Unit 2

2.5 **Precision accuracy and uncertainty** – to be covered by Physics. Apply the concepts when carrying out calculations in this course.

- **Uncertainty in measurements**

2.6 **Significant figures** – to be covered by Physics. Apply the concepts when carrying out calculations in this course.

- **Rules for determining significant figures**
- **Rules for rounding numbers**

2.7 **Calculations involving significant figures** – to be covered by Physics. Apply the concepts when carrying out calculations in this course.

- **Rules for addition and subtraction**
- **Rules for multiplication and division**

Reading: Hebden – page 26 – 34

2.8 **Density**

Reading: Hebden – page 24 – 25

2.9 **Specific gravity**

PROBLEMS:
Significant figures
Unit conversion
Word problems

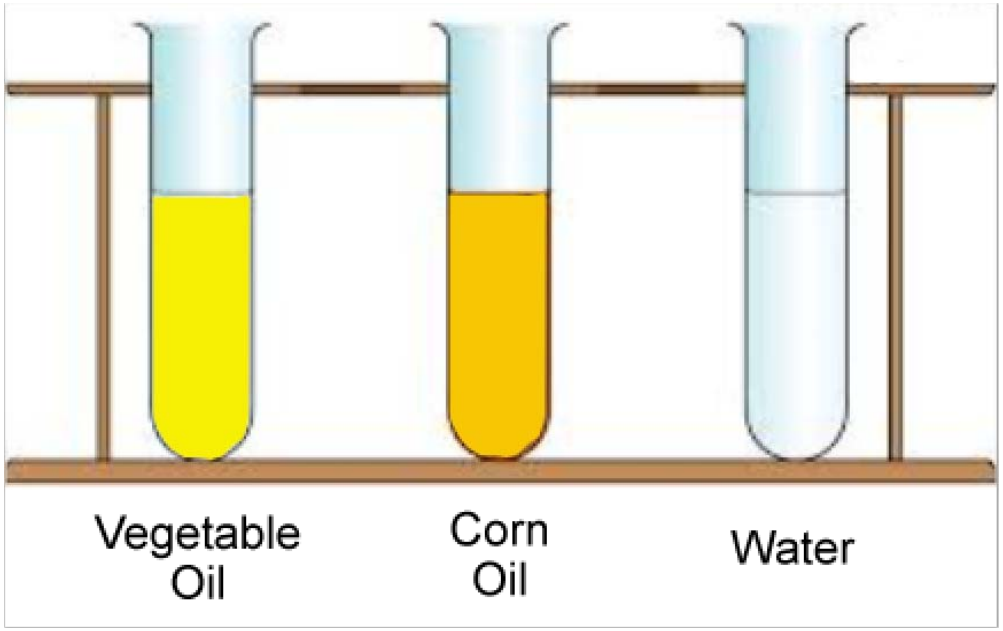
Dimensional Analysis

Unit given x *conversion factor(s)* = *unit sought*

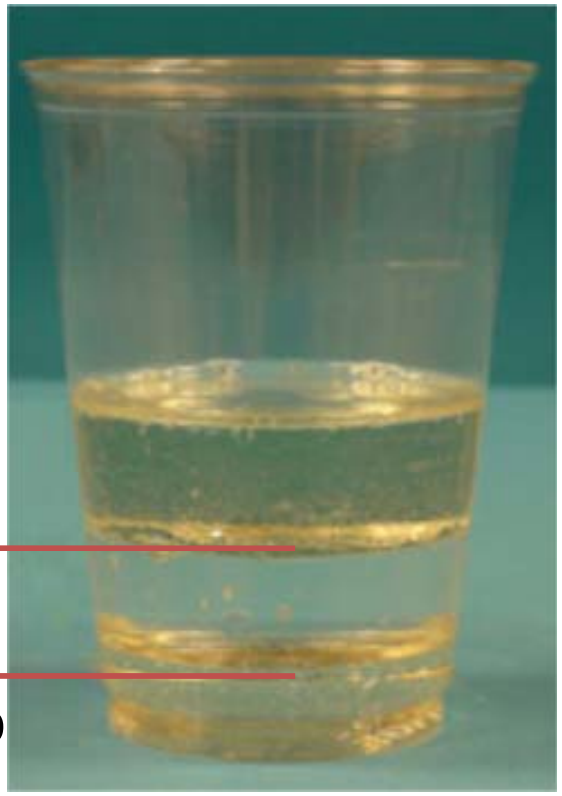
All about unit cancellation

Density, D

Three liquids – *What happens when they are poured together?*



Immiscible – when liquids do not mix



Relative position is determined by the liquid's density

Density of Vegetable Oil < 1 $^{g}/_{mL}$

Density of water = 1 $^{g}/_{mL}$

Density of Corn Syrup > 1 $^{g}/_{mL}$

Density, D

Unit in $\frac{g}{cm^3}, \frac{g}{L}, \frac{g}{mL}$

$$D = \frac{mass}{Volume}$$

Unit in grams, g

Unit in cm^3, mL, L

Express **mass** in terms of Density and volume.

