PHYSICOCHEMICAL PROPERTIES OF SEAWATER

"OCEAN CONNECTIONS"

DIDACTIC UNIT

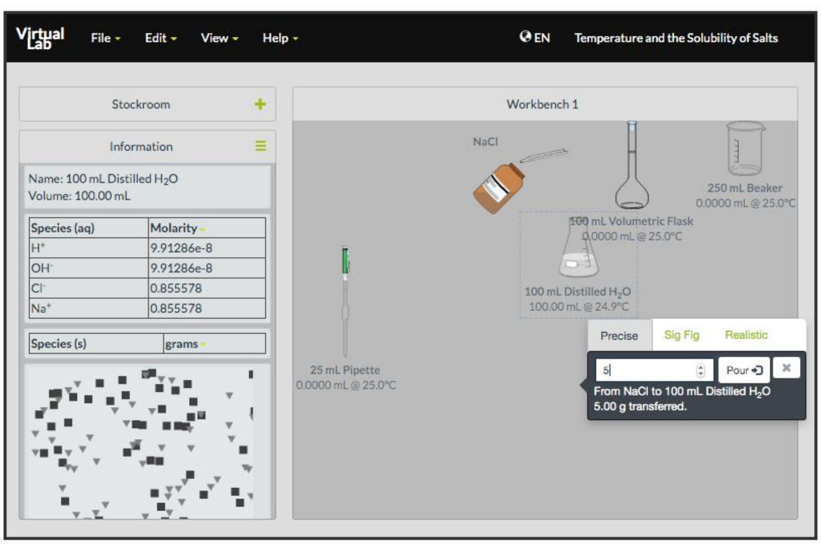
OBJECTIVES

- Study physical properties (temperature, density, electrical conductivity ...) and chemical properties (composition, pH ...) in a context of special interest such as the ocean.
- Deepen the concept of dissolution and methods of separation of mixtures.
- Promote habits of respect for the environment.
- Develop skills for practical work in the science lab.

INTRODUCTION

The ocean is formed by a complex saline solution, with a constant concentration. **Seawater is a solution** in which a large number of chemical elements, dissolved gases and nutrients are found. The dissolved salts are electrolytes in ionized aqueous solution, which gives the seawater complex physicochemical properties.

To begin our study, we will begin working with a **virtual laboratory** for the preparation of salt solutions ***(annex 1)***.



ACTIVITIES

1. Sampling: we collect **samples of sea water** on the beach, we take advantage of it to measure the temperature in situ and we complement it with an activity of **cleaning and waste collection**, reflecting on the environmental problem caused by the contamination of the beaches, especially as regards **Plastics** refers.

If possible we will have the advice of professionals for **sampling**. But in any case it is important to take into account basic aspects such as the need to use suitable **containers** (glass bottles with screw cap) and a refrigerator that allows the transport of the samples at approximately 4 ° C. **Labels** to indicate from which beach and on what date the water was collected. Samples should be taken in areas with a minimum **depth** of 1 m and about 30 cm below the surface.

2. Temperature: it would be interesting to record the **temperature** directly on the beaches periodically, but taking into account the impossibility of doing so we can work on AEMET Opendata data: satellite images of sea water temperature and prediction data on various beaches ***(annex 2)***.

3. pH: we measure the **pH** of seawater with various indicators of acidity and basicity (liquids and paper) and compare results with those obtained for other solutions ***(annex 3)***.

4. Density: to draw conclusions regarding density we qualitatively observe the **buoyancy** difference in fresh and salt water. Optionally, we quantitatively measure the **density of seawater** with a pycnometer ***(annex 4)***.

5. Salinity: we build a homemade seawater **purifier** and at the same time determine in percentage the **amount of salt** present in the seawater by evaporation ***(annex***

5).

6. Electric conductivity: we check with a simple circuit how the **electric current** circulates through seawater, but not distilled water, and optionally we can measure the **conductivity** with a conductivity meter ***(annex 6)***.

