C1WS5 By: Dr. Robert Belford

Part 1: Conversion Factors

Allow a measurement to be transformed from one scale to another.

Three Basic Types

A. Different prefixes of same base scale (cm -> Km
B. Conversions between scales (cm -> in)
C. Physical Constants d=M/V

A. Different Prefixes of same base scale.

Basic Technique: Set up two equivelence statements

How many micrograms are in a kilogram?
Set up conversion factors based on an equivalence statements.

$1kg = 10^3 g \; and \; 1\mu g = 10^{-6} g$

so, this gives two conversion factors

$$\left(\frac{10^3 g}{1kg}\right) and \left(\frac{1\mu g}{10^{-6} g}\right)$$

Use Factor-Label Method

$$1kg\left(\frac{10^3 g}{1kg}\right)\left(\frac{1\mu g}{10^{-6} g}\right) = 10^{3-(-6)}\mu g = 10^9 \mu g$$

Example: Convert 32.4 ng to Mg.

$$32.4ng\left(\frac{10^{-9} g}{ng}\right)\left(\frac{Mg}{10^6 g}\right) = 32.4x10^{(-9-6)} Mg = 32.4x10^{-15} Mg = 3.24x10^{-14} Mg$$

Problems: Solve the following:

1.) 56.4Tbytes = ___Mbytes

2.) 34.6nsec = ___Gsec

3.) 4.0Mg = ___ kg

Conversions of Units

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Advanced Technique: Set up 1 equivalence statement
How many micrograms are in a kilogram?
Set up a conversion factor based on an equivalence statement.

$1\mu g = 10^{-6} g \quad \therefore \quad 1g = 10^{6} \mu g$

$1kg = 10^{3} g \quad \therefore \quad 1g = 10^{-3} kg$

so, this gives two conversion factors

a.) $\frac{1g}{1g} = 1 = \frac{10^{6} \mu g}{10^{-3} kg} = \frac{10^{9} \mu g}{kg}$

or

b.) $\frac{1g}{1g} = 1 = \frac{10^{-3} kg}{10^{6} \mu g} = \frac{10^{-9} kg}{\mu g}$

Use the ratio which has the starting unit in the denominator and ending unit in the numerator.
Use (a.) to convert kilograms to micrograms
(b.) to convert micrograms to kilograms

Example: Convert 32.4 ng to Mg.

$1g = 10^{-6} Mg = 10^{9} ng$

$32.4ng\left(\frac{10^{-6} Mg}{10^{9} ng}\right) = 32.4x10^{(-6-9)} Mg = 32.4x10^{-15} Mg = 3.24x10^{-14} Mg$

Conversion Factors and Scientific Notation

Convert $3.57x10^{14}$ μl to ml

$3.57x10^{14} \mu l\left(\frac{10^{3} ml}{10^{6} \mu l}\right) = 3.57x10^{(14+3-6)} ml = 3.57x10^{11} ml$

Problems: Solve the following

1.) Convert $4.337x10^{14}$ Tl to μl

2.) Convert $4.78x10^{24}$ fg to Mg

3.) Convert $2.00x10^{-4}$ μsec to psec

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B. Conversions between different scales:

YOU MUST SHOW WORK AS SOME CALCULATORS AUTOMATICALLY DO CONVERSIONS

You need equivalence statements between different units.

KNOW: 2.54cm=1in (exact) (Metric length to English Length)
1ml = $1cm^3$ (Metric volume to Metric length cubed)

Note* Many of these are not exact, see back cover of book.

How many dm are in an object which is 2.45 feet long?
given 12in = 1 ft,

$$2.450\,ft\left(\frac{12in}{ft}\right)\left(\frac{2.54cm}{in}\right)\left(\frac{10^1 dm}{10^2 cm}\right) = 7.4676dm = 7.468dm$$

How many gallons are in a cuboid can that is 2.05 ft wide, 12.4 inches long and 1.30 yards deep?

Given: 4 qt = 1 gal, 1.057qt=1L, 12in = 1 ft, 3 ft = 1 yd:

$$2.05\,ft\,(12.4in)(1.30yd)\left(\frac{3ft}{yd}\right)\left(\frac{12in}{ft}\right)^2\left(\frac{2.54cm}{in}\right)^3\left(\frac{1mL}{1cm^3}\right)\left(\frac{1L}{1000mL}\right)\left(\frac{1.057qt}{1L}\right)\left(\frac{gal}{4qt}\right) = 61.8gal$$

Problems:

1.) How many square inches are in a rectangle which is 3.24ft by 2.67 yd?

2.) How many cubic inches are in a mL?

3.) How many cubic feet are in a TL?

4.) How many kL are in a cube which is $3.24x10^{21}$mm on each side?

5.) How many square inches are in a rectangle which is $1.75x10^{11}$mm by $7.34x10^{-13}$km

6.) How many mL are in an cuboid that is $2.00x10^{21}$mm by 3.0010^2yard by $5.00x10^{18}$ft?

C. Physical Constants

These are typically measured and have significant digits.

Density: Allows conversion from Mass to Volume.

