SOLN.

Name _____ Date _____ Class _____

Math Skills for Science

MATH SKILLS

The Unit Factor and Dimensional Analysis

The measurements you take in science class, whether for time, mass, weight, or distance, are more than just numbers—they are also units. To make comparisons between measurements, it is convenient to have your measurements in the same units. A mathematical tool called a **unit factor** is used to convert back and forth between different kinds of units. A unit factor is a ratio that is equal to 1. Because it is equal to 1, multiplying a measurement by a unit factor changes the measurement's units but does not change its value. The skill of converting with a unit factor is known as **dimensional analysis**. Read on to see how it works.

Part 1: Converting with a Unit Factor

PROCEDURE: To convert units with a unit factor, determine the conversion factor between the units you have and the units you want to convert to. Then create the unit factor by making a ratio, in the form of a fraction, between the units you want to convert to in the numerator and the units you already have in the denominator. Finally, multiply your measurement by this unit factor to convert to the new units.

SAMPLE PROBLEM A: Convert 3.5 km to millimeters.

Step 1: Determine the conversion factor between kilometers and millimeters.

$$1 \text{ km} = 1{,}000{,}000 \text{ mm}$$

Step 2: Create the unit factor. Put the units you want to convert to in the numerator and the units you already have in the denominator.

$$\frac{1{,}000{,}000 \text{ mm}}{1 \text{ km}} = 1$$

Step 3: Multiply the unit factor by the measurement. Notice that the original unit of the measurement cancels out with the unit in the denominator of the unit factor, leaving the units you are converting to.

$$3.5 \text{ km} \times \frac{1{,}000{,}000 \text{ mm}}{1 \text{ km}} = 3{,}500{,}000 \text{ mm}$$

On Your Own!

1. Convert the following measurements using a unit factor:

Conversion	Unit factor	Answer
a. 2.34 cm = ? mm	$2.34 \text{ cm} \times \frac{10 \text{ mm}}{1 \text{ cm}} =$	23.4 mm
b. 54.6 mL = ? L	$54.6 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} =$	0.0546 L
c. 12 kg = ? g	$12 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} =$	12,000 g

Name _____ Date _____ Class _____

Part 2: Working with Square Units

Many times in your science class, you will work with units of two dimensions, such as square centimeters (cm^2) or square kilometers (km^2). Dimensional analysis is especially useful when working with these types of units because it can help you to avoid confusing the different dimensions of your units. Carefully follow the steps in Sample Problem B to see how it works.

SAMPLE PROBLEM B: 1 km^2 is how many square meters?

Step 1: Simplify the units you are converting.

$1\ km^2 = 1\ km \times 1\ km$

Step 2: Create the unit factor for converting meters to kilometers. As in Sample Problem A, put the units you are converting *to* in the numerator.

$$\frac{1000\ m}{1\ km} = 1$$

Step 3: Multiply the measurement you are converting by the unit factor. Because 1 km^2 = 1 km × 1 km, you will need to multiply the measurement you are converting from by *two* unit factors. Notice that the original unit of measurement cancels the units in the denominator. This leaves the units you are converting *to*.

$$1\ km^2 \times \frac{1000\ m}{1\ km} \times \frac{1000\ m}{1\ km} = 1{,}000{,}000\ m \times m$$

$$1\ km^2 = \mathbf{1{,}000{,}000\ m^2}$$

Practice Your Skills!

2. Convert the following measurements:

Conversion	Unit factor	Answer
a. 3 cm^2 = ? m^2	$3\ cm^2 \times \frac{1\ m}{100\ cm} \times \frac{1\ m}{100\ cm}$	$0.0003\ m^2$
b. 12,000 m^2 = ? km^2	$12{,}000\ m^2 \times \frac{1\ km}{1000\ m} \times \frac{1\ km}{1000\ m}$	$0.012\ km^2$
c. 980 cm^2 = ? mm^2	$980\ cm^2 \times \frac{10\ mm}{1\ cm} \times \frac{10\ mm}{1\ cm}$	$98{,}000\ mm^2$

3. An Olympic-sized soccer field has an area of 0.007776 km^2. How many square meters does a soccer field cover?

$$.007776\ km^2 \times \frac{1000\ m}{1\ km} \times \frac{1000\ m}{1\ km} = 7{,}776\ m^2$$

MATH SKILLS