



Sequence 13: electrical energy transfer



Fiches de synthèse mobilisées (collection en français) :

- Fiche 13 : transferts d'énergie électrique



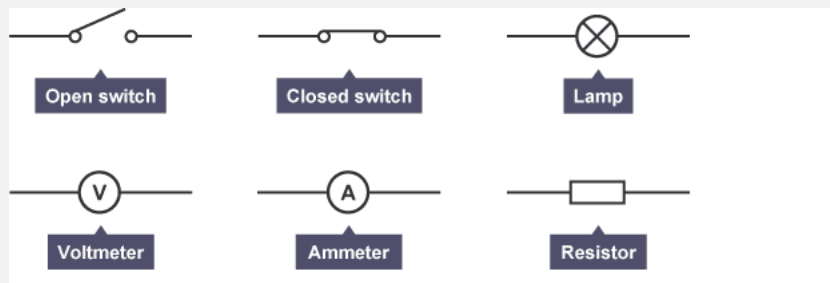
Sommaire des activités ETLV :

- ACTIVITY 1: Electrical circuit symbols
- ACTIVITY 2: Reinvesting Ohm's law
- ACTIVITY 3: Circuit rules
- ACTIVITY 4: Solar energy and electricity
- ACTIVITY 5: Measuring the current-voltage characteristics of a single solar cell

ACTIVITY 1: Electrical circuit symbols

Objective: acquiring simple vocabulary

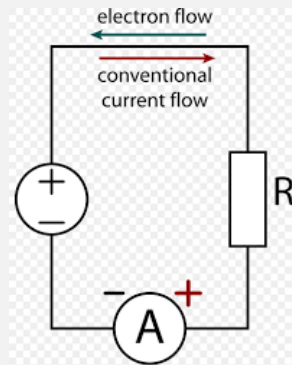
DOCUMENT 1: Electrical circuit symbols



Source : wikipedia

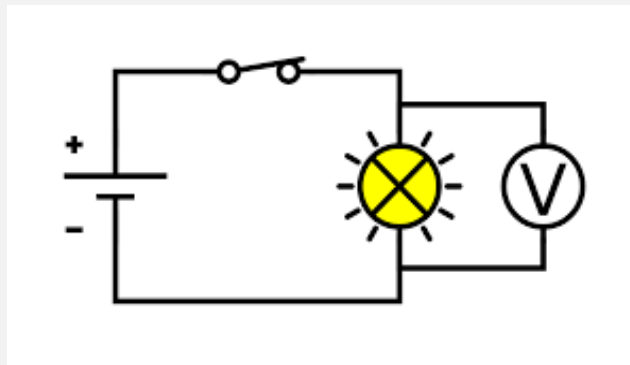


DOCUMENT 2: ammeter



Source : wikipedia

DOCUMENT 3: voltmeter



Source : wikipedia

■ **Acquiring vocabulary:**

Fill in the blanks:

Definition or description	Name
Used to turn a circuit on (closed) and off (open).	
An electrical current heats the filament in a bulb so that it gives out light.	
Restricts or limits the flow of electrical current. A fixed ... has a resistance that does not change.	
Is used to measure a current.	
Is used to measure a potential difference.	

■ **Acquiring vocabulary:**

In the text below you can choose between the words:

voltage, current, in parallel, in series

To measure the _____ through a component, the ammeter must be placed _____ with that component.



To measure the potential difference across a component, a voltmeter must be placed _____ with that component in order to measure the difference in energy from one side of the component to the other. Potential difference is also known as _____ and is measured in volts (V).



