YR 11 CALCULATION PRACTICE

1. **Iron Oxide (Fe_2O_3) can be reduced in a blast furnace by carbon monoxide to produce liquid iron according to the following equation:**

   $$Fe_2O_{3(s)} + 3CO_{(g)} \rightarrow 2Fe_{(l)} + 3CO_{2(g)}$$

   How many grams of iron can be produced if 25kg of carbon monoxide are consumed in the process?

2. **Magnesium metal burns in carbon dioxide producing a white ash of magnesium oxide mixed with black powdered carbon according to the following equation:**

   $$2Mg_{(s)} + CO_{2(g)} \rightarrow 2MgO_{(s)} + C_{(s)}$$

   If 558.9 grams of magnesium are burnt in 0.968kg of carbon dioxide what mass of magnesium oxide will be produced?

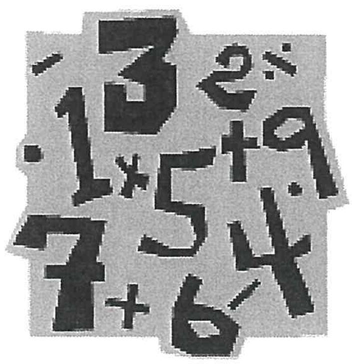
3. **The equations below represent the reactions that occur in the manufacture of nitric acid from ammonia.**

   $$4NH_3\ (g) + 5O_2\ (g) \rightarrow 4NO\ (g) + 6H_2O\ (g)$$

   $$2NO\ (g) + O_2\ (g) \rightarrow 2NO_2\ (g)$$

   $$3NO_2\ (g) + H_2O\ (l) \rightarrow 2HNO_3\ (aq) + NO\ (g)$$

   If 5.00×10^3 kg of ammonia (NH_3) is consumed in this process, calculate the mass of HNO_3 produced.



YR 11 CALCULATION PRACTICE (2)

1) If you are given 320 grams of sodium hydroxide:
   a) How many moles is this?
   b) How many formula units will there be in this much NaOH?
   c) How many oxygen atoms would be required to make this much NaOH?

2) Magnesium metal reacts with hydrochloric acid to produce a hydrogen gas and a clear, colourless solution according to the following equation;

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

What mass of $MgCl_2$ will be produced when 234 grams of HCl is reacted with excess magnesium metal?

3) Iron Oxide reacts with carbon monoxide when heated to produce iron metal (liquid form) and carbon dioxide according to the following equation:

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(l) + 3CO_2(g)$$

How many grams of iron will be produced when 638.40 grams of iron oxide are heated with 109.20 grams of carbon monoxide?

4) The reactions involved in the manufacture of nitric acid can be represented as follows:

$$N_2 + 3H_2 \rightarrow 2NH_3$$
$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$
$$2NO + O_2 \rightarrow 2NO_2$$
$$4NO_2 + 2H_2O + O_2 \rightarrow 4HNO_3$$

Calculate:
a) The initial amount of nitrogen used, if 25 kg of HNO_3 is produced?
b) The total amount of oxygen used in grams?

YR 11 CALCULATION PRACTICE (3)

1. **If you are given 840 grams of Aluminium Oxide (Al_2O_3):**

   a. How many moles is this?

   b. How many formula units would there be in this much Al_2O_3?

   c. How many moles of Aluminium atoms is there in this much Al_2O_3?

   d. How many Aluminium atoms is there in this much Al_2O_3?

   e. How many moles of Oxygen (O) would there be in this much Al_2O_3?

   f. How many Oxygen atoms would be needed to make this much Al_2O_3?

2. **Iron (III) Oxide is reduced in a blast furnace by carbon monoxide as shown by the following reaction:**

$$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$$

   If 460g of CO is fully consumed during this reaction then calculate the number of moles of Iron produced in this reaction.

3. **Butane gas is combusted in pure oxygen as shown by the following reaction:**

$$2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$$

   If there is 840g of butane and 215g of oxygen present in this reaction, calculate the mass of carbon dioxide produced in this reaction.

