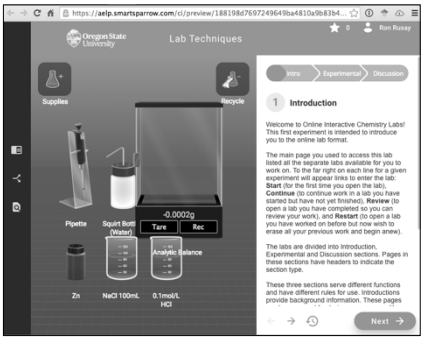
Lab #1

Lab Techniques

Week #2

https://aelp.smartsparrow.com/v/pjpjfede/j5jebl79



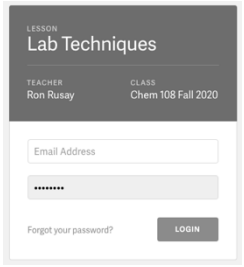
Lab #1

Doing: Lab Techniques

https://aelp.smartsparrow.com/v/pjpjfede

https://aelp.smartsparrow.com/v/pjpjfede/j5jebl79

Must register using the exact same e-mail address that you provided in submitting the Introductory Survey. If you don't remember send an e-mail to Dr. R from that account

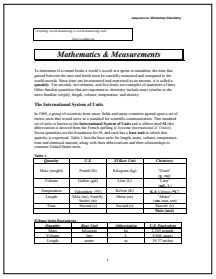


Lab #1

Doing: Lab Techniques

Metric Measurements
[Background Reading]

http://chemconnections.org/general/chem108/Math & Measurement-2018.pdf

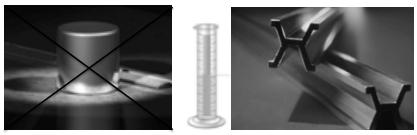


Mathematics & Measurements

Lab #1

Doing: Lab Techniques

Metric Measurement [Adaptation of DVC Experiment #1]
(DVC Chem 108 Lab Manual pp. 9-11; pp. 12-15 [Report Form])



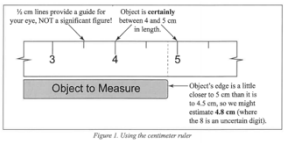


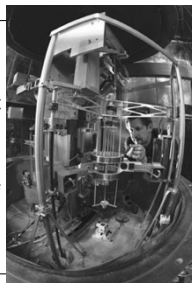
Figure 1. Using the centimeter ruler

Lab #1

Doing: Lab Techniques

Metric Measurement: SI Units
International Standards (SI)

The SI mass standard is the kilogram (kg) that is currently defined by a measurement of light, taking the fixed numerical value of the Planck constant h to be $6.62607015 \times 10^{-34}$ when expressed in the unit J s, which is equal to kg $m^2 s^{-1}$, where the meter and the second are defined in terms of c and $\Delta\nu Cs$. It is an "electronic" standard and is measured with the instrument on the right.

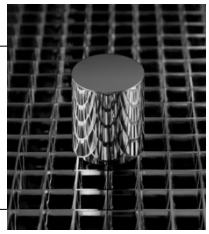


Lab #1

Doing: Lab Techniques

Metric Measurement: SI Units
International Standards (SI)

However, in the United States the primary standard of mass is the Prototype Kilogram 20, which is a platinum-iridium cylinder kept at the National Institute of Standards & Technology (NIST), which is part of the US Department of Commerce.



https://www.nist.gov/pml/weights-and-measures/si-units-mass

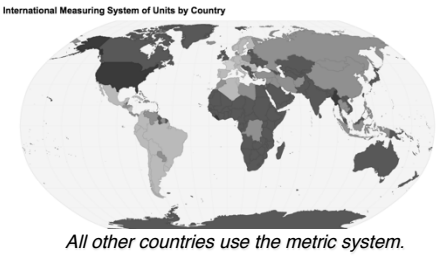
Units of Measurement

Base Units	*U.S.*	*SI*
Mass (weight)	Pound (lb)	Kilogram (kg)
Volume	Gallon (gal)	Liter (L)
Temperature	Fahrenheit (°F)	Kelvin (K)
Length	Mile (mi)Feet(ft), Inches (in)	Meter (m)
Time		Second (s)

https://www.youtube.com/watch?v=7bUVjJWA6Vw

International SI units are based on the metric system, not the British units commonly used in the U.S.

