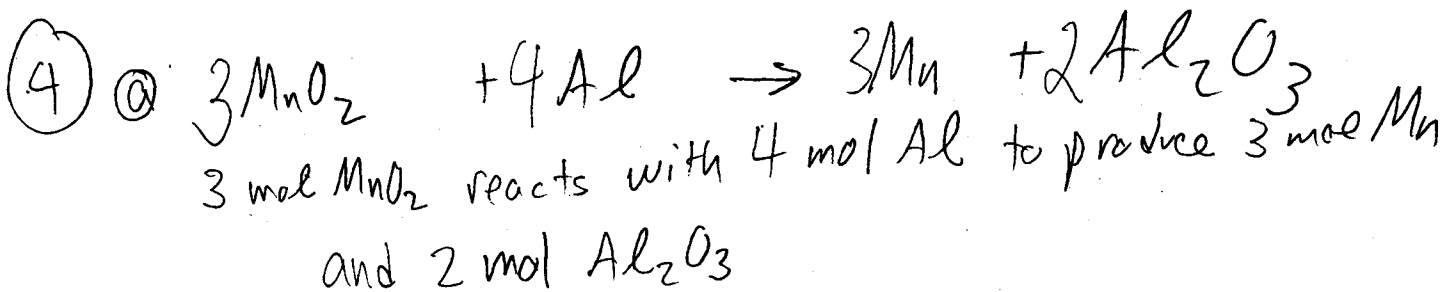
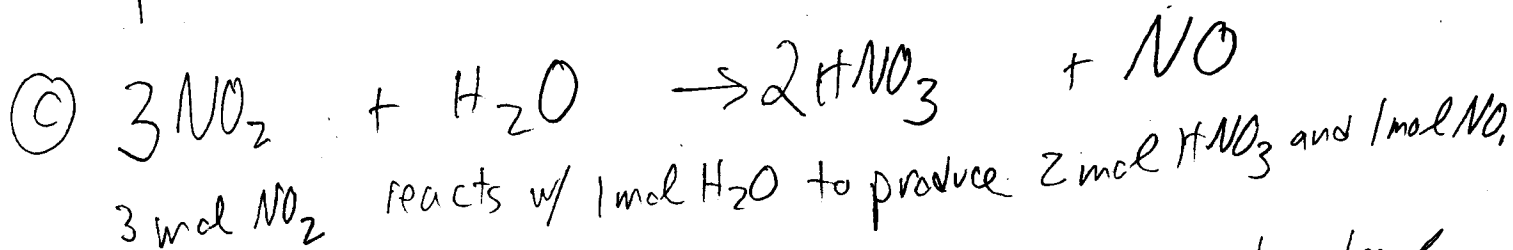


Chapter 9 problems, p. 281

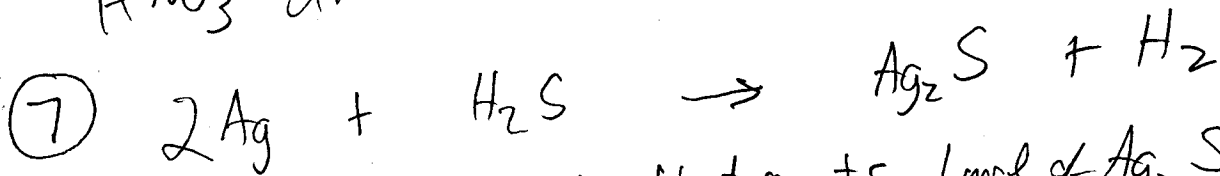
(2) That equation says that 1 mol of C reacts with one mole of O₂. Thus, 12g of C will react with 32g of O₂. This is not the same ratio as 1g C : 1g O₂.



