County Implementation Award Program (CIAP) Math and Science Lesson

Unit Title:
Energy-Grade 4

Lesson Title:
Lights! Camera! Action! Energy Conversions

Author:
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Grade Level:
4

Time Frame:
3-60 minutes sessions

Targeted Standard(s):
NGSS-4-PS3-4-Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.
Math 4.NBT 4-Fluently add and subtract multi-digit whole numbers using the standard algorithm.
6.PS.5.C. Giving quantitative measures of center (median and/or mean) and variability, as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered.

Targeted Phenomenon: Have students observe a solar powered toy as it moves. Ask them to record what they notice and wonder.

The photovoltaic cell in a solar powered toy, when exposed to light, will begin a series of energy conversions that will result in the motion of the toy.

Three Dimensions of NGSS

Science & Engineering Practice/s (SEP):
Constructing Explanations and Designing Solutions
Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to the use of evidence in constructing explanations that specify variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Apply scientific ideas to solve design problems. (4-PS3-4)

Crosscutting Concept/s (CCC):

Energy and Matter

§ Energy can be transferred in various ways and between objects. (4-PS3-1), (4-PS3-2), (4-PS3-3), (4-PS3-4)

Connections to Engineering, Technology, and Applications of Science

Influence of Engineering, Technology, and Science on Society and the Natural World

§ Engineers improve existing technologies or develop new ones. (4-PS3-4)

Connections to Nature of Science

Science is a Human Endeavor

§ Most scientists and engineers work in teams. (4-PS3-4)

Science affects everyday life. (4-PS3-4) Cause and Effect, Energy and Matter, Interdependence of Science, Engineering, and Technology

Disciplinary Core Idea/s (DCI):

PS3.A: Definitions of Energy PS3.B: Conservation of Energy and Energy Transfer PS3.C: Relationship Between Energy and Forces ETS1.A: Defining Engineering Problems

§ Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2), (4-PS3-4)

Language Supports:

Component labels with definitions, photos of components, diagram of energy conversions

Materials Needed:

Solar powered toys ($1 store), flathead screwdrivers, science notebook, pencil, colored pencils, electrical tape, stopwatches, poster board for each team, markers

Objective(s): Students will be able to:

1. Take apart the solar powered toy, examine the components, and explain how the energy is converted from solar energy to kinetic energy.
2. Observe and record how long the solar powered toy continues to move without a light source and find the average time it takes to stop movement.
3. Draw a “Rube Goldberg” type machine that shows at least three energy conversions.

How Math and Science concepts/skills/practices were integrated in this lesson:

Students come to an understanding of energy conversions as well as potential energy in the math portion of this lesson as they will discover that the solar powered toy continues to move without a light source.

Possible Challenges /Misconceptions:

Students aren’t familiar with the different types of energy. Students get components’ functions confused. Students don’t understand the path that the energy follows. Students have difficulty taking apart the solar powered toy. Students’ diagram of Rube Goldberg machine doesn’t have proper energy conversions.

Formative Assessment:

