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Experimental proposals for an interdisciplinary approach to physics and chemistry in high school

Experimental proposals for an interdisciplinary approach to physics and chemistry in higher education school

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SUMMARY
The educational product presented here is part of research that was developed during a Professional Master's Degree in Physics Teaching at the Federal University of Western Pará, and consists of instructional material aimed at teachers who wish to develop experimental activities in high school from an interdisciplinary perspective. focusing on Physics and Chemistry. The material presents three possibilities for experiments with an indication of the materials, methodological possibilities, explanations about the physical and chemical phenomena that occurred, as well as an indication of sources where the teacher can find more information to approach that experiment. Therefore, it is expected that this instrumental material will be useful as a first step that Physics and Chemistry teachers can take towards the development of interdisciplinary activities in schools. For teaching action to be successful in experimental practices involving Physics and Chemistry, it is necessary for teachers to be involved in planning activities, as such action is important to guide the development of practices to be worked on with students. . **Key words:**Educational product. Instrumental Material. Physics and chemistry.

ABSTRACT
The educational product presented here is part of a research that was developed during a Professional Master's Degree in Physics Teaching at the Federal University of Western Pará, and consists of an instructional material intended for teachers who wish to develop experimental activities in high school from an interdisciplinary perspective. focusing on Physics and Chemistry. The material presents three possibilities for experiments with an indication of the materials, methodological possibilities, explanations about the physical and chemical phenomena that occurred, as well as an indication of sources where the teacher can find more information for the approach to that experiment. Thus, it is expected that this instrumental material will be useful for a first step that Physics and Chemistry teachers can take towards the development of interdisciplinary activities in schools. For the teaching action to be successful in experimental practices involving Physics and Chemistry, it is necessary that the teachers be involved in the planning of activities, since such action is important to guide the development of practices to be worked with the students.
Keywords: Educational product. Material instrumental. Physics and chemistry.

1 INTRODUCTION

The educational product presented here is part of research that was developed during a Professional Master's Degree in Physics Teaching at the Federal University of Western Pará, and consists of instructional material aimed at teachers who wish to develop experimental activities in high school from an interdisciplinary perspective. focusing on Physics and Chemistry.

The material presents three possibilities for experiments with an indication of the materials, methodological possibilities, explanations about the physical and chemical phenomena that occurred, as well as an indication of sources where the teacher can find more information on how to approach that experiment.

It is assumed that "experimentation in teaching enhances learning capacity, as it contributes to overcoming cognitive obstacles" (SILVA; MOURA, 2018. p. 13). The fact that Physics and Chemistry are Sciences related to the understanding of nature and of an eminently experimental nature (GIBIN; SOUZA FILHO, 2016) also favors interdisciplinarity in teaching. In this way, the use of an interdisciplinary approach between these two areas of knowledge presents itself as a possibility of reorganizing knowledge to produce new knowledge (FAZENDA, 2013).

It is possible to see that the lack of professionals with specific training in Chemistry and Physics is often one of the main causes of difficulties in developing experimental practices in the school environment (GIBIN; SOUZA FILHO, 2016). On the other hand, the absence of interdisciplinary discussions during initial or continuing training courses does not encourage teachers to begin developing this type of necessary and emerging practice. In several educational documents, such as the 2006 National Curricular Parameters for Secondary Education (BRASIL, 2006), the National Common Curricular Base – BNCC (BRASIL, 2018) and the documents for the new secondary education, they speak of the need for contextualization and interdisciplinarity as a factor of developing teaching and promoting learning.

Therefore, it is expected that this instrumental material will be useful as a first step that Physics and Chemistry teachers can take towards the development of interdisciplinary activities in schools.

2 EXPERIMENTAL ACTIVITIES

We present three experiments below: Flame that sucks water, Electric current through water and Electromagnetic motor. For each experiment, the necessary materials are presented, topics covered regarding Chemistry and Physics, a methodological proposal for the approach, interpretation of the phenomenon that occurred from the perspective of both areas and suggestions for other sources of consultation so that teachers can delve deeper into what they judge. necessary.

