Math-in-CTE Lesson Plan

Lesson Title: Conversions in Automotive Applications	**Lesson # AT01**

Occupational Area: Automotive Technology
CTE Concept(s): Conversions in automotive applications
Math Concept(s): Equivalent forms; computation; computation in context.

Lesson Objective:	Required conversions techniques needed in automotive technology
Supplies Needed:	Visuals such as meter stick/yard stick, ruler with inches and centimeters, dual unit measuring cups, quarts, etc. These items may be used in the introduction as well as in step 6.
Link to Accompanying Materials:	Auto AT01 Downloads

THE "7 ELEMENTS"	**TEACHER NOTES (and answer key)**
1. Introduce the CTE lesson. Let's list all the automotive-related conversions you can think of. Why are these conversions needed in the automotive field? In this lesson we will learn how to perform various conversions on mathematical quantities used in the automotive field. In our first example we will show in detail how to perform a cubic inch to liter conversion of the 302 cubic inch engine.	*NOTE: This lesson can be reviewed throughout the year, and concepts should be reinforced as they appear in other lessons.* Keep the students focused on the automotive field as much as possible. Too many non-related examples at this point may lose the interest of the students. To pull the students in better have each student work on making a list of conversions as well as describe how the conversion is needed. See who can come up with the longest list. Give students a copy of the automotive-related Conversion Factors Handout and have them describe why or how each conversion is used in the automotive field. Remember to have them keep it automotive related.
2. Assess students' math awareness as it relates to the CTE lesson. Most of you probably know that a 305 cubic inch engine is considered to be equivalent to a 5 liter engine. Is a 302 cubic inch engine close enough	Have the students try to convert the 302 in^3 to liters to see how many already understand the procedure involved in solving the question.

in size to also be equivalent to a 5 liter engine? How would you set up this problem in order to see if a 302 in^3 can be called a 5.0 liter? Can you show how you would set up any type of basic conversion? Can problems with different units all be done the same way?	See the next topic below for a detailed procedure of how a problem of this type is set up. Students who understand the setup well enough will understand that the same procedure can be used regardless of what units are being used.
3. Work through the math example *embedded* in the CTE lesson. How big, in liters to the nearest tenth of a cubic inch, is a 302 in^3 engine? A. Write the number that you are trying to convert (302 in^3) on the left side of an equal sign and leave enough space for your conversion factor. **Include the unit with the number.** Place the number 1 underneath this number. This helps to organize the math steps we will take. Write the unit of the number you are trying to convert to on the right side of the equal sign. Leave space for the answer. Example: $\frac{302\ in^3}{1} = \qquad liters$ B. Look up the conversion factor for liters to cubic inches (or cubic inches to liters) in the appendix. Example: 1 liter = 61.024 in^3 C. Make a fraction out of your conversion by putting the number with the unit you are trying to find on top and the number with unit you are trying to convert from on the bottom. Example: $\frac{1\ liter}{61.024\ in^3}$	Before you begin you may want to physically show the students some conversions such as how big in inches 100 mm in on a ruler, or how big a cubic centimeter is physically, etc. *NOTE: This way of setting up the problems is effective with special needs students who need a clear and repetitious method of solving problems.* You may want to point out to the students that since this is a volume type of unit, they can find it quicker by going to the volume conversions. It has also been suggested that you might want to make a wall poster of the conversion factors listed in the appendix. You may want to point out that this is why it is called a conversion **factor**. You will recall that a factor is one number divided by another. You also may want to start to use the terms **numerator** for the top of the fraction and **denominator** for the bottom of the fraction.

