Solar Relay

Wisconsin's K-12 Energy Education Program (KEEP)
College of Natural Resources
University of Wisconsin-Stevens Point

Solar Relay

Modeling the movement of electrons through a solar cell

Esimated Time: 30 minutes
Age: 4th-12th grade

PARTICIPANTS SHOULD GAIN AN UNDERSTANDING OF

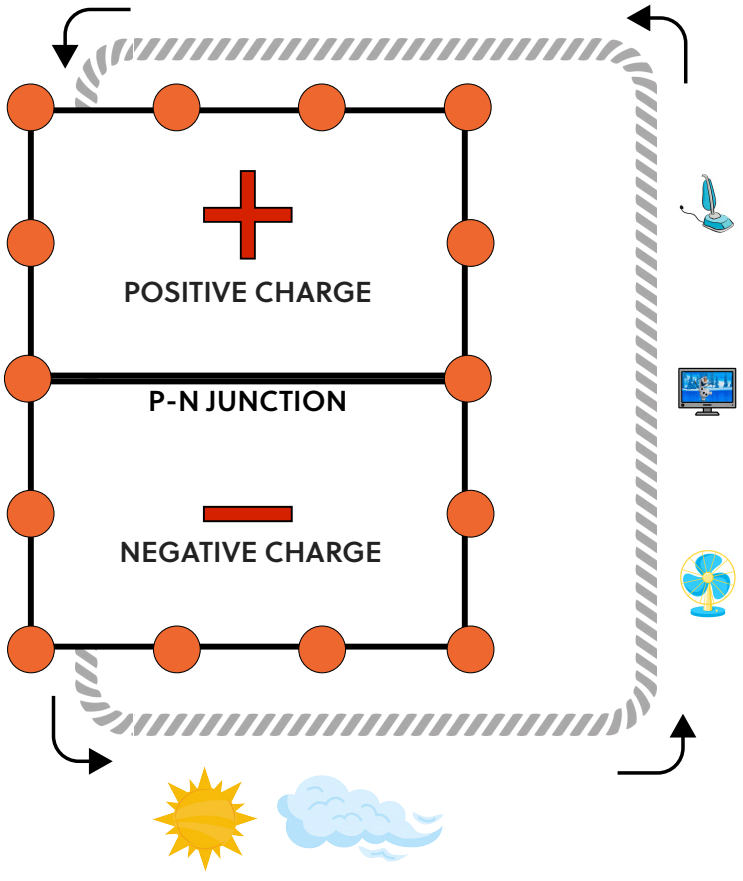
- How electrons move through a solar circuit to produce electricity

SUPPLIES

- Plastic cones or other space markers
- Rope
- Three space labels:
  - "+" and "Positive charge"
  - "-" and "Negative charge"
  - "P-N Junction"
- Pictures of solar panels, sun, cloud, appliances

ADVANCE SET-UP

- Mark off a portion of the ground with cones into two large rectangular areas, with enough space to hold all students
- Place the labels inside the rectangles
- Use the rope to make a path around the area, representing an electrical circuit



Solar Relay

Modeling the movement of electrons through a solar cell and circuit

INTRODUCTION: Electricity as a Form of Energy (10 min)

- Ask students what we use electricity for
  - Examples: lighting, tv, phone - get at least one with rechargeable batteries
  - Hint - describe the evidences of energy: heat, light, sound, and movement

- Ask students if they know how we get our electricity
  - 37% - Natural Gas
  - 36% - Coal
  - 16% - Nuclear
  - 11% - Renewables
    (Aug 2023 - WI Energy Profile, www.eia.gov)

- Types of energy
  - Renewable- energy from a source that is not depleted when used/will not run out
  - Non-renewable- energy from a source that is not replaced as fast as consumed and we only have a limited amount
  - Categorize types they brainstormed as renewable or non-renewable

- Why would people want to use renewable energy?
  - Save money
  - School example:
    - Average cost of electricity for a school could be $100,000/year
    - Even 1% of that is $1,000
    - Savings could create room in the budget for other items
  - Help the environment
  - Less habitat destruction (from mining)
  - Less air pollution
  - Energy stability (we will not run out)

- Ask if and where they have seen solar panels in their local community, while travelling, or show photos

- Ask students if anyone knows how solar panels produce electricity
  - In a coal or natural gas power plant:
    - Burning these fuels near water creates steam
    - Steam spins a turbine, which spins a generator
    - The spinning moves tiny particles called electrons along wires to produce electricity
  - In a solar panel:
    - Solar energy is changed to electrical energy
    - Electrons are excited by the sunlight and move along the wire

Solar Relay

Modeling the movement of electrons through a solar cell and circuit

ACTIVITY: Model electrons in a solar cell (15 min)

- Students will be playing the role of electrons in a solar cell and an electrical circuit.

