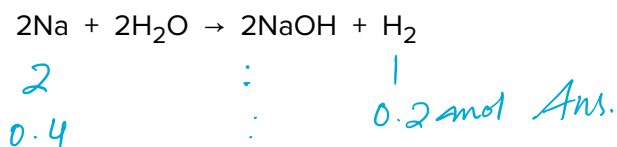


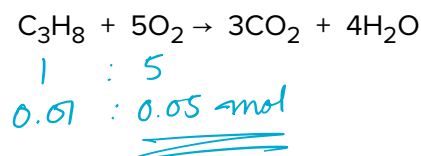
## CHEMISTRY CALCULATIONS WS 2

### Moles & Mass

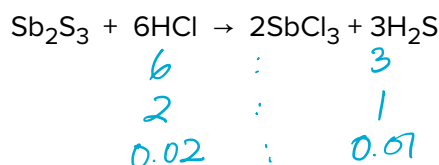
- 1 How many moles of hydrogen gas are produced when 0.4 moles of sodium react with excess water?



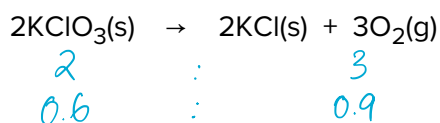
- 2 How many moles of O<sub>2</sub> react with 0.01 mol C<sub>3</sub>H<sub>8</sub>?



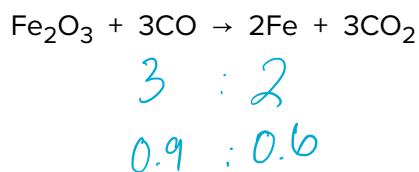
- 3 How many moles of H<sub>2</sub>S are formed when 0.02mol of HCl react with excess Sb<sub>2</sub>S<sub>3</sub>?



- 4 How many moles of oxygen are formed when 0.6mol of KClO<sub>3</sub> react?

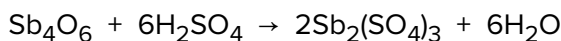


- 5 How many moles of iron are formed when 0.9mol CO react with excess iron oxide?



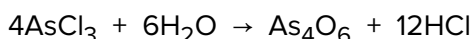
6 a. What is the limiting reactant in each of the following reactions?

0.1 mol  $\text{Sb}_4\text{O}_6$  reacts with 0.5 mol  $\text{H}_2\text{SO}_4$



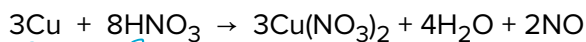
1 mol of  $\text{Sb}_4\text{O}_6$  needs 6 mol of  $\text{H}_2\text{SO}_4$ .  
SO 0.1 mol  $\text{Sb}_4\text{O}_6$  won't completely react with 0.5 mol of  $\text{H}_2\text{SO}_4$  is limiting the reaction.

b. 0.20 mol  $\text{AsCl}_3$  reacts with 0.25 mol  $\text{H}_2\text{O}$



4 : 6  
0.2 : 0.3  
We need 0.05 mol more of  $\text{H}_2\text{O}$  to complete the reaction.  
 $\text{H}_2\text{O}$  is the limiting factor.

c. 0.25 mol  $\text{Cu}$  react with 0.50 mol dilute  $\text{HNO}_3$  according to the equation:



3 : 8  
0.25 : 0.66

$\text{HNO}_3$  is the limiting factor.

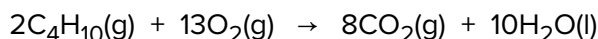
d. 0.10 mol  $\text{NaCl}$  reacts with 0.15 mol  $\text{MnO}_2$  and 0.20 mol  $\text{H}_2\text{SO}_4$



2 : 1 : 2  
0.1 : 0.05 : 0.1

Everything else is in excess. So the reaction stops when all of  $\text{NaCl}$  is consumed, therefore it's the limiting agent.

7 Consider the combustion of butane:

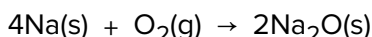


10.00g of butane reacts exactly with 35.78g of oxygen to produce 30.28g of carbon dioxide. What mass of water was produced?

$30.28g$  of  $CO_2$  is produced  
 That is  $\frac{30.28}{44} = 0.688 \text{ mol}$   
 Ratio of  $CO_2 : H_2O$   
 $4 : 5$

$0.688 : 0.86 \text{ mol}$   
 $\text{Mass of } H_2O = n \times M_{\text{olar}} \text{ Mass}$   
 $= 0.86 \times 18$   
 $= 15.48g \text{ Ans.}$

8 Consider the reaction of sodium with oxygen:



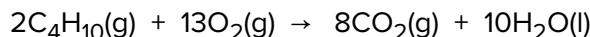
a. How much sodium reacts exactly with 3.20 g of oxygen?

$O_2 \ n = \frac{3.2}{32} = 0.1 \text{ mol}$   
 $0.4 \text{ mol Na is going to react with } 0.1 \ O_2$   
 $\text{Mass of Na} = 0.4 \times 23 = 9.20 \text{ g}$

b. What mass of  $Na_2O$  is produced?

$0.4 \text{ mol of Na is going to produce } 0.2 \text{ mol of } Na_2O$   
 $\text{Mass of } Na_2O = 0.2 \times (23 \times 2 + 16)$   
 $= 12.4 \text{ g}$

9 The following equation represents the combustion of butane:



If 10.00 g of butane is used, calculate:

a. the mass of oxygen required for the exact reaction

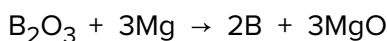
$M_r \text{ of } C_4H_{10} = (12 \times 4) + 10$   
 $= 58$

$58g \text{ of Butane} \rightarrow \frac{13 \times 32}{2} \text{ g of } O_2$   
 $58g \rightarrow 208g$   
 $10g \rightarrow 35.86g$

b. the mass of carbon dioxide produced.

