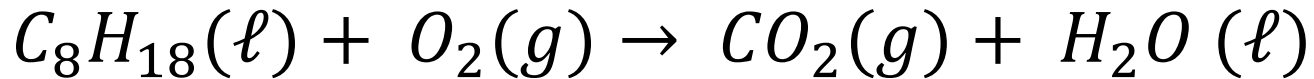
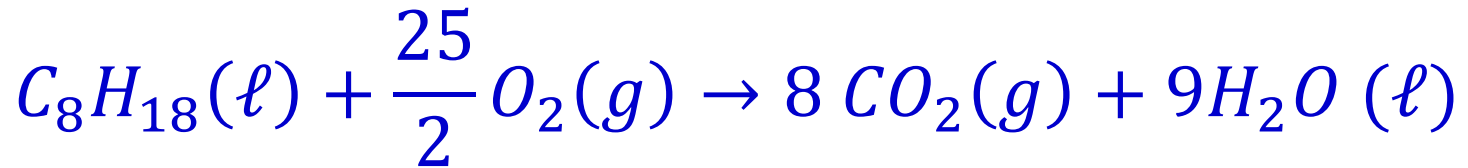


Determine the theoretical yield for the combustion of octane if 1 liter of octane fuel is mixed with 1420 liters of O_2 . Please first balance the chemical equation. [The density of octane is 0.7 gm/cm^3]



Solution: Step 1. Balance the chemical equation:

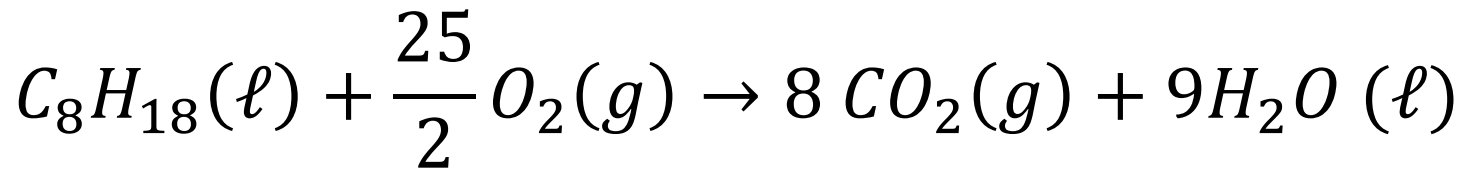


Step 2. calculate the number of moles of C_8H_{18} and O_2 as reactants.

$$n_1 = \frac{\rho_1 V_1}{M_{m,1}} = \frac{(0.70)(1)(1000)}{114} = 6.14 \text{ mol}$$

The factor of 1000 converts from cm^3 to L.

Determine the theoretical yield for the combustion of octane if 1 liter of octane fuel is mixed with 1420 liters of O_2 .



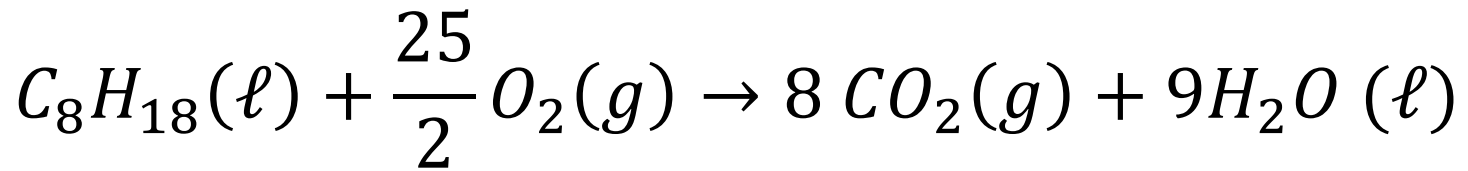
Step 2 (contd.). Let's conduct a unit analysis of the expression we used on the previous slide.

$$n_1 = \frac{\rho_1 V_1}{M_{m,1}} = \frac{(\text{gm}/\text{cm}^3)(\text{L})(\text{cm}^3/\text{L})}{\text{gm}/\text{mol}} = \text{mol}$$

And of course the molar mass of octane is

$$M_m = 8(12) + 18 = 114 \text{ amu}$$

Determine the theoretical yield for the combustion of octane if 1 liter of octane fuel is mixed with 1420 liters of O_2 .

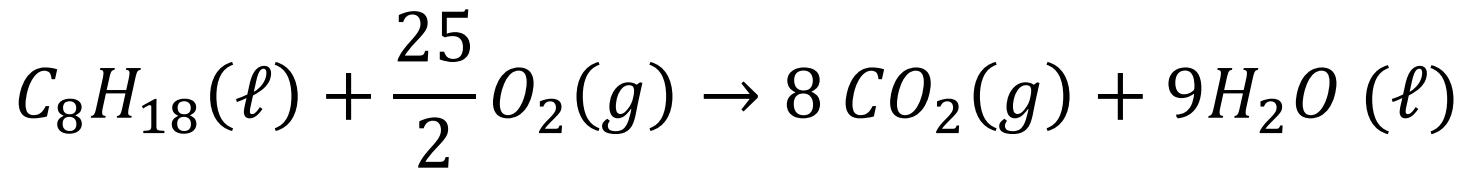


Step 2 (contd.). calculate the number of moles of C_8H_{18} and O_2 as reactants.

$$n_1 = \frac{\rho_1 V_1}{M_{m,1}} = \frac{(0.70)(1)(1000)}{114} = 6.14 \text{ mol}$$

$$n_2 = \frac{PV_2}{RT} = \frac{(1 \text{ atm})(1420 \text{ L})}{\left(0.08206 \frac{\text{Latm}}{\text{molK}}\right) (298 \text{ K})} = 58.1 \text{ moles}$$

Determine the theoretical yield for the combustion of octane if 1 liter of octane fuel is mixed with 1420 liters of O₂.



Step 3. Compare the actual molar ratio to the stoichiometry

$$Actual = \frac{n_2}{n_1} = \frac{58.1}{6.14} = 9.46$$

The stoichiometry requires a ratio of 12.5. We will run out of O₂ before the combustion is complete. The ratio of the actual to theoretically required O₂ is

$$Yield = \frac{9.46}{12.5} = 0.756 = 75.6\%$$