Science notebook entries, individual/team/whole class discussions, science talks

Lesson Opening	
Teacher Actions	**Student Actions**

Session 1: Show pictures of solar panels on homes. Show them a solar powered toy. Ask, "How do you think this solar powered toy works?" Write student responses on chart paper. **Session 2:** Show the students a solar powered toy that is moving. Ask, "What do you think will happen when I turn off the lights?" Write their responses on chart paper. **Session 3:** Show the students a video of a Rube Goldberg type machine. Ask, "What energy conversions did you notice in this video?" Record the students' responses on chart paper.	**Session 1:** Students write in their science notebook how they think a solar powered toy works and share with their team. **Session 2:** Students talk to their team about what they think will happen when the lights are turned off. **Session 3:** Students watch the Rube Goldberg type machine video. Students discuss with their team what energy conversions they noticed in the video and share with the class.
Lesson Introduction	
Teacher Actions	**Student Actions**
Session 1: Say, "You will take apart a solar powered toy and observe the inside components. Discuss with your team the energy conversions that take place in the toy to make it move." Review the different types of energy and give examples of energy conversions. (Example: electrical energy to light energy) Give each team a solar powered toy, screwdriver, goggles, and gloves. **Session 2:** Say, "We are going to do an investigation to see what happens when we cover the solar panel on a solar powered toy. Write in your science journal what you think will happen, then share with your team what you think will happen." **Session 3:** Say, "Your team has a challenge today. Draw a "Rube Goldberg machine" diagram that includes at least three energy conversions that completes a task." Brainstorm some ideas for tasks that their machine could complete.	**Session 1:** Students take apart the solar powered toy using the screwdriver and any way they can figure out to take it apart. They discuss with their team members what energy conversions are involved in the toy to make it move. **Session 2:** Students write in their science notebook what they think will happen if the solar panel is covered. They share with their team what they think. **Session 3:** Students brainstorm ideas for tasks their machine could complete using at least three energy conversions. Each team decides on a task for their machine to complete.
Body of Lesson	
Teacher Actions	**Student Actions**
Session 1: Walk around to the different teams and ask questions such as, "What do you think this component does?" "What type of energy conversions do you think are happening in the toy to make it move?" "What is the path that the energy takes?" **Session 2:** Set a solar powered toy in the middle of each team's table and instruct them not to move it. Give each team a piece of electrical tape. Say, "We will observe the solar powered toy for a	**Session 1:** Students discuss with their team members what types of energy conversions are happening in the toy to make it move, the path the energy takes, and what the different components' functions are. **Session 2:** Students observe the solar powered toy while it is moving. One team member places the electrical tape over the solar panel without moving the toy while another team member

few minutes. After a few minutes we will place the electrical tape over the solar panel without moving the toy and start the stopwatch. Observe the toy and record the time when the toy stops moving." **Session 3:** Provide students with pictures of possible parts of their machine such as a switch, iron, light bulb, bicycle, horn, etc., as well as show them examples of Rube Goldberg machines.	starts the stopwatch. Students record the time it takes to stop moving in their science notebook. **Session 3:** Students get ideas from looking at pictures/videos of Rube Goldberg machines and draw the parts of their machine and put it together on a poster board. Each student could be given a piece of the machine to design and then put it together on the poster board.
Lesson Closure	
Teacher Actions **Session 1:** Say, "Now you will make a model by drawing the inside components of the solar powered toy, attach the labels, and explain in writing how the energy is converted in the toy to make it move. **Session 2:** Ask each team to give you the time it took for the toy to stop moving. Record it on a chart. Say, "We will find the average time it takes for a solar powered toy to stop moving." Teach the students how to find the average by adding up all the numbers, then divide by how many numbers there are. You will need to teach them where the decimal point goes as well. Ask, "Why do you think the solar powered toy kept moving after the solar panel was covered?" **Session 3:** Say, "Each team will present their machine to the class. First tell us what task is to be completed by the machine. Explain the energy conversions in your machine from start to finish. When you are done with your presentation, the audience will have the opportunity to ask questions or give a comment."	**Student Actions** **Session 1:** Students draw a model in their science notebook explaining the energy conversions that make the solar powered toy move. **Session 2:** Students add the numbers of all teams and divide by the number of teams to find the average. They record this in their science notebook. Students discuss in their team why they think the toy kept moving after the solar panel was covered. Students write in their notebook why they think the toy kept moving when the solar panel was covered. **Session 3:** Students present their energy conversion machine diagram to the class. Students respond to questions and comments.
Summative Assessment: Students draw a "Rube Goldberg" type machine that uses at least three energy conversions. Each form of energy is labeled and uses arrows to show the path the energy is following. The task is shown completed.	
Other Teaching Resources:	
Lab Safety: Goggles and gloves while taking apart the solar powered toy	

Extensions (if any):
Art: Students take apart the cosmetic parts of solar powered toy and create something new using items such as feathers, googly eyes, felt, fabric, beads, etc.

