Balancing Equations (Difficult Ones)

In AQA exams there are commonly some quite difficult balancing equations questions. There is often an aspect of trial and error and balancing equations but there are some guidelines to follow.

Which element to start with?

- Look for elements you have been given a balancing number for
- Look elements that are changing oxidation number
- Look for elements that only appear once in reactants and products

Don't start with elements that appear several times

Example 1

$Mg_3Si_2O_5(OH)_4$ + ...CO_2 → .....$MgCO_3$ + ...SiO_2 + ...H_2O

In this example we know the reactant $Mg_3Si_2O_5(OH)_4$ has a balancing number of 1 so this is our starting point. We can also see Mg, Si and H only appear once in the reactants and products so start with these.

- There are 3 Mg's in reactant so there must be 3 $MgCO_3$
- There are 2 Si's in reactant so there must be 2 SiO_2
- There are 4 H's in reactant so there must be 2 H_2O

$Mg_3Si_2O_5(OH)_4$ + ...CO_2 → .....3...$MgCO_3$ + ...2...SiO_2 + ...2.....H_2O

We can also see C only appears once in the reactants and products so now we can balance C

- There are 3C's in 3$MgCO_3$ so there must be 3CO_2

$Mg_3Si_2O_5(OH)_4$ + ...3...CO_2 → .....3...$MgCO_3$ + ...2...SiO_2 + ...2.....H_2O

Check the O's balance :15 on both sides

Example 2

..... $AsCl_3$ + ... $NaBH_4$→..... AsH_3 + ... NaCl + ... BCl_3

In this example it can be difficult to know where best to start as 3 of the elements appear once in the reactants and products. It is only Cl that appears in two products. The key is the hydrogen because it only appears once in the reactants as NaB**H_4** and once in products as As**H_3**. To get these to balance we need to multiply up to get 12 H's on both sides – 3$NaBH_4$ and 4AsH_3

..... $AsCl_3$ + ...3... $NaBH_4$→...4... AsH_3 + ... NaCl + ... BCl_3

This allows the rest to be easily balanced.

- 4 AsH_3 means 4 $AsCl_3$
- 3 **Na**BH_4 means 3 **Na**Cl
- 3 Na**B**H_4 means 3 **B**Cl_3

...4... $AsCl_3$ + ...3... $NaBH_4$→...4... AsH_3 + ...3... NaCl + ...3... BCl_3

Check the Cl's balance : 12 on both sides

Example 3

3 CuS + ...HNO_3 → .....$CuSO_4$ + ...NO + ...H_2O

In this example we know the reactant CuS has a balancing number of 3 so this is our starting point.

- There are 3 Cu's in reactant so there must be 3 $CuSO_4$
- The same is true for S

3 CuS + ...HNO_3 → .....3....$CuSO_4$ + ...NO + ...H_2O

The H's ,N's and O's are all interlinked. Whatever the balancing number of HNO_3 must be the balancing number of the NO. We can see there must be at least 14 O's on the right so HNO_3 must have a balancing number equal or greater than 5. You could by trial and error increase the balancing number of HNO_3 until you got something that worked- which is 8 HNO_3.

It would be better to spot that this is a redox equation and use the idea that the total increase in oxidation number of S will be the same as the total decrease in oxidation number of N.
S in CuS has an oxidation number of -2
S in $CuSO_4$ has an oxidation number of +6
So between 3CuS to 3 $CuSO_4$ there will be a total increase of 3 x +8 = +24

This means N must decrease by -24
In HNO_3 the oxidation number Of N is +5 and in NO it is +2. The change is -3
Therefore there must be 8 N's to decrease by -24 (8 x-3). So we must have 8HNO_3 and 8NO

3 CuS + ...8...HNO_3 → .....3....$CuSO_4$ + ...8.....NO + ...H_2O

Which just leaves 4H_2O to balance up the H's

a) C_4H_{10} + F_2 → C_4F_{10} + HF

b) $NH_3(g)$ + $O_2(g)$ → $N_2O(g)$ + $H_2O(l)$

c) $Mg(NO_3)_2(s)$ → MgO(s) + $NO_2(g)$ + $O_2(g)$

d) $B_2O_3(s)$ + C(s) + $Cl_2(g)$ → $BCl_3(g)$ + CO(g)

e) .....$CH_3CH_2CH_2CH_3$ + ... O_2 → .....$C_2H_2(CO)_2O$ + ... H_2O

f) $NO_2(g)$ + $H_2O(l)$ → $HNO_3(aq)$ + NO(g)

g) ……$CuFeS_2$ + ……SiO_2 + ……O_2 → Cu_2S + ……$FeSiO_3$ + ……SO_2

h) .....FeS_2 + ...O_2 → ..... Fe_2O_3 + ...SO_2

i) $TiCl_4(g)$ + Na(l) → NaCl(s) + Ti(s)

j) Cu + ... HNO_3 → $Cu(NO_3)_2$ + ... NO_2 + ... H_2O

k) I_2 + 10HNO_3 → .....HIO_3 + ...NO_2 + ...H_2O

l) .....$Ca_5F(PO_4)_3$ + 9SiO_2 + ...C → 9$CaSiO_3$ + CaF_2 + ...CO + ...P

m) ..... $FeCr_2O_4$ + ... Na_2CO_3 + ... O_2 → ..... Na_2CrO_4 + 2Fe_2O_3 + 8CO_2