ACTIVITY 2: Reinvesting Ohm's law

Objective: to use Ohm's law during a simple experiment

DOCUMENT 1: A simple experiment



Practical Experiments - GCSE Physics

Resistance of a Wire Experiment - GCSE Physics Required Practical

Source: <https://youtu.be/nEaVoqzL6Rg>

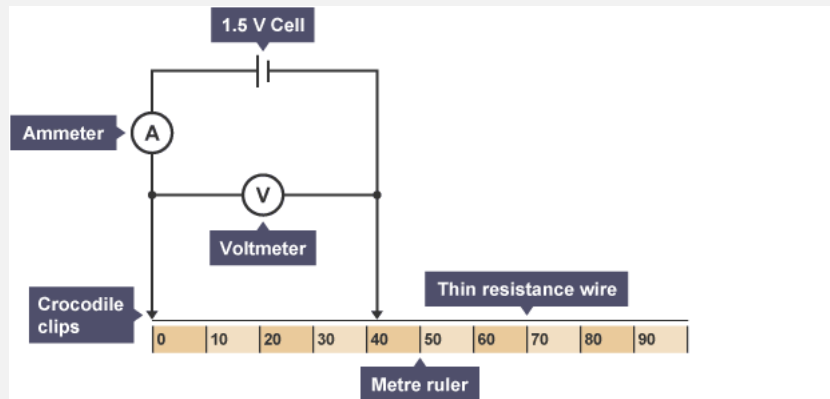
■ Acquiring vocabulary:

Watch the video and make a list of the equipment you need for this experiment:



DOCUMENT 2: Method

Aim of the experiment: to investigate how changing the length of the wire affects its resistance.



Method

- Connect the circuit as shown in the diagram above.
- Connect the crocodile clips to the resistance wire, 100 centimetres (cm) apart.
- Record the reading on the ammeter and on the voltmeter.
- Move one of the crocodile clips closer until they are 90 cm apart.
- Record the new readings on the ammeter and the voltmeter.
- Repeat the previous steps reducing the length of the wire by 10 cm each time down to a minimum length of 10 cm.
- Use the results to calculate the resistance of each length of wire by using $R = V/I$, where R is resistance, V is voltage and I is current.
- Plot a graph of resistance against length for the resistance wire.

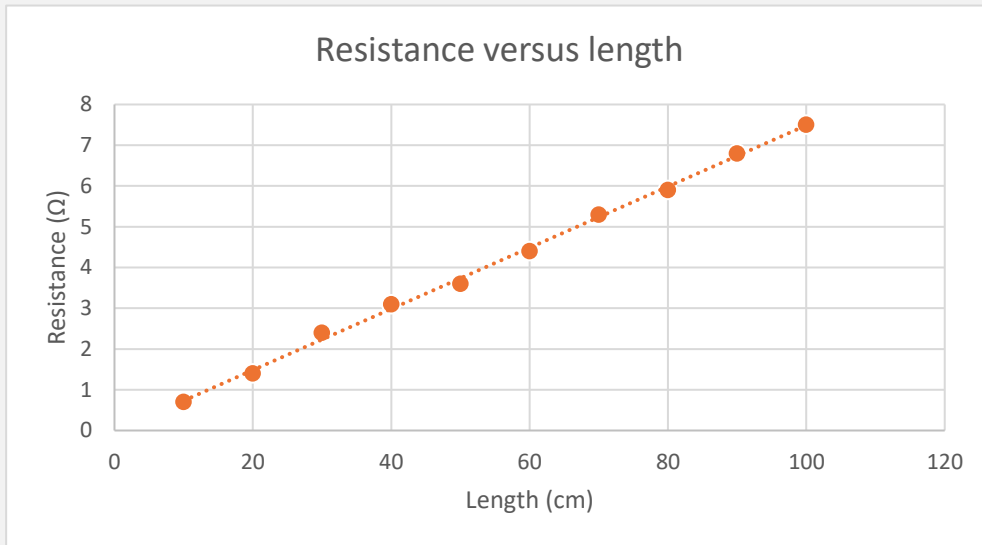
Source: BBC bitesize science

DOCUMENT 3: the results

Length (cm)	Potential difference (V)	Current (A)	Resistance (Ω)
100	1.2	0.16	7.5
90	1.18	0.17	6.8
80	1	0.17	5.9
70	0.96	0.18	5.3
60	0.93	0.21	4.4
50	0.89	0.25	3.6
40	0.84	0.27	3.1
30	0.75	0.31	2.4
20	0.63	0.44	1.4
10	0.41	0.63	0.7



DOCUMENT 4: the results



■ Reinvesting:

How is the resistance of the wire related to the length of the wire?