D. Write the conversion factor to the right of the number you are trying to convert (i.e. to the left of the equal sign). Place a multiplication sign between the number and your conversion factor. Example: $\frac{302\ in^3}{1} \times \frac{1\ liter}{61.024\ in^3} = \quad liters$	Point out that we can do this since **1 liter** divided by **61.024 in^3** is equal to 1. Remember that these two quantities are equal to each other and that anything divided by something equal to itself is one. Anything multiplied by 1 doesn't change. This concept forms the basis for all conversion factors that can be created.
E. One of the reasons we include the units with our number is that it allows us to see if the units cancel out properly and leave us with the unit we want. Example: $\frac{302\ \cancel{in}^3}{1} \times \frac{1\ liter}{61.024\ \cancel{in}^3} = \quad liters$	Point out that units cancel just like numbers do. Also show them that if the conversion factor is upside down, nothing will cancel. The answer will be wrong as well as the units. Example: $\frac{302\ in^3}{1} \times \frac{61.024\ in^3}{1\ liter} =$ The answer to this problem would be 21358 in^6/liter. Notice how unrealistically large the answer is and that the units do not make any sense. (Rules of mathematics requires us to multiply in^3 times in^3 which equals in^6)
F. After the units have been canceled this is what we have left to work with. $\frac{302}{1} \times \frac{1\ liter}{61.024} = \quad liters$	Point out that all that is left are liters (which are what we were looking for all along).
G. Complete the problem by multiplying the two numerators by each other and the two denominators by each other. $\frac{302 \times 1}{1 \times 61.024} liters = \frac{302}{61.024} liters$	
H. Finally divide the numerator by the denominator. $\frac{302}{61.024} = 4.948 \approx 4.9$ liters (Rounded to the nearest 10th) Therefore a 302 in^3 should not be called a 5.0 liter engine.	Some might argue that 4.948 liters is close enough to 5 that a 302 can be called a 5 liter. That's fine if that is your position but speaking from a purely mathematical position you would be required to call it a 5 liter not a 5.0 liter.

4. Work through *related, contextual* math-in-CTE examples.

1. How many cubic inches are in a 600 cc (cubic centimeter) motorcycle?

$$\frac{600cc}{1} \times \frac{.06102in^3}{1cc} = 36.612in^3$$

2. In hybrid technology, motors that are electrically based are generally rated in watts. What is the horsepower rating of a hybrid electric motor that is rated at 25,000 watts?

$$\frac{25000\,watts}{1} \times \frac{1\,hp}{746\,watts} = 33.51\,hp$$

3. If 1 mile/hour is equal to 0.447 meter/sec, how many miles/hour is 50 meters per second?

$$\frac{50\frac{meters}{\sec}}{1} \times \frac{1\frac{mile}{hour}}{.447\frac{meters}{\sec}} = 111.86\frac{miles}{hour}$$

4. Which metric wrench is closest in size to a 7/16 inch wrench?

   (hint: change 7/16 to it's decimal form and then do the conversion)

(7/16 inch = .4375 inch)

$$\frac{.4375in}{1} \times \frac{25.4mm}{1in} = 11.1mm$$

5. The lowest recommended caster setting on a Nissan is 45 minutes. What would this be in a fraction of a degree?

$$\frac{45\,\min}{1} \times \frac{1\,\text{degrees}}{60\,\min} = \frac{3}{4} = .75\,\text{degrees}$$

5. Work through *traditional math* examples.

1. How many feet is the 100 meter dash?

$$\frac{100\,meters}{1} \times \frac{1\,ft}{.3048\,meters} = 328\,ft$$

2. If your backyard is 37,560 square feet, what part of an acre is this?

$$\frac{37{,}560\,ft^2}{1} \times \frac{1\,acre}{43{,}560\,ft^2} = .862\,acres$$

3. You determine that you need 295 cubic feet of concrete to pour a driveway, how many cubic yards should you order?	$\frac{295\ ft^3}{1} \times \frac{1\ cubic\ yard}{27\ ft^3} = 10.9\ cubic\ yards$
4. A load of gravel weighs 3,500 pounds, how many tons is this?	$\frac{3{,}500\ pounds}{1} \times \frac{1\ ton}{2{,}000\ pounds} = 1.75\ tons$
5. How many hours are in 560 minutes?	$\frac{560\ \text{min}}{1} \times \frac{1\ hour}{60\ \text{min}} = 9.33\ hours$
6. Sometimes it is necessary to use two or more different conversion factors to get the answer you are looking for. Let's try this for example: A car travels a city block (about 700 feet) in 16 seconds. How fast is this in mile per hour (mph)?	$\frac{700\ feet}{16\ \text{sec}} \times \frac{60\ \text{sec}}{1\ \text{min}} \times \frac{60\ \text{min}}{hour} \times \frac{1\ mile}{5{,}280\ feet} = 29.8\ mph$
6. Students demonstrate their understanding. Have students perform a volume or length conversion mathematically and then verify that their calculation was correct by physically making the measurement using related measuring devices.	
7. Formal assessment. See attached test and key for assessment.	