

The Metric System

Chapter 3

Dimensional Analysis or Unit Analysis

Always start with what is given -

Always end with what they are asking for -

Choose the correct Unit Factor - This part is tricky!
Always make sure your units cancel!!!

Unit Factor: A ratio of two parts of a statement that relates two units.

We can write 1 min = 60 sec as two *unit factors* (conversion factors).

$$\frac{1 \text{ min}}{60 \text{ sec}} \quad \text{or} \quad \frac{60 \text{ sec}}{1 \text{ min}}$$

We can write 1 day = 24 hours as two *unit factors* (conversion factors).

$$\frac{1 \text{ day}}{24 \text{ hrs}} \quad \text{or} \quad \frac{24 \text{ hrs}}{1 \text{ day}}$$

- Try these examples using Dimensional Analysis**
- How many weeks are there in 63 days?
 - How many inches are there in 2.95 ft?
 - How many miles will an automobile travel in 4.25 hours at an average speed of 68 miles per hour?

The Metric System

The Metric System: Simple and coherent

- Uses a single base unit for each quantity measured.
- Decimal system that uses prefixes to enlarge or reduce a basic unit.

The Metric Base Units

Length	meter	m
Mass	gram	g
Volume	liter	L
Time	second	s

Prefix Multipliers

<u>Prefix</u>	<u>Symbol</u>	<u>Multiplier</u>	
tera-	T	1,000,000,000,000	10 ¹²
giga-	G	1,000,000,000	10 ⁹
mega-	M	1,000,000	10 ⁶
kilo-	k	1,000	10 ³
"unit"		1	
deci-	d	0.1	10 ⁻¹
centi-	c	0.01	10 ⁻²
milli-	m	0.001	10 ⁻³
micro-	μ	0.000001	10 ⁻⁶
nano-	n	0.000000001	10 ⁻⁹
pico-	p	0.000000000000001	10 ⁻¹⁵

You are responsible only for those in blue!

Metric Conversion Factors

A Simpler Way to Remember the Prefix Multipliers!

<u>Mass</u>	<u>Volume</u>	<u>Length</u>
1000 g = 1 kg	1000 L = 1 kL	1000 m = 1 km
1 g = 10 dg	1 L = 10 dL	1 m = 10 dm
1 g = 100 cg	1 L = 100 cL	1 m = 100 cm
1 g = 1000 mg	1 L = 1000 mL	1 m = 1000 mm

- How many mm are there in 12.5 m?
- How many mm are there in 55.5 km?
- How many g are there in 77.89 cg?
- How many kL are there in 123.7 mL?

Metric-English Conversions

1 inch = 2.54 cm
1 pound = 454 g
1 quart = 946 mL

Know these conversions!!

Also know the basics!!

-(like 1 lb = 16 oz, 12 in = 1 foot, 3ft = 1 yd,
1 qt = 32 fl oz, etc. . .)

1. Convert 200.0 g into pounds.
2. Convert 20.0 qt into mL.
3. Convert 88.8 cm into in.
4. Convert 5.68 m into inches
5. Convert 7.0 dg into ounces

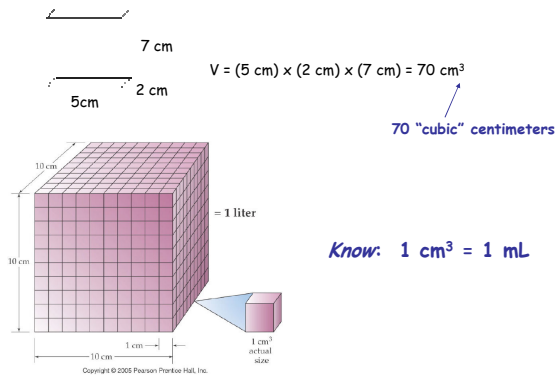
More Difficult Problems

If the EPA city mileage for a SUV is 15 miles per gallon, what is the mileage in kilometers per liter?
(Given: 1 mi = 1.61 km and 1 gal = 3.784 L)

An oxygen molecule travels at 975 mi/hr at room temperature. What is the velocity in meters per second?

The density of mercury is 13.534 g/cm³. Convert the density to lbs/gal.