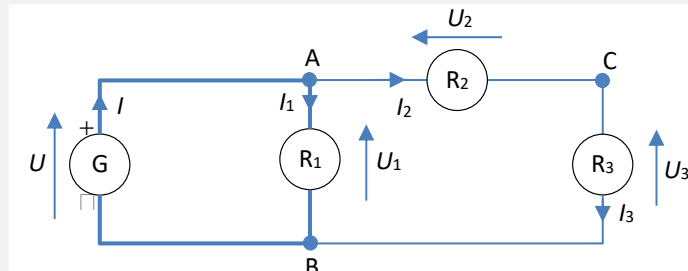


ACTIVITY 3: Circuit rules

Objective: learning the basic circuit rules

DOCUMENT 1: the junction rule

This law, also called Kirchhoff's first law, or Kirchhoff's **junction rule**, states that, for any node (junction) in an electrical circuit, the sum of currents flowing into that node is equal to the sum of currents flowing out of that node; or equivalently:

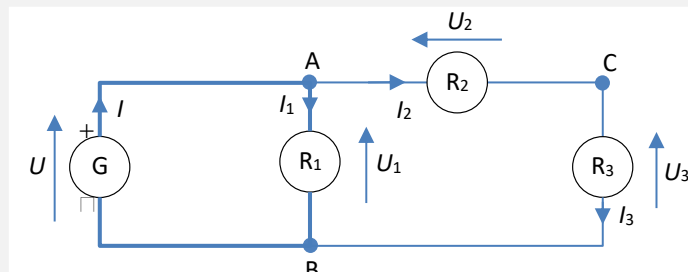


■ **Reinvesting:**

Write the equation that relates I , I_1 and I_2 :

DOCUMENT 2: the loop rule

This law, also called Kirchhoff's second law, or Kirchhoff's **loop rule**, states the following: the directed sum of the potential differences (voltages) around any closed loop is zero.



■ **Reinvesting:**

Write the equation that relates U , and U_1 :

Write the equation that relates U_1 , U_2 and U_3 :

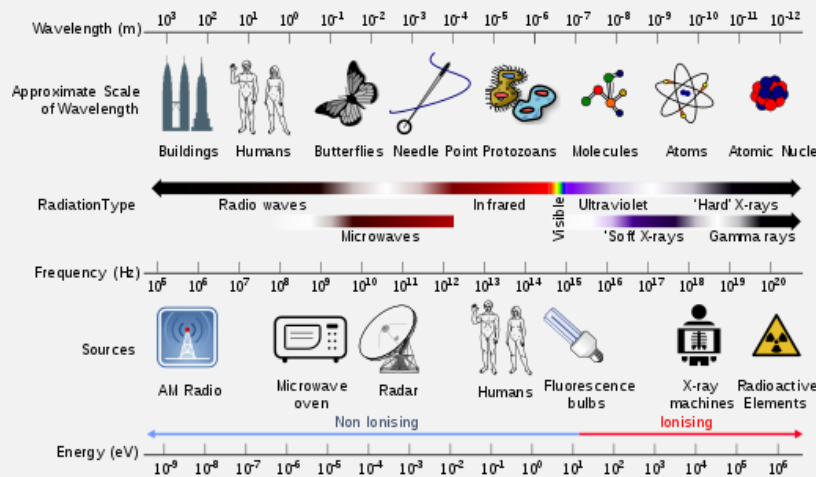




ACTIVITY 4: Solar energy and electricity

Objective: understanding how a solar cell works

DOCUMENT 1: What is sunlight?



The sun emits what we call electromagnetic radiation which can be divided up into seven regions: radio waves, microwaves, infra-red radiation, visible light, ultra-violet light, X-rays and gamma radiation. This is known as the electromagnetic spectrum. We are protected from a lot of the harmful parts of the electromagnetic radiation by Earth's atmosphere. However, some ultra-violet light can get through and causes sunburn if we are in the sun for too long without sunscreen.