- Show the students the area representing the solar panel:
  - The Positive layer
  - The Negative layer
  - The Positive-Negative (p-n junction)

- Tell students the junction acts like a one-way door through which electrons can pass from the positive layer into the negative layer, **but not the other way!**

- Student Roles:
  - Electrons standing in the positive layer
  - Electrons standing in the negative layer
  - Optional: add barrier of students along the p-n junction who prevent electrons from passing the wrong way
  - The Sun - Stand facing the negative layer
  - The Cloud - Stand next to the sun
  - Appliances - Stand next to the rope (space out)
  - Remaining students play electrons evenly spaced along the rope (electrical wire/circuit)

- When everyone is positioned, start the simulation:
  - The Sun "shines" on the solar cell
  - Electrons in the solar cell begin moving and wiggling around
  - Walk and wiggle until they reach the edge of their layer, then turn and walk in a different direction until they reach the next edge
  - Electrons in the positive layer eventually move, one by one, into the negative layer.
  - The p-n junction allows electrons to pass into the negative layer but prevents wiggly electrons in the negative layer from moving back (with optional barrier students)
  - The only place for the electrons in the negative layer to go is into the wire
  - Have one electron enter the wire
  - Electron students along the wire move forward along the wire back toward the positive layer.

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ACTIVITY CONTINUED: Model electrons in a solar cell (15 min)

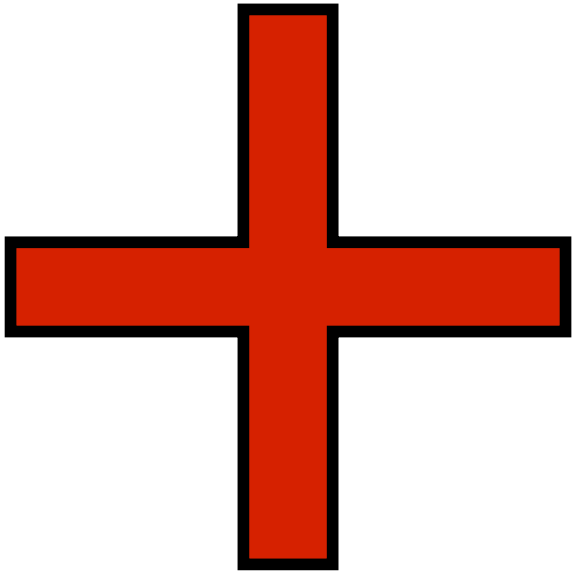
- Appliances turn on when electrons are moving.
  - Encourage students to do the motions/sounds of the devices!
  - Appliances stay on as long as the sun is shining
  - Electrons give appliances a high-five as they pass to simulate energy transfer
- When an electron enters the wire, an electron at the other end of the wire can step into the postive layer
- After an electron enters the positive layer from the wire, the student should move and wiggle until it is their turn to enter the negative layer
- With practice, the electrons should cyclically move from the positive layer, into the negative layer, through the wire, and back to the positive layer, completing the circuit
- Change the flow of the electrons by having the sun "set" or get blocked by the cloud
- Ask students what would happen to the electron flow (slows or stops)

DISCUSSION (5 min)

- Reflect on why solar panels are a renewable source of energy:
  - Will we ever run out of the sun?
  - Are there any waste products of solar energy?
- Describe potential drawbacks of solar PV:
  - Solar energy is not always available (such as at night)
  - It is not consistently sunny everywhere
  - It might be difficult to get solar panels
  - Requires large initial investment

WRAP-UP AND EXTENTION IDEAS

- Have students describe how a solar cell produces electricity using introduced vocabulary
- Using objects with solar cells (calculators, toys, outdoor lights), students can describe the energy transfer from solar to electric to kinetic or electromagnetic energy (light)
- Visit a location with solar panels
- Check out either the Solar Tilt Kit or the Solar Load Kit for FREE from KEEP:
  - Connect a solar panel to a multimeter to measure how much electricity is produced
  - Investigate the effect that tilt has on solar electricity production
  - Measure the effect of shading on electricity production
  - Measure how much solar energy is needed to run small appliances
- Renewable energy lessons and activities from KEEP

