Metric Conversions

Metric System to English Conversions:

1 inch = 2.54 cm (EXACT)
1 pound = 454 g
1 liter = 1.06 quarts

How many liters of gasoline can a 16 gallon gas tank hold?

$$16.\ \text{gal} \times \frac{4\ \text{qts}}{1\ \text{gal}} \times \frac{1\ \text{L}}{1.06\ \text{qt}} = 60.37736\ \text{L} \Rightarrow 60.\ \text{L}$$

$$16.0\ \text{gal} \times \frac{4\ \text{qts}}{1\ \text{gal}} \times \frac{1\ \text{L}}{1.06\ \text{qt}} = 60.37736\ \text{L} \Rightarrow 60.4\ \text{L}$$

$$16.00\ \text{gal} \times \frac{4\ \text{qts}}{1\ \text{gal}} \times \frac{1\ \text{L}}{1.06\ \text{qt}} = 60.37736\ \text{L} \Rightarrow 60.38\ \text{L}$$

Number of digits in measurements controls sig figs in solution

Improper Sig Figs Lead to Disaster

A cargo has a density of 0.84937 kg / L.
What is the mass of 100,000 L?

100,000 L x 0.8 kg / L = 80,000 kg
100,000 L x 0.85 kg / L = 85,000 kg
100,000 L x 0.849 kg / L = 84,900 kg
100,000 L x 0.8494 kg / L = 84,940 kg
100,000 L x 0.84937 kg / L = 84,937 kg

Metric Conversions

How many liters are in a gallon of milk?

$$1.00\ \text{gal} \times \frac{4\ \text{gt}}{1\ \text{gal}} \times \frac{1\ \text{liter}}{1.06\ \text{qt}} = 3.77\ \text{L}$$

A newborn baby weighs 7.70 pounds. How much drug does the baby receive if the drug dose is 0.147 mg / kg body weight?

$$7.70\ \text{lbs} \times \frac{454\ \text{g}}{1\ \text{lb}} \times \frac{1\ \text{kg}}{1000\ \text{g}} \times \frac{0.147\ \text{mg}}{1\ \text{kg}} = 0.514\ \text{mg}$$

The weather report lists the barometric pressure as 754.6 mm?
What is this pressure in inches?

$$754.6\ \text{mm} \times \frac{1\ \text{m}}{1000\ \text{mm}} \times \frac{100\ \text{cm}}{1\ \text{m}} \times \frac{1\ \text{in}}{2.54\ \text{cm}} = 29.71\ \text{in}$$

A fabric sells for $ 3.05 per yard. Across the street the same fabric is $ 3.24 per meter. Which is a better buy?

$$1.00\ \text{m} \times \frac{100\ \text{cm}}{1\ \text{m}} \times \frac{1\ \text{in}}{2.54\ \text{cm}} \times \frac{1\ \text{yd}}{36\ \text{in}} = 1.09\ \text{yd}$$

\$ 3.05 / yd or \$ 3.24 / 1.09 yd = <u>\$ 2.97 /yd</u>

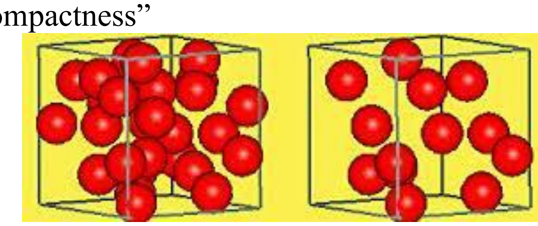
Density

Density cannot be measured directly; must be calculated from mass and volume

Density = mass per unit volume (density = "per" expression)
Density = A Derived, not basic unit

$$\textbf{Density} = \frac{\textbf{mass}}{\textbf{volume}} \qquad \textbf{D} = \frac{\textbf{m}}{\textbf{V}}$$

Mass: amount of "stuff"
Weight: result of a force (gravity) acting on mass
Density: how much "stuff" per unit volume
Density: measures "compactness"



