



Chapter 11

Introduction to...

**Dimensional Analysis,
Significant Figures and the Metric System**

Dimensional Analysis

- The process used to convert from one unit to another.
- Can be used, for example, to convert *inches into miles* or *centimeters into kilometers* or even *inches into kilometers*.
- We use “identity statements” when converting from one unit to another
- Let’s look at an easy example:

Convert 2 miles into inches:

- What do you need to know in order to make this conversion?
- *Identity statements:*
 - 12 inches = 1 foot
 - 5280 feet = 1 mile

Convert 2 cm into kilometers.

- **Identity statements:**

- 100 cm = 1 meter
- 1000 m = 1 km

Convert 2 miles into mm:

- **Identity statements:**

- 5280 feet = 1 mile
- 12 inches = 1 foot
- 2.54 cm = 1 inch
- 1000 mm = 1 meter
- 100 cm = 1 meter

What are “sig figs”?

- “Sig figs” mean “significant figures”
- Significant figures tell you about the amount of *precision* of your measuring device.
- You must use the correct number of sig figs when using *dimensional analysis*.
- Sig figs only matter for MEASURED numbers.
- Here are the rules you must **MEMORIZE:**

4 Rules for determining the correct number of sig figs:

1. All "non-zero" numbers are significant.
1, 2, 3, 4, 5, 6, 7, 8, 9
2. All zeros that are between "non-zero" numbers are significant.
40007.009
3. All zeros that "trail" on the right side of the decimal point are significant.
.00000556700
4. All zeros that "trail" on the left side of the decimal point are **NOT** significant unless you have a decimal point.
56700000 56700000.

Use *sig figs* in solving this dimensional analysis:

Convert 3.00 cm into kilometers

Convert 2.07 inches into mm:

Metric system prefixes:

- You must **MEMORIZE** these 5 common metric prefixes...
- Centi means 1/100 or 10^{-2}
- Milli means 1/1000 or 10^{-3}
- Kilo means 1000 or 10^3
- Micro (μ) means 1/100,000 or 10^{-6}
- Nano (n) means 10^{-9}

Metric system prefixes:

- When you *use* these prefixes in dimensional analysis, use **POSITIVE** exponents.
- Centi 100 or 10^2 cm = 1 m
- Milli 1000 or 10^3 mm = 1 m
- Micro (μ) 10^6 μ m = 1 m
- Nano (n) 10^9 nm = 1 m
- Kilo 10^3 m = 1 km

Dealing with exponents on your calculator:

- On your scientific calculator, find the EE button (also sometimes labeled as EXP or even $\times 10^n$)
- This button is set up to perform the function $\times 10^n$.
- Button $\pm/-$ is the change sign key.

When using metric prefixes in dimensional analysis:

- Convert the metric prefix and go back to “base” metric unit.
- Here are the metric base units you must *MEMORIZE*:
 - Liter (measures volume) L
 - Meter (measures length) m
 - Gram (measures mass) g
- Always use positive exponents for metric identity statements ($10^3 \text{ mm} = 1 \text{ m}$)

Convert 2.9 mm into km:

- Identity statements:
 - $1 \text{ m} = 10^3 \text{ mm}$
 - $1 \text{ m} = 10^2 \text{ cm}$
 - $10^3 \text{ m} = 1 \text{ km}$

Convert $2.3 \times 10^5 \text{ km}$ into nm

Dealing with exponents

- Remember to multiply all the factors in the numerator first.
- Then pressing the DIVIDE sign each time, divide all your denominator.
- Perform this calculation on your calculator:

$$\frac{(4.5 \times 10^{12}) (3.599 \times 10^{-7}) (3.599 \times 10^{-7})}{(5.0 \times 10^3) (6 \times 10^{-9}) (8.9 \times 10^{-9})}$$

- Press the / sign here

How do you figure out how many SF in your answer?

- After you've done all the multiplication and division, you need to figure out how many SF in your answer.
- **RULE:** Your answer has the same number of SF as the factor with the fewest SF.

$$\frac{(4.5 \times 10^{12} \text{ cm}) (3.599 \times 10^{-7} \text{ cm})}{(5.0 \times 10^3 \text{ cm}) (6 \times 10^{-9} \text{ cm})}$$
