Math for CH 301 Workshop

UT Learning Center
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Welcome to the Math for Chemistry workshop! We are going to cover some math-related topics that you are expected to be proficient in for your first semester chemistry course. We will often refer to your textbook, *Chemical Principles: The Quest for Insight,* so keep it handy.

Workshop Topics:

Scientific Notation and Exponents
Significant Figures
Units and Unit Conversions
Measurement
Error
Proportionality, Variables, and Constants

I strongly encourage you to attend the Algebra Review for Calc/Chemistry/Physics taught next week (9/13 & 9/15, TTH, 5-6:15 pm). It will cover more topics that are very important to master for all your classes.. You may sign up at the UT Learning Center in Jester A332.

Scientific Notation and Exponents

Exponent Rules

Definitions

1. $a^n = a{\cdot}a{\cdot}a{\cdots}a$ (n times)

2. $a^0 = 1, \quad a \neq 0$

3. $a^{-n} = \dfrac{1}{a^n}, \quad a \neq 0$

4. $a^{m/n} = \sqrt[n]{a^m} = \left(\sqrt[n]{a}\right)^m, \quad a \geq 0,\ m \geq 0,\ n > 0$

Combining

1. multiplication: $a^x a^y = a^{x+y}$

2. division: $a^x a^y = a^{x+y}, \quad a \neq 0$

3. powers: $(a^x)^y = a^{xy}$

Distributing $(a \geq 0, b \geq 0)$

1. $(ab)^x = a^x b^x$

2. $\left(\dfrac{a}{b}\right)^x = \dfrac{a^x}{b^x}, \quad b \neq 0$

Careful!!

1. $(a+b)^n \neq a^n + b^n$

2. $(a-b)^n \neq a^n - b^n$

<u>Scientific Notation</u>
See UTLC handout and Appendix 1D in your chemistry textbook.

Practice Problems:

1. $(4.56\times 10^{-3}) \times (7.65\times 10^{6}) =$

2. $\dfrac{4.31\times 10^{5}}{9.87\times 10^{-8}} =$

3. $(1.00\times 10^{3}) + (2.00\times 10^{2}) =$

4. $(2.88\times10^{4})^{3} =$

5. As planets orbit the sun, the closest Pluto gets to the Earth is approximately 2710000000 miles. Write this number in scientific notation.

6. A proton and a neutron each weigh 1.67 X 10^{-24} g. An electron weighs 9.11 X 10^{-28} g. Find the mass of one He atom, which contains 2 protons, 2 neutrons, and 2 electrons.

7. Evaluate $\left(2\times10^{-5}\right)\left(3\times10^{7}\right)$ without a calculator.

8. Evaluate $\left(7\times10^{3}\right)\left(5\times10^{-1}\right)$ without a calculator.

9. Rewrite 0.000000718 in scientific notation.

10. The speed of light in a vacuum is approximately 186000 miles per second. What is this speed in scientific notation?

Significant Figures

Rules for Significant Figures

1) Number of significant figures: Begin counting with the first nonzero digit and end with last digit. For example:

	3.45 g	3 sig figs
	2.4 oz	2 sig figs

2) Zeros *within* a number are always significant.
Ex: Both 4308 and 40.05 contain 4 sig figs
Zeros that do nothing but *set the decimal point* are not significant.
Ex: 470,000 has 2 sig figs
Trailing zeros that aren't needed to hold the decimal point are significant.
Ex: 4.00 has 3 sig figs

3) Rounding: When the answer to a calculation contains too many significant figures, it must be rounded off.
Round up if the last digit is above 5 and round down if it is below 5.
For numbers ending in 5, round off final digit to the *nearest even #.*

4) Addition/Subtraction: When combining measurements with different degrees of accuracy and precision, the accuracy of the final answer can be no greater than the least accurate measurement. This principle can be translated into a simple rule for addition and subtraction: **When measurements are added or subtracted, the answer can contain no more decimal places than the least accurate measurement.** Thus, round off the answer to the number that has the least number of decimal places.