Component Labels

capacitor: two-terminal electrical component used to temporarily store electrical energy

electrical board: backboard for holding wires close to each other

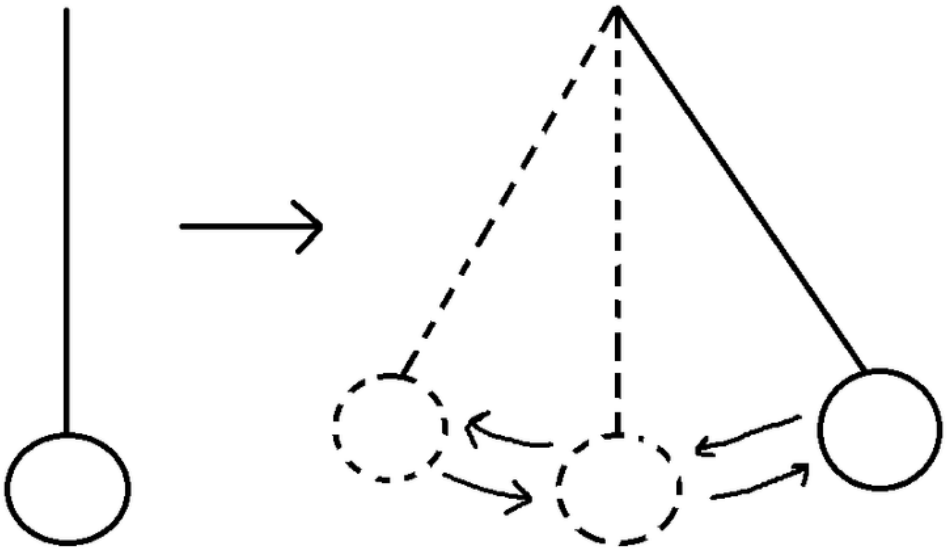
magnet: attracted to a magnetic field causing the moving of the level arm to which it is attached

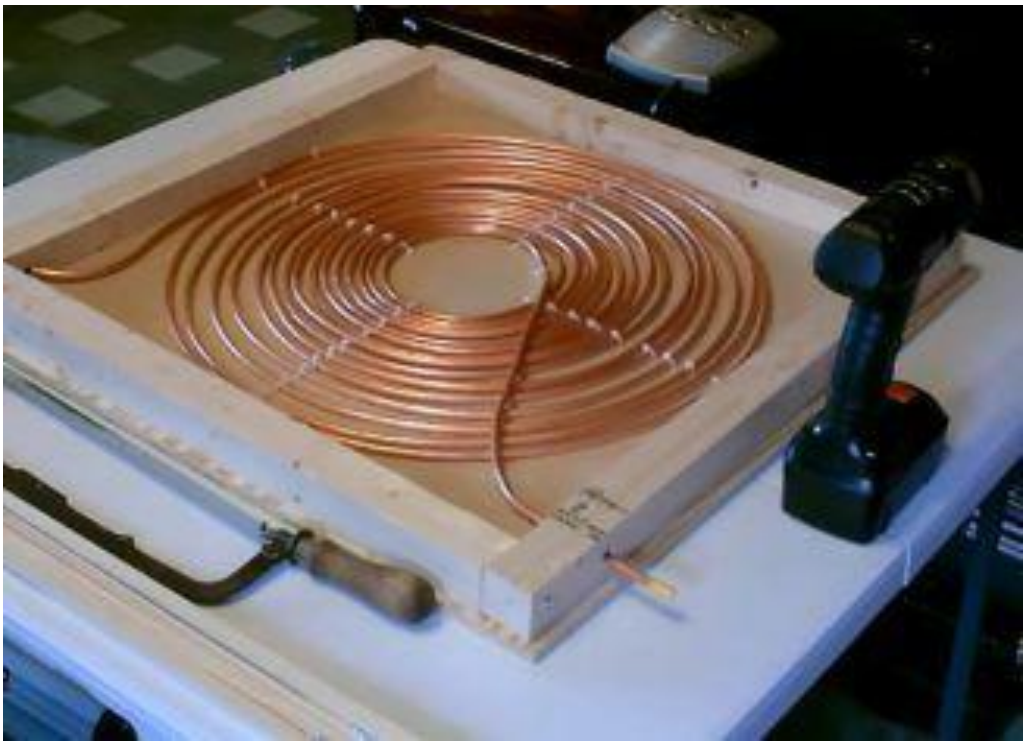
pendulum: weight suspended from a pivot so that it can swing freely

photovoltaic (PV) cell: device that converts energy from light directly into electricity

voice coil: provides a conduit for electrical energy: a magnetic field is generated along its axis

