LETTER TO THE EDITOR

PHLOGISTON AND MODERN CHEMISTRY

In a recent issue of *Bulletin for the History of Chemistry* Woodcock made a clever attempt to compare phlogiston with Gibbs free energy (L. V. Woodcock, "Phlogiston Theory and Chemical Revolutions," *Bull. Hist. Chem.*, **2005**, *30*, 63-69).

While this is quite interesting, it is however rather complicated. A more simple analogy would be to compare phlogiston with the electron. Thus, the classic equation:

Metal → Calx + Phlogiston

would be represented by:

$M \rightarrow M^{2+} + 2e^-$

$\frac{1}{2} O_2 + 2e^- \rightarrow O^{2-}$

$M^{2+} + O^{2-} \rightarrow MO$

where M is a divalent metal and MO will be the calx.

Similarly, the familiar equation:

Calx + ϕ + Acid → Calx + Acid + ϕ

[Metal] [Salt] [Inflammable air]

can be represented in modern terms as follows:

$M \rightarrow M^{2+} + 2 e^-$

$2 H^+ + 2 e^- \rightarrow H_2$

Fathi Habashi, Laval University, Canada

AUTHOR'S RESPONSE

I think Habashi's short communication provides a clearer background to phlogiston than my article, and the idea of identifying phlogiston with the electron is, I believe, both novel and fascinating. Indeed, had the phlogiston theory survived longer, as it might have done, I can imagine that the unit of energy that developed from electrochemistry, namely the "electron-volt," might have become known as the "phlogiston."

In my article, I identified phlogiston with the Gibbs chemical potential of a material with respect to its oxide. That is a phenomenological interpretation consistent with 18th century phenomenology, and needs make no reference to either the molecular or electronic level of interpretation of chemical reaction phenomena. These levels of interpretation were unknown at the time.

The connection between phlogiston and the electrons transferred is: phlogiston = number of electrons x Faraday constant x EMF (voltage). It is clear that all chemical reactions involving, for instance, the transfer of one electron have widely varying amounts of phlogiston, depending on the EMF, which is proportional to the phlogiston content.

This highlights the limitation of the phlogiston = electron transferred idea. For example, hydrogen would have only one quarter the amount of phlogiston as carbon, when they react with oxygen; but in fact, hydrogen has about 10 times the phlogiston (i.e., Gibbs free energy) of carbon.

Leslie V. Woodcock