Stoichiometry and Chem. Formula Calc.

Worksheet - Stoichiometry

Set A:

1. 36.14 g O (out of 100 g compound) $\times \left(\frac{1\text{ mol O}}{16.00\text{ g O}}\right) \times \left(\frac{2\text{ mol H}}{3\text{ mol O}}\right)\left(\frac{1.008\text{ g H}}{1\text{ mol H}}\right) = 15.18\text{ g H}$

100 g sample = 36.14 g O + 15.18 g H + ____ g B

g B = 48.68 g B

B	H	O
$\frac{48.68\text{ g}}{10.80\text{ g/mol}}$	$\frac{15.18\text{ g}}{1.008\text{ g/mol}}$	$\frac{36.14\text{ g O}}{16.00\text{ g/mol}}$
$\frac{4.507}{2.259}$	$\frac{15.06}{2.259}$	$\frac{2.259}{2.259}$
2	6.67	1
	$\downarrow \times 3$	

$B_6 H_{20} O_3$ $\therefore$ $x = 6$

2)

$$122\text{g mixture} \times \frac{32.50\text{g CoO}}{100\text{g mix.}} \times \frac{1\text{mol CoO}}{74.90\text{g}} \times \frac{1\text{mol } O^{2-}\text{ ion}}{1\text{mol CoO}} = 0.529 \text{ mol } O^{2-}$$

$$122\text{g mixture} \times \frac{67.50\text{g } Co_2O_3}{100\text{g mix}} \times \frac{1\text{mol } Co_2O_3}{165.8\text{g } Co_2O_3} \times \frac{3\text{mol } O^{2-}\text{ ion}}{1\text{mol } Co_2O_3} = 1.49 \text{ mol } O^{2-}$$

$$2.02 \text{ mol } O^{2-}$$

$$2.02\text{mol } O^{2-} \times \frac{6.02\times10^{23} O^{2-}\text{ ions}}{1\text{mol}} = 1.22\times10^{24} O^{2-}\text{ ions}$$

3.

a) $$5.46\times10^{-3}\text{g } BaSO_4 \times \frac{1\text{mol } BaSO_4}{233.3\text{g } BaSO_4} \times \frac{1\text{mol S}}{1\text{mol } BaSO_4} \times \frac{32.0\text{g S}}{1\text{mol}}$$

$$= 7.52\times10^{-4}\text{g S}$$

$$\%\text{S} = \frac{7.52\times10^{-4}\text{g S}}{8.19\times10^{-3}\text{g Compd.}}(100)$$

$$= 9.18\%\text{S}$$

b) $$9.18\%\text{S} = \frac{9.18\text{g S}}{100\text{g Compd}}$$

$$\frac{100\text{g Compd}}{9.18\text{g S}} \times \frac{32.0\text{g S}}{1\text{mol S}} \times \frac{1\text{mol S}}{1\text{mol Compd}}$$

$$= \frac{349\text{g Compd}}{1\text{mol compd.}}$$

#4

Co Rh Mn ⟶ $Co_2Rh_5Mn_2$

2 atoms, 5 atoms, 2 atoms → 9 atoms total

$$8.75\times10^{21}\text{ atoms} \times \frac{1\text{ molecule}}{9\text{ atoms}} \times \frac{1\text{ mol}}{6.02\times10^{23}\text{ molecules}} \times \frac{742.1\text{ g}}{1\text{ mole}} = 1.20\text{ g } Co_2Rh_5Mn_2$$

#5

Al_2X_3

$$\frac{18.56\text{ g Al}}{100\text{ compd}} \rightarrow (100-18.56)\text{ g X}$$

