Summer Review

Chemistry Honors and College Preparatory

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Document Objective

This document outlines the concepts required to have a solid and successful introduction to high school chemistry, concepts students should have learned in 8th. grade and during their high school freshman year.

Document Review History

Date	Author	Action	Description
03/04/2025	Chemistry Department	Document creation	First version - school year ‘25-’26

Class Objectives and Activities Planner

To build and maintain the required math skills to have a solid foundation for high school chemistry, students are encouraged to engage in some form of mathematics review. The review suggested in this document reinforces the prerequisite skills and concepts for each student to consolidate their math performance in the coming year.

Although optional, it is strongly recommended for rising sophomores to complete this summer review guide.

All Chemistry students will have an assessment of the contents presented in this document within the first one or two weeks of school to measure their readiness to begin building upon prior knowledge.

In support of summer review, this document contains a variety of resources containing guided online lessons from Khan Academy, guided examples, and practice exercises covering the mathematical concepts used across the year.

In addition to the required mathematical skills the student needs to have a solid understanding on the use of their scientific calculator (Ti-84 Plus CE or equivalent model).

The suggested summer review material for chemistry includes the following topics:

Module #	Area of Interest
1	The Scientific Method
2	Scientific Notation
3	Significant Figures
4	Dimensional Analysis
5	Ti-84 Plus CE tutorials

If you have any questions about the Frassati Catholic Chemistry Review resources posted here, please contact Mrs. Eileen Bartsch (e.bartsch@frassaticatholic.org). The Frassati chemistry teachers look forward to seeing you on campus in August and appreciate your efforts to begin the school year with the strongest possible skill set.

Have a blessed summer!

How to Use This Document

The document is divided in modules based on the specific concepts to be reinforced. Each module contains the following sections:

a) ***Prerequisite*** contains a description of the concepts covered by the module.
b) ***Resources*** include a list of suggested online resources to be used to review the concepts covered in the module.
c) ***Exercises*** show sample problems to be used to practice the concepts reviewed.
    i) ***Sample*** exercises include a visual representation of how to solve the problems included on the module.
    ii) ***Self-paced*** exercises include the problems the student needs to complete.

Sources

All problems and graphic examples from “Tro, Nivaldo J. *Introductory Chemistry*. Pearson, 2018.”

Module 1. The Scientific Method

Prerequisite

Basic understanding of what is the scientific method and the different steps that a scientist needs to follow during experimentation.

Resources

Check "Khan Academy: Intro to scientific method" material in Google Classroom "FCHS Science Summer Review".

Module 2. Scientific Notation

Prerequisite

Be able to convert any number from standard to scientific notation and vice versa. This is key to properly express small and large quantities in science.

Resources

Check "Khan Academy: Intro to scientific notation" material in Google Classroom "FCHS Science Summer Review". Additional resources on scientific notation can be found here.

Exercises

Sample

The 2016 U.S. population was estimated to be 323,000,000 people. Express this number in scientific notation.

To obtain a number between 1 and 10, move the decimal point to the left eight decimal places; the exponent is 8. Because you move the decimal point to the left, the sign of the exponent is positive.

SOLUTION

$323{,}000{,}000 \text{ people} = 3.23 \times 10^{8} \text{ people}$

The radius of a carbon atom is approximately 0.000000000070 m. Express this number in scientific notation.

To obtain a number between 1 and 10, move the decimal point to the right 11 decimal places; therefore, the exponent is 11. Because you moved the decimal point to the right, the sign of the exponent is negative.