$$Mass = D \cdot Volume$$

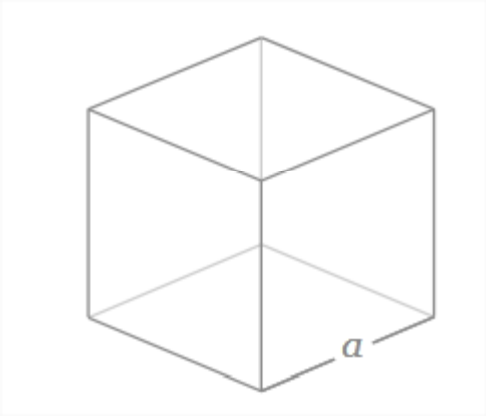
Express **volume** in terms of Density and mass.

$$Volume \cdot D = \frac{mass}{Volume} \cdot Volume$$

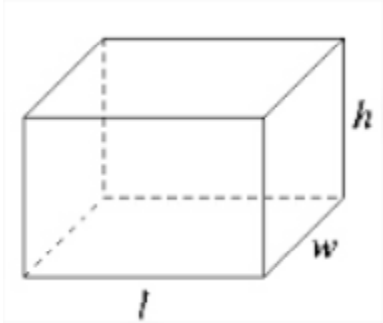
$$\frac{1}{D} \cdot Volume \cdot D = Mass \cdot \frac{1}{D}$$

$$Volume = \frac{mass}{D}$$

Volume

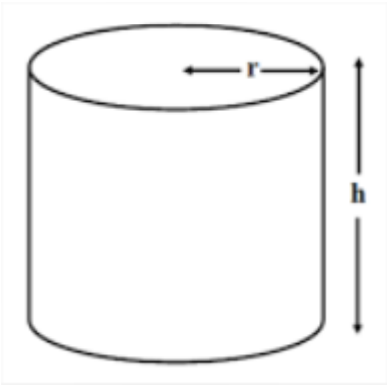


Volume = a^3

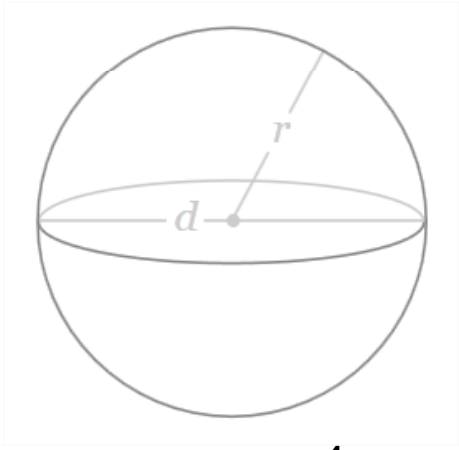


Volume = $l \cdot w \cdot h$

Foil: l and $w >> h$



Volume = $\pi r^2 h$

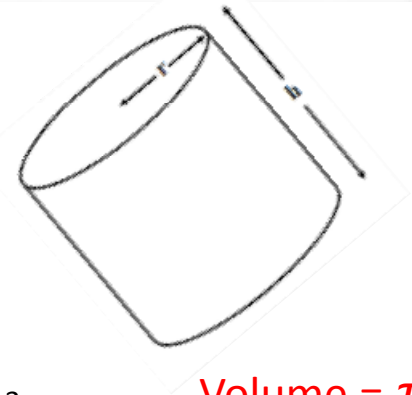


$$\text{Volume} = \frac{4}{3}\pi r^3$$

ball bearing, marble

Density Problems

The diameter of a metal wire is referred to by its wire gauge number. A 16-gauge wire has a diameter of 0.05082 inch. What length of wire, in meters, is there in a 1.00 kg of 16-gauge copper wire? The density of copper is 8.92 $^{g}/_{cm^3}$.
[Area of a circle = $\pi \cdot r^2$; 1 inch = 2.54 cm]



Wire is a cylinder, so the volume of a strand of wire can be calculated using the volume equation for a cylinder. Find *h*.

