TOPIC # 1: SIGNIFICANT FIGURES, DIMENSIONAL ANALYSIS, SUBATOMIC PARTICLES

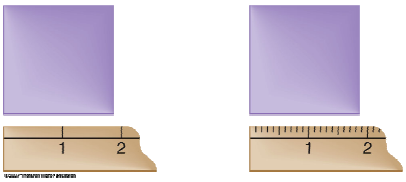
Significant Figures / Sig Figs - a means of expressing the degree of confidence in a measured number.

General Information:

- Significant figures are the numbers in a measurement that represent the certainty of the measurement, plus one number representing an estimate.
- The last digit in a reported measurement is uncertain (estimated).
- The greater the number of sig figs, the more accurate/ precise the measurement is.

The number of significant figures in a measurement depends on:

- The measuring device (see figure at right)
- The skill of the operator of the measuring device

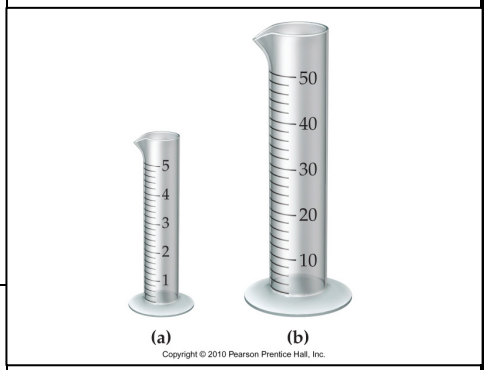


Activity 1

Assume that you have two graduated cylinders, one with a capacity of 5 mL (a) and the other with a capacity of 50 mL (b).

A. If you needed to measure 2.64 mL of water; which cylinder will give the more accurate measurement? Explain

B. If you needed to measure 25.6 mL of water; which cylinder will give the more accurate measurement? Explain.



Significant Figures for Measured Numbers and Calculations

General Information:

- The accuracy of the answer in a calculation is limited by the least accurately known measurement.
  - The least accurately known measurement will be the measurement with the fewest number of significant figures.

Rules to determine the number of significant figures in a measured number:

1. Any digit that is not zero is significant.
2. Captive/buried zeros ⇒ zeros between non-zero numbers are significant.
3. Leading zeros ⇒ zeros at the beginning of a number with a decimal point are not significant.
4. Trailing zeros ⇒ zeros at the end of a number with a decimal point are significant.
5. Zeros at the end of a number w/o a decimal point are ambiguous; they may or may not be significant.
   a. The student should avoid this situation by expressing the number using **standard scientific notation**.

Calculations:

Adding and Subtracting:

- **Rule**: The final answer has the same number of digits past the decimal place as there are in the measurement with the **fewest** digits after the decimal place.

Multiplying and Dividing:

- **Rule**: The final answer contains the same number of **SIGNIFICANT FIGURES** as there are in the measurement with the **fewest** number of significant figures.

Activity 2

Determine how many significant figures are in the following measured numbers.

A. 109
B. 2.8000949586
C. 101.4300
D. 0.00002
E. 0.00000020
F. 20
G. 123.54760049000
H. 10000001
I. 3
J. 1040

Activity 3

Complete the following calculations.

A. $(6.9371 + 0.30) \times 0.01689 =$

B. $\dfrac{(0.7761 \times 22.1)}{(49.01 - 48.89)} =$

C. $(3.8621 \times 1.5630) - 5.98 =$

D. $15.234 - 15.208 =$

E. $458.1 \times 0.002000 =$

F. $(7.54 + 4.535) / (152.23 - 12.23) =$

G. $6.8 \times 10^{-8} + 3.250 \times 10^{-6} =$

H. $7.61 + 3.52 =$

Dimensional Analysis

General Information:

- All measured quantities consist of a number AND a unit.
- Not all measurements contain the desired unit.
- In order to convert from one unit to another, a conversion factor must be used relating the units.
  - Conversion factors are ratios used to express a quantity in different units.
- If a conversion factor is correctly applied, **a unit will always cancel.**

Conversion Factor: 1 mile = 5280 feet So, you will have two options to choose from.

$$\frac{1 \text{ mile}}{5280 \text{ feet}} \quad \text{OR} \quad \frac{5280 \text{ feet}}{1 \text{ mile}}$$

Always keep the following in mind when solving problems:

1. All numbers should carry the appropriate units.
2. Write down your work so you can make sure you are setting up the problem correctly.
3. Cancel out your units in your calculation, which ensures that you end with the desired unit!
4. The answer should be reported with the proper number of significant digits and carry the appropriate units.
5. Ask yourself if the answer makes sense.