- or -
 3 formula units of MnO₂ react with 4 atoms of Al to produce 3 atoms of Mn and 2 formula units of Al₂O₃

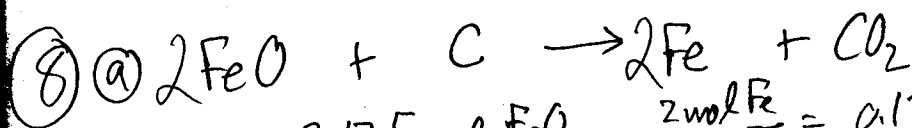


- or -
 3 molecules of NO₂ react w/ 1 molecule of H₂O to produce 2 molecules of HNO₃ and 1 molecule of NO



For every 2 mol of Ag that reacts, 1 mol of Ag₂S and 1 mol of H₂ could be produced (assuming that sufficient H₂S is available).

$$\frac{2\text{mol Ag}}{1\text{mol Ag}_2\text{S}} \text{ or } \frac{1\text{mol Ag}_2\text{S}}{2\text{mol Ag}} \parallel \frac{2\text{mol Ag}}{1\text{mol H}_2} \text{ or } \frac{1\text{mol H}_2}{2\text{mol Ag}}$$



$$0.125 \text{ mol FeO} \times \frac{2 \text{ mol Fe}}{2 \text{ mol FeO}} = 0.125 \text{ mol Fe}$$

$$0.125 \text{ mol FeO} \times \frac{1 \text{ mol CO}_2}{2 \text{ mol FeO}} = 0.0625 \text{ mol CO}_2$$

8) (c) Skip this; it can not be balanced as written.

9) (a) $0.50 \text{ mol NH}_3 \times \frac{1 \text{ mol NH}_4\text{Cl}}{1 \text{ mol NH}_3} = 0.50 \text{ mol NH}_4\text{Cl}$

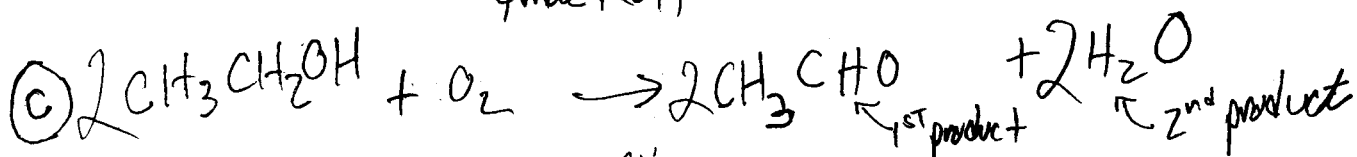
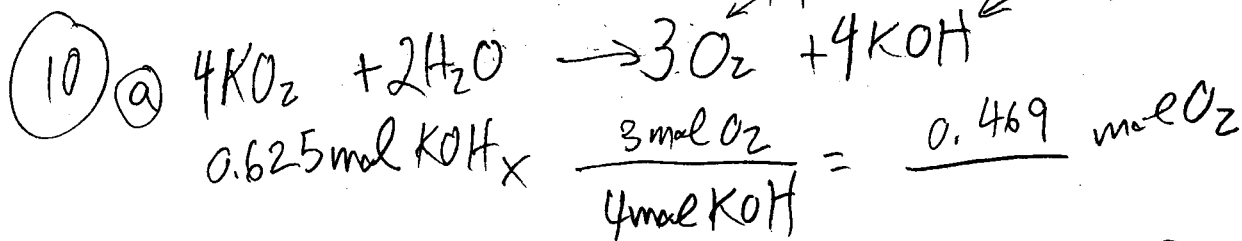
$0.50 \text{ mol NH}_3 \times \frac{1 \text{ mol NH}_4\text{Cl}}{1 \text{ mol NH}_3} \times \frac{53.5 \text{ g NH}_4\text{Cl}}{1 \text{ mol NH}_4\text{Cl}} = 27 \text{ g NH}_4\text{Cl}$

(c) $0.50 \text{ mol PCl}_3 \times \frac{1 \text{ mol H}_3\text{PO}_3}{1 \text{ mol PCl}_3} = 0.50 \text{ mol H}_3\text{PO}_3$

