



Science 20F In Motion





PART ONE:

“SIGNIFICANT FIGURES”



What is Precision?

Precision

- **Precision** is a quality that Physicists are fanatical about
- **HOWEVER** the application of Precision in Physics (and Science in General) differs from the theoretical approach to Precision you may have seen in a Math Class
- **For example,**
 - If you adding the numbers 1.7 to 2.356 you would reasonably come to the answer 4.056 **BUT** a Physicist (or a Scientist that understands measurement and uncertainty) would come to the answer 4.1

WHY?

Significant Figures ("Sig Figs")

- A **Significant Figure** is the number of digits in a value , often a measurement, that contribute to the degree of accuracy of the value.
- More simply, a Significant Figure reflects how accurately the tool used to make a measurement is at making the measurement
- Mathematics does not take into account how a measurement is made so any digit included in the calculation and answer is kept. **However**, in the real world, we need to consider how a measurement is made when we use it in a calculation and adjust our answer accordingly

Counting Significant Figures

In order to use Significant Figures we first need to know how to count (identify) them.

The Rules:

1. All Non-Zero Digits are Significant

(ex) 374 (3 sig figs) 8.2 (2 sig figs)

2. All Zeroes BETWEEN Non-Zero digits are Significant

3. Leading Zeroes in a decimal are NOT Significant

(ex) 0.54 (2 Sig Figs) 0.00098 (2 Sig figs)

4. Trailing Zeroes are Significant ONLY IF they are AFTER the decimal point

(ex) 3.7000 (5 sig figs) 37000 (2 sig figs)

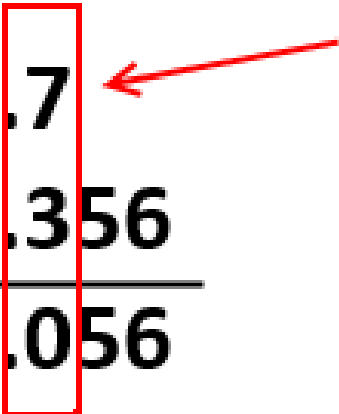
Adding and Subtracting with Sig Figs

- When adding or subtracting with Significant Figures, you must round your answer to the **least accurate place**

(ex) $1.7 + 2.356$

$$\begin{array}{r} 1.7 \\ + 2.356 \\ \hline 4.056 \end{array}$$

least accurate
(last certain place)
is the tenths place



= **4.1** (to proper sig figs)

****THE EXCEPTION****

- Watch to see if “**Rounding Rules**” have been applied to the question

(ex) Round to 3 sig figs:

$$1.7 + 2.356 = 4.06$$

Rounding Rule



Rounded to
3 sig figs



Multiplying and Dividing with Sig Figs

- When multiplying and dividing with significant figures your answer can only have as many sig figs as the number in the calculation with the fewest number of sig figs....

(pause and think about this for a moment)

(ex) **Multiply 1.7(2.001)**

$$1.7 (2.0001) = 3.40017$$

2 Sig Figs 5 Sig Figs 6 Sig Figs

SO, the answer can only have 2 Sig Figs

$$1.7(2.0001) = 3.4 \leftarrow 2 \text{ Sig Figs}$$

****THE EXCEPTION** Watch for Rounding Rules**



**PART TWO:
“S.I. UNITS”**



What is a S.I. Unit?

S.I. Units

- The “**Systeme Internationale**” has established a series of **Standard Base Units** which are used to establish universal standards for physical measurements

Quantity	S.I. Unit
Mass	Kilogram (kg)
Length	Metre (m)
Time	Second (s)
Force	Newton (N)
Volume	Litre (L)

Converting a measurement to S.I. Units

- In order to use the different relationships that exist to describe motion we must convert any given units of measurement into SI Units

Here is a general method to use:

Step #1: What Quantity are we measuring and what is the SI Unit for the Quantity?

Step #2: Is the given unit bigger or smaller than the SI Unit for the Quantity

Step #3: Use a Conversion Factor to convert the given unit into the SI Unit

$$\text{Given Unit} \times \frac{\text{SI Unit}}{\text{Given Unit}} = \text{___ SI Unit}$$

(ex #1) Write 200km as an SI Unit

Some Reasoning (That you should eventually do in your head)

- This is a measurement of **length or distance** and the SI Unit for length or distance is **the metre**.
- A Kilometre is **1000X larger** than a Metre
- Set up the conversion factor as follows:

SI Unit is SMALLER
and there are 1000m
in 1km

$$\begin{array}{ccccccc} & & & & \text{SI Unit} & & \\ & & & & \swarrow & & \\ & & & & \mathbf{1000m} & & \\ & & & & \hline & & & & \mathbf{1km} & & \\ & & & & \swarrow & \nwarrow & \\ & & & & \text{Given Unit} & \text{Given Unit} & \\ \text{Given Unit} & \times & & = & \mathbf{20000m} & & \text{SI Unit} \\ \uparrow & & & & \uparrow & & \\ & & & & \text{Given Unit is} & & \\ & & & & \text{LARGER so we} & & \\ & & & & \text{put a 1 in front of it} & & \end{array}$$