2.1 Flame that sucks water

2.1.1 Required materials

- 01 common candle
- 01 clear glass cup
- 01 dish
- 200 ml of water
- 01 matchbox or lighter
- Gouache or cake paint (optional).

2.1.2 Topics covered

- Physics: Forms of heat propagation and their consequences;
- Chemistry: Combustion Reaction and its consequences.

2.1.3 Methodological proposal

This is a seemingly simple experiment that appears in many textbooks in both Physics and Chemistry. The proposal consists of placing a candle on a plate with a little melted wax, adding water to the plate and then lighting the candle. If a product is added that makes the water colored (gouache or aniline, for example), the phenomenon that will be observed becomes clearer. When placing an empty glass cup covering the candle as shown in figure 01, the candle flame goes out and the water on the plate is sucked into the transparent glass cup, as shown in figure 02.

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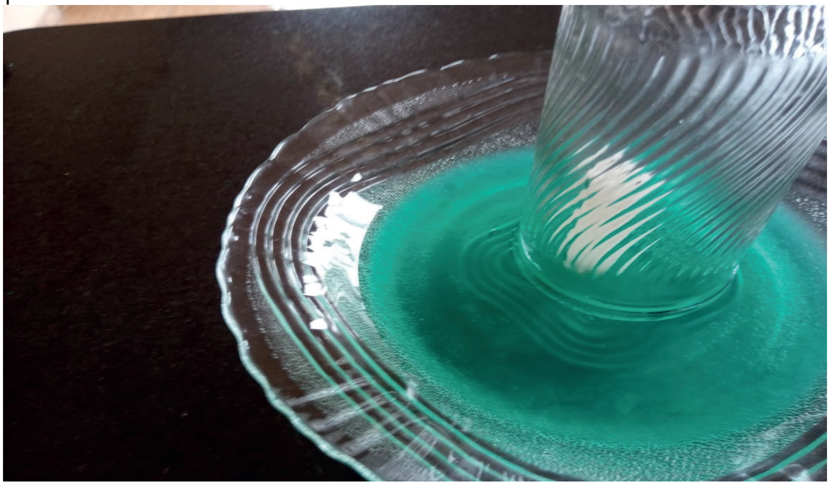
Figure 1 -Experiment with an unlit candle



Source: The author (2020).

Figure 02 –Water being sucked into the glass

Source: The author (2020).

The teacher who wishes to use this experiment as a motivator for the study of the theory seen in the classroom, can show the experiment to the students so that they can follow what happens while the candle goes out and create their hypotheses as to why the water is sucked in when the candle goes out. candle goes out. It is likely that the students' hypotheses will relate to both physical and chemical aspects and it may be a good opportunity for the teacher to discuss the phenomenon with the class from an interdisciplinary point of view.

Another possibility is to use the experiment to demonstrate the theory seen in the classroom. In this case, the teacher can address the theory of physical and chemical phenomena and then present the experiment demonstrating these theories and highlighting that it is possible to understand the experiment from different areas of knowledge and that they can be complementary to understanding the phenomenon with a all.

2.1.4 Interpretation of the phenomenon that occurred from the perspective of Physics and Chemistry

When the candle burns it undergoes a chemical process known as combustion. This process needs a fuel that provides energy for burning (represented in the experiment by the candle paraffin that is a Hydrocarbon), an oxidizer which is the substance that will react chemically with the fuel (the oxygen in the air, in this case) and a source of heat that will trigger the chemical reaction of the fuel with the oxidizer (the match or lighter in this case). The combustion reaction can be written generically as observed in equation 01:

