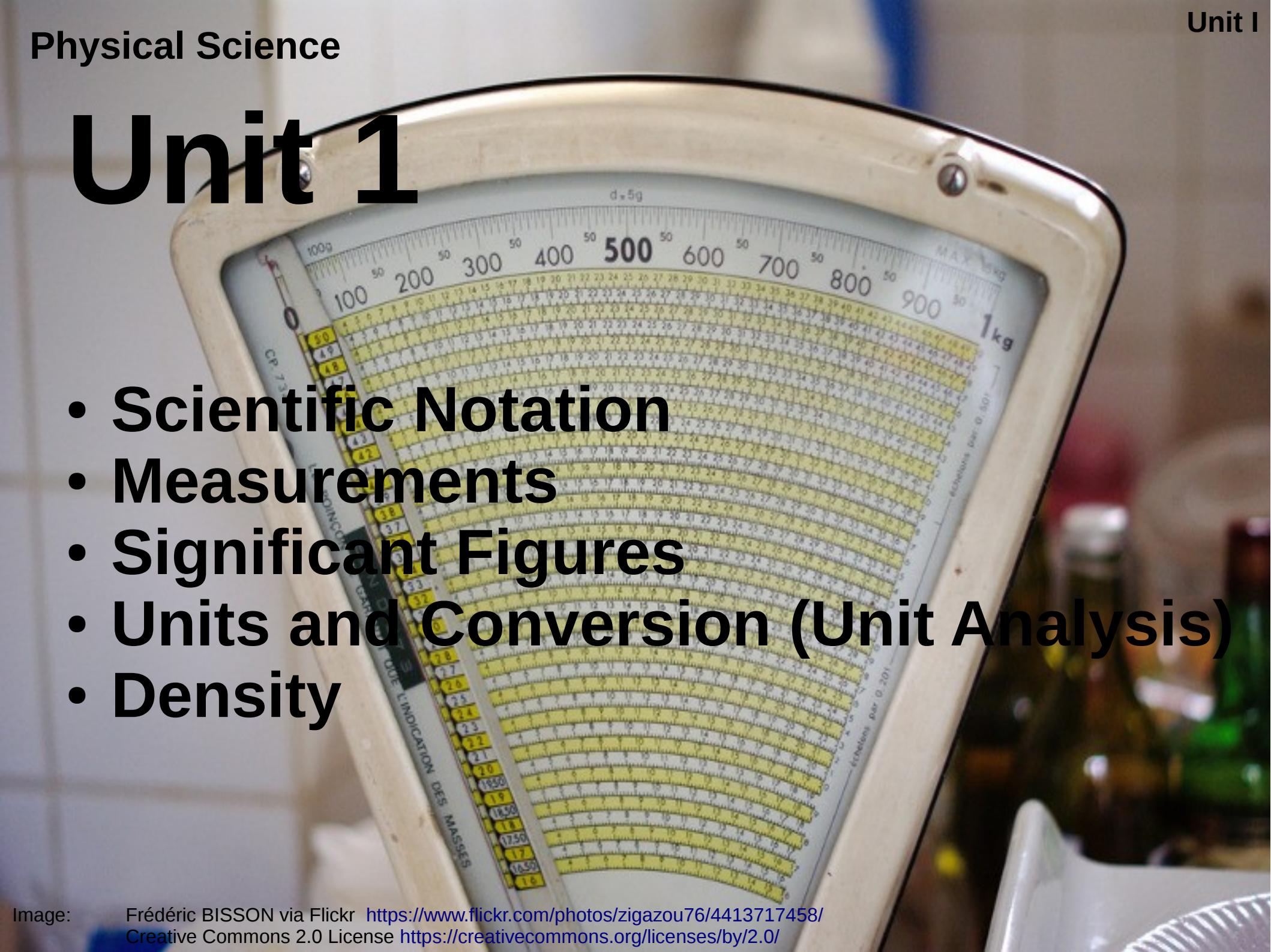
Unit 1

- Scientific Notation
- Measurements
- Significant Figures
- Units and Conversion (Unit Analysis)
- Density



