LES 12

O B S E R V A T O R Y
ENVIRONMENTAL SCIENCE AND TECHNOLOGY (EST)
Teacher's Guide A
Second Year of Secondary Cycle Two

HOW DOES IT WORK?

STUDENT LOG

WORKING DOCUMENTS

EVALUATION DOCUMENTS

PROCEDURE AND EVALUATION: SSC2 – TECHNOLOGY

Observatory / Guide
11129-A

ERPI

The case study

One winter evening there's a power outage.

***After groping around and finally finding your flashlight,
you realize that the batteries are flat.
But there are no more batteries in the house.***

Why not buy a BATTERY-FREE FLASHLIGHT for the next time?

Our flashlight model works with a **dynamo,** a device that converts mechanical energy into electrical energy through electromagnetic induction. All you have to do is turn the handle a few times to recharge the **storage battery** (a 3.6-V Ni-MH lithium battery).

EFFICIENT

No more incandescent bulbs, which transform only 5 percent of all the electrical energy they consume into light energy and lose 95 percent in heat. Our flashlight is equipped with three LEDs (light-emitting diodes), which are energy-efficient electronic components that emit light when current flows through them.

POWERFUL

With the white light from the three LEDs, you can see more than 10 m in front of you.

ECONOMICAL

The battery can be recharged at least **500 times**. In theory, if you use our dynamo flashlight once a week, it should last at least **10 years**.

PRACTICAL

Compact and light, our flashlight is always ready to use, whether you're camping, travelling or caught in an emergency (power outage, car breakdown).

ENVIRONMENTALLY FRIENDLY

No batteries to buy or throw away.
Using this dynamo flashlight helps protect the environment.

Turning the handle for 1 minute ≈ 10 minutes of light

The case study (*continued*)

PROPOSAL FOR RESEARCH ON FLASHLIGHTS

Dynamo flashlights are becoming more widely available on the market. Before deciding whether to recommend them, we would like to conduct a study to compare the energy consumption of this type of flashlight (with a dynamo and LEDs) to the energy consumption of a traditional flashlight (with batteries and incandescent bulbs).

First, we will analyze the technology behind a dynamo flashlight. Then, we will pursue the analysis by measuring the following data in model electrical circuits of the two types of flashlights:

- the potential difference of the power supply
- the potential difference at the terminals of each circuit element
- the total current intensity
- the current intensity flowing through each of the circuit elements

We will thus be able to calculate the value of each of the resistors in the circuit, the energy consumed by each flashlight after 10 minutes' use and the energy consumed by each LED or bulb.

EST We must also calculate the equivalent resistance value of all the resistors in the dynamo flashlight circuit. Then, we must show that the circuits follow Kirchhoff's laws.

Centre for Environmental Studies

In this context, you will play the role of an expert who must issue a recommendation for or against the purchase of dynamo flashlights.

Name: ______________________ Group: ______________ **EST**

Creating the context

I ask myself questions

1. What is a flashlight?

2. What is a dynamo?

3. What is an LED?

4. What is an incandescent bulb?

5. What is an electrical circuit?

6. What is a circuit diagram?

Creating the context (*continued*)

7. What questions should guide you in your technological analysis of the dynamo flashlight and in your information gathering?

I must

8. Reformulate the goal of the case study.

Creating the context (*continued*)

I think

9. Would you recommend the purchase of a dynamo flashlight? Explain your answer.

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What I know and what I must find out

10. Write the information you already know and the information you need to find out.

What I know	What I must find out

Creating the context (*continued*)

I prepare

11. Where will you find the information you need to do your work?

12. Define the main steps of your case study in chronological order.

Reflection

	Yes	No
Do I fully understand what I have to do?	☐	☐

Gathering information

I do research

1. What is electrical charge? What is its unit of measurement?

2. What is the difference between static electricity and dynamic electricity?

3. a) What is electric current?

EST **b)** Using the concept of electrical field, explain what happens to charges in an electric current.

4. What is current intensity? What is its unit of measurement?

5. What is the mathematical formula for the relationship between current intensity and electrical charge? Identify each variable and its unit of measurement.

Name: ____________________ Group: __________ **EST**

Gathering information (*continued*)

6. What is potential difference? What is its unit of measurement?

7. What is the formula for the relationship between potential difference and electrical charge? Identify each variable and its unit of measurement.

8. What is electrical resistance? What is its unit of measurement?

9. What is Ohm's law? Write the mathematical formula that describes the law and identify each variable and its unit of measurement.

10. How is a value of electrical resistance determined?

Gathering information (*continued*)

11. Briefly explain what you should do to collect the data you need to calculate the resistance value of each of the resistors in the flashlight circuits.

12. What is electrical power?

13. What is the mathematical formula for calculating electrical power in this case study? Identify each variable and its unit of measurement.

14. What is the mathematical formula for calculating electrical energy? Identify each variable and its unit of measurement.

15. a) What is a series circuit?

b) What is a parallel circuit?

EST **c)** What is Kirchhoff's first law?

Gathering information (*continued*)

EST **d)** What is the mathematical formula that expresses Kirchhoff's first law . . .

- in a series circuit? ______________________
- in a parallel circuit? ______________________

EST **e)** What is Kirchhoff's second law?

____

EST **f)** What is the mathematical formula that expresses Kirchhoff's second law . . .

- in a series circuit? ______________________
- in a parallel circuit? ______________________

EST **g)** What is the mathematical formula for determining equivalent resistance . . .

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16. a) What is a magnetic field?

