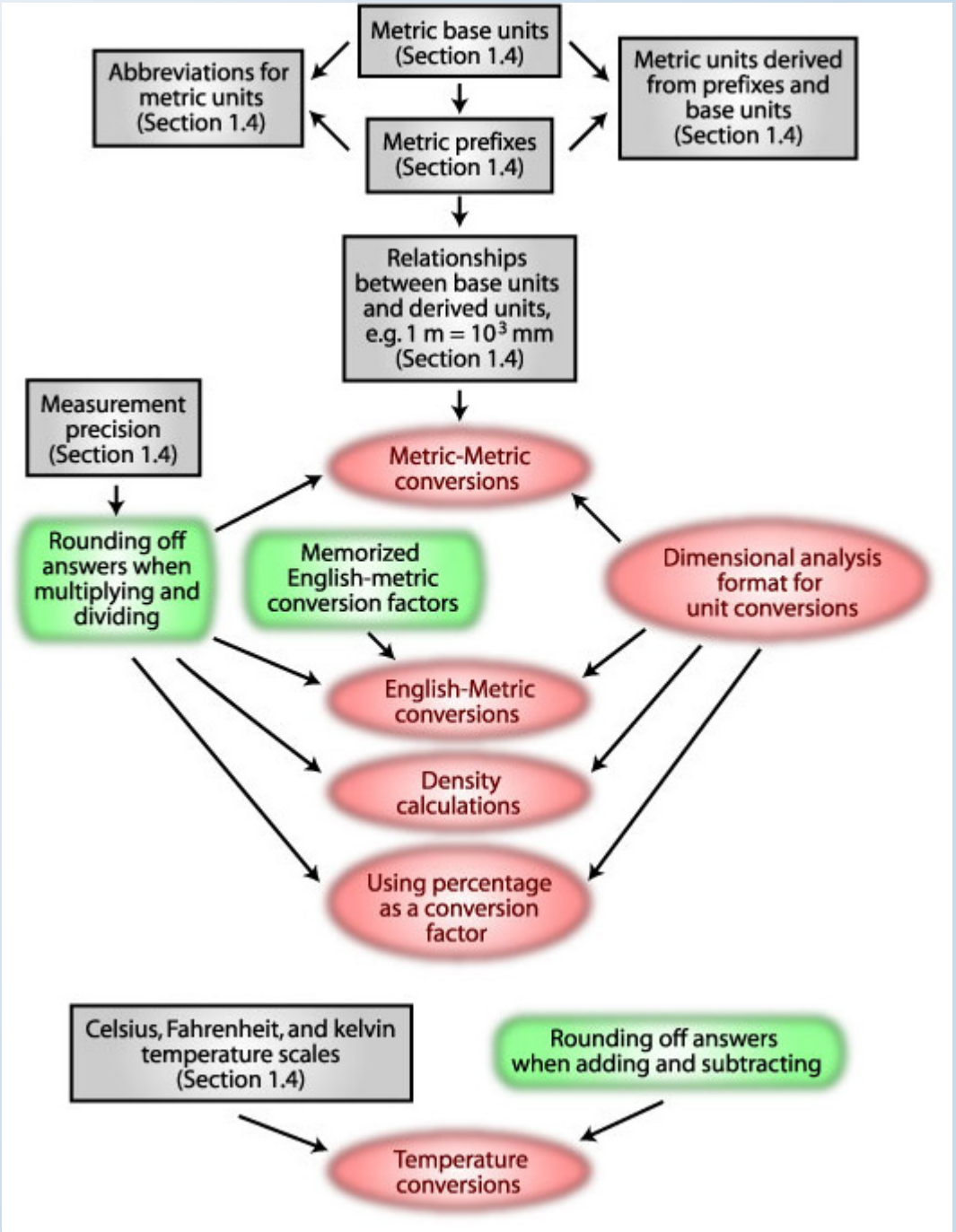
Chapter 8

Unit Conversions

Chapter Map


Metric base units (Section 1.4)
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Metric prefixes (Section 1.4)
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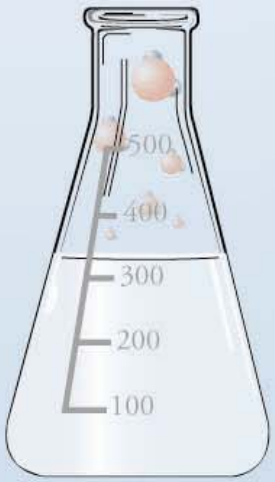
Unit Conversions

