

JUNK TO FUNK: Make a Moon Base

Building Sustainable Moon Habitat with Recycled Materials

Teacher Book

Proposal

Class/Grade Level: 4 th Class		Workshop period ¹ :
Related Subjects: Science, Technology, Engineering, Art, Math		
<p>Project Background & Overview: ESA's Moon Village initiative and NASA's Artemis Program are developing humanity's first sustainable lunar base, with China's Chang'e Project and Japan's JAXX lunar station planned before 2030. These bases will enable long-term scientific research and deep-space technology testing. Building a moon base is no longer just a dream! Students work in team as lunar architects to design and make a moon base model. The moon base will include at least three parts: living and lab area, food supply area and power plant. Teachers will pick a best model for the exhibition in SPACE Fest TUD.</p>		
Learning Goals	Knowledge	Review the knowledge of ecosystem, electricity and renewable energy.
	Skills	Make circuits. Use tools for crafts.
	Social Emotional Learning	Communicate efficiently and nicely. Build happy and inclusive teams. Support teammates and help each other. ...
	...	
Core Knowledge	Ecosystem: Components of ecosystem, Water cycle, Food chain Electronics: Circuits Renewable Energy: How to use renewable energy to generate electricity	
Driving Question	<p>Driving Question: Dear lunar architects, You and your team are invited to design a moon base for scientist to live and work. Can you design and build a moon base model with living and lab area, food supply area, and power plant that addresses:</p> <ol style="list-style-type: none"> 1.Lunar environmental adaptation (1/6 gravity, $\pm 170^{\circ}\text{C}$ swings, vacuum) 2.Closed-loop ecosystem (oxygen/water/food cycles) 3.Sustainable energy supply (14-earth-day lunar nights)? 	

¹ E.g. 40mins/day, last for 1 week; 3 full days...

	<p>Please use Recyclable Materials to make your model. Recyclable Materials to Suggest:</p> <ul style="list-style-type: none"> • Cardboard (cereal boxes, toilet paper tubes, etc.) • Plastic bottles and caps • Foil, string, yarn • Old newspapers and magazines • Wires, buttons, LED lights • Broken toys, cotton • Soil, moss, stones 	
	<p>Supporting Questions: Research & Think</p> <ul style="list-style-type: none"> • How is the living environment in the moon? • Why is it challenging to live in the moon? • How can plants grow in moon without air? • How to generate electricity? <p>Discuss & Design</p> <ul style="list-style-type: none"> • How does the moon base look like? • Where do you place three areas? Are they connected to each other? • What will the electricity circuit look like in our moon base? Is it for lab, warning light, or...? • Do you want to add more areas? <p>Make a Model</p> <ul style="list-style-type: none"> • Show your ideas in a Moon Base Model! • Use recyclable materials • Work in team and help each other • How can we explain our ideas, by text, QR code or ...? 	
Expected Product	A moon base model.	
Requirements	Size	The base should be smaller than 80cmx55cm.
	Basic	<p>3 Essential Zones</p> <ol style="list-style-type: none"> 1. Living and lab area: Make circuit to power the area 2. Food supply: Make closed ecosystem for farm, garden... 3. Power Plant (Energy supply): use renewable energy to generate electricity
	Advanced	<p>Choose 1+ Feature</p> <ol style="list-style-type: none"> 1. Interactive device 2. Temperature Warning Lights 3. Introduction in QR code/NFC
Assessment Criteria	See PDF "Judging Sheet"	

Assessment Method ²		
Timeline	Preparation	
	Entry Event	
	Research & Think	
	Discuss & Design	
	Make a Model	
	Summative Event	
	Implementation (*Important Tips: Predict learning difficulties and make detailed instruction and presentation)	Start the Project
Research & Think		
Discuss & Design		
Make a Model		
Summative Event		
Materials	Student Workbook	
	Hands-on materials	Teacher offer: Students take:
Resource	Brainstorm Tool	OpenAI (e.g. ChatGPT, DeepSeek ...), YouTube, Instagram
	Website of space projects	https://www.esa.int/ https://www.nasa.gov/ https://www.cnsa.gov.cn/ https://biosphere2.org/about/about-biosphere-2
	DIY ideas	How To Make Your Own Moon Base https://www.youtube.com/watch?v=6LpV7HJV8PE How to make hydro powerplant working model https://www.youtube.com/watch?v=0DD65XEr4ws How to make solar panel at home https://www.youtube.com/watch?v=uANLrzclJAA ...