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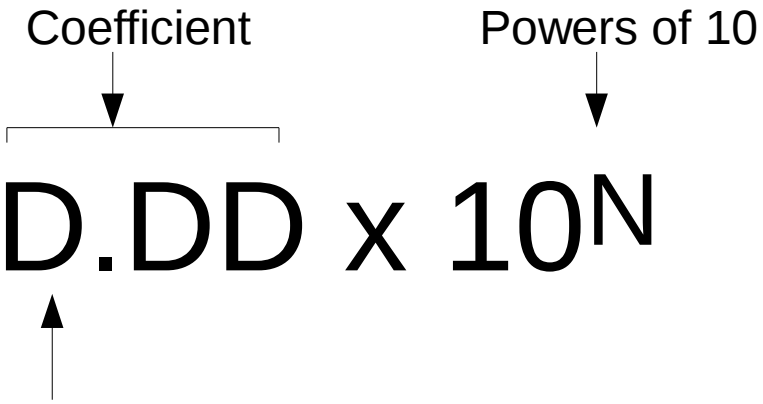
Competencies

The student will be able to:

- **convert any number from decimal to scientific (exponential) notation and vice versa.**
- add, subtract, multiply, and divide numbers written in scientific notation.
- **express the answer of an arithmetical calculation to the proper number of significant figures.**
- name the basic metric units of length, volume, mass, temperature and time and give the correct abbreviation for each.
- define the three temperature scales and convert from one to the other.
- name the metric unit of volume and give the correct abbreviation.
- **use the definition of density to solve a problem either by dimensional analysis or by using a formula.**
- **use dimensional analysis and formulas to solve various types of problems.**
- ~~draw a linear graph from a table of data and determine its slope.~~

Scientific Notation



Additional Rules

$10^A x 10^B = 10^{(A+B)}$
$10^A / 10^B = 10^{(A-B)}$

→ Do Unit I – Problem 1 + 2

Scientific notation → Ordinary number

N > 0 → Shift decimal point right N-times
N < 0 → Shift decimal point left N-times

3.31×10^4 → 33100
2.1×10^{-3} → 0.0021

Ordinary number → Scientific notation

Shift decimal point left N-Times → N > 0
Shift decimal point right N-Times → N < 0

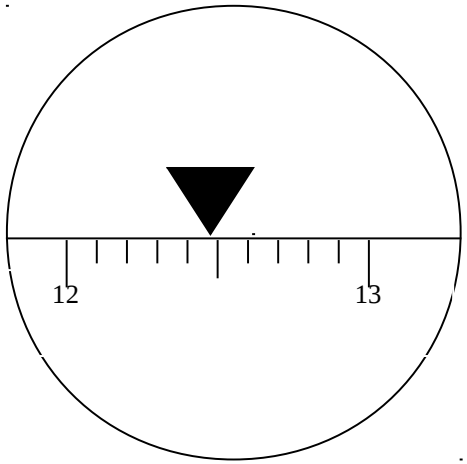
33100 → 3.31×10^4
0.0021 → 2.1×10^{-3}

Calculator

Use “EE” or “Exp” buttons, avoid “10^”

Measurements

… why 2 cm and 2.0 cm is not the same



- It is not possible to make an exact measurement.
- The last written digit is the estimated digit

→ 2 cm : Anything between 1 and 3 cm
→ 2.0 cm: Anything between 1.9 and 2.1 cm

→ Do Unit I – Problem 3

Significant Figures

… all known digits + the estimated digits

A number is significant when it is:

- not a zero — *123* → *3 significant figures*
- a zero between non-zero digits — *1001* → *4 significant figures*
- a zero after a-non zero on the right of the decimal point or on the left of the decimal point — *1.00* → *3 significant figures*; *100.* → *3 significant figures*
- in the coefficient of a scientific number — *1.00×10^3* → *3 significant figures*

A zero is not significant when it is:

- on the left of all non-zero digits — *0.03* → *1 significant figure*
- on the right of all non-zeros in a number without decimal point — *100* → *1 significant figure*

→ Do Unit I – Problem 4

Significant Figures

Exact Numbers

Counted:
12 eggs, 3 donuts

Definitions:
1 foot = 12 inches
1 meter = 100 cm

→ Do Unit I – Problem 5

Calculation rules

Always ignore exact numbers

Addition / Subtraction
Give the result with the fewest decimals

1.00 + 2.3 = 3.3
5.5 - 0.50 = 5.0

Multiplication / Division
Give the result with the fewest significant figures.