Use your textbook or other resources available to answer the following questions.

Activity 3

You're throwing a pizza party for 15. You call up the pizza place and learn that each pizza will cost you $14.78 and will be cut into 12 slices. You tell them you'll call back.

How many pizzas and how much money do you need if you allot four slices per person?

Activity 4

You have come down with a bad case of the geebies, but fortunately your grandmother knows how to cure the geebies. She sends you an eyedropper bottle labeled:

"Take 1 drop per 10 lbs. of body weight per day divided into 4 doses until the geebies are gone."

If your weight was 128 pounds, how many drops should you take per dose?

Activity 5

Your car's gas tank holds 18.6 gallons and is one quarter full. Your car gets 16 miles/gal. You see a sign saying, "Next gas station 73 miles." Your often-wrong brother, who is driving, is sure you'll make it without running out of gas. You're not so sure and need to do some quick figuring.

Is your brother right? Do you have enough gas to make it to the next gas station, or should you stop?

Activity 6

At a frat party you and two friends decide to go to Mexico City from El Paso, TX where y'all live. You volunteer your car if everyone chips in for gas. It is 2015 km to Mexico City from El Paso. Gas costs 5.8 pesos per liter in Mexico. The exchange rate is 11 cents to the peso. And you know your car gets 21 miles to the gallon. How much (in dollars) is the trip going to cost each person for gas?
[1 mile = 1.609 km, 1gal = 3.79 liter]

Activity 7

The landing speed of the Apollo 11 moon landing was 2.8 feet per second. Convert this speed to miles per hour. Using your knowledge about speed, describe this event as a gentle bump or a violent crash.

Activity 8

To qualify for the Boston Marathon a 45 year old man must finish a prior marathon (26.22 miles) in 3.50 hours or less. What is this speed in meters per second (m/s)?

Activity 9: Not only for pre-med hopefuls!

You just opened a 500-mL bottle of a prescribed drug and will be giving 1 tablespoon per dose. How many doses are in the bottle? In other words how many tablespoons are in 500 mL?
[Tbsp=3 teaspoons (tsp); 1 tsp=5mL]

You give your patient an unopened 500-mL bottle of a prescribed drug and tell them to take 2 teaspoons 4 times a day as ordered. How long will the bottle last?

Activity 10

Your 18 year old friend failed chemistry and had to start working at the local burger joint. He works 5 days a week, 8 hours per day and every 3 hours he wraps 350 hamburgers. He gets paid $440.34 (after taxes!) every 2 weeks.

Approximately how many hamburgers will he have to wrap to make his first one million dollars? This will be an estimate, so round to 1 significant figure.

How many years will it take to wrap all those hamburgers? Assume that he will work 500 weeks out of the year (2 weeks unpaid vacation) and that he works with the same efficiency everyday. Be careful—no one works 24 hours a day! Round your answer to the nearest year. State any assumptions made.

Subatomic Particles

General Information:

- An **atom** is **electrically neutral** and consists of **three** subatomic particles.
  - **Proton** – Positively charged subatomic particle found in the nucleus of an atom.
  - **Neutron** – Neutral subatomic particle found in the nucleus of an atom.
  - **Electron** – Negatively charged subatomic particle found outside of the nucleus in an atom.

- **Atomic Number** (Z) - The number of ***protons*** (and electrons) in the nucleus of an atom.
- **Mass Number** (A) – The total number of ***protons and neutrons*** in the nucleus of an atom.

- **Isotope** – Atoms of an element having the same number of protons and electrons but different number of neutrons.

Activity 7

1. Fill in the blanks in the chart that follows. Be sure to include ionic charges when appropriate. The first row is completed as an example.

Symbol	# protons	# neutrons	# electrons	Atomic Number, Z	Mass Number, A
$^{63}_{29}Cu$	29	34	29	29	63
$^{65}_{29}Cu^{+2}$			27		
	10	10	10		
			10	8	18
$^{25}Mg^{2+}$				12	
$^{19}_{9}F^{-}$			10		
^{56}Fe				26	

2. Refer to the chart completed in 1, and identify:
   a. All of the isotopes.

   b. The atoms and ions that are **isoelectronic** (those with the same number of electrons).

3. Which element is the standard for assigning the atomic mass of all elements? Explain.

4. Arrange in order of increasing mass: (a) the mass of a proton, (b) the mass of a grain of sand, (c) the mass of a small pea (d) the mass of a single carbon atom, (e) the mass of an electron and, (f) 30.97 amu.