5) Multiplication/Division: **When measurements are multiplied or divided, the answer can contain no more significant figures than the least accurate measurement.** Round off the answer to the same number of sig figs as the smallest number of sig figs in any factor.

Practice Problems:

1. How many significant figures does each measurement contain:?

   11 cm
   11. cm
   10. cm
   10 cm
   10.0 cm
   10.010 cm
   0.0001 cm
   0.00010 cm

2. Round off 1.42627 cm^3 to the correct number of sig figs:

   round to 4 sig figs:
   round to 3 sig figs:
   round to 2 sig figs:

3. Round the following to 3 sig figs :

   1.435 cm^3
   1.425 cm^3
   1.459 cm^3
   1.454 cm^3

4. Compute the following and report your answer with the correct number of sig figs.

   a. $319.542\,\text{g} + 20.460\,\text{g} + 38.2\,\text{g} + 4.173\,\text{g} =$

   b. $150.0\,\text{g H}_2\text{O} + 0.507\,\text{g NaCl} =$

   c. $0.0639\,\text{g} + 38.2\ \text{g} + 4.173\ \text{g} =$

   d. $\dfrac{8.69\,\text{g}}{3.5\ \text{cm}^3} =$

   e. $2.531\ \text{g} \times \dfrac{1\ \text{lb}}{453.6\ \text{g}} \times \dfrac{\$0.67}{1\ \text{lb}} =$

   Note: Don’t consider 1 lb. as having only one sig fig. Unit factors based on definitions have an infinite number of sig figs.

Units and Unit Conversions

<u>Units</u>
Check out the Tables in Appendix 1B of your textbook.

Practice Problems:

1. Fill in the missing information in the table below. You are expected to memorize this for your chemistry class. You won't be able to memorize them during this class period—you may want to make flashcards with the number on one side and the name and abbreviation on the other, or make lists with the units first listed in order, then scrambled to quiz yourself.

Typical SI Prefixes

Prefix:		kilo	mega	giga					
Abbreviation:	da		M	G	T				
Factor:	10	10^3			10^{12}				
Prefix:	deci	centi	milli	micro	nano	pico	femto	atta	
Abbreviation:	d	c			n		f		z
Factor:			10^{-3}	10^{-6}		10^{-12}		10^{-18}	10^{-21}

<u>Derived Units and Unit Conversions</u>
Make sure you know how to convert between the common units and SI equivalents (Table 5).

Table 4, Appendix 1. Derived units with special names.

Physical quantity	**Name of unit**	**Abbreviation**	**Definition**
Absorbed dose	gray	Gy	$J \cdot kg^{-1}$
Dose equivalent	sievert	Sv	$J \cdot kg^{-1}$
Electric charge	coulomb	C	$A \cdot s$
Electric potential	volt	V	$J \cdot C^{-1}$
Energy	joule	J	$N \cdot m$, $kg \cdot m^2 \cdot s^{-2}$
Force	newton	N	$kg \cdot m^2 \cdot s^{-2}$
Frequency	hertz	Hz	s^{-1}
Power	watt	W	$J \cdot s^{-1}$
Pressure	pascal	Pa	$N \cdot m\text{-}^2$, $kg \cdot m^{-1} \cdot s^{-2}$
volume	liter	L	dm^3

Table 5, Appendix 1. Relations between Units.

Physical quantity	Common unit	Abbreviation	SI equivalent
mass	pound tonne	lb t	0.45359237 kg 10^3 kg (1 Mg)
length	inch foot	in. ft	2.54 cm 30.48 cm
volume	U.S. quart U.S. gallon	qt gal	0.9463525 L 3.78541 L
time	minute hour	min h	60 s 3600 s
energy	calorie electronvolt kilowatt-hour liter-atmosphere	cal eV kWh L·atm	4.184 J 1.602177×10^{-19} J 3.6×10^6 J 101.325 J
pressure	torr atmosphere bar pounds/square inch	Torr Atm Bar psi	133.322 Pa 101325 Pa (=760 Torr) 10^5 Pa 6894.76 Pa
power	horsepower	hp	745.7 W
dipole moment	Debye	D	$3.33564\text{X}10^{-30}$ C·m