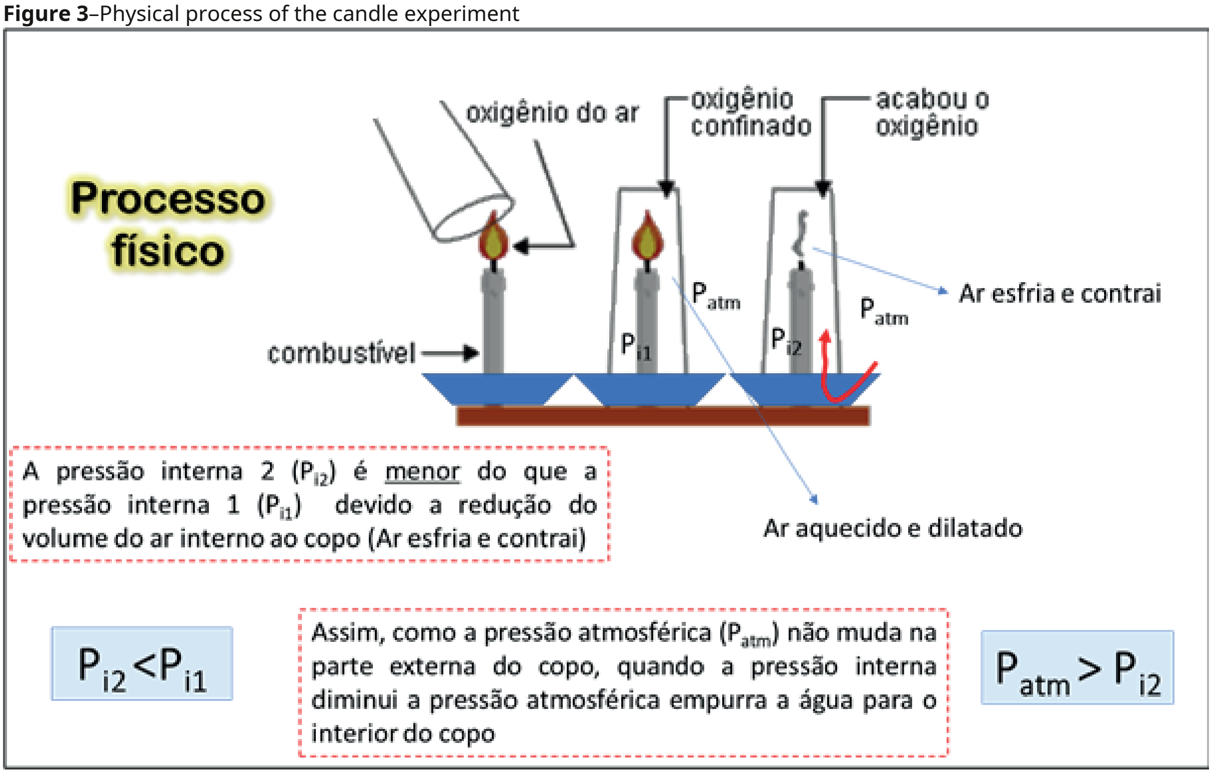
$$C_{25}H_{52(S)} + 38O_{2(g)} \rightarrow 25CO_{2(g)} + 26H_{two}O_{(g)} \quad (01)$$

Note that the product of this reaction is carbon dioxide (CO_{two}) and water ($H_{two}O$), in the form of vapor that will later condense). This way, when you place the glass over the lit candle you are confining a small part of the atmospheric air in this region close to the candle and the oxidant (O) is limited. Thus, when combustion consumes all the oxygen gas that is confined in the glass, the candle will go out.

However, why does it suck out the water when it turns off? In some textbooks this phenomenon of sucking water is explained by the fact that there is oxygen consumption and therefore the volume of air would decrease inside the glass, which would lead to the water occupying part of the glass to compensate for this loss of internal volume. However, we can see in the combustion reaction that oxygen is consumed, but as a product it creates carbon dioxide (CO) and water (HO). Furthermore, Lavoisier, still in the 17th century, published the Law of conservation of mass in an isolated system, which says that the total mass in a reaction is conserved, which leads us to believe that this explanation is not satisfactory.

