

# LEARNING GUIDE 6: DIMENSIONAL ANALYSIS

## STATE CONTENT STANDARDS

Investigation and experimentation

## MAJOR CONCEPTS

- Convert complex units using dimensional analysis
- Students can construct conversion factors from equivalent measurements
- Equivalence statement
- Calculate the density of a material from experimental data

## VOCABULARY

Understand each vocabulary word.

1. Conversion factor p.130
2. Equivalence statement p.131
3. Dimensional Analysis p.13
4. Exact numbers
5. Factor-label method

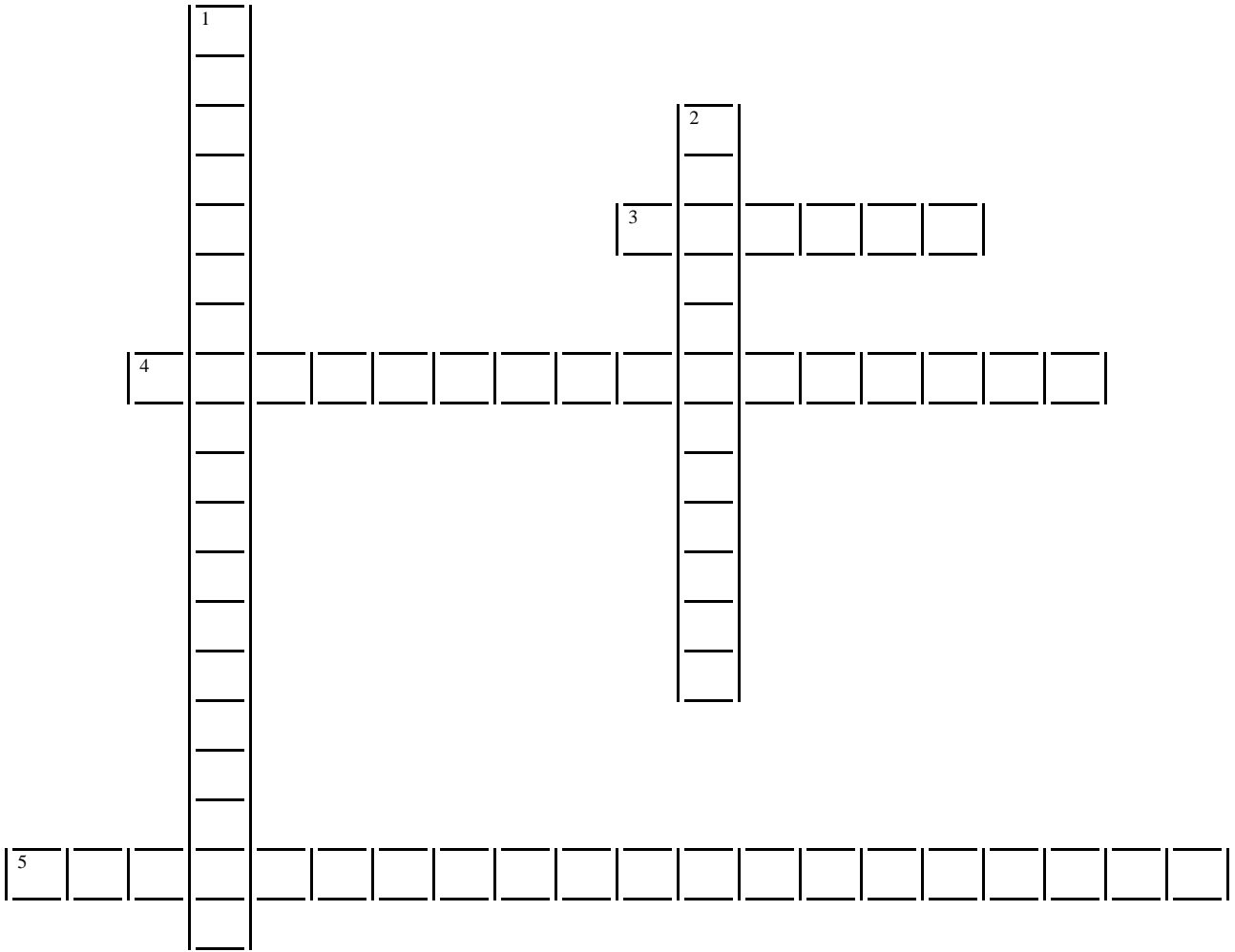
Then complete the following crossword puzzle

### ACROSS

- 3** Label method/ label method used to determine quantities by using equivalence statements
- 4** A numerical factor used to multiply or divide a quantity when converting from one system of units to another.
- 5** 1 ft = 12 inches is an example of an \_\_\_\_\_.

### DOWN

- 1** A technique that involves the study of dimensions of physical quantities, used primarily as a tool for obtaining information about physical systems
- 2** Numbers obtained from counting and are therefore known with certainty





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## READING GUIDE

5.6 Title: \_\_\_\_\_

1. What is a conversion factor?
2. What is an equivalence statement?
3. Following the pattern shown in the text, write the two possible conversion factors for the following equivalence statement:  $1 \text{ m} = 3.28 \text{ ft}$
4. Conversion factors are \_\_\_\_\_ of the two parts of the \_\_\_\_\_ that relates the two units.
5. We choose the conversion factor that \_\_\_\_\_ the units we want to discard.
6. What is dimensional analysis?
7. Complete self-check exercise 5.4 (p.133)
8. Complete self-check exercise 5.5 (p. 134)

## LECTURE NOTES

Combine your notes from class with the notes on TheChemBook. Use the Cornell Notes Strategy to review your notes each night (5 min.).

