Limiting Reagents / Percentage Yield Wksht

1. $I_2O_5 + 5CO \rightarrow 5CO_2 + I_2$

a) mass of I_2 ?

80.0g I_2O_5 28.0g CO

determine limiting reactant

$80.0\text{g } I_2O_5 \times \frac{1\text{mol } I_2O_5}{333.8\text{g}} = 0.240\text{ mol } I_2O_5$

$28.0\text{g CO} \times \frac{1\text{mol CO}}{28.01\text{g}} = \frac{0.9996\text{mol CO}}{5} = 0.1999$

CO limiting reactant

$0.996\text{ mol CO} \times \frac{1\text{mol } I_2}{5\text{mol CO}} = 0.1999\text{ mol } I_2 \times \frac{253.8\text{g } I_2}{1\text{mol } I_2} = \boxed{50.7\text{g } I_2}$

b) i) $0.160\text{ mol } I_2 \times \frac{253.8\text{g } I_2}{1\text{mol } I_2} = \boxed{40.6\text{g } I_2}$

ii) $\frac{40.6\text{g } I_2}{50.7\text{g}} \times 100 = \boxed{80.1\%}$

2. $Zn + S \rightarrow ZnS$

25.0g Zn 30.0g S

a) $25.0\text{g Zn} \times \frac{1\text{mol}}{65.39\text{g}} = \frac{0.382\text{ mol Zn}}{1}$

$30.0\text{g S} \times \frac{1\text{mol}}{32.07\text{g}} = \frac{0.935\text{mol S}}{1}$

Zn is limiting

b) $0.382 \times 1\text{ mol ZnS} = 0.382\text{ mol ZnS} \times \frac{97.45\text{g}}{1\text{mol}} = \boxed{37.2\text{g ZnS}}$

c) $0.935\text{ mol S} - 0.382\text{ mol} =$

$0.553\text{ mol S} \times \frac{32.07\text{g S}}{\text{mol S}} = \boxed{17.7\text{g S}}$

3. 3.00g Mg 2.20g O_2

$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$

a) $3.00\,g\,Mg \times \frac{mol\,Mg}{24.31\,g\,Mg} = \frac{0.123\,mol\,Mg}{2} = 0.0615$

$2.20\,g\,O_2 \times \frac{1\,mol\,O_2}{32\,g\,O_2} = 0.06875\,mol\,O_2$

Mg is limiting

b) O_2 is excess

$0.06875\,mol\,O_2 - 0.0615 = 0.00725\,mol\,O_2 \times \frac{32\,g\,O_2}{1\,mol} = \boxed{0.23\,g\,O_2 \text{ excess}}$

c) $0.0615 \times 2\,mol\,MgO = \boxed{0.123\,mol\,MgO}$

4. 5.00g Al heated 10.0g S

$2Al(s) + 3S(s) \longrightarrow Al_2S_3(s)$

$5.00\,g\,Al \times \frac{1\,mol\,Al}{26.98\,g} = \frac{0.185\,mol\,Al}{2} = 0.0925$

$10.0\,g\,S \times \frac{1\,mol\,S}{32.07\,g\,S} = \frac{0.312\,mol\,S}{3} = 0.104$

Al limiting

$0.0925 \times 1\,mol\,Al_2S_3 = 0.0925\,mol\,Al_2S_3 \times \frac{150.17\,g\,Al_2S_3}{1\,mol\,Al_2S_3} = \boxed{13.9\,g\ Al_2S_3}$

5. $3Zn(s) + 2MoO_3(s) \longrightarrow Mo_2O_3(s) + 3ZnO(s)$

20.0g MoO_3 10.0g Zn

$20.0\,g\,MoO_3 \times \frac{1\,mol}{143.95\,g\,MoO_3} = \frac{0.139\,mol\,MoO_3}{2} = 0.0695$

$10.0\,g\,Zn \times \frac{mol\,Zn}{65.38\,g} = \frac{0.153\,mol\,Zn}{3} = 0.051$

Zn limiting

$0.051 \times 3\,mol\,ZnO = 0.153\,mol\,ZnO \times \frac{81.38\,g}{mol} = \boxed{12.5\,g\ ZnO}$

a)

6. $3AgNO_3 + FeCl_3 \longrightarrow 3AgCl + Fe(NO_3)_3$

$25.0g\ AgNO_3 \quad 45.0g\ FeCl_3$

b) $25.0g\ AgNO_3 \times \frac{mol}{169.88g} = \frac{0.1472\ mol}{3} = 0.04907$

$45.0g\ FeCl_3 \times \frac{mol}{162.195g} = \frac{0.2774\ mol}{1}$

$AgNO_3$ is limiting → 0.147 mol AgCl

c) $0.04907\ (3\ mol\ AgCl) \times \frac{143.32g}{1\ mol\ AgCl} = 7.03g\ AgCl$

d) 7.03g AgCl

e) $FeCl_3$ excess

$0.2774\ mol - 0.04907 = 0.2283\ mol \times \frac{162.2g}{1\ mol\ FeCl_3} =$ 37.0g $FeCl_3$ excess

