

34.15 A fuel composed of 40% methane, 49% propane, and 11% nitrogen is burned in air. A dry gas analysis shows the product gas to contain 7% carbon dioxide, 4% carbene monoxide, 5% oxygen, and 84% nitrogen. What is the air-to-fuel ratio?

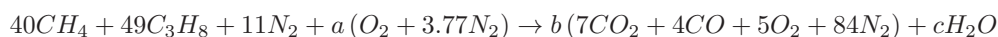
A. $13 \frac{lb_{air}}{lb_{fuel}}$

B. $15 \frac{lb_{air}}{lb_{fuel}}$

C. $17 \frac{lb_{air}}{lb_{fuel}}$

D. $19 \frac{lb_{air}}{lb_{fuel}}$

Since two hydrocarbons are being mixed, the blended fuel is not a **Common Fuel Constituent**. Write the unbalanced reaction using the percentages as coefficients for each reactant or product. Assign an arbitrary constant, a , to the quantity of air since the air to fuel ratio is unknown. Use a ratio of 3.77 nitrogen molecules per oxygen molecule in air. Assign a second constant, b , to the entire set of dry products. Assign a third constant, c , to water vapor, which is a product of any combustion reaction but is omitted from dry analysis.



Balance the carbon. Refer to the **Periodic Table** to gather molar mass values as needed.

$$40 + 3(49) = b(7 + 4)$$

$$b = 17$$

Balance the hydrogen.

$$4(40) + 8(49) = 2c$$

$$c = 276$$

Balance the oxygen.

$$2a = 17[2(7) + 4 + 2(5)] + 276$$

$$a = 376$$

Perform an optional check of the nitrogen balance if time allows. Inconsistencies at this stage may point to mistakes earlier in the solution.

$$2(11) + 2(3.77)(376) = 2(84)(17)$$

$$2857 \approx 2856 \checkmark$$

Calculate the air-to-fuel ratio by dividing the mass of air by the mass of fuel, both from the product side of the reaction.

$$\frac{A}{F} = \frac{m_{air}}{m_{fuel}} = \frac{376 [2 (16) + 3.77 (2) (14)]}{40 [12 + 4] + 49 [3 (12) + 8] + 11 [14 (2)]} = 16.7 \frac{lb_{air}}{lb_{fuel}}$$

Answer C