4. **Potassium perchlorate ($KClO_4$) can be prepared as shown in the following sequence of reactions:**

$$Cl_2 + 2KOH \rightarrow KCl + KClO + H_2O$$

$$3KClO \rightarrow 2KCl + KClO_3$$

$$4KClO_3 \rightarrow 3KClO_4 + KCl$$

   Calculate the mass of Potassium perchlorate, which can be obtained from 10.0 kg of Chlorine gas (Cl_2).

SOLUTIONS

1. (a)

*Al_2O_3

$M(Al_2O_3) = (26.98) \times 2 + (16.0) \times 3$

$\therefore M(Al_2O_3) = 101.96 g.mol^{-1}$

$n(Al_2O_3) = \frac{m}{M} = \frac{840}{101.96}$

$\therefore n(Al_2O_3) = 8.24 mol$ (3s.f)

(b)

$N(Al_2O_3) = n \times N_A = 8.24 \times 6.02 \times 10^{23}$

$\therefore N(Al_2O_3) = 4.96 \times 10^{24}$ F. units

(c)

$n(Al) = 2 \times n(Al_2O_3) = 2 \times 8.24$

$\therefore n(Al) = 16.5 mol$

(d)

$N(Al) = n \times N_A = 16.5 \times N_A$

$\therefore N(Al) = 9.92 \times 10^{24}$ atoms

(e)

$n(O) = 3 \times n(Al_2O_3) = 3 \times 8.24$

$\therefore n(O) = 24.7 mol$

(f)

$N(O) = n \times N_A = 24.7 \times N_A$

$\therefore N(O) = 1.49 \times 10^{25}$

2.

✓ ?

$Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$

*CO

$M(CO) = 12.01 + 16$

$\therefore M(CO) = 28.10 gmol^{-1}$

$n(CO) = \frac{m}{M} = \frac{460}{28.01}$

$\therefore n(CO) = 16.4 mol$

$n(Fe) = 2/3 \times n(CO) = 2/3 \times 16.4$

$\therefore n(Fe) = 10.9 mol$

✓ ✓✓ ?

3. $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

*C_4H_{10}

$M(C_4H_{10}) = (12.01) \times 4 + (1.008) \times 10$

$\therefore M(C_4H_{10}) = 58.12 g.mol^{-1}$

$n(C_4H_{10}) = \frac{m}{M} = \frac{840}{58.12}$

$\therefore n(C_4H_{10}) = 14.5 mol$

$n(O_2) = \frac{m}{M} = \frac{215}{32}$

$\therefore n(O_2) = 6.72 mol$

Limiting Reactant Justification:

- **If All (O_2) used up:**

$n(C_4H_{10}) = 2/13 \times n(O_2)$
$= 2/13 \times 6.72$
$\therefore n(C_4H_{10}) = 1.03$ mol

*We have more than 1.03 mol, we have 14.5 mol!!
$\therefore C_4H_{10}$ in excess
$\therefore O_2$ is **limiting**!!

$$n(CO_2) = 8/13 \times n(O_2)$$
$= 8/13 \times 6.72$
$\therefore n(CO_2) = 4.13$ mol

*CO_2

$M(CO_2) = 12.01 + (16) \times 2$

$\therefore M(CO_2) = 44.01 gmol^{-1}$

$m(CO_2) = n \times M$
$= 4.13 \times 44.01$
$\therefore m(CO_2) = 182$ g

✓

4. $Cl_2 + 2KOH \rightarrow KCl + KClO + H_2O$
1 1

$3KClO \rightarrow 2KCl + KClO_3$
1 1/3

?

$4KClO_3 \rightarrow 3KClO_4 + KCl$
1/3 **3/12**
(0.25)

$n(Cl_2) = \frac{m}{M} = \frac{10000}{70.9}$

$\therefore n(Cl_2) = 141$ mol

$n(KClO_4) = 3/12 \times n(Cl_2)$
$n(KClO_4) = 3/12 \times n(Cl_2)$
$= 3/12 \times 141$
$\therefore n(KClO_4) = 35.25 mol$

*$KClO_4$

$M(KClO_4) = 39.10 + 35.45 + (16) \times 4$

$\therefore M(KClO_4) = 138.55 gmol^{-1}$

$m(KClO_4) = n \times M$
$= 35.25 \times 138.55$
$\therefore m(KClO_4) = 4{,}883.8 = 4{,}880 g$