$0.5 \text{ mol PCl}_3 \times \frac{1 \text{ mol H}_3\text{PO}_3}{1 \text{ mol PCl}_3} \times \frac{82 \text{ g H}_3\text{PO}_3}{1 \text{ mol H}_3\text{PO}_3} = 41 \text{ g H}_3\text{PO}_3$

$0.5 \text{ mol PCl}_3 \times \frac{3 \text{ mol HCl}}{1 \text{ mol PCl}_3} = 1.5 \text{ mol HCl}$

$0.5 \text{ mol PCl}_3 \times \frac{3 \text{ mol HCl}}{1 \text{ mol PCl}_3} \times \frac{36.5 \text{ g HCl}}{1 \text{ mol HCl}} = 55 \text{ g HCl}$



$0.625 \text{ mol H}_2\text{O} \times \frac{2 \text{ mol CH}_3\text{CHO}}{2 \text{ mol H}_2\text{O}} = 0.625 \text{ mol CH}_3\text{CHO}$

12) ~~I have no idea.~~ The balanced chemical reaction describes the mole ratios that exist between the reactants & products,

Chapter 9 problems, p. 282

(13) (a) $2.01 \times 10^{-2} \text{ g Ag} \times \frac{1 \text{ mol Ag}}{108 \text{ g Ag}} = \frac{1.86 \times 10^{-4}}{\text{mol Ag}}$

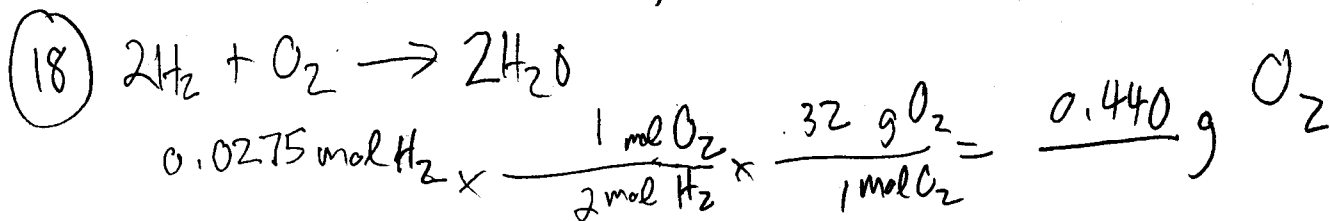
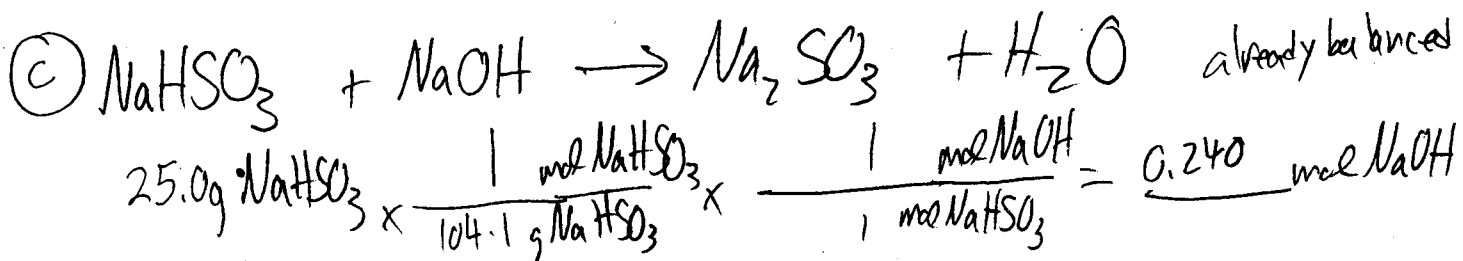
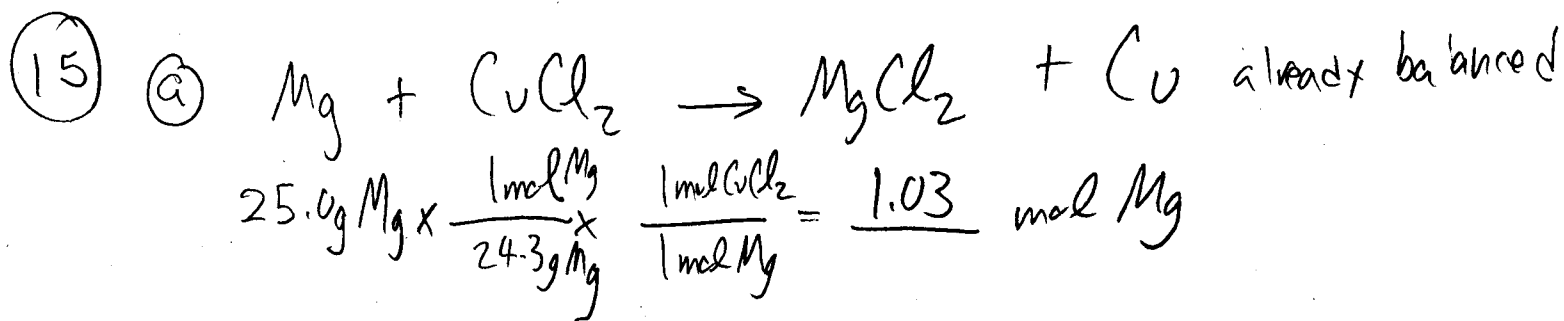
(c) $61.7 \mu\text{g U} \times \frac{1 \text{ g}}{10^6 \mu\text{g}} \times \frac{1 \text{ mol}}{238} = \frac{2.59 \times 10^{-7}}{\text{mol U}}$