Solano County Office of Education





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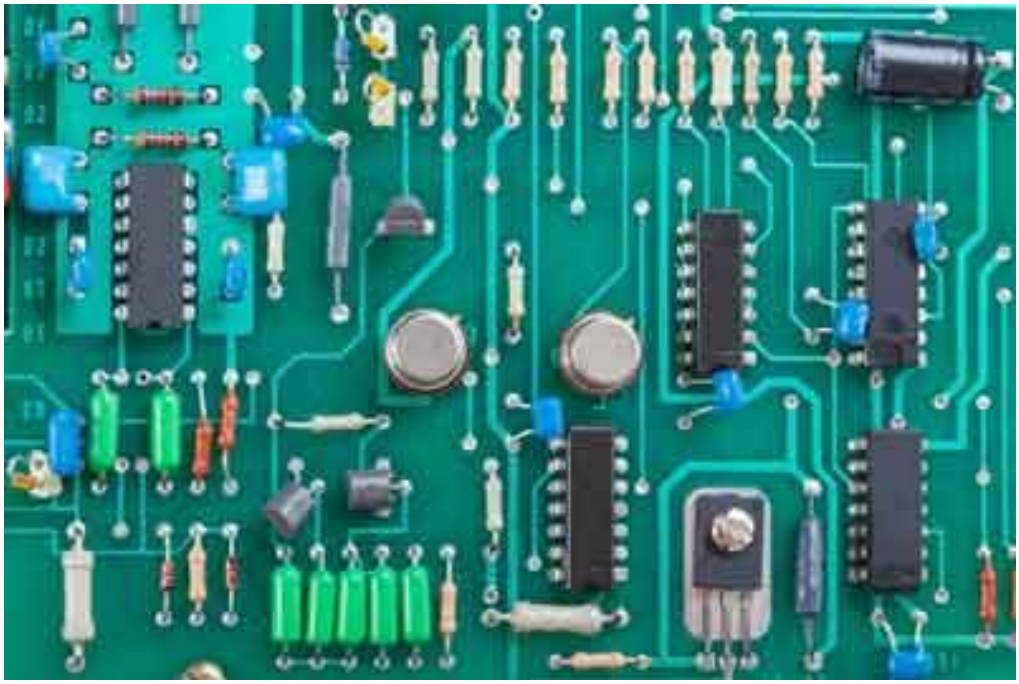

Name_____ Date_____

Lights! Camera! Action!

If we cover the PV cell in the solar powered toy then

_____

_____

Record time it takes for solar powered toy to stop moving.

Team 1	
Team 2	
Team 3	
Team 4	
Team 5	
Team 6	
Team 7	
Team 8	
Total Time	

Divide the sum of the numbers by how many numbers there are. This will give you the mean. The mean is the average of the numbers.

I think the solar powered toy kept moving after we covered the PV cell because

_____

_____

_____

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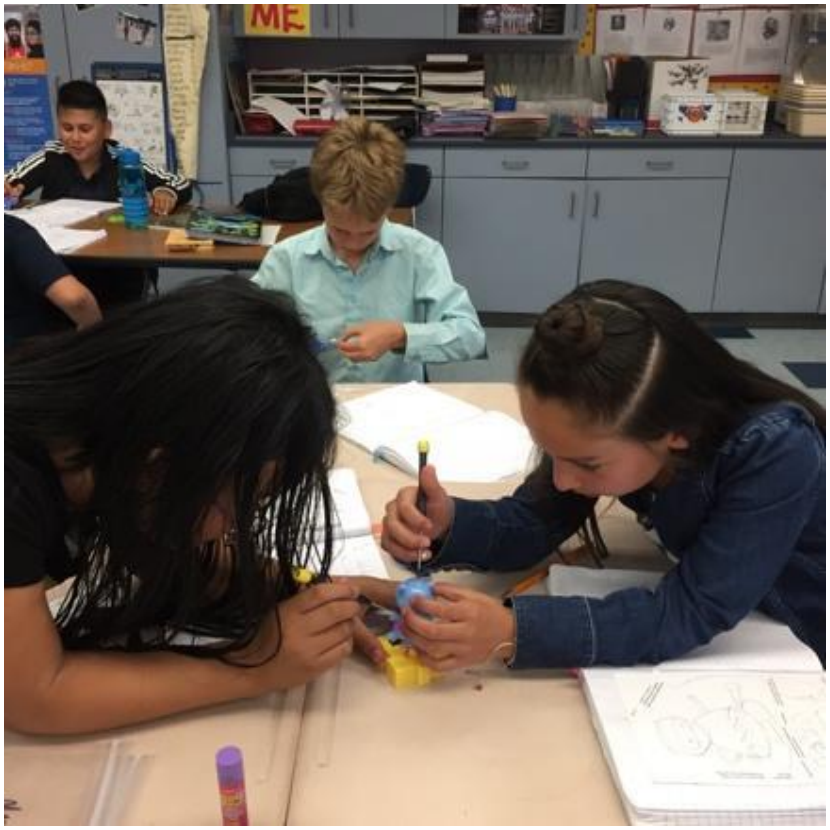