Density of copper = 8.92 $^{g}/_{cm^3}$

Mass = 1.00 kg = 1.00 x 10^3 g

Volume = $\pi r^2 h$

$$D = \frac{\text{mass}}{\text{Volume}}$$

Volume

r = ½ · diameter = ½ · 0.05082 inch

$$8.92 = \frac{1.00 \times 10^3}{0.0130866\ h} = \frac{76414.04}{h}$$

Convert radius to centimeter, cm

$$h = \frac{76414.04}{8.92} = 8566.6 \text{ cm}$$

Dimensional Analysis: Unit given x Conversion factor = Unit sought

r = ½ · 0.05082 inch · ($^{2.54\ cm}/_{1\ in}$) = 0.0645414 cm

h = 8566.6 cm · $^{1\ m}/_{100\ cm}$ =85.7 m

Volume = $\pi \cdot (0.0645414)^2 \cdot h$ = 0.0130866 h

3 significant figures

Download Density Worksheet

Scanned Lecture Notes

Road Maps:

- Mole – Mass – Volume – Particles conversion
- From Percent Composition to Empirical Formula to Chemical Formula

Worksheets:

- Lab Report Write up Instructions
- Unit 2 – Density Questions Worksheet
- Unit 3 – Name to Chemical Formula and Chemical Formula to Name Worksheet
- Unit 5 – Mole Concept Worksheet
- Unit 5 – Salt & Sugar Worksheet
- Unit 5 – Solution Worksheet – Maple TA Type Questions
- Unit 5 – Solution Dilution Worksheet
- Unit 5 – Percent Composition, Empirical Formula, Chemical Formula Worksheet

Download Density Worksheet

1. Density - volume displacement given final mass

Question:

A simple way to determine the density of a solid is to immerse the solid in a known quantity of water. When a piece of metal weighing 105 g is placed in a graduated cylinder containing 203 mL of water, the final volume of water read 243 mL.

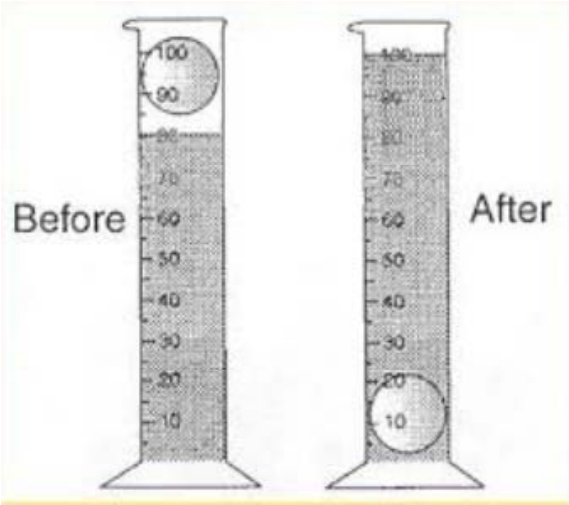
Calculate the density (in $^{g}/_{mL}$) of the metal.

$^{g}/_{mL}$

(Answer to 2 significant figures)

243
-203

(2 sig figs)



$$D = \frac{\text{mass}}{\text{Volume}}$$

Download Density Worksheet

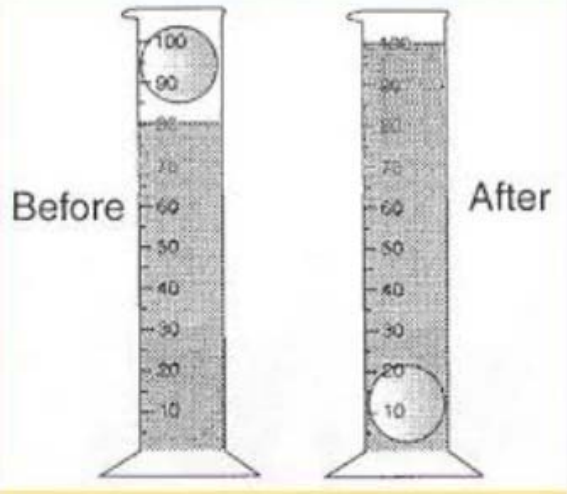
2. Density - volume displacement

A simple way to determine the density of a solid is to immerse the solid in a known quantity of water. A graduated cylinder containing 27.97 mL of water initially weighs 72.7 g. When an irregular shaped object is placed in the graduated cylinder, the final mass rises to 119 g and the volume of water rises to 35.27 mL.

