Teaching –learning module compiled by the PARSEL consortium
as part of an EC FP6 funded project (SAS6-CT-2006-042922-PARSEL) on
Popularity and Relevance of Science Education for scientific Literacy

No smoke without a fire - (Un)desirable Combustion

Teacher Materials

The teaching of units is organized in four phases:

- Encountering phase
- Curiosity and planning phase
- Formulating phase
- Networking and intensifying phase

All phases are designed in rich methodologic variation, to involve the students into planning and conducting the experiments.

Guiding question of the unit “Combustion”

>>What is burned, is gone, destroyed, missing.<< - That is a widely held common belief. At the same time, however, there is a discussion about exhaust fumes and the products of combustion. What happens then with the >>fuel<<? Couldn’t a method be developed for combustion without exhaust fumes and without the undesirable consequences?

Developer: **Martin Lindner, based on Materials from Chemistry in Context. Idea: Ilka Parchmann, unit developed by groups of Teachers in Lower Saxonia and Bavaria**
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Goals

The lesson unit about combustion and its consequences will

- introduce the concept of chemical reactions using the everyday activity combustion
- introduce the atomic theory in a meaningful connection;
- give insight to the discussion in the media about climate change and the increase in the level of CO2 in the atmosphere;
- impart factually based judgmental competency and show the importance of knowledge about chemistry when participating in societal discussions and for structuring one's own individual life.

Encountering phase

In the schoolyard the students conduct various experiments about burning and extinguishing fires and note their questions concerning their observations.

Picture:

Students from Gymnasium Parsberg experiment under the supervision of the fire department.

Possible student questions about the context

- The fire department advises keeping doors and windows closed when rooms burn. Why?
- In order to contain a forest fire, a corridor is often cut through the forest. Why?
- Why can a fire (grill) be intensified by blowing, but a candle be extinguished?
- How does a fire extinguisher function? What is in it?
- What are flames? What is smoke made of?
- What makes something combustible or not?

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Curiosity and planning phase

The students in this study are presented with contradictory everyday conceptions about combustion. Some statements suggest combustion without products:

- >> The worldwide petroleum reserves are irrevocably destroyed.<<
- >> Just a pile of ashes was all that was left of the firewood.<<

On the other hand, the media bring up the problem of combustion products (=exhaust fumes) again and again:

- >> Demand a definitive reduction of greenhouse gases. <<
- >> Victim suffered from smoke inhalation. <<

This contradiction provides a starting point for various further questions from students. These are compiled together with the questions from the encountering phase in a mind map.

Experiment with the >>manipulated<< light bulb

Developing the principle of chemical reaction using combustion as an example offers the chance to delineate the discussion about the everyday term reactions from other processes. It is, for example, possible to scrutinize the term “burn” in various connections: Does combustion take place in the body, in a fuel cell, in a light bulb? The light bulb can really be stimulated to “react” using a little manipulation.

Material: Bunsen burner or butane burner, light bulb with a hole (40 to 100 Watt), frame with a voltage source and cable, alternative: normal socket

Preparation: Using a burner a small hole is melt in the glass plunger of a light bulb. To do so, the whole plunger has to be carefully warmed by rotating it in the flame. Then the non-luminous flame from the burner has to be focused on one point until the plunger arches and finally bursts.

Observation: If the manipulated light bulb is put in a socket and voltage is applied, the light burns very bright for a short period and then extinguishes. The filament breaks and is incomplete. A white-yellow product has formed instead (wolfram oxide) and is deposited on the inner wall of the glass. The students work out the characteristics of combustion at the material level based on this experiment.

Developing phase

The student questions collected in the mind map form the structural background for a methodologically diverse lesson during the developing phase. The relationship of a work order to the context should always be clear to the students. Two examples are presented in the following.

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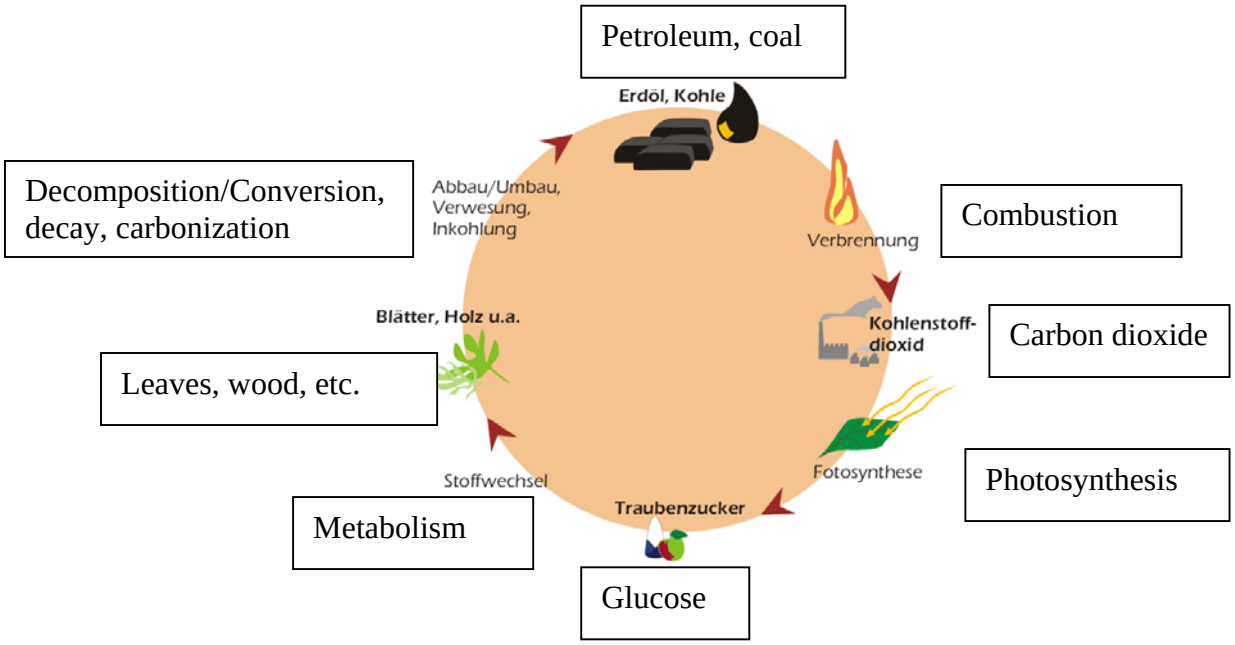
Work out a >> basic concept of material particles <<

