For Students

Salt – the good, the bad, and the tasty

Task description

You know that **salts** are a main class of *inorganic compounds*. Everybody also knows **cooking salt**. In this module, you will study the origin of salt. You will surprised to know that apart from the sea, there is also **mineral salt** that may come under various colours. This connects salt with geology. **Salt crystals** are beautiful, and here is your chance to study **crystals**, **crystal structure**, and even grow your own big salt crystals. Salt provides also a good chance to introduce you to the concept of electricity conducting materials and especially to **electrolytes**, and further to the concept of **ionic bonding**. Last but not least, you will study the many uses of salt, and its positive but also negative role in our health.

Sea-salt foam

Phase 1

This phase consists of an introductory lesson, during which you will discuss in class about the origin of salt from sea but also from mines. You will have the chance to see large salt crystals, not only white, but also colourful. The property of melted salt as well as of salt aqueous solutions to conduct electricity will be investigated and contrasted with other non-conducting materials (e.g. sugar). The lesson will be completed with a theoretical study of ionic bonding. The teacher will give students a home assignment to study at home crystallisation and starting an experimental activity by which they will grow at home big salt crystals.

_ i. Look at the following book advertisement. We don't intend to advertise the book here, but to let you get a feeling right from the start how important salt is for life:

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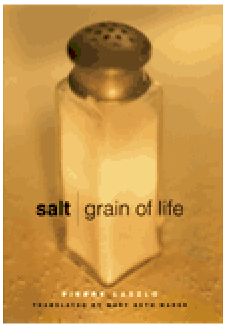

Salt
Grain of Life

Pierre Laszlo
Translated by Mary Beth Mader

Cloth, 256 page August, 2001

Columbia University Press

ISBN: **0-231-12198-9**s

"Rich in fact and analysis. . .takes the seemingly trivial subject of salt and implies that it is not merely an essential element of life but that it is perhaps *the* veritable motor of human history."
—*Gastronomica*

"Offers a rich pickle barrel of facts and anecdotes about salt."
—*London Review of Books*

"Readers will never again think of salt . . . in the same simple way."
—*The Washington Post Book World*

"A breathless read. . . because of the suprising appeal and importance of the subject itself."
—*Houston Chronicle*

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_ ii. Try to think in what ways can the topic of salt be so important, so useful, so fascinating that could lead to the writing of a whole book about it, by Pierre Laszlo, a distinguished organic chemist. A discussion about this will take place in class.

_ iii. Taking into account that (a) the continents of the earth are actulaly floating like a ship on the fluid earth manltle (which is composed of melted rocks), and this floatation makes them move about as well as up and down; and (b) the fact that petrified remains of sea organisms have been found on land, even on high mountains,* try to explain the creation of salt deposits on the land. In class, you will discuss the great geological trasformations that have taken place over millinps of years – in fact, 200-250 million years ago, the situation on earth was quite different.

* In Bolivia there is a mountain plain laid with salt. Also, salt mining is done on the Himalayas, in Africa, and in the U.S.A. Actually, 70% of world salt production comes from mineral salt.

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_ iv. Next, you will observe a very importan experiment, one that will demostrate that melted salt is a conductor of electricity (an **electrolyte**).

NaCl is an electrolyte

In solid state, NaCl is not a conductor of electricity. But when it is melted or when it is dissolved into water, it conducts electricity (Fig. 1). On passing of the electric current through melted NaCl, the phenomenon of electrolysis takes place. In the two electrodes, the constituent elements of sodium chloride are liberated: metallic sodium on the negative electrode (cathode), and chlorine gas on the positive electrode (anode).

NOTE: Apart from melted NaCl, an aqueous solution of NaCl is also an electrolyte (that is, it conducts electricity and undergoes electrolysis). Contrast this with sugar, which is an electricity insulator (that is, does not conduct electricity) neither melted nor as an aqueous solution.

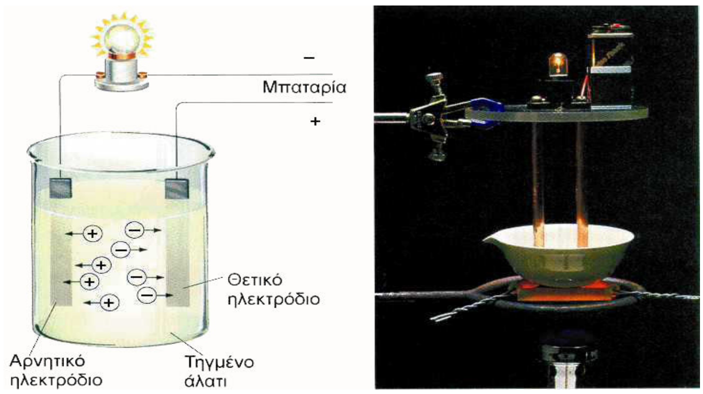

Figure. On melting, the sodium chloride crystals ‘break’, when the ions move about freely. This explains why melted NaCl conducts electricity.

_ iii. Finally, an introduction of the concept of ionic bonding in salt wii be exploited, starting form the explanation of the property of melted salt to act as an electrolyte. Ionic bonding must be contrasted to covalent bonding which is present for instance in sugar molecules.