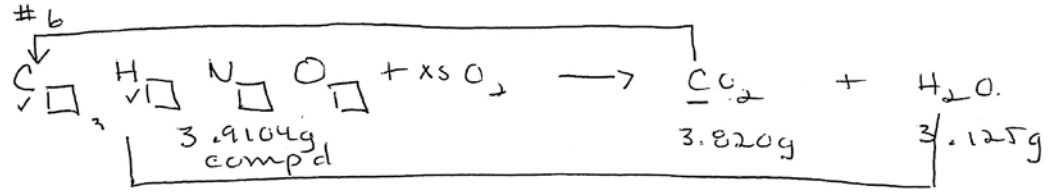
$$MM_X = \frac{(100-18.56)\text{ g X}}{1.031\text{ mol X}} = 79.00\text{ g/mol X}$$

"mol X" calc

$$18.56\text{ g Al} \times \frac{1\text{ mol Al}}{27.00\text{ g}} \times \frac{3\text{ mol X}}{2\text{ mol Al}} = 1.031\text{ mol X}$$

Set A

**** #6



H

$$3.125\text{g } H_2O \times \frac{1\text{mol } H_2O}{18.0\text{g}} \times \frac{2\text{mol H}}{1\text{ mol } H_2O} \times \frac{1.01\text{g H}}{1\text{mol}}$$

$$= .3501\text{g H}$$

$$\%H = \frac{.3501\text{g H}}{3.9104\text{g compd}}(100) = \boxed{8.95\%\text{ H}}$$

C

$$3.820\text{g } CO_2 \times \frac{1\text{mol } CO_2}{44.0\text{g}} \times \frac{1\text{mol C}}{1\text{mol } CO_2} \times \frac{12.0\text{g C}}{1\text{mol}} = 1.042\text{g C}$$

$$\%\text{ C} = \frac{1.042\text{g C}}{3.9104\text{g compd}}(100) = \boxed{26.65\%\text{C}}$$

N $\boxed{46.62\%\text{ N}}$

O $100\% - 8.95\%\text{H} - 26.65\%\text{C} - 46.62\%\text{N} = 17.78\%\text{O}$

EF calc

C	H	O	N
$\frac{26.65\text{g}}{12.00\text{g/mol}}$	$\frac{8.95\text{g}}{1.01\text{g/mol}}$	$\frac{17.78\text{g}}{16.00\text{g/mol}}$	$\frac{46.62\text{g}}{14.01\text{g/mol}}$
↓	↓	↓	↓
$\frac{2.22}{1.11}$	$\frac{8.86}{1.11}$	$\frac{1.11}{1.11}$	$\frac{3.32}{1.11}$
↓	↓	↓	↓
2	8	1	3

EF = $C_2H_8N_3O$

b. Molecular Formula:

$$\#\text{ of EF units} = \frac{\text{Molar mass}}{\text{EF mass}}$$

$$= \frac{170\ g\ (\pm 15)}{90.1\ g/mol} = 1.88$$

$$EF = \frac{\begin{array}{l}2\ (12.01\ g/mol\ C)\\ 8\ (1.01\ g/mol\ H)\\ 3\ (14.01\ g/mol\ N)\\ 1\ (16.00\ g/mol\ O)\end{array}}{90.1\ g/mol\ Compd}$$

rounded to 2 "

$$MF = 2\ (C_2H_8N_3O) = C_4H_{16}N_6O_2$$

#7

$$4FeCr_2O_4 + 8K_2CO_3 + 7O_2 \longrightarrow 8K_2CrO_4 + 2Fe_2O_3 + 8CO_2$$

169 g — 298 g — xs — ↑ 194 g Actual

LR calc!

$$\underbrace{169\text{ g } FeCr_2O_4}_{\text{reactant 1}} \times \frac{1\text{ mol } FeCr_2O_4}{223.8\text{ g}} \times \frac{8\text{ mol } K_2CrO_4}{4\text{ mol } FeCr_2O_4} = 1.50\text{ mol } K_2CrO_4$$

(amt. made)

Lesser amt. is made!