² E.g. Students present their models and ideas and vote for the best one in the class/school.

Teaching Plan

Start the Project

Intro:

ESA's Moon Village initiative and NASA's Artemis Program are developing humanity's first sustainable lunar base, with China's Chang'e Project and Japan's JAXX lunar station planned before 2030. These bases will enable long-term scientific research and deep-space technology testing. **Building a moon base is no longer just a dream!**

[show pictures of moon bases from ESA, NASA, Chang'e project and JAXX]

Task Release:

TU Dublin is going to have a SPACE Fest in June. You're all invited to design and make a moon base model to display and present ideas in TUD campus. Here is their invitation poster: [show poster] Dear lunar architects...

Quick Brainstorm:

If you are an engineer, how will you design the moon base?

[Write down their ideas in the board.]

Build Teams:

4 people in a group. Tips for looking for a teammate:

- Have similar ideas.
- Can do something you're weak at.
- Inclusive, passionate, kind...

Discuss with teams. Decide your roles in the team:

- Ecologist: offer knowledge about ecosystem and make important decisions for food supply area and air recycle in living and lab area.
- Electrical engineer: offer knowledge about electricity and make important decisions for power plant and circuit in living and lab area.
- Architect: Design the blueprint of moon base. Give suggestions for model making and decoration. (PS: if you like art, this is a good role for you!)

Discuss about the team rules in class/group and sign (Student Workbook P2):

1. Be inclusive, supportive, passionate and positive.
2. Feel free and safe to ask questions.
3. Don't be afraid to try and make mistakes. The most important thing is to know what went wrong and make it right.
4. Everyone contributes and be helpful.
5. ...

Research & Think

To make a moon base, we need to:

1. Do research about the living environment in moon. Write down the challenges we might face to live in moon. Think about how to solve these problems.
2. Discuss in team about how to face the challenges. Make decisions on your team ideas and design. Artists need to draw the blueprint/draft, others need to give suggestions.
3. Prepare materials and make a moon base model.
4. Share ideas and discuss in a bigger group: is this moon base sustainable?

Let's try to break down the question for Research & Think together! (Student Workbook P3)

Are you curious about how the life will be like in the Moon? What are you curious about?

Answers: [If you can use ChatGPT in the classroom, students can ask it questions and looking for further information in official website like NASA and ESA to check if the info is correct]

- Challenges for Ecologists
 - How can people get air support? How can we have air cycle in moon?
 - Is there water? Can we make water cycle in moon?
 - How strong is the sun light? When can we have sunlight in moon?
 - Can lunar soil grow plants?
 - Can we build ecosystems for plants?
 - How is the temperature?
- Challenges for Electrical engineers
 - How can we generate electricity? Can we use solar energy and wind turbine?
 - What do we need electricity for?
 - How can people know danger is coming?
 - What kinds of entertainment will we have in moon base?
 - How can people communicate with people on the Earth?
- Challenges for Artists
 - What kinds of protection do we need to survive in extreme temperatures?
 - Do we have resource in moon to build houses?
 - Are there any examples of moon base design?
- ...

Students finish research part at home/in classroom/in computer room... Since there is lots of information, students can take charge of one part according to their roles in the teams.

*This Section is to help students have a wide knowledge about Moon. Once they have some background knowledge, we can guide them to learn deeper.

*Tools to help you and students organize the information they find: Mind Map (XMind is a good APP!), Form, Sticker...

Discuss & Design

Discuss and Decide

What kind of challenges are we facing? Share the information you got with your teammates/classmates. [You can write down their answers in the board.]

Since we're not supermen/superwomen, scientists always focus on 1-2 problems and try best to solve them. These challenges are most important for surviving and working in moon [tick the challenges, see below]. Let's brainstorm together! [discuss one by one]

- How can we build a closed ecosystem in the moon?
 - Do you remember how we make our terrariums?
- How can we have electricity in the moon?
 - We can use solar boards to transfer sunlight/solar energy into electricity. We can also ...
- How can we show that we will have lights in living and lab areas?
 - Do you remember how to make a circuit?
- Can we make circuits for warning light to let people know cold night is coming?
- ...