(e) $272 \text{ g Fe(NO}_3)_3 \times \frac{1 \text{ mol}}{241.85 \text{ g}} = \frac{1.12}{\text{mol Fe(NO}_3)_3}$

(14) (a) $2.21 \times 10^{-4} \text{ mol CaCO}_3 \times \frac{100.1 \text{ g}}{1 \text{ mol}} = \frac{0.0100}{\text{g CaCO}_3}$

(c) $0.00975 \text{ mol O}_2 \times \frac{32 \text{ g}}{1 \text{ mol}} = \frac{0.312}{\text{g O}_2}$

(e) $0.835 \text{ mol FeS} \times \frac{87.91 \text{ g}}{1 \text{ mol}} = \frac{73.4 \text{ g FeS}}$

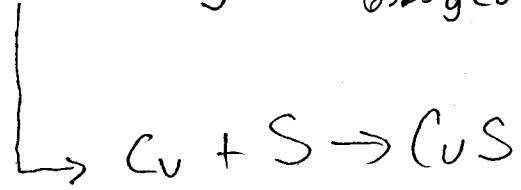


Chapter 9 problems, P. 283

= 45.0 mg FeCl₃

(20) $2\text{Fe} + 3\text{Cl}_2 \rightarrow 2\text{FeCl}_3$
 $15.5 \text{ mg Fe} \times \frac{1 \text{ g Fe}}{1000 \text{ mg Fe}} \times \frac{1 \text{ mol Fe}}{55.85 \text{ g Fe}} \times \frac{2 \text{ mol FeCl}_3}{2 \text{ mol Fe}} \times \frac{162.2 \text{ g FeCl}_3}{1 \text{ mol FeCl}_3} \times \frac{10^3 \text{ mg FeCl}_3}{1 \text{ g FeCl}_3}$

(22) $1.25 \text{ g Cu} \times \frac{1 \text{ mol Cu}}{63.55 \text{ g Cu}} \times \frac{1 \text{ mol S}}{1 \text{ mol Cu}} \times \frac{32.06 \text{ g S}}{1 \text{ mol S}} = 0.631 \text{ g S}$