compare

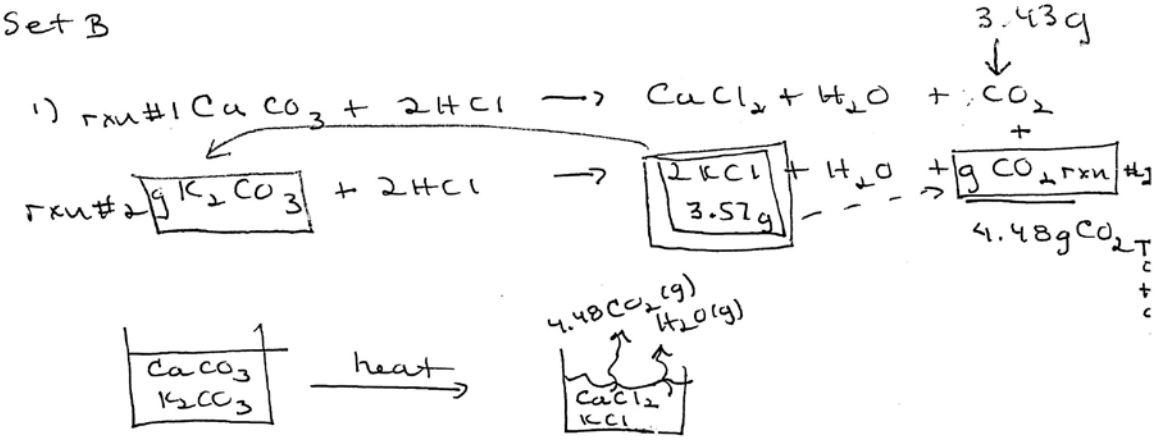
$$\underbrace{298\text{ g } K_2CO_3}_{\text{reactant 2}} \times \frac{1\text{ mol } K_2CO_3}{138.2\text{ g}} \times \frac{8\text{ mol } K_2CrO_4}{8\text{ mol } K_2CO_3} = 2.15\text{ mol } K_2CrO_4$$

$$1.50\text{ mol } K_2CrO_4 \times \frac{138.2\text{ g } K_2CrO_4}{1\text{ mol}} = 291\text{ g } K_2CrO_4 \text{ Theo.}$$

$$\%\text{ yield} = \frac{194\text{ g } K_2CrO_4 \text{ Actual}}{291\text{ g } K_2CrO_4 \text{ Theo}} (100)$$

$$= 66.6\%$$

Set B



1st g K_2CO_3 calc

$$3.57\text{g KCl} \times \frac{1\text{mol KCl}}{74.6\text{g}} \times \frac{1\text{mol } K_2CO_3}{2\text{mol KCl}} \times \frac{138\text{g } K_2CO_3}{1\text{mol}} = 3.30\text{g } K_2CO_3$$

export

2nd g $CaCO_3$ calc

a) $3.57\text{g KCl} \times \frac{1\text{mol KCl}}{74.6\text{g}} \times \frac{1\text{mol } CO_2}{2\text{mol KCl}} \times \frac{44.0\text{g } CO_2}{1\text{mol}} =$

$= 1.05\text{g } CO_2$ rxn#2

b) g CO_2 rxn#1 = 4.48g CO_2 Total − 1.05g CO_2 rxn#2

= 3.43g CO_2 rxn#1

$CaCO_3$

c) $\text{g } CaCO_3 = 3.43\text{g } CO_2 \text{ rxn\#1} \times \frac{1\text{mol } CO_2}{44.0\text{g}} \times \frac{1\text{mol } CaCO_3}{1\text{mol } CO_2} \times \frac{100.1\text{g}}{1\text{mol}}$

$= 7.80\text{g } CaCO_3$

export

3rd

g mixture = 7.80 g $CaCO_3$ + 3.30 g K_2CO_3

= 11.10g mixture.