Brainstorm for details in teams: Every team can have your own way to solve the problem. Discuss with teammates and start with your rough draft if you want. (Student Workbook P4)

Design and Draw (Student Workbook P5)

Turn your ideas into draft! Artists can draw the final draft, while others can be your assistants. This draft should show the shapes and **size** of the three areas.

Things you can do when they're discussing and drawing:

- Frequently check their process and remind them of time. A timer is always helpful.
- Check the instructions they need. Give instructions to individuals/groups/class.
- Assess their collaboration if you want to take this as part of their learning assessment. See assessment tools on Judge Sheet.
- Take good photos!

Prepare for Model Making (Student Workbook P6)

If you finish your draft early, discuss how to make the model:

- How can we make our 2D design into 3D models?
- What kind of recyclable materials are we going to use?
- How do we separate our labour?
- ...

Students can use the materials they got from previous Try Five+ workshops or find more recyclable materials at home/park/... Teachers can also prepare some materials in case they forget to bring enough. See Try Five+ materials list at www.tryfive.ie.

Make a Model

This section will require lots of teamwork. Set up the rules in advance will make your life easier. Here are some options you can go through before starting the hands-on section:

- Review the team rules with students. If you have rules for your daily teaching, you can remind them of that.
- What-if Q&A: quick questions and answers about the situation they might meet:
 - What if we have different ideas? Who should make the final decision?
 - What if we have better ideas than our original design?
 - What if someone is not helping?
 - What if someone is unhappy with the work?
 - What if we want to borrow materials from another group?
 - What if we want to check other groups' work?
 - ...
- Rules for stop and listen to your instruction. Sometimes it's helpful to stop them and give instructions for whole group/class.
- Rules for learning from other groups. Kids are always curious about what others are making. Better guide them how to learn from each other, instead of stopping them "steal" ideas.

Safety is important! (See Student Workbook P6)

Things you can do when they're doing hands-on stuff:

- Frequently check their process and remind them of time. A timer is always helpful.
- Check the instructions they need. Give instructions to individuals/groups/class.
- Assess their collaboration if you want to take this as part of their learning assessment. See assessment tools on Judge Sheet.
- Take good photos!

5 Tips to help students cooperate better:

1. Positive Interdependence: Your success is also mine!

E.g. Set up a same goal. Share resource and materials. Share prize.

2. Interact, instead of working alone: Body language and eye contact are helpful!

3. Individual Accountability: everyone contributes!

E.g. First think individually, then discuss in group. Take turns to speak. Randomly check individual's contributions, such as "Can the ecologist from group 3 explain the design of living area?". Evaluate individuals and groups.

4. Social Skills

E.g. Role-play conflict scenarios. Teach collaborative language, such as "I suggest..." "What do you think about...". Use collaboration rule posters.

5. Group Reflection

E.g. Spend the last 5 minutes of every collaborate session filling reflection sheets, such as "3 things our group did well today". Share success stories in class. Give specific feedback.

Summative Event

Summarize What We Did

A good summarize is as important as a good start. It can help students structure the knowledge and skills they learnt from this project. It's not just making stuff. Learning is happening when they're thinking and solving the problems. Here is an example of what you can say:

“Congratulations, lunar architects, on completing this interstellar challenge! From studying the Moon to designing your own base, you've demonstrated true pioneering spirit.

Ecologists, you built closed ecosystems attempting air, water, and energy cycles on the Moon. Electrical engineers, you created mini solar power stations with tin foil and wires, connecting circuits to light up habitats. Artists, you designed and constructed tech-inspired structures that are both safe and structurally sound.

What matters most: When Team A found their design hard to build, they brainstormed solutions together – everyone contributed ideas. Team B shared materials with others – these actions shine brighter than any model.

Now comes the final and most crucial step. Whether scientists or engineers, they always share discoveries with peers to improve their work. Take your lunar bases to the exhibition stage, and let your brilliant ideas sparkle for all to see!”

Present and Evaluation

Every team present their models and ideas. Teacher and other students evaluate their work and presentation (See “Judging sheet”). After each presentation, you can invite students to give feedback or ask questions. If you want, you can let them vote their favourite moon base.

Prize-giving

You can pick either best score moon bases or best bases in different way. For example, you can have prize like Best Team, Most Creative Idea, Easiest to Realize, Most Popular, Best Craft... You can link this with your class management system.