High Density **Low Density**

Density is a physical property of substances.

air	0.0012 g/cm^3	Al	2.7 g/cm^3
pine	0.5 g/cm^3	Pb	11.4 g/cm^3
oak	0.8 g/cm^3	Hg	13.6 g/cm^3
water	1.0 g/cm^3	Au	19.3 g/cm^3

Water ~ 833 times more dense than air

Find Density

What is the density of copper if 29.4 cm^3 of Cu weighs 265 g

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

$$\text{Density} = \frac{265\ \text{g}}{29.4\ \text{cm}^3}$$

Density = 9.0136 g/cm^3 ➔ 9.01 g/cm^3

Find Mass

What is the mass of 15.7 mL of Hg (density of 13.6 g/mL)

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

Mass = Density x Volume

$m = \frac{13.6\ g}{1\ mL} \times 15.7\ mL$

m = 213. 52 g ➔ 214 g

Find Volume

What is the volume of a 46.0 g of Al (density Al =2.7 g/cm^3)

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

Volume = $\frac{46\ g}{2.7\ g/\ cm^3}$

Volume = 17.037 cm^3 ➔ 17 cm^3

Find Identity

The following are densities for some metals:

manganese	=	7.21 g/cm^3
iron	=	7.87 g/cm^3
nickel	=	8.90 g/cm^3

A piece of wire has a mass of 38.2 g and a volume of 5.30 cm^3.
What is the identity of the metal wire?

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

Density = $\frac{38.2\ g}{5.30\ cm^3}$

Density = 7.2075 g/cm^3 ➔ 7.21 g/cm^3 Metal = manganese

Archimedes Principle

An object partially or wholly immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object

Translation (for water):
objects more dense than water (like lead) will sink
objects less dense than water (like cork) will float
objects of the same density will remain at the same level (hover)

A presumed gold ring has a mass of 2.832 g. When placed in a a 10-mL graduate cylinder , the water level goes from 5.00 mL to 5.15 mL. Is the ring gold (d = 19.3 g/mL) ?

Volume of ring = 5.15 mL – 5.00 mL = 0.15 mL

$$d = \frac{\text{mass}}{\text{volume}} \rightarrow \frac{2.832\ \text{g}}{0.15\ \text{mL}} \rightarrow 18.9\ \text{g / mL} \rightarrow 19\ \text{g/mL}$$

Density slightly less than pure gold, so it is a gold ring with some metal alloy to give it strength.

Density: Sink or float?

You land on a planet near a liquid methane sea (density 422.6 kg / m^3).

a. Express this density as g/ cm^3

$$\frac{422.6\ \text{kg}}{\text{m}^3} \times \frac{1000\ \text{g}}{1\ \text{kg}} \times \frac{1\ \text{m}}{100\ \text{cm}} \times \frac{1\ \text{m}}{100\ \text{cm}} \times \frac{1\ \text{m}}{100\ \text{cm}} = 0.4223\ \text{g / cm}^3$$

b. Will your instruments (density 1.53 g / cm^3) sink or float in this sea? Why?

Package is more dense than the fluid, so it sinks.

Density: Loading Cargo

A toy boat (mass of 14.50 g) has a volume of 450.00 cm^3. The boat is placed in a small pool of fresh water (d: 1.0000 g/cm^3) and carefully filled with pennies. If a penny has a mass of 2.500 g, how many pennies can be safely added to the boat without sinking?

To totally sink, the mass of the boat must exceed:
450.00 cm^3 x 1.0000 g / cm^3 = 450.00 g
Mass of pennies needed:
450.00 g - 14.50 g = 435.50 g
Number of pennies needed to sink boat:

$$435.50\ \text{g} \times \frac{1\ \text{penny}}{2.500\ \text{g}} = 174.2 \rightarrow 175\ \text{pennies}$$

Number of pennies that can be added: 174

A toy boat (mass of 14.50 g) has a volume of 450.00 cm^3. The boat is placed in a small pool of salt water (d: 1.0250 g/cm^3) and carefully filled with pennies. If a penny has a mass of 2.500 g, how many pennies can be safely added to the boat without sinking?