Set B

Prob 2 Mn_5X_2 42.10% Mn

$$\frac{42.10\text{ g Mn}}{100\text{ g } Mn_5X_2}$$

a) $42.10\text{ g Mn} \times \frac{1\text{ mol Mn}}{54.93\text{ g Mn}} \times \frac{2\text{ mol X}}{5\text{ mol Mn}} = 0.3097\text{ mol X}$

b) $100\text{ g } Mn_5X_2 - 42.10\text{ g Mn} = 57.90\text{ g X}$

export

Ans: $\frac{57.90\text{ g X}}{.3097\text{ mol X}}$

$$= \boxed{\frac{186.9\text{ g X}}{1\text{ mol}}}$$

Prob 3

g K_3PO_4 + g KNO_3 = 83.5 g mix.

$\frac{36.55\text{ g } KNO_3}{100\text{ g mix}}$ ∴

a) 100 g mix − 36.55 g KNO_3 = 63.45 g K_3PO_4

b) $63.45\text{ g } K_3PO_4 \times \frac{1\text{ mol } K_3PO_4}{212\text{ g}} \times \frac{3\text{ mol } K^+}{1\text{ mol } K_3PO_4} = .898\text{ mol } K^+$

$36.55\text{ g } KNO_3 \times \frac{1\text{ mol } KNO_3}{101.1\text{ g}} \times \frac{1\text{ mol } K^+}{1\text{ mol } KNO_3} = .362\text{ mol } K^+$

$= 1.260\text{ mol } K^+$ in 100 g mix.

$$\frac{1.260\text{ mol } K^+}{100\text{ g MIX.}} \times 83.5\text{ g MIX.} \times \frac{6.02\times10^{23}\text{ ions } K^+}{1\text{ mol } K^+}$$

$= 6.32 \times 10^{23}$ ions K^+

Set B

Prob 4 a) 31.23 g sample 1.203×10^2 g $SrCO_3$

Ans: $\frac{9.780 \text{ g C}}{31.23 \text{ g Sample}}(100) = 31.30\ \%$ C

export

calc. $1.203 \times 10^2 \text{ g } SrCO_3 \times \frac{1 \text{ mol } SrCO_3}{147.6 \text{ g } SrCO_3} \times \frac{1 \text{ mol C}}{1 \text{ mol } SrCO_3} \times \frac{12.01 \text{ g C}}{1 \text{ mo}}$

export

$= 9.780$ g C

b) $\frac{3 \text{ C atoms}}{1 \text{ molecule}} = \frac{3 \text{ mol C}}{1 \text{ molec cmpd}}$

Ans: $\frac{31.23 \text{ g cmpd}}{.2720 \text{ mol cmpd}} = 114.8 \frac{\text{g cmpd}}{\text{mol cmpd}}$

export

$9.780 \text{ g C} \times \frac{1 \text{ mol C}}{12.01 \text{ g}} \times \frac{1 \text{ mol cmpd}}{3 \text{ mol C}} = .2720$ mol cmpd

Set B

5. $2\ KClO_3 + 4\ HCl \rightarrow 2\ KCl + 2\ ClO_2 + Cl_2 + 2\ H_2O$

$$80.0\text{ g } KClO_3 \times \frac{1\text{ mol } KClO_3}{122.6\text{ g}} \times \frac{1\text{ mol } Cl_2}{2\text{ mol } KClO_3} \times \frac{71.0\text{ g } Cl_2}{1\text{ mol}} = 23.2\text{ g } Cl_2$$

$$59.5\text{ g } HCl \times \frac{1\text{ mol } HCl}{36.5\text{ g}} \times \frac{1\text{ mol } Cl_2}{4\text{ mol } HCl} \times \frac{71.0\text{ g } Cl_2}{1\text{ mol}} = 28.9\text{ g } Cl_2$$

$$\%\text{ yield} = \frac{18.7\text{ g } Cl_2, \text{ Act}}{23.2\text{ g } Cl_2, \text{ Theo}} (100)$$

$$= 80.6\%\text{ yield}$$

Set B

*Prob 6 a) $C_{\square} H_{\square} S_{\square} O_{\square} + O_2 \text{ xs} \rightarrow \underline{CO_2}_{35.25\,g} + \underline{SO_2}_{14.65\,g} + H_2O$

