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

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

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

Systematic Approach to Problem Solving

Convert 5.70 L to cubic inches		
• Sort Information	Given: Desired:	5.70 $in.^3$
• Strategize	Conceptual Plan Relationships:	L ⇨ mL ⇨ cm^3 ⇨ 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: $5.70\ L \times \frac{1\ mL}{10^{-3}\ L} \times \frac{1\ cm^3}{1\ mL} \times \frac{(1\ in.)^3}{(2.54\ cm)^3} = 347.835\ in.^3$	
• 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

Mass ⟺ Volume (*conversion factor*)

Density (g/cm3, g/mL)

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:	L ⇨ mL ⇨ g ⇨ 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: $173{,}231\ \cancel{L} \times \frac{1\ \cancel{mL}}{10^{-3}\ \cancel{L}} \times \frac{0.768\ \cancel{g}}{1\ \cancel{mL}} \times \frac{1\ kg}{1000\ \cancel{g}} = 1.3304 \times 10^5\ kg$	
• Sig. figs. and round	Round	$1.3304 \times 10^5\ kg = 1.33 \times 10^5\ kg$
• 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 cm^3**)

solid volume (cubic centimeters, cm^3)

1 m^3 = 10^6 cm^3

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

liquid or gas volume (milliliters, mL)

1 mL = 0.001 L = 10^{-3} L

1L = 1 dm^3 = 1000 mL =10^3 mL

Practice Problems

1. Use the prefix multipliers to express each measurement without any exponents.
   a) 1.2×10^{-9} m
   b) 22×10^{-15} s
   c) 1.5×10^{9} g
   d) 3.5×10^{6} L
2. Perform the following conversions.
   a) 25.5 mg to g
   b) 4.0×10^{-10} m to nm
   c) 0. 575 mm to μm
   d) 68.3 cm^3 to cubic meters
   e) 242 lb to milligrams (1lb = 453.6 g)
3. The density of platinum is 21.45 g/cm^3 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/cm^3. Convert the density to units of kg/m^3.

References:
Tro, Chemistry: A Molecular Approach 2nd ed., Pearson
Brown/LeMay/Bursten, Chemistry: The Central Science, 12th ed., Pearson

Answers

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