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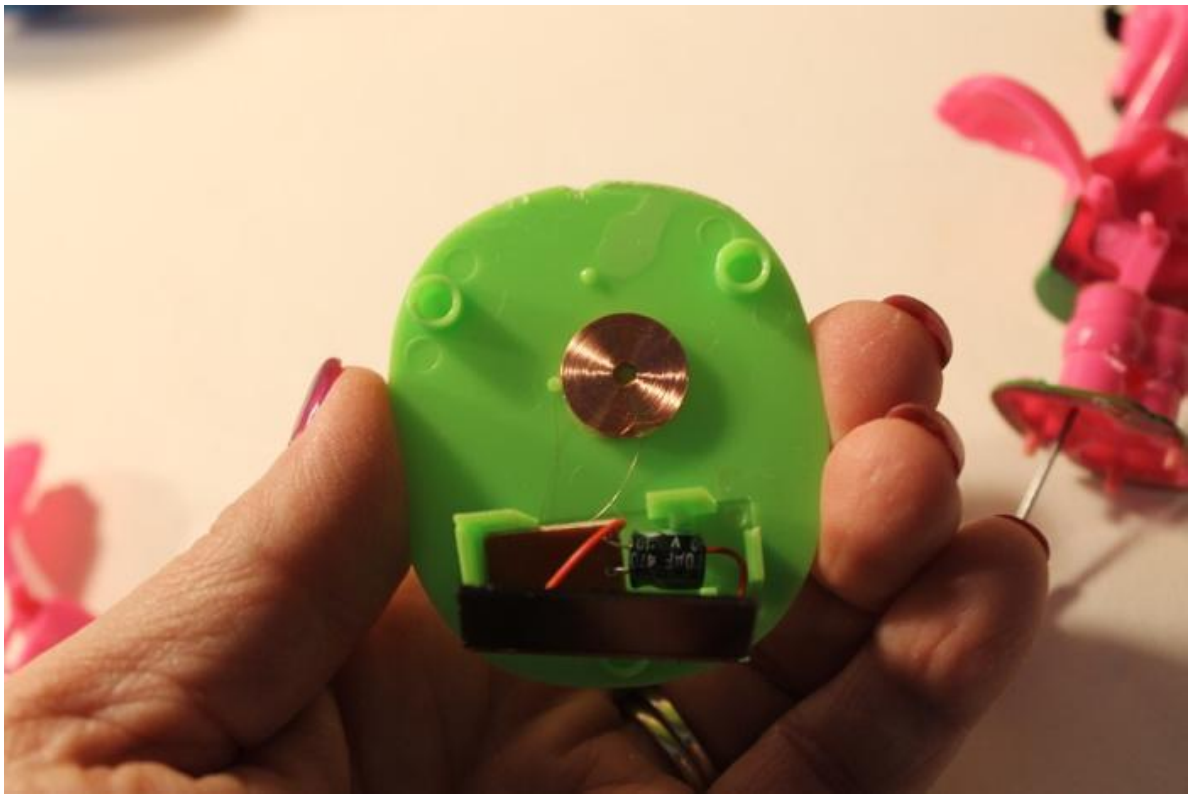
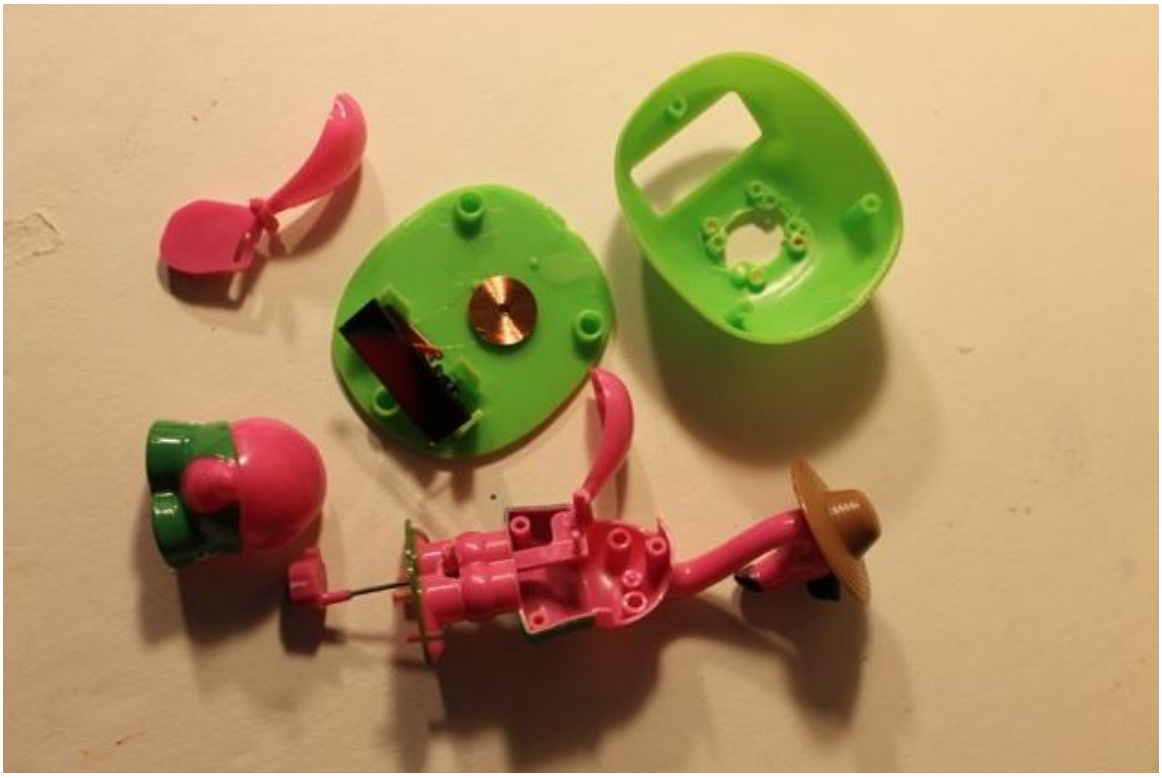