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b) How can the presence of a magnetic field be detected? Explain your answer.

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c) What can generate a magnetic field?

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Gathering information *(continued)*

I analyze my results

17. What is the general purpose of a dynamo flashlight?

18. Suggest some constraints (material, human or aesthetic) that may have guided the design of the dynamo flashlight.

19. a) What does the dynamo do?

b) What do the gears do?

20. Are light-emitting diodes connected in series or in parallel? Explain your answer.

21. Are light-emitting diodes connected in series or in parallel with their resistors? Explain your answer.

Gathering information (*continued*)

22. Draw the circuit diagram of the dynamo flashlight and give your diagram a title. In the diagram, identify the points at which you will take the various readings, the devices you will use and how they will be connected.

Gathering information (*continued*)

23. a) Have your dynamo flashlight circuit diagram approved.

b) In the space below, prepare a table for recording your results and measurements. Remember to give it a title.

c) Complete the table with your measurements.

Gathering information (*continued*)

24. Draw the circuit diagram of the traditional flashlight and give your diagram a title. In the diagram, identify the points at which you will take the various readings, the devices you will use and how they will be connected.

Gathering information (*continued*)

25. a) Have your traditional flashlight circuit diagram approved.

b) In the space below, prepare a table for recording your results and measurements. Remember to give it a title.

c) Complete the table with your measurements.

Reflection

	Yes	No
Do I fully understand the concepts covered in this situation?	☐	☐

Name: ______________________________ Group: ______________ **EST**

Completing the case study

1. a) Calculate the resistance of each of the circuit components in the dynamo flashlight.

EST **b)** Calculate the equivalent resistance of all the resistors in the dynamo flashlight circuit.

2. Calculate the energy consumed by each of the LEDs in 10 minutes.

3. Calculate the energy consumed by the dynamo flashlight circuit in 10 minutes.

Name: ______________________________ Group: ______________ **EST**

Completing the case study (*continued*)

4. Calculate the resistance of each of the circuit components in the traditional flashlight.

5. Calculate the energy consumed by each of the bulbs in 10 minutes.

6. Calculate the energy consumed by the traditional flashlight circuit in 10 minutes.

Reflection

	Yes	No
Have I considered other approaches?	☐	☐

Name: ____________________ Group: __________ **EST**

Validating the case study

I justify my approach

1. Case study conclusions:

a) Would you recommend the purchase of a dynamo flashlight? Justify your answer, taking into consideration the calculations you have done and the environmental impact of each of the flashlights.

Validating the case study (*continued*)

b) Are there any other factors to take into account before advising for or against the purchase of dynamo flashlights?

EST **c)** Is the data you collected for the flashlight circuits consistent with Kirchhoff's laws? Explain your answer.

2. Suggest improvements to your work.

Name: ______________________ Group: ____________ **EST**

My evaluation

Use the evaluation grid on the following page to evaluate yourself. Write A, B, C, D or E in the "Me" column of the chart below.

SSC2—Makes the most of his/her knowledge of science and technology				
Criteria*	Observable indicators	Me	Teacher	Comments
1	**Creating the context** Definition of the goal and description of the procedure		☐ With help	
2	**Gathering information** Completion of the circuit diagrams and collection of relevant data		☐ With help	
3	**Completing the case study** Calculations		☐ With help	
4	**Validating the case study** Justification of the recommendation EST Confirmation of Kirchhoff's laws		☐ With help	

*** Evaluation criteria**

1 Formulation of appropriate questions
2 Appropriate use of scientific and technological concepts, laws, models and theories
3 Relevant explanations or solutions
4 Suitable justification of explanations, solutions, decisions or opinions

Name: ______________________ Group: ____________ EST

Evaluation grid

SSC2 Makes the most of his/her knowledge of science and technology

Criteria*	Observable indicators	A	B	C	D	E
1	**Creating the context** Definition of the goal and description of the procedure	The goal of the case study is very clearly defined, and all of the steps in the procedure are relevant.	The goal of the case study is clearly defined, and most of the steps in the procedure are relevant.	The goal of the case study is not very clearly defined, OR some of the steps in the procedure are irrelevant.	The goal of the case study is not very clearly defined, AND some of the steps in the procedure are irrelevant.	The work must be done again.
2	**Gathering information** Completion of the circuit diagrams and collection of relevant data	The circuit diagrams are well-drawn representations of the flashlight circuits. All the relevant data has been collected and recorded properly.	The circuit diagrams represent the flashlight circuits, but they contain minor errors. Most of the relevant data has been collected and recorded properly.	The circuit diagrams contain many errors, OR only some of the relevant data has been collected and recorded properly.	The circuit diagrams contain many errors, AND only some of the relevant data has been collected and recorded properly.	The work must be done again.
3	**Completing the case study** Calculations	The required calculations are complete and correct. All the units of measurement are indicated correctly.	The required calculations are complete, but they contain minor errors.	The calculations contain many errors or are irrelevant.	Most of the calculations are incorrect or irrelevant.	The work must be done again.
4	**Validating the case study** Justification of the recommendation (STE) Confirmation of Kirchhoff's laws	The justification is relevant and very clear.	The justification is relevant and clear.	The justification is partially relevant.	The justification is not very relevant.	The work must be done again.

* Evaluation criteria

1 Formulation of appropriate questions
2 Appropriate use of scientific and technological concepts, laws, models and theories
3 Relevant explanations or solutions
4 Suitable justification of explanations, solutions, decisions or opinions