All science requires mathematics. The knowledge of mathematical things is almost innate in us. . . [Mathematics] is the easiest of sciences, a fact which is obvious in that no one's brain rejects it…

Roger Bacon (c. 1214-c. 1294)

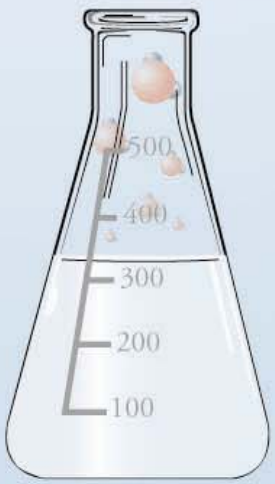
Stand firm in your refusal to remain conscious during algebra. In real life, I assure you, there is no such thing as algebra.

Fran Lebowitz (b. 1951)



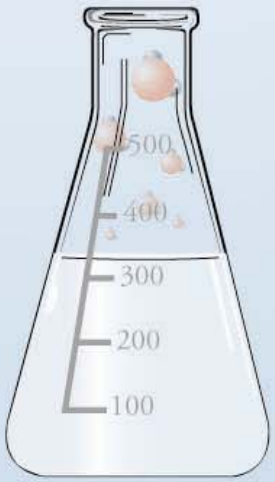
Unit Analysis Step 1

- **Step 1:** State your question in an expression that sets the unknown unit equal to the value given.
  - Start with the same number of units as you want.
    - If you want a single unit, start with a value that has a single unit.
    - If you want a ratio of two units, start with a value that has a ratio of two units, or start with a ratio of two values, each of which have one unit.
  - Put the correct type of unit in the correct position.



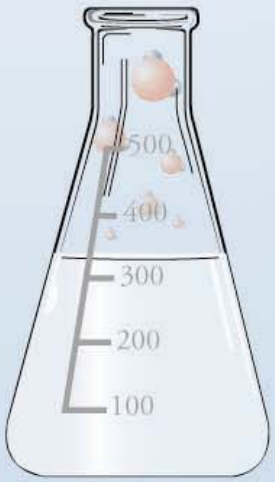
Unit Analysis Step 2

- **Step 2:** Multiply the expression to the right of the equals sign by one or more conversion factors that cancel the unwanted units and generate the desired unit.
  - If you are not certain which conversion factor to use, ask yourself, "What is the fundamental conversion and what conversion factor do I use for that type of conversion?"



Unit Analysis Steps 3 & 4

- **Step 3:** Check to be sure you used correct conversion factors and that your units cancel to yield the desired unit.
- **Step 4:** Do the calculation, rounding your answer to the correct number of significant figures and combining it with the correct unit.

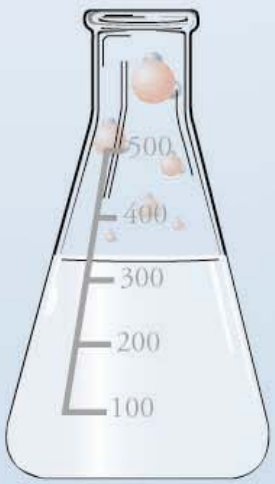


English-Metric Conversion Factors

Type of Measurement	Probably Most Useful to Know	Others Useful to Know		
Length	$\frac{2.54\ \text{cm}}{1\ \text{in.}}$	$\frac{1.609\ \text{km}}{1\ \text{mi}}$	$\frac{39.37\ \text{in.}}{1\ \text{m}}$	$\frac{1.094\ \text{yd}}{1\ \text{m}}$
Mass	$\frac{453.6\ \text{g}}{1\ \text{lb}}$	$\frac{2.205\ \text{lb}}{1\ \text{kg}}$		
Volume	$\frac{3.785\ \text{L}}{1\ \text{gal}}$	$\frac{1.057\ \text{qt}}{1\ \text{L}}$		

