence correctly determines the number of milliliters the patient should receive every 12 hours? 1 kg = 2.2 lb.

(A) $\left[\frac{20\text{ mL}}{1\text{ g}}\right]\times\left[\frac{1\text{ g}}{1000\text{ mg}}\right]\times\left[\frac{15\text{ mg}}{1\text{ kg}}\right]\times\left[\frac{2.2\text{ lb}}{1\text{ kg}}\right]\times\left[\frac{1}{143\text{ lb}}\right]$

(B) $\left[\frac{20\text{ mL}}{1\text{ g}}\right]\times\left[\frac{1\text{ g}}{1000\text{ mg}}\right]\times\left[\frac{15\text{ mg}}{1\text{ kg}}\right]\times\left[\frac{1\text{ kg}}{2.2\text{ lb}}\right]\times\left[\frac{143\text{ lb}}{1}\right]$

(C) $\left[\frac{20\text{ mL}}{1\text{ g}}\right]\times\left[\frac{1\text{ g}}{1000\text{ mg}}\right]\times\left[\frac{15\text{ mg}}{1\text{ kg}}\right]\times\left[\frac{2.2\text{ kg}}{1\text{ lb}}\right]\times\left[\frac{143\text{ lb}}{1}\right]$

(D) $\left[\frac{1\text{ mL}}{20\text{ g}}\right]\times\left[\frac{1\text{ g}}{1000\text{ mg}}\right]\times\left[\frac{15\text{ mg}}{1\text{ kg}}\right]\times\left[\frac{1\text{ kg}}{2.2\text{ lb}}\right]\times\left[\frac{143\text{ lb}}{1}\right]$

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Answer: B

Solution: $\left[\frac{20\text{ mL}}{1\text{ g}}\right]\times\left[\frac{1\text{ g}}{1000\text{ mg}}\right]\times\left[\frac{15\text{ mg}}{1\text{ kg}}\right]\times\left[\frac{1\text{ kg}}{2.2\text{ lb}}\right]\times\left[\frac{143\text{ lb}}{1}\right]=19.5\text{ mL}$

2.69 A 27-kilogram (kg) child with HIV is prescribed 150 mg of the drug Abacavir *daily* to help treat her disease. If she is given an oral liquid containing 100 mg/5 mL, how many mL should the nurse give her to take home each week? Select the correct sequence of conversions.

(A) $\frac{100\text{ mg}}{5.0\text{ ml}}\quad\frac{150\text{ mg}}{\text{d}}\quad\frac{7\text{ d}}{1\text{ wk}}$

(B) $\frac{5.0\text{ ml}}{100\text{ mg}}\quad\frac{150\text{ mg}}{\text{d}}\quad\frac{7\text{ d}}{1\text{ wk}}$

(C) $\frac{5.0\text{ ml}}{100\text{ mg}}\quad\frac{1\text{ d}}{150\text{ mg}}\quad\frac{7\text{ d}}{1\text{ wk}}$

(D) $\frac{5.0\text{ ml}}{100\text{ mg}}\quad\frac{150\text{ mg}}{\text{d}}\quad\frac{1\text{ wk}}{7\text{ d}}$

Answer: B

Solution: $\left[\frac{5.0\text{ mL}}{100\text{ mg}}\right]\times\left[\frac{150\text{ mg}}{1\text{ d}}\right]\times\left[\frac{7\text{ d}}{1\text{ wk}}\right]=52.5\frac{\text{mL}}{\text{wk}}$

2.70 A 67-year-old patient is prescribed 20 mg daily of the drug Lisinopril daily to help treat his hypertension (high blood pressure). How many 10 mg pills should the nurse give him for a 30-day supply? Express your answer in standard notation with two significant figures and units of pills.

Answer: **60 pills**

Solution: $\left[\frac{20\text{ mg}}{1\text{ d}}\right]\times\left[\frac{1\text{ pill}}{10\text{ mg}}\right]\times\left[\frac{30\text{ d}}{1}\right]=60\text{ pills}$

2.71 A patient with Chronic Obstructive Pulmonary Disease (COPD), a serious lung disease, needs a 40 mg IV per dose of the drug Solu-Medrol. A solution of the drug contains 12.5 mg/2 ml. How many mL of this solution should the nurse give to the patient per dose? Express your answer in standard notation with two significant figures and units of mL/dose.

