SUPPLEMENTAL INSTRUCTION ACTIVITY

TOPIC: **Conversions and Dimensional Analysis**

APPLICABLE COURSES: All chemistry courses starting from Chem 110 and other courses in other disciplines.

LEARNING OUTCOME: (What will students be able to do by the end of the workshop?)

> ***After completing this workshop, students should be able to perform unit conversion using dimensional analysis this includes reporting answers with correct number of significant figures and in scientific notation.***

CONTENT: (What do students need to know to accomplish the outcome?)

1. Definition of Dimensional Analysis and Conversion Factor
2. Single Step Unit Conversions
3. Multistep Unit Conversions
4. Conversions Involving Units Raised to a Power

METHOD: (How will the instructor deliver content? Short lecture, handouts, Powerpoint, other audio-visual presentation)

Short lecture followed by active learning exercise and worksheet (40 minutes)

- Teach 1 and 2 (10 minutes)
  Practice 1 and 2 (10 minutes)
- Teach 3 and 4 (10 minutes)
  Practice 3 and 4 (10 minutes)

  - The lesson is divided into segments composed of lecture and examples followed by student practice and sharing.
  - First, the instructor distributes the exercise worksheet and any supporting handouts.
  - Then the instructor presents segments 1 and 2 (Definition of Dimensional Analysis and Conversion Factor and Single Step Unit Conversions).
  - After this brief lecture with examples, students individually think about how they will solve the set of problems for these segments (2 min), and then complete them (5 min).
  - Next, in pairs, students each take a turn to explain to their partner how they solved one of the problems (3 min). At the end of this 10-minute segment, the instructor posts the solutions/answers on the screen for students to check their work.
  - Follow the same lecture/practice procedure for segments 3 and 4 (Multistep Unit Conversions and Conversions involving Units Raised to a Power).

Note: If time is short, only one student explains his/her process to the partner for each segment of the lesson, taking turns for each segment.

ACTIVE LEARNING STRATEGIES: (How will students apply their knowledge? Solve a problem, create a project, analyze a case, and explain a process)

Students reflect on the exercises and teach each other by verbalizing the steps they took to reach their conclusions.

ASSESSMENT METHOD: (How will the instructor know that the students met the outcome? Check for understanding.)
(15 minutes.)

Students complete a quiz where they are asked to work various problems involving unit conversions. After completing the quiz, the instructor posts the solutions/answers on the screen. Students check their results. The instructor can also look over the quizzes while the students are completing the self-reflection activity to give feedback to students. If students do not successfully complete the worksheet quiz, they may be referred to individual tutoring or a guided learning activity.

SELF-REFLECTION ACTIVITY: (What will the instructor do to get students to reflect on how they learned the content? What they learned, how they learned it, how they will apply it in their coursework)
(5 minutes.)

-Which segment of conversions and dimensional analysis was most challenging for you?
-What steps are you going to take to learn this subject?

Conversions and Dimensional Analysis **Handout**	**Name:** **Date:**

Objective: **Perform Unit Conversions Using Dimensional Analysis**

Segment 1: We can use units as a guide to solving problems.

Definition

Dimensional Analysis – the method of converting units.
Conversion Factor – factional quantity used to convert units.

When we are given a quantity in some units, we can convert these to another unit according to:

Information given x conversion factor(s) = information sought

or

$$given\ unit \times \frac{desired\ unit}{given\ unit} = desired\ unit$$

Notice the "given unit" will cancel out, resulting in desired unit.

