Sample Problem 1.3.1 — Addition and Subtraction

1. Add 4021.7 cm + 0.089 cm.
2. Subtract 5643.92 m – 5643.7 m.

What to Think About	How to Do It
1. Addition 1. Determine uncertain digits to be added. Indicated in bold italic type. 2. Solve and report with the correct number of digits after decimal the point.	4021.7 cm + 0.089 cm ≅ 4021.8 cm
1. Subtraction 1. Determine uncertain digits to be added. Indicated in bold. 2. Solve and report with the correct number of digits after the decimal point. 3. Notice that the subtraction of two precise measurements has produced a very imprecise difference.	5643.92 m – 5643.7 m ≅ 0.2 m

Practice Problems 1.3.1 — Addition and Subtraction

Complete the following operations, using the rules for adding or subtracting measurements.

1. 12.678 mm + 0.25 mm

12.678 mm
+ 0.25 mm
12.928 mm
= 12.93 mm

2. 45.987 m^3 + 2.1 m^3

45.987 m^3
+ 2.1 m^3
48.087 = 48.1 m^3

3. 12.345 mL – 0.34 mL

12.345 mL
– 0.34 mL
12.005 mL = 12.01 mL

4. 1.0001 mm – 0.1 mm

1.0001 mm
– 0.1 mm
0.9000 mm
= 0.9 mm

5. 12.5 g + 0.0005 g

12.5 g

6. 16.768 kg – 1.0 g

16.768 kg
– 0.0010 kg
16.7670 kg = 16.767 kg

Multiplying or Dividing Measurements

You measure the dimensions of a wall to be 8.53 m × 2.74 m. What is the area of the wall? Imagine your calculator battery is dead, and you have to multiply the old-fashioned way. In the two measurements, the last digit is uncertain, so any product involving either of these two digits will also be uncertain.

$$\begin{array}{r} 8.5\mathbf{3}\ \text{m} \\ \times\ 2.7\mathbf{4}\ \text{m} \\ \hline \mathbf{3412} \\ 597\mathbf{1} \\ 170\mathbf{6} \\ \hline 23.\mathbf{3722}\ \text{m}^2 \end{array} \cong 23.\mathbf{4}\ \text{m}^2$$

Since the **3** following the decimal is an uncertain digit, all digits following it are meaningless. Round off the **.3722** to **.4**, and write 23.**4** m^2 for the area of the wall.

Use the following common sense rule when multiplying or dividing measurements:

> When multiplying or dividing measurements, the product or quotient must have no more significant digits than the single measurement with the fewest significant digits. In other words, the least precise single measurement determines the precision of the final product or quotient.

Sample Problem 1.3.2 — Multiplication and Division

1. Multiply 2.5**4** cm × 5.0**8** cm.
2. Divide 56.**8** m^2 by 2.**3** m.

What to Think About	How to Do It
1. Multiplication	
1. Determine uncertain digits. Indicated in bold.	2.54 cm × 5.08 cm
2. Multiple with calculator.	12.9032 cm^2
3. Answer is not to correct number of significant digits.	
4. Solve and report with correct number of digits after decimal point. Remember to multiple units as well.	12.9 cm^2
2. Division	
1. Determine uncertain digits. Indicated in bold.	56.8 m^2 by 2.3 m
2. Divide with calculator.	24.695652
3. Answer is not to correct number of significant digits.	
4. Solve and report with correct number of digits after decimal point. Remember to divide units as well.	25 m

Practice Problems 1.3.2 — Multiplication and Division

Perform the following operations, using the rule for multiplying and dividing measurements. Express answers in proper measuring units.

1. 1.25 m × 0.25 m

$= 0.3125\ m^2$

$= 0.31\ m^2$

2. 3.987654 cm × 1.3 cm

3. $14.0\ cm^2 \div 2.1\ cm$

4. 5.646 mL × 13.6 g/mL

$= 76.78\ mL \cdot g/mL$

$= 76.8\ g$

5. $\frac{(98.45\ g/mL \times 5.762\ mL)}{1.4\ mL}$

$= 405.1920714\ g/mL$

$= 4.1 \times 10^2\ mL$

(or 410 mL)

Scientific Notation

Scientific notation is a convenient way to express numbers that are very large or very small. For example, one ampere of electric current is a measurement of 6 240 000 000 000 000 000 electrons passing a point in a wire in 1 s. This same number can be written, in scientific notation, as 6.24×10^{18} electrons/second. This means 624 followed by 16 zeros.

Any number can be expressed in scientific notation. Here are some examples:

$$0.10 = 1.0 \times 10^{-1}$$
$$1.0 = 1.0 \times 10^{0}$$
$$10.0 = 1.00 \times 10^{1}$$
$$100.0 = 1.000 \times 10^{2}$$
$$1\,000.0 = 1.0000 \times 10^{3}$$

Quick Check

1. Write the following measurements in scientific notation.

(a) 0.00572 kg 5.72×10^{-3} kg

(b) 520 000 000 000 km 5.2×10^{11} km

(c) 300 000 000 m/s 3×10^{8} m/s

(d) 0.000 000 000 000 000 000 16 C 1.6×10^{-19} C

(e) 118.70004 g 1.1870004×10^{2} g

2. Simplify.

(a) $10^{3}\times10^{7}\times10^{12}$ 10^{22}

(b) $10^{23}\div10^{5}$ 10^{18}

(c) $10^{12}\times10^{-13}$ 10^{-1}

(d) $10^{-8}\times10^{-12}$ 10^{-20}

(e) $10^{5}\div10^{-7}$ 10^{12}

(f) $10^{-2}\div10^{-9}$ 10^{7}

3. Do the following calculations, and express your answers in scientific notation with the correct number of significant digits.

(a) $(6.25\times10^{-7})\div(0.25\times10^{4})$ ← 2 sf

2.5×10^{-10}

(b) $\dfrac{(93.8\times10^{5})(6.1\times10^{1})}{(7.6\times10^{11})(1.22\times10^{7})}$

$=6.2\times10^{-11}$ (2 sf)

(c) $4.10\times10^{7}+5.9\times10^{6}$ ← smaller ∴ change

$4.10\times10^{7}+0.59\times10^{7}$ (both 2 dec)

$=4.69\times10^{7}$ (2 dec)

(d) $(4.536\times10^{-3})-(0.347\times10^{-4})$ ← smaller ∴ change

$4.536\times10^{-3}-0.0347\times10^{-3}$

$=4.5013\times10^{-3}=4.501\times10^{-3}$ (3 dec.)

4. A room has dimensions 13.48 m × 8.35 m × 3.18 m. What is its volume? Express your answer in scientific notation, with the correct number of significant digits.

$13.48\text{m}\times8.35\text{m}\times3.18\text{m}=357.934\text{ m}^3$

$=358\text{ m}^3$ (3 sf)

5. The volume of water in a graduated cylinder is 5.00 mL. A small lead sphere is gently lowered into the graduated cylinder, and the volume rises to 5.10 mL. The mass of the lead sphere is 1.10 g. What is the density of the lead? (Density = mass/volume)

$V_{LEAD}=5.10\text{ mL}-5.00\text{mL}=0.10\text{ mL}$ (2 sf.)

$m=1.10\text{ g}$

$D=\dfrac{m}{V}=\dfrac{1.10\text{g}}{0.10\text{mL}}=11\text{ g/mL}$ (2 sf)

↑ 2 s.f.