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Popularity and Relevance of Science Education for scientific Literacy



# No smoke without a fire - (Un)desirable Combustion

## Student Materials

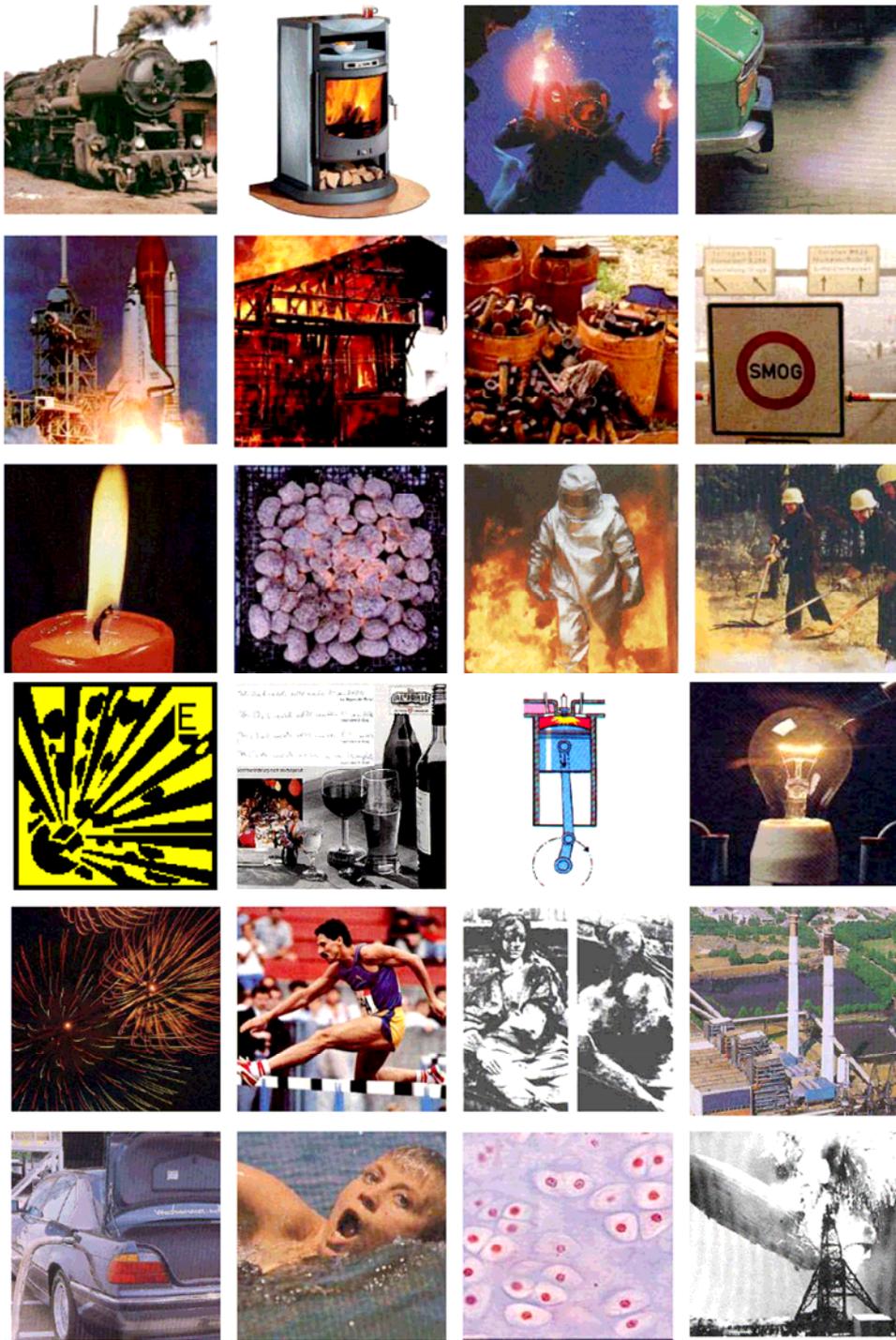


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**Developer:** Martin Lindner, based on Materials from Chemistry in Context. Idea: Ilka Parchmann, unit developed by groups of Teachers in Lower Saxonia and Bavaria  
**Institution:** IPN - Leibniz-Institute for Science Education, University of Kiel  
**Country:** Germany

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## Student material 1 - Pictures to be discussed



1. What are your spontaneous comments on these pictures? - Make some notes.
2. What is the common sense of all the pictures?
3. Try to find groups among the pictures and discuss their common ideas.

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## Student material 2 - Experiments

Exp. 1	What makes something combustible or not?	
Bunsen burner, fireproof mat		Bring the cotton and the mineral wool close to the flame of the burner!
Cotton, mineral wool		Write down your observations! Write down your conclusions!

