CH301
FALL 2011
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MORE STOICHIOMETRY PRACTICE

1. Consider the following reaction:
$$4KO_2(s) + 2CO_2(g) \rightarrow 2K_2CO_3(s) + 3O_2(g)$$

How many moles of KO_2 are needed to react with 75.0 L of carbon dioxide at -25°C and 215 kPa?

[1] unit conversions

$-25\,^\circ C = -25 + 273.15\,K = 248.15\,K$

$215\,kPa = \frac{215}{101.325}\,atm = 2.122\,atm$

[2] $n_{CO_2} = \frac{PV}{RT} = \frac{(2.122\,atm)(75.0\,L)}{\left(0.08206\,\frac{L\cdot atm}{mol\,K}\right)(248.15\,K)} = 7.8156\,mol$

[3] $\frac{n_{KO_2}}{n_{CO_2}} = \frac{4}{2} \Rightarrow n_{KO_2} = 2n_{CO_2}$

$= 2(7.8156\,mol)$

$= 15.631\,mol$

2. Consider the following reaction:
$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$$

(a) How many grams of carbon dioxide are formed when 55.5 g of butane reacts with 45.5 g O_2?

[1] $n_{butane} = \frac{m_{butane}}{MW_{butane}} = \frac{55.5\,g}{58\,\frac{g}{mol}} = 0.9569\,mol$

$n_{O_2} = \frac{m_{O_2}}{MW_{O_2}} = \frac{45.5\,g}{32\,g/mol} = 1.4219\,mol$

[2] Limiting reagent is O_2 b/c

$n_{O_2} \rightarrow \frac{1.4219}{13} = 0.1094 < 0.4784 = \frac{0.9569}{2}$ ← n_{butane}

[3] $\frac{n_{O_2}}{n_{CO_2}} = \frac{13}{8} \Rightarrow n_{CO_2} = n_{O_2}\left(\frac{8}{13}\right)$

$= 1.4219\left(\frac{8}{13}\right)$

$= 0.8750\,mol$

(b) If P=135 kPa and T=270 K, what is the volume of this amount of carbon dioxide? What is the total final volume of this system?

[1] $V_{CO_2} = \frac{nRT}{P} = \frac{(0.8750\,mol)\left(0.08206\,\frac{L\cdot atm}{mol\,K}\right)(270\,K)}{\left(\frac{135}{101.325}\,atm\right)} = 14.55\,L$

[4] $m_{CO_2} = n_{CO_2} \times MW_{CO_2}$

$= (0.8750\,mol)\times\left(44\,\frac{g}{mol}\right)$

$= 38.5\,g$

[2] $n_{butane\ remaining} = 0.9569 - 2(0.1094) = 0.7381\,mol$

$V_{butane\ remaining} = \frac{nRT}{P} = 12.275\,L$

[3] $V_{TOT} = V_{CO_2} + V_{butane\ remain}$

$= 14.55 + 12.275$

$= 26.83\,L$

(c) Starting over, 43.2 L of butane is mixed with 76.0 L of O_2 at the same pressure and temperature to give an initial volume of 119.2 L. After butane and O_2 react, the total volume changes, Assuming that the reaction runs to completion, what is the final volume?

[1] B/c P = cte & T = cte, the problem can be worked in liters ($n \propto V$ b/c $n = \frac{P}{RT}V$, P = cte, T = cte)

[2] Limiting reagent is O_2 b/c $\frac{43.2}{2} = 21.6 > 5.85 = \frac{76}{13}$

[3] $V_{final} = V_{CO_2} + V_{C_4H_{10}\ remain.} = 8(5.85) + (43.2 - 2(5.85))$

$= 46.8 + (43.2 - 11.7)$

$= 78.3\,L$