To totally sink, the mass of the boat must exceed:

$450.00\ cm^3 \times 1.0250\ g / cm^3 = 461.25\ g$

Mass of pennies needed:

$461.25\ g - 14.50\ g = 446.75\ g$

Number of pennies needed to sink boat:

$446.75\ g \times \frac{1\ penny}{2.500\ g} = 178.7 \rightarrow 179$ pennies

Number of pennies that can be added: 178

A boy scout troop has collected 2536 lbs of aluminum soda cans.
If the density of the cans is 2.70 g/cm^3, what is the minimum volume needed to transport this material to a recycle center?

$2536\ pounds \times \frac{454\ g}{1\ lb} \times \frac{1\ cm^3}{2.70\ g} \times \frac{1\ inch}{2.54\ cm} \times \frac{1\ inch}{2.54\ cm} \times \frac{1\ inch}{2.54\ cm}$

Continuing (without isolation):

$\times \frac{1\ ft}{12\ in} \times \frac{1\ ft}{12\ in} \times \frac{1\ ft}{12\ in} = 17.7824\ ft^3 \rightarrow 17.8\ ft^3$

Desity of Water Phases

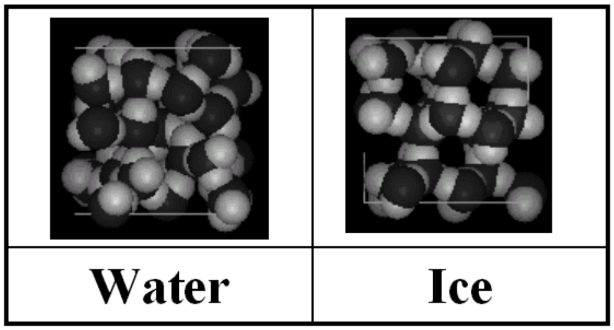
Liquid water at 4 ^oC has a density of 1.00 g/mL
Solid water at 0 ^oC has a density of 0.92 g/mL
What volume will 100. g of water have at these temperatures?

100. g x mL / 1.000 g = 100. mL
100. g x mL / 0.920 g = 109 mL

% change:
(109 – 100) / 100 x 100 = 9 %

This is why frozen pipes burst.

Water & Ice



Same Volume ➔ more mass in water **Less mass in ice, so it floats**

If ice did not float, most fresh water critters would not survive winter

Form & Function Are intimately related

Forgetting Units Leads to Disaster

In 1983 Air Canada flight 143 crew manually calculated (Canada was in process of converting to metric system) the volume of fuel needed for a full load of 22,300 kg . They used a density of 1.77 (no units). Turns out the density they used was in units of pounds (not kg) per liter.

This is what they did (V = M / D)

$$V = \frac{22{,}300}{1.77} = 1.26 \times 10^4 \text{ liters}$$

They loaded a total 1.26×10^4 liters of fuel.

This is what they should have loaded:

$$22{,}300 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ lb}}{454 \text{ g}} \times \frac{1 \text{ liter}}{1.77 \text{ lb}} = 2.31 \times 10^4 \text{ liters}$$

This Air Canada flight ran out of fuel at 41,000 feet one hour into the flight and glided 20 km (12.4 miles) to a safe landing

Calculations, without units, just don't "look right"

And are often quite wrong!

Let the units drive the solution

Assignment:

Continue taking Unit 3 Practice Test
  Blackboard only records highest score
  Take until multiple 100’s have been scored (questions are variable)
  (Gives sense of test exam format and content)

The Practice Quiz is very similar to the Unit Exam
Success on Unit exam is directly related to practice exam experiences

Continue memorizing:
  Conversion factors
  Polyatomic Ions
  Elemental Symbols