In this way, we can then think from the point of view of the physical phenomena that occur. The candle heats the air that is confined in the glass mainly through the process of irradiation and convection, causing its thermal expansion. When the candle goes out, the air will cool down and the pressure inside the glass will decrease, as pressure and temperature are directly proportional quantities. Since the atmospheric pressure is acting on the outside of the cup and is greater than the pressure inside, the water in the dish is then pushed into the cup due to this pressure difference. Figure 3 summarizes the physical process of the experiment.

Figure 3–Physical process of the candle experiment



Source: The Author (2020)

2.1.5 Suggestions for other sources of consultation

We indicate below other materials relating to this experiment for further elaboration that teachers can consult.

- Sailing Experience (4). Available in:https://redes.moderna.com.br/2016/10/31/o-experimento-da- - candle/ . Accessed on 02/28/2020.
- The candle that raises water. Available in:https://sites.unipampa.edu.br/pibid2014/files/2017/08/efeitos- - da-difference-de-pressure-lucas-fagundes-de-souza.pdfAccessed on 02/28/2020.

2.2 Electric current through water

2.2.1 Required materials

- 01 beaker glass or 500 ml PET bottle container

- 06 1.5 V batteries
- 02 plates of different metals (zinc and copper)
- 01 enameled copper wire
- 01 LED Bulb Lamp

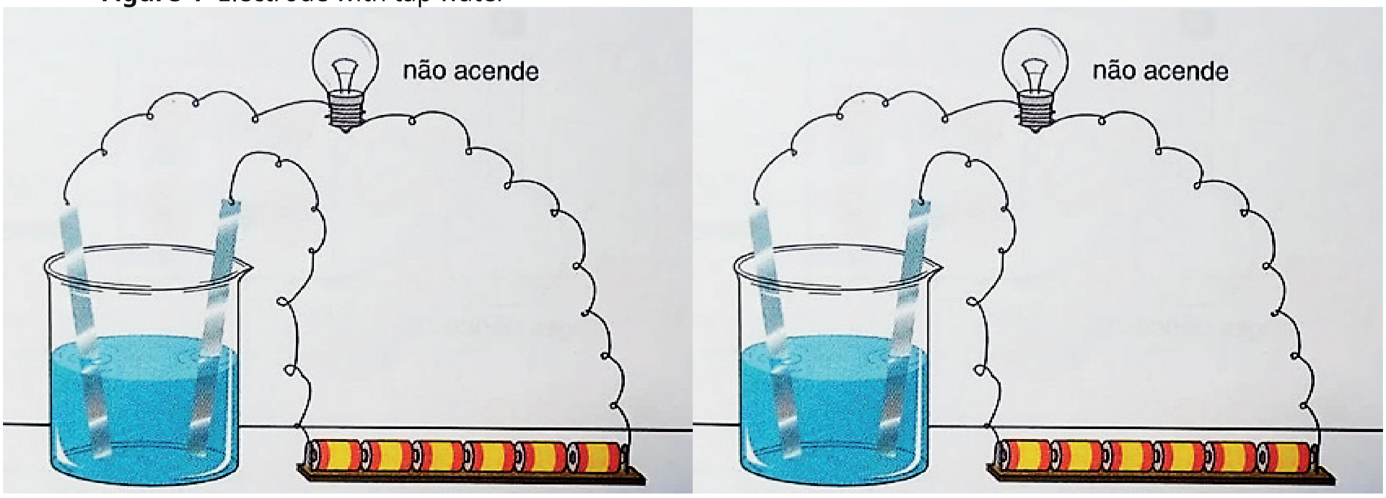
2.2.2 Subjects covered

- Physics: Electric charges and electric current;
- Chemistry: Functions of salts (electrolytes and non-electrolytes) and the process of ionic dissociation.