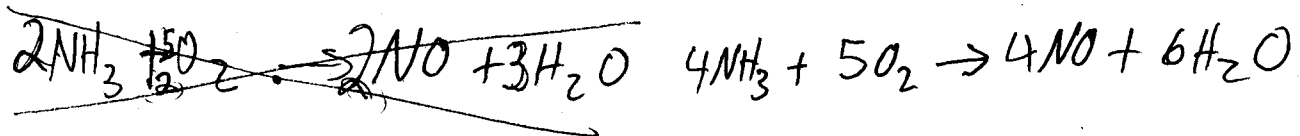


(24) $1.25 \text{ g Mg} \times \frac{1 \text{ mol Mg}}{24.31 \text{ g Mg}} \times \frac{2 \text{ mol MgO}}{2 \text{ mol Mg}} \times \frac{40.31 \text{ g MgO}}{1 \text{ mol MgO}} = 2.07 \text{ g MgO}$

(25) $\text{Cl}_2 + 2\text{KI} \rightarrow \text{I}_2 + 2\text{KCl}$
 $4.50 \times 10^3 \text{ g Cl}_2 \times \frac{1 \text{ mol Cl}_2}{70.9 \text{ g Cl}_2} \times \frac{1 \text{ mol I}_2}{1 \text{ mol Cl}_2} \times \frac{253.8 \text{ g I}_2}{1 \text{ mol I}_2} = 1.61 \times 10^4 \text{ g I}_2$

(28) $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
 $1.00 \text{ g CH}_4 \times \frac{1 \text{ mol CH}_4}{16 \text{ g CH}_4} \times \frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol CH}_4} \times \frac{18 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 2.25 \text{ g H}_2\text{O}$

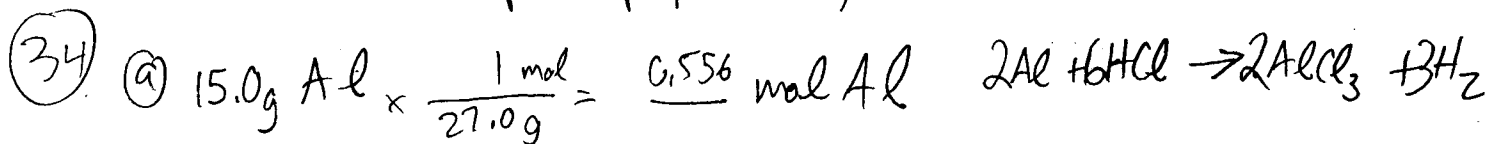
$2.25 \text{ g H}_2\text{O} \times \frac{1 \text{ mol H}_2\text{O}}{18 \text{ g H}_2\text{O}} \times \frac{4 \text{ mol NH}_3}{6 \text{ mol H}_2\text{O}} \times \frac{17 \text{ g NH}_3}{1 \text{ mol NH}_3} = 1.42 \text{ g NH}_3$



(29) The reactant which gets entirely consumed in a chemical reaction. The reaction stops because all reactants are necessary for a reaction to proceed.

(33) Excess; some of it remains at completion of reaction. No; it gets entirely used up. No, because the excess portion does not react.

Chapter 9 problems, p. 284



$15.0 \text{ g HCl} \times \frac{1 \text{ mol}}{36.5 \text{ g}} = 0.411 \text{ mol HCl}$

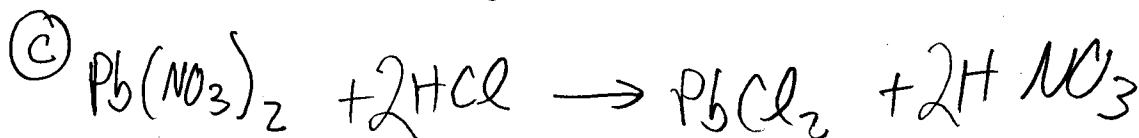
$0.556 \text{ mol Al available} \times \frac{6 \text{ mol HCl}}{2 \text{ mol Al}} = 1.668 \text{ mol HCl needed to use up all Aluminum.}$

There is not enough HCl (there is only 0.411 mol HCl).

HCl is limiting reactant.