In the course of the unit the students learn that chemical phenomena cannot only be seen as material, but also as particles (>>material – particle concepts<<). In addition, a very simplified presentation of the carbon cycle can serve as a reference for many of the questions asked by the students. At the same time it is possible to relate the students' knowledge interdisciplinarily.
The students themselves develop the idea of a cycle based on their knowledge of the genesis of fossil sources of energy, combustion processes and photosynthesis as shown in the following statements by students.

Student statement
>>The actions are related because the product is always a result of the next reaction<<
>>The cycle begins from the beginning again. The material can be retrieved.<<



What is actually going around in this cycle? In answering this question, John Dalton (an English naturalist, precursor of the atomic theory) offers one anwer: >>We can more easily try to add a new planet to the solar system or to destroy one than to create a new atom or destroy one. Changes that we can bring forth only have to do with splitting atoms that were connected or in connecting them.<<

Intensifying and networking phase

Main ideas: Other cycles of matter (e.g. nitrogen cycle, idea of recycling), renewable raw materials (bio-diesel), hydrogen – a fuel without carbon atoms

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Based on the knowledge worked out in this unit, the students intensify their work with the problems of the undesirable consequences of combustion brought up in the beginning, at the same time search for possible solutions. Role playing or a group puzzle are possible methods here. The results of this phase can be fixed in a flow chart:

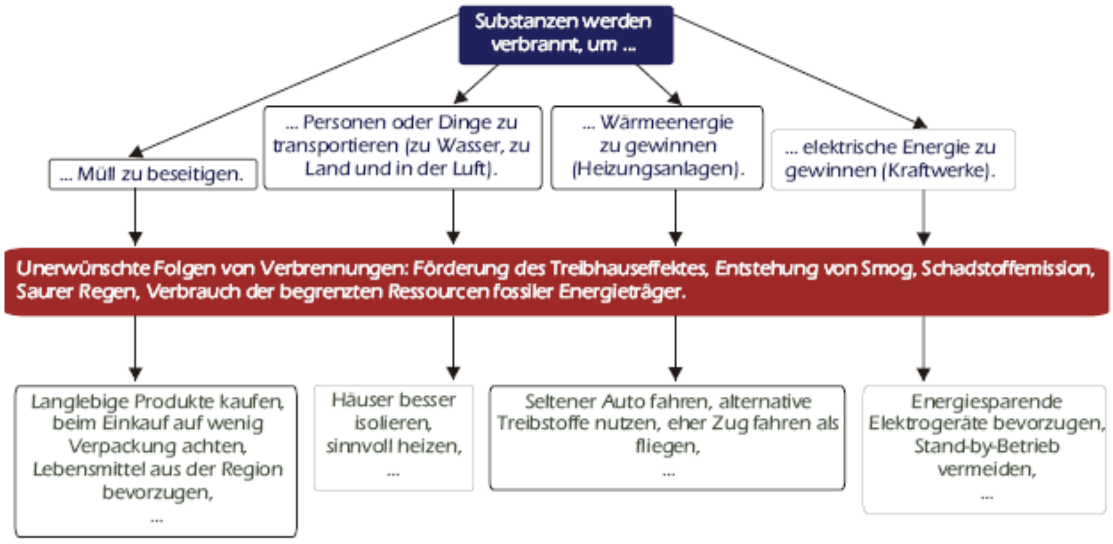
Substances are burned to

- dispose of waste
- to transport people or things (by water, land or in the air)
- generate energy (heating systems)
- generate electricity (power plants)

Undesirable consequences of combustion: boosting the greenhouse effect, generating smog, pollution, acid rain, consumption of the limited fossil resources

How to avoid this?

- purchase durable products, buy products with little packaging, buy foodstuffs from the region insulate buildings better, heat wisely
- drive less often, use alternative fuels,
- go by train rather than plane
- prefer power-saving appliances,
- avoid stand-by



Finally, it is important that the material – particle concept worked out in this unit be decontextualized; i.e. it needs to be taken out of a concrete context and into a basic concept where it can be used again in another context. The easiest would be to continue to the next lesson unit. A further excursion (e.g. to the nitrogen cycle) can also be taken.

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