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?

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

2 : 1

0.4 : 0.2 mol Ans.

2 How many moles of O_2 react with 0.01 mol C_3H_8?

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

1 : 5

0.01 : 0.05 mol

3 How many moles of H_2S are formed when 0.02mol of HCl react with excess Sb_2S_3?

$$Sb_2S_3 + 6HCl \rightarrow 2SbCl_3 + 3H_2S$$

6 : 3

2 : 1

0.02 : 0.01

4 How many moles of oxygen are formed when 0.6mol of $KClO_3$ react?

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

2 : 3

0.6 : 0.9

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

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

3 : 2

0.9 : 0.6

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

0.1 mol Sb_4O_6 reacts with 0.5 mol H_2SO_4

$$Sb_4O_6 + 6H_2SO_4 \rightarrow 2Sb_2(SO_4)_3 + 6H_2O$$

1 mol of Sb_4O_6 needs 6 mol of H_2SO_4.
So 0.1 " 0.6 "
0.1 mol Sb_4O_6 wont completely react with 0.5 mol of
H_2SO_4 is limiting the reaction.

b. 0.20 mol $AsCl_3$ reacts with 0.25 mol H_2O

$$4AsCl_3 + 6H_2O \rightarrow As_4O_6 + 12HCl$$

4 : 6
0.2 : 0.3
We need 0.05 mol more of H_2O to complete the reaction.
H_2O is the limiting factor.

c. 0.25mol Cu react with 0.50mol dilute HNO_3 according to the equation:

$$3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 4H_2O + 2NO$$

3 : 8
0.25 : 0.66
HNO_3 is the limiting factor.

d. 0.10mol NaCl reacts with 0.15mol MnO_2 and 0.20mol H_2SO_4

$$2NaCl + MnO_2 + 2H_2SO_4 \rightarrow Na_2SO_4 + MnSO_4 + 2H_2O + Cl_2$$

2 : 1 : 2
0.1 : 0.05 : 0.1

Everything else is in excess. So the reaction stops when all of NaCl is consumed, therefore its the limiting agent.

7 Consider the combustion of butane:

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$$

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 $\frac{30.28}{44} = 0.688$ mol
Ratio of $CO_2 : H_2O$
4 : 5

0.688 : 0.86 mol
Mass of $H_2O = n \times$ Molar Mass
$= 0.86 \times 18$
$= 15.48g$ Ans.

8 Consider the reaction of sodium with oxygen:

$$4Na(s) + O_2(g) \rightarrow 2Na_2O(s)$$

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

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

b. What mass of Na_2O is produced?

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

9 The following equation represents the combustion of butane:

$$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$$

If 10.00 g of butane is used, calculate:

a. the mass of oxygen required for the exact reaction

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

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

b. the mass of carbon dioxide produced.

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

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

$$B_2O_3 + 3Mg \rightarrow 2B + 3MgO$$

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

	Mr	n x Quantity
B_2O_3	69.6	0.01077
Mg	24.3	0.00658 – Limiting reactant.
B	10.8	–

$n\,B = 2 \times 0.00658 = 0.01316$ mol.

Mass $= 10.8 \times 0.01316 = 0.14$ g.

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

$$Fe_2O_3 + 3C \rightarrow 2Fe + 3CO$$

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

$Fe_2O_3 = 158.4$
$3C = 36$
$2Fe = 110.4$

158.4g FeO_3 + $\boxed{36g\ C}$ → 110.4g Fe
4.4 Ton 1 Ton 3.06 Ton Ans.

12 Consider the reaction between magnesium and nitrogen:

$$3Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$$

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 mol : 0.178 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:

$$4Fe_2Cr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$$

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:

$$3Mg(s) + N_2(g) \rightarrow Mg_3N_2(s)$$

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

$3Mg = 3(24.3) = 72.9$
$N_2 = 28$

Mg is the limiting agent.

15 Consider the reaction between sulfur and fluorine:

$$S(s) + 3F_2(g) \rightarrow SF_6(g)$$

10.00g of sulfur reacts with 10.00g of fluorine.

a. Which is the limiting reactant?

$\underline{32g\ S} + 114g\ 3F_2 \rightarrow xg\ SF_6$ / F_2 is the limiting factor.

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

Mr of $SF_6 = 32 + 114 = 146$, so $3F_2 : SF_6 = 114 : 146 = 10 : \underline{12.8}$

12.8g of SF_6 is formed

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

114g of F_2 requires 32g of S
so 10g " $\underline{2.8g}$ "
2.8g of the 10g reacted, excess = 10 − 2.8 = 7.2g

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

a. When 2.50 g of SO_2 is heated with excess oxygen, 2.50 g of SO_3 is obtained.

128.2g : 160g
2.5g : $\underline{3.12g}$
Theoretical Yield

$$2SO_2 + O_2 \rightarrow 2SO_3$$

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

b. When 10.0g of arsenic is heated in excess oxygen, 12.5 g of As_4O_6 is produced.

$$4As + 3O_2 \rightarrow As_4O_6$$

299g : 395.6g
10g : $\underline{13.23g}$ 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.

28g : 187.8g
1.2g : $\underline{8.048g}$
Th. yield

$$C_2H_4 + Br_2 \rightarrow CH_2BrCH_2Br$$

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