Answer: **6.4 mL/dose**

Solution: $\left[\frac{40\text{ mg}}{\text{dose}}\right]\times\left[\frac{2\text{ mL}}{12.5\text{ mg hr}}\right]=6.4\frac{\text{mL}}{\text{dose}}$

2.72 A physician in the emergency room has ordered an IV drip of Fentanyl for sedation and pain management of a patient in a severe car accident. The concentration of the drug in the IV bag is 1 mg/100 mL. If the dose needs to be 0.100 mg/h, what should the flow rate in mL/h be in the patient's IV?

Part A: Set up the conversion sequence by dragging the correct missing two factors into place:

Answer: $\left[\frac{\textbf{100 mL}}{\textbf{1 mg}}\right]$ **and** $\left[\frac{\textbf{0.100 mg}}{\textbf{1 h}}\right]$

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Part B: Now use the conversion sequence above to calculate the final answer and express it in standard decimal form with three significant figures and units of mL/hr.

Answer: **10.0 mL/h**

Solution:
$$\left[\frac{100\ \text{mL}}{1\ \cancel{\text{mg}}}\right]\times\left[\frac{0.100\ \cancel{\text{mg}}}{1\ \text{h}}\right]=10.0\frac{\text{mL}}{\text{h}}$$

2.73 An elderly patient with an eye infection has been prescribed 50 mg of gentamicin by injection. The label on the drug vial states the concentration is 20 mg/5 mL. How many mL should the nurse administer to the patient by injection? Express your answer in standard decimal form with three significant figures and units of mL.

Answer: **12.5 mL**

Solution:
$$\left[\frac{50\ \cancel{\text{mg}}}{1}\right]\times\left[\frac{5\ \text{mL}}{20\ \cancel{\text{mg}}}\right]=12.5\ \text{mL}$$

2.74 A 12-year-old girl with asthma is prescribed the drug Solumedrol to help manage her condition. The prescription is for 1.5 mg/kg and the girl weighs 82 pounds (lb). Solumedrol is available in liquid form at a concentration of 125 mg/2 mL liquid. How many mL should the nurse administer to the girl?

Part A: Complete the conversion by dragging the correct missing two steps into place:

Answer: **1.5 mg / 1 kg and 2.0 mL / 125 mg**

Part B: Now use the completed conversion sequence above to calculate the final answer and express it in standard decimal form with two significant figures and units of mL.

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Answer: **0.89 mL.**

Solution:
$$\left[\frac{82\ \cancel{\text{lb.}}}{1}\right]\times\left[\frac{1\ \cancel{\text{kg}}}{2.2\ \cancel{\text{lb.}}}\right]\times\left[\frac{1.5\ \cancel{\text{mg}}}{1\ \cancel{\text{kg}}}\right]\times\left[\frac{2.0\ \text{mL}}{125\ \cancel{\text{mg}}}\right]=0.89\ \text{mL}$$

2.75 A 52 kilogram, 28-year-old patient in the hospital needs to receive a dosage of Diazepam through an IV drip to help treat her seizures and anxiety. The doctor prescribes 0.4 mg/kg/h by continuous IV infusion. If the IV bag contains 0.1 mg/mL drug, what should the IV flow rate be in mL/h to administer the drug properly?

Part A: Complete the conversion by dragging the correct missing two steps into place:

Answer: **1 ml / 0.1 mg**

Part B: Now use the completed conversion sequence above to calculate the final answer and express it in standard notation with three significant figures and units of mL/h.

Answer: **208 mL/h**

Solution:
$$\left[\frac{52\ \cancel{\text{kg}}}{1}\right]\times\left[\frac{0.4\ \cancel{\text{mg}}}{\cancel{\text{kg}}\ \text{hr}}\right]\times\left[\frac{1\ \text{mL}}{0.1\ \cancel{\text{mg}}}\right]=208\frac{\text{mL}}{\text{h}}$$

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2.5 Common Units in Environmental Science

LO 5: Solve problems with conversion factors and units commonly used in environmental science.

