Limiting Reagents and First Law

Please show your work and either circle your final answer or put in the spaces provided

1) (5 pts) 12.1 g of \( \text{C}_4\text{H}_6 \) is mixed with 32.2 g of \( \text{Cl}_2 \). The following reaction goes to completion.

\[
\text{C}_4\text{H}_6 + 2 \text{Cl}_2 \rightarrow \text{C}_4\text{Cl}_4\text{H}_6
\]

What at the masses (in grams) of all substances remaining after the reaction has gone to completion?

(MW[\text{C}_4\text{H}_6] = 54.092 \quad \text{MW[Cl}_2] = 70.905 \quad \text{MW[Cl}_4\text{H}_6] = 195.902)

\[
\text{WE FIRST DETERMINE THE MOLES OF C}_4\text{H}_6 \text{ AND C}_2\text{.}
\]

\[
\text{mol C}_4\text{H}_6 = \frac{12.1 \text{ g}}{54.092 \text{ g/mol}} = 0.224 \text{ mol}
\]

\[
\text{mol Cl}_2 = \frac{32.2 \text{ g}}{70.905 \text{ g/mol}} = 0.454 \text{ mol}
\]

\[
\text{NEXT, WE MAKE AN INITIAL/CHANGE/FINAL TABLE}
\]

\[
\begin{array}{ccc}
\text{C}_4\text{H}_6 & + & 2 \text{Cl}_2 & \rightarrow \text{C}_4\text{Cl}_4\text{H}_6 \\
\text{T} & 0.224 & 0.454 \\
\text{C} & -2x & -2x & +x \\
\text{F} & 0.224 -x & 0.454 -2x & +x
\end{array}
\]

C loses to zero when
\[
x = \frac{0.224}{2} = 0.227
\]

Smaller x so this is limiting reagent

\[
\text{NOW THAT WE KNOW X, WE CAN FILL OUT THE TABLE}
\]

\[
\begin{array}{ccc}
\text{C}_4\text{H}_6 & + & 2 \text{Cl}_2 & \rightarrow \text{C}_4\text{Cl}_4\text{H}_6 \\
\text{T} & 0.224 & 0.454 \\
\text{C} & -0.224 & -2(0.224) & +0.224 \\
\text{F} & 0 & 0.006 & +0.224
\end{array}
\]

Converting from moles back to mass in g, we let

\[
\text{mass Cl}_2 = 0.006 \text{ mol} \left(\frac{70.905 \text{ g}}{1 \text{ mol}}\right) = 0.42 \text{ g Cl}_2
\]

\[
\text{mass C}_4\text{Cl}_4\text{H}_6 = 0.224 \text{ mol} \left(\frac{195.902 \text{ g}}{1 \text{ mol}}\right) = 43.9 \text{ g C}_4\text{Cl}_4\text{H}_6
\]
2) (5 pts) Consider a monatomic ideal gas stored in an insulated container (such that it can not exchange heat with the surroundings or the container). Initially, the temperature is 25°C and the volume is 1 liter. If the gas is then compressed to 0.5 liter, what are the signs of $q$ and $w$ for the gas:

$q$: positive negative zero (circle one, 2pts)

$w$: positive negative zero (circle one, 3pts)