

# How to Calculate Compression Ratio in a Single Cylinder

## Lesson 9

Remember:

**P**retty **P**lease **M**y **D**ear **A**unt **S**ally

(From left to right; **P**arentheses; **P**ower; **M**ultiply; **D**ivide; **A**dd, **S**ubtract)

This lesson is set up to follow the piston displacement lesson. Please note that piston displacement is the same thing as cylinder volume. Compression ratio demonstrates direct and indirect variation (our next lesson) and solving an equation given the values

### Identify The Math, Math Terms, Vocabulary, Description Or Definitions

Equations    Volume    Ratios    Conversions

#### Formula for Compression Ratio

Note the steps, rules and underlying principles of the concept or theory.

**Substitution:** replacing one symbol by another.

**Improper Fraction:** a fraction in which the numerator is equal to or larger than the denominator. An improper fraction is equal to or greater than 1.

**Piston Displacement:** is the volume the piston displaces (moves) as it travels from TDC to BDC. The formula for **Piston Displacement:**

$$PD = \frac{\text{bore}^2 \times 3.14 \times \text{stroke}}{4}$$

Example: An engine has a 4" bore and 3" stroke.

$$PD = \frac{4^2 \times 3.14 \times 3}{4}$$

$$PD = 37.68 \text{ cu. in.}$$

And that's how we get the .7854 in the piston displacement formula

**Engine Compression Ratio** compares the cylinder volume with the piston at TDC (**Top Dead Center**) to the cylinder volume with the piston at BDC (**Bottom Dead Center**). An engine's compression ratio illustrates how much the air-fuel mixture is compressed on the compression stroke. Compression ratio is given as two numbers. For example, an engine having compression ration of 9:1 (9 to 1) means the maximum cylinder volume is nine times as large as the minimum cylinder volume. Minimum cylinder volume occurs at TDC.

The formula of **Piston Displacement** is:

**Engine Displacement** is TT x the bore squared x stroke x the number of cylinders/4 =

$$0.7854 \times (\text{bore})^2 \times \text{stroke} \times \# \text{ of cylinders}$$

Example: Bore = 4"

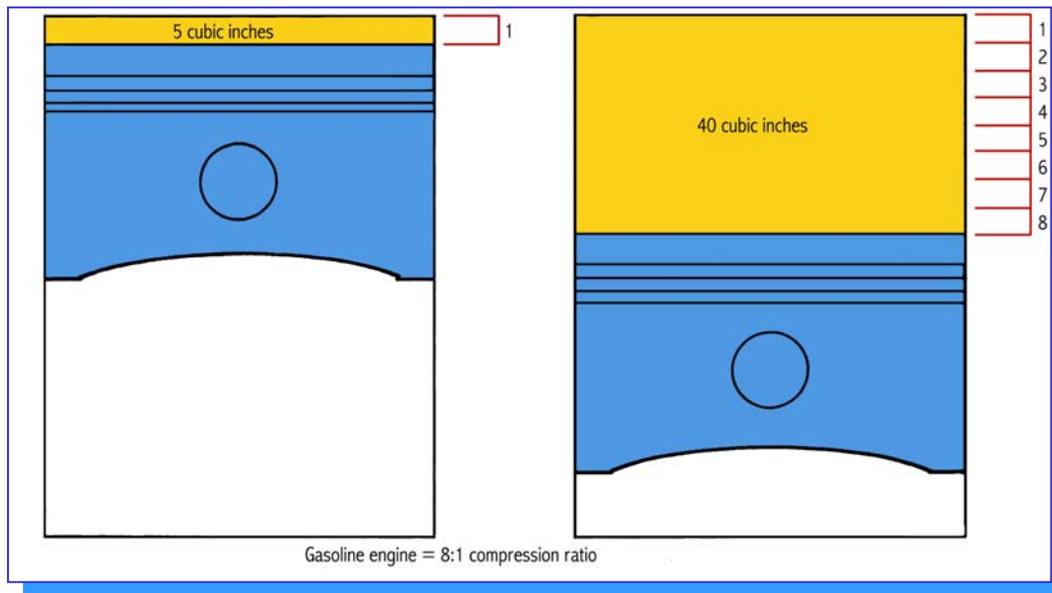
Stroke = 3"

No. of cylinders = 8

301 cu. in engine

### The Formula For Compression Ratio:

$$\text{CR} = \frac{\text{Cylinder Volume} + \text{Combustion Chamber Volume}}{\text{Combustion Chamber Volume}}$$



TDC

BDC

Example: the **Compression Ratio** in this cylinder is 40 cu.in to 5 cu.in OR 8:1

Review how to convert inches to centimeters using dimensional analysis: Cubic Inch to Cubic Centimeter formula: 1 cubic inch equals 16.387064...