Volume = length x width x height



Convert 45.6 cm³ into mL.

Convert 345 cm³ into in³.

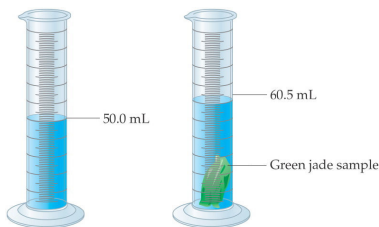
Convert 10.0 m³ into mL.

A rectangular solid piece of brass measures 3.67 cm by 1.55 cm by 0.847 cm. What is the volume in cubic meters?

A sheet of aluminum foil measures 25.9 cm by 81.0 cm. What is the thickness of the foil if the volume is 4.02 cm³?

Volume by Displacement

- First fill a graduated cylinder with water and record the volume.
- Then add the object, carefully, and record the new volume.
- Subtract the two volumes to determined the volume of the object.



The initial water level in a 50.0-mL graduated cylinder reads 25.8 mL. After an irregularly shaped piece of platinum is placed gently in the cylinder, the water level reads 36.5 mL. What is the volume of the platinum rock?

Density

Directly Proportionate

↑ A ↑ B

Inversely Proportionate

↑ A ↓ B

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$D = \frac{M}{V}$$

Density describes the relative "heaviness" of a substance.

Why does ice float in water if they are both made of water molecules?

The density of a given pure substance in a given state of matter is a measure of how tightly packed the molecules are in that state.

Table 3.4 Density of Selected Solids, Liquids, and Gases	
Example	Density (d)
Solids	
ice	0.917 g/cm ³ or g/mL
rubber	1.19
magnesium	1.74
aluminum	2.70
iron	7.87
lead	11.3
gold	18.9
Liquids	
ethyl ether	0.714 g/cm ³ or g/mL
ethyl alcohol	0.789
water	1.00
chloroform	1.48
mercury	13.6
Gases*	
hydrogen	0.090 g/L
helium	0.179
ammonia	0.760
air	1.29
oxygen	1.43

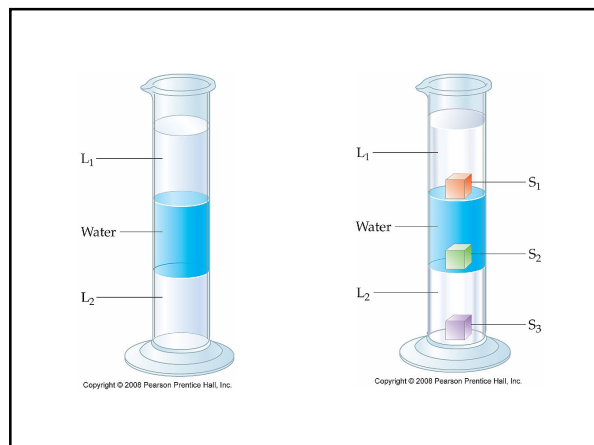
*The listed density value of each gas is given at 0°C and normal atmospheric pressure.
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Examples

Calculate the density of a piece of unknown metal that has a mass of 58.9 g and displaces a volume of 3.17 mL.

Calculate the mass of a block of wood that has a density of 0.500 g/mL and displaces a volume of 3.2 L.

Calculate the mass of a mercury that completely fills a container with a volume of 0.56 L. The density of mercury is 13.6 g/cm³.



Temperature

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KNOW: $T_{°F} - 32 = 1.8 \times T_{°C}$

$T_K = T_{°C} + 273$

Examples

Convert 34.6 °C into °F.

Convert 86.7 °C into K.

Convert 86.7 °F into K.

Heat

Heat is the flow of energy from an object at a **higher** temperature to an object at a **lower** temperature.

Heat measures **TOTAL** energy.

Temperature measures **AVERAGE** energy.

(a) (b)

1) Which of the two beakers, (a) or (b), has the higher temperature? Why?

2) Which has the greater amount of heat? Why?

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What is the hottest part of the flame?



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What happens when you hold a cold ice cube?
(Hint: Are you gaining or losing heat?)

Why does the stone countertop in the lab feel cool
when you place your hand on it?

Why do you burn your fingers on a hot lightbulb?