**For teachers**

# Brushing up on chemistry

## Objectives/Competences

Through the study of toothpaste, a common, well-known product of daily use, we aim to connect chemistry with everyday life, and increase students' interest in chemistry. In addition, through toothpaste, we have the opportunity to refer to a large number of chemical substances. A notable feature of the practical activity is its **creativity** feature; it is known that students express a preference for such activities. This activity offers the opportunity to discuss in class the importance of regular dental care and other related issues:

## Task description

## Phase 1

We distribute the students into groups of 3-5 (an optimum number is 4).[2] We take care that in each group there is a mixing a male and female students, as well as of varying abilities; a mixing of students of different cultural origins if such a differentiation is the case.

[2] There have been studies (Webb, 1989) that suggested that pairs function better because peers cannot withdraw and leave the responsibility of the discussion to others. On the other hand, larger groups (e.g. fours) allow students to consider a wider range of ideas (Needham, 1987). Additional research reported that students progressed significantly more in their physics reasoning when interacting in fours rather than in pairs (Alexopoulou & Driver, 1996). Working in groups of four seemed acceptable to the majority of students in another study (Tsaparlis & Gorezi, 2007).

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Immediately, we assign each group the task of going to a supermarket and bye a small selection of toothpastes, including toothpastes that have different purpose (for instance, whitening, with baking soda, for gingivitis). Following that they should cooperate in identifying from the product packages the ingredients of each brand. It might be advisable that each group concentrate on one brand product.

## Phase 2

In class, students work under the teacher's guidance to group the ingredients into particular groups, depending on their action/functioning. This action is then discussed in class. A general reference to the composition of toothpastes can be made afterwards.

Phase 3

Students present their previous work in class to their schoolmates. Each group presents its own category of ingredients. This activity is very important for the development of communication and presentation skills. Traditionally, students lack experience in communication skills, and as a result are very poor presenters. Power-point presentations are very convenient and will contribute to developing and projecting their abilities in computer technologies.

Phase 4

Students undertake to prepare in lab of naïve toothpaste, using available at home materials, and testing the action of their toothpaste by comparing it to that of a commercial brand.

**SAFETY NOTE!** *Students should not use the homemade tooth- paste or eat hard-boiled eggs that have been in the laboratory or in contact with laboratory equipment.*

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**Picture 1** – Students testing their toothpaste in a Greek ninth-grade class.

Many recipes for homemade toothpaste similar to the one used in this Activity are available. Most use the same ingredients used in this Activity. An online example with scientific tests similar to this Activity is cited below *(3)*. Most of the materials required are available at grocery and drug stores. Only white eggs should be used. It is suggested that students be provided with hard-boiled eggs, but students could boil their own eggs in the laboratory. This may require that the Activity be spread over two days. (The prcedure for the egg dying is described below.) The food coloring on the eggs is not removed by rinsing or brushing with water alone, but is removed by both commercial and homemade toothpastes. If desired, you can also stain eggs with tea, coffee, fruit drinks, etc. If a difference in cleaning is noted, it is usually that more color is removed by the homemade toothpaste than the commercial toothpaste. Areas for discussion include the differences between an eggshell and tooth enamel, the use of cleaning or whitening agents, and the facts that a homemade toothpaste costs less, does not contain fluoride, and is more abrasive (which might damage tooth enamel).

Procedure for egg dyeing – The effect of acidity

Coloured eggs are used for various purposes(e.g. for decoration). Also, in some countries (e.g. in Orthodox Christianity) it is part of religion tradition to dye eggs (especially red-coloured ones) for the Easter celebration. In such cases, students might have watched their mothers dye eggs.

**1)** Prepare about 1 litre of a solution of cool dye by dissolution of red cool egg dye in water.

**2)** Put 100 $cm^3$ from the dye solution to a beaker. Add to this solution dropwise 30 drops of 0.01 M HCl solution (pH ~2).

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3) Make similar dye solutions by adding dropwise 20 and 10 drops respectively of the HCl solution.
4) In the same way, make dye solutions by adding dropwise 30, 20 and 10 drops respectively of 0.01 M NαOH solution (pH ~13).
5) Check that the colour of the added dye has not changed with the addition of the acid or base.
6) Introduce hen eggs into the beaker with the dye solutions and let them stay for 10 minutes.
7) After half an hour, wash the eggs with tap water. Compare again the colours. In which dying solution is the weakening of the colour larger?

**NOTE**: The eggshell consists by 95% of calcium carbonate ($CaCO_3$). On its surface, a thin layer of proteinic nature covers the shell. The dye adheres chemically to this layer. Addition of acid to the solution facilitates this adhering. That is the reason why when dyeing eggs at home, women add vinegar to dye solution.

## Phase 5

### Comments

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# The importance of dental care

This activity offers the opportunity to discuss in class the importance of regular dental care and other related issues:

- Foods that are damaging to teeth, especially sugars.
- The practice of water fluorination for teeth protection. The importance of REGULAR and PROPER brushing of teeth.
- The types and role of toothbrushes, and need to replace them frequently.
- Various other dental-care products (dental rinses and gels, dental floss).
- The necessity to visit the dentist at least once a year for a check of the condition of teeth, and for a professional cleaning of teeth (which removes built-up dental caries that brushing has failed to remove. (The dentist also will teach the optimum method of brushing the teeth.
- Teeth-colorants used for checking presence of caries in teeth.

**Answers to Questions**

1. See background section above. In homemade toothpaste, baking soda and salt are abrasives, glycerin is a humectant. Fluoride, detergents, thickeners, preservatives, flavoring, coloring, and sweeteners are not included.
2. Homemade toothpaste is more abrasive. Abrasives remove stains and plaque but can also damage tooth enamel.
3. Water and commercial toothpaste are approximately neutral; homemade toothpaste is slightly basic. The more basic substance is useful because it neutralizes acids that cause cavities.
4. Both remove color that brushing with water alone did not. The homemade toothpaste may remove color more easily because it is more abrasive.
5. Fluoride prevents cavities because it is incorporated into tooth enamel making it more resistant to attack by acid. Fluoride compounds are toxic and toothpastes containing fluoride should not be swallowed, especially by young children (see label warnings). Brushing with homemade toothpaste would help prevent cavities by removing food particles and plaque, but the abrasive ingredients might also damage tooth enamel.

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6. Whitening toothpaste could be made by adding more abrasives or a bleaching agent such as hydrogen peroxide. Stained eggshell could be brushed with or soaked in a new formula.
7. Attempting to remove tea or coffee stains would be a particularly interesting experiment.

## Bibliography

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