2.00 x 2.0 = 4.0
4 / 2.00 = 2

Units – The SI System

- Length: Meter [m]
- Mass: Kilogram [kg]
- Time: Second [s]
- Temperature: Kelvin [K]
- Current: Ampere [A]

Examples:

Prefixes:

tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

Unit Conversion (Unit analysis)

$$\text{New Unit} = \text{Old Unit} \times \frac{\text{New Unit value}}{\text{Old Unit value}}$$

May be repeated several times

Keep same amount of SF

Example 1: Convert 300 m to km

$$300\ \cancel{\text{m}} \times \frac{1\ \text{km}}{1000\ \cancel{\text{m}}} = 300 \times 1 / 1000\ \text{km} = 0.3\ \text{km}$$

→ Do Unit I – Problem 6a-f *(Use additional equivalences Unit I Page 5)*

Example 2: Convert 5.0 km/h to m/s

$$5.0\ \frac{\cancel{\text{km}}}{\text{h}} \times \frac{1000\ \text{m}}{1\ \cancel{\text{km}}} \times \ldots$$

→ Do Unit I – Problem 6g-k

Units – Volume

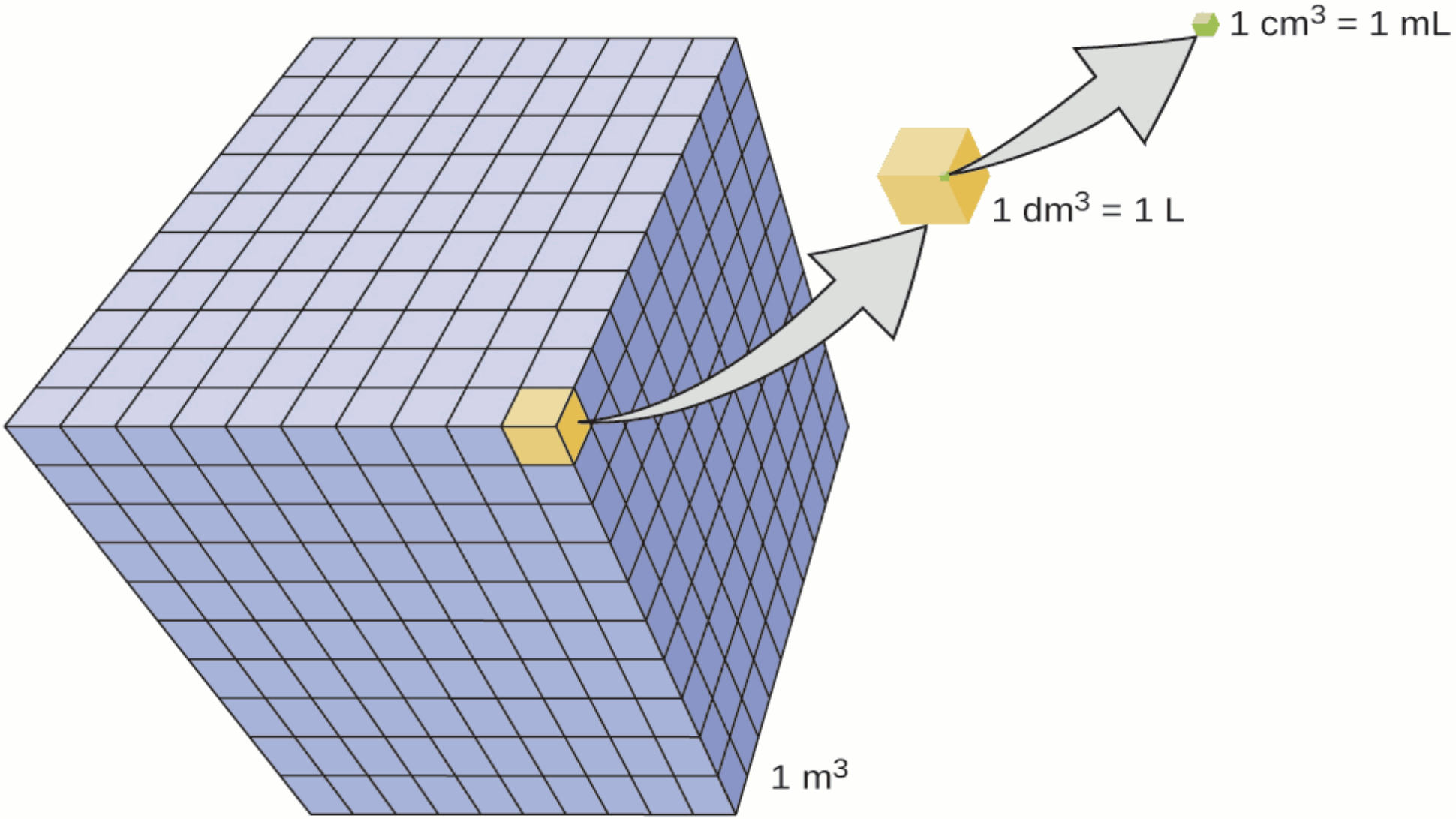


Image: OpenStax College, Chemistry. OpenStax CNX. Oct 13, 2015
http://cnx.org/contents/85abf193-2bd2-4908-8563-90b8a7ac8df6@9.110
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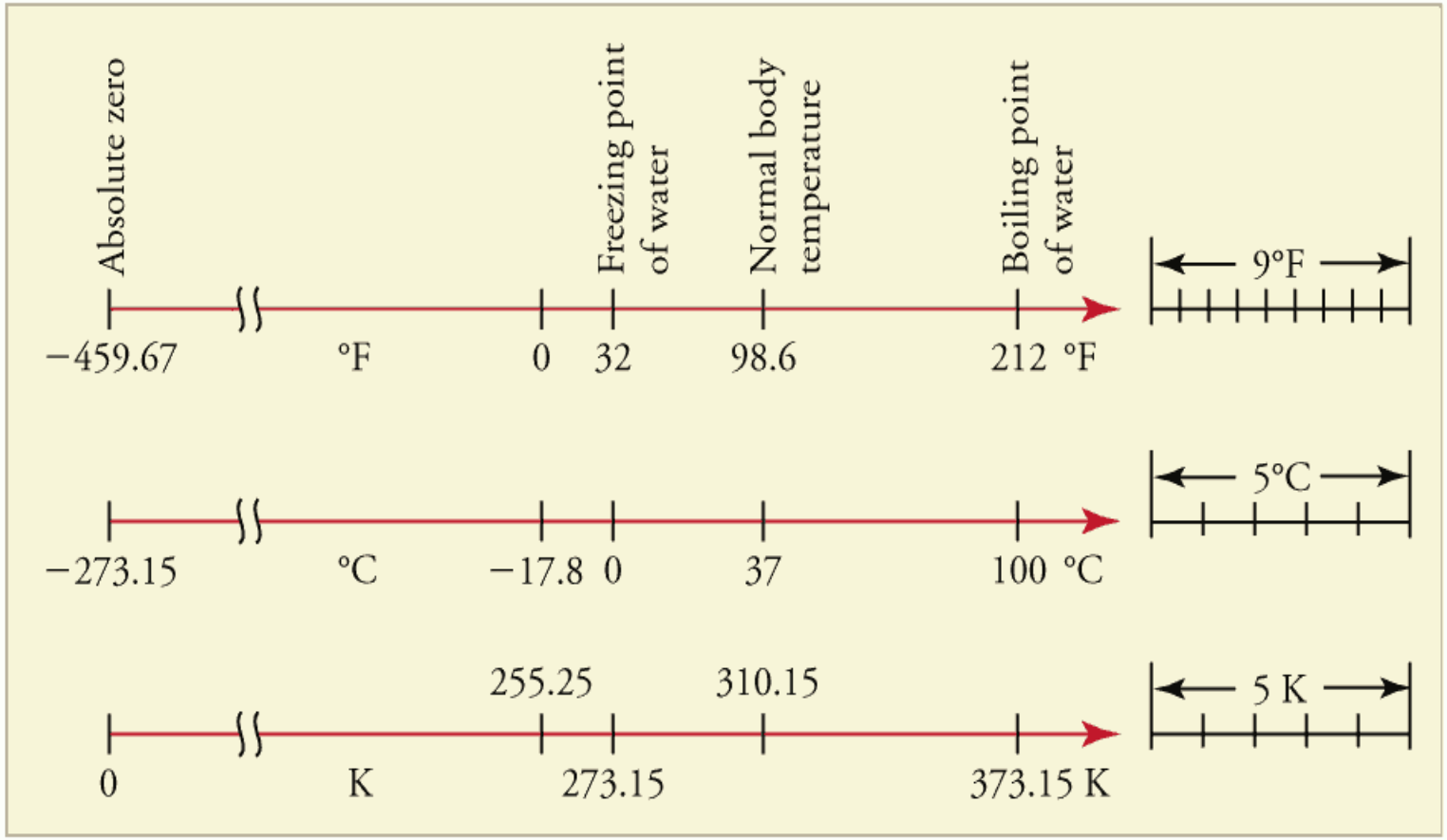
Units – Temperature