Practice Problems:

1. Express a density of $6.5\ \text{g} \cdot \text{mm}^{-3}$ in micrograms per nanometer cubed.

2. Express an acceleration of $9.81\ \text{m} \cdot \text{s}^{-2}$ in kilometers per hour squared.

3. A rectangular block of iron has dimensions 7.45 cm X 9.70 cm X 19.7 cm and a mass of 11.2 kg. What is the density of iron in units of g/cm^3?

4. If 116 g of ethanol (density= 0.789 g/mL) is needed for a chemical reaction, what volume of liquid would you use?

5. A pure gold crown weighed 2271.0 g. when the crown was submerged in H_2O, the weight of the H_2O displaced was 118 g. Find the density of the crown. (Density H_2O=1 g/cm^3)

6. Express 54g in units of kg

7. How many ounces are in 2.27 kg?

8. If the price of potatoes is $1.25 for 5 lbs, what is the price per kg?

9. How many psi are in 52 bar?

Measurement

<u>Precision and accuracy</u>
Chemistry can be qualitative, as in describing in general chemical and physical properties (e.g., hydrogen is colorless and reacts with oxygen). Or, chemistry can be quantitative (e.g., the mass of one mole of hydrogen atoms is 1.0079 g). To be quantitative one must be deliberate in making and reporting measurements. You should be familiar with the terms **precision, accuracy,** and **significant figures**.

Practice problems:

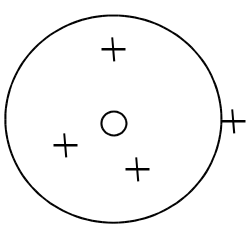
1. Define the following and give an example of each:

Precision:

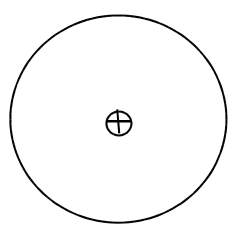
Accuracy:

Significant Figures:

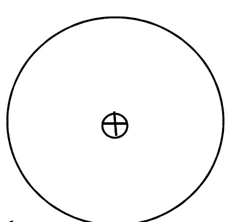
2. Label the following bulls-eye targets as being accurate, precise, both, or neither. Target B represents only one try; A, C, and D represent 4 tries (some are overlapping).



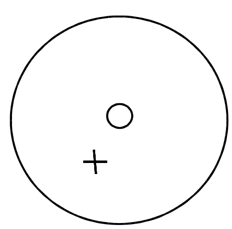
A



B



C



D

Error

Types of Error

Practice Problems:

1. Define the following major types of error with an example of each:

systematic:

random:

2. Which of the following procedures would lead to systematic errors, and which would produce random errors?

a. Using a 1-quart milk carton to measure 1-liter samples of milk.

b. Using a balance that is sensitive to 0.1 gram to obtain 250 mg of vitamin C.

c. Using a 100-milliliter graduated cylinder to measure 2.5 milliliters of solution.

Constants, Variables, and Proportionality

Example: Ideal Gas Law (Section 4.8)

$PV = nRT$

Class discussion questions:

Which letters represent variables, and which represent constants?

How are P and T related?

If V, n, and R are held constant, what will happen to P when T increases?

How are P and V related?

If V, n, and R are held constant, what will happen to P when T increases?

If n, R, and T are held constant, what will happen to P when V decreases?

Practice Problems:

1. Measuring Speed. The speed of an automobile in miles per hour varies directly with its speed in km/hr. A speed of 64 miles/hr is equivalent to a speed of 103 km/hr.
   a. Find a linear model that relates your speed in miles per hour to your speed in kilometers per hour. (Let x be the speed in miles per hour and y be the speed in kilometers per hour.)

   b. You are driving through Canada and see the speed limit sign 80 km/hr. What is the maximum speed you can drive in miles per hour?