28.50 g compd

b) 8.514 % H = $\frac{8.514\ g\ H}{100\ g\ compd.}$

a calc

%C: $35.25\,g\,CO_2 \times \frac{1\,mol\,CO_2}{44.0\,g} \times \frac{1\,mol\,C}{1\,mol\,CO_2} \times \frac{12.01\,g\,C}{1\,mol\,C} = 9.614\,g\,C$

$\%C = \frac{9.614\,g\,C}{28.50\,g\ compd} (100) = \boxed{33.7\ \%C}$

%S: $14.65\,g\,SO_2 \times \frac{1\,mol\,SO_2}{64.00\,g} \times \frac{1\,mol\,S}{1\,mol\,SO_2} \times \frac{32.00\,g\,S}{1\,mol} = 7.325\,g\,S$

$\%S = \frac{7.325\,g\,S}{28.50\,g\ compd} (100) = \boxed{25.7\ \%S}$

b) %O calc

$100\% = \underline{\ ?\ }\%O + \underline{33.7}\%C + \underline{8.514}\%H + \underline{25.7}\%S$

$\%O = 32.08\%O$

c) Empirical Formula

$C_{\frac{33.7\,g}{12.0\,g/mol}}\ H_{\frac{8.514\,g}{1.01\,g/mol}}\ S_{\frac{25.7\,g}{32.0\,g/mol}}\ O_{\frac{32.08\,g}{16.0\,g/mol}}$

$= C_{\frac{2.81}{.803}}\ H_{\frac{8.42}{.803}}\ S_{\frac{.803}{.803}}\ O_{\frac{2.00}{.803}}$

$= C_{3.45}\ H_{10.5}\ S_1\ O_{2.5}$ ×2

$= C_7 H_{21} S_2 O_5$

d) EF wt = $7(12.01\,g/mol\ C) + 21(1.01\,g/mol\ H) + 2(32.0\,g/mol\ S) + 5(16.0\,g/mol) = 249\,g/mol\ C_7H_{21}S_2O_5$

e) # EF units = $\frac{500\,g/mol}{249\,g/mol} = 2$

$2 \times (C_7 H_{21} S_2 O_5) = \boxed{C_{14} H_{42} S_4 O_{10}}$

Setc

#1

7.88 g sample/compd. 4.75 g $Mg_3(PO_4)_2$

$$\% = \frac{1.12\ g\ P}{7.88\ g\ compd} (100) = 14.2\%\ P$$

$$4.75\ g\ Mg_3(PO_4)_2 \times \frac{1\ mol\ Mg_3(PO_4)_2}{262.9\ g} \times \frac{2\ mol\ P}{1\ mol\ Mg_3(PO_4)_2} \times \frac{31.0\ g\ P}{1\ mol\ P} = 1.12\ g\ P$$