2.76 What does the abbreviation ppm stand for in environmental science?

(A) pounds per meter
(B) pressure per minute
(C) parts per million
(D) proton precession magnetometer

Answer: C

2.77 What does the abbreviation ppb stand for in environmental science?

(A) protons per boson
(B) parts per billion
(C) production-possibility boundary
(D) plasma protein binding

Answer: B

2.78 Which value is expressed in units of ppm for a soil sample contaminated with a toxic heavy metal?

(A) 0.0005 g / min
(B) 3.0 mL / 100 mL
(C) 8 mg / kg
(D) 2.5 lb/kg

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Answer: C

2.79 Which value is expressed in units of ppm for a sample of contaminated drinking water?

(A) 0.5 g / kg
(B) 0.005 mL / 1000 dL
(C) 0.2 g / mL
(D) 6.4 mg / L

Answer: D

2.80 Which value is expressed in units of ppb for a soil sample contaminated with a pesticide?

(A) 9 micrograms per kilogram
(B) 2 kilograms per liter
(C) 5 milligrams per kilogram
(D) 8 milliliters per deciliter

Answer: A

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2.81 Which value is expressed in units of ppb for a sample of lake water contaminated with dioxin?

(A) 3 grams per microliter
(B) 8 milligrams per milliliter
(C) 4 micrograms per liter
(D) 1 microgram per milliliter

Answer: C

2.82 Which option shows two values representing the same concentration of a nutrient in the soil?

(A) 5 mg/kg and 5 ppm
(B) 5 mg/g and 5 ppb
(C) 5 g/kg and 5 ppm
(D) 5 mg/kg and 5 ppb

Answer: A

2.83 Which option shows two values representing the same concentration of lead at an industrial site?

(A) 8 µg/mg and 8 ppm
(B) 8 ppm and 8,000 ppb
(C) 8 g/kg and 8 ppb
(D) 8 mg/kg and 8 ppb

Answer: B

2.84 Identify the option that shows two values having the same concentration of a rare metal in the soil?

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(A) 25 g/kg and 2.5 ppb
(B) 4 mg/dL and 4,000 ppb
(C) 1.4 µg/mg and 1.4 ppm
(D) 2,000 ppb and 2,000 µg/kg

Answer: D

2.85 Which option shows two values representing the same concentration of a toxin in the ground water near a town?

(A) 0.1 ng/dL and 0.1 ppm
(B) 0.1 mL/L and 0.1 ppb
(C) 0.1 mg/L and 0.1 ppm
(D) 5 mg/kg and 5 ppb

Answer: C

2.86 Which shows two values representing the same concentration of a mineral that was measured in drinking water?

(A) 9,000 mg/L and 9 ppb
(B) 9,000 µg/L and 9 ppm
(C) 9,000 mg/L and 9 ppm
(D) 9 µg/L and 9 ppm

Answer: B

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2.87 The fluoride level in a sample of drinking water was determined to be 0.75 milligrams of fluoride per liter of water. Calculate the total number of milligrams of fluoride a child who drinks 1.5 L of water each day will consume in a 7-day week. Express your answer in standard decimal form with two significant figures and units of mg/wk.

Answer: **7.9 mg/wk**

Solution: $$\left[\frac{0.75\text{ mg}}{1\text{ }\cancel{\text{L}}}\right]\times\left[\frac{1.5\text{ }\cancel{\text{L}}}{1\text{ }\cancel{\text{d}}}\right]\times\left[\frac{7\text{ }\cancel{\text{d}}}{1\text{ wk}}\right]=7.875=7.9\frac{\text{mg}}{\text{wk}}\text{ with 2 SF}$$

2.88 Green chemistry is the design of chemical products and processes that reduce or eliminate the generation of hazardous substances. If a company develops a method to eliminate 248 liters of hazardous materials each day, how many liters are eliminated every year if the production facility operates 305 days per "production year"? Express your answer in scientific notation to three significant figures with units of L/yr.

Answer: **7.56×10^4 L/yr**

Solution: $$\left[\frac{248\text{ L}}{1\text{ }\cancel{\text{d}}}\right]\times\left[\frac{305\text{ }\cancel{\text{d}}}{1\text{ yr}}\right]=7.56\times10^4\ \frac{\text{L}}{\text{yr}}$$

2.89 Dichloromethane is one of the most commonly used solvents in manufacturing. Annually, its use is in the hundreds of millions of pounds, yet the U.S. Environmental Protection Agency (EPA) has set the maximum contamination level (MCL) in drinking water at 0.005 mg/L.