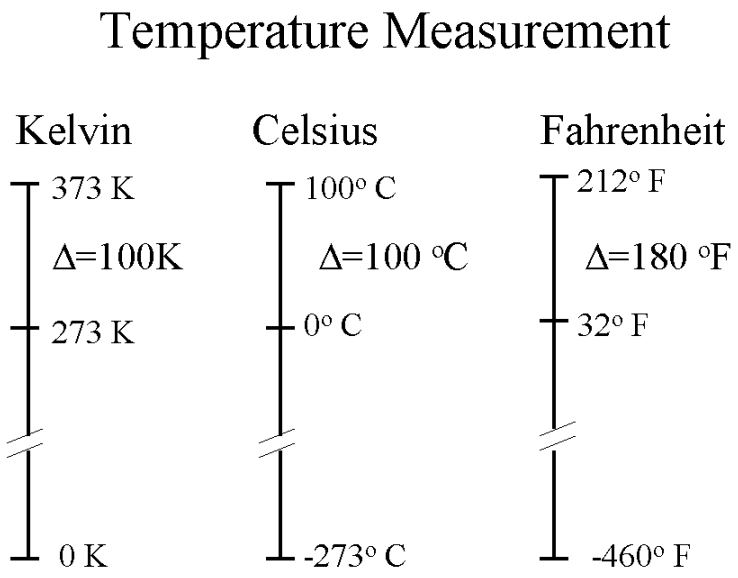
D=M/V
How many pounds does the above container weight at a given temperature if water has a density of 0.98g/mL?

$$61.8gal\left(\frac{4qt}{gal}\right)\left(\frac{L}{1.057qt}\right)\left(\frac{1000mL}{L}\right)\left(\frac{0.98g}{mL}\right)\left(\frac{lb}{453.6g}\right)=505.27lb=510lb$$

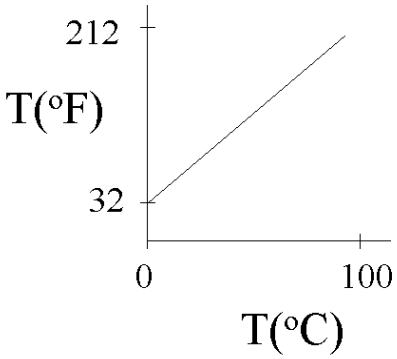
Note the answer has 2 significant digits because of the density

Part 2 Temperature Conversion and equation for a straight line

$T_C = T_K + 273.15$



Temperature Conversions



$$y = mx + b$$

$$^0F = \frac{212-32}{100-0}\,^0C + 32$$

$$= \frac{180}{100}\,^0C + 32$$

$$= \frac{9}{5}\,^0C + 32$$

$$= 1.8\,^0C + 32$$

Temperature Conversions

$$°C = \frac{1}{1.8}(°F - 32)$$

$$°F = 1.8(°C) + 32$$

At what Temperature do these scales converge?

-40°C=-40°F

Temperature Conversions

+40/-40 Method

1. Add 40 to number
2. If going from C to F, multiply by 1.8

   (the change is greater)

   If going from F to C, divide by 1.8

   (the change is smaller)
3. Subtract 40 from number

Convert 98.6ºF to Cº and K.

$$(98.6+40)\left(\frac{1}{1.8}\right)-40=37.0^{o}C$$

$$37.0+273.15=310.2K$$

What is Absolute Zero in Fahrenheit?

$$0K=-273.15^{o}C$$

$$(-273.15+40)(1.8)-40=-459.67^{o}F$$

Part 3: Percent: - way of expressing a fraction

Fraction = part/whole

Percent = fraction(100)

Note, the some of the parts = the whole
(sum of fractions = 1 sum of percents = 100)

What is the percent salt if 23.5 g of salt is mixed with 91 g water?

$$\%Salt = \left(\frac{m_{Salt}}{m_{Salt} + m_{Water}} \right) 100 = \frac{23.5g}{23.5g + 91g} 100$$

$$= \frac{23.5}{114.5} 100 = .20524(100) = 20.5\% salt$$

What is the percent water if 23.5 g of salt is mixed with 91 g water?

$$\%Water = \left(\frac{m_{Water}}{m_{Salt} + m_{Water}} \right) 100 = \frac{91g}{23.5g + 91g} 100$$

$$= \frac{91}{114.5} 100 = .79476(100) = 79\% salt$$

Note, there are two ways as we already know % salt, be BE CAREFUL of Sig Figs.
Whole - % salt = % water
100% - 20.5% = 79.5%
(exact) (meas)

This second way is considered wrong

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What mass of Water do you need to add to 55.4g of salt to make a solution that is 15.0% Salt?

$$\%salt = \frac{m_S}{m_S + m_W}(100)$$

$$Fraction\,salt = f_S = \frac{\%salt}{100}$$

$$f_S = \frac{m_S}{m_S + m_W}$$

$$f_S\left(m_S + m_W\right) = m_S$$

$$f_S m_S + f_S m_W = m_S$$

$$f_S m_W = m_S - f_S m_S = m_S(1 - f_S)$$

$$m_W = \frac{(1 - f_S)}{f_S} m_S = \frac{(1 - .150)}{.150} 55.4g = \frac{.850}{.150} 55.4g = 314g$$