Automotive Technology (47.0604) T-Chart

Calculate electrical power and horsepower	=	Apply and extend the properties of exponents to solve problems with rational exponents

Program Task: Use a dynamometer.

Program Associated Vocabulary:
TORQUE, ROTATIONAL VELOCITY, POWER, HORSEPOWER, LB-FT, HP, RPM

Program Formulas and Procedures:
A dynamometer is a device used to measure force, torque, or power. For example, the power produced by an engine or motor can be calculated by simultaneously measuring torque and rotational speed.

The formula for this calculation is:

$$P = \frac{\tau \times \omega}{5252}$$ where:

P = power (horsepower)
τ = torque (pound-feet)
ω = rotational velocity (revolutions per minute)

Example 1:
A mechanic uses a dynamometer to measure torque and rotational speed. The engine is running with 300 ft. lbs. of torque and 6500 revolutions per minute. What is the horsepower of the engine? (Round to nearest whole number)

$$P = \frac{T \times w}{5252}$$

$$P = \frac{300 \times 6500}{5252}$$

$$P = 371 \text{ HP}$$

Example 2:
A mechanic uses a dynamometer to simulate an automobile being driven over a mountain pass at 8325 feet in altitude. The engine is rated at 255 hp. at 5200 rpm. What is the loss in horsepower due to elevation?

$$\text{HP loss} = \left(\text{Elevation in feet} \div 1000\right) \times 0.03 \times \text{Sea Level HP}$$

$$\text{HP loss} = \left(8325 \div 1000\right) \times 0.03 \times 255$$

$$\text{HP loss} = 8.325 \times 0.03 \times 255$$

$$\text{HP loss} = 0.24975 \times 255$$

$$\text{HP loss} = 63.69 \text{ HP}$$

PA Core Standard: CC.2.1.HS.F.1

Description: Apply and extend the properties of exponents to solve problems with rational exponents.

Math Associated Vocabulary:
SIMPLIFY NUMERICAL EXPRESSION, TERM

Formulas and Procedures:

P Do all operations in **PARENTHESIS**. Start with the innermost set.

E Evaluate all **EXPONENTS**.

M **D** Do **MULTIPLICATION** and **DIVISION** in order from left to right.

A **S** Do **ADDITION** and **SUBTRACTION** in order from left to right.

One way to remember the order of operations is:

Please **E**xcuse **M**y **D**ear **A**unt **S**ally.

Remembering that my and dear go together since they both describe Aunt Sally who is one person.

Example:

$(7 + 3)^2 - 21 \div 7 + 10(2) =$
$10^2 - 21 \div 7 + 10(2)$ Parentheses
$100 - 21 \div 7 + 10(2)$ Exponents
$100 - 3 + 20$ Multiplication and Division
$97 + 20$ Addition and Subtraction
$= 117$

Instructor's Script - Comparing and Contrasting
Order of Operations is an essential skill for any student in a technical area that uses formulas. In addition to substituting values into the formula, the student must also apply the order of operations to reach a solution

Common Mistakes Made By Students
Improper use of calculators: Students are usually very quick to use calculators when faced with formulas but if they are not proficient in using the order of operations, they will not insert parentheses where needed or press "=" at the wrong points and arrive at incorrect answers.

Familiarity with the calculator: In some calculators, you must enter the radical sign first and in some calculators the radical sign is entered after the number is entered. Some calculators automatically do some of the correct order of operations. You need to know your calculator. Calculators are great tools, but you need to know the correct way to use them.

When entering the square of a negative number in a calculator it is important to put it in parentheses. You need to enter $(-2)^2$ not -2^2. For the latter the calculator thinks you are saying the negative of 2 squared or -4, and not (-2) (-2) = 4.

When dealing with fractions students often will forget to put the numerator of the fraction and the denominator of the fraction in parentheses. If you enter (3 + 6)/9 into the scientific calculator, it recognizes that 3 + 6 is in the numerator and does this operation first, giving the answer 9/9 or 1. If you put 3 + 6/9 (without the parentheses) into a scientific calculator, it will give you an answer of 3.66…

CTE Instructor's Extended Discussion
When testing a car's power output during performance tuning, mechanics use a device called a dynamometer, or dyno. An engine dyno is one of the two main types of dynamometers, measuring power by hooking the engine up to one of several devices designed to measure the engine's ability to do work. This is the application of this mathematical concept. It is always good to understand the math involved so if the test machine is defective, you have a basic understanding of the correct answer.