Part A: Complete the conversion needed to calculate the maximum number of milligrams allowed (MCL) in a 465-gallon drinking water storage tank used on a family farm. Drag the correct missing two steps into place:

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Answer: **3.785 L / 1 gal and 0.005 mg/ 1 L**

Part B: Now use the completed conversion sequence above to calculate the final answer and express it in standard decimal form with three significant figures with units of mg.

Answer: **8.80 mg**

Solution: $$\left[\frac{465\text{ }\cancel{\text{gal}}}{1}\right]\times\left[\frac{3.785\text{ }\cancel{\text{L}}}{\cancel{\text{gal}}}\right]\times\left[\frac{0.005\text{ mg}}{1\text{ }\cancel{\text{L}}}\right]=8.80\text{ mg}$$

2.90 A pregnant woman eats an average of 8.0 ounces of salmon each week for the 39 weeks of her pregnancy. If the fish she is eating has an average mercury concentration of 2.0 micrograms (μg) per 4.0 ounce serving, how many total micrograms will she have consumed during her pregnancy? Express your answer in scientific notation to two significant figures with units of μg.

Answer: **1.6×10^2 μg**

Solution: $$\left[\frac{8.0\text{ }\cancel{\text{oz}}}{1\text{ }\cancel{\text{wk}}}\right]\times\left[\frac{39\text{ }\cancel{\text{wk}}}{1}\right]\times\left[\frac{2.0\text{ μg}}{4\text{ }\cancel{\text{oz}}}\right]=156\text{ μg}=1.6\times10^2\text{ μg when rounded}$$

2.91 If a solar panel can provide an average of 4800 Watts of energy to your home each day, how many kW could the solar panel produce each 365-day year? Express your answer in scientific notation with two significant figures and units of kW/yr. 1 kW = 1000 W.

Answer: **1.8×10^3 kW/yr**

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Solution: $$\left[\frac{4800\ \cancel{\text{W}}}{1\ \cancel{\text{d}}}\right]\times\left[\frac{365\ \cancel{\text{d}}}{\text{yr}}\right]\times\left[\frac{1\ \text{kW}}{1000\ \text{W}}\right]=1752\ \frac{\text{kW}}{\text{yr}}=1.8\times10^{3}\ \frac{\text{kW}}{\text{yr}}\ \text{when rounded}$$

2.92 Bioremediation is a treatment that uses naturally occurring organisms or substances to break down hazardous materials into less toxic or non-toxic substances. In San Francisco Bay, an area known as Hunters Point is heavily contaminated with polychlorinated biphenyls (PCBs). The concentration of PCBs in the sediment of this area was measured to be 1,570 ppb. If a bioremediation effort using activated carbon filtration was found that could reduce the levels by 70% under ideal conditions, what would be the resulting PCB contamination if the entire area could be treated in this way? Express your answer in scientific notation with two significant figures and units of ppb.

Answer: **4.7×10^2 ppb**
Solution: (100% of contamination level) − (70% reduction) = 30% remaining
(1570 ppb) × (0.30) = 471 ppb = 4.7×10^2 ppb (2 S.F.)

2.6 Measuring Temperature

LO 6: Convert temperature measurements from one scale to another.

2.93 What is the freezing point of water on the Celsius temperature scale?

(A) 37 °C
(B) −32 °C
(C) −100 °C
(D) 0 °C

Answer: D

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2.94 What is the boiling point of water on the Celsius temperature scale?

(A) 212 °C
(B) 32 °C
(C) 100 °C
(D) 373 °C

Answer: C

2.95 What is the freezing point of water on the Fahrenheit temperature scale?

(A) 32 °F
(B) 0 °F
(C) 273 °F
(D) −100 °F

Answer: A

2.96 What is the boiling point of water on the Fahrenheit temperature scale?

(A) 100 °F
(B) 373 °F
(C) 212 °F
(D) 273 °F

Answer: C

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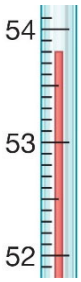
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2.97 Select the temperature scales whose units have the same magnitude.

(A) Kelvin and Fahrenheit
(B) Celsius and Kelvin
(C) Celsius and Fahrenheit
(D) Celsius, Kelvin, and Fahrenheit

Answer: B

2.98 Determine the temperature on the Celsius thermometer then identity this same temperature expressed in Kelvin.



(A) 53.8 K
(B) 153.8 K
(C) 219.2 K
(D) 326.8 K

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Answer: D

2.99 Convert the temperature value 35.5 °C into the corresponding temperature in °F. Express your answer with three significant figures and units of °F.