$$T_C = \frac{5}{9}(T_F - 32)$$

$$T_K = T_C + 273$$

Image: OpenStax College, College Physics. OpenStax CNX. Sep 29, 2015
http://cnx.org/contents/Ax2o07Ul@9.4:2ou0Jg2y@3/Temperature
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→ Do Unit I – Problem 6l

Density

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

Example 1:
An object has a mass of 50.0 g and a volume of 3.0 cm^3. *Calculate the density of the material.*

$$Density = \frac{Mass}{Volume} = \frac{50.0\,g}{3.0\,cm^3} = \ldots$$

Example 2:
An object is made of 20. g osmium (Os). Osmium has a density of 22.5 g/cm^2.
Calculate the volume of the object.

$$Density = \frac{Mass}{Volume} \rightarrow 2.25\,g/cm^3 = \frac{20.\,g}{x} \rightarrow \ldots$$

Density

Archimedes Problem : Is the crown made of gold?

$Density_{Gold}$: 19.3 g/mL

$Mass_{Crown}$: 1500 g

$Volume_{Crown}$: ???

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Density

Archimedes Problem : Is the crown made of gold?

$Density_{Gold}$: 19.3 g/mL

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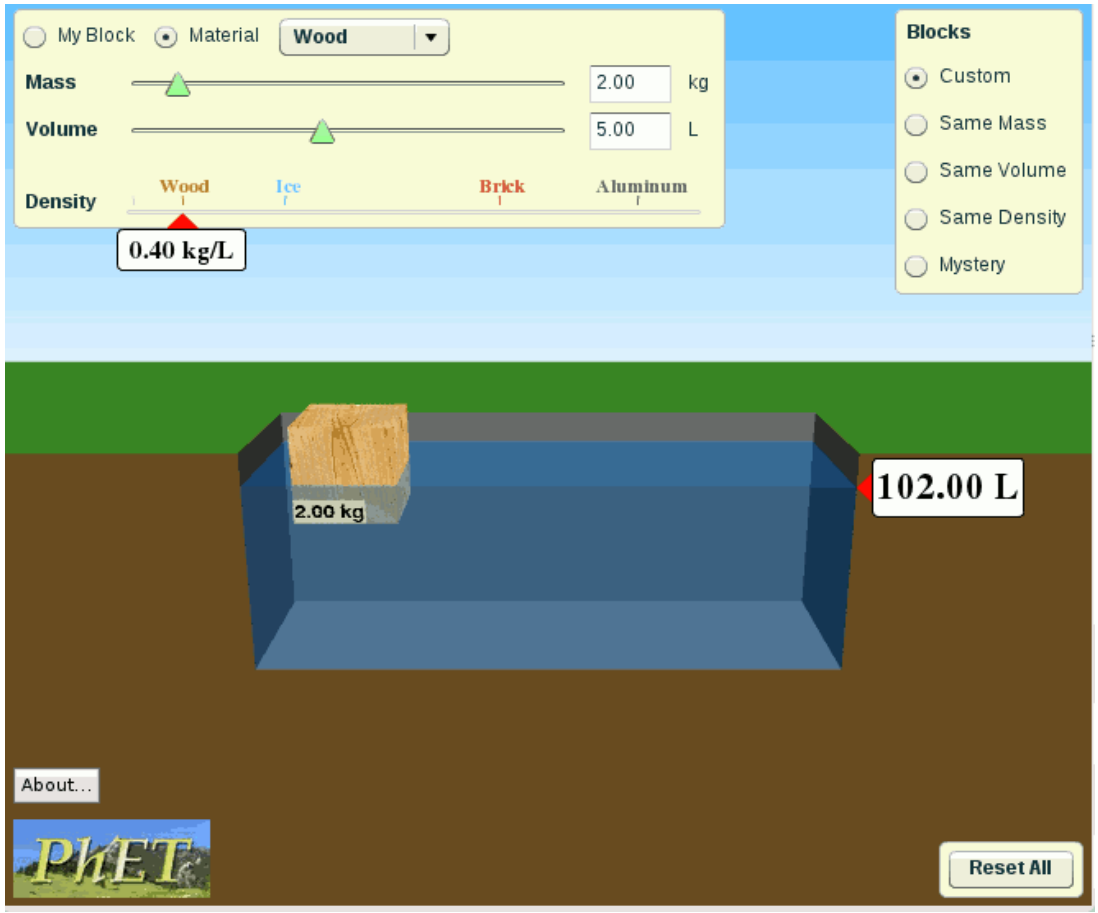
Density

Sink of float ?



