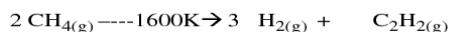


**Gas Stoichiometry : Answer Key.**

1. Cracking. At  $T > 1600\text{ K}$  two methane ( $\text{CH}_4$ ) molecules rearrange to give three molecules of hydrogen and one molecule of acetylene ( $\text{C}_2\text{H}_2$ ). A 50.0 L steel vessel was filled with methane to a P of 10.0 atm at 298 K. The gas was heated to 1600. K to crack methane and produce  $\text{C}_2\text{H}_2$ . If this process went to 100% yield, what mass of  $\text{C}_2\text{H}_2$  would be produced? What P would the reactor reach at 1600 K?

Need a balanced chemical equation:



a) Write plan:  $P \text{CH}_4 \xrightarrow{\text{Ideal gas law}} \text{mol CH}_4 \xrightarrow{\text{SR}} \text{mol C}_2\text{H}_2 \xrightarrow{\text{MM}} \text{mass C}_2\text{H}_2$

$$n = \frac{(10.0 \text{ atm})(50.0\text{L}) \text{ mol K}}{(0.0286 \text{ L atm})(298 \text{ K})} = 20.45 \text{ mol CH}_4$$

$$(20.45 \text{ mol CH}_4) \left( \frac{\text{mol C}_2\text{H}_2}{2 \text{ mol CH}_4} \right) \left( \frac{26.04 \text{ g C}_2\text{H}_2}{1 \text{ mol C}_2\text{H}_2} \right) = 266 \text{ g acetylene}$$

b) Write a data table

T = 1600 K

R from table

V = 50.0 L

n = moles in the reactor at the end of reaction = mol  $\text{H}_2$  + mol  $\text{C}_2\text{H}_2$

P = ? use ideal gas law.

To get the moles of product there are several possibilities (as in most problems). Some of them:

a)  $P \text{CH}_4 \xrightarrow{\text{Ideal gas law}} \text{mol CH}_4 \xrightarrow{\text{SR}} \text{mol H}_2$   
 $\text{mol CH}_4 \xrightarrow{\text{SR}} \text{mol C}_2\text{H}_2$  add the results

b)  $\text{mol CH}_4 \xrightarrow{\text{SR}} \text{mol C}_2\text{H}_2$   
 $\text{mol C}_2\text{H}_2 \xrightarrow{\text{SR}} \text{mol H}_2$  add the results.

c) Here, we will try mol of  $\text{CH}_4$  to mol of product using the stoichiometric ratio for both gases present:

$$(20.45 \text{ mol CH}_4) \left( \frac{4 \text{ mol gases}}{2 \text{ mol CH}_4} \right) = 40.9 \text{ mol in reactor}$$

P = 107 atm. (Substitute all values in ideal gas law)