Reflection

Link knowledge and skills with their products. Summarize their learning performance. Give suggestions for further learning.

Background Knowledge

To help you prepare yourself for the project, here are some background knowledge about moon base and living environment in the moon. Feel free to explore more!

Living Environment

Basic Data

Element	Moon	Earth	Example
Gravity	1.62m/s ² (1/6 of Earth)	9.8m/s ²	"On the Moon, you could lift a desk easily, but your base must be anchored!"
Air	No oxygen	21% oxygen	"Moon has no air – your base must be sealed like our jars!"
Water	No water	Enough	"Moon has no water – we can bring water from earth but your base must have water cycle."
Temperature	-173°C (night) ~127°C (day)	-89°C~56°C (extremes)	"Temperature swings can melt ice cream and freeze it instantly - super insulation needed!"
Day/Night	14 Earth-day cycle	24 hours	"Two weeks of darkness mean storing energy like a hibernating squirrel!"
Radiation	200× Earth's level (no atmosphere)	Low	"Moon radiation is like invisible bullets – build a 'shield' with moon soil!"

*The colour darker, the data more essential for students to know.

What we learned about Ecosystem in Workshop 2

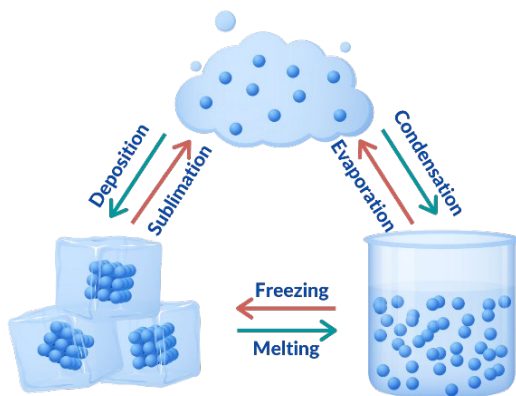
Air Cycle - Plants are our oxygen factories!

Core Principle: Plants absorb CO₂ and release O₂ ↔ Humans breathe O₂ and release CO₂.

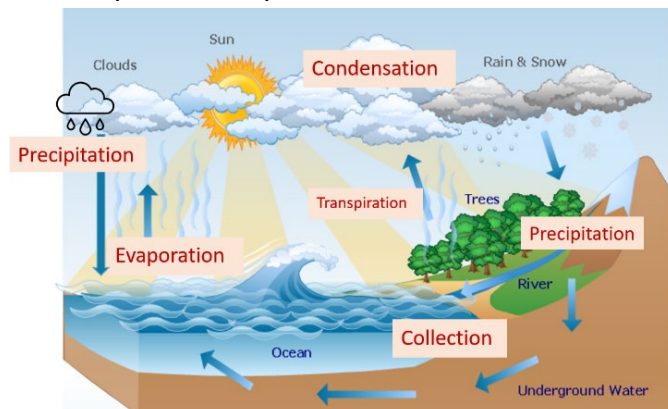
Water Cycle

States of water: gas(vapor), liquid, solid(ice)

Transfer of the states:

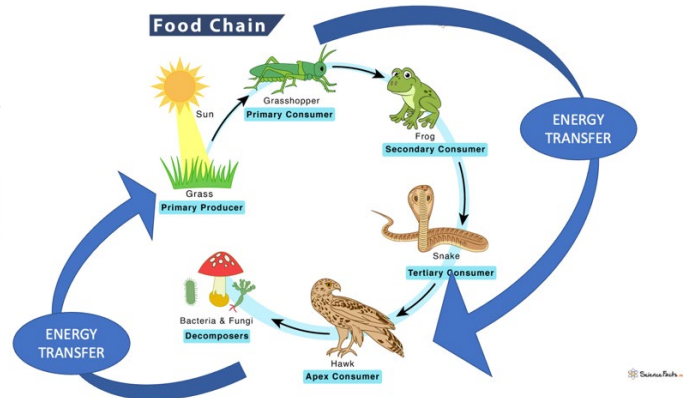
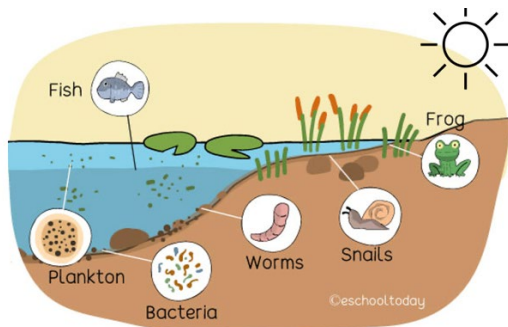