Exp. 2	The ignition point	
Bunsen burner, tripod, iron sheet		Distribute the three materials on an iron plate on the tripod.
Soft paper, splint, match		Heat the iron plate with the bunsen burner. Write down your observations! Write down your conclusions

Exp. 3	The flashing point	
Porcellane dish, fireproof mat, splint, beer mat, sheet, bunsen burner		Drop 10 drops of fuel into the porcellane dish and put it on top of the fireproof mat. Slowly approach a burning splint. Write down your observations!
Benzine, Diesel		Repeat the experiment and cover the burning fuel quickly with a beer mat and a sheet. Write down your observations.
<b>Security: Do not lean over the flames!</b>		Try to find an explanation.

Exp. 4	How important is crushing?	
Gaslighter, 4,5V-battery, candle		Try to light iron powder and iron wool with the given tools!
Iron powder, iron wool		Write down your observations!
<b>Security: Do not lean over the flames!</b>		Try to find a relation between the level of crushing and combustibility.

## Fire fighting:

### "smothering" of flames through deoxygenation

A laboratory usually is equipped with blankets, sand and a fire-extinguisher. The role of these tools will experimentally be researched in these activities.

G: Candles, beaker, iron plate, beer mat, cellophane, cotton sheet, paper sheet, soda  
Ch: water, tube, stopper with hole

#### Experiment 1 Covering of a candle with different materials

- put a candle into a beaker and enlight it
- cover the beaker with different materials: iron plate, beer mat, cellophane, cotton sheet, paper sheet

#### Experiment 2 Distinguish the candle with carbon dioxide

- put a candle into a beaker and enlight it
- open a new bottle with soda and cover it with a stopper. Connect the hole in the stopper with a tube and lead the gas into the beaker. You can also breathe into a plastic bag and lead the air into the beaker.

#### Observations:

##### Experiment 1

- > Most effective is the cotton cloth. It extinguishes the candle and is not enlightened.
- > The iron plate is also useful, but it is heated and the heat spreads over the whole plate.
- > The beer mat is consumed - paper is inflammable.
- > Cellophane melts and is pyrolyzed, gases are produced.

##### Experiment 2

- > Candle is extinguished (lead the gas directly onto the flame)

#### Conclusions:

Firefighting often means to extract the partner of the burning material: the oxygen. Most effective is to cover the burning material with anything that does not burn or is hard to enlight. Most useable are blankets or sand.

But not only solids are helpful: also carbon dioxide can be used. As it is more dense than air it concentrates on the surface or in depressions. As it is not inflammable or able to donate oxygen to other materials, it extinguishes flames.

#### Main Conclusion:

To cover a flame with non-inflammable materials means to remove oxygen.

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## Student material 3 - Combustion is a chemical reaction

### Is the light burning?

Experiment 1: An electric bulb is connected to the electric plug.

- The bulb is „burning“, but remains as it was.
- The electric wire glows, but was not oxidated. There was no chemical reaction.!

Experiment 2: Connect a prepared electric bulb to the electric plug.

- The bulb light is much stronger, but after a short while it expires.
- The wire is burned, ashes remain. As there was a change in the state of matter we had a chemical process.

### Is this combustion a synthetic or a corrosive process?

#### 1. Hypothesis: The combustion is a corrosive process!

*How to test this hypothesis? Check the mass in front of and after the reaction of:*

Experiment 3: „Complete burning of Paper“.

- The ash is lighter than the paper, but Gases could have eluded!

Experiment 4: Combustion of iron wool fixed to a balance.

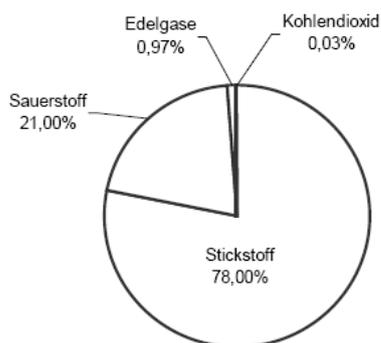
- The mass of the iron wool increases through burning.
- The iron is combined with other substances.
- What substance is reacting with the iron?

#### 2. Hypotheses: Burning means to combine substances with parts of the air.

*Which parts of the air react with the combustible substance?*

Experiment 5: Combustion in a closed container with air.

- Students experiment with a candle in a beaker or
- Demonstration of burning of phosphorus in a cloche which is standing in a dish with water
- Result: +/- a fifth of the air is consumed.  
---- Oxygene is the partner of the reactions



Composition of air

**If something is oxydised, the matter is combined with oxygene. This is called oxydation. The product is called Oxide!**

Experiment 6: A prepared electric bulb is filled with oxygene.

- The light is even brighter but last even shorter!
- Students experiments with combustion in oxygene (splint, charcoal, cigarette, ....)

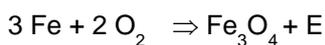
Experiment 7: Potassiumnitrate is melted in a test tube. Add little peaces of coal.

- The coal burns heavily.
- Even if no oxygene is present, the oxydation is intense.

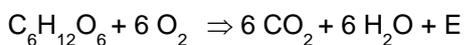
**All substances which enable oxydation are called oxidants.**

Formulate chemical equilibriums

1. Iron + Oxygene  $\Rightarrow$  Ironoxide + Energy



2. Cotton + Oxygene  $\Rightarrow$  Carbondioxide + Water + Energy



3. ....