2.2.3 Methodological proposal

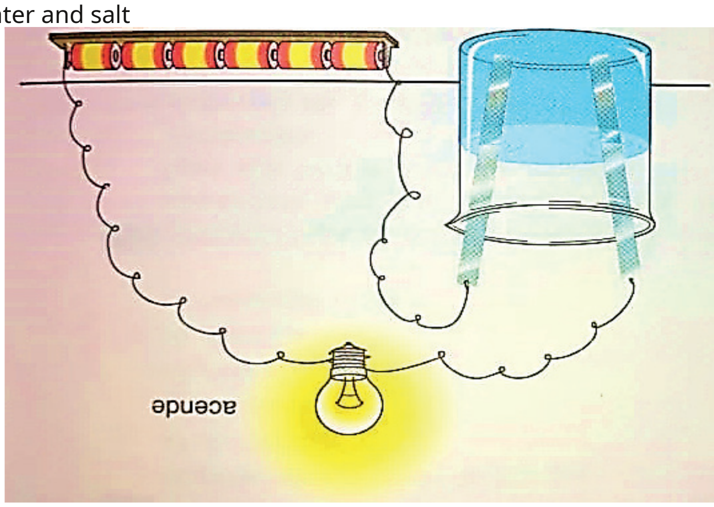
This is an experiment that draws the attention of students, since it is common to have the idea that water can conduct electric current, and this issue is portrayed in many textbooks in both Physics and Chemistry. The proposal for developing the experiment is to place six batteries associated in series, and at the ends of the filament, a copper wire connected to the positive and negative poles. The other ends of the copper wire are interconnected with different metals, one zinc and the other copper, which are inside the container. Between one of the battery poles and the metal, a lamp is inserted and attached to the copper wire. When placing the wire in contact with tap water[1], the lamp is off, as shown in figure 4. It is observed that the lamp is on when salt is added to the container, as shown in figure 5.

Figure 4 -Electrode with tap water

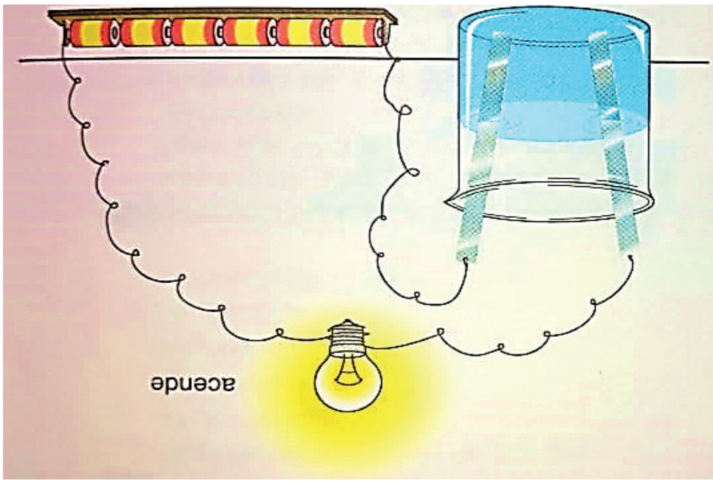


Source: Sardella (2000, p. 134).

Figure 5 –Electrode with tap water and salt



1 Although tap water is not pure (only HO), the amount of salts dissolved in it is small, which we will see which will not be enough to light the lamp. two



Source: Sardella (2000, p. 135)

The teacher who uses the experiment as a motivator for the study of content theory, can choose to show it to the students so that they can follow what happens when the copper wire is placed in the container containing tap water, and in this way, the students can imagine situations why the lamp lights up when tap water comes into contact with salt. It is possible that the students' questions relate to both physical and chemical aspects and it could be a good opportunity for the teacher to relate the two disciplines and discuss the phenomenon with the class from an interdisciplinary point of view. The use of the experiment in this first moment from an investigative perspective, which allows students to create hypotheses to check whether they were correct later.

Another possibility is to use the experiment to demonstrate the content theory. In this case, the teacher can address the theory of physical and chemical phenomena and then present the experiment demonstrating these theories and emphasize that it is possible to understand the experiment from different areas of knowledge and that they can be interconnected in such a way that their links can favor the understanding of natural phenomena.

