Lesson Title	How BIG is 400?
Length of Lesson	45 min. in class, 30 min. individual work/homework
Created By	Chris Ruhs and Kelli Dawkins
Subject	Dimensional Analysis
Grade Level	10-12
State Standards	Chemistry 1: needed as an underpinning skill for State Standard 2
DOK Level	DOK 2
DOK Application	Solve problems, calculate, demonstrate use of knowledge, present, explain
National Standards	9-12: A. Inquiry
Graduate Research Element	Increasing familiarity and confidence with converting units, recognizing when units need to be converted, and problem solving are used in conducting research with biogeochemistry, especially when presenting results in comparable units, making solutions, and understanding readouts from field and laboratory instruments.

Student Learning Goal:
10^{th} – 12^{th} Chemistry: Students will apply algebra and arithmetic skills to real world scenarios involving unit conversions and simple formulas. Students will understand the value of being able to convert units and how this skill applies to chemistry. Students will be able to present and explain to their peers an example unit conversion. Students will become confident with unit conversions through independent practice (individual work/homework). This skill is foundational and essential for the rest of the chemistry course.

National Science Education Standards of Content
9-12 A. Science as Inquiry
Abilities: Use technology and mathematics to improve investigations and communications. *Students use algebra and measured dimensions to develop the understanding and skill of converting units.*
Abilities: communicate and defend a scientific argument. *Students choose and present unit conversion problems to their peers and explain their answers.*

Materials Needed (supplies, hand-outs, resources):
"Selected Scenarios" hand-out, writing utensils, calculators, a ruler/measuring tape, a balance, chalkboard/whiteboard/smartboard for student example presentations.

Lesson Performance Task/Assessment:
A student from each group will choose one of the scenarios from their assigned problems on the hand-out to present on the board for the rest of the class. This student must identify the real-world problem and work the problem using dimensional analysis on the board.

The rest of the class will be instructed to take notes as the student presents and encouraged to assess their peer's work respectfully. This presentation will represent a formative assessment of the student's understanding. If the student has mistakes, it becomes a teachable moment, but must be corrected with care. Other students may catch the mistake and speak up, but their critiques should be respectful. After each group has presented their scenario of choice, there will be 6 other scenarios that have not been presented and 3 bonus scenarios that relate directly to chemistry due for individual work/homework. The entire completed hand-out will represent a summative assessment of each student's understanding and ability to perform unit conversions.

Lesson Relevance to Performance Task and Students:
Allowing students to discuss and understand the concepts of dimensional analysis, see example problems, work on problems for themselves, choose a problem to present to their peers, critique their peers' presentations of problems, and then practice problems individually will accomplish several goals:

1. Students will become familiar and confident with units, unit conversions, simple formulas, and dimensional analysis.
2. Students will value and appreciate this skill as it applies to a multitude of real-world scenarios and relates to other fields of study as well as being crucial for chemistry.
3. The opportunity to present, explain, and teach concepts with an example problem will reinforce students' own understanding of the material, strengthen their presentation and communications skills, and expose them to instant positive feedback (whether they make mistakes or do it perfectly, positive feedback should be given—mistakes play a crucial and positive role in the learning process).
4. The opportunity to evaluate and assess their peers' work respectfully will subtly expose them to part of the scientific process known as peer review, which will build their own confidence, develop active learning skills, and strengthen interpersonal skills.
5. Individual work/homework will provide the practice needed to instill confidence and cement understanding in students to be able to perform unit conversions long term.

Anticipatory Set/Capture Interest:
"How BIG is 400?" will be the initial question that will get students thinking about numbers and what numbers represent, i.e. units. This question will launch the student-teacher discussion on dimensional analysis, which in turn will be followed up by demonstrations and examples problems.

Guided Practice:
Students will be led by the teacher in a discussion on dimensional analysis beginning with the question, "How big is 400?" This question should cause students to respond, "it depends on what you're talking about." This answer will lead into a discussion on units,

unit conversions, and dimensional analysis. Students will be asked why units are important and exposed to archaic and different units than what is culturally normal. Students will be asked why scientists don't simply choose one unit for each dimension to simplify everything. Discussion should then be lead to talking about useful or convenient units, i.e. we don't want to measure the distance to the moon in millimeters. This discussion will ultimately lead to the fact that in science, in many other fields of study, and in life we often need to change the units being used. The teacher will then show how a unit conversion is conducted, drawing from algebra. The teacher will also demonstrate that the same length is a different number of inches than centimeters, and the same weight is a different number of pounds than kilograms. These demonstrations should be used to tie the concept to a practical and tangible reality and used to allow the students to "discover" conversion factors. The teacher will then hand out "The "Selected Scenarios" hand-out, which contains 17 real life scenarios that require unit conversions. The first 2 scenarios will be worked out by the teacher on the board as examples while students take notes.

Independent Practice:
Students will then be divided into groups of 3-4 so that there are 6 groups in total. Each group will be assigned and responsible for 2 scenarios. After students are given enough time to work through their two scenarios,

Remediation and/or Enrichment:
Remediation:
Individual IEP; partner help throughout lesson; shorten parts of assignment; focus on fewer conversions.

Enrichment/Extension:
Give students a problem with made-up units.
Have students write their own problems.
Attempt progressively harder unit conversions.

Check(s) for Understanding:
How might we use this in chemistry?
Where have you used conversions in real life?
What if you know the units you need, but do not know the formula?
Bonus questions relating to chemistry.
Have students challenge the teacher with example problems they dream up.
Try using imaginary units.

Closure:
Have students sum up the lesson and ask questions. Get students thinking about where they will see this during the year, so they know it will be expected of them to perform.

Possible Alternate Subject Integrations:
Integrates into Algebra and any science class that uses unit conversions. May also have interesting tie-ins to history and literature when students come across archaic units, e.g. 20,000 Leagues Under the Sea.

Teacher Notes:
Allow students to be involved in the demonstrations: let them hold on end of tape measure, have volunteers stand on the scale/balance to get their weight. Their inclusion will secure their attention.