Chemical Reaction: Combustion of Wax (as in Activity 5A)

Scientists depict chemical reactions in a way that looks similar to a mathematical equation. The format is called a ***chemical equation***, but instead of an equals sign (=), an arrow (→) is used to depict the irreversible chemical reaction.

The term "***reactants***" refers to the elements and compounds that participate in the reaction. The reactants are the original chemicals, as they were before the reaction takes place. The reactants are shown on the left side of the chemical equation.

The term "***products***" refers to the elements and compounds that are produced as a result of the reaction. The products are the new chemicals that appear after the reaction occurs. The products are shown on the right side of the chemical equation.

The chemical reaction process cannot be reversed. In other words, the products cannot be broken apart and immediately recombined in the form of the original reactants. Technically, they might eventually be transformed back into the original reactants, but it would be a several step process, not a simple reversal.

The form of chemical equations looks like this:

Reactants → Products

The chemical equation for the combustion (burning) of wax, expressed in words:

wax + oxygen → carbon dioxide + water + *energy (heat + light)*
(in the presence of heat)

The chemical equation for the combustion (burning) of wax, expressed as a ***balanced equation***:

$$C_{25}H_{52} + 38\ O_2 \rightarrow 25\ CO_2 + 26\ H_2O + \textit{energy (heat + light)}$$

Balanced Equations:

Chemical reactions that are actually physically possible are always "balanced". This means that the total number of each of type atom in the reactants equals the total number of each type of atom in the products.

No atoms are added to, or removed from, the system. But, during the reaction molecules of elements and compounds in the reactants break apart. Those freed atoms then join with other freed atoms to form molecules of new elements or compounds (products of the reaction).

Since all the atoms came from the original reactants, the total number of each type of atom in the reactants must equal the total number of each type of atom in the products.

The charts below show that the chemical equation for the combustion of wax is indeed balanced:

$$C_{25}H_{52} + 38\ O_2 \rightarrow 25\ CO_2 + 26\ H_2O + \textit{energy (heat + light)}$$

Reactants	**Chemical Formula**	**Atoms in 1 molecule**	**Number of molecules in the balanced reaction**
Wax	$C_{25}H_{52}$	25 atoms of Carbon (C) 52 atoms of Hydrogen (H)	1
Oxygen	O_2	2 atoms of Oxygen (O)	38

Products	**Chemical Formula**	**Atoms in 1 molecule**	**Number of molecules in the balanced reaction**
Carbon Dioxide	CO_2	1 atom of Carbon (C) 2 atoms of Oxygen (O)	25
Water	H_2O	2 atoms of Hydrogen (H) 1 atom of Oxygen (O)	26

Element	**Total number of atoms in the *reactant* compounds** (# of molecules × # of atoms per molecule)	**Total number of atoms in the *product* compounds** (# of molecules × # of atoms per molecule)
Carbon	1 × 25 = 25 atoms	25 × 1 = 25 atoms
Hydrogen	1 × 52 = 52 atoms	26 × 2 = 52 atoms
Oxygen	38 × 2 = 76 atom	(25 × 2) + (26 × 1) = 76 atoms

You may have noticed that the ***wick*** of the candle (probably made of cotton string) is not included in the combustion equation. The job of the wick is to absorb the liquid wax and pull it upward, providing fuel (wax) to the flame. The wick also burns, but not as quickly or efficiently as wax. So, although the wick is a vital part the candle (the flame could not be sustained without it) in terms of the ***chemical process*** of combustion, the wick has only a very small role.

As shown in the chemical equation, if the combustion of wax were perfect and complete, the only products would be ***carbon dioxide*** and ***water***. But, as observed in Activity 5A, ***black soot*** was also produced, appearing as a wisp of smoke, and as black particles deposited on the copper wire. So, what happened?

Soot is a powdery black substance composed of carbon. It is a byproduct of ***incomplete combustion***. In the case of candles, smoke and soot is likely due to both the incomplete combustion of the ***wick***, and disturbance of the flame, making the burning of wax uneven.