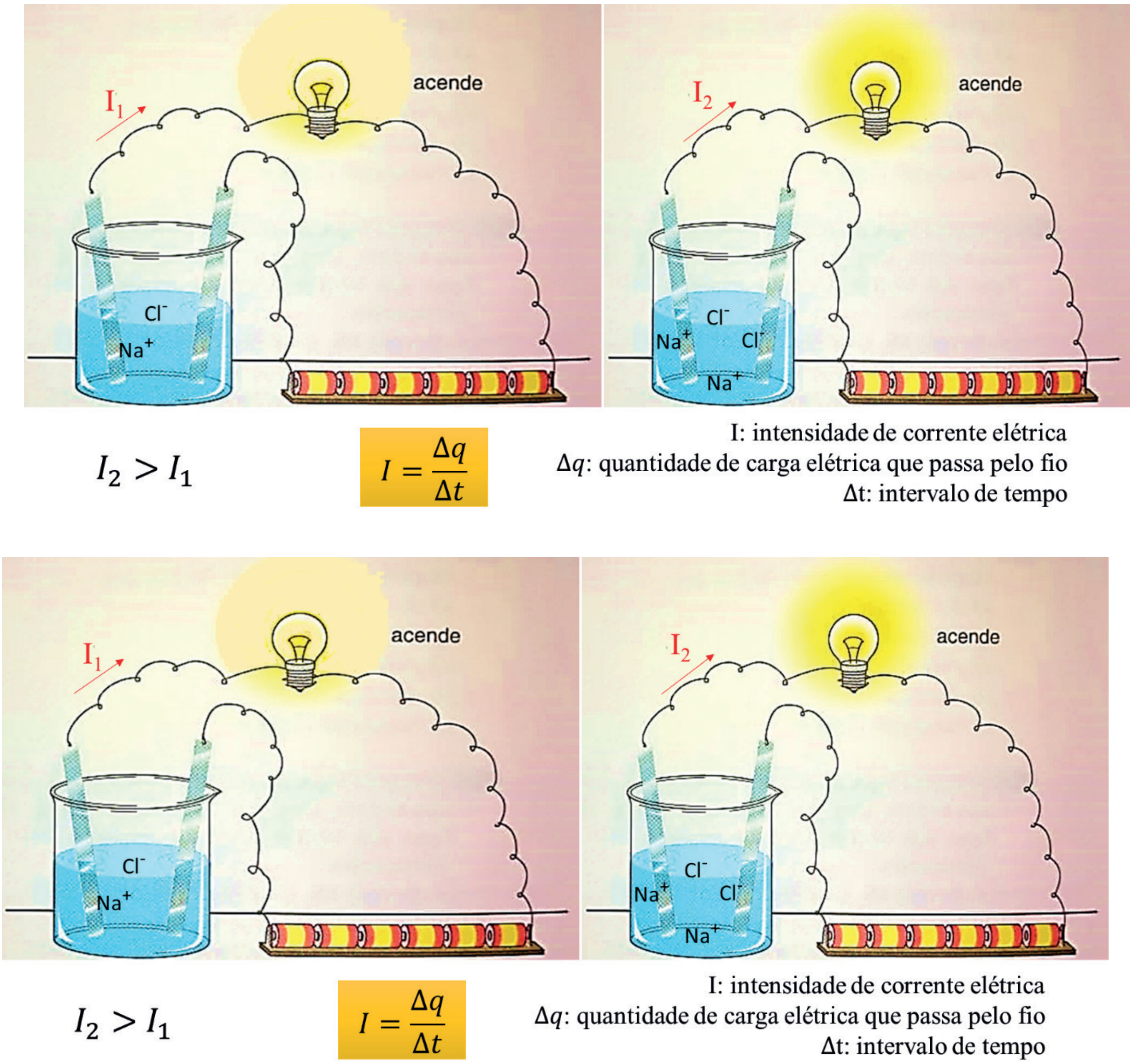
2.2.4 Interpretation of the phenomenon that occurred from the perspective of Physics and Chemistry

Water is a substance formed by $H_{two}O$ molecules and is considered a universal solvent as it can dissolve most other substances through a process of ionic dissociation. Salt (NaCl), which is an ionic substance, comes into contact with water, releasing a Na cation^{+}and a Cl anion^{-}, as indicated in equation 02. This is the chemical phenomenon of the process.

$$\mathbf{NaCl_{(s)} \rightarrow Na^{+}_{(aqueous)} + Cl^{-}_{(aqueous)}} \quad \textbf{(02)}$$

For the lamp to light, the existence of an electric current is necessary, which is generated from the movement of these ions ($Na^{+}$and Cl^{-}) by the conductive wire connected to the two metal plates (conductors) that are immersed in the water. Thus, the more salt is added to the water, the greater the electrical current generated and, consequently, the brighter the lamp will be (Figure 6).