Countries using "British" Units
in red



All other countries use the metric system.

"British"/"Imperial": Metric Comparisons

Measurement & Units
International SI units & common units in Chemistry

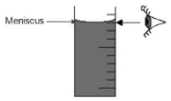
- MASS (Chem 108: gram; SI: kg; other mg)
- LENGTH (Chem 108: cm & mm; SI: m; other km)
- TEMPERATURE (Celsius & Kelvin; SI: K)
- VOLUME (Chem 108: mL; SI: Liter; other dL)
- CHEMICAL AMOUNT: mole (mol); SI: (mol); other (mmol)

The units used in Chem 108 are metric, but most are smaller than the standard SI units.

Exp. 1 – Metric Measurement
Mass Measurement with an Electronic Balance:

https://www.youtube.com/watch?v=QtnPiKSKKtI

Exp. 1 – Metric Measurement
Volume Measurement (Liquids)

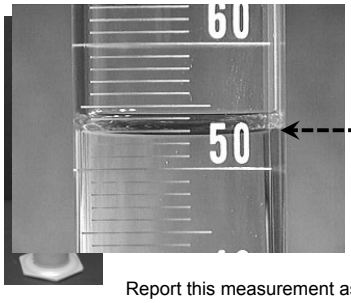


Measure at the ***bottom of the meniscus at eye level***

Measurements with a Graduated Cylinder:

Exp. 1 – Metric Measurement

Measurement with a 100 mL Graduated Cylinder:

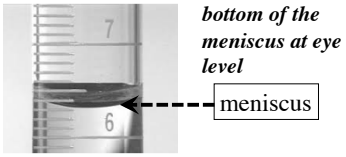


Report this measurement as?

52.9 mL

Exp. 1 – Metric Measurement

Measurement with a 10 mL Graduated Cylinder:



Report this measurement as?

6.31 mL

Exp. 1 – Metric Measurement

- Important to record ***measurements*** to the correct limits of the equipment used (i.e. uncertainty/significant figures). NOTE: For this experiment the uncertainty limits (+/−) of the equipment is to be included.
- Uncertainty limits are not normally included in calculations but are inferred from the correctly reported significant figure in the experimental value.
- Estimating to 6.3**0** mL is ok if the meniscus is viewed to be exactly on the mark.

Report: 6.3**0 +/- 0.01** mL

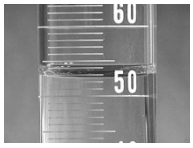
- Estimating to 6.3**1** mL is also ok if the meniscus is viewed to be off the mark.

Report: 6.3**1 +/- 0.01** mL

Exp. 1 – Metric Measurement

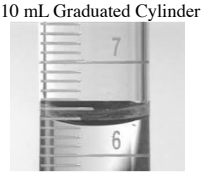
Measurement with a Graduated Cylinder:

100 mL Graduated Cylinder



Measurement: 52.9 +/– 0.1mL

10 mL Graduated Cylinder

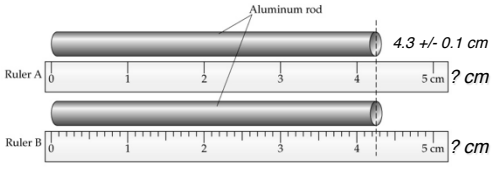


Measurement: 6.31 +/– 0.01mL

- Notice the difference in precision (uncertainty) with each instrument used and their maximum capacities

What is the length of the rod?

