Automotive Technology (47.0604) T-Chart

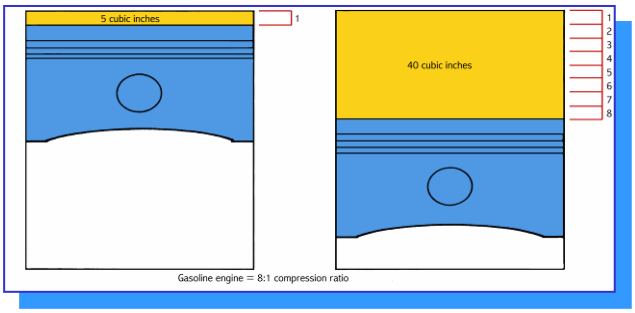
Determine cylinder compression ratios	=	Write functions or sequences that model relationships between two quantities

Program Task: Determine cylinder compression ratios.

Program Associated Vocabulary:
EXPANDED VOLUME, COMPRESSED VOLUME, RATIO, PROPORTION, COMPRESSION RATIO, BOTTOM DEAD CENTER, TOP DEAD CENTER

Program Formulas and Procedures:
Engine Compression Ratio (CR) is the difference when a cylinder (piston) is at the bottom of its stroke (Bottom Dead Center) and the air/fuel mixture is at its maximum expanded volume or at the top of its stroke (Top Dead Center) and the air/fuel mixture is at its maximum compressed volume.

$$CR = \frac{\text{Expanded Volume}}{\text{Compressed Volume}}$$



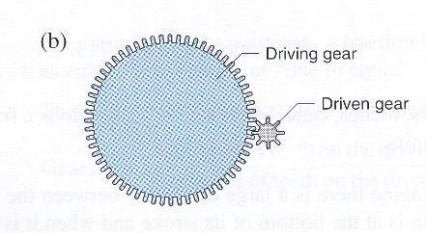
Compressed Volume
TDC (5cu.in)

Expanded Volume
BDC (40cu.in)

Example 1: In the above diagram, we find the CR to be 8 to 1 (8:1).

$$CR = \frac{40\,\text{cu.in}}{5\,\text{cu.in}} = \frac{8}{1} = 8:1$$

Example 2: The ratio of two gears, one a 60 tooth driving gear, the other a driven gear with 8 teeth can be written as a ratio using:



$$\text{Gear ratio} = \frac{\text{number of teeth on the driving gear}}{\text{number of teeth on the driven gear}}$$

This example would be written as:

$$\text{Gear ratio} = \frac{60}{8} = \frac{15}{2} \text{ or } 7.5:1$$

PA Core Standard: CC.2.2.HS.C.3

Description: Write functions or sequences that model relationships between two quantities.

Math Associated Vocabulary:
RATIO, PROPORTION, CROSS MULTIPLY, SCALE, COEFFICIENT

Formulas and Procedures:
A proportion states that two ratios are equal.

$$\frac{a}{b} = \frac{c}{d}$$

Example: Girls outnumber boys 5 to 3. If there were 21 boys in the class, how many girls would one expect to find?

Steps:

1. Identify the proportional relationship and label the units:

   5 girls to 3 boys: $\frac{5\,\text{girls}}{3\,\text{boys}}$

2. Set up the proportional relationship, using a variable for the missing value.

   $$\frac{5\,\text{girls}}{3\,\text{boys}} = \frac{x\,\text{girls}}{21\,\text{boys}}$$

3. Cross multiply.

   $(5)(21) = 3x \rightarrow 105 = 3x$

4. Divide by the coefficient.

   $$\frac{105}{3} = x \qquad x = 35$$

   One would expect to find 35 girls

Instructor's Script – Comparing and Contrasting

Proportion problems are formed by 2 ratios. In technical applications, ratios are often expressed as a single number (compression ratio is 8, gear ratio is 7.5) but it is important to realize this still implies a ratio of 2 values, with the second value set to 1 (the ratio of the expanded volume to compressed volume is 8 to 1). So, to set up the proportion problem and use cross-multiplication, you will need to place the given ratio number over 1:

In the above gear example, the gear ratio = 7.5 $\quad \frac{\text{GearRatio}}{1} = \frac{7.5}{1}$

Any time you divide the numerator (top) by the denominator (bottom) of a ratio, you will be "simplifying" the ratio down to some number of units of the top value per 1 unit of the bottom (7.5 teeth on the driving gear per 1 tooth on the driven gear).

Common Mistakes Made By Students

Students will try to shy away from the fraction formed when the first value is placed on top of the second value. This may cause confusion if you try to show them the cross-multiplication method. Have them place the computed value over 1 before attempting the cross-multiplication.

