Scientific Math Skills

1. Significant Figures

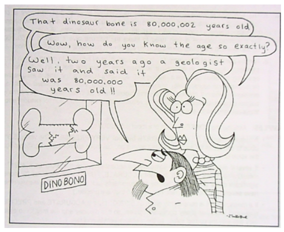
When **measuring** any value (time, mass, volume, length, etc) you can **never** find the exact value. This is because you can always look at a smaller quantity within that measurement. In other words, you are limited by the accuracy of your measuring device.

Ex) Using a standard stopwatch Donovan Bailey Ran the 100 m race in 9.84 s.

We say that it is *possible* for one to measure *precisely* but **impossible** to measure **exactly**.

Every measurement comes with a varying degree of **uncertainty**. We must consider this uncertainty when dealing with math involving measurements so we can report the correct precision in our answers.

We call a digit in a number that is measured a **significant figure** (it is meaningful).



The more significant figures means the more precise a value is.

Ex) One scale says a beaker is 97.53 g. A second scale says the same beaker has a mass of 97.5295 g.

However, just because a digit appears in a number doesn't necessarily mean the digit is significant. Therefore, we will use a set of rules to determine whether or not a digit is meaningful.

Significant Figure Rules

Rule 1: Any non-zero number in a value is significant.
Ex) 56 321

Rule 2: Any zero between two non-zero numbers is significant (**trapped** zeroes).
Ex) 4007 2301 40 208

Rule 3: Any **leading** zero (on the left side of all other non zero numbers) is **not** significant. We say these zeroes are just 'place holding'.
Ex) 4 0.04 0.0000000435

Rule 4: Any **trailing** zero is only considered significant **if** there is a decimal present.
Ex) 50 1300 3.00

This last rule is there because numbers are often rounded to the nearest 10, 100, 1000, etc. Therefore numbers like 50 can represent a range of values.

1.1 Scientific Math Review

When writing numbers with trailing zeroes you want to be significant you have two options.

Option 1: draw a line over the last zero you want to be significant. This means that all numbers (including zeroes) to the left of it are significant.

Ex) Write 50 so it has two sig figs. Write 1300 so it has 4 sig figs.

Option 2: write the value in scientific notation.

Ex) Write 50 so it has two sig figs. Write 1300 s it has 4 sig figs.

When doing math in this course we need to follow one basic rule: **an answer can only be as precise as the least precise measurement.**

Ex) 4 x 7.0 =

Ex) 9.00/3.0 =

Ex) 500(0.01) =

Ex) 5076 + 12.3 =

2. Scientific Notation

Scientific notation is a way for us to write very large or very small numbers in a concise manner. For example, if you needed to use the number 4.5 billion in a calculation, it would be tedious to write out all of the zeroes involved. Likewise, it would be tedious to put all of those numbers into a calculator.

A number written in scientific notation must follow these guidelines:
1. It must be written as a product of two numbers.
2. The first number must have a value between 1-10.
3. The second number must be a power of 10. If the value of the overall number is greater than 1 then the exponent on 10 will be positive. If the value of the overall number is smaller than 1 then the exponent will be negative.

For example, 3.28×10^{-2} is in scientific notation, but 32.8×10^{-3} is not. Technically, these numbers are the exact same.

When we change scientific notation to standard notation (or visa-versa), we can just move our decimal place left or right. If the exponent is **positive**, we move the decimal to the right. If the exponent is **negative**, we move the decimal to the left.

2. Scientific Notation

Ex) Write the following numbers in standard form:

a) 7.588×10^5 b) 5.347×10^{-4} c) 2.5×10^0

Ex) Write the following numbers in scientific notation:

a) 7650 b) 4.79 c) 0.00567 d) 30

Scientific Notation and Calculators:
To enter 2.88×10^2 you would press 2.88 **EE** or **EXP** 2 (these buttons mean "10 to the ___"). This tells the calculator that I am entering in **one number** and not a list of operations. Alternatively, you can use brackets.

Ex) Calculate the following using your scientific notation button:

$3.00 \times 10^{-8} \div 95.1 \times 10^6$

Note: only the decimal number in scientific notation is counted for sig-figs.

Operations with Scientific Notation

Addition and Subtraction

Before numbers in scientific notation can be added or subtracted, the exponents must be equal.

Not equal — Equal

$$(3.4 \times 10^2) + (4.57 \times 10^3) = (0.34 \times 10^3) + (4.57 \times 10^3)$$

The decimal is moved to the left to increase the exponent.

$$= (0.34 + 4.57) \times 10^3$$

$$= 4.91 \times 10^3$$

Multiplication

When numbers in scientific notation are multiplied, only the number is multiplied. The exponents are added.

$$(2.00 \times 10^3)(4.00 \times 10^4) = (2.00)(4.00) \times 10^{3+4}$$

$$= 8.00 \times 10^7$$

Division

When numbers in scientific notation are divided, only the number is divided. The exponents are subtracted.

$$\frac{9.60 \times 10^7}{1.60 \times 10^4} = \frac{9.60}{1.60} \times 10^{7-4}$$

$$= 6.00 \times 10^3$$

3. Conversions and Dimensional Analysis

As we know, there are several different units of measurement in the realm of science (inches, cm, m, L, mL, etc.)

It is imperative that we communicate the units for the measurements we take for two reasons.
1. we are all on the same page
2. we use the measurements correctly when applying them to problems

http://www.cnn.com/TECH/space/9909/30/mars.metric.02/

Since there are so many different units out there, we must learn how to convert between units.

We are all familiar with the metric system. However, scientists have universally agreed to follow a very similar system called the S.I. system of measurements. The S.I. stands for *Système international*.

The vast majority of units in this system are the same as the metric system (metres, litres, etc). Therefore, we can use a guide to help us with the conversions called a Metric Staircase (resource package).

Ex) 28.6 km = ________ m

12 cm = ________ mm

1.88×10^3 km = __________ m

23.4 mHz = _________ MHz

18 g = ________ dag

3.26×10^6 mL = ________ kL

3. Conversions and Dimensional Analysis

S.I. Units

Measurement	Unit	Symbol
Mass	Kilograms	
Volume	Litre	
Length	Meter	
Energy	Joule	
Time	Seconds	
Temperature	Kelvin	

If we are not converting within the metric system, dimensional analysis is very helpful! Dimensional analysis is the analysis of relationships between different physical quantities by finding their dimensions (units) of measurement and tracking these dimensions as calculations are performed.

ex) How many centimeters are in 6.00 inches (1 in = 2.54 cm)

ex) How many second are in 2.0 years?

Assignment

Use the information in this section to answer the following questions. When done, check your answers using the key provided.

1. How many sig figs do the following numbers have?

a. 1234 ___________

b. 0.00120 ____________

c. 0.0001 _______________

d. 9010.0 __________

e. 8120 ____________

2. Convert the following to scientific notation:

a. 0.005 = _______________________

b. 0.00080 = _______________________

c. 502 000 = ________________________

3. Convert the following to standard notation:

a. 1.5×10^{3} = ______________________

b. 3.35×10^{-6} = _________________________

c. 3.75×10^{1} = _____________________

4. Perform the following operations and express answers in scientific notation with the correct number of sig figs.

a. $1.2 \times 10^{5} + 5.35 \times 10^{6}$ = _____________________

b. $4.3 \times 10^{8} \times 2.00 \times 10^{6}$ = ___________________________

c. $8.1 \times 10^{-2} / 9.0 \times 10^{2}$ = ____________________

5. Convert 4.65 km to m

6. Convert 8.41 g/mL to Kg/L

7. Convert 10095 m/s to miles/s