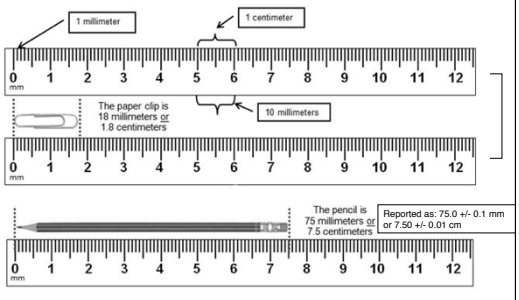
Different measurement tools give different numbers: Which ruler is better?



4.25 +/- 0.01 cm
or
4.25 +/- 0.05 cm

Exp. 1 – Metric Measurement

Measurement with a centimeter/millimeter ruler (Length)



Exp. 1 – Metric Measurement

- When measuring the diameter of liquid containers with the ruler, the inner diameter is used, NOT the outer diameter. Why?
- When pouring water out of test tube into a graduated cylinder, some is always left in test tube; how does this systematic error affect accuracy of measured volume? *Higher or Lower?*
  - Think about how equipment and handling relate to measurements and "systematic" errors.
  - "Human Error" is **NOT** acceptable error. Using good lab practices reduce the risk of error, or of an "accident", and they are **UNCONDITIONAL,** as is Lab Safety.

Exp. 1 – Metric Measurement

"Human Error" is **NOT** acceptable in scientific measurements……. as in aeronautics.

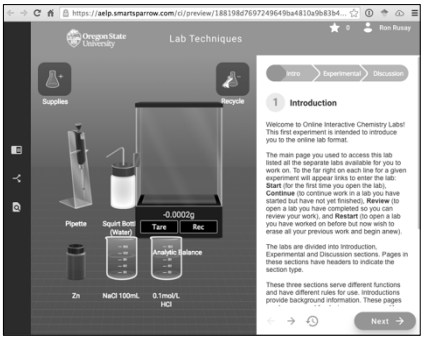
SFO July 6, 2013

Lab #1

Lab Techniques

Week #2

https://aelp.smartsparrow.com/v/pjpjfede/j5jebl79



Language describes numerical scale (prefixes)

Shorthand Prefixes

Table: SI prefixes

Factor	Name	Symbol	Factor	Name	Symbol
10^{24}	yotta	Y	10^{-1}	deci	d
10^{21}	zetta	Z	10^{-2}	centi	c
10^{18}	exa	E	10^{-3}	milli	m
10^{15}	peta	P	10^{-6}	micro	μ
10^{12}	tera	T	10^{-9}	nano	n
10^{9}	giga	G	10^{-12}	pico	p
10^{6}	mega	M	10^{-15}	femto	f
10^{3}	kilo	k	10^{-18}	atto	a
10^{2}	hecto	h	10^{-21}	zepto	z
10^{1}	deka	da	10^{-24}	yocto	y

Hella is a prefix associated with Northern California: UC Davis, UC Berkeley, LBL, LLNL & adopted by Google (2010) & Wolfram Alpha (2011)

"hella-" = 10^{27}

Commonly Used Prefixes in Chemistry

Metric Prefixes

Prefix	Symbol	Multiple/Fraction
giga-	G	$1{,}000{,}000{,}000 = 1 \times 10^{9}$
mega-	M	$1{,}000{,}000 = 1 \times 10^{6}$
kilo-	k	$1{,}000 = 1 \times 10^{3}$
Basic unit: meter, gram, liter, second		
deci-	d	$0.1 = 1 \times 10^{-1}$
centi-	c	$0.01 = 1 \times 10^{-2}$
milli-	m	$0.001 = 1 \times 10^{-3}$
micro-	μ	$0.000\,001 = 1 \times 10^{-6}$
nano-	n	$0.000\,000\,001 = 1 \times 10^{-9}$

Measurement & Numbers

The Importance of Units

- Measurement - quantitative observation consisting of 2 parts
  - Part 1 - number
  - Part 2 – unit
  - Relates to the instrument (tool) used for the measurement. Examples:
  - 20.0 grams
  - 6.63×10^{-34} joules / second