The visible and infra-red regions of the spectrum are what our sun produces the most of. Therefore, it is important for people designing solar cells to try and capture these regions in order to make electricity and usually scientists concentrate on absorbing the visible region. The visible region can be split up into the colours of the rainbow. You see a rainbow when visible sunlight is split into its colours by water in the air.

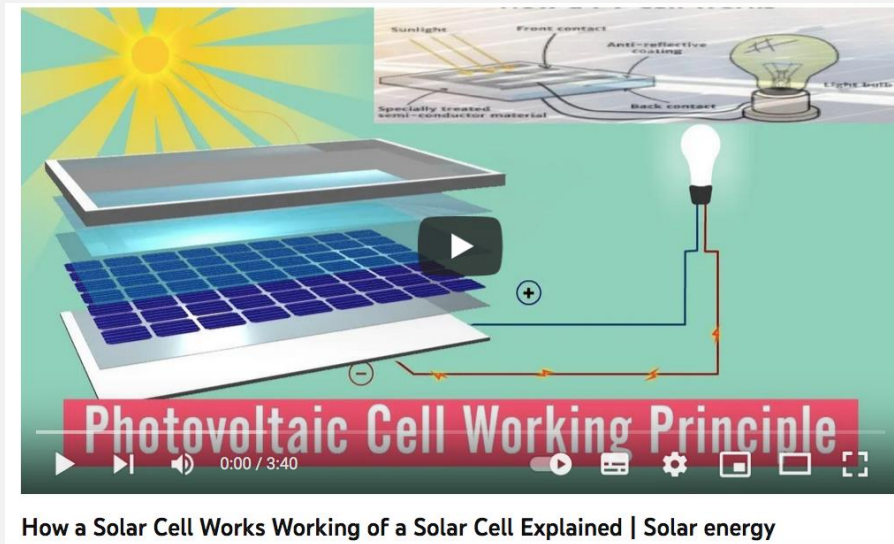
DOCUMENT 2: Solar power and photovoltaics cells

Solar is the first energy source in the world. Solar energy is mostly used in generating light and heat. It was this energy that is believed to have been responsible for the breaking of ice during the ice age, which creates the separation of lands and sea. Energy from the sun can be used in solar furnaces, solar thermal heating systems and photovoltaics. Photovoltaics use the sun's energy to make electricity. Solar energy can be used *everywhere*, although solar farms are often constructed in deserts and open sunny ground. Once installed, solar devices need little maintenance and provide free, green energy with no carbon dioxide emissions. The sun's energy cannot be stored which leads to problems at night-time. Photovoltaics can be used to charge batteries during the day so that we can still get electricity at night, but only when they are making electricity. "Photovoltaic cells", more commonly known as "solar cells" are used to convert the sun's light energy into direct current electricity (the kind of electricity that produced by batteries). This "photovoltaic effect" is not new technology; in fact, it was observed in 1839 by a French scientist called Alexandre-Edmond Becquerel, and silicon solar panels have been used in space for over 50 years! They are now used down here on Earth, and are undoubtedly the most common type of photovoltaic (PV) technology seen today. However, there are lots of other types of solar cells and panels used nowadays.



DOCUMENT 3: How can sunlight make electricity?

Electricity is the flow of electric charge through a circuit. The photoelectric effect was first observed in 1887. This effect is where the absorption of sunlight by a material causes the material to emit electrons. The sunlight absorbed is usually in the visible or ultra-violet region of the electromagnetic spectrum. This phenomenon is where solar power all started. The ability of the sun’s energy to separate an electron from an atom in this material is the first step to making electricity. The electron can be separated from the now positively charged atom (ion). Once we have this charge separation, we can bring about a flow of electric charge through a circuit and this is our electricity.