Example of a conversion factor: 1 in = 2.54 cm

Thus, depending on what the desired unit is, this conversion factor can be used as $\frac{2.54\ cm}{1\ in}$ or $\frac{1\ in}{2.54\ cm}$

Units and Measurement

Length	meters (m)
Mass	grams (g)
Time	seconds (s)
Volume	liters (L)
Energy	Joules (J)

Metric System Prefix Multipliers

tera-	T	1×10^{12}	deci-	d	1×10^{-1}
giga-	G	1×10^{9}	centi-	c	1×10^{-2}
mega-	M	1×10^{6}	milli-	m	1×10^{-3}
kilo-	k	1×10^{3}	micro-	μ	1×10^{-6}
			nano-	n	1×10^{-9}
			pico-	p	1×10^{-12}
			femto-	f	1×10^{-15}

1 km = 1000 m = 1 x 10^3 m
1 mm = 0.001 m = 1 x 10^{-3} m (or 1 m = 1000 mm = 1 x 10^3 mm)

Some Common Units and Their Equivalents

1 km = 0.6214 mi	1 kg = 2.205 lb	1 hr = 60 min
1 m = 39.37 in	1 lb = 453.59 g	1 min = 60 sec
1 m = 1.097 yd	1 oz = 28.35 g	1 cal = 4.184 J (exact)
1 ft = 30.48 cm	1 L = 1000 mL	1 atm = 760 mmHg
1 in = 2.54 cm (exact)	1 L = 1000 cm^3	1 atm = 760 torr
1 acre = 43,560 ft^2	1 L = 1.057 qt	
1 ton = 2000 lb	1 US gal = 3.785 L	

Segment 2: Single Step Unit Conversions

1. Write down given quantity and its units.
2. Write down the quantity you want to find.
3. Write down the appropriate conversion factor.
4. Set up your dimensional analysis beginning with given quantity and unit. Multiply by appropriate conversion factor, canceling units to arrive at desired unit.
5. Round your answer to correct number of significant figures and use Scientific Notation.

Example 1 **Convert 56.0 cm to inches**

Given: 56.0 cm
Find: in
Conversion Factor: 1 in = 2.54 cm

$$56.0\ cm \times \frac{1\ in}{2.54\ cm} = 22.0\ in = 2.20x10^{1}\ in$$

Example 2 **Convert 78.9 mg to g**

Given: 78.9 mg
Find: g
Conversion Factor: 1000 mg = 1 g

$$78.9\ mg \times \frac{1\ g}{1000\ mg} = 0.0789\ g = 7.89x10^{-2}\ g$$

Practice 1 **Convert 693.4 nm to m**

Practice 2 **Convert 54 mi to km**

Segment 3: Multistep Unit Conversions

This method can be expanded to involve multistep conversions.

1. Write down given quantity and its units.
2. Write down the quantity you want to find.
3. Write down the appropriate conversion factors.
4. Set up your dimensional analysis beginning with given quantity and unit. Multiply by appropriate conversion factors, canceling units to arrive at desired unit.
5. Round your answer to correct number of significant figures and use Scientific Notation.

Example 3 **Convert 1789 ft to km.**

Given: 1789 ft
Find: km
Conversion Factors: 1 ft = 12 in, 1 m = 39.37 in, 1 km = 1000 m

$$1789\ ft \times \frac{12\ in}{1\ ft} \times \frac{1\ m}{39.37\ in} \times \frac{1\ km}{1000\ m} = 0.5452\ km = 5.452x10^{-1}\ km$$

Example 4 **Ethylene glycol has a density of 1.11 g/cm^3. What is the volume in liters of 7.9 kg of this liquid?**

Given: 7.9 kg
Find: L
Conversion Factors: 1.11 g = 1 cm^3, 1 mL = 1 cm^3, 1 L= 1000 mL, 1 kg = 1000 g

$$7.9\ kg \times \frac{1000\ g}{1\ kg} \times \frac{1\ cm^3}{1.11\ g} \times \frac{1\ mL}{1\ cm^3} \times \frac{1\ L}{1000\ mL} = 7.1\ L$$

Practice 3 **Convert 0.35 oz to µg.**

Practice 4 **A car has a mileage rating of 42 miles per gallon of gasoline. How many liters of gasoline is needed for the car to travel 75.5 kilometers?**

Segment 4: Conversion Involving Units Raised to a Power

When converting quantities with units raised to a power, such as cm^3, the conversion factor must also be raised to that power.