EVALUATION

Learning Standards	Low level	Acceptable level	Good level	Excellent level
FQB1.1.1. Formulate, in a guided way, hypotheses to explain everyday phenomena, using scientific theories and models.				
FQB1.1.2. Record observations and data in an organized and rigorous manner, and communicate them orally and in writing using diagrams, charts and tables.				
FQB1.3.1. Establish relationships between magnitudes and units, preferably using the International System of Units to express the results.				
FQB1.3.2. Performs practical measurements of physical quantities of daily life using the appropriate material and instruments, and expresses the results correctly in the International System of Units.				
FQB1.4.2. Identifies basic laboratory materials and instruments and knows how to use them to carry out experiments, respecting safety standards and identifying preventive attitudes and measures.				
FQB1.6.2. Participates, values, manages and respects individual and team work.				
FQB2.1.1. Distinguishes between general and characteristic properties of matter, and uses the latter for characterizing substances.				
FQB2.2.1. It justifies that a substance can appear in different states of aggregation depending on the conditions of pressure and temperature in which it approaches.				
FQB2.4.2. Identifies the solvent and solute by analyzing the composition of homogeneous mixtures of particular interest.				
FQB2.4.3. Performs simple solution preparation experiments, describes the procedure followed and the material used, determines the concentration and expresses it in grams / liter.				
FQB2.5.1. Design mixing methods according to the characteristic properties of the substances that make them, describe the appropriate laboratory material and carry out the process.				

FQB3.4.1. It proposes measures and attitudes, at the individual and collective level, to mitigate environmental problems of global importance.				
FQB5.3.1. It explains the concept of temperature in terms of the kinetic-molecular model, and differentiates between temperature, energy and heat.				

CONCLUSIONS

Once the experimental part is finished, a bibliographic search of **results published by scientists** will be carried out in similar investigations to guarantee the validity of the data obtained and/or reflect on possible methodological errors and proposals for improvement.

After this process, the students will prepare a brief **report with the data obtained** from the study of sea water in the region, data that will be shared with those obtained by students from other countries in order to establish **comparisons**.

Such data could be placed, for example, on a **collaborative map of Europe** where you can complete the point-to-point created with the Google My Maps app or another one with similar characteristics.

REFERENCES

1. Seawater sampling and collection (JoVE): https://www.jove.com/video/1159/el-agua-de-mar-de-muestreo-y-recoleccin?language=Spanish
2. Seawater, ocean waters (Scientific experiments): https://www.experimentoscientificos.es/agua/agua-de-mar/
3. Geography of the sea course (Catholic University of Chile): http://www7.uc.cl/sw_educ/geo_mar/html/h30.html
4. The ocean and its resources (Digital library): http://bibliotecadigital.ilce.edu.mx/sites/ciencia/volumen1/ciencia2/17/htm/oceano.htm
5. AEMET Opendata: https://opendata.aemet.es/centrodedescargas/productosAEMET?
6. Physicochemical properties of seawater (Autonomous University of Baja California): http://rdurazo.ens.uabc.mx/educacion/ocefis/propiedades_agua_mar2.pdf
7. Virtual Lab: Temperature and the solubility of salts http://chemcollective.org/vlab/87
8. Physical properties of seawater (FNOB): http://www.fnob.org/content/download/9710/191043/version/2/file/12_pm_cast_ESO2018.pdf

ANNEX 1. WORK SHEET: SALT DISSOLUTION VIRTUAL LABORATORY

Name_____________________ Surnames____ 2º ___

Copy the URL to your browser's address bar http://chemcollective.org/vlab/87 You will access a virtual laboratory where you can simulate the preparation of multiple NaCl solutions. Pay special attention to the material you use and the steps you follow in the task to perform the activities on this sheet.

1. Complete the following table, drawing and naming the laboratory material you choose to **prepare 100 mL of a 2 g solution of NaCl in water**, explaining what it is for and indicating what its hazards are and the standards or recommendations for safe use if it is the case:

DRAWING				
NAME				
UTILITY				
RISKS				
SAFE HANDLING				

2. Order the steps described in the following table for the preparation of the solution from 1 to 6.

	Stir the mixture with the help of a glass rod
	Pour the 2 g of NaCl into a beaker
	Add water to the volumetric flask to the mark of the plow
	Weigh the 2 g of NaCl
	Pour the mixture into a 100 mL volumetric flask
	Pour a small amount of water into the beaker

