Balancing by inspection

Unbalanced equation:

NH_3	**+**	**O_2**	**—>**	**NO**	**+**	**H_2O**
Ammonia	**and**	**oxygen**	**yield**	**nitric oxide**	**and**	**water.**

Step 1: balance nitrogen atoms

After noting that nitrogen appears in only one reactant molecule, NH_3, and one product molecule, NO, balance the nitrogen atoms.

$$1\ NH_3 + O_2 \longrightarrow 1\ NO + H_2O$$

Step 2: balance hydrogen atoms

Since 3 hydrogen atoms appear in the reactants, there must be three hydrogens in the products. If the coefficient of ammonia reactant is 1, the coefficient of water product must be $^3/_2$.

$$1\ NH_3 + O_2 \longrightarrow 1\ NO + {}^3/_2\ H_2O$$

Step 3: balance oxygen atoms

There are $1+{}^3/_2={}^5/_2$ moles of oxygen atoms in the products. Making the coefficient of O_2 equal to $^5/_4$ will produce the same number of moles of oxygen in the reactants.

$$1\ NH_3 + {}^5/_4\ O_2 \longrightarrow 1\ NO + {}^3/_2\ H_2O$$

Step 4: Obtain lowest whole number coefficients

Multiply all coefficients in the result of the previous step by 4.

$$4\ NH_3 + 5\ O_2 \longrightarrow 4\ NO + 6\ H_2O$$

Although the above example uses the fraction method to get the final balanced chemical equation, remember that you could just as well have restarted in Step 2 while balancing the hydrogen atoms to give $2\ NH_3 + O_2 \longrightarrow 2\ NO + 3\ H_2O$.

Then, in Step 3 you would also start over when you discovered that you had 5 oxygens on the right and needed an even number on the left. The most convenient thing is to go up 2 more so that the coefficient for the NH_3 is 4, and this would give $4\ NH_3 + 5\ O_2 \longrightarrow 4\ NO + 6\ H_2O$, which is the same answer we got above through the fractions.

Another example of balancing by inspection

1. **Unbalanced equation:**

PbO_2	+	**HCl**	—>	**$PbCl_2$**	+	**Cl_2**	+	**H_2O**
lead(IV) oxide*		**hydrochloric acid**		**lead(II) chloride***		**chlorine**		**water**

Step 1: balance lead atoms

$$1\ PbO_2 + HCl \longrightarrow 1\ PbCl_2 + Cl_2 + H_2O$$

Step 2: balance oxygen atoms

$$1\ PbO_2 + HCl \longrightarrow 1\ PbCl_2 + Cl_2 + 2\ H_2O$$

Step 3: balance hydrogen atoms

$$1\ PbO_2 + 4\ HCl \longrightarrow 1\ PbCl_2 + Cl_2 + 2\ H_2O$$

Step 4: balance chlorine atoms

$$1\ PbO_2 + 4\ HCl \longrightarrow 1\ PbCl_2 + 1\ Cl_2 + 2\ H_2O$$

Step 5: Obtain lowest whole number coefficients

(The result of step 4 is already in standard form.)

$$PbO_2 + 4\ HCl \longrightarrow PbCl_2 + Cl_2 + 2\ H_2O$$

*Remember: The roman numerals are used to distinguish several existing compounds between lead and oxygen, and lead and chloride. (Chapter 4!!)