1. Write down given quantity and its units.
2. Write down the quantity you want to find.
3. Write down the appropriate conversion factors.
4. Set up your dimensional analysis beginning with given quantity and unit. Multiply by appropriate conversion factors, canceling units to arrive at desired unit. Conversion factor must be raised to power, for example 2.54 cm = 1 in, so to use cm^3, $(2.54\ cm)^3 = (1\ in)^3$ or $(2.54)^3\ cm^3 = 1^3\ cm^3$.
5. Round your answer to correct number of significant figures and use Scientific Notation.

Example 5 **Convert 75 acres to square meters (m^2).**

Given: 75 acres
Find: km^2
Conversion Factors: 1 acre = 43,560 ft^2, 1 ft = 30.48 cm, 1 m = 100 cm, 1 km = 1000m

$$75\ acres \times \frac{43{,}560\ ft^2}{1\ acre} \times \frac{(30.48)^2\ cm^2}{1^2\ ft^2} \times \frac{1^2\ m^2}{(100)^2\ cm^2} \times \frac{1^2\ km^2}{(1000)^2\ m^2} = 0.30\ km^2 = 3.0x10^{-1}\ km^2$$

Practice 5 **Convert 4637 nm^3 to in^3.**

Conversions and Dimensional Analysis Handout-Answers	Name: Date:

Objective: **Perform Unit Conversions Using Dimensional Analysis**

Segment 1: We can use units as a guide to solving problems.

Practice 1 **Convert 693.4 nm to m**

6.934×10^{-7} m

Practice 2 **Convert 54 mi to km**

8.7×10^{1} km

Segment 3: Multistep Unit Conversions

Practice 3 **Convert 0.35 oz to µg**

9.9×10^{5} µg

Practice 4 **A car has a mileage rating of 42 miles per gallon of gasoline. How many liters of gasoline is needed for the car to travel 75.5 kilometers?**

4.2 L

Segment 4: Conversion Involving Units Raised to a Power

Practice 5 **Convert 4637 nm^3 to in^3.**

2.830×10^{-19} in^3

Conversions and Dimensional Analysis **Quiz**	**Name**_____ **Date**_____

Perform the following single step unit conversions:

1. Convert 0.568 mg to g.

2. Convert 357 km to m.

3. Convert 4.53 cm to in.

Perform the following multistep unit conversions:

4. Convert 75 mL to gallons.

5. Convert 4.59 mi^2 to m^2

6. An iron cylinder has a volume of 346 cm^3 and a density of 7.87 g/cm^3. What is the mass in kilograms?

7. The lava flow from a volcano can travel up to 100 km/hr. If a village is located 3.6 miles from the volcano, how many minutes will it take the lava to reach the village?

SELF-REFLECTION ACTIVITY

1) Which segment of ***Conversions and Dimensional Analysis*** was the most challenging for you?

2) What steps are you going to take to learn this subject?

3) What steps are you going to take to learn this subject?

Conversions and Dimensional Analysis **Quiz-Answers**	**Name**_____ **Date**_____

Perform the following single step unit conversions:

1. Convert 0.568 mg to g = 5.68×10^{-4} g
2. Convert 357 km to m = 3.57×10^{5} m
3. Convert 4.53 cm to in = 1.78 in

Perform the following multistep unit conversions:

4. Convert 75 mL to gallons = 2.0×10^{-2} gal
5. Convert 4.59 mi^2 to m^2 = 1.19×10^{7} m^2

6. An iron cylinder has a volume of 346 cm^3 and a density of 7.87 g/cm^3. What is the mass in kilograms?
   2.72 kg

7. The lava flow from a volcano can travel up to 100 km/hr. If a village is located 3.6 miles from the volcano, how many minutes will it take the lava to reach the village?

   3.5 min