Answer: **95.9 °F**
Solution: °F = 1.8(°C) + 32 1.8 (35.5) + 32 = 95.9 °F

2.100 Convert 76.2 °C into the corresponding temperature in °F. Express your answer with three significant figures and units of °F.

Answer: **169 °F**
Solution: °F = 1.8(°C) + 32 1.8 (76.2) + 32 = 169 °F

2.101 Convert 121 °F into the corresponding temperature in °C. Express your answer with three significant figures and units of °C.

Answer: **49.4 °C**
Solution: °C = (°F – 32)/1.8 (121 – 32)/1.8 = 49.4 °C

2.102 Convert 177 °F into the corresponding temperature in °C. Express your answer with three significant figures and units of °C.

Answer: **80.6 °C**
Solution: °C = (°F – 32)/1.8 (177 – 32)/1.8 = 80.6 °C

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2.103 Convert 68.5 °C into the corresponding temperature in Kelvin. Express your answer with three significant figures and units of K.

Answer: **342 K**
Solution: K = °C + 273 K = 68.5 + 273 = 342 K

2.104 Convert 298 K into the corresponding temperature in °C. Express your answer with three significant figures and units of °C.

Answer: **25.0 °C**
Solution: °C = K – 273 298 – 273 = 25.0 °C

2.105 A woman from the United States that is visiting Spain is not feeling well. She calls the local clinic and explains that she has a fever of 104 °F. The nurse needs to convert this temperature in Fahrenheit to a temperature in Celsius because Spain uses the metric system. What is the woman's temperature in Celsius? Calculate the answer and express it in standard decimal form to two significant figures.

Answer: **40.°C**
Solution: °C = (°F – 32)/1.8 (104 – 32)/1.8 = 40.°C

2.106 Although the sun, solar wind, and gases around stars can be quite hot, much of "empty space" is very cold. The so-called "cosmic background temperature" is around minus 455 degrees Fahrenheit. Calculate the cosmic background temperature in Celsius, and express your answer in standard decimal form to three significant figures with units of °C.

Answer: **–271 °C**
Solution: °C = (°F – 32)/1.8 (–455 – 32)/1.8 = –271 °C

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2.107 A family from Japan is visiting the United States, and their young daughter is sick with a fever. The mother measures her temperature to be 39.5 °C and calls the doctor's office with the information. The physician's assistant in the hospital needs to convert the Celsius temperature to Fahrenheit in order to assess the situation. What is the child's temperature in Fahrenheit? Calculate the answer and express it in standard decimal form to three significant figures with units of °F.

Answer: **103 °F**
Solution: T = 1.8 (39.5) + 32 = 103 °F

2.108 Convert 425 K into the corresponding temperature in °F. Express your answer with three significant figures and units of °F.

Answer: **306 °F**
Solution: °C = 425 – 273 = 152 °C then: °F = 1.8(152) + 32 = 306 °F

2.109 Convert 98.8 °F into the corresponding temperature in K. Express your answer with three significant figures and units of K.

Answer: **310 K**
Solution: °C = (98.8 – 32)/1.8 = 37.11 °C then: 37.11 + 273 = 310 K

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2.110 Four buckets of water have the temperatures shown. If you put your hand in each bucket of water, which feels the warmest to you?

(A) 197 °F
(B) 93 °C
(C) 362 K
(D) 98.6 °F

Answer: B

Solution: 197 °F = 91.7 °C; 362 K = 88.9 °C; 98.6 °F = 37.0 °C.

2.7 Density and Specific Gravity

LO 7: Explain the concept of density and specific gravity, and solve problems involving density, mass, and volume measurements.

2.111 In 2010, a tragic explosion of an oil well at the bottom of the Gulf of Mexico resulted in the Deepwater Horizon/BP oil spill that released 200,000–2,000,000 gallons of oil a day into the Gulf. It took 87 days to stop the flow and the oil company was found to be responsible for the release of 3.1 million barrels (about 490 million liters). The oil was a mixture of petroleum-based materials with an average density of 0.95 g/cm^3. The surrounding seawater has a density of 1.03 g/cm^3. How can this information help you explain the images of the oil spill?

