IO8 - Electricity

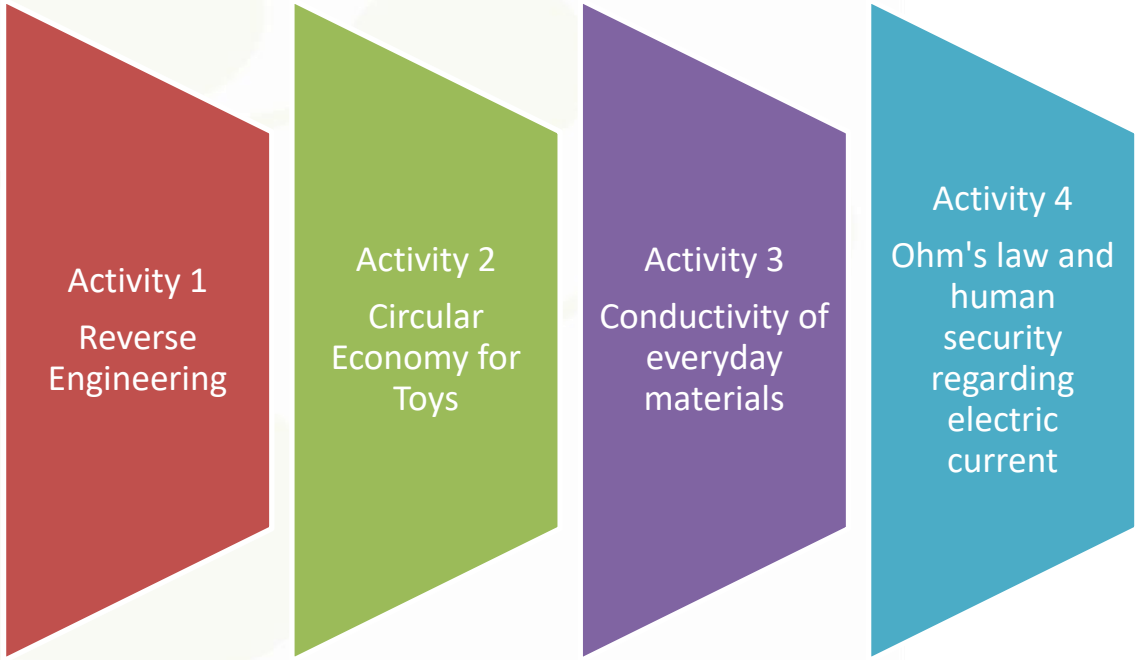
STEMkey
Teaching standard STEM topics with a key competence approach

Co-funded by the Erasmus+ Programme of the European Union

INSTITUTO DE EDUCAÇÃO — ULISBOA

Module Structure

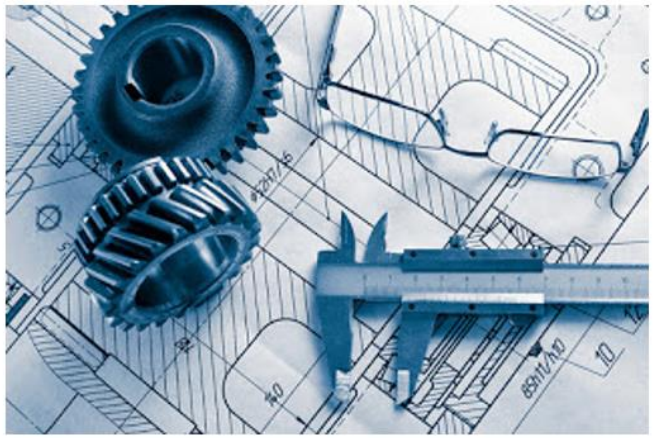
Four Activities



Activity 1: Reverse Engineering

Activity 1
Reverse Engineering

Worksheet



Reverse engineering is the process of discovering the technological principles and the design of a device, object or system, through the analysis of its structure, function and operation. Objectively, **reverse engineering** consists of, for example, disassembling a machine to find out how it works. In this way, we can admit that technological evolution is not always marked by innovation, but by the constant improvement of existing products. There are many examples of technological companies that compete with each other in the same business segment, applying this technique to remain competitive in the market.

(Adapted from https://engenharia360.com/engenharia-reversa)

Activity 1: Reverse Engineering

Activity 1

Reverse Engineering

Imagine that you are a group of engineers, technicians and electricians who work in an electrical equipment company and your boss asked you to analyse and find out how a new product works, from a competing company, which is being a sales success, for then develop a similar one.

Pay attention to the mystery box. Apply the reverse engineering technique to understand its operation and then design another one with the same principle.

1. Observe and explore the mystery box without opening it.
2. Describe your observations.
3. Design your own box with the same features as the mystery box.
4. Draw a picture or take a photo of your box.
5. Open the mystery box and look inside.

