Assignment #3 KEY

April 9, 2018 10:18 AM

26. mass of CS_2 (based on C) $= 17.5\text{ g C} \times \frac{1\text{ mol C}}{12.0\text{ g C}} \times \frac{1\text{ mol }CS_2}{5\text{ mol C}} \times \frac{76.2\text{ g }CS_2}{1\text{ mol }CS_2} = 22.2\text{ g}$

mass of CS_2 (based on SO_2) $= 39.5\text{ g }SO_2 \times \frac{1\text{ mol }SO_2}{64.1\text{ g }SO_2} \times \frac{1\text{ mol }CS_2}{2\text{ mol }SO_2} \times \frac{76.2\text{ g }CS_2}{1\text{ mol }CS_2} = 23.5\text{ g}$

Since C produces the least amount of CS_2, then the mass of CS_2 produced is **22.2 g.** The SO_2 is present in excess, so the mass of SO_2 used can be calculated arbitrarily based on the mass of C.

mass of SO_2 used $= 17.5\text{ g C} \times \frac{1\text{ mol C}}{12.0\text{ g C}} \times \frac{2\text{ mol }SO_2}{5\text{ mol C}} \times \frac{64.1\text{ g }SO_2}{1\text{ mol }SO_2} = 37.4\text{ g}$

mass of SO_2 in excess = 39.5 – 37.4 = **2.1 g**

27. mass of NO (based on Cu) $= 87.0\text{ g Cu} \times \frac{1\text{ mol Cu}}{63.5\text{ g Cu}} \times \frac{2\text{ mol NO}}{3\text{ mol Cu}} \times \frac{30.0\text{ g NO}}{1\text{ mol NO}} = 27.4\text{ g}$

mass of NO (based on HNO_3) $= 225\text{ g }HNO_3 \times \frac{1\text{ mol }HNO_3}{63.0\text{ g }HNO_3} \times \frac{2\text{ mol NO}}{8\text{ mol }HNO_3} \times \frac{30.0\text{ g NO}}{1\text{ mol NO}} = 26.8\text{ g}$

Since HNO_3 produces the least amount of NO, then the mass of NO produced is **26.8 g.**
Now find the mass of Cu in excess, based on the amount of HNO_3 used.

mass of Cu used $= 225\text{ g }HNO_3 \times \frac{1\text{ mol }HNO_3}{63.0\text{ g }HNO_3} \times \frac{3\text{ mol Cu}}{8\text{ mol }HNO_3} \times \frac{63.5\text{ g Cu}}{1\text{ mol Cu}} = 85.0\text{ g}$

mass of Cu in excess = 87.0 – 85.0 = **2.0 g**

28. mass of P_4 [based on $Ca_3(PO_4)_2$] $= 41.5\text{ g }Ca_3(PO_4)_2 \times \frac{1\text{ mol }Ca_3(PO_4)_2}{310.3\text{ g }Ca_3(PO_4)_2} \times \frac{1\text{ mol }P_4}{2\text{ mol }Ca_3(PO_4)_2} \times \frac{124.0\text{ g }P_4}{1\text{ mol }P_4} = 8.29\text{ g}$

mass of P_4 (based on SiO_2) $= 26.5\text{ g }SiO_2 \times \frac{1\text{ mol }SiO_2}{60.1\text{ g }SiO_2} \times \frac{1\text{ mol }P_4}{6\text{ mol }SiO_2} \times \frac{124.0\text{ g }P_4}{1\text{ mol }P_4} = 9.11\text{ g}$

mass of P_4 (based on C) $= 7.80\text{ g C} \times \frac{1\text{ mol C}}{12.0\text{ g C}} \times \frac{1\text{ mol }P_4}{10\text{ mol C}} \times \frac{124.0\text{ g }P_4}{1\text{ mol }P_4} = 8.06\text{ g}$

Since C produces the least amount of P_4, then the mass of P_4 produced is **8.06 g.**
Next, calculate the masses of both $Ca_3(PO_4)_2$ and SiO_2 used by the C:

mass of $Ca_3(PO_4)_2$ used $= 7.80\text{ g C} \times \frac{1\text{ mol C}}{12.0\text{ g C}} \times \frac{2\text{ mol }Ca_3(PO_4)_2}{10\text{ mol C}} \times \frac{310.3\text{ g }Ca_3(PO_4)_2}{1\text{ mol }Ca_3(PO_4)_2} = 40.3\text{ g}$

mass of $Ca_3(PO_4)_2$ in excess = 41.5 – 40.3 = **1.2 g**

mass of SiO_2 used $= 7.80\text{ g C} \times \frac{1\text{ mol C}}{12.0\text{ g C}} \times \frac{6\text{ mol }SiO_2}{10\text{ mol C}} \times \frac{60.1\text{ g }SiO_2}{1\text{ mol }SiO_2} = 23.4\text{ g}$

mass of SiO_2 in excess = 26.5 – 23.4 = **3.1 g**

29. mass of Br_2 (based on $K_2Cr_2O_7$) $= 25.0 \text{ g } K_2Cr_2O_7 \times \frac{1 \text{ mol } K_2Cr_2O_7}{294.2 \text{ g } K_2Cr_2O_7} \times \frac{3 \text{ mol } Br_2}{1 \text{ mol } K_2Cr_2O_7} \times \frac{159.8 \text{ g } Br_2}{1 \text{ mol } Br_2}$