(A) The oil released has a greater density than sea water.
(B) The oil released has the same density as the sea water.
(C) The oil released is less dense than the sea water.
(D) Not enough information is provided.

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Answer: C

2.112 Which of the following best describes density?

(A) a chemical property
(B) a physical change
(C) a physical property
(D) a chemical change

Answer: C

2.113 Calculate the density of an 89.5 mL liquid sample that has a mass of 93.7 g. Express your answer with three significant figures and units of g/mL.

Answer: **1.05 g/mL**
Solution: d = m/v = 93.7 g / 89.5 mL = 1.05 g/mL

2.114 What is the mass of a 38.2 mL sample of ethanol? The density of ethanol is 0.789 g/mL. Express your answer with three significant figures and units of g.

Answer: **30.1 g**
Solution: m = d × V = 0.789 g / mL × 38.2 mL = 30.1 g

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2.115 The density of aluminum (Al) is 2.7 g/cm^3. What volume in cm^3 is occupied by 9.8 g of aluminum? Express your answer with two significant figures and units of cm^3.

Answer: **3.6 cm^3**
Solution: V = m/d = 9.8 g / (2.7 g/cm^3) = 3.6 cm^3

2.116 Specific gravity is the ratio of which two values?

(A) mass of a substance and the density of water
(B) density of water and the density of a substance
(C) volume of water and the mass of a substance
(D) density of a substance and the mass of water

Answer: B

2.117 What units do specific gravity values have?

(A) g/mL
(B) ppm
(C) mg/kg
(D) no units

Answer: D

2.118 The volume of a solid can be determined by a method known as volume displacement. When a solid is completely submerged in water for example, it displaces a volume that is equal to the volume of the solid object. The volume of the object is determined by measuring the water level before and after an object is submerged in a measuring device such as a graduated cylinder. If an object displaces 25.0 mL of water and has a mass of 64.3 g, what is its density?

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(A) 1.17 g/mL
(B) 0.389 g/mL
(C) 2.57 g/mL
(D) 1.29 g/mL

Answer: C

2.119 The volume of an object is determined using water displacement. The initial volume of water in a graduated cylinder is determined to be 17.5 mL. After the object is placed in the graduated cylinder, the water level is found to be 43.1 mL. If the dry object has a mass of 95.2 g, what is the density of the object? Express your answer with three significant figures and units of g/mL.

Answer: **3.72 g/mL**
Solution: V = 43.1 mL – 17.5 mL = 25.6 mL; d = 95.2 g / 25.6 mL = 3.72 g/mL

2.120 If a bag of intravenous (IV) glucose solution being administered to a hospital patient has a volume of 1.50 L and a density of 1.15 g/mL, what mass of fluid is the patient receiving? Express your answer in scientific notation with three significant figures and units of grams. Hint: You may need to convert mL to L.

Answer: **1.73×10^3 g**

Solution: $$\left[\frac{1.15\ \text{g}}{1\ \cancel{\text{mL}}}\right]\times\left[\frac{1000\ \cancel{\text{mL}}}{1\ \cancel{\text{L}}}\right]\times\left[\frac{1.50\ \cancel{\text{L}}}{1}\right]=1725\text{g}=1.73\times10^3\ \text{g}\ \text{ to 3 S.F.}$$

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2.121 The density of lead contaminated soil that is being removed from a hazardous site is 2450 kg/m^3. If the truck hauling away the contaminated dirt can carry 48,500 kg per load, what volume of contaminated soil can be removed each trip the truck takes? Express your answer in standard decimal form with three significant figures and units of m^3.

Answer: **19.8 m^3**

Solution: $$V = \frac{m}{D} = \frac{48{,}500\ \cancel{kg}}{2450\ \cancel{kg}/m^3} = 19.7959\ m^3 = 19.8\ m^3 \text{ to 3 S.F.}$$

2.122 Hospitals and clinics near mountainous areas or at high elevation sometimes see patients suffering from HAPE (High Altitude Pulmonary Edema). Although HAPE is not completely understood, it can be induced by rapidly climbing to high elevations where oxygen levels are significantly lower than at lower elevations. For example, the city of Lhasa in Tibet lies at an altitude of almost 12,000 ft above sea level and hosts a large number of tourists seeking adventures in the Himalayan Mountains. If the air we breathe at sea level contains around 78% nitrogen and 21% oxygen, and the percentage of oxygen decreases with increasing altitude, what is your prediction about the relative density of nitrogen gas compared with oxygen gas?