Problems	Occupational (Contextual) Math Concepts	Solutions
1. Calculate the horsepower of a car with 375 lb. ft. of torque running at 6400 rpms.		
2. A mechanic uses a dynamometer to simulate an auto mobile being driven over a mountain pass at 8325 feet in altitude. The engine is rated at 255 hp at 5200 rpm. What is the loss in horsepower due to elevation? What would be the Final HP?		
3. Let's assume that a car boasts 250 horsepower. When the engine is running at a speed of 4000 rpms, what should the torque be?		
Problems	**Related, Generic Math Concepts**	**Solutions**
4. Simplify $3(5 + 7)^2 – 10/5$		
5. Simplify $5(8 + 2) + (-5 + (2 + 3)(7 – 4))$		
6. Simplify $(5 + 8)^2 - (7 + 5)^2$		
Problems	**PA Core Math Look**	**Solutions**
7. Simplify $(5 + 7 + 3) \div (3 + 2)$		
8. Simplify $5 + 7 + 3 \div 3 + 2$		
9. Compare problem #7 with problem #8. Explain how someone may make the mistake of thinking they are the same problem.		

Problems	Occupational (Contextual) Math Concepts	Solutions
1. Calculate the horsepower of a car with 375 lb. ft. of torque running at 6400 rpms. (Round to the nearest whole number.)		$P = \frac{T \times w}{5252} \rightarrow P = \frac{375 \times 6400}{5252} \rightarrow P = \frac{2400000}{5252}$ $P = 456.97$ HP
2. A mechanic uses a dynamometer to simulate an auto mobile being driven up a hill at 1900 feet in altitude. The engine is rated at 255 hp at 5200 rpm. What is the loss in horsepower due to elevation? What would be the Final HP?		$\text{HP loss} = (\text{Elevation in feet} \div 1000) \times 0.03 \times \text{Sea Level HP}$ $\text{HP loss} = (1900 \div 1000) \times 0.03 \times 255$ $\text{HP loss} = 1.9 \times 0.03 \times 255$ $\text{HP loss} = 0.057 \times 255$ $\text{HP loss} = 14.54$ hp Final HP = Sea Level HP - HP Loss Final HP = $255 - 14.54 = 240.46$ hp
3. Let's assume that a car boasts 250 horsepower. When the engine is running at a speed of 4000 rpms, what should the torque be?		$P = \frac{T \times w}{5252} \quad 250 = \frac{T \times 6400}{5252} \quad \frac{250}{1} = \frac{T \times 6400}{5252}$ $6400T = 1313000$ $\frac{6400T}{6400} = \frac{1313000}{6400}$ $T = 205.16$ ft. - lbs.
Problems	**Related, Generic Math Concepts**	**Solutions**
4. Simplify $3(5 + 7)^2 - 10/5$		$3(5 +7)^2 - 10/5 = 3(12)^2 - 10/5 = 3(144) - 10/5 = 432 - 2 =$ 430
5. Simplify $5(8 + 2) + (-5 + (2 + 3)(7 - 4))$		$5(8 +2) + (-5 +(2 + 3)(7 - 4)) =$ $5(8 +2) + (-5 +(5)(3)) =$ $5(10) + (-5 + 15) =$ $5(10) + (10) = 50 + 10 = 60$
6. Simplify $(5 + 8)^2 - (7 + 5)^2$		$(5 + 8)^2 - (7 + 5)^2 =$ $13^2 - 12^2 =$ $169 - 144 =$ 25
Problems	**PA Core Math Look**	**Solutions**
7. Simplify $(5 + 7 + 3) \div (3 + 2)$		Following the order of operations, $(5 + 7 + 3) \div (3 + 2) =$ Parenthesis $15 \div 5 =$ Division 3
8. Simplify $5 + 7 + 3 \div 3 + 2$		Following the order of operations, $5 + 7 + (3 \div 3) + 2 =$ Division $5 + 7 + 1 + 2 =$ Addition 15
9. Compare problem #7 with problem #8. Explain how someone may make the mistake of thinking they are the same problem.		In problem #7 you are asked to add 5 + 7 + 3 first, then add 3 + 2, and finally divide the two answers (5 + 7 + 3)/(3 + 2). In problem #8, the first thing to do is divide 3 by 3 and then add 5 + 7 + 1 + 2.