$= 40.7 \text{ g}$

mass of Br_2 (based on KBr) $= 55.0 \text{ g KBr} \times \frac{1 \text{ mol KBr}}{119.0 \text{ g KBr}} \times \frac{3 \text{ mol } Br_2}{6 \text{ mol KBr}} \times \frac{159.8 \text{ g } Br_2}{1 \text{ mol } Br_2} = 36.9 \text{ g}$

mass of Br_2 (based on H_2SO_4) $= 60.0 \text{ g } H_2SO_4 \times \frac{1 \text{ mol } H_2SO_4}{98.1 \text{ g } H_2SO_4} \times \frac{3 \text{ mol } Br_2}{7 \text{ mol } H_2SO_4} \times \frac{159.8 \text{ g } Br_2}{1 \text{ mol } Br_2}$

$= 41.9 \text{ g}$

KBr is the limiting reactant (it produces the least amount of Br_2). $K_2Cr_2O_7$ and H_2SO_4 are in excess. Calculate the mass of $K_2Cr_2O_7$ and H_2SO_4 present in excess, arbitrarily based on the mass of KBr.

mass of $K_2Cr_2O_7$ used $= 55.0 \text{ g KBr} \times \frac{1 \text{ mol KBr}}{119.0 \text{ g KBr}} \times \frac{1 \text{ mol } K_2Cr_2O_7}{6 \text{ mol KBr}} \times \frac{294.2 \text{ g } K_2Cr_2O_7}{1 \text{ mol } K_2Cr_2O_7} = 22.7 \text{ g}$

mass of $K_2Cr_2O_7$ in excess = 25.0 – 22.7 = **2.3 g**

mass of H_2SO_4 used $= 55.0 \text{ g KBr} \times \frac{1 \text{ mol KBr}}{119.0 \text{ g KBr}} \times \frac{7 \text{ mol } H_2SO_4}{6 \text{ mol KBr}} \times \frac{98.1 \text{ g } H_2SO_4}{1 \text{ mol } H_2SO_4} = 52.9 \text{ g}$

mass of H_2SO_4 in excess = 60.0 – 52.9 = **7.1 g**

30. volume of CO_2 (based on C_5H_{12}) $= 0.0250 \text{ L } C_5H_{12} \times \frac{626.0 \text{ g } C_5H_{12}}{1 \text{ L } C_5H_{12}} \times \frac{1 \text{ mol } C_5H_{12}}{72.0 \text{ g } C_5H_{12}} \times \frac{5 \text{ mol } CO_2}{1 \text{ mol } C_5H_{12}}$

$\times \frac{22.4 \text{ L } CO_2}{1 \text{ mol } CO_2} = 24.3 \text{ L}$

volume of CO_2 (based on O_2) $= 40.0 \text{ L } O_2 \times \frac{1 \text{ mol } O_2}{22.4 \text{ L } O_2} \times \frac{5 \text{ mol } CO_2}{8 \text{ mol } O_2} \times \frac{22.4 \text{ L } CO_2}{1 \text{ mol } CO_2} = 25.0 \text{ L}$

Hence, the C_5H_{12} is the limiting reactant and **24.3 L** of CO_2(g) will be produced.

31. moles of HCl $= 0.100 \frac{\text{mol}}{\text{L}} \times 0.0500 \text{ L} = 5.00 \times 10^{-3} \text{ mol}$

moles of NaCl (based on HCl) $= 5.00 \times 10^{-3} \text{ mol HCl} \times \frac{1 \text{ mol NaCl}}{1 \text{ mol HCl}} = 5.00 \times 10^{-3} \text{ mol}$

moles of NaOH $= 0.200 \frac{\text{mol}}{\text{L}} \times 0.0300 \text{ L} = 6.00 \times 10^{-3} \text{ mol}$

moles of NaCl (based on NaOH) $= 6.00 \times 10^{-3} \text{ mol NaOH} \times \frac{1 \text{ mol NaCl}}{1 \text{ mol NaOH}} = 6.00 \times 10^{-3} \text{ mol}$

Since the NaOH can produce more NaCl, the **NaOH** is in excess.

32. mass of $BaBr_2$ [based on $Ba(OH)_2$] $= 0.250 \text{ g } Ba(OH)_2 \times \frac{1 \text{ mol } Ba(OH)_2}{171.3 \text{ g } Ba(OH)_2} \times \frac{1 \text{ mol } BaBr_2}{1 \text{ mol } Ba(OH)_2}$

$\times \frac{297.1 \text{ g } BaBr_2}{1 \text{ mol } BaBr_2} = 0.434 \text{ g}$

moles of HBr $= 0.125 \frac{\text{mol}}{\text{L}} \times 0.0150 \text{ L} = 1.875 \times 10^{-3} \text{ mol}$

mass of $BaBr_2$ (based on HBr) $= 1.875 \times 10^{-3} \text{ mol HBr} \times \frac{1 \text{ mol } BaBr_2}{2 \text{ mol HBr}} \times \frac{297.1 \text{ g } BaBr_2}{1 \text{ mol } BaBr_2} = 0.279 \text{ g}$

Since HBr is the limiting reactant, **0.279 g** of $BaBr_2$ can be formed.