1 Joule (J):

- *The heat required to raise the temperature of 1 g of water by 0.24 K; 1 J = 0.24 calories.[6]*
- *The heat released as heat by a person at rest every 1/60 second (~17 ms); [7]*
- *The kinetic energy of a 50 kg (110 lb) human moving at 0.43 mi/hr).*
- *The amount of electricity required to light a 1 watt LED for 1 s.*

Measurements & Numbers

- **Any number determined by any method of measurement: MUST ALWAYS INCLUDE the UNIT being measured.**
  Example: 20.0 grams
- Short Hand expression translates the number to **Scientific Notation**
  Example: 2.00 x 10^1 grams

Converting a Number to Scientific Notation

units are not included in the examples

$5983 = 5.983 \times 10^3$

3 2 1

- If the decimal point is moved to the left, the exponent is positive.

$0.00034 = 3.4 \times 10^{-4}$

1 2 3 4

- If the decimal point is moved to the right, the exponent is negative.

Powers of Ten: Scale

10^n (n: exponent; base number: 10)

Powers of 10

Exponential Number	Ordinary Number
$1 \times 10^6 = 10 \times 10 \times 10 \times 10 \times 10 \times 10$	1,000,000
$1 \times 10^3 = 10 \times 10 \times 10$	1,000
$1 \times 10^2 = 10 \times 10$	100
$1 \times 10^1 = 10$	10
$1 \times 10^0 = 1$	1
$1 \times 10^{-1} = \frac{1}{10}$	0.1
$1 \times 10^{-2} = \frac{1}{10} \times \frac{1}{10}$	0.01
$1 \times 10^{-3} = \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$	0.001
$1 \times 10^{-6} = \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10} \times \frac{1}{10}$	0.000 001

Powers of Ten (GQ)

Measurements & Relative Scale

http://chemconnections.org/general/chem108/Powers%20of%20Ten-Guide.html

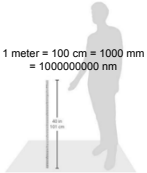
Refer to:
Video in the previous Guiding Question (GQ) class assignment

Math

S

Calderwood
Glasgow,
Scotland

1 meter = 100 cm = 1000 mm
= 1000000000 nm



Lori: But the whale is 800cm, not just 100cm.

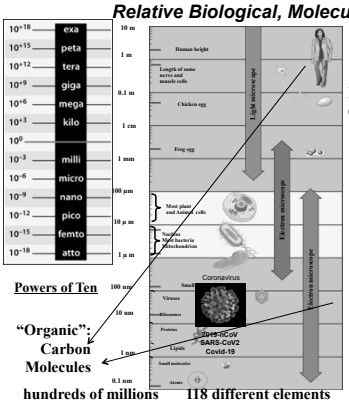
Toby: We can't measure it with that stick.

Miss Dunn: I wonder what we could do then...?

Lucy: We will have to just use that one. Like over and over.

Noah: One stick is 100cm. There are 800cm. I think we could use the stick 8 times or something.

Relative Biological, Molecular & Atomic Sizes



← You

Bones? 206 bones
Organs? 78 organs

Cells
# of cells? ~5 x 10^{13} cells

~22,000 Proteins / DNA
3 x 10^9 bases
(Genome)

Powers of Ten

"Organic": Carbon Molecules
hundreds of millions

118 different elements

Measurements
1 centimeter (cm) = 10^{-2} meter (m) = 0.4 inch
1 millimeter (mm) = 10^{-3} m
1 micrometer (μm) = 10^{-3} mm = 10^{-6} m
1 nanometer (nm) = 10^{-3} mm = 10^{-9} m

Mathematics & Powers of 10

Size, Measurement & Scale

Coronavirus cases

Number of confirmed cases of the novel coronavirus as of Jan. 23.