$0.411 \text{ mol HCl} \times \frac{2 \text{ mol AlCl}_3}{6 \text{ mol HCl}} \times \frac{133.35 \text{ g AlCl}_3}{1 \text{ mol AlCl}_3} = 18.3 \text{ g AlCl}_3$

$0.411 \text{ mol HCl} \times \frac{3 \text{ mol H}_2}{6 \text{ mol HCl}} \times \frac{2.02 \text{ g H}_2}{1 \text{ mol H}_2} = 0.415 \text{ g H}_2$



$15.0 \text{ g Pb}(\text{NO}_3)_2 \times \frac{1 \text{ mol}}{331.2 \text{ g}} = 0.0453 \text{ mol Pb}(\text{NO}_3)_2$

$15.0 \text{ g HCl} \times \frac{1 \text{ mol}}{36.5 \text{ g}} = 0.411 \text{ mol HCl}$

$0.0453 \text{ mol Pb}(\text{NO}_3)_2 \text{ available} \times \frac{2 \text{ mol HCl}}{1 \text{ mol Pb}(\text{NO}_3)_2} = 0.0906 \text{ mol HCl needed to use up all of the available Pb}(\text{NO}_3)_2.$

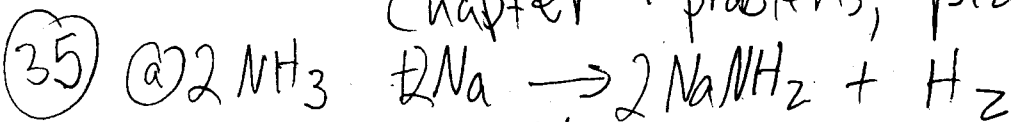
There is way too much HCl available.

Pb(NO₃)₂ is the limiting reactant

$0.0453 \text{ mol Pb}(\text{NO}_3)_2 \times \frac{1 \text{ mol PbCl}_2}{1 \text{ mol Pb}(\text{NO}_3)_2} \times \frac{278.1 \text{ g PbCl}_2}{1 \text{ mol PbCl}_2} = 12.6 \text{ g PbCl}_2$

$0.0453 \text{ mol Pb}(\text{NO}_3)_2 \times \frac{2 \text{ mol HNO}_3}{1 \text{ mol Pb}(\text{NO}_3)_2} \times \frac{63 \text{ g HNO}_3}{1 \text{ mol HNO}_3} = 5.71 \text{ g HNO}_3$

Chapter 9 problems, p. 284



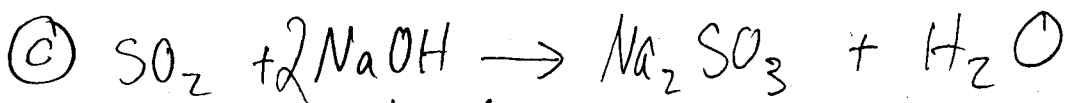
$$50.0 \text{g NH}_3 \times \frac{1 \text{ mol NH}_3}{17 \text{ g NH}_3} = 2.94 \text{ mol NH}_3$$

$$50.0 \text{g Na} \times \frac{1 \text{ mol Na}}{23.0 \text{ g Na}} = 2.17 \text{ mol Na}$$

$$2.94 \text{ mol NH}_3 \text{ available} \times \frac{2 \text{ mol Na}}{2 \text{ mol NH}_3} = 2.94 \text{ mol Na} \rightarrow \text{Na is the L.R., because there is too little Na available}$$

needed to use up all of the NH_3 available.

$$2.17 \text{ mol Na} \times \frac{2 \text{ mol NaNH}_2}{2 \text{ mol Na}} \times \frac{39.0 \text{ g NaNH}_2}{1 \text{ mol NaNH}_2} = 84.6 \text{ g NaNH}_2$$



$$50.0 \text{g SO}_2 \times \frac{1 \text{ mol}}{64.1 \text{ g}} = 0.780 \text{ mol SO}_2$$

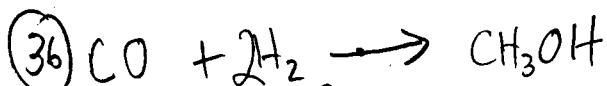
$$50.0 \text{g NaOH} \times \frac{1 \text{ mol}}{40.0 \text{ g}} = 1.25 \text{ mol NaOH}$$

$$0.780 \text{ mol SO}_2 \text{ Available} \times \frac{2 \text{ mol NaOH}}{1 \text{ mol SO}_2} = 1.56 \text{ mol NaOH needed to use all available SO}_2$$

There is not enough NaOH, NaOH is L.R.