SOLUTION

$0.000000000070 \text{ m} = 7.0 \times 10^{-11} \text{ m}$

Self-paced

31. Express each number in scientific notation.
(a) 38,802,000 (population of California)
(b) 1,419,000 (population of Hawaii)
(c) 19,746,000 (population of New York)
(d) 584,000 (population of Wyoming)

33. Express each number in scientific notation.
(a) 0.00000000007461 m (length of a hydrogen–hydrogen chemical bond)
(b) 0.0000158 mi (number of miles in an inch)
(c) 0.000000632 m (wavelength of red light)
(d) 0.000015 m (diameter of a human hair)

35. Express each number in decimal notation (i.e., express the number without using scientific notation).
(a) 6.022×10^{23} (number of carbon atoms in 12.01 g of carbon)
(b) 1.6×10^{-19} C (charge of a proton in coulombs)
(c) 2.99×10^{8} m/s (speed of light)
(d) 3.44×10^{2} m/s (speed of sound)

37. Express each number in decimal notation (i.e., express the number without using scientific notation).
(a) 3.22×10^{7}
(b) 7.2×10^{-3}
(c) 1.18×10^{11}
(d) 9.43×10^{-6}

39. Complete the table.

Decimal Notation	Scientific Notation
2,000,000,000	_____
_____	1.211×10^{9}
0.000874	_____
_____	3.2×10^{11}

Module 3. Significant Figures

Prerequisite

Significant figures indicate the precision of a measurement or calculation, ensuring that results are not presented as more accurate than the data used to obtain them.

Resources

Check significant figures material (intro, rules, multiplying and dividing, addition and subtraction) in Google Classroom "FCHS Science Summer Review". Use the links below to go to the corresponding resource material.

a) Introduction
b) Rules
c) Addition and subtraction
d) Multiplication and division
e) Practice video

Exercises

Sample

The bathroom scale in ▼ FIGURE 2.3 has markings at every 1 lb. Report the reading to the correct number of digits.

▲ FIGURE 2.3 Reading a bathroom scale

SOLUTION

Because the pointer is between the 147- and 148-lb markings, you mentally divide the space between the markings into 10 equal spaces and estimate the next digit. In this case, you should report the result as:

147.7 lb

What if you estimated a little differently and wrote 147.6 lb? In general, one unit of difference in the last digit is acceptable because the last digit is estimated and different people might estimate it slightly differently. However, if you wrote 147.2 lb, you would clearly be wrong.

How many significant figures are in each number?

(a) 0.0035 (b) 1.080 (c) 2371 (d) 2.97×10^5 (e) 1 dozen = 12 (f) 100.00 (g) 100,000

The 3 and the 5 are significant (rule 1). The leading zeros only mark the decimal place and are not significant (rule 5).	**SOLUTION** **(a)** 0.0035 two significant figures
The interior zero is significant (rule 2), and the trailing zero is significant (rule 3). The 1 and the 8 are also significant (rule 1).	**(b)** 1.080 four significant figures
All digits are significant (rule 1).	**(c)** 2371 four significant figures
All digits in the decimal part are significant (rule 1).	**(d)** 2.97×10^5 three significant figures
Defined numbers are exact and therefore have an unlimited number of significant figures.	**(e)** 1 dozen = 12 unlimited significant figures
The 1 is significant (rule 1), and the trailing zeros before the decimal point are significant (rule 4). The trailing zeros after the decimal point are also significant (rule 3).	**(f)** 100.00 five significant figures
This number is ambiguous. Write as 1×10^5 to indicate one significant figure or as 1.00000×10^5 to indicate six significant figures.	**(g)** 100,000 ambiguous

Perform each calculation to the correct number of significant figures.

(a) $1.01 \times 0.12 \times 53.51 \div 96$
(b) $56.55 \times 0.920 \div 34.2585$

Round the intermediate result (in blue) to two significant figures to reflect the two significant figures in the least precisely known quantities (0.12 and 96).	**SOLUTION** **(a)** $1.01 \times 0.12 \times 53.51 \div 96 = 0.067556 = 0.068$
Round the intermediate result (in blue) to three significant figures to reflect the three significant figures in the least precisely known quantity (0.920).	**(b)** $56.55 \times 0.920 \div 34.2585 = 1.51863 = 1.52$

Perform the calculations to the correct number of significant figures.