Mathematics & Powers of 10

Size, Measurement & Scale

Biological Structure	Actual Diameter (in Meters)	Size Relative to Cell	Object Used to Model Biological structure	Measured Size of Model Object	Size Relative to Model Cell (the Room)
Cell	1×10^{-5}	$\frac{1 \times 10^{-5}}{1 \times 10^{-5}} = 1$	Room	10 meters	$\frac{10}{10} = 1$
Bacterium	1×10^{-6}	$\frac{1 \times 10^{-6}}{1 \times 10^{-5}} = \frac{1}{10} = 0.1$	Desk	1 meter	$\frac{1}{10} = \frac{1}{10} = 0.1$
Mitochondrion	5×10^{-7}	$\frac{5 \times 10^{-7}}{1 \times 10^{-5}} = \frac{1}{20} = 0.05$	½ Desk	½ meter	1/20 = 0.05
Virus	1×10^{-7}		Ruler	1/10 meter	
Ribosome	1×10^{-8}		Ruler ?		
Protein	5×10^{-9}		?		
Glucose molecule	1×10^{-9}		?		
H_2O molecule	1×10^{-10}		?		

Coronavirus
2019-nCoV
SARS-CoV2
Covid-19

Mathematics & Powers of 10

Size, Measurement & Scale

Biological Structure	Actual Diameter (in Meters)	Size Relative to Cell	Object Used to Model Biological structure	Measured Size of Model Object	Size Relative to Model Cell (the Room)
Cell	1×10^{-5}	$\frac{1 \times 10^{-5}}{1 \times 10^{-5}} = 1$	Room	10 meters	$\frac{10}{10} = 1$
Bacterium	1×10^{-6}	$\frac{1 \times 10^{-6}}{1 \times 10^{-5}} = \frac{1}{10} = 0.1$	Desk	1 meter	$\frac{1}{10} = \frac{1}{10} = 0.1$
Mitochondrion	5×10^{-7}	$\frac{5 \times 10^{-7}}{1 \times 10^{-5}} = \frac{1}{20} = 0.05$	½ Desk	½ meter	1/20 = 0.05
Virus	1×10^{-7}		Ruler	1/10 meter	
Ribosome	1×10^{-8}		Ruler ?		
Protein	5×10^{-9}		?		
Glucose molecule	1×10^{-9}		?		
H_2O molecule	1×10^{-10}		?		

Coronavirus
2019-nCoV
SARS-CoV2
Covid-19
~1 x 10^{-7}meters

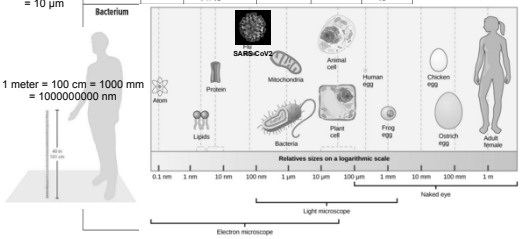
Mathematics & Powers of 10

Size, Measurement & Scale

0.00001 m
= 10 µm

1 meter = 100 cm = 1000 mm
= 1000000000 nm

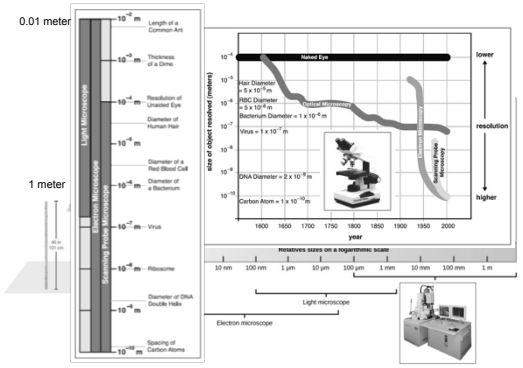
Biological Structure	Actual Diameter (in Meters)	Size Relative to Cell	Object Used to Model Biological structure	Measured Size of Model Object	Size Relative to Model Cell (the Room)
Cell	1×10^{-5}	$\frac{1 \times 10^{-5}}{1 \times 10^{-5}} = 1$	Room	10 meters	$\frac{10}{10} = 1$
Bacterium					



