UNIT 2 PART III

Dimensional Analysis Introduction

Dimensional Analysis is a technique for solving problems. Particularly, this technique is suited to converting one kind of unit into another.

Converting one unit to another changes nothing: it just expresses a distance, a volume, a mass (etc) in different units. In effect, you are multiplying by one. Using it is the easiest way to find out how many miles someone from Canada means when they say that the hockey rink is about 42 km away. Here's what you do:

$$42\ \text{km} \times \frac{1\ \text{mi}}{1.61\ \text{km}} = 26\ \text{mi}$$ This works because 1 mi = 1.61 km

Multiplying by any conversion factor is just like multiplying by one. You change the number but not the quantity.

These proportions are called **unit factors** because they are equal to the number one. Remember, multiplying by the number one does not change the numerical value! The unit factor is used to convert one unit to another unit as in the examples we will do together. Pick the unit factor you use carefully as the units must cancel out. If the unit to be cancelled is not part of a fraction or is in the numerator then the unit factor must be written with that unit in the denominator.

The Real Value of Dimensional Analysis

Dimensional analysis is useful for simple unit conversions but if applied properly it is also a generalized problem-solving method. Use the following steps to solve almost any problem involving numbers with units:

i. Read the problem once through very carefully. Draw a picture if that will help.
ii. Identify and write down all numbers with their units. Include numbers that were written as words and remember to write units such as mph correctly: 25 mph is 25 mi/hr.
iii. Identify the unit required for the answer to the problem.
iv. Set up a conversion process that converts the units of the given numbers into the units of the answer. Make sure to cancel out all other units.
v. Units can be classified as either length, mass or weight, volume, money, or time. Use separate conversion paths for each type of unit to move toward the units of the answer.
vi. Check your work when you finish. First, check to make sure the units calculation is correct—often students end up with the right unit but it is *under* the fraction bar. Second, check your arithmetic.

Ch. 2 Formulas and Equalities

$D = m/V \quad m = DV \quad V = m/D$

% ERROR FOR PRECISION

$$\%\ error = \frac{\pm\ amount}{average} \times 100$$

% ERROR FOR ACCURACY

$$\%\ error = \frac{|Measured - Actual|}{Actual} \times 100$$

$1ft = 12in$
$1mi = 5280\ ft$
$1lb = 16\ oz$
$1\ qt = 32\ liq.\ oz$
$1\ gal = 4\ qt$

$1in = 2.54\ cm$
$1\ mi = 1.61\ km$
$1\ lb = 454\ g$
$1.057\ qt = 1\ L$

$1\ m = 100\ cm$
$1\ km = 1000\ m$
$1\ kg = 1000\ g$
$1\ L = 1000\ mL$
$1\ mL = 1\ cm^3$

B. DIMENSIONAL ANALYSIS – SET UP ALL PROBLEMS AND SHOW ALL WORK!!!!!

1. How many milliliters are in 1.00 quart of milk?

2. You have 1.5 pounds of gold. Find its volume in cm3 if the density of gold is 19.3 g/cm3.

3. How many liters of water would fill a container that measures 75.0 in^3?

4. Your European hairdresser wants to cut your hair 8.0 cm shorter. How many inches will he be cutting off?

5. Taft football needs 550 cm for a 1st down. How many yards is this?

6. A piece of wire is 1.3 m long. How many 1.5-cm pieces can be cut from this wire?

Dimensional Analysis – Show all work

Use dimensional analysis to solve the following problems. Show all work. To help you get started always do the following for each problem:

i. Write down all given and relevant information that you know in the form of conversion factors.
ii. Figure out what the unit will be for the correct answer and write it down.
iii. Find a conversion pathway to take you from the units you have to the unit of the answer.

1. Say that \$1.44 is equivalent to €1.00 (the euro: the currency used in the European Union). What is \$4.50 equivalent to in euros?

2. High speed trains in Japan reach speeds of around 200 km/hr. Trains running between Boston and New York can attain a speed of up to 160 mi/hr. Which trains are faster, those in the US or in Japan?

3. You pass a road sign stating that the distance to Montreal is 125 km. If you travel at a constant speed of 90. km/hr how long will it take you to reach the city?

4. You are in the German city of Freiburg in Breisgau. In the Marktplatz there is a farmer's market where you find peaches for a price of €2.45 per kilogram. Using the exchange rate quoted in the first problem on this page calculate the cost of a pound of peaches.

5. The deepest point in the earth's oceans is found in the Mariana Trench, a deep crevasse located about 1000 miles south-east of Japan beneath the Pacific Ocean. Its maximum depth is 6033.5 fathoms. One fathom is defined as 6 feet. Calculate the depth of the Mariana Trench in meters.

#_____

Chapter 2 Parts 2 & 3

Name _____ Period _____ Date _____

UNITS & UNIT CONVERSIONS

PART A – SI UNITS

What type of measurement is indicated by each of the following units? Choices are in the last column.

1. g/mL _____
2. s _____
3. km _____
4. g _____
5. cm^3 _____
6. mm _____
7. mg _____
8. L _____
9. g/cm^3 _____

density
length
mass
time
volume

PART B – DENSITY

10. A small gold nugget has volume of 0.87 cm^3. What is its mass if the density of gold is 19.3 g/cm^3?

11. What volume is occupied by 35.2 g of carbon tetrachloride if its density is 1.60 g/mL?

PART B – UNIT CONVERSIONS

Perform the following SI prefix conversions:

12. 25 kg = _____ g
13. 9.3 mL = _____ L
14. 0.36 mm = _____ μm
15. 24 cm = _____ km

16. How many kilometers are there in 3.4 miles?

17. If a man's mass is 180 pounds, find his mass in grams.

18. How many kilograms is a 43.5-in^3 sample of silver if the density of silver is 10.5 g/cm^3?

19. How many liters are there in 13 cases of cola if each can is 12 ounces and each case contains 24 cans. (1 quart = 32 ounces)