

Unit Conversions

Important Tips

- Always write every number with its associated unit.
- Always include units in your calculation.
 - ✓ you can do the same kind of operations on units as you can on numbers
 - ✓ using units as a guide to problem solving is called **dimensional analysis**
- Conversion factors are relationships between two units
- Conversion factors can be generated from equivalence statements (e.g. 1 inch = 2.54 cm)
- Arrange conversion factors so the starting unit is on the bottom of the first conversion factor

Conceptual Plan

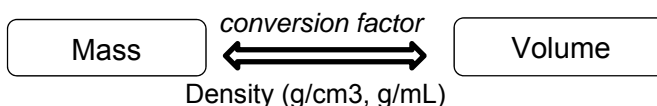
$$\cancel{\text{given unit}} \times \frac{\text{related unit}}{\cancel{\text{given unit}}} = \text{desired unit}$$

$$\cancel{\text{given unit}} \times \frac{\cancel{\text{related unit}}}{\cancel{\text{given unit}}} \times \frac{\text{desired unit}}{\cancel{\text{related unit}}} = \text{desired unit}$$

Systematic Approach to Problem Solving

Convert 5.70 L to cubic inches		
• Sort Information	Given: Desired:	5.70 in. ³
• Strategize	Conceptual Plan Relationships:	$\boxed{\text{L}} \Rightarrow \boxed{\text{mL}} \Rightarrow \boxed{\text{cm}^3} \Rightarrow \boxed{\text{in}^3}$ 1 mL = 1 cm ³ , 1 mL = 10 ⁻³ L 1 in. = 2.54 cm.
• Follow the conceptual plan to solve the problem	Solution:	$5.70 \text{ L} \times \frac{1 \text{ mL}}{10^{-3} \text{ L}} \times \frac{1 \text{ cm}^3}{1 \text{ mL}} \times \frac{(1 \text{ in.})^3}{(2.54 \text{ cm})^3} = 347.835 \text{ in.}^3$
• Sig. figs. and round	Round	347.835 in. ³ = 348 in. ³ (3 sig. fig.)
• Check	units are correct; number makes sense: in. ³ << L	

Density as a Conversion Factor



What is the mass in kg of 173,231 L of jet fuel whose density is 0.768 g/mL?		
• Sort Information	Given: Desired:	173.231L, density = 0.768 g/mL Mass, kg
• Strategize	Conceptual Plan Relationships:	$\boxed{\text{L}} \Rightarrow \boxed{\text{mL}} \Rightarrow \boxed{\text{g}} \Rightarrow \boxed{\text{kg}}$ 1 mL = 0.768 g (from density) 1 mL = 10 ⁻³ L, 1 kg = 1000g
• Follow the conceptual plan to solve the problem	Solution:	$173,231 \cancel{\text{L}} \times \frac{1 \cancel{\text{mL}}}{10^{-3} \cancel{\text{L}}} \times \frac{0.768 \cancel{\text{g}}}{1 \cancel{\text{mL}}} \times \frac{1 \text{ kg}}{1000 \cancel{\text{g}}} = 1.3304 \times 10^5 \text{ kg}$
• Sig. figs. and round	Round	1.3304 x 10 ⁵ kg = 1.33 x 10 ⁵ kg
• Check	units and number makes sense	

SI Prefix Multipliers

Prefix	Symbol	Multiplier	Power of 10
giga	G	1,000,000,000	Base x 10^9
mega	M	1,000,000	Base x 10^6
kilo	k	1,000	Base x 10^3
deci	d	0.1	Base x 10^{-1}
centi	c	0.01	Base x 10^{-2}
milli	m	0.001	Base x 10^{-3}
micro	μ	0.0000001	Base x 10^{-6}
mano	n	0.0000000001	Base x 10^{-9}
pico	p	0.0000000000001	Base x 10^{-12}

Volume (1 mL = 1 cm³)

solid volume (cubic centimeters, cm³)

$$1 \text{ m}^3 = 10^6 \text{ cm}^3$$

$$1 \text{ cm}^3 = 10^{-6} \text{ m}^3 = 0.000 \text{ 001 m}^3$$

liquid or gas volume (milliliters, mL)

$$1 \text{ mL} = 0.001 \text{ L} = 10^{-3} \text{ L}$$

$$1 \text{ L} = 1 \text{ dm}^3 = 1000 \text{ mL} = 10^3 \text{ mL}$$

Practice Problems

1. Use the prefix multipliers to express each measurement without any exponents.

- $1.2 \times 10^{-9} \text{ m}$
- $22 \times 10^{-15} \text{ s}$
- $1.5 \times 10^9 \text{ g}$
- $3.5 \times 10^6 \text{ L}$

2. Perform the following conversions.

- 25.5 mg to g
- $4.0 \times 10^{-10} \text{ m}$ to nm
- 0.575 mm to μm
- 68.3 cm³ to cubic meters
- 242 lb to milligrams (1 lb = 453.6 g)

3. The density of platinum is 21.45 g/cm³ at 20 °C. What is the volume of 87.50 g of this metal at this temperature?

4. Mercury is the only metal that is a liquid at room temperature. Its density is 13.6 g/mL. How many grams of mercury will occupy a volume of 95.8 mL?

5. Liquid nitrogen is obtained from liquefied air and is used to prepare frozen goods and in low-temperature research. The density of the liquid at its boiling point (-196 °C) is 0.808 g/cm³. Convert the density to units of kg/m³.

References:

Tro, *Chemistry: A Molecular Approach 2nd ed.*, Pearson

Brown/LeMay/Bursten, *Chemistry: The Central Science, 12th ed.*, Pearson

1. a) 1.2 nm; b) 22 fs; c) 1.5 Gg; d) 3.5 ML
 2. a) $2.55 \times 10^{-2} \text{ g}$; b) 0.40 nm; c) 575 μm ; d) $6.83 \times 10^5 \text{ m}^3$; e) $1.10 \times 10^8 \text{ mg}$
 3. 50.35 cm³; 4. $1.30 \times 10^3 \text{ g}$; 5. 808 kg/m³

Answers