NaOH is L.R.

$$1.25 \text{ mol NaOH} \times \frac{1 \text{ mol Na}_2\text{SO}_3}{2 \text{ mol NaOH}} \times \frac{126.1 \text{ g Na}_2\text{SO}_3}{1 \text{ mol Na}_2\text{SO}_3} = 78.8 \text{ g Na}_2\text{SO}_3$$



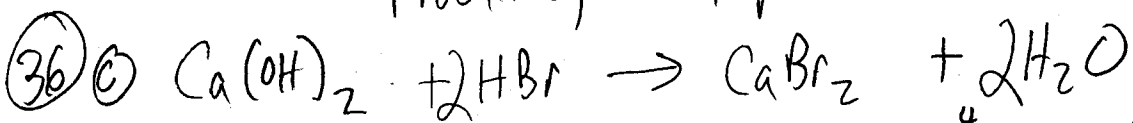
(a) $10.0 \text{mg CO} \times \frac{1 \text{ g CO}}{1000 \text{ mg CO}} \times \frac{1 \text{ mol CO}}{28 \text{ g CO}} = 3.57 \times 10^{-4} \text{ mol CO}$

$$10.0 \text{mg H}_2 \times \frac{1 \text{ g H}_2}{1000 \text{ mg H}_2} \times \frac{1 \text{ mol H}_2}{2.02 \text{ g H}_2} = 4.95 \times 10^{-3} \text{ mol H}_2$$

$$3.57 \times 10^{-4} \text{ mol CO available} \times \frac{2 \text{ mol H}_2}{1 \text{ mol CO}} = 7.14 \times 10^{-4} \text{ mol H}_2 \text{ needed}$$

There is a lot more H_2 than this, so H_2 is excess reactant, CO is L.R.

$$3.57 \times 10^{-4} \text{ mol CO} \times \frac{1 \text{ mol CH}_3\text{OH}}{1 \text{ mol CO}} \times \frac{32 \text{ g CH}_3\text{OH}}{1 \text{ mol CH}_3\text{OH}} = 0.0114 \text{ g CH}_3\text{OH}$$



$$10.0 \text{ mg Ca(OH)}_2 \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ mol}}{74.1 \text{ g}} = \frac{1.35 \times 10^{-4}}{\text{mol}} \text{ Ca(OH)}_2$$

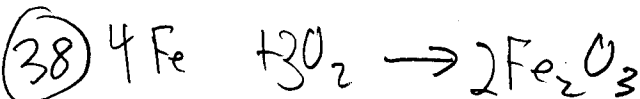
$$100 \text{ mg} \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ mol}}{80.9 \text{ g}} = \frac{1.24 \times 10^{-4}}{\text{mol}} \text{ HBr}$$

$$1.35 \times 10^{-4} \text{ mol Ca(OH)}_2 \times \frac{2 \text{ mol HBr}}{1 \text{ mol Ca(OH)}_2} = \frac{2.70 \times 10^{-4}}{\text{mol}} \text{ HBr needed}$$

There is not enough HBr, HBr is L.R.

$$1.24 \times 10^{-4} \text{ mol HBr} \times \frac{1 \text{ mol CaBr}_2}{2 \text{ mol HBr}} \times \frac{199.9 \text{ g CaBr}_2}{1 \text{ mol CaBr}_2} = \frac{0.0124}{\text{g}} \text{ CaBr}_2$$

$$1.24 \times 10^{-4} \text{ mol HBr} \times \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol HBr}} \times \frac{18 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = \frac{2.23 \times 10^{-3}}{\text{g}} \text{ H}_2\text{O}$$