Activity 1: Reverse Engineering

Activity 1

Reverse Engineering

- ***Knowledge:*** Connect electricity to daily life phenomena, construct simple electric circuits (i.e., series and parallel circuits), connect different components and draw the scientific representation of circuits.
- ***Skills:*** Observe, discuss and apply the principle of reverse engineering to investigate how things work. Think about how a circuit should be constructed to provide a specific application.
- ***Attitudes:*** Foster a creative mindset through brainstorming new applications and innovations in electric circuits.

Activity 1: Reverse Engineering

Activity 1
Reverse Engineering

- **Previous knowledge overview**
  - Abstract thinking and conceptualization of different circuits.
  - Identify how energy is stored and transferred.
- **Brief description**
  - Investigate the product (mistery box) of a competing company. Predict the circuit hidden inside. Describe the function of the box and its components. Design your own box with the same features as the mystery box or innovate the original design.

Activity 1: Reverse Engineering

Activity 1
Reverse Engineering

- **Previous knowledge overview**
  - Abstract thinking and conceptualization of different circuits.
  - Identify how energy is stored and transferred.
- **Brief description**
  - Investigate the product (mistery box) of a competing company. Predict the circuit hidden inside. Describe the function of the box and its components. Design your own box with the same features as the mystery box or innovate the original design.

Activity 2: Circular Economy for Toys

Activity 2

Circular Economy for Toys

Worksheet

Driven by rapid urbanization and growing populations, global waste generation is expected to jump 70% by 2050, up from 2.01 billion tones in 2016. Toys are prime examples of items that are designed to 'spark joy' but often end up as waste when a child's play interests change. The value of the global toy market exceeded 80 billion EUR in 2019 but with some claiming as much as 80% of all toys end up in landfills, incinerators, or the ocean much of this value is lost when toys are thrown away. With waste and pollution causing damage to the environment and to our health, and valuable materials being lost from the economy, many toymakers are rethinking the future of their business. This involves redesigning not only how toys are made and played with, but also toy ownership. Together, these are critical steps towards a circular economy.

Adapted from What a Waste 2.0 (World Bank, 2018) and "Creating a circular economy for toys" by Ellen MacArthur Foundation.

Activity 2: Circular Economy for Toys

Activity 2

Circular Economy for Toys

1. Apply the concept of Reverse Engineering to a toy that is no longer used.
2. Describe the function of the different components that you have found in the toy. Organize data in a table.
3. Use the components of our toy to create an innovative product (prototype). Brainstorm with your colleagues and write your plan, including the material needed. (Note: Arduino can help you in the creation of the innovative product - See Appendix 1).
4. Test and evaluate your plan. Does it work as you expected? Write your results.
5. Iterate your prototype until you reach a good solution. Detail your steps and explain how the prototype improved for a previous version(s).
6. Communicate the process of designing the prototype and present your final product.
7. Discuss how a circular economy for toys could be beneficial for the planet.

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Activity 2: Circular Economy for Toys

Activity 2

Circular Economy for Toys

- ***Knowledge:*** Understand the principles of electronics by designing and prototyping different applications with Arduino. Build electronic circuits on breadboards and use different components. Compile code trough different applications.
- ***Skills:*** Observe, discuss and apply the principle of reverse engineering to investigate how things work. Use the engineering design process to develop new products.
- ***Attitudes:*** Foster a creativity mindset in the development of new applications. Discuss the benefits of a circular economy for toys. Sustainability on the recycle of old products.

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Activity 2: Circular Economy for Toys

Activity 2

Circular Economy for Toys

- **Previous knowledge overview**
  - Series and parallel circuits
  - Describe the function of different components
  - Scientific and symbolic representation of circuits

- **Transdisciplinary approach in brief**
  - This activity presents an opportunity for pre-service and in-service teachers to reflect on environmental issues of global waste and the importance of recycling old toys. Pre-service and in-service teachers apply the engineering design process to the development of a new product, use technology as a vehicle for creativity, writing and testing their own code and applying previous knowledge on building electronic circuits.

Activity 3: Electrical Equipment

Activity 3

Conductivity of everyday materials

Worksheet

Read the following text:

> Electrical engineers work on electrical equipment. They design equipment such as communication systems, navigation systems, energy production systems, motors, and radar, as well as equipment that is directly related to power generation and distribution. In addition, they develop the equipment, oversee its manufacturing process, and then test it before it is made available to the consumer. Different careers are available for electrical engineers. For example, in communications systems they would develop equipment that transmits digital signals to cell phones. They would also design electrical grids that would help conserve energy. In energy production systems, they would develop sustainable energy technology for harvesting power (Sawah & Clark, 2017, p. 57).

As mentioned in the text, electrical engineers work on electrical equipment. Is there a safe way to electrical engineers' test which materials are adequate without being electrically shocked?