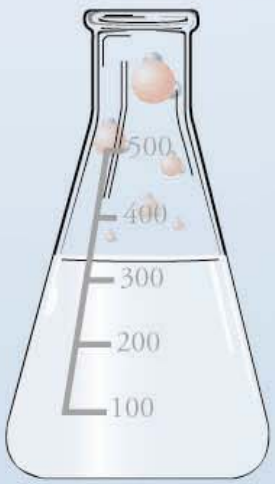
Rounding Answers from Multiplication and Division Step 1

- **Step 1:** Determine whether each value is exact, and ignore exact values.
  - Exact values
    - Numbers that come from definitions are exact.
    - Numbers derived from counting are exact.
  - Do Step 2 for values that are not exact.
    - Values that come from measurements are never exact.
    - We will assume that values derived from calculations are not exact unless otherwise indicated.



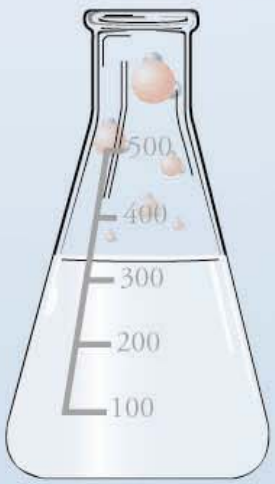
Rounding Answers from Multiplication and Division Step 2

- **Step 2:** Determine the number of significant figures in each value that is not exact.
  - All non-zero digits are significant.
  - Zeros between nonzero digits are significant.
  - Zeros to the left of nonzero digits are not significant.
  - Zeros to the right of nonzero digits in numbers that include decimal points are significant.
  - Zeros to the right of nonzero digits in numbers without decimal points are ambiguous for significant figures.



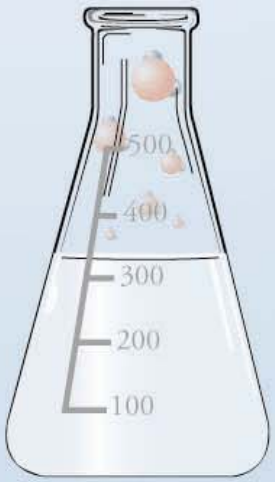
Rounding Answers from Multiplication and Division Step 3

- **Step 3:** When multiplying and dividing, round your answer off to the same number of significant figures as the value used with the fewest significant figures.
  - If the digit to the right of the final digit you want to retain is less than 5, round down (the last digit remains the same).
  - If the digit to the right of the final digit you want to retain is 5 or greater, round up (the last significant digit increases by 1).



Rounding Answers from Addition and Subtraction

- **Step 1:** Determine whether each value is exact, and ignore exact values.
  - Skip exact values.
  - Do Step 2 for values that are not exact.
- **Step 2:** Determine the number of decimal positions for each value that is not exact.
- **Step 3:** Round your answer to the same number of decimal positions as the inexact value with the fewest decimal places.

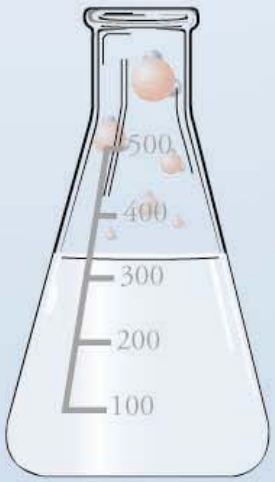


Density

- ***Mass density*** is mass divided by volume. It is usually just called density.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

- It can be used as a unit analysis conversion factor that converts mass to volume or volume to mass.



