CHE 1031: Guide to conversions using of railroad tracks

Conversion FAQs

- <u>Which unit is one</u>?
  All conversion factors have two numbers and two units. One of the numbers is usually ONE and the other is not. It's critical that you know which number belongs with which unit. For example:

  2.54 cm/inch ……… Better stated as 2.54 cm/1 inch

- <u>Which way is up</u>?
  Because conversion factors have two units they can be flipped, and it's critical to know which unit and number should be on top in each conversion problem that you set up. For example, should you use:

  2.54 cm/1 inch or 1 inch/2.54 cm?

- <u>Why are metric pre-fixes so confusing</u>?
  Probably because the relative size of units represented by prefixes are yet obvious to you. I think that the following "system" can help simply use of the metric (or Greek) prefixes.
  - <u>Memorize just the exponent of 10 that corresponds to each prefix</u>; don't bother with the sign. For example, pico's exponent is 12: there are 1 E12 picograms in one gram.
  - <u>Learn the relative sizes of the units</u>. For example, g > mg > ug > ng > pg > fg.
  - When using a metric prefix conversion factor in a conversion problem, ask yourself this question: "<u>Which unit is larger?</u>" The larger unit should be assigned the number one, and the smaller unit should be assigned 10 raised to the appropriate exponent.

  $$\frac{g}{pg} \quad \rightarrow \quad \frac{1\,g}{1\,E12\,pg}$$

- <u>Both units and VALUES must be squared or cubed</u>!
  Sometimes conversion factors have to be squared or cubed. Remember that both the values (numbers) and the units must be squared or cubed. For example, if converting squared inches to squared cm:

  $$\frac{3\,\cancel{in}^3 \quad (2.54)^3\,cm^3}{(1)^3\,\cancel{in}^3}$$

Guide to Using Railroad Tracks

Do you have to use *railroad tracks* to do chem conversions? Absolutely NOT!

But they do offer a big advantage: they prevent you from "flipping" your conversion factors and keep you on track to the right answer.

The horizontal track separates old units from new units and ensures that your factors are used right side up.

Old unit (A̶)	New unit (B̶)	New unit (C̶)	New unit (D
Old unit (A̶)	Old unit (A̶)	Old unit (B̶)	Old unit (C̶)

1. You start with a number that has only *one unit*.
2. Then choose a conversion factor that has that unit *and* the new unit you're trying to convert to.
3. Place the conversion factor next to the single-unit number so that:
   (a) Old units cancel diagonally (usually down); and
   (b) The new unit is on top of the conversion factor.
4. Get all of the units properly arranged so that all old units cancel.
5. Then, and only then, fill place numbers in the conversion factors.
6. Most conversion factors will have a number 1 in them. When multiplying & dividing through the problem (down the tracks) ignore the 1's & look at whether the non-1 numbers are above or below the track.
   (a) If the non-1 number is above, multiply by it.
   (b) If the non-1 number is below, divide by it.

Remember, choosing the right conversion factor(s) is half the battle!

METRIC EXAMPLE: Convert 23.2 ng into kg.

Solve the problem in a series of steps

1. Find the conversion factors: 'nano' means 1 E9 & 'kilo' means 1 E3.

2. Start setting up the railroad tracks: start with the units that you are given and end with the units you are converting into.

   23.2 ng _____ kg

3. Add the conversion factors, but focus on the UNITS ONLY at this step. In the example below I've set up units, and confirmed that everything but kg cancels out.

23.2 n̶g̶	g̶	kg =
	n̶g̶	g̶

4. Finally, put in the numbers that go with the units and punch it into the calculator. Divide when the non-1 number is below the line, multiply when it's above.

   So, 23.2/1 E9/1 E3 = 2.3 E-11

23.2 n̶g̶	1 g̶	1 kg = 2.3 E-11
	1 E9 n̶g̶	1 E3 g̶

ENGLISH – METRIC EXAMPLE:
Convert 23.2 mile per hour to mm per minute.

Again, solve the problem in a series of steps.
1. Develop a strategies & choose conversion factors
   (a) Distance: You can go from miles to mm like this: miles → km → m → mm.
      So, you'll need 3 conversion factors, one for each arrow:
         1.609 km/1 mile
         1 km/1 E3 m
         1 m/1 E3 mm
   (b) Time: You can go from hours to minutes using a single conversion factor:
         1 hr/60 min

2. Set up the start & end points of your railroad tracks:

23.2 miles					mm
1 hour					min

3. Add your conversion factors, using UNITS ONLY, & be sure that units cancel

23.2 ~~miles~~	~~km~~	~~m~~	mm	~~hr~~	mm
1 ~~hour~~	~~mile~~	~~km~~	~~m~~	min	min

4. Add the numbers for the conversion factors that you listed in step 1.

23.2 ~~miles~~	1.609 ~~km~~	1 E3 ~~m~~	1 E3 mm	1 ~~hr~~	mm
1 ~~hour~~	1 ~~mile~~	1 ~~km~~	1m	60 min	min

5. Punch the numbers in! So, 23.2 x 1.609 x 1 E3 x 1 E3 ÷ 60 = 6.22 E5 mm/min.

CUBED UNIT EXAMPLE
A block of gold has a volume of 5 cubic inches and gold has a density of 19.3 g/mL. What is the mass of the block of gold?

1. Set up the start and end points of your railroad tracks.

$5\ in^3$			g

2. Add conversion factors, using UNITS ONLY and cancelling as you go.

$5\ \cancel{in^3}$	$\cancel{cm^3}$	$\cancel{mL}$	g
	$\cancel{in^3}$	$\cancel{cm^3}$	$\cancel{mL}$

3. Add the numbers for the conversion factors.

$5\ \cancel{in^3}$	$(2.54)^3\ \cancel{cm^3}$	$1\ \cancel{mL}$	19.3 g
	$(1)^3\ \cancel{in^3}$	$1\ \cancel{cm^3}$	$1\ \cancel{mL}$

4. Punch it in! So, $5 / 2.54^3$ x 19.3 = 6 g

EXAMPLE PROBLEMS
Try these problems. I've given you the answer and the number of conversion factors. You show the work!

1. Convert 20 μm to cm.   *2 cf / 2 E-3 cm*

2. Convert 512 pounds (lb) into grams.   *1 cf / 2.32 E5 g*

3. Convert 38 ft into mm.   *4 cf / 1.2 E4 mm*

4. Convert 5 E12 nm into miles.   *3 cf / 3 miles*

5. Convert 8 E-3 m/s into miles/hour.   *4 cf / 2 E-2 mi/hr*