⇑ Ans

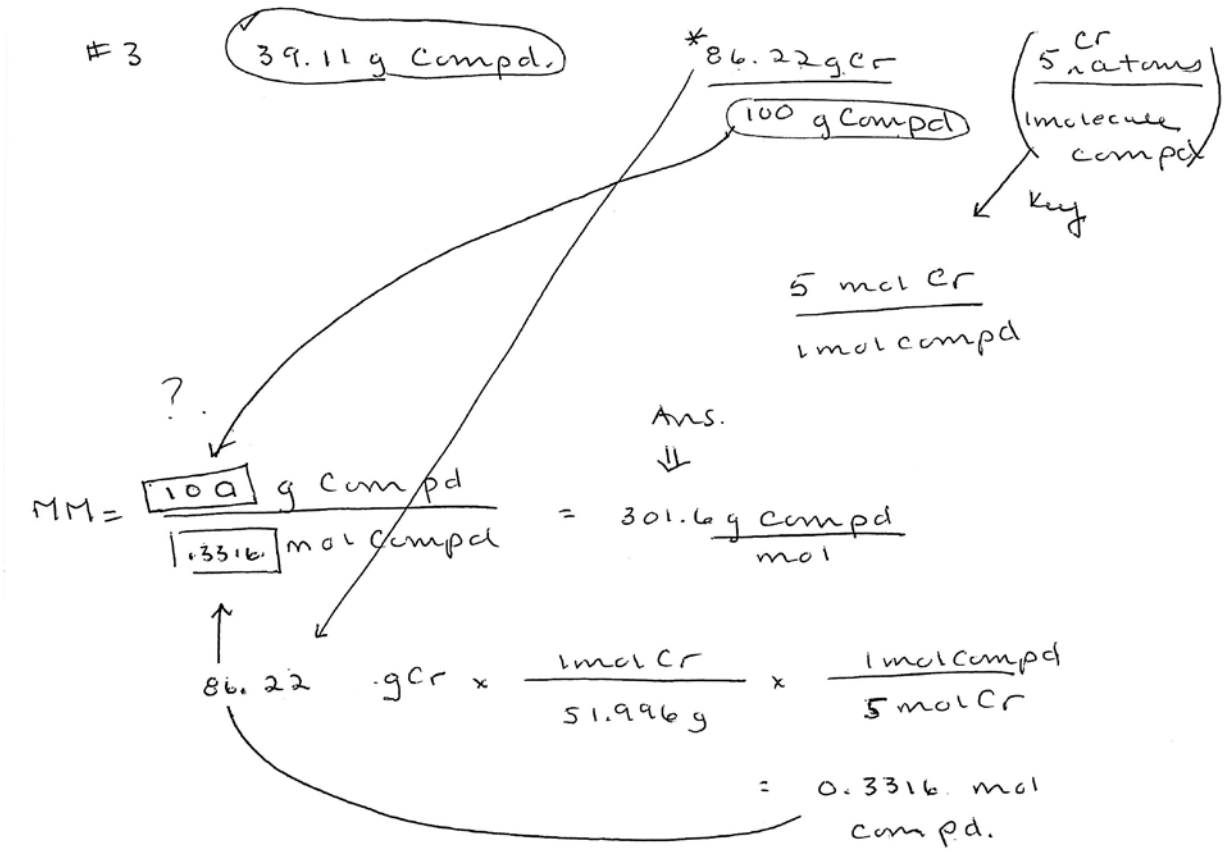
#2

$$\frac{42.1\ g\ B}{100\ g\ B_7X_3} \quad \& \quad 1\ mol\ B_7X_3 : 7\ mol\ B : 3\ mol\ X$$