(a)
$$\begin{array}{r} 0.987 \\ +125.1 \\ -1.22 \\ \hline \end{array}$$

(b)
$$\begin{array}{r} 0.765 \\ -3.449 \\ -5.98 \\ \hline \end{array}$$

Round the intermediate answer (in blue) to one decimal place to reflect the quantity with the fewest decimal places (125.1). Notice that 125.1 is not the quantity with the fewest significant figures—it has four while the other quantities only have three—but because it has the fewest decimal places, it determines the number of decimal places in the answer.	**SOLUTION** (a) $0.987 + 125.1 - 1.22 = 124.867 = 124.9$
Round the intermediate answer (in blue) to two decimal places to reflect the quantity with the fewest decimal places (5.98).	(b) $0.765 - 3.449 - 5.98 = -8.664 = -8.66$

Perform the calculations to the correct number of significant figures.

(a) $6.78 \times 5.903 \times (5.489 - 5.01)$
(b) $19.667 - (5.4 \times 0.916)$

Do the step in parentheses first. Use the subtraction rule to mark 0.479 to two decimal places because 5.01, the number in the parentheses with the least number of decimal places, has two.

Then perform the multiplication and round the answer to two significant figures because the number with the least number of significant figures has two.

Do the step in parentheses first. The number with the least number of significant figures within the parentheses (5.4) has two, so mark the answer to two significant figures.

Then perform the subtraction and round the answer to one decimal place because the number with the least number of decimal places has one.

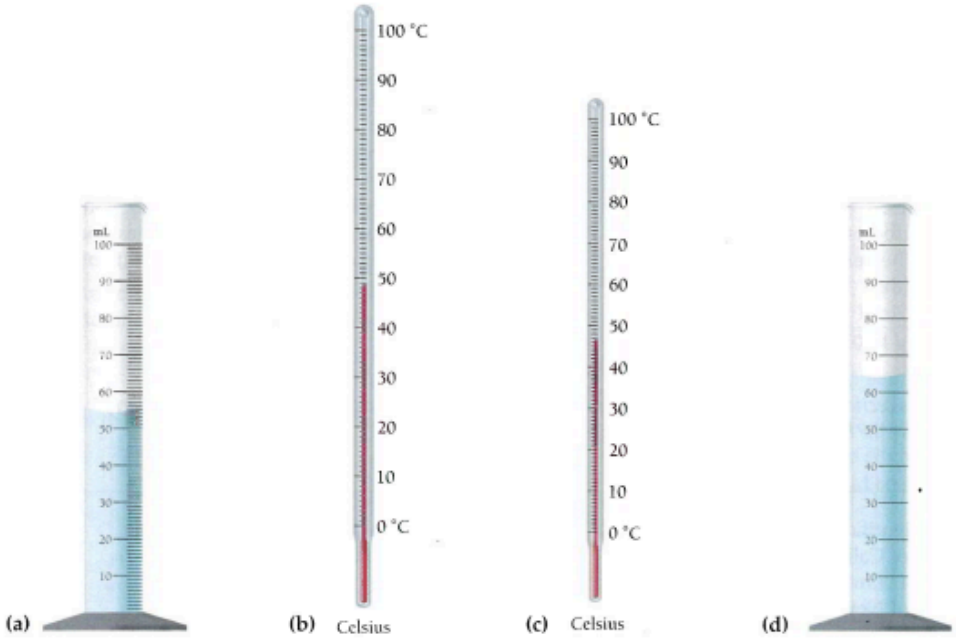
SOLUTION

(a) $6.78 \times 5.903 \times (5.489 - 5.01)$
$= 6.78 \times 5.903 \times (0.479)$
$= 6.78 \times 5.903 \times 0.479$
$6.78 \times 5.903 \times 0.479 = 19.1707$
$= 19$

(b) $19.667 - (5.4 \times 0.916)$
$= 19.667 - (4.9464)$
$= 19.667 - 4.9464$
$19.667 - 4.9464 = 14.7206$
$= 14.7$

Self-paced

41. Read each instrument to the correct number of significant figures. Laboratory glassware should always be read from the bottom of the *meniscus* (the curved surface at the top of the liquid column).



43. For each measured quantity, underline the zeros that are significant and draw an *X* through the zeros that are not.
(a) 0.005050 m
(b) 0.0000000000000060 s
(c) 220,103 kg
(d) 0.00108 in.

