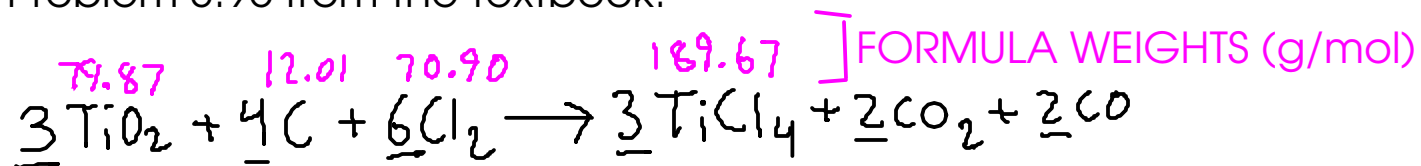


Problem 3.95 from the textbook:



A vessel contains 4.15 g of titanium(IV) oxide, 5.67 g of carbon, and 6.78 g of chlorine gas. If the reaction goes to completion as written, how many grams of titanium(IV) chloride can be produced?

$$\begin{array}{l} \text{TiO}_2: \quad 79.87 \text{ g TiO}_2 = \text{mol TiO}_2 \quad 3 \text{ mol TiO}_2 = 3 \text{ mol TiCl}_4 \quad 189.67 \text{ g TiCl}_4 = \text{mol TiCl}_4 \\ 4.15 \text{ g TiO}_2 \times \frac{\text{mol TiO}_2}{79.87 \text{ g TiO}_2} \times \frac{3 \text{ mol TiCl}_4}{3 \text{ mol TiO}_2} \times \frac{189.67 \text{ g TiCl}_4}{\text{mol TiCl}_4} = 9.86 \text{ g TiCl}_4 \end{array}$$

$$\begin{array}{l} \text{C}: \quad 12.01 \text{ g C} = \text{mol C} \quad 4 \text{ mol C} = 3 \text{ mol TiCl}_4 \quad 189.67 \text{ g TiCl}_4 = \text{mol TiCl}_4 \\ 5.67 \text{ g C} \times \frac{\text{mol C}}{12.01 \text{ g C}} \times \frac{3 \text{ mol TiCl}_4}{4 \text{ mol C}} \times \frac{189.67 \text{ g TiCl}_4}{\text{mol TiCl}_4} = 67.2 \text{ g TiCl}_4 \end{array}$$

$$\begin{array}{l} \text{Cl}_2: \quad 70.90 \text{ g Cl}_2 = \text{mol Cl}_2 \quad 6 \text{ mol Cl}_2 = 3 \text{ mol TiCl}_4 \quad 189.67 \text{ g TiCl}_4 = \text{mol TiCl}_4 \\ 6.78 \text{ g Cl}_2 \times \frac{\text{mol Cl}_2}{70.90 \text{ g Cl}_2} \times \frac{3 \text{ mol TiCl}_4}{6 \text{ mol Cl}_2} \times \frac{189.67 \text{ g TiCl}_4}{\text{mol TiCl}_4} = 9.07 \text{ g TiCl}_4 \end{array}$$

Since all of these reactants are being consumed at once, the reaction will stop when any one reactant runs out. Chlorine gas runs out first, and 9.07 grams of product has been produced at that point. The final answer to the problem is:

$$\boxed{9.07 \text{ g TiCl}_4}$$

(This is a limiting reactant problem!)