- If the Given Unit is **LARGER** than the SI Unit we will end up **multiplying** the Given Unit by some factor of 10

(ex #2) Write 10g as an SI Unit

Some Reasoning (Again you should do this in your head):

- This is a measurement of **mass** and **the kilogram** is the SI Unit for mass
- A Gram is **1000X smaller** than the kilogram
- Set up the conversion factor as follows:

SI Unit is LARGER
so we put a 1 in
front of it

$$\begin{array}{ccccccc} & & & & \text{SI Unit} & & \\ & & & & \swarrow & & \\ & & & & \mathbf{1kg} & & \\ & & & & \hline & & & & \mathbf{1000g} & & \\ & & & & \swarrow & & \\ & & & & \text{Given Unit} & & \\ \mathbf{10g} & \times & & = & \mathbf{0.01kg} & & \\ \swarrow & & & & \swarrow & & \\ \text{Given Unit} & & & & \text{SI Unit} & & \end{array}$$

Given Unit is SMALLER
and there are 1000g in 1kg

- If the Given Unit is **SMALLER** than the SI Unit then the we will end up **dividing** by some factor of 10

- *Here is a conversion table that you can use to convert given units into SI Units:*

Metric Prefixes

Prefix	Symbol	Relationship to the base unit
giga-	G	$10^9 = 1\,000\,000\,000$
mega-	M	$10^6 = 1\,000\,000$
kilo-	k	$10^3 = 1\,000$
hecto-	h	$10^2 = 100$
deca-	da	$10^1 = 10$
–	–	$10^0 = 1$
deci-	d	$10^{-1} = 0.1$
centi-	c	$10^{-2} = 0.01$
milli-	m	$10^{-3} = 0.001$
micro-	μ	$10^{-6} = 0.000\,001$
nano-	n	$10^{-9} = 0.000\,000\,001$



PART TWO:
“SCIENTIFIC NOTATION”



**Would doing calculations with
numbers like
63,000,000,000,000,000 or
0.000000000725 kind of suck?**

Scientific Notation

- **Scientific Notation** is a method of writing very large or very small numbers in a more manageable form using a **base number** multiplied by an **exponential factor of 10**

(ex #1) **Convert 65,000,000,000,000,000 into Scientific Notation:**

$$6.5 \times 10^{16}$$

Base Number

Made by putting a decimal point after the first non-zero number in the number we are converting to Scientific Notation

Power of 10

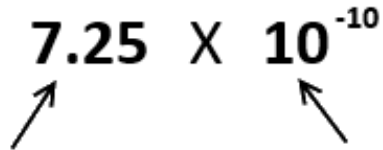
Determined by figuring out by what power of 10 do we need to multiply the base number by to get the original (standard notation) number

OR

by counting how many times we have to move the decimal place from the Base Number to get to the end of the original (standard notation) number

The Exponent is POSITIVE because we are making the base number LARGER

(ex #2) Convert 0.000000000725 into Scientific Notation

$$7.25 \times 10^{-10}$$


Base Number

Made by putting a decimal point after the first non-zero number in the number we are converting to Scientific Notation

Power of 10

Determined by figuring out by what power of 10 do we need to multiply the base number by to get the original (standard notation) number

OR

by counting how many times we have to move the decimal place from the Base Number to get to the end of the original (standard notation) number

The Exponent is NEGATIVE because we are making the base number SMALLER

Calculations and Scientific Notation

1. **Adding/Subtracting with Scientific Notation can only be done if the exponents are the same**

(ex #1) $1.13 \times 10^4 + 3.71 \times 10^4 = 4.84 \times 10^4$

IF the exponents are different you must “convert” one of the numbers first (pick the smaller one)

(ex #2) $2.0 \times 10^5 + 2.0 \times 10^4$
 $= 2.0 \times 10^5 + 0.2 \times 10^5$
 $= 2.2 \times 10^5$

- 2. When Multiplying with Scientific Notation, multiply the base numbers and then add the exponents**

$$\begin{aligned} \text{(ex \#3)} \quad & 2.0 \times 10^3 (2.0 \times 10^4) \\ & = 4.0 \times 10^{3+4} = 4.0 \times 10^7 \end{aligned}$$

- 3. When Dividing with Scientific Notation, divide the base numbers and then subtract the exponents**

$$\begin{aligned} \text{(ex \#4)} \quad & 4.0 \times 10^7 \div 2.0 \times 10^4 \\ & = 2.0 \times 10^{7-4} = 2.0 \times 10^3 \end{aligned}$$