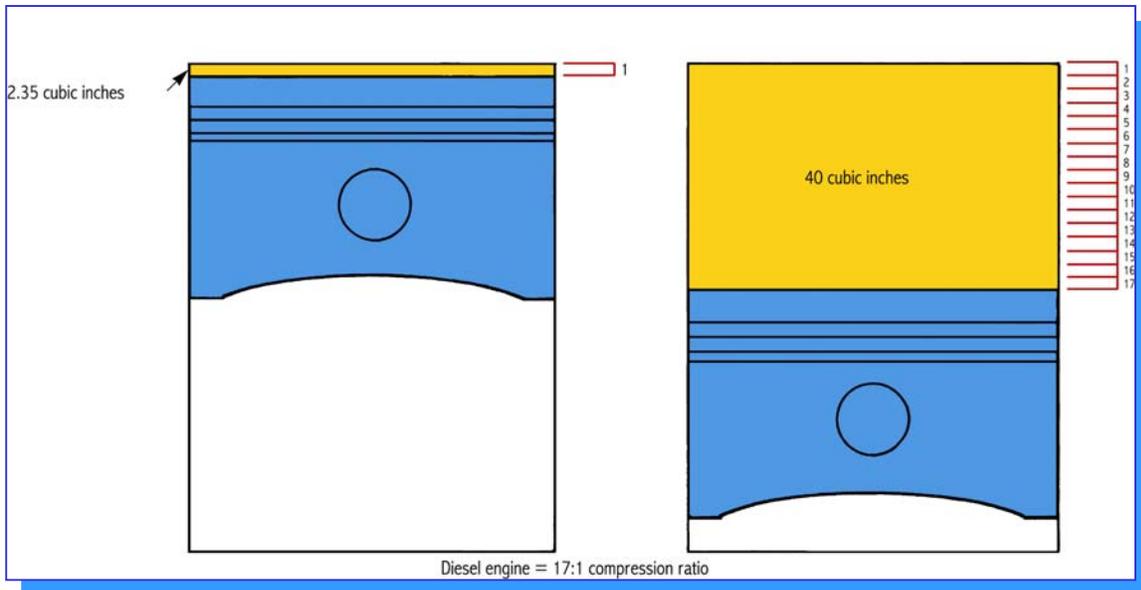
Cubic inch displacement (CID) • 16.387 = cubic centimeters (cc)

a.  $350 \text{ in}^3 \cdot 16.387 = \underline{\hspace{2cm}}$

Convert Cubic centimeters to cubic inches. Cubic centimeter (cc) • 0.061 = cubic inches

b.  $5735 \text{ cc} \cdot 0.061 = \underline{\hspace{2cm}}$

## Compression Ratio In A Diesel Engine 17:1



1. What is the **Compression Ratio** for a 5.0 L Mustang with a 302 CID (cubic inch displacement) engine, and a piston displacement of 618.60 cc and a **Combustion Chamber Volume** of 75 cc?
2. What is the **Compression Ratio** for a 5.0 L Mustang with a 302 CID, a piston displacement of 618.60 cc and a **Combustion Chamber Volume** of 68 cc?
3. A 284 CID engine has a **Cylinder Volume** (piston displacement) of 610.0 cc and a **Combustion Chamber Volume** of 35 cc. What is the compression ratio?
4. Find the piston displacement for a 426 Hemi engine with a stroke of 3.75 inches, 8 cylinders and a bore of 4.25 inches.
5. An 8-cylinder 350 CID engine has and a **Combustion Chamber Volume** of 40cc.
  - a. What is the **Compression Ratio**?
  - b. What is the **Compression Ratio** if the combustion chamber volume is increased to 60cc?
  - c. What is the **Compression Ratio** if CID is increased to 370 CID and a combustion chamber volume 60cc?

Let's Look At This Formula

$$P = \frac{F}{A}$$

- a. As A increases, what happens to P? Is this direct or indirect variation?
- b. As F increases, what happens to P? Is this direct or indirect variation?

6.

$$K = \frac{X}{Y}$$

- a. As X increases, what happens to K? Is this direct or indirect variation?
- b. As X decreases, what happens to K? Is this direct or indirect variation?

K varies directly or indirectly with X

7. Find the value of y in the equation  $y = 3x + 4$  if  $x = 6$

8. Find the value of y in the equation:

$$y = \frac{2x+1}{z} \quad \text{if } x = 5 \text{ and } z = 3$$

Leave as an improper fraction

9. Find the value of y in the equation:

$$y = \frac{9x-z}{z} \quad \text{if } x = 3 \text{ and } z = 11$$

Leave as an improper fraction.

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Lesson 9 Worksheet – Compression Ratio

Name: \_\_\_\_\_ AM-1: \_\_\_\_\_ PM \_\_\_\_\_ Date: \_\_\_\_\_

$$\text{CR} = \frac{\text{Cylinder Volume} + \text{Combustion Chamber Volume}}{\text{Combustion Chamber Volume}}$$

1. A 283 CID (cubic inch displacement) engine has a Cylinder Volume (Piston Displacement) of 579.6 cc and a combustion chamber volume of 60 cc. What is the compression ratio?

2. A 350 CID engine has a piston displacement of 716.90 and a chamber volume of 40 cc. What is the compression ratio?

3.

$$I = \frac{E}{R}$$

a. As E increases, what happens to I? Is this direct or indirect variation?

b. As E decreases, what happens to I? Is this direct or indirect variation?

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Lesson 9 Homework - Compression Ratio

Name: \_\_\_\_\_ AM-1: \_\_\_\_\_ PM \_\_\_\_\_ Date: \_\_\_\_\_

1. A 364 C.I.D (cubic inch displacement) engine has a cylinder volume (piston displacement) of 649.5 cc and a combustion chamber volume of 60 cc. What is the compression ratio?

2. A 375 CID engine has a piston displacement of 687.9 and a chamber volume of 50 cc.

a. What is the compression ratio?

b. If the piston displacement is increased to 702.4, what is the new compression ratio?

c. If the chamber volume is increased to 70 cc while the piston displacement remains at 687.9, what is the new compression ratio?

3. Looking at our original formula

$$CR = \frac{PD + CV}{CV}$$

a. When we increase PD, does the CR increase, decrease, or stay the same?

b. When we increase the CV, does the CR increase, decrease, or stay the same?

4. Look at this formula

$$Hp = \frac{d \times w}{33,000}$$

a. As the distance (d) increases, what happens to hp? Is this direct or indirect variation?

b. As the weight (w) increases, what happens to hp? Is this direct or indirect variation?

5. Given the equation,

$$C = \frac{A}{T}$$

circle the word that makes each statement correct:

a. C varies (directly, indirectly) with A

b. C varies (directly, indirectly) with T