(A) Nitrogen gas is more dense than oxygen gas.
(B) Nitrogen gas has the same density as oxygen gas.
(C) Nitrogen gas is less dense than oxygen gas.
(D) Not enough information is provided to predict.

Answer: C

2.123 Patients suffering from bladder problems often need a catheter connected to a urine bag to collect and hold urine. A nurse is monitoring the mass of urine produced by a patient every eight hours.

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Part A: If a patient produces 0.210 L of urine in eight hours, and the mass of this urine is 0.231 kg, calculate the density of the patient's urine. Express your answer in standard decimal form to three significant figures with units of kg/L:

Answer: **1.10 kg/L**

Solution: $$D = \frac{m}{V} = \frac{0.231\ kg}{0.210\ L} = 1.10\ \frac{kg}{L} \text{ to 3 S.F.}$$

Part B: If the average density range of urine is between 1.002 and 1.030 kg/L, and the density of pure water is 1.00 kg/L, does your answer to part (A) indicate that the patient in this example is properly hydrated, dehydrated, or overhydrated?

(A) The patient is properly hydrated.
(B) The patient is over hydrated.
(C) The patient is dehydrated (under hydrated).
(D) Not enough information is provided to predict.

Answer: C

2.124 Blood is a precious and perishable resource needed by patients around the world. Hospitals and clinics depend on healthy caring citizens to donate blood in order to keep their reserves fresh and ready to use. In a typical blood donation, a nurse draws a one pint "unit" from a donor.

Part A: Complete the conversion needed to calculate how many kilograms each one pint "unit" of blood weighs. A typical blood sample has a density of 1060 kg/m^3. Drag the correct missing two steps into place.

Answer: **1 L / 1000 mL and 1060 kg / m^3**

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Part B: Now use the completed conversion sequence above to calculate the final answer and express it in standard decimal form with three significant figures with units of kg.

Answer: **0.502 kg**

Solution: $$1\ \cancel{\text{pt}}\left[\frac{473.176\ \cancel{\text{mL}}}{1\ \cancel{\text{pt}}}\right]\times\left[\frac{1\ \cancel{\text{L}}}{1000\ \cancel{\text{mL}}}\right]\times\left[\frac{1\ \cancel{\text{m}^3}}{1000\ \cancel{\text{L}}}\right]\times\left[\frac{1060\ \text{kg}}{1\ \cancel{\text{m}^3}}\right]=0.502\ \text{kg}$$

2.125 Tissue engineering scientists use cells imbedded into a three-dimensional scaffold to produce a functional organ or tissue. If a scientist is able to grow heart cells at a density of 6.8×10^7 cells/cm^3 in a scaffold, how many cells occupy an engineered heart tissue sample that is 34.5 cm^3 in volume? Express your answer in scientific notation to two significant figures with units of cells. Hint: You can treat the number of cells as if it were the "mass" term in the standard density relationship.

Answer: **2.3×10^9 cells**

Solution: $$\left[\frac{6.8\times10^7\ \text{cells}}{1\ \cancel{\text{cm}^3}}\right]\times\left[\frac{34.5\ \cancel{\text{cm}^3}}{1}\right]=2.346\times10^9\ \text{cells}=2.3\times10^9\ \text{cells}\ \text{ to 2 S.F.}$$

2.126 Your body mass index (BMI) is a key indicator of overall health. The formula for measuring BMI is given below and is a slight variation on the standard density formula. Note: the numerator in both cases is a mass term, but the denominator has units of height (in meters) squared for BMI instead of cubed for density.

Part A: Calculate the BMI of a 45-year-old man that is 167 cm tall and weighs 73.8 kg. Express your answer in standard decimal form to three significant figures with units of kg/m^2.

Answer: **26.5 kg/m^2**

Solution: $$\text{BMI}=\frac{73.8\ \text{kg}}{(1.67\ \text{m})^2}=26.4620\frac{\text{kg}}{\text{m}^2}=26.5\frac{\text{kg}}{\text{m}^2}\ \text{to 3 S.F.}$$

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Part B: Consult the BMI chart in the book and determine if he is considered underweight, normal, overweight, or obese.

(A) underweight
(B) normal
(C) overweight
(D) obese
(E) clinically obese

Answer: C

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