Balancing reaction equations by inspection

1. Identify the elements* that occur in only <u>one compound</u> (but ***not*** in the elemental state like $O_2(g)$ or Cu(s)) on <u>each side</u> of the equation.
2. If more than one element qualifies, select the one that occurs in the compound with the largest number of elements.
3. Balance the equation first in the selected element.
4. In balancing an element write the coefficient for a compound even if it is just 1, so you can easily see which compounds are "done" at any point.
5. Continue the process by balancing the equation in other elements that are components of <u>one still-not-done</u> (i.e. without a coefficient) compound <u>only</u>. If the element occurs in elemental form ($O_2(g)$, S(s), $S_8(s)$, Cu(s), etc.) in addition to a compound without a coefficient, it's no good.
   If you can't find a qualifying element to continue the process, go back to step 2 and proceed with an alternative qualifying element**.
6. If you had to use a fractional coefficient at any step in the above process, multiply all the coefficients that you determined up to that point by the <u>denominator</u> of the fraction to obtain integer coefficients as soon as you created the fractional coefficient. That way, you avoid dealing with the error-prone process of adding or subtracting fractions.
7. Balance the charges (if any) using an ion that is not balanced yet. All compounds or ions should now end up being balanced.
8. Balance any substances that are elements.

*If a polyatomic ion (SO_4^{2-}, NO_3^-, etc.), as part of a compound or alone, seems to survive the reaction intact, treating it like an "atom" may simplify balancing significantly. If you do that, the O, S or N (or whatever atoms present in the polyatomic ion) in the polyatomic ion does not count in balancing the O, S, or N (or whatever atoms present in the polyatomic ion) that occur in other entities. In doing this, though, you need to make sure all of the particular polyatomic ion indeed survive the reaction intact. If some of the, say, nitrates get transferred to another compound while some change into something else (say NO_2), the balance will be incorrect.

**Using this method should work for most reactions. Occasionally it is necessary to introduce a temporarily unknown coefficient (e.g x) or two (e.g. x and y) and solve for it (or them) later. But we will try to avoid those cases for now.

Note: there are reaction equations that are in fact the sum of two independent reactions. Those balancing problems don't have a unique solution, and any procedure will fail to give a unique set of coefficients.