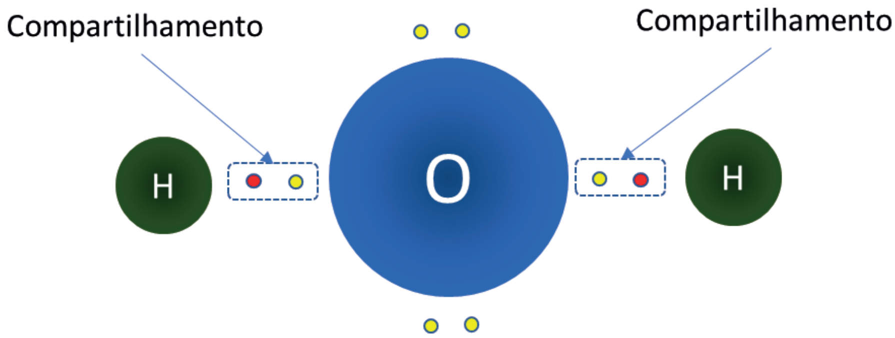
Figure 6 –Electric current in the experiment. The more salt in the water, the brighter the lamp



Source: Sardella (2000), with adaptations

On the other hand, if we have pure water from a distillation process, that is, without salt or any other substance, the lamp will not light up, as there will be no ions to generate electrical current. The water molecule has covalent bonds, that is, the electrons are shared between the atoms (See figure 7).

Figure 7 –Water molecule being represented with covalent bonds



Source: The Author (2020)

2.2.5 Suggestions for other sources of consultation

We indicate below other materials relating to this experiment for further elaboration that teachers can consult.

Electrical conductivity of vinegar, lemon juice, sugar and salt. Available in:https://www.youtube.com/ watch?v=hivJgTk9WOQ. Accessed on: 10/20/2020.

- Electrical conductivity of ionic compounds. Available at: <https://phet.colorado.edu/en/simulation/legacy/sugar-and-salt-solutions >. Accessed on: 03/01/2020.

2.3 Electromagnetic motor

2.3.1 Required materials

- 01 1.5 V battery
- 01 copper wire
- 01 magnet
- 01 balloon (used on birthdays)
- 01 elastic
- 01 stylus
- 02 safety pins

2.3.2 Topics covered

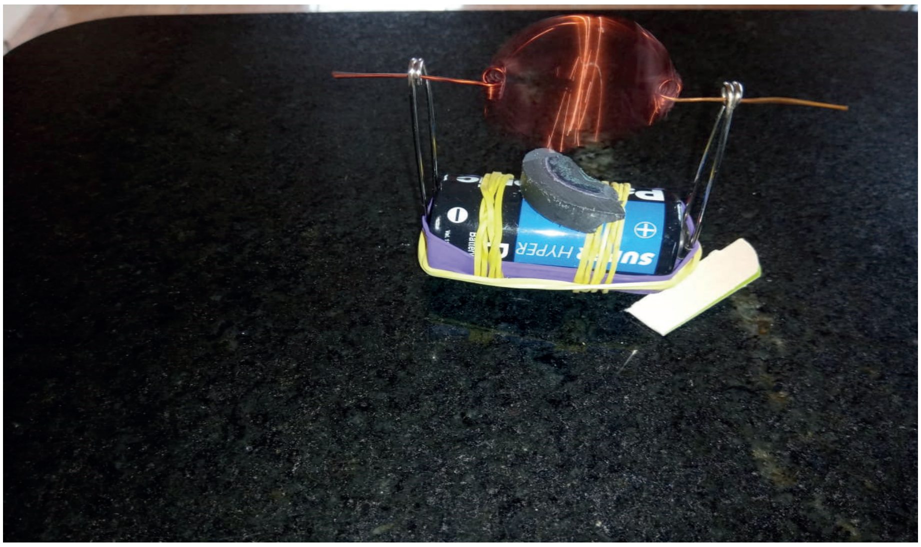
- Physics: Electromagnetism;
- Chemistry: Redox reactions in a battery.