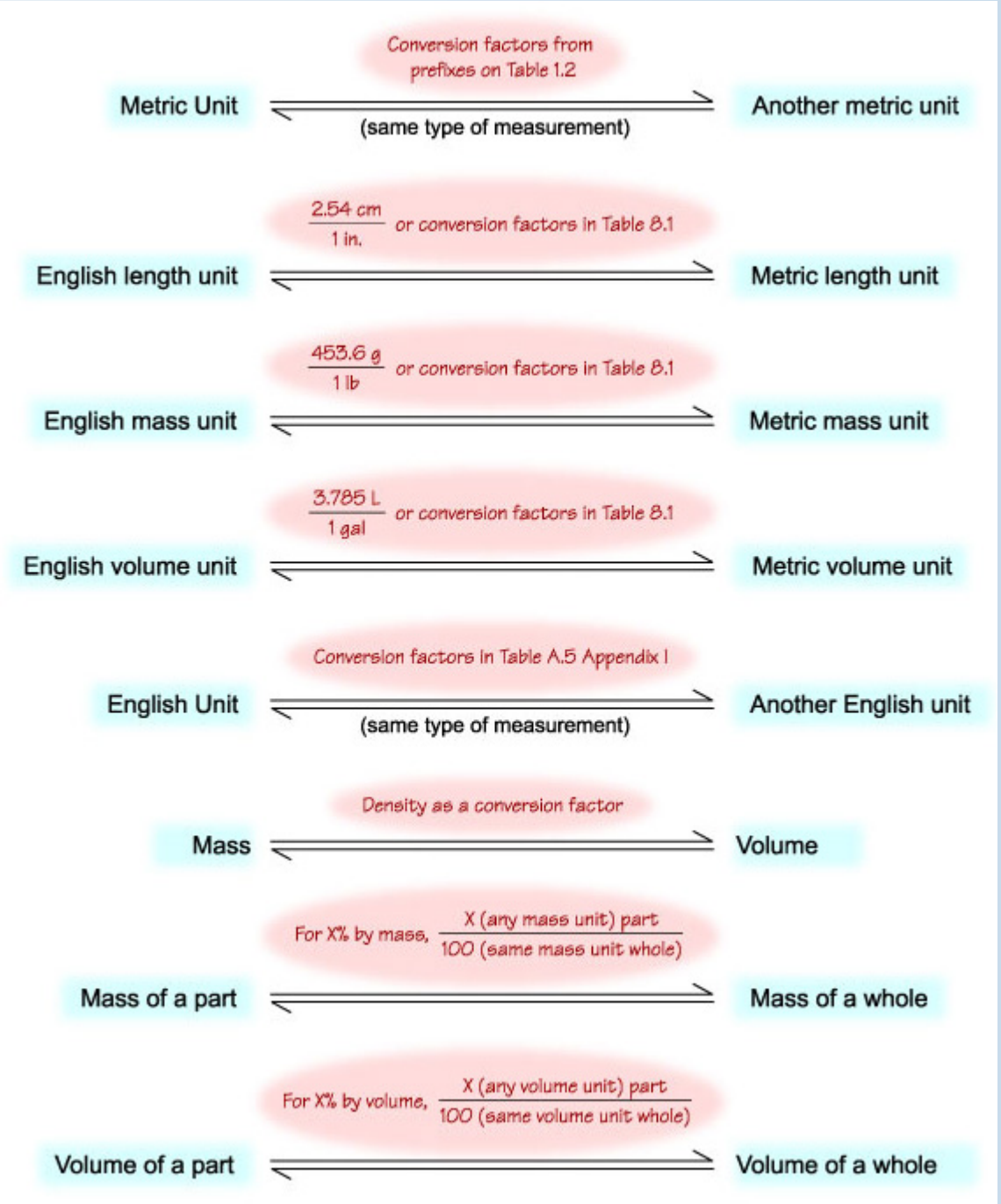
Percentage and Percentage Calculations

- Mass percentages and volume percentage can be used as unit analysis conversion factors to convert between units of the part and units of the whole.

For X% by mass $\frac{\text{X (any mass unit) part}}{\text{100 (same mass unit) whole}}$

For X% by volume $\frac{\text{X (any volume unit) part}}{\text{100 (same volume unit) whole}}$

Conversion Types



Temperature Conversions

$$?\,°F = \text{---}\,°C\left(\frac{1.8\,°F}{1°C}\right) + 32\,°F$$

$$?\,°C = \left(\text{---}\,°F - 32\,°F\right)\left(\frac{1°C}{1.8\,°F}\right)$$

$$?\,K = \text{---}\,°C + 273.15$$

$$?\,°C = \text{---}\,K - 273.15$$