Phet Simulation:
http://phet.colorado.edu/sims/density-and-buoyancy/density_en.html

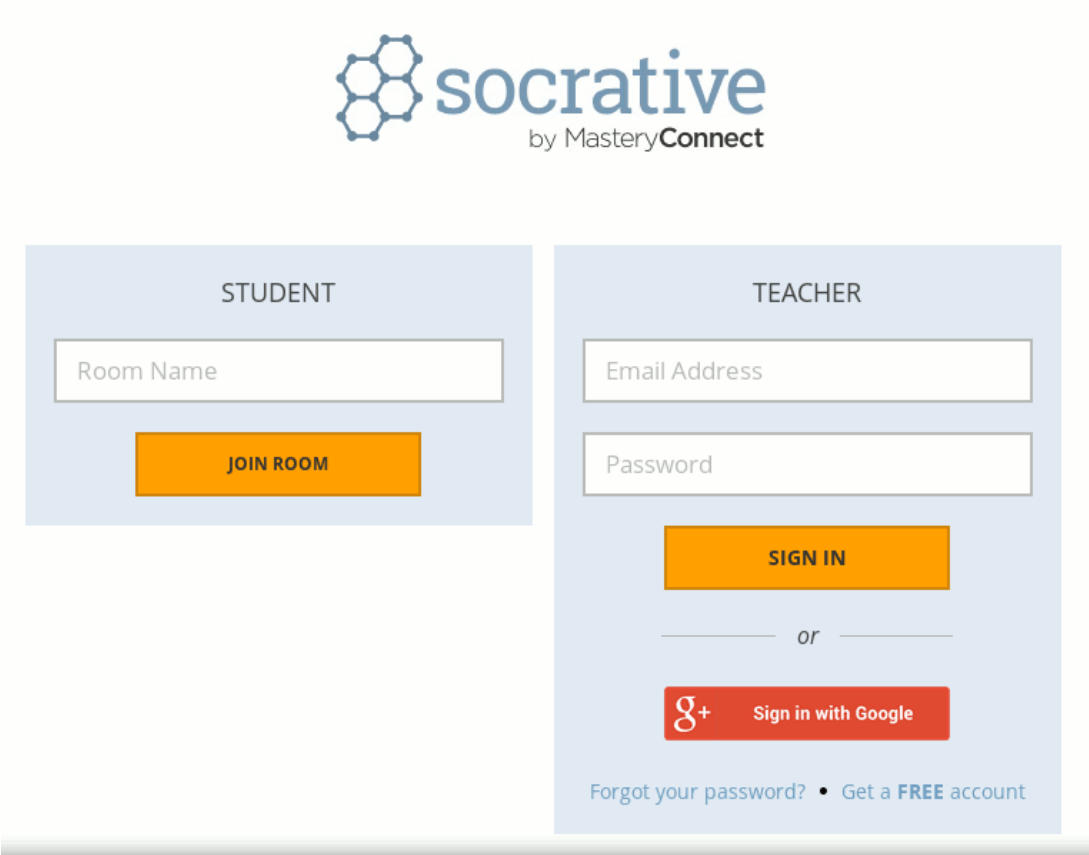
- What is the density of water?
- When does an object sink?
- Why do steel-ships float?

→ Do Unit I – Problem 7-14

Review

Clicker Review Activity : Sec 4 – Measurements and Density

http://b.socrative.com



Additional Resources

- Physical Quantities and Units in “College Physics”
  http://cnx.org/contents/Ax2o07Ul@9.4:EC6WBNqn@7/Physical-Quantities-and-Units
- Measurements and Density in „College Chemistry“
  http://cnx.org/contents/havxkyvS@9.110:GCPSnOuw@5/Measurements