2.3.3 Methodological proposal

This is an experiment that represents the operation of a miniature engine, using low-cost materials. A motor transforms electrical energy into mechanical energy and to use the experiment as a motivator for theory, the teacher can bring it ready to assemble and present it to the students asking the necessary questions, but they can also build the experiment with the students. To do this, you must place the stack horizontally and attach pins to both ends, as shown in figure 8. Supported andA coil made of enamelled copper wire will be placed between the pins, which will have 2 cm at its ends on each side. For the electromagnetic motor to work, it will be necessary to strip one end of the copper wire. A magnet must be placed in a position below the coil, as it will be responsible for generating the magnetic field.

It is important to say that the coil should only be placed when the experiment is being demonstrated, so that the battery does not discharge quickly. Another important observation is that the teacher may need to give the coil a small touch so that it starts to rotate in order to overcome inertia.

Figure 8 –Electromagnetic motor



Source: The author (2020)

The teacher who is going to use this experiment as a motivator for the study of the theory seen in the classroom, can show the experiment to the students so that they can follow what happens when the copper wire comes into contact with the poles of the battery, and the charge flow around the coil. Students can create their hypotheses as to why one of the ends of the copper wire is peeled in half. It is likely that the students' hypotheses will be linked to physical aspects rather than chemical aspects, and, in this case, there will be a good opportunity for the teacher(s) to discuss with the class the phenomenon from a perspective interdisciplinary, as it will be able to cover the Chemistry part that is included in the experiment.

Another possibility is to use the experiment to demonstrate the theory seen in the classroom. In this case, the teacher can address the theory of physical and chemical phenomena and then present the experiment demonstrating these theories and highlighting that it is possible to understand the experiment from different areas of knowledge and that they can be complementary to understanding the phenomenon of nature. in your totality.

2.3.4 Interpretation of the phenomenon that occurred from the perspective of Physics and Chemistry

In the experiment, the presence of a battery is observed as part of the experimental structure, which has the function of generating electric current through a spontaneous redox reaction, in which one of the electrodes loses electrons, and the other electrode gains electrons, thus doing Charges flow through the copper wire, which is connected to the poles.

The battery supplies electrical energy to the circuit formed by copper wires, through which a current passes, which runs through the loop, and generates a magnetic field associated with this current, transforming it into a small electromagnet.

The magnet placed on the surface of the battery has one of its poles facing the loop and when it becomes an electromagnet, there is a repulsion interaction, which moves the loop, forming the electromagnetic motor.

2.3.5 Suggestions for other sources of consultation

We indicate below other materials relating to this experiment for further elaboration that teachers can consult.

- Electric Motor. Available at: http://www2.fc.unesp.br/experimentosdefisica/ele04.htm. Accessed on: 03/01/2020.
- Electromagnetism. Available in:https://educacao.uol.com.br/disciplinas/fisica/eletromagnetismo--4-oersted-faraday-eo-electric-motor---3.htm . Accessed on: 03/01/2010.

3 CONCLUSION

For teaching action to be successful in experimental practices involving Physics and Chemistry, it is necessary for teachers to be involved in planning activities, as such action is important to guide the development of practices to be worked on with students. .

The instructional product in question must be flexible in application by the teacher who uses it, and, in this context, the teacher may adopt mechanisms different from those observed in the work in question, given that the main objective of classroom practices is to contribute to the teaching-learning process, favoring interaction and dialogue between teachers and students. students.

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