Units are very important to keep straight. The ratios on both sides of a direct proportion problem must have the same units in the numerator and consistent units in the denominator:

$$\frac{\text{Driving Gear 1 Teeth}}{\text{Driven Gear 1 Teeth}} = \frac{\text{Driving Gear 2 Teeth}}{\text{Driven Gear 2 Teeth}}$$

CTE Instructor's Extended Discussion

Technical tasks are usually not presented using this model. Therefore, it is important that technical instructors demonstrate to students how these math concepts link to and are relevant in their technical training and that the math is presented in a way which shows a relationship to the math to which CTE students use in their academic school settings.

For problem #1 on page 3, use the formula : $\text{Ratio} = \frac{\text{Diameter of Pulley A}}{\text{Diameter of Pulley B}}$

Problems	Career and Technical Math Concepts	Solutions
1. Pulleys are used to transfer power from one system to another and will determine relative pulley speed (example: crankshaft to alternator). Find the ratio of the pulley diameters if pulley A diameter = 21" and pulley B diameter = 9".		
2. Determine the CR of a gasoline engine that has an expanded cylinder volume of 47 in.3 and a compressed cylinder volume of 5.00 in.3.		
3. The headlights on a car are set so the light beam drops 2 in. for each 25 ft. measured horizontally. If the headlights are mounted 30 in. above the ground, how far ahead of the car will they hit the ground?		
Problems	**Related, Generic Math Concepts**	**Solutions**
4. One oil change takes ¼ hr. How many changes can be done in one hour		
5. Luke can print five posters in 15 minutes. How many can he print in one hour?		
6. Mark works 35 hours and makes $420. How much does he make if he works 25 hours at the same rate?		
Problems	**PA Core Math Look**	**Solutions**
7. Vincent buys four burgers for $20. What is the cost of 10 burgers?		
8. There are 27 pairs of shoes in a case. How many pairs are there in 12 cases?		
9. Margie can buy seven shirts for $94.50. What would it cost if she only bought four?		

Problems	Career and Technical Math Concepts	Solutions
1. Pulleys are used to transfer power from one system to another and will determine relative pulley speed (example: crankshaft to alternator). Find the ratio of the pulley diameters if pulley A diameter = 21" and pulley B diameter = 9".		$\text{Ratio} = \frac{21}{9} = \frac{7}{3} = 7:3$
2. Determine the CR of a gasoline engine that has an expanded cylinder volume of 47 in.3 and a compressed cylinder volume of 5.00 in.3.		$\text{CR} = \frac{47\text{ cu.in.}}{5.0\text{ cu.in.}} = \frac{47}{5.0} = 9.4:1$
3. The headlights on a car are set so the light beam drops 2 in. for each 25 ft. measured horizontally. If the headlights are mounted 30 in. above the ground, how far ahead of the car will they hit the ground?		$\frac{2}{30} = \frac{25}{D}$ $30 \times 25 = 2D$ $D = 375$ ft.
Problems	**Related, Generic Math Concepts**	**Solutions**
4. One oil change takes ¼ hr. How many changes can be done in one hour?		$\frac{\frac{1}{4}\text{ hr.}}{1\text{ oil change}} = \frac{1\text{ hr.}}{x\text{ oil changes}}$ $\frac{1}{4}x = 1$ $(4)\frac{1}{4}x = 1(4)$ $x = 4$
5. Luke can print five posters in 15 minutes. How many can he print in one hour?		$\frac{5\text{ posters}}{15\text{ min.}} = \frac{x\text{ posters}}{60\text{ min.}}$ $15x = 5(60)$ $15x = 300$ $x = 20$
6. Mark works 35 hours and makes $420. How much does he make if he works 25 hours at the same rate?		$\frac{35\text{ hrs.}}{\$420} = \frac{25\text{ hrs.}}{\$\,x}$ $35x = 425(25)$ $35x = 10{,}500$ $x = 300.00$
Problems	**PA Core Math Look**	**Solutions**
7. Vincent buys four burgers for $20. What is the cost of 10 burgers?		$\frac{4}{\$20} = \frac{10}{\$x}$ $20(10) = 4x$ $200 = 4x$ $x = \$50$
8. There are 27 pairs of shoes in a case. How many pairs are there in 12 cases		$\frac{27\text{ pairs}}{1\text{case}} = \frac{x\text{ pairs}}{12\text{ cases}}$ $1x = 27(12)$ $x = 324$
9. Margie can buy seven shirts for $94.50. What would it cost if she only bought four?		$\frac{7\text{ shirts}}{\$94.50} = \frac{4\text{ shirts}}{\$\,x}$ $7x = 94.50(4)$ $7x = 378.00$ $x = \$54$