For Teachers

What is worse, cigarettes or narghile?

Developers: Ron Blonder

Institute: The Weizmann Institute of Science, Rehovot. And Belmonte Science Laboratories center, The Hebrew University of Jerusalem.
Country: Israel

Subject: Science for all, Chemistry.

Grade level: 9-12.

Curriculum content: Acids/bases, solids, gases.

Kind of activity: Laboratory activity.

Anticipated time: 3 lessons of 45 minutes each.

Objectives/Competences

Reveal the chemistry concept behind smoking. Present the relevance of chemistry in real life. Base the decission regarding smoking on scientific knowledge.

Task description

This activity describes laboratory activity that examines the chemical process of smoking and the components of smoke, of both cigarettes and water-pipes (narghiles also known as "hookah"). The aim of this activity is to expose adolescents to the scientific aspects of smoking; and to present the relevance of chemistry in everyday life.

Teaching guide

This activity is a laboratory activity dealing with smoking from a scientific view point. The activity includes 4 stations. Each station explore a different aspect of smoking phenomena. It is not nessesary to conduct all four stations, but the whole activity gives a complite picture, and helps the students to construct their opinion regarding smoking. We suggest to follow the experimet with a discusion regrding the question, what is worse, cigarretes or narghile, and to ask the students to write their argumatations.

Station 1 – tips for success, and results:

- Preparing the Bromothymol blue solution: Bromothymol blue was prepared by dissolving ~30 mg in 2 liters of tap water. We used tap water and not (acidic) distilled water, which has a pH<7, in order to start the experiment with a blue color, at neutral pH, and to follow the decrease of the pH and the color change to green. It is possible to prepare the indicator solution with distilled water, and to adjust the pH to natural with dilute sodium hydroxide solution. We use this indicator because smoke of one cigarette causes a change in the solution's color.
- The acidification of the solution is obtained because of the presence of oxides in the cigarette smoke. (CO, CO_2, NO_x, SO_2). When these oxides dissolve in water the products are conjugated acids (H_2CO_3, HNO_3, H_2SO_4) and an acid solution is formed and a decrease in the pH is obtained.
- It may be interesting for the students to know that this is the also the mechanism underlying acid rain.
- During this station students often ask inquiry question regarding the effect of number of the smoked cigarettes on the pH. And some of the groups investigate this question.

Station 2 – tips for success, and results:

- Connecting the two flasks (with filter paper between them) is done with "Plasticine" (a synthetic clay, usually used for children's play), as shown in figure a. If you do not see the smoke entering the flasks, it means that you did not close the clay well enough around the flasks.

Figure a: A picture of the "smoking machine" for station 1.

- The results of a filter after smoking 1 cigarette is shown in figure b.

Figure b: Tar from one cigarette.

- During this station students often ask inquiry questions regarding the effect of the filter of the cigarette on the solid particles of cigarette smoke . And some of the groups investigate this question.

Station 3 – tips for success, and results:

- Suction of the smoke is more difficult at this station because the smoke must go through the detection tubes. Therefore: make sure all connections are tight, and use an oil vacuum pump, as described in Figure 3.
- To obtain comparable results when comparing the toxin gases from cigarette smoke and narghile smoke, the students measure time for smoking two cigarette, and use the same period for analyzing the narghile smoke.
- Observed changes in the commercial tubes, and their chemical explanations:

  CO – indicator tube: white turns to brown.

  $5CO + I_2O_5 \xrightarrow{H_2SO_4} I_2 + 5CO_2$ (Iodine pent-oxide is reduced)

  NO_x – indicator tube: white turns to yellow.

$3NO + 2CrO_3 \xrightarrow{H_2SO_4} 3NO_2 + Cr_2O_3$ (By reacting with the oxidized, NO_2 is produced)

$2NO_2 + 2(C_6H_5)_2NH \rightarrow (C_6H_5)_2NNO + (C_6H_5)_2NH : HNO_3$ (By reacting with the diphenylamine, N-nitroso-diphenylamine is produced)

SO_2 – indicator tube: purple turns to yellow.

$SO_2 + 2NaOH \rightarrow Na_2SO_3 + H_2O$ (By reacting with an alkali, pH indicator is discolored).

Station 4 – tips for success, and results:

- In addition to the pig lungs kit, we usually show the students pictures of human lungs (healthy and after smoking). Examples of such pictures are shown in figure c. More pictures are easy to find on the Web.

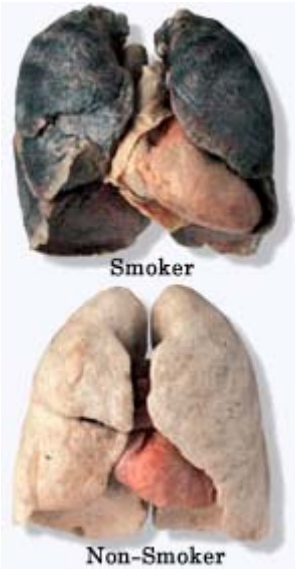

Figure c - Human lungs, kept in a polymeric preservative

It is important to have these pictures, because they demonstrate the similarity of human and pig lungs, and because the human lungs were not stimulated, like the pig lungs; they just belong to a smoker. These pictures can also replace the use of the pig lungs kit if it is not available at school.

Teachers notes:

Operation of the narghile is explained at:

How to Assemble Narghile : A Step by Step Guide.

http://comm.tulumba.com/topicitem.asp?topic_id=1326 (accessed Nov 2006).

Chemicals

- Filter papers (used at station 2) are Whatman No. 2 qualitative, Cat No. 1002090.
- Bromothymol blue (3',3"-Dibromothymolsulfonphthalein; 3',3"-Dibromothymolsulfonephthalein) CAS # 34722-90-2 was purchased from Sigma Aldrich.
- 1,3-dihydroxypropane, CAS# 504-63-2.
- Methanol, CAS# 67-56-1.
- Healthy and "smoking" lungs are a commercially available kit that was purchased at eNasco. http://www.enasco.com/ (accessed Nov. 2006).
- Tubes for detecting poisonous gases were bought from Kitagawa: SO_2 (No.103SE), NOx (No.175SA) and CO (No.1061).
- Plasticine

Hazards:

Methanol

Toxic by inhalation, ingestion or skin absorption. May be a reproductive hazard. Ingestion may be fatal. Risk of very serious, irreversible damage if swallowed. Exposure may cause eye, kidney, heart and liver damage. Chronic or substantial acute exposure may cause serious eye damage, including blindness, irritant. Methanol is used in station 2. The students try to dissolve the *tar* in methanol. This step should be performed inside the hood; students should use it only wearing protective gloves and safety goggles.

1,3-dihydroxypropane

Harmful if swallowed, inhaled or absorbed through the skin. The pig's lungs are kept in 1,3-dihydroxypropane. Students should touch them only wearing protective gloves and safety goggles.

Impulsion

All the "smoking machines" in the activity work under vacuum and are build from glass apparatus. Under a vacuum glass apparatus is subject to implosion. Therefore we use glass shield separating the students from the smoking machines. And students wear safety goggles during all the stations.

All experiments are performed in well-ventilated fume hoods, with a glass shield separating the students from the smoking machines. Students wear safety goggles during all the stations and safety gloves are needed only in stations number 2 and