

## Balancing Combustion Equations

Chemistry BC2001x

Some textbooks (e.g Oxtoby 4th Ed.) introduce a formal algebraic way of balancing equations. This approach is cumbersome, and few chemists do it this way. For most reactions, you can balance by inspection. This will be true of acid-base and precipitation reactions. Later we will learn how to tackle more general oxidation-reduction equations.

For **combustion** reactions, there is a logical procedure to follow which allows you to find each coefficient in sequence, without going back. Take the example



Since coefficients of balanced equations express **ratios** (we are allowed to multiply or divide all coefficients by any value and the equation is still correct) we can always choose one coefficient arbitrarily. So for combustions, choose **1** as the coefficient of the stuff being burned, (the fuel), *and do not change it thereafter*. (Writing the coefficient 1 is optional, but it is a good idea in this case, as a reminder that this coefficient has been established.)



All elements but O, in this case C, H, and N, appear on the left only in this molecule, and each appears only once on the right. Thus the coefficients of all product molecules are chosen to conserve atoms of C (with CO<sub>2</sub>), H (with H<sub>2</sub>O), and N (with NO<sub>2</sub>). With 3 atoms of H on the left, and two per water on the right, we need a fractional coefficient for water. Fractions are fine!



The coefficient of O<sub>2</sub> is determined last, with its value chosen to balance O atoms, since oxygen appears in several different molecules on the right. There are 3(2) + 6(2) + 3/2 = 19 1/2 O atoms in the products (on the right). In the reactants (on the left), 7 are in the fuel. So we need 12 1/2 or 25/2 O atoms from the molecule O<sub>2</sub>. Since each O<sub>2</sub> has 2 atoms, we need (1/2)(25/2) = 25/4 O<sub>2</sub>:



If you want to write with integral coefficients (not required, but some prefer it) you can multiply through by the largest common denominator, here 4. Be very careful to multiply all coefficients, so you do not undo the balancing.