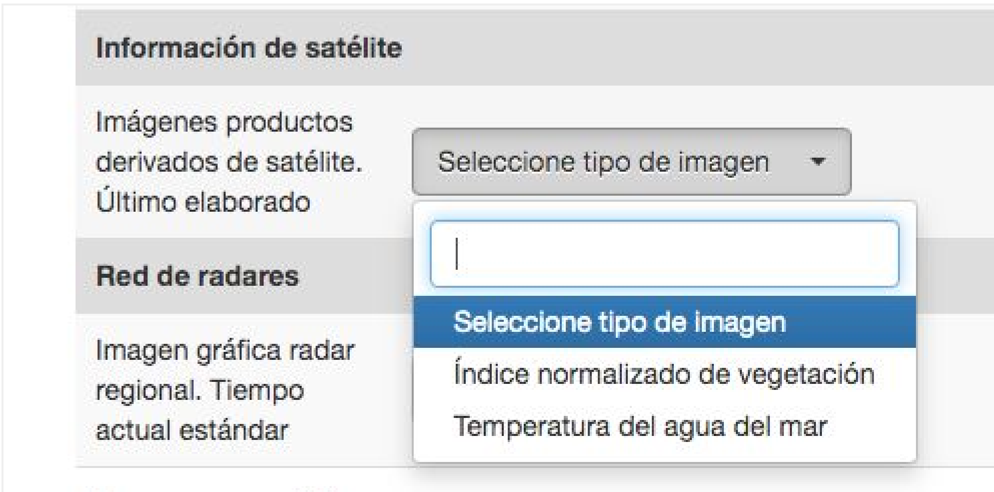
3. Are there any laboratory instruments you miss among those offered by this application? Which?

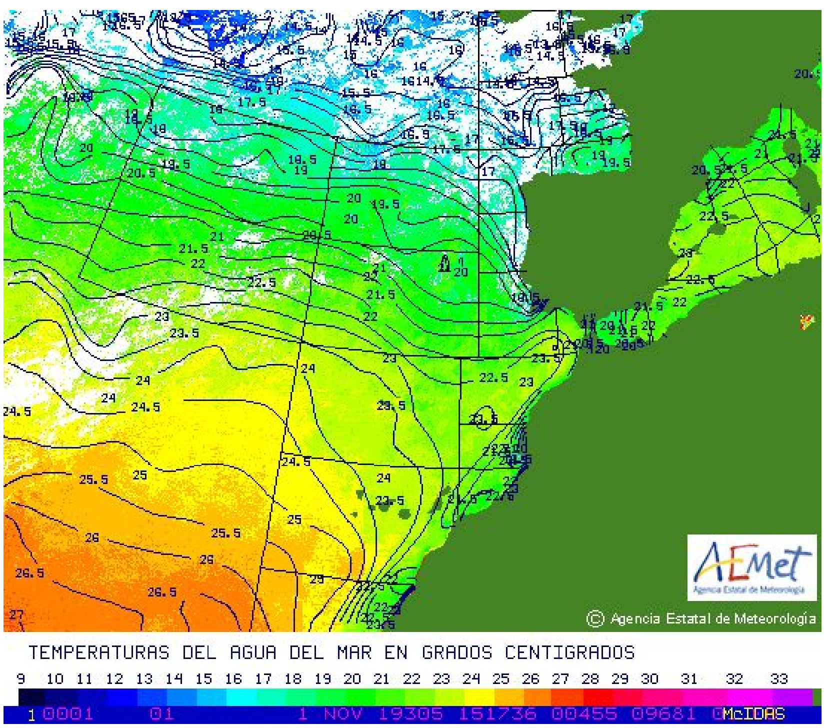
4. Make a scheme that briefly explains the procedure you would follow to prepare the same solution in a real laboratory:

ANNEX 2. WORK SHEET: TEMPERATURE DATA ANALYSIS

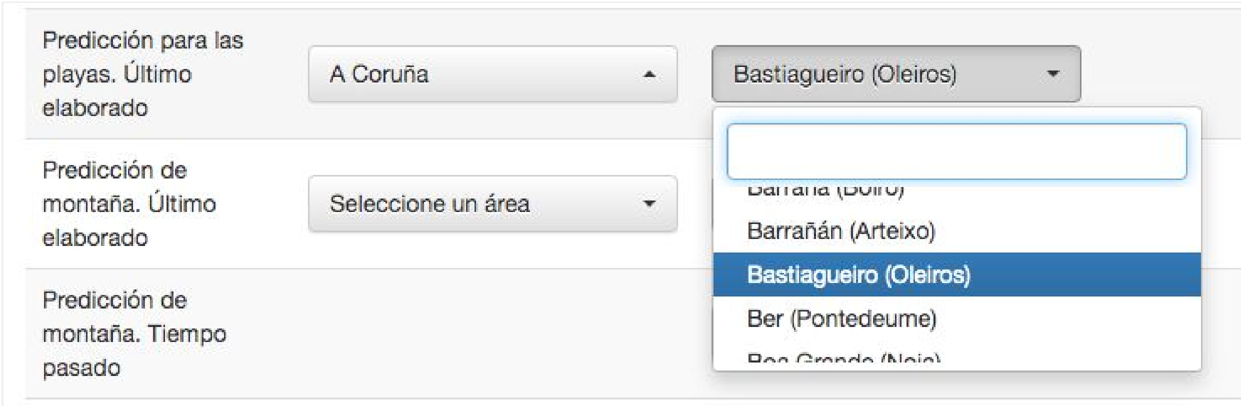
Copy the URL to your browser's address bar https://opendata.aemet.es/centrodedescargas/inicio You will access the website of the state meteorological agency to download weather data. You will need to request a Key API if you want to download your own data.

1. Graphic data:





2. Number data:




```
"tAgua" : {
  "value" : "",
  "valor1" : 18
},
```

```
{
        "tAgua": [{

                "id": "valor1",
                "descripcion": "Temperatura del agua en grados Celsius prevista",
                "tipo_datos": "byte",
                "unidad": "grados Celsius",
                "requerido": true
        }, {
                "id": "value",
                "descripcion": "Campo auxiliar",
                "tipo_datos": "string",
                "requerido": true
        }]
},
```


For several weeks and at different times of the year we must collect **temperature data** on one or several beaches (real or virtually). As you can see in the screenshots on these lines, the **State Meteorological Agency** provides real data through radar images and numerical prediction on file.

Once we have a considerable number of data we can establish **comparisons, more or less rigorous**, between different geographical areas of our region, between different months in the year or with control data from the same or from other countries and oceans, **developing tables and graphs**.

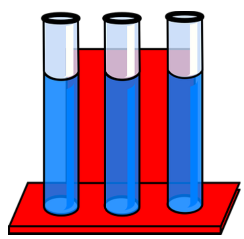
ANNEX 3. LABORATORY SCRIPT: PH DETERMINATION

Objectives:

- Introduce the concepts of acid, base and pH.
- Acquire skills for the safe handling of physics and chemistry laboratory equipment.

Theoric introduction: pH is a magnitude that takes values between 1 and 14 and is related to the degree of acidity or basicity of a substance.

Materials: acks, test tubes, pH indicators (test strips, universal liquid indicator ...), pH meter, acids and control bases with which to compare.



Process:

1. With the students divided into teams, assigning a rack to each group, we put in different test tubes the different solutions from which we want to measure the pH.
2. We proceed to measure the pH of each solution using several methods: test strips, self-made indicator with red cabbage and pH meter.
3. We write the results in a table and draw conclusions from the comparison of the different methods and the values obtained for each substance.

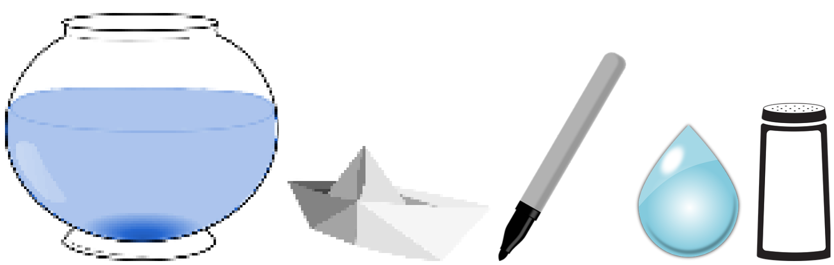
ANNEX 4. LABORATORY SCRIPT: WATER DENSITY STUDY

Objectives:

- Understand the Archimedes principle.
- Analyze the relationship between the magnitudes: density, mass and volume.
- Acquire skills for the safe handling of physics and chemistry laboratory equipment.