$58g \text{ of Butane} \rightarrow \left(\frac{44 \times 8}{2}\right)g \text{ of } CO_2$   
 $58g \quad \quad \rightarrow 176g$   
 $10g \quad \quad \rightarrow 30.3g$

10 Boron can be prepared by reacting  $B_2O_3$  with magnesium at high temperatures:

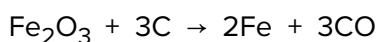


What mass of B is obtained if 0.75 g  $B_2O_3$  is reacted with 0.50 g Mg?

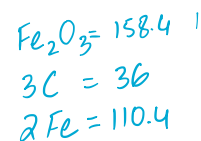
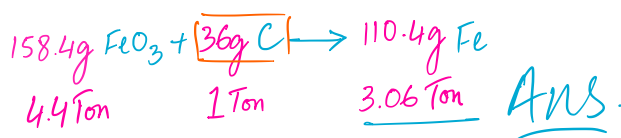
	Mr	$n \times$ Quantity
$B_2O_3$	69.6	0.01077
Mg	24.3	0.00658 - Limiting reactant.
B	10.8	-

$n_B = 2 \times 0.00658 = 0.01316 \text{ mol.}$   
 Mass =  $10.8 \times 0.01316 = 0.14 \text{ g.}$

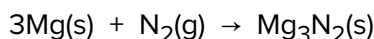
11 Iron(III) oxide reacts with carbon to produce iron:



What mass of Fe is obtained if 10.0 tonnes of  $Fe_2O_3$  is reacted with 1.00 tonne of C?



12 Consider the reaction between magnesium and nitrogen:



10.00g of magnesium is reacted with 5.00g of nitrogen. Which is the limiting reactant?

3 Mg	72.9
$N_2$	28
$Mg_3N_2$	100.9

$$10g : 5g$$

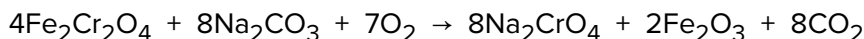
$$0.411 \text{ mol} : 0.178 \text{ mol}$$

$$2.3 : 1$$

Divided by Molar Mass, that's why values are a bit off.

The ratio should have been 3:1 for the reactants to be completely used up. As  $N_2$  is in excess, The Limit is due to magnesium.

13 For the reaction:



there is 100.0g of each reactant available. Which is the limiting reactant?

Mr:

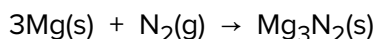
$$4Fe_2Cr_2O_4 = 4[2(55.8) + 2(52) + 4(16)] = 1118.4$$

$$8Na_2CO_3 = 8[2(23) + 12 + 3(16)] = 848.4$$

$$7O_2 = 224$$

Clearly  $Fe_2Cr_2O_4$  is the limiting agent.

- 14 Consider the reaction between magnesium and nitrogen:



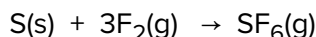
10.00g of magnesium is reacted with 5.00g of nitrogen. Which is the limiting reactant?

$$3\text{Mg} = 3(24.3) = 72.9$$

$$\text{N}_2 = 28$$

Mg is the limiting agent.

- 15 Consider the reaction between sulfur and fluorine:



10.00g of sulfur reacts with 10.00g of fluorine.

- a. Which is the limiting reactant?



- b. What mass of sulfur(VI) fluoride is formed?

Mr of  $\text{SF}_6 = 32 + 114 = 146$ , so  $3\text{F}_2 : \text{SF}_6 = 114 : 146 = 10 : 12.8$

12.8g of  $\text{SF}_6$  is formed

- c. What mass of the reactant in excess is left at the end?

114g of  $\text{F}_2$  requires 32g of S  
 so 10g " " 2.8g "  
 2.8g of the 10g reacted, excess =  $10 - 2.8 = 7.2\text{g}$

- 16 Calculate the percentage yield in each of the following reactions.

- a. When 2.50 g of  $\text{SO}_2$  is heated with excess oxygen, 2.50 g of  $\text{SO}_3$  is obtained.

$$2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$$

128.2g	:	160g	
2.5g	:	<u>3.12g</u>	

Theoretical Yield

$$\% \text{ Yield} = \frac{\text{Actual}}{\text{Theoretical}} \times 100\% = \frac{2.5}{3.12} \times 100\% = 80.13\%$$

- b. When 10.0g of arsenic is heated in excess oxygen, 12.5 g of  $\text{As}_4\text{O}_6$  is produced.

$$4\text{As} + 3\text{O}_2 \rightarrow \text{As}_4\text{O}_6$$

299g	:	395.6g	
10g	:	<u>13.23g</u>	

Th. Yield.

$$\% \text{ yield} = \frac{12.5}{13.23} \times 100 = 94.4\%$$

- (c) When 1.20 g ethene reacts with excess bromine, 5.23 g of 1,2-dibromoethane is produced.

$$\text{C}_2\text{H}_4 + \text{Br}_2 \rightarrow \text{CH}_2\text{BrCH}_2\text{Br}$$

28g	:	187.8g	
1.2g	:	<u>8.048g</u>	

Th. yield

$$\% \text{ Yield} = \frac{5.23}{8.048} \times 100 = 64.9\%$$