45. How many significant figures are in each measured quantity?
(a) 0.001125 m
(b) 0.1125 m
(c) 1.12500×10^4 m
(d) 11205 m

49. Round each number to four significant figures.
(a) 255.98612
(b) 0.0004893222
(c) 2.900856×10^{-4}
(d) 2,231,479

55. Round the number on the left to the number of significant figures indicated by the example in the first row. (Use scientific notation as needed to avoid ambiguity.)

Number	Rounded to 4 Significant Figures	Rounded to 2 Significant Figures	Rounded to 1 Significant Figure
1.45815	1.458	1.5	1
8.32466			
84.57225			
132.5512			

57. Perform each calculation to the correct number of significant figures.
(a) $4.5 \times 0.03060 \times 0.391$
(b) $5.55 \div 8.97$
(c) $(7.890 \times 10^{12}) \div (6.7 \times 10^4)$
(d) $67.8 \times 9.8 \div 100.04$

59. Correct any answers that have the incorrect number of significant figures.
(a) $34.00 \times 567 \div 4.564 = 4.2239 \times 10^3$
(b) $79.3 \div 0.004 \times 35.4 = 7 \times 10^5$
(c) $89.763 \div 22.4581 = 3.997$
(d) $(4.32 \times 10^{12}) \div (3.1 \times 10^{-4}) = 1.4 \times 10^{16}$

61. Perform each calculation to the correct number of significant figures.
(a) $87.6 + 9.888 + 2.3 + 10.77$
(b) $43.7 - 2.341$
(c) $89.6 + 98.33 - 4.674$
(d) $6.99 - 5.772$

63. Correct any answers that have the incorrect number of significant figures.
(a) $(3.8 \times 10^5) - (8.45 \times 10^5) = -4.7 \times 10^5$
(b) $0.00456 + 1.0936 = 1.10$
(c) $8475.45 - 34.899 = 8440.55$
(d) $908.87 - 905.34095 = 3.5291$

65. Perform each calculation to the correct number of significant figures.
(a) $(78.4 - 44.889) \div 0.0087$
(b) $(34.6784 \times 5.38) + 445.56$
(c) $(78.7 \times 10^5 \div 88.529) + 356.99$
(d) $(892 \div 986.7) + 5.44$

67. Correct any answers that have the incorrect number of significant figures.
(a) $(78.56 - 9.44) \times 45.6 = 3152$
(b) $(8.9 \times 10^5 \div 2.348 \times 10^2) + 121 = 3.9 \times 10^3$
(c) $(45.8 \div 3.2) - 12.3 = 2$
(d) $(4.5 \times 10^3 - 1.53 \times 10^3) \div 34.5 = 86$

Module 4. Dimensional Analysis

Prerequisite

Be able to convert one unit to another one to ensure the correctness of equations and calculations by verifying that units on both sides of an equation are consistent, and it aids in unit conversions and understanding relationships between physical quantities..

Resources

Check "Khan Academy: Intro to dimensional analysis" material in Google Classroom "FCHS Science Summer Review".