Size, Measurement & Scale

0.01 meter

1 meter



Size, Measurement & Scale

Scientific Notation & Mathematics

- Short Hand expression:
  Powers of Ten / Exponents of base Ten
- Count decimal places: to left (+) and to the right (-) 1,000,000,000 kg/m^3 = 1 x 10^9 kg/m^3
  0.00000018 kg/cm^3 = 1.8 x 10^{-7} kg/cm^3
- Multiplication: add exponents
- Division: subtract exponents

Mathematics & Powers of 10
Relative Size, Measurement & Scale
(Proportionalities)

$$\frac{1{,}000{,}000{,}000\ kg/m^3 = 1 \times 10^{9}\ kg/m^3}{0.00000018\ kg/cm^3 = 1.8 \times 10^{-7}\ kg/cm^3} =$$

How much larger is the red object than the blue?

0.55×10^{16}

- Multiplication: add exponents
- Division: subtract exponents

How much smaller is the blue object than the red?

$$\frac{0.00000018\ kg/cm^3 = 1.8 \times 10^{-7}\ kg/cm^3}{1{,}000{,}000{,}000\ kg/m^3 = 1 \times 10^{9}\ kg/m^3} =$$

1.8×10^{-16}

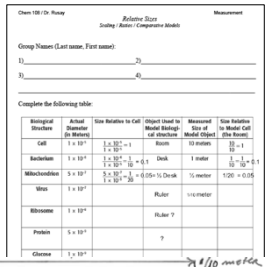
Mathematics & Powers of 10
Relative Size, Measurement & Scale
(Proportionalities)

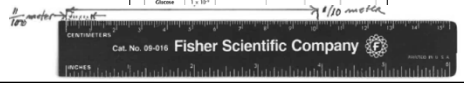
Recommended: Group Collaboration

Form your own groups: starting with your zoom breakout classmates

http://chemconnections.org/general/chem108/Relative%20Sizes-Group.WKS.pdf

Mathematics & Powers of 10
Relative Size, Measurement & Scale
(Proportionalities)





Groups:

@ End of today's session: Introduce yourself to the group & exchange contact information.

Arrange to complete Worksheet as a Group if you choose to.

Check answers.

Mathematics & Powers of 10
Relative Size, Measurement & Scale
(Proportionalities)

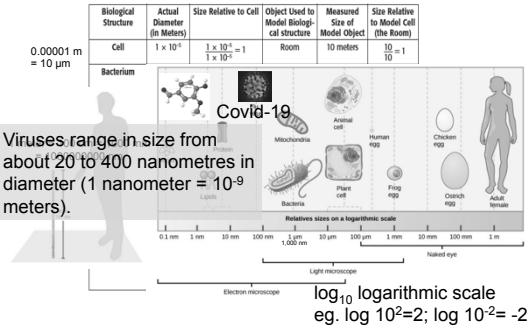
Group Collaboration

Recommended

Check answers.