Phase 2

In this phase, you will have to carry out at home two assignments. One is a further theoretical study about covalent and ionic bonding. The other is the setting up of an experimental activity whereby you will grow at home big salt crystals.

Crystals, crystallisation, re-crystallisation *(Growing crystals from a solution)*

You surely must have seen crystals before, at least tiny ones. Salt and sugar consist of tiny crystals. If you see them magnified under a microscope, you will be impressed. Diamonds and sapphires are crystals. Ice and metals are also crystalline. Large crystals are impressive.

In this activity, you will study crystals, and how to grow crystals form a solution, including large crystals.

See how many of these questions you can answer

1. What happens if we boil to the dry seawater in a pan?
2. What would happen if seawater is let to evaporate on its own slowly? Explain the phenomenon by referring to saturated and super-saturated solutions.
3. What do we mean by saying that a substance has crystallised from its solution?
4. How do we obtain salt from seawater?
5. How do obtain sugar from sugar canes?
6. What is re-crystallisation and when is it useful to do it?
7. How can we grow large crystals?
8. Which are the features of crystals?
9. Do crystals grow always symmetrically?
10. What are liquid crystals and which are their uses?
11. Which solid materials are called amorphous? (Give an example.)

- *If water evaporates slowly from an unsaturated aqueous solution, then as water becomes less, the solution becomes denser, until it becomes............................ When more water evaporates, the solution becomes denser, until it..................................; Which penomenon do we expect then to occur?* The .... solution contains more than the allowed quantity of solute, and so becomes unstable. The extra dissolved substance will separate from the solution and take the form of small crystals. Often these crystals are well-shaped. We say that the substance has crystallised from its solution. The phenomenon is called **crystallisation**.

Salt is produced from sea water by the process of crystallisation. Also sugar is taken from sugar canes by means of crystallisation. Sugar canes are cut down and then mixed with water, which dissolves the contained sugar. The sugar solution is separated from the pulp. Then evaporation of water takes place, leaving behind crystalline sugar.

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Recrystallisation

Sometimes, crystals are not poor, but contain various admixtures, e.g. soil in dry salt that is collected from salt mines. This is due to the complete removal (evaporation) of water, leaving behind the mixture of substances that were contained in solution. We can take pure crystals by dissolving the substance in de-ionised water, and then by letting the substance crystallise, without letting all the solvent (the water) evaporate. This process is called **re-crystallisation**. Re-crystallization is a very useful process for chemistry, allowing the preparation of pure substances.

Growing large crystals

Place one relatively large and one clearly smaller sodium chloride crystal into a wide container containing a dense sodium chloride aqueous solution, and leave it to stay for many days with the glass uncovered. Observe what will happen, and try to explain it. Can you exploit this phenomenon for growing a large crystal of sodium chloride?

Features of crystals

Your teacher may show you real crystals. It is worth to watch crystals under the microscope. If available, have now a look at real sulfur, the quartz, and the amethyst crystals or photographs of them. What do you observe in all sulfur crystals? What do you observe in all quartz crystals? What do you observe in all amethyst crystals?

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The scientists have shown that all crystals of a substance have similar shape. However, the number of different crystal shapes is not the same with the number of crystalline substances. Sometimes, crystals do not grow in the same way in all of their sides (as we say *they do not grow symmetrically*), and their shape is somehow distorted.

Questions

1. As a rule, the solubility of solid substances in water increases with temperature (and is reduced on cooling). Use this property to suggest a method for making re-crystallision fast.
2. We dissolve potassium chloride to 100 cm^3 water at 60^oC, until we make a saturated solution. Then, we cool the solution down to 20^oC. How many grams of potassium chloride are going to crystallise? Data: Solubility of potassium chloride: 23.8 g/100 cm^3 water at 20^oC and 40.2 g/100 cm^3 water at 60^oC.

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Phase 3

In this phase, you will consider in class three big issues: one is theoretical: the study of crystal structure. The other is a discussion of industrial and everyday uses of salt. Finally, you will be assigned the task to discuss at home and/or schoolmates and friends the role of salt in human health.

Before coming to next class, you must have checked in a supermarket's shelves for various types of salt products, as well as for various additives to salts and for various salt substitutes. Make a list of the additives and of the substitutes, and prepare for a discussion in class of their purposes.

In addition, consider the following ten statements about the effect of salt on human health. Some of them are generally true and some are generally false, but there exceptions to the rules. *Discuss these at home with your parents or with other relatives or friends.*

1. Salt is responsible for high blood pressure.
2. Not all people are in the same way sensitivity to salt.
3. Decreasing salt intake is general cure.
4. Salt is essential to human body.
5. Hidden salt is bad.
6. Salt is allowed to pregnant women.
7. Products with less added salt are better for everybody.
8. About 6 to 8 grams of salt cover for the recommended daily intake.
9. People who are working in high-temperature environments must take more salt.
10. Athletes need salt capsules.

Phase 4

In this phase, you will discuss in class information and knowledge gathered from your discussions about the additives in salt and various salt substitutes, as well as the role of salt for health, especially its bad role in raising blood pressure.

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