7. $255g\ CaCO_3 \quad 135g\ SO_2$

$CaCO_3 + SO_2 \longrightarrow CaSO_3 + CO_2$

a) $255g\ CaCO_3 \times \frac{mol}{100.09g} = 2.548\ mol\ CaCO_3$

$135g\ SO_2 \times \frac{mol}{64.07g} = 2.11\ mol\ SO_2$

SO_2 limiting reactant

$2.11 \times 1\ mol\ CaSO_3 = 2.11\ mol\ CaSO_3 \times \frac{120.15g}{1\ mol} =$ 253.52g $CaSO_3$

b) $198g\ CaSO_3$

% yield: $\frac{198g\ CaSO_3}{253.52g} =$ 78.1% yield

8. 100g chlorobenzene is a 65% yield

$$\frac{100g}{x} = \frac{65}{100}$$

$$x = 153.85g$$

$$C_6H_6 + Cl_2 \rightarrow C_6H_5Cl + HCl$$

$$153.85g\ C_6H_5Cl \times \frac{mol\ C_6H_5Cl}{112.56g} \times \frac{1mol\ C_6H_6}{1mol\ C_6H_5Cl} \times \frac{78.12g\ C_6H_6}{1mol\ C_6H_6} = \boxed{106.78g\ C_6H_6}$$

9. $C_7H_8 + 2KMnO_4 \rightarrow KC_7H_5O_2 + 2MnO_2 + KOH + H_2O$

68% yield $KC_7H_5O_2$

10.0g $KC_7H_5O_2$ needed

g toluene = ?

$$\frac{10.0}{x} = \frac{68}{100} \quad x = 14.71g$$

$$14.71g\ KC_7H_5O_2 \times \frac{1mol\ KC_7H_5O_2}{163.22g} \times \frac{1mol\ C_7H_8}{1mol\ KC_7H_5O_2} \times \frac{92.15g}{1mol\ C_7H_8} = \boxed{8.30g\ C_7H_8}$$

10. $2NaOH + 2Al + 2H_2O \rightarrow 2NaAlO_2 + 3H_2$

i.) 84.1g NaOH 51.0g Al

$$84.1g\ NaOH \times \frac{1mol\ NaOH}{40g\ NaOH} = \frac{2.10mol\ NaOH}{2} = 1.05$$

$$51.0g\ Al \times \frac{1mol}{26.98g} = \frac{1.00mol\ Al}{2} = 0.50$$

Al is limiting reactant

ii) NaOH excess

$$2.10mol\ NaOH - (0.50 \times 2) = 1.10mol \times \frac{40g\ NaOH}{mol} = \boxed{44.0g\ NaOH\ excess}$$

iii) $0.50(3) = 1.50mol\ H_2 \times \frac{2.02g\ H_2}{1mol\ H_2} = \boxed{3.03g\ H_2}$

11. i) $(CH_3)_2NNH_2 + N_2O_4 + 2O_2 \longrightarrow 4H_2O + 2N_2 + 2CO_2$

ii) $150{,}000\,g\ (CH_3)_2NNH_2 \times \frac{1\,mol\,(CH_3)_2NNH_2}{60.12\,g} = 2495.01\,mol$

$460{,}000\,g\ N_2O_4 \times \frac{1\,mol\,N_2O_4}{92.02\,g} = 4998.91\,mol$

$(CH_3)_2NNH_2$ limiting

$2495.01 \times 2\,mol\,N_2 = 4990.02\,mol\,N_2 \times \frac{28.02\,g}{1\,mol\,N_2} = 139820.36\,g \approx 139.8 \sim \boxed{140\,kg\,N_2}$

iii) $\frac{30}{x} = \frac{68}{100}$

$x = 44.12\,kg$

$44{,}120\,g\,N_2 \times \frac{1\,mol\,N_2}{28.02\,g\,N_2} \times \frac{1\,mol\,N_2O_4}{2\,mol\,N_2} \times \frac{92.02\,g}{1\,mol\,N_2O_4} = 72.45\,kg\,N_2O_4$

12. $2Mg + O_2 \longrightarrow 2MgO$

$5.00\,g\ Mg \quad 5.00\,g\ O_2$

$g\ MgO$?

g excess ?

$5.00\,g\,Mg \times \frac{1\,mol\,Mg}{24.31\,g\,Mg} = \frac{0.206\,mol\,Mg}{2} = 0.103$

$5.00\,g\,O_2 \times \frac{1\,mol\,O_2}{32\,g\,O_2} = \frac{0.156\,mol\,O_2}{1} = 0.156$

Mg is limiting

$0.103 \times 2\,mol\,MgO = 0.206\,mol\,MgO \times \frac{40.31\,g\,MgO}{1\,mol\,MgO} = \boxed{8.30\,g\,MgO}$

$0.156 - 0.103\,mol\,O_2 = 0.053 \times \frac{32\,g\,O_2}{1\,mol\,O_2} = \boxed{1.70\,g\,O_2\ excess}$

(mol O_2)

13. $3C_6H_{10} + 4Na_2Cr_2O_7 + 16H_2SO_4 \rightarrow 3C_6H_{10}O_4 + 4Cr_2(SO_4)_3 + 4Na_2SO_4 + 16H_2O$

68.6% yield $C_6H_{10}O_4$

a) 12.5g $C_6H_{10}O_4$

g C_6H_{10} ?

$\frac{12.5g}{x} = \frac{68.6}{100}$ $x = 18.22g$

$18.22g\ C_6H_{10}O_4 \times \frac{1mol\ C_6H_{10}O_4}{146.16g} \times \frac{3mol\ C_6H_{10}}{3mol\ C_6H_{10}O_4} \times \frac{82.16g}{1mol\ C_6H_{10}} = \boxed{3.41g\ C_6H_{10}}$

b) $18.22g\ C_6H_{10}O_4 \times \frac{1mol\ C_6H_{10}O_4}{146.16g} \times \frac{4mol\ Na_2Cr_2O_7 \cdot 2H_2O}{3mol\ C_6H_{10}O_4} \times \frac{298.02g}{1mol\ Na_2Cr_2O_7 \cdot 2H_2O}$

$= \boxed{49.53g\ Na_2Cr_2O_7 \cdot 2H_2O}$