

## Chem11 Balancing Equations : Notes - 28

It is important to be able to balance chemical equations. The reason we balance equations is to conserve atoms. Since atoms can't be created or destroyed, the number of atoms of each type should be the same on both sides of an equation.

There are two methods for balancing equations : guess a solution, or solve the problem using a mathematical method.

The simpler equations can be solved using guesswork.

e.g. hydrogen gas and oxygen gas react to form water.



e.g. butane gas combines with oxygen gas (burns) to form carbon dioxide plus water.



More complex equations can be solved by using the method shown below.

e.g. nitrogen gas combines with hydrogen gas (using a catalyst) to form ammonia.

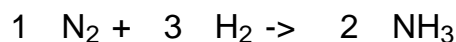


We can find the integers ; a, b, and c, by writing down equations that conserve atoms.

$$2 a = c \qquad \text{conserve N atoms}$$

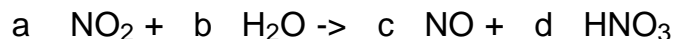
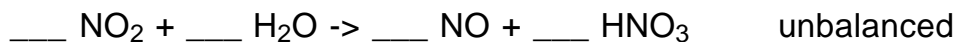
$$2 b = 3 c \qquad \text{conserve H atoms}$$

Here, we have two equations and three unknowns. We have to "guess" the solution to one of the unknowns. Let  $c = 1$ . Therefore,  $a = 1/2$ , and  $b = 3/2$ . Multiply by two. The solution is :  $a = 1$ ,  $b = 3$ , and  $c = 2$ . Therefore :



This method always works. Although there will be one less equation than there are unknowns, the solution will be correct to within a constant factor.

e.g. nitrogen dioxide reacts with water to form nitrogen monoxide and nitric acid.



$$a = c + d \qquad \text{conserve N}$$

$$2 b = d \qquad \text{conserve H}$$

$$2a + b = c + 3 d \qquad \text{conserve O}$$

Let  $b = 1$ . Therefore  $d = 2$ . We are left with two equations to be solved for two unknowns.  $a = c + 2$ , and  $2a + 1 = c + 6$ . Solving this system for the two unknowns, we find that ;  $a = 3$ , and  $c = 1$ . Therefore :

