Stoichiometry WS #5

① $6Na + Fe_2O_3 \rightarrow 3Na_2O + 2Fe$

$6x \quad x \quad 3x \quad 2x$

a) Na: $\frac{100g}{23 g/mol} = 4.348 \text{ mol}$

$6x = 4.348$

$x = 0.725 \text{ mol}$

$Fe = 2x = 2(0.725) = 1.449 \text{ mol}$

Sodium

Fe_2O_3: $\frac{100g}{159.6 g/mol} = 0.627 \text{ mol} = x$

$Fe = 2x = 2(0.627) = 1.253 \text{ mol}$

Fe_2O_3

Since Fe_2O_3 results in less, **Fe_2O_3 is limiting**

b) Na is excess

c) Fe = 1.253 mol (from part a)

$1.253 \text{ mol} \times 55.8 g/mol = \boxed{69.9 g}$

d) $Fe_2O_3 = 0.627 \text{ mol} = x$ (from part a)

$Na = 6x = 6(0.627) = 3.759 \text{ mol}$

$3.759 \text{ mol} \times 23 g/mol = 86.5 g$

$100g - 86.5g = \boxed{13.5g \text{ Na left}}$

② $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$

$6x \quad 6x \quad x \quad 6x$

a) CO_2: $\frac{88\,g}{44\,g/mol} = 2\ mol$

$6x = 2$

$x = 0.\overline{3}\ mol$

$C_6H_{12}O_6 = x = 0.\overline{3}\ mol$

H_2O: $\frac{64\,g}{18.02\,g/mol} = 3.552\ mol$

$6x = 3.552$

$x = 0.592\ mol$

$C_6H_{12}O_6 = x = 0.592\ mol$

∴ CO_2 is limiting

b) H_2O is excess

$C_6H_{12}O_6 = x = 0.\overline{3}\ mol$ (from a)

$H_2O = 6x = 6(0.\overline{3}) = 2\ mol$

$2\ mol \times 18.02\,g/mol = 36.04\,g$

$64\,g - 36.04\,g = \boxed{27.96\,g\ H_2O\ left}$

c) $C_6H_{12}O_6 = 0.\overline{3}\ mol$

$0.\overline{3}\ mol \times 180.12\,g/mol = \boxed{60\,g}$

③ $Fe + 2NiO(OH) + 2H_2O \rightarrow Fe(OH)_2 + 2Ni(OH)_2$

$x \quad 2x \quad 2x \quad x \quad 2x$

$Fe = x = 5\ mol$

$Fe(OH)_2 = x = 5\ mol$

Fe

$NiO(OH) = 2x = 8\ mol$

$x = 4\ mol$

$NiO(OH)$

$Fe(OH)_2 = x = 4\ mol$

∴ $NiO(OH)$ is limiting

4 mol $Fe(OH)_2$ are produced

④ $Zn + 2MnO_2 + H_2O \rightarrow Zn(OH)_2 + Mn_2O_3$

$x \quad 2x \quad x \quad x \quad x$

a) $Zn: \frac{25\ g}{65.4\ g/mol} = 0.382\ mol = x$

$Zn(OH)_2 = x = 0.382\ mol$

$MnO_2: \frac{30\ g}{86.9\ g/mol} = 0.345\ mol$

$2x = 0.345$

$x = 0.173\ mol$

$Zn(OH)_2 = x = 0.173\ mol$

∴ MnO_2 is limiting

④ b) $Zn(OH)_2 = 0.173$ mol

$0.173 \text{ mol} \times 99.42 \text{ g/mol} = \boxed{17.2 \text{ g}}$

⑤ $3NH_4NO_3 + Na_3PO_4 \rightarrow (NH_4)_3PO_4 + 3NaNO_3$

$3x \qquad x \qquad x \qquad 3x$

a) NH_4NO_3: $\frac{30 \text{ g}}{80.04 \text{ g/mol}} = 0.375$ mol

$3x = 0.375$

$x = 0.125$ mol

$(NH_4)_3PO_4 = x = 0.125$ mol

Na_3PO_4: $\frac{50 \text{ g}}{164 \text{ g/mol}} = 0.305$ mol $= x$

$(NH_4)_3PO_4 = x = 0.305$ mol

∴ NH_4NO_3 is limiting reactant

b) $(NH_4)_3PO_4 = 0.125$ mol

$0.125 \text{ mol} \times 149.12 \text{ g/mol} = \boxed{18.6 \text{ g}}$

c) $NaNO_3 = 3x = 3(0.125) = 0.375$ mol

$0.375 \text{ mol} \times 85 \text{ g/mol} = \boxed{31.9 \text{ g}}$

(5) d) Na_3PO_4 is excess reactant

$Na_3PO_4 = x = 0.125$ mol

0.125 mol $\times$ 164 g/mol $= 20.5$ g

50 g $- 20.5$ g $= \boxed{29.5 \text{ g}}$

(6) $3\,CaCO_3 + 2\,FePO_4 \rightarrow Ca_3(PO_4)_2 + Fe_2(CO_3)_3$

$3x \quad 2x \quad x \quad x$

a) $CaCO_3$: $\frac{100 \text{ g}}{100.1 \text{ g/mol}} = 1$ mol

$3x = 1$ mol

$x = 0.333$

$Ca_3(PO_4)_2 = x = 0.333$ mol

$FePO_4$: $\frac{45 \text{ g}}{150.8 \text{ g/mol}} = 0.298$ mol

$2x = 0.298$ mol

$x = 0.149$

$Ca_3(PO_4)_2 = x = 0.149$

So $FePO_4$ is limiting reactant

⑥ b) $Ca_3(PO_4)_2 = x = 0.149$ mol

$0.149 \text{ mol} \times 310.3 \text{ g/mol} = \boxed{46.2 \text{ g}}$

c) $Fe_2(CO_3)_3 = x = 0.149$ mol

$0.149 \text{ mol} \times 291.6 \text{ g/mol} = \boxed{43.4 \text{ g}}$

d) $CaCO_3$ is excess reactant

$CaCO_3 = 3x = 3(0.149) = 0.448$ mol

$0.448 \text{ mol} \times 100.1 \text{ g/mol} = 44.8 \text{ g}$

$100 \text{ g} - 44.8 \text{ g} = \boxed{55.2 \text{ g}}$