Calculate the density (in $^{g}/_{mL}$) of the object.

$^{g}/_{mL}$

(Answer to 2 significant figures)



$$D = \frac{\text{mass}}{\text{Volume}}$$

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3. Density - volume of object is (l)(w)(h)

The following measurements of a metal bar were made by a student.

- length = 5.10 cm
- width = 9.10 cm
- height = 4.10 mm

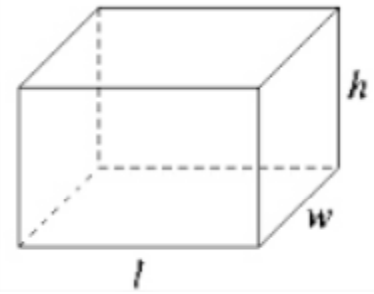
Convert to centimeter first

The mass of the bar is 45 grams.

Calculate the density (g/cm^3) of the material.

g/cm^3

(Answer to 2 significant figures)



Volume = $l \cdot w \cdot h$

Download Density Worksheet

4. Density - of a flask (filling with water) - given the density of water

A simple way to determine the volume of a flask is to weigh the flask when it is dry and weigh it again when it is filled with water.

The weight of the dry flask = 34.00 g
The weight of the filled flask = 115.4 g

Difference is the mass of the water

Given that the density of water is 0.996 g/mL, calculate the volume of the flask in liters.

liter

(Answer to 3 significant figures)

$$D = \frac{\text{mass}}{\text{Volume}} \quad \Rightarrow \quad \text{Volume} = \frac{\text{mass}}{D}$$

Download Density Worksheet

6. Density - ball bearing

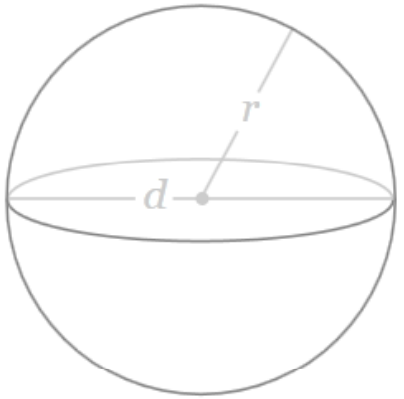
Convert to centimeter first

A steel ball-bearing with a circumference of 27.5 mm weighs 5.11 g. What is the density of the steel in $^{g}/_{cm^3}$?

Given,

- Volume of a sphere = $(^{4}/_{3})(\pi)(r^3)$, where π=3.14.
- Circumference of a circle = 2 π r

- 1.45E3 $^{g}/_{cm^3}$
- 14.5 $^{g}/_{cm^3}$
- 1.45 $^{g}/_{cm^3}$
- 0.145 $^{g}/_{cm^3}$



$$\text{Volume} = \frac{4}{3}\pi r^3$$

Steps:

1. Solve for the radius, r from the circumference.
2. Use r and solve for the volume of the ball-bearing.
3. Calculate density.

$$D = \frac{\text{mass}}{\text{Volume}}$$

Specific Gravity

Specific gravity of a substance a comparison of the density of a substance relative to a standard value. Scientists express specific gravity of liquids and solids using water at 4°C as the standard.

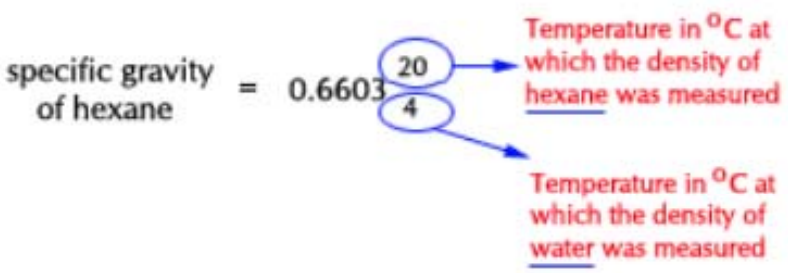
$$\text{specific gravity} = \frac{\text{density of substance}}{\text{density of water at } 4^{\circ}\text{C}}$$

Specific Gravity has no unit!!

In calculating the specific gravity of a substance, the density of the substance and the density of water are expressed in the same units. This leaves specific gravity unitless.

The density of water at 4°C is 1.00 g/mL. Therefore, the density of solids or liquids expressed as g/mL is numerically equal to their specific gravities.

The notation of expressing specific gravity is given below.



Density changes with temperature.

< 1 means less dense than water

> 1 means more dense than water