Water cycle in ecosystem on earth:



Water Cycle diagram by K.Tapdiqova

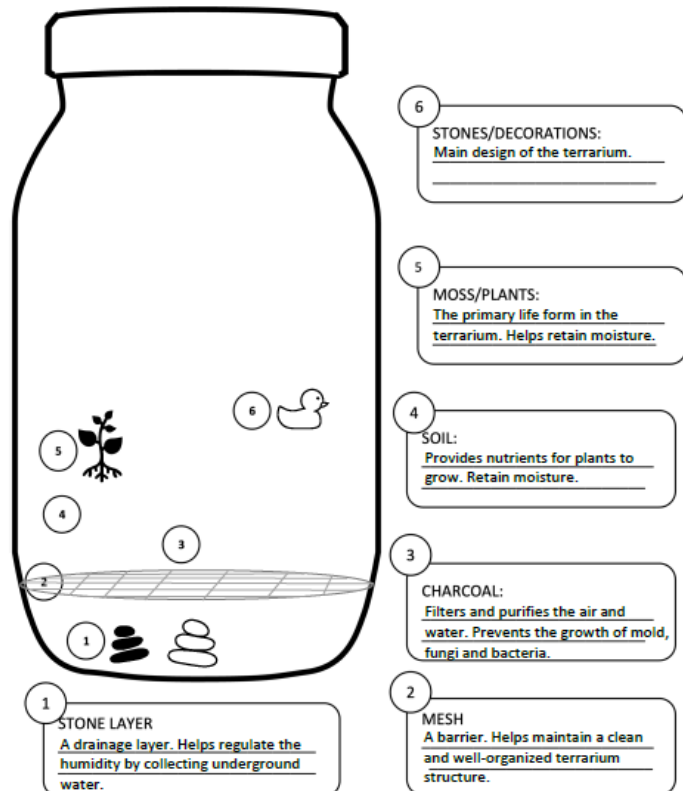
Energy Cycle (Food Chain)



Closed Ecosystem

A closed ecosystem jar is like a tiny, self-sustaining world inside a glass. Everything inside the jar—plants, water, air—depends on each other to stay healthy and balanced. Here's how it works:

- Water Cycle in Action:** Inside the jar, water from the soil and moss evaporates, turns into condensation on the walls, and then drips back down.
- Balanced Air Supply:** The plants inside the jar use sunlight to make their own food through photosynthesis. They take in carbon dioxide (CO₂) from the air and release oxygen (O₂), creating a balanced atmosphere for the plants and any small creatures inside. Everything works together to keep the air fresh and healthy.



Moon Base Ideas

Make a closed food supply area

Example:

Basic Materials: soil, stones, paper, transparent cake box/plastic bottle

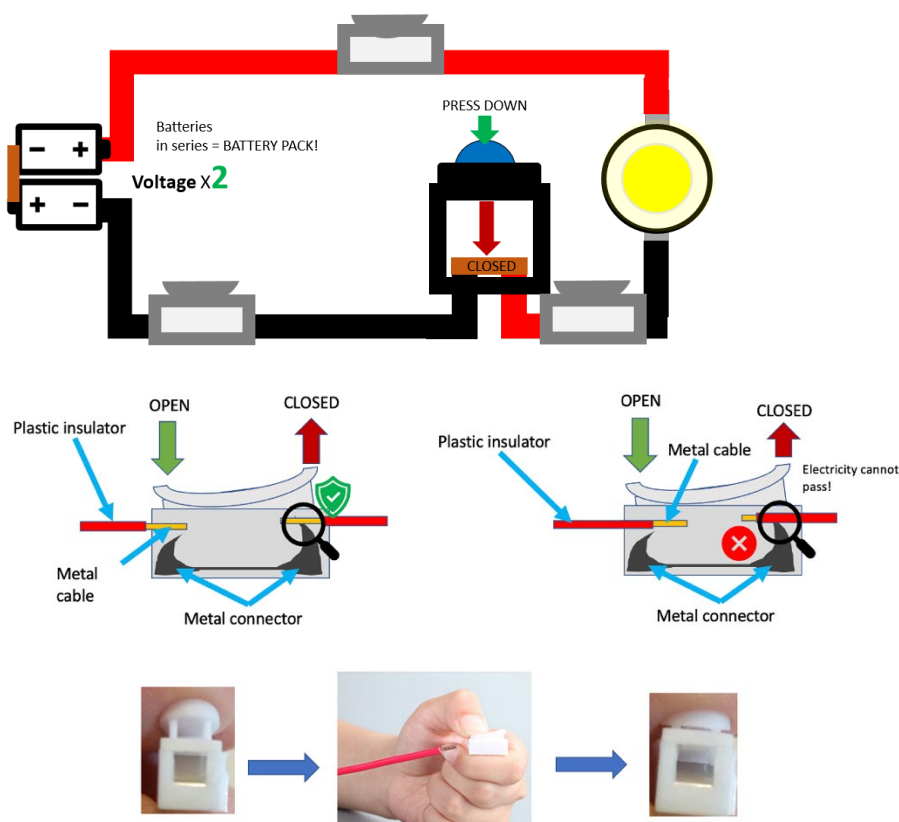
Put the soil on the board as the base. Draw some plants/animals you want to grow or put moss/mini plants you collected from garden/park on top. Put some stones as decoration. Close the ecosystem within a transparent cake box/plastic bottle.

Electronics Basics

Core Concepts

- **Electricity:** Electricity is produced by the **flow of electrical charges**. It can also mean the energy you get when **electrons flow from place to place**.
- **Circuit:** A closed loop that electrons can travel in; switches act as "gates."

What we learned about Electronics in Workshop 3



KEEP IN MIND:

- LEDs are fussy little lamps that always like to receive the current in a particular way, so pay attention to the polarity. **LEDs like to be connected with their positive side towards the positive side of the battery!**
- Often **red** is used to designate **positive** and **black** to designate **negative** when using electronic components.
- If there is no LED in the circuit, electrons won't be happy when it comes back home (batteries). Then **it will smoke, even explode!** If it happens, break the circuit.

Moon Base Idea

- Basic: Living and Lab Area lighting
- Advanced: Fan, alarm system, sending Morse Code by using light...

Renewable Energy

Wind Turbines(Earth Model)

Principle: Wind spins blades → motor generates electricity → stored energy.

A wind turbine turns wind energy into electricity using the power of spinning blades and electromagnetism:

1) **Wind Turns the Blades:**

When the wind blows, it pushes against the turbine blades, causing them to spin. The shape and design of the blades help them capture as much wind energy as possible.

2) **Spinning the Shaft:**

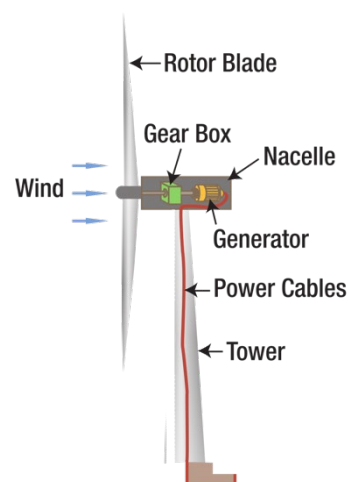
The blades are connected to a shaft inside the turbine. When the blades spin, the shaft spins too.

3) **Generating Electricity:**

The spinning shaft is connected to a **motor (or generator)**. Inside the motor, the movement of the shaft causes magnets to rotate near coils of wire. This creates an **electric current** through a process called **electromagnetic induction**.

4) **Powering Devices:**

The electricity generated can be used to power devices or stored for later use.



Moon Limitation: No Air!

Turn students' wind turbines into fans

Connect a circuit with batteries, switch and wind turbine base, then it becomes a fan! It might be useful in high temperature...

Energy Plant Alternative: Solar Power

Principle: Photovoltaic effect (light → electricity). Aluminum foil boosts reflection.

Check this video for more info: <https://www.youtube.com/watch?v=xKxrkht7CpY>

Moon Advantage: No clouds but must handle long nights.

Tips: Students are not required to really make a solar panel and make it work. They can use paper craft or other materials instead, just to show the idea. If you want to make a functioning solar panel, here is a instruction video:

<https://www.youtube.com/watch?v=uANLrzclJAA>