1. A 2.0 L sample of nitrogen gas combines chemically with a 5.0 L sample of oxygen (both at STP) to form 2.0 L of a gaseous product.
   a. Write the simplest possible chemical equation for this reaction, making no prior assumptions about N and O being diatomic or monatomic. Did this problem require you to make nitrogen and/or oxygen diatomic? Why?
   b. We know from other observations that both nitrogen and oxygen are diatomic. Rewrite your equation to account for this.

2. 2.0 L of carbon vapor combine chemically with 3 L of chlorine gas and 1.0 L of hydrogen gas to form 2.0 L of chloroform (with all gases at the same T and P). If both hydrogen and chlorine are diatomic and carbon is monatomic, what is the formula for chloroform? Write the complete equation for this reaction.

3. It is observed that 20 L of methanol vapor, CH₃OH, combine with 30 L of oxygen gas to form 20 L of carbon dioxide gas, CO₂, and 40 L of water vapor (with all substances at the same T and P). Does this observation support the claim that oxygen is diatomic? Explain.

4. 500 mL of chlorine gas combine chemically with 250 mL of oxygen gas to form 500 mL of a gaseous product, all at STP.
   a. Write the simplest possible chemical equation for this reaction, making no prior assumptions about Cl and O being diatomic or monatomic. Did this problem require you to make chlorine and/or oxygen diatomic? Why?
   b. We know from other observations that both chlorine and oxygen are diatomic. Rewrite your equation to account for this.

ANSWERS:

1. [a] 2 N (g) + 5 O₂ (g) --> 2 NO₅ (g)
   [b] 2N₂ (g) + 5 O₂ (g) --> 2 N₂O₅ (g)

2. 2C (g) + 3Cl₂(g) + H₂ (g) --> 2 CCl₃H (g)

3. 2CH₃OH (g) + 3O₂ (g) --> 2CO₂ (g) + 4H₂O (g)
   Yes, it does support the claim that oxygen is diatomic. If oxygen is diatomic then oxygens are conserved in the equation: 2x1 + 3x2 = 8 on the reactant side and 2x2 + 4x1 = 8 on the product side. If oxygen were monatomic the oxygens would not be conserved: you’d have only 5 O on the reactant side vs. 8 O on the product side.

4. [a] 2Cl (g) + O₂ (g) --> 2 ClO (g)
\[ 2\text{Cl}_2 (g) + \text{O}_2 (g) \rightarrow 2\text{Cl}_2\text{O} (g) \]