Lesson Title	Converting Metric Units and Prefixes
Length of Lesson	90 minutes (1 period)
Created By	Christopher Ramos
Subject	Science
Grade Level	10-12 (Physical Science)
State Standards	Physical Science: 1b, c, g
DOK Level	Three
DOK Application	Identify, Investigate, Apply, Communicate
National Standards	9-12: A (Inquiry); B (Physical Science)
Graduate Research Element	Use of measurement tools.

Student Learning Goal: The students will continue to learn about metric prefixes, including their associated symbols (eg: milli, centi, deci) and values. This will be accompanied by an online demonstration of scale.

As well, they will continue to learn about different units of measure and their associated symbols: meters (distance), kilograms (mass), seconds (time), amps (current), Kelvin (temperature), etc.

The students will be able to relate orders of magnitude (base 10) to physical objects as well as figures (see Lesson Performance Task).

<u>National Science Education Standards of Content</u>
9-12: Science as Inquiry: Understandings about Scientific Inquiry
*Scientists conduct investigations for a wide variety of reasons. For example, they may wish to discover new aspects of the natural world, explain recently observed phenomena, or test the conclusions of prior investigations or the predictions of current theories.
*Scientists rely on technology to enhance the gathering and manipulation of data. New techniques and tools provide new evidence to guide inquiry and new methods to gather data, thereby contributing to the advance of science. The accuracy and precision of the data, and therefore the quality of the exploration, depends on the technology used.

9-12: Physical Science: Structure of Atoms:
*Matter is made of minute paticles called atoms, and atoms are composed of even smaller components. These components have measurable properties, such as mass and electrical charge. Each atom has a positively charged nucleus surrounded by negatively charged electrons. The electric force between the nucleus and electrons holds the atoms together.

Materials Needed (supplies, hand-outs, resources): Metric scale rulers for each student, large white board and markers, proscopes, yarn

scale-activity guide: (INSPIRE_HO_Ramos_07-14-10_scale.pdf)
units and prefixes lab sheet: (INSPIRE_LAB_Ramos_07-14-10_units-and-prefixes.pdf)

link for "newgrounds" interactive animation of scale:
(http://www.newgrounds.com/portal/view/525347)

Lesson Performance Task/Assessment: Students will work on the "Length Lab" (INSPIRE_LAB_Ramos_07-14-10_units-and-prefixes). In pairs, they will work with rulers to determine the lengths and areas of various shapes. They will also be required to convert between units (between millimeters and kilometers or between kilograms and grams for instance).

Lesson Relevance to Performance Task and Students: The usage of online resources will provide students with a visual demonstration of scale from nanometers up to megameters.

Anticipatory Set/Capture Interest: First, students will be given five minutes to brainstorm. The task is to think of the smallest and the largest thing they can. After which, they will be asked to share their thoughts.

Students might consider atoms to be the smallest known objects; however, teachers may point out that even atoms are made up of even smaller objects (protons, electrons, neutrons). If students continue to probe further, the teacher can point out that electrons are considered to be fundamental (nothing smaller), while protons and neutrons are made up of the fundamental particles quarks and gluons. Though unnecessary to introductory chemistry, teachers can also bring this up as a side note when teaching the periodic table of elements.

The largest known "object" might be obvious to the students: the observable universe - which is approximately 93 billion light-years in diameter. However, it should be noted that students are only required to know up to the 6^{th} magnitude (10^6, or mega).

Students can then be shown an online demonstration of the scale of the universe (http://www.newgrounds.com/portal/view/525347). Teachers can also refer to http://www.nikon.com/about/feelnikon/universcale/index.htm, however, the newgrounds resource loads more quickly and is more user friendly.

Guided Practice: Teachers will hand out the "scale-activity" worksheet (INSPIRE_HO_Ramos_07-14-10_scale) to give the students an idea of what is expected of them. Beforehand, the teacher will have sketched out the same diagram on an available chalkboard or whiteboard. There can be a few minutes of discussion and questions before the activity commences.

Each student can write down the name of an object that they believe fits into the sections provided. Afterwards, the teacher can go through a few of the objects with the class to ascertain whether or not said objects are in the appropriate section.

Independent Practice: Students will work on length lab.

Remediation and/or Enrichment:

*Enrichment***:** Students who are finished early can be asked to write a paragraph on jobs that depend on careful measurement. As well, students can use a piece of yarn and a ruler to measure the circumference of their head. As well, students can explore different surfaces around the classroom using the proscopes.

*Remediation***:** Individual IEP, shorten assignment.

Check(s) for Understanding: The teacher can go through a drill where they call out a particular order of magnitude and call on students to give the correct metric prefix.
1) When it comes to unit conversions, students have an easier time with converting lengh (say, meters into kilometers) than they do with converting areas (cm^2 to km^2). Try asking a question like: How many square-centimeters in five square-kilometers?
2) Make sure students can distinguish between types of units. Ask something like, how many milliliters in twenty centimeters. Trying to convert here is useless as the base units in the question measure volume and length, respectively.

Closure: End with opening up the classroom to questions.

Possible Alternate Subject Integrations: Can be used in any science class from physics, to biology, or even chemistry.

Notes for Teachers:
When it comes to unit conversions, I find it helpful to think of prefixes as “numbers in disguise”. Asking the student to think of prefixes as “numbers in disguise” will help them remember to treat a prefix as such when converting. This is especially useful when converting units of area or units of volume as students often forget to apply the appropriate arithmetic to the prefix.

For example, how many square-centimeters in five square-kilometers?

A common incorrect answer would be the follows:
There are 500,000 cm^2

However, that answer is off by five orders of magnitude. The correct answer is 50,000,000,000 [cm^2] or $5*10^{10}$ [cm^2]

The error came from not squaring the numerical values of the prefixes "centi=0.01" and "kilo=1000".