Lesson #17: Combustion –What's Your Theory?

Stage 1 – Desired Results

Essential Questions: SLO D1: Use the concepts of similarity and diversity for organizing our experiences with the world
SLO A5: Describe disciplinary processes used to enable us to investigate and understand natural phenomena and develop technological solutions

Understandings:	Essential Questions: What is the basic chemistry of hydrocarbons and how do we TAKE them from earth and MAKE products out of them? **SLO A2:** What are the power and limitations of science as a way of answering questions about the world and explaining natural phenomenon?
Students will understand that…1. Scientific theory is continually being scrutinized. 2. Combustion is an everyday phenomena that we have developed scientific theory for	
Students will know… 1. how a hydrocarbon burns 2. different theories have historically been able to explain the same set of observations until more evidence was provided.	Students will be able to…1. Describe the combustion of a hydrocarbon at a visual and a molecular level of representation 2. Create and balance combustion equations.

Stage 2- Assessment Evidence

Knowledge: 1. Assess the application of their knowledge on their write-up "My Description of How a Candle Burns"	**Skills:** 1. Assess the students ability to create an equation for the combustion of a hydrocarbon (one they have never encountered before), balance the equation and describe what is happening on a visual level and a molecular level. It might be neat to have both complete and incomplete combustion included here. 2. Have students create a comic/demo for younger students describing the essential elements of combustion. Present it to them of course!

Materials Required

HANDOUTS: Theories of Combustion
Notes on Burning Hydrocarbons
My Description of How a Candle Burns
Materials for Part A (burning magnesium)
Access to web
"The Phlogiston Theory"
http://www.timelinescience.org/resource/students/phlog/phlog_th.htm
"Antoine Lavoisier – the first "modern' chemist"
http://www.timelinescience.org/resource/students/phlog/phlog_th.htm
"Joseph Priestley – a lucky dabbler"
http://www.timelinescience.org/resource/students/phlog/phlog_th.htm
(alternately provide these as handouts)

Stage 3 – Learning Plan

1. HANDOUT: Theories of Combustion
Observing safety precautions, complete Activity 1 Part A by burning magnesium. Have students write down their theory of "How Things Burn".
2. DIRECT students to read The Phlogiston Theory (on-line at http://www.timelinescience.org/resource/students/phlog/phlog_th.htm or as a handout)
3. Complete Activity 1 Part B and Part C.
4. DIRECT students to read "Antoine Lavoisier – the first "modern' chemist" and "Joseph Priestley – a lucky dabbler" (on-line at http://www.timelinescience.org/resource/students/phlog/phlog_th.htm or as a handout)
5. Complete Activity 3

6. DISCUSS the nature of science – that theories are proposed and continually tested and scrutinized by peers. 7. DIRECT students to apply their knowledge about burning to write "My Description of How a Candle Burns" 8. Use the on-line description (http://home.howstuffworks.com/question267.htm) to guide in enhancing their answers. 9. HANDOUT: Notes on combustion. Review. Use as practice for balancing equations. (Provide additional review where necessary). Extend to oxidation states if desired. REVIEW answers.
Extension Learning Activities
Complete Activity 2.

Educator Notes

Theories on Combustion

For our purposes, let's agree that combustion is another word for burning.

My Theory on "How Things Burn"

What I would see:

Chemical Changes:

Physical Changes:

How the Burning Happens (molecular level):

Scientist in the 18th Century – Theory on How Things Burn

What he/she would see:

Chemical Changes:

Physical Changes:

How the Burning Happens (molecular level):

Studying Science

1. Do both theories accurately explain what is observed?

2. If two theories can accurately explain the same set of observations, how do scientists decide which theory is "more" accurate?

Letter to _____
(Priestley/Lavoisier)

Date: _____

Dear _____,

My Description of "How A Candle Burns"

Notes on Burning Hydrocarbons

1. requires oxygen
2. produces carbon dioxide and water
3. The chemical equation is

   _____ + O_2 → CO_2 + $H_2 0$
   (a hydrocarbon)

   For example the combustion of methane is

   ___ CH_4 + ___ O_2 → ___ CO_2 + ___ $H_2 0$

   Try to balance this equation using **coefficients**!

3. Complete combustion
   *occurs when there is plenty of air
   *means that the carbon is oxidized to its highest "oxidation state". In the example above the carbon was oxidized to +4

4. Incomplete combustion occurs when there is a limited amount of oxygen available. Because the carbon is oxidized only to a state of +2, carbon monoxide is produced rather than carbon dioxide. This reaction would be

   ___ CH_4 + ___ O_2 → ___ CO + ___ $H_2 0$

   Try to balance this equation using **coefficients**!

Real-Life

1. You might have seen incomplete combustion when you see black soot rising from a candle or on the bottom of a pan. What do you think this compound is?

2. You might have heard of the dangers of carbon monoxide. Carbon monoxide bonds to your hemoglobin in your blood more easily than oxygen. What are the causes and consequences of carbon monoxide poisoning?