Activity 3: Electrical Equipment

Activity 3

Conductivity of everyday materials

1. Predict what are the materials tested by electrical engineers without being electrically shocked.
2. Plan an experiment (materials to use and procedure) that will allow you to test the materials. Write your plan (you can use representations).
3. Test the materials and organize the information.
4. Identify two categories of materials tested.
5. Search how the categories identified in the previous question are scientifically designated.
6. Write which tested materials you would use to work on electrical equipment without being electrically shocked and explain why.

Activity 3: Electrical Equipment

Activity 3

Conductivity of everyday materials

Even though the human body is a conductor (because it's made of mostly water that has electrolytes) it's a poor conductor when using a power source like a battery. That's why it's safe to place a finger in the circuit. Do not use a power source like an electric outlet (Sawah & Clark, 2017, p. 56).

1. Search the meaning of electrolytes. Write its meaning.
2. Prepare a water-based electrolyte and test its electrical conductivity with the experiment you have planned.
3. Explain why the human body is a good conductor of electricity.

Activity 3: Electrical Equipment

Activity 3

Conductivity of everyday materials

- ***Knowledge***: Check electrical conductivity of different materials and good electrical, using an electrical circuit.
- ***Skills:*** Plan an investigation to investigate a research question, observe and record the results, critique experimental design and draw conclusions.
- ***Attitudes:*** Foster creativity during the planning, investigation and find solutions/explanations to the research question.

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Activity 3: Electrical Equipment

- **Previous knowledge overview**
  - Series and parallel circuits
  - Describe the function of different components
  - Scientific and symbolic representation of circuits

- **Transdisciplinary approach in brief**
  - The activity shows the close relationship between physics, biology, math and technology and show how pre-service and in-service teachers can develop responsibility in their own learning, as well as develop emotional and scientific literacy.

Activity 4: Ohm's Law and Electric Shocks

Activity 4

Ohm's law and human security regarding electric current

Many people are damaged each year by current from common 120-V electric circuits. To prevent, it is necessary to know how to use electric current and to know its effects on the human body. The answers to the following questions assess your knowledge of these issues.

Is an electric shock with a 12V car battery dangerous?

Why should you handle electrical equipment with dry hands?

Are the effects of electric shocks on the human body, when it is crossed by an electric current, all the same? What does this electric current depend on?

Is it safe to use the hairdryer barefoot in a wet bathroom?

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Activity 4: Ohm's Law and Electric Shocks

Activity 4

Ohm's law and human security regarding electric current

1. Search on the internet for three components that allow you to build an electrical circuit. Write the components selected and justify your options.

2. Using the components selected, plan an investigation to measure the value of the tension in an electrical circuit (U) divided by the current that flow through it (I). Write your plan.

3. Carry out the plan and collect the values of U and I in the electrical circuit. Repeat the procedure using three different voltage sources. Determine U/I.

4. Draw a conclusion about the results.

5. Search in the internet information about the law, related with numerical equation explored in the previous question.

Activity 4: Ohm's Law and Electric Shocks

Activity 4

Ohm's law and human security regarding electric current

Let's answer the initial questions...

6. Search on the internet how much resistance the human body is worth, with dry skin and damp skin. Collect the values.
7. Consider the table below (Hewitt, 2015).

TABLE 1 EFFECTS OF ELECTRIC CURRENTS ON THE BODY

Current (A)	Effect
0.001	Can be felt
0.005	Is painful
0.010	Causes involuntary muscle contractions (spasms)
0.015	Causes loss of muscle control
0.070	If through the heart, causes serious disruption; probably fatal if current lasts longer than 1 s

8. Determine the electric current that passes through the human body when you touch one of the terminals of a 12-V battery with one hand and the other terminal of the battery with the other:
a) With the skin of the hand dry.
b) With the skin of the hand damp.
c) Look table 1 and write if an electric shock with a 12 V car battery is dangerous.
9. Why should electrical equipment be handled with dry hands? Explain your reasoning.
10. Are the effects of electric shocks on the human body when it is crossed by a current all the same? What does this electric current depend on?
11. It is safe to use a 120 V hair dryer barefoot in a wet bathroom? Explain your reasoning.

Activity 4: Ohm's Law and Electric Shocks

- ***Knowledge***: Understand Ohm's law, know how to use electric current in different daily life situations and understand the effects of electric current in the human body.
- ***Skills****:* Plan an investigation to investigate a research question, observe and record the results, critique experimental design and draw conclusions.
- ***Attitudes****:* Foster creativity during the planning, investigation and find solutions/explanations to the research question.

Activity 4: Ohm's Law and Electric Shocks

- **Previous knowledge overview**
  - Series and parallel circuits
  - Knowledge on tension, current and resistance
  - Measure electrical quantities, I and U
- **Transdisciplinary approach in brief**
  - The activity shows the close relationship between physics, biology, math and technology and show how pre-service and in-service teachers can develop responsibility in their own learning, as well as develop emotional and scientific literacy.