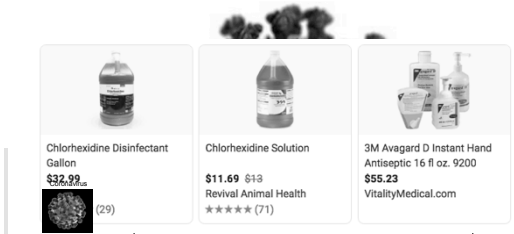
Group.KEY.pdf

Mathematics & Powers of 10
Size, Measurement & Scale

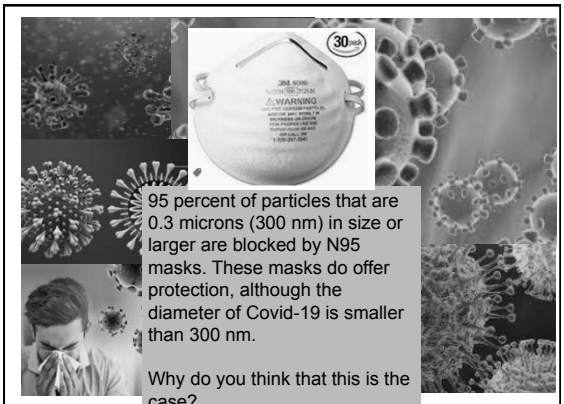


$\log_{10}$ logarithmic scale
eg. $\log 10^2 = 2$; $\log 10^{-2} = -2$

Mathematics & Powers of 10



and can be effectively inactivated by lipid solvents, and ether (75%), ethanol (>60%), chlorine-containing disinfectants, peroxyacetic acid and chloroform, (but not chlorhexidine).



95 percent of particles that are 0.3 microns (300 nm) in size or larger are blocked by N95 masks. These masks do offer protection, although the diameter of Covid-19 is smaller than 300 nm.

Why do you think that this is the case?

5300. mL
5300 mL
0.01 kg
0.0100 kg

Group Collaboration

Recommended

What are significant figures?

In scientific notation?

5.300×10^3 mL
5.3×10^3 mL
1×10^{-2} kg
1.00×10^{-2} kg

http://chemconnections.org/general/chem108/Math%20%26%20Measurements-WKS.f18.pdf

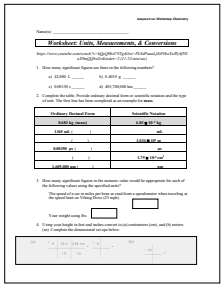
Doing: Lab Experiments

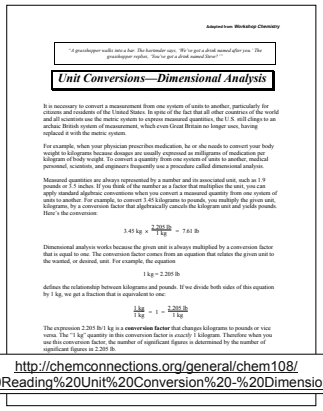
Metric Measurement
Units & Conversions Worksheet

http://chemconnections.org/general/chem108/Math & Measurements-WKS.f18.pdf

Group Collaboration

Recommended





Unit Conversions—Dimensional Analysis

http://chemconnections.org/general/chem108/WKS%20Reading%20Unit%20Conversion%20-%20Dimensional%20A.pdf

Dimensional Analysis
Conversion/Unit Factor Calculations

An average adult needs at least 150 grams (1.50×10^2 g) of carbohydrates in the diet each day. A can of vegetarian refried beans has 19 g of carbohydrate per serving. Each serving is 128 g of beans.

If your only dietary source of carbohydrate were vegetarian refried beans, how many pounds of beans would you need to eat today to satisfy your carbohydrate dietary needs?

$$\frac{?\text{ lb beans}}{\text{day}} = \frac{1.50 \times 10^2 \text{ g carbo}}{1 \text{ day}}$$

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= 2.23 lb beans/day

Caution

A natural side effect of eating beans, which is caused by raffinose sugars being broken up by the flora in our lower intestine.

Even vegetarians!

Science & Chem 108

Metric Values Only

How many grams of beans are there in 2.23 lbs of beans (454 grams = 1 lb)?

$$\frac{2.23 \text{ lb} \quad 454 \text{ g}}{1 \text{ lb}} = ?$$

Science & Chem 108

Metric Values Only

How many grams of beans are there in 2.23 lbs of beans (454 grams = 1 lb)?

$$\frac{2.23 \text{ lb} \quad 454 \text{ g}}{1 \text{ lb}} = 1012.42 \text{ g} \quad \textit{(grams)}$$

1010 g ***(grams)***

Science & Chem 108

Metric Values Only

How many kilograms (kg) of beans are there in 1120 g of beans (1000 g = 1 kg)?

$$\frac{1120\ g}{1000\ g} \times \frac{1\ kg}{} = 1.12\ kg$$

"International SI Unit of mass"