### 5.6 Dimensional Analysis

#### I. Dimensional Analysis (also known as "factor-labeling")

- A. An approach to solving problems
  - a. Think of ratios (e.g., cow example)
    - i. 1 cow makes 3 moos; therefore, 3 cows make how many moos? The ratio 1 cow / 3 moos is important.
  
- B. Converting between units
  - a. One step
  - b. Two step
  
- C. Basics

Yesterday we showed that there are 2 parts to a problem, the numbers and the units.

$$112.07 \text{ g} \div 9.2 \text{ mL} = 12.181521739 \text{ g/mL}$$

We round the answer to 12 g/mL because 9.2 mL has 2 significant figures. The sig. fig. rule to remember is that in multiplication and division the answer is rounded to the least significant figure from the variable terms.

- (1) Do the math on your calculator
- (2) Do the units
  - a. Never forget the units. We do not say someone is "6 tall" but "6-feet tall"

Quick Note

Did you realize the above example is a density problem? Density is a derived unit.

#### D. Setting up conversions

What if we want to convert from mm to cm? This type of unit conversion can be done on the unit line. We simply count the distance between units and move the decimal in the correct direction.

Example: 5 km to mm

Is there another way? Yes. We can use a process called "dimensional analysis," a process also known as "factor labeling"

#### E. Basic conversion problems

Let's revisit the example and set up a grid.

$$\begin{array}{r} 5 \text{ km} \quad | \quad 10^6 \text{ mm} \qquad \qquad 5 \times 10^6 \text{ mm} \\ \hline \qquad \qquad | \quad 1 \text{ km} \end{array} =$$



### C. Operations with Units

1. Cancellation occurs with the units in the same way that it occurs with numbers common to both the numerator and denominator
  - a. Units are handled algebraically, just like numbers
  - b. Analysis of units can be a clue as to whether a problem was set up correctly
2. Calculations involving units must have the correct units shown throughout the working of the problem and attached to the answer

### FOCUS QUESTIONS

1. Write the conversion factors for the following relationships
  - a. mL to Liter
  - b. g to Kg
  - c. m to mm
  - d. m to Kg
2. Perform the following conversions; set up the appropriate conversion
  - a. 254.3g to Kg
  - b. 2.75 Kg to g
3. Given the following mass, volume and density information, calculate the missing quantity.
  - c. mass = 142.4 g; volume = ? mL; density = 0.915 g/mL
  - d. mass = 4.2 g; volume = cm<sup>3</sup>; density = 3.75 g/cm<sup>3</sup>

### PRACTICE DIMENSIONAL ANALYSIS

1. Use Dimensional Analysis to solve the following problems.
  - a. A person's weight is 154 pounds. Convert this to kilograms. (1 lbs. = 454 grams)
  
  - b. An aspirin tablet contains 325 mg of acetaminophen. How many grams is this?

2. Solve using the conversion factors that are listed in the table below.
- a. Your cruise ship is leaving for a 610 mile adventure. How many kilometers is this?
  
  
  
  
  
  
  
  
  
  
  - b. Later the ship is discovered at 38 kilometers deep under water. Convert this to meters.
  
  
  
  
  
  
  
  
  
  
  - c. If you are rationed to 32 Quarts of fresh water a day. How many liters is this?
  
  
  
  
  
  
  
  
  
  
  - d. To reach the top of a palm tree for a coconut you will have to climb 7.4 meters. How many feet is this

| <b>Table of Weights and Measures</b>  |   |
|---|---|
| <b>Length</b>   | <b>Volume</b>   |
| 1 yards = 3 feet<br>1 inch = 2.54 cm<br>1 km = 1000 meter<br>1 mile = 5280 feet | 2 pints = 1 quart<br>1 liter = 1.0567 quarts<br>1 gallon = 4 quarts |

3. Using the table below answer the following conversion factors.

| <b>1L</b>  | <b>1000mL</b> |
|------------|---------------|
| <b>1g</b>  | 1000Kg        |
| <b>1m</b>  | 1000mm        |
| <b>1Km</b> | 1000m         |

8700mL=\_\_\_L

5400Kg=\_\_\_\_\_g

15L=\_\_\_mL

345m=\_\_\_mm

20g=\_\_\_Kg

7940mm=\_\_\_\_\_m

### JOURNAL

What points in the material strike you as important?

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Have you learned anything new? If so, what did you learn?

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Do you have any questions about what you learned?

How does what you learned relate to other information that you have learned in this course?

### UNIT 0 EXAM REVIEW QUESTIONS

Remember to study for the Unit 0 exam. Review ALL of the concepts in the 6 learning guides.

1. Define chemistry.

2. Define hypothesis, theory, and law.

3. Identify the number of significant figures to a measurement and in the result of a calculation?

a) 0934.0453

b) 00001.0

c) 1523465

d) 1.000000

5. Explain how alchemy laid the groundwork for chemistry.

6. Describe how Lavoisier transformed chemistry.

Place your answers to Workbook 6 in your 3-ring binder, Unit 0

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7. Identify the steps in the scientific method.

Place your answers to Workbook 6 in your 3-ring binder, Unit 0