■ **Acquiring vocabulary:**

1. Match these words with their definition

visible light	particles which have a positive charge
electricity	particles which have a negative charge
protons	a range of electromagnetic radiation (380 to 750 nm) that can be detected by the human eye
electrons	flow of electric charges through a circuit

2. To generate electricity, explain which particles need to be separated in order to create a flow of electric charges.

3. What is the energy conversion process in a solar cell?

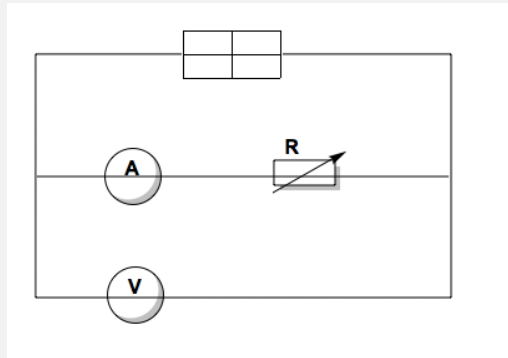
4. Explain briefly how solar cells work to produce electricity.



ACTIVITY 5: Measuring the current-voltage characteristics of a single solar cell

Objective: recording voltage and current characteristics of a single solar cell

DOCUMENT 1: Materials, equipment and definitions



Open-circuit voltage of a solar cell

The open-circuit voltage V_{oc} is the maximum voltage available from a solar cell. V_{oc} is measured using a voltmeter connected across the solar cell when no load is connected.

Short-circuit current of a PV cell

The short-circuit current I_{sc} is the maximum current a solar cell can supply. The current is measured using an ammeter connected directly across the solar cell.

DOCUMENT 2: Experimental procedure

- Connect the solar cell to a potentiometer as shown in document 1. Connect the voltmeter in parallel with the solar cells, and the ammeter in series to measure the output voltage and current respectively.
- Use a desk lamp as a light source to illuminate the solar cell.
- Direct the light beam towards the solar cell and measure the irradiance. It should be at its maximum. Do not move then neither solar cell nor the desk lamp.
- Vary the value of the potentiometer sequentially according to document 3. Use the voltmeter and ammeter to measure the output voltage and current with different potentiometer values.
- Record the voltage, current and power values in Table 1. Save the data in an Excel file.
- After having completely recorded the voltage and current values, plot the current-voltage curve and the power-voltage curve for the solar cell.



DOCUMENT 3: Voltage and current for a single solar cell

Potentiometer (Ω)	Output voltage (V)	Output current (A)	Output power (W)
0.0			
20			
30			
50			
60			
80			
110			
170			
260			

1. According to document 1, make a list of the materials and equipment you need for this experiment.

2. Identify the open-circuit voltage V_{oc} and the short-circuit current I_{sc} on the current voltage curve.

3. Identify the maximum power point on the current-voltage curve and on the power-voltage curve respectively.



Activity summary

What you must remember:

- **ammeter**
- **voltmeter**
- **voltage, current**
- **electromagnetic radiation**
- **production of electricity**
- **conversion of light energy to electric energy**
- **photovoltaic (PV) cell**

Skills linked to the curriculum:

Compétences	Capacités à maîtriser	Où dans cette séquence ?
APP	Utiliser du vocabulaire spécifique	Activités 1, 2, 3, 4, et 5
	Lire et comprendre des documents scientifiques	Activités 1, 2 et 3 et 5
ANA	Mettre en lien des documents pour émettre des hypothèses en réponse à une question scientifique	Activités 1 et 2 et 4
COM	S'exprimer à l'écrit en utilisant le vocabulaire adapté	Activités 1, 2, 3, 4 et 5
REA	<ul style="list-style-type: none"> • Citer et exploiter la loi des nœuds et la loi des mailles dans le cas d'un circuit simple. • Citer et exploiter la loi d'Ohm. • Réaliser un circuit électrique d'après un schéma donné. • Mesurer une tension électrique et une intensité électrique dans un circuit. • Concevoir et réaliser un protocole expérimental pour déterminer la caractéristique intensité-tension d'un panneau photovoltaïque. 	Activité 3 Activité 2 Activité 4 Activité 5