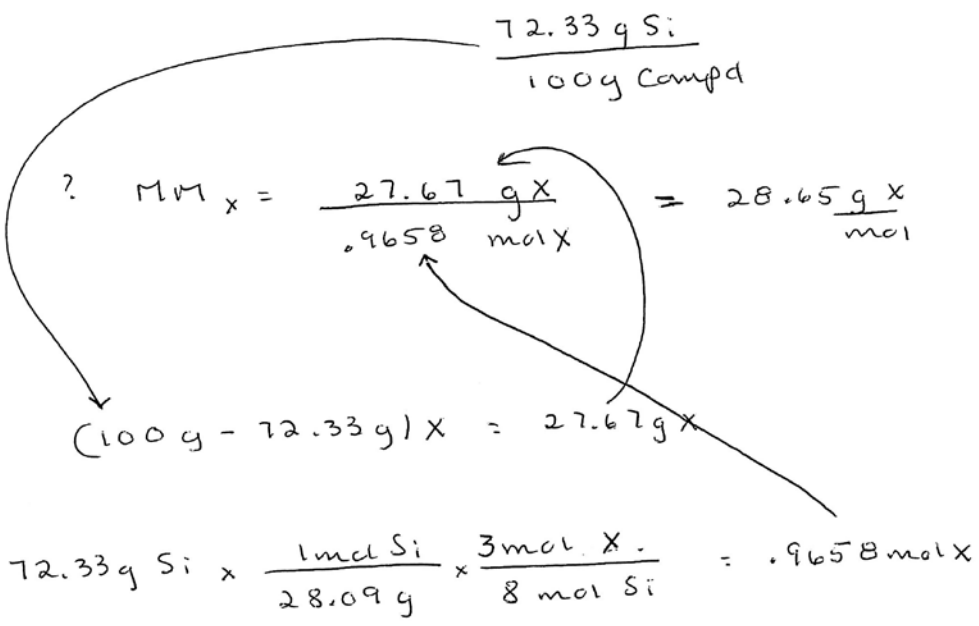
$$(100 - 42.1)\ g\ X = 57.9\ g\ X$$

? $\frac{57.9\ g\ X}{1.67\ mol\ X} = 34.7\ \frac{g}{mol}\ X$ ⇐ Ans

$$42.1\ g\ B \times \frac{1\ mol\ B}{10.8\ g} \times \frac{3\ mol\ X}{7\ mol\ B} = 1.67\ mol\ X$$


#3
39.11 g Compd.
*86.22 g Cr
100 g Compd
5 Cr atoms
1 molecule compd
Key
5 mol Cr
1 mol compd
?
Ans.
MM = 100 g Compd / .3316 mol Compd = 301.6 g compd / mol
86.22 g Cr x 1 mol Cr / 51.996 g x 1 mol compd / 5 mol Cr
= 0.3316 mol compd.

#4 $Si_8X_3 \rightarrow$ 8 mol Si : 3 mol X : 1 mol compd



$$72.33\text{ g Si} \times \frac{1\text{ mol Si}}{28.09\text{ g}} \times \frac{3\text{ mol X}}{8\text{ mol Si}} = .9658\text{ mol X}$$

Set C

5 a)

$$22.44\ g\ CaBr_2 \times \frac{1\ mol\ CaBr_2}{199.9\ g\ CaBr_2} \times \frac{1\ mol\ Ca_3(PO_4)_2}{3\ mol\ CaBr_2} \times \frac{207.2\ g\ Ca_3(PO_4)_2}{1\ mol\ Ca_3(PO_4)_2} =$$

$$= 7.739\ g\ Ca_3(PO_4)_2$$

compare

$$16.85\ g\ Na_3PO_4 \times \frac{1\ mol\ Na_3PO_4}{164.0\ g\ Na_3PO_4} \times \frac{1\ mol\ Ca_3(PO_4)_2}{2\ mol\ Na_3PO_4} \times \frac{207.2\ g\ Ca_3(PO_4)_2}{1\ mol\ Ca_3(PO_4)_2}$$

$$= 10.64\ g\ Ca_3(PO_4)_2$$

The lesser amt. is produced: $7.739\ g\ Ca_3(PO_4)_2$

The LR = $CaBr_2$

b)

$$x\ s\ Na_3PO_4 = 16.85\ g\ Na_3PO_4, initial - \frac{12.27}{\text{used in rxn}}\ g\ Na_3PO_4,$$

$$= 4.58\ g\ Na_3PO_4,\ x\ s$$

$$22.44\ g\ CaBr_2 \times \frac{1\ mol\ CaBr_2}{199.9\ g\ CaBr_2} \times \frac{2\ mol\ Na_3PO_4}{3\ mol\ CaBr_2} \times \frac{164.0\ g\ Na_3PO_4}{1\ mol\ Na_3PO_4}$$

$$= 12.27\ g\ Na_3PO_4 \text{ used in rxn}$$