Chemistry HP Final Review Problem

Methane (CH_4) reacts with ammonia (NH_3) and oxygen to produce hydrocyanic acid and water.
(a) Write a balanced chemical for this reaction.
(b) Methane has a density of 0.717 g/mL, determine the mass of 50.0 mL of methane. Calculate the moles of methane present.
(c) Calculate the number of moles of ammonia present in 1.20×10^{24} molecules of ammonia.
(d) The methane and ammonia are reacted in the presence of oxygen. Determine the mass of hydrocyanic acid and water produced. Calculate the number of molecules of hydrocyanic acid produced. Determine the volume of water produced.
(e) Calculate the mass of oxygen required in the reaction. How many molecules of oxygen are required?
(f) What mass of the excess reactant in used in the reaction and what mass of the excess reactant remains after the reaction?
(g) Draw a Lewis Structure for each compound in the reaction. Classify the VSEPR shape of each molecule.

a) $\underline{2}CH_4 + \underline{2}NH_3 + \underline{3}O_2 \longrightarrow \underline{2}HCN + \underline{6}H_2O$

2	C	2
14	H	14
2	N	2
6	O	6

b) $50 \text{ mL } CH_4 \times \frac{0.717 \text{ g}}{1 \text{ mL}} = 35.85 \text{ g } CH_4$

$35.85 \text{ g } CH_4 \times \frac{1 \text{ mol}}{16.04 \text{ g } CH_4} = 2.235 \text{ mol } CH_4$

c) $1.20 \times 10^{24} \text{ molecules } NH_3 \times \frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ molecules}} = 1.99 \text{ mole } NH_3$

d) $2.235 \text{ mol } CH_4 \times \frac{2 \text{ mol HCN}}{2 \text{ mol } CH_4} \times \frac{27.03 \text{ g HCN}}{1 \text{ mol HCN}} = 60.41 \text{ g HCN}$

NH_3 = LR
CH_4 = excess

$1.99 \text{ mol } NH_3 \times \frac{2 \text{ mol HCN}}{2 \text{ mol } NH_3} \times \frac{27.03 \text{ g HCN}}{1 \text{ mol HCN}} = 53.8 \text{ g HCN}$

$1.99 \text{ mol } NH_3 \times \frac{6 \text{ mol } H_2O}{2 \text{ mol } NH_3} \times \frac{18.02 \text{ g } H_2O}{1 \text{ mol } H_2O} = 107.57 \text{ g } H_2O$

$53.8 \text{ g HCN} \times \frac{1 \text{ mol HCN}}{27.03 \text{ g HCN}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol HCN}} = 1.20 \times 10^{24} \text{ molecules HCN}$

$107.57 \text{ g } H_2O \times \frac{1 \text{ mL}}{1 \text{ g}} = 107.57 \text{ mL } H_2O$

(Density H_2O)

e) $1.99 \text{ mol } NH_3 \times \frac{3 \text{ mol } O_2}{2 \text{ mol } NH_3} \times \frac{32 \text{ g } O_2}{1 \text{ mol } O_2} = 95.5 \text{ g } O_2$

$1.99 \text{ mol } NH_3 \times \frac{3 \text{ mol } O_2}{2 \text{ mol } NH_3} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol } O_2} = 1.80 \times 10^{24}$ molecules of O_2

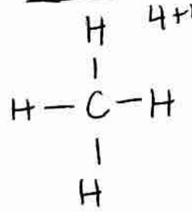
f) CH_4 = excess

$1.99 \text{ mol } NH_3 \times \frac{2 \text{ mol } CH_4}{2 \text{ mol } NH_3} \times \frac{16.04 \text{ g } CH_4}{1 \text{ mol } CH_4} = 31.9 \text{ g } CH_4$ used

$35.85 \text{ g } CH_4$ (initial) $- 31.9 \text{ g } CH_4$ (used) $= 3.4 \text{ g } CH_4$ (remains in excess)

g) CH_4

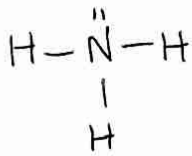
$4+4(1)=8$



tetrahedral

NH_3

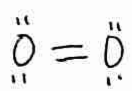
$5+3(1)=8$



trigonal pyrimidal

O_2

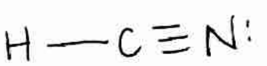
$2(6)=12$



linear

HCN

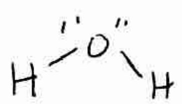
$1+4+5=10$



linear

H_2O

$2(1)+6=8$



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