Converting to squared or to cubic units

➢When using linear factors conversion factors to "square" or "cube" be sure to square or cube the factor

e.g.) Convert 6.81 mm² to cm²

10 mm = 1 cm

From: 6.81 mm² To: cm²

$$\frac{6.81\ mm^2}{1}$$

$$= 6.81 \times 10^{-2}\ cm^2$$

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To: m² | 1 m = 1000 mm
1 m² = (1000 mm)² = 10^6 mm²
1 m³ = (1000 mm)³ = 10^9 mm³ | = 6.81 x 10^{-6} m²

Critical Chemistry

Tutorials

https://aelp.smartsparrow.com/c/ls/ndmw2ybz

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inspark

Can you calculate how many tablets of ibuprofen a patient should take?

Calculating doses in hospitals isn't so different from following a recipe. Many times, a doctor will prescribe a medication in one unit, although the medicine is distributed in a different unit.

For example, let's say your doctor recommends you take 400 mg of ibuprofen in a certain amount of time. The problem is ibuprofen is given out in tablets and not in milligrams.

So, how many tablets should you take? In other words, how many tablets equates to 400 mg?

Each tablet of ibuprofen weighs 200 milligrams.

https://aelp.smartsparrow.com/c/ls/ndmw2ybz

A Case Study

inspark

In this course, you'll learn chemistry though seeing it applied to the world around you.

In this lesson, you'll learn a skill called dimensional analysis which hospital staff uses on a daily basis to measure out medication. To learn this important skill, we're going to take you through a real case study involving a mother and her twins that took place in 1998.

By the end of this lesson, you'll not only learn a valuable skill, but you'll also help solve this case. Good luck!

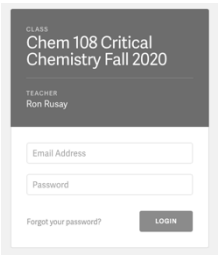
https://aelp.smartsparrow.com/c/ls/ndmw2ybz

Critical Chemistry

Tutorial Lessons

https://aelp.smartsparrow.com/c/ls/ndmw2ybz

Must register using the exact same e-mail address that you provided in submitting the Introductory Survey. If you don't remember, send an e-mail from that account to Dr. R



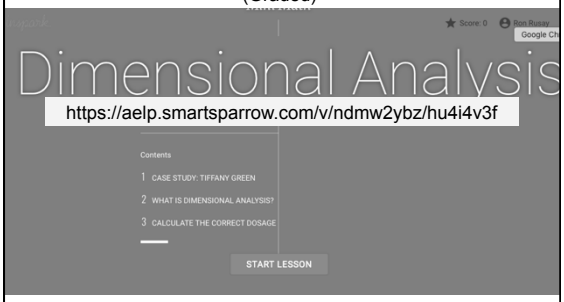
Separate account from Lab:

Must register for both.

https://aelp.smartsparrow.com/v/ndmw2ybz/hu4i4v3f

Tutorial Lesson
(Graded)

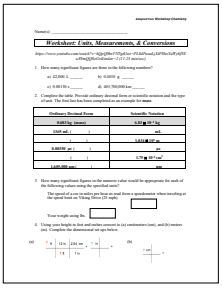
inspark



Consult course calendar for Due Date

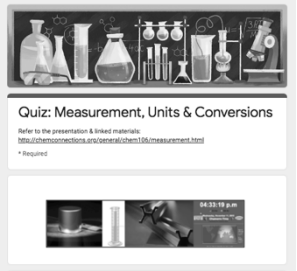
Metric Measurement
Units & Conversions Worksheet
Check Answers:

http://chemconnections.org/general/chem108/Math%2520%26%2520Measurement-2018.KEY.pdf



[Lab Techniques & Measurement Quiz]

To Be Posted at a later date: Refer to Calendar



Quizzes and exams are to be completed individually without consulting anyone & submitted individually.