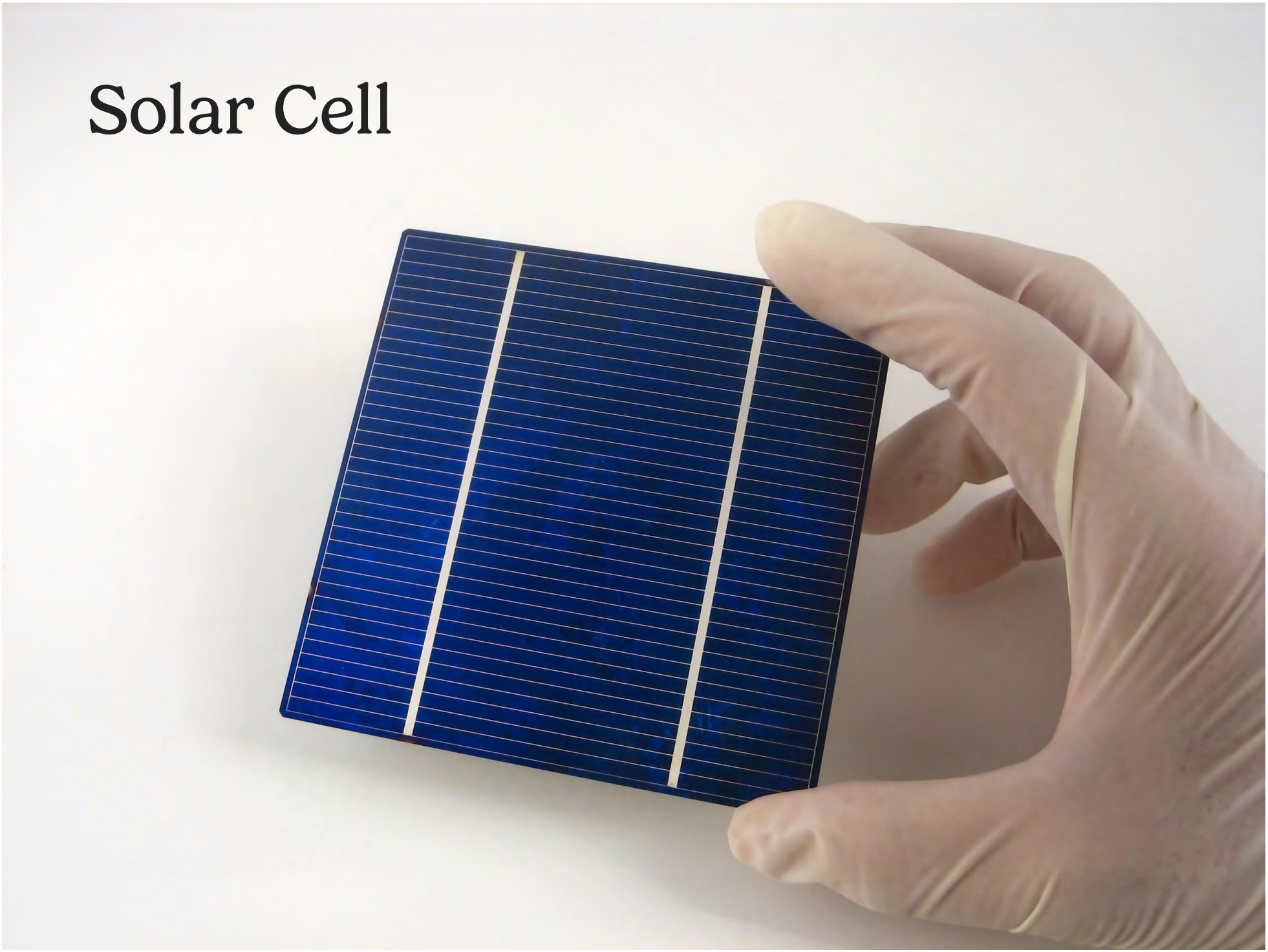


POSITIVE CHARGE

NEGATIVE CHARGE

P-N JUNCTION

Solar Cell



Installers Carrying a Solar Panel

Many Solar Panels Make a Solar Array