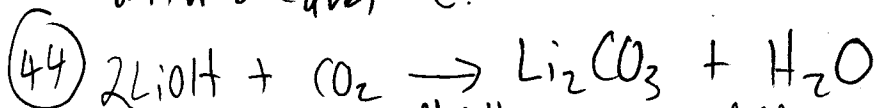
$$1.25 \text{ g Fe} \times \frac{1 \text{ mol}}{55.85 \text{ g}} = \frac{0.0224}{\text{mol}} \text{ Fe}$$

$$0.0224 \text{ mol Fe} \times \frac{3 \text{ mol O}_2}{4 \text{ mol Fe}} = \frac{0.0168}{\text{mol}} \text{ O}_2 \text{ needed to use all Fe}$$

There is 0.0204 mol O₂ available, which is too much (more than needed).

$$0.0224 \text{ mol Fe} \times \frac{2 \text{ mol Fe}_2\text{O}_3}{4 \text{ mol Fe}} \times \frac{159.7 \text{ g Fe}_2\text{O}_3}{1 \text{ mol Fe}_2\text{O}_3} = \frac{1.79}{\text{g}} \text{ Fe}_2\text{O}_3$$

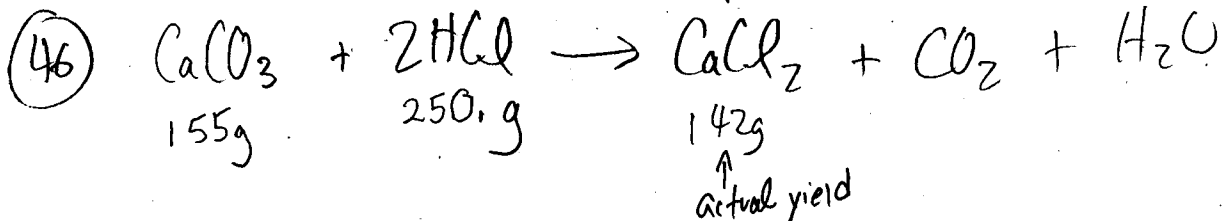
(41) Perhaps not all reactant molecules can actually come into contact with one another.



$$\rightarrow 155 \text{ g LiOH} \times \frac{1 \text{ mol LiOH}}{23.9 \text{ g LiOH}} \times \frac{1 \text{ mol CO}_2}{2 \text{ mol LiOH}} \times \frac{44 \text{ g CO}_2}{1 \text{ mol CO}_2} = \frac{142}{\text{g}} \text{ CO}_2$$

$$\rightarrow (102/142) \times 100 = 71.6\% \text{ of capacity}$$

Chapter 9 problems, P. 285



$$155\text{g CaCO}_3 \times \frac{1 \text{ mol CaCO}_3}{100.1 \text{ g CaCO}_3} = 1.55 \text{ mol CaCO}_3$$

$$250.\text{g HCl} \times \frac{1 \text{ mol HCl}}{36.5 \text{ g HCl}} = 6.85 \text{ mol HCl}$$

$$1.55 \text{ mol CaCO}_3 \text{ available} \times \frac{2 \text{ mol HCl}}{1 \text{ mol CaCO}_3} = 3.10 \text{ mol HCl needed to consume all available CaCO}_3.$$

There is too much HCl,
CaCO₃ is L.R.

$$1.55 \text{ mol CaCO}_3 \times \frac{1 \text{ mol CaCl}_2}{1 \text{ mol CaCO}_3} \times \frac{111 \text{ g CaCl}_2}{1 \text{ mol CaCl}_2} = 172.0 \text{ g CaCl}_2 \text{ should have been produced}$$

$$\frac{142 \text{ g} = \text{actual yield}}{172 \text{ g} = \text{theoretical yield}} \times 100 = 82.5\% \text{ yield}$$