Theoric introduction: Archimedes' principle says that "every body submerged in a fluid experiences a vertical and upward force, called thrust, which is equal to the weight of the volume of fluid it dislodges." Thus, the thrust will be all the more intense the higher the density of the fluid in question and therefore the lower or greater buoyancy of a body can allow us to establish relationships between the densities of different fluids.

Materials: large container (fish tank or aquarium), paper boats, marker, water, salt, pycnometer, funnel, digital scale, pasteur pipette.



Process:

1. We prepare solutions with different salt concentrations.
2. We compare the densities qualitatively by analyzing the buoyancy of a paper ship, marking with a marker the level to which the ship is immersed in each solution.
3. We measure the densities quantitatively and precisely with the pycnometer method taking the density of distilled water as a starting point and reference.

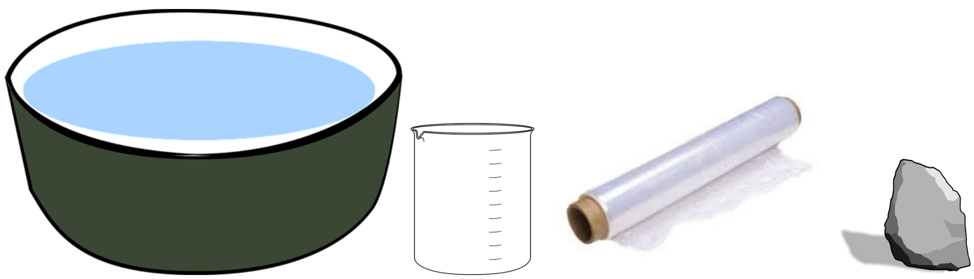
ANNEX 5. LABORATORY SCRIPT: SEA WATER POTABILIZER

Objectives:

- Deepen the concept of dissolution and methods of separation of mixtures.
- Acquire skills for the safe handling of physics and chemistry laboratory equipment.

Theoric introduction: The changes in the state of water between liquid and vapor are called evaporation and condensation, depending on whether the change occurs in that direction or the other way around. Playing with both allows us to separate the water, solvent from a saline solution, from its solutes.

Materials: large bowl, a glass, paper and a stone.



Process:

1. We place the glass in the center of the container, with the salt water around.
2. We cover the whole with the film placing a stone on it so that it sinks towards the center of the container where the glass.
3. We leave the set in a sunny area.

With the heat the water will evaporate and condense on the inner surface of the film, being inclined east towards the center by the stone, the drops of purified water will go to that area and will fall into the glass in which the water will accumulate without Salt.

If we wait for the evaporation to be complete in the valley, the salt that our seawater contained will remain, if we collect it and weigh it we can determine its salinity in percentage.

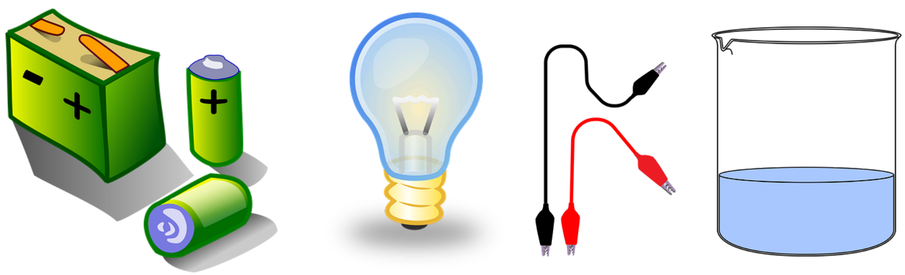
ANNEX 6. LABORATORY SCRIPT: ELECTRICITY THROUGH WATER

Objectives:

- Analyze and compare the electrical conductivity of pure water and NaCl solutions prepared with it.
- Acquire skills for the safe handling of physics and chemistry laboratory equipment.

Theoric introduction: Contrary to what is usually a popular belief, pure water (H2O) does not conduct electricity. It conducts the running water through the dissolved mineral salts, in the seawater the salt concentration is higher and therefore the electrical conductivity is higher.

Materials: batteries, light bulbs, connecting cables, beaker, distilled water and sea water or sodium chloride solution.



Process:

1. We assemble a basic circuit with batteries, a bulb and cables, leaving it open with two loose connectors
2. We put water or the solution we want to analyze in a beaker.
3. We introduce the connectors in the water or in the solution.
4. We check if the bulb turns on or not in each case.