Exercises

Problem-Solving Procedure	EXAMPLE 2.8 **UNIT CONVERSION** Convert 7.8 km to miles.	EXAMPLE 2.9 **UNIT CONVERSION** Convert 0.825 m to millimeters.
SORT Begin by sorting the information in the problem into *given* and *find*.	**GIVEN:** 7.8 km **FIND:** mi	**GIVEN:** 0.825 m **FIND:** mm
STRATEGIZE Draw a *solution map* for the problem. Begin with the *given* quantity and symbolize each step with an arrow. Below the arrow, write the conversion factor for that step. The solution map ends at the *find* quantity. (In these examples, the relationships used in the conversions are below the solution map.)	**SOLUTION MAP** km → mi $\frac{0.6214 \text{ mi}}{1 \text{ km}}$ **RELATIONSHIPS USED** $1 \text{ km} = 0.6214 \text{ mi}$ (This conversion factor is from Table 2.3.)	**SOLUTION MAP** m → mm $\frac{1 \text{ mm}}{10^{-3} \text{ m}}$ **RELATIONSHIPS USED** $1 \text{ mm} = 10^{-3} \text{ m}$ (This conversion factor is from Table 2.2.)
SOLVE Follow the *solution map* to solve the problem. Begin with the *given* quantity and its units. Multiply by the appropriate conversion factor, canceling units to arrive at the *find* quantity. Round the answer to the correct number of significant figures. (If possible, obtain conversion factors to enough significant figures so that they do not limit the number of significant figures in the answer.)	**SOLUTION** $7.8 \text{ km} \times \frac{0.6214 \text{ mi}}{1 \text{ km}} = 4.84692 \text{ mi}$ $4.84692 \text{ mi} = 4.8 \text{ mi}$ Round the answer to two significant figures because the quantity given has two significant figures.	**SOLUTION** $0.825 \text{ m} \times \frac{1 \text{ mm}}{10^{-3} \text{ m}} = 825 \text{ mm}$ $825 \text{ mm} = 825 \text{ mm}$ Leave the answer with three significant figures because the quantity given has three significant figures and the conversion factor is a definition and therefore does not limit the number of significant figures in the answer.
CHECK Check your answer. Are the units correct? Does the answer make sense?	The units, mi, are correct. The magnitude of the answer is reasonable. A mile is longer than a kilometer, so the value in miles should be smaller than the value in kilometers.	The units, mm, are correct, and the magnitude is reasonable. A millimeter is shorter than a meter, so the value in millimeters should be larger than the value in meters.
	▶ **SKILLBUILDER 2.8 | Unit Conversion** Convert 56.0 cm to inches.	▶ **SKILLBUILDER 2.9 | Unit Conversion** Convert 5678 m to kilometers.
	▶ **FOR MORE PRACTICE** Example 2.26; Problems 73, 74, 75, 76.	▶ **FOR MORE PRACTICE** Problems 69, 70, 71, 72.

EXAMPLE 2.12 Solving Unit Conversions in the Numerator and Denominator

A prescription medication requires 11.5 mg per kg of body weight. Convert this quantity to the number of grams required per pound of body weight and determine the correct dose (in g) for a 145-lb patient.

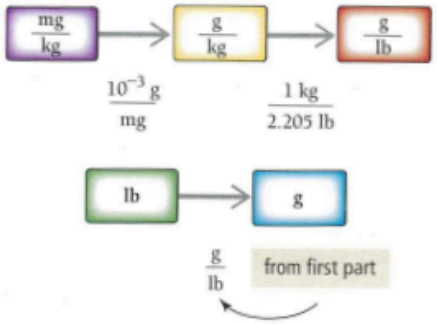
SORT
Begin by sorting the information in the problem into given and find. You are given the dose of the drug in mg/kg and the weight of the patient in lb. You are asked to find the dose in g/lb and the dose in g for the 145-lb patient.

GIVEN: $11.5\ \frac{\text{mg}}{\text{kg}}$
$145\ \text{lb}$

FIND: $\frac{\text{g}}{\text{lb}}$; dose in g

STRATEGIZE
The solution map has two parts. In the first part, convert from mg/kg to g/lb. In the second part, use the result from the first part to determine the correct dose for a 145-lb patient.

SOLUTION MAP



RELATIONSHIPS USED
$1\ \text{mg} = 10^{-3}\ \text{g}$ (from Table 2.2)
$1\ \text{kg} = 2.205\ \text{lb}$ (from Table 2.3)

SOLVE
Follow the solution map to solve the problem. For the first part, begin with 11.5 mg/kg and multiply by the two conversion factors to arrive at the dose in g/lb. Mark the answer to three significant figures to reflect the three significant figures in the least precisely known quantity.

For the second part, begin with 145 lb and use the dose obtained in the first part to convert to g. Then round the answer to the correct number of significant figures, which is three.

SOLUTION

$$11.5\ \frac{\text{mg}}{\text{kg}} \times \frac{10^{-3}\ \text{g}}{\text{mg}} \times \frac{1\ \text{kg}}{2.205\ \text{lb}} = 0.005215\ \frac{\text{g}}{\text{lb}}$$

$$145\ \text{lb} \times \frac{0.005215\ \text{g}}{\text{lb}} = 0.75617\ \text{g} = 0.756\ \text{g}$$

CHECK
Check your answer. Are the units correct? Does the answer make physical sense?

The units of the answer are correct, and the value of the answer makes sense. Drug doses can vary over some range, but in many cases they are between 0 and 1 gram.

EXAMPLE 2.13 Converting Quantities Involving Units Raised to a Power

A circle has an area of 2659 cm^2. What is its area in square meters?

SORT
You are given an area in square centimeters and asked to convert the area to square meters.

GIVEN: 2659 cm^2

FIND: m^2

STRATEGIZE
Build a solution map beginning with cm^2 and ending with m^2. Remember that you must square the conversion factor.

SOLUTION MAP

$cm^2 \rightarrow m^2$

$\frac{(0.01\ m)^2}{(1\ cm)^2}$

RELATIONSHIPS USED

1 cm = 0.01 m (from Table 2.2)

SOLVE
Follow the solution map to solve the problem. Square the conversion factor (both the units and the number) as you carry out the calculation.

Round the answer to four significant figures to reflect the four significant figures in the given quantity. The conversion factor is exact and therefore does not limit the number of significant figures.

SOLUTION

$$2659\ cm^2 \times \frac{(0.01\ m)^2}{(1\ cm)^2} = 2659\ cm^2 \times \frac{10^{-4}\ m^2}{1\ cm^2}$$

$$= 0.265900\ m^2$$

$$= 0.2659\ m^2$$

CHECK
Check your answer. Are the units correct? Does the answer make physical sense?

The units of the answer are correct, and the magnitude makes physical sense. A square meter is much larger than a square centimeter, so the value in square meters should be much smaller than the value in square centimeters.

Self-paced

69. Perform each conversion.
(a) 3.55 kg to grams
(b) 8944 mm to meters
(c) 4598 mg to kilograms
(d) 0.0187 L to milliliters

71. Perform each conversion.
(a) 5.88 dL to liters
(b) 3.41×10^{-5} g to micrograms
(c) 1.01×10^{-8} s to nanoseconds
(d) 2.19 pm to meters

73. Perform each conversion.
(a) 22.5 in. to centimeters
(b) 126 ft to meters
(c) 825 yd to kilometers
(d) 2.4 in. to millimeters

77. Complete the table.

m	km	Mm	Gm	Tm
5.08×10^8 m	____	508 Mm	____	____
____	____	27,976 Mm	____	____
____	____	____	____	1.77 Tm
____	1.5×10^5 km	____	____	____
____	____	____	423 Gm	____

83. A runner wants to run 10.0 km. She knows that her running pace is 7.5 mi/h. How many minutes must she run?
Hint: Use 7.5 mi/h as a conversion factor between distance and time.

87. Fill in the blanks.
(a) 1.0 km^2 = _____ m^2
(b) 1.0 cm^3 = _____ m^3
(c) 1.0 mm^3 = _____ m^3

89. The hydrogen atom has a volume of approximately 6.2×10^{-31} m^3. What is this volume in each unit?
(a) cubic picometers
(b) cubic nanometers
(c) cubic angstroms (1 angstrom = 10^{-10} m)

91. A house has an area of 215 m^2. What is its area in each unit?
(a) km^2 **(b)** dm^2 **(c)** cm^2

95. The speed limit on many U.S. highways is 65 mi/hr. Convert this speed into each alternative unit.
(a) km/day **(b)** ft/s **(c)** m/s **(d)** yd/min

97. A prescription medication requires 7.55 mg per kg of body weight. Convert this quantity to the number of grams required per pound of body weight and determine the correct dose (in g) for a 175-lb patient.

Module 5. Ti-84 Plus CE Tutorials

Prerequisite

Be able to perform complex calculations using scientific notation in a Ti-84 Plus CE (or equivalent) calculator. This is extremely important since many quizzes and tests require the use of the calculator.

Resources

Check "Texas Instruments: Ti-84 Plus CE student tutorials" material in Google Classroom "FCHS Science Summer Review".