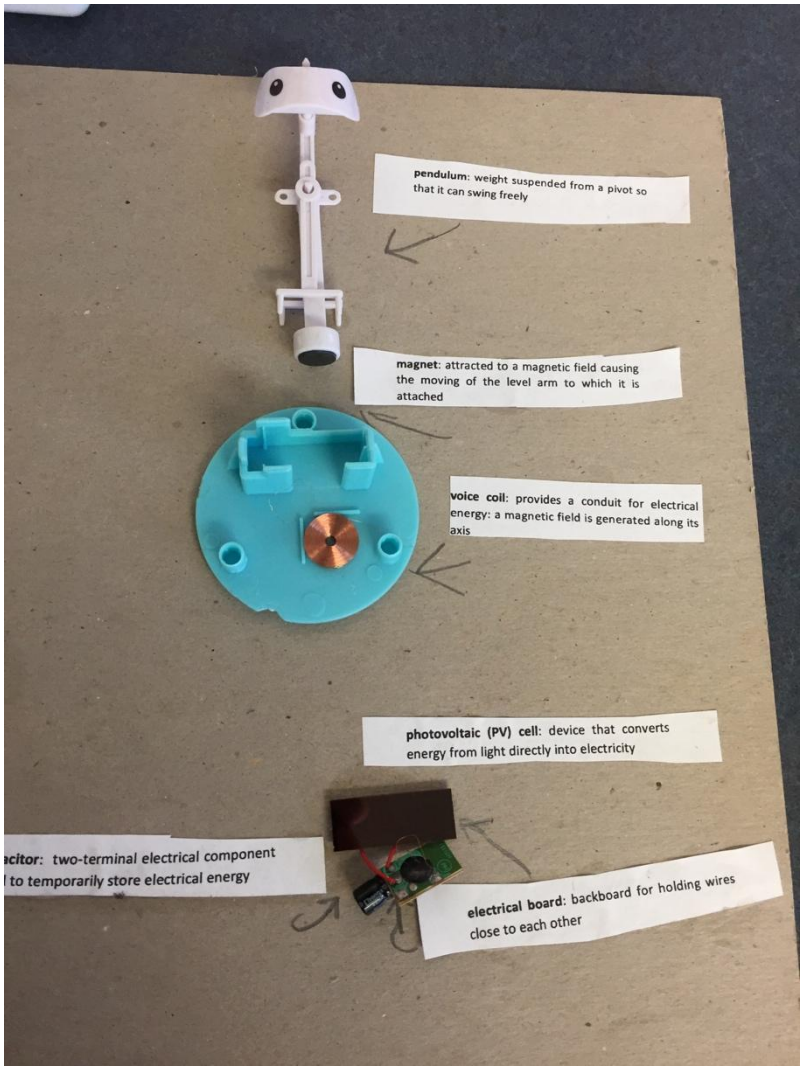
Learning Objective:

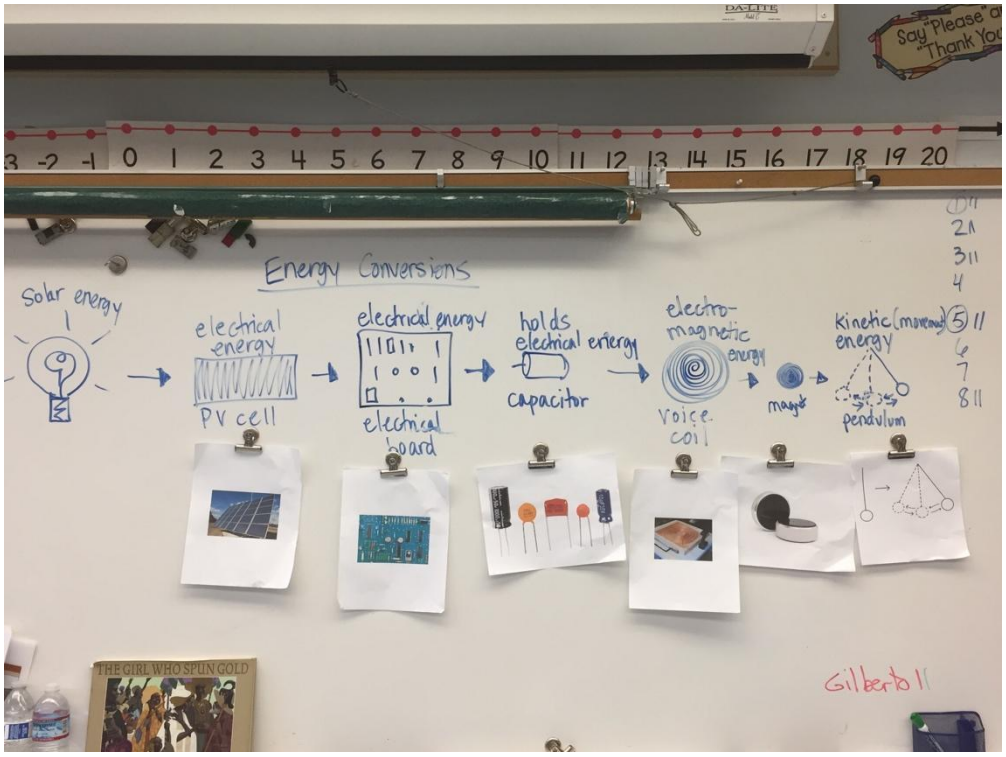
We will take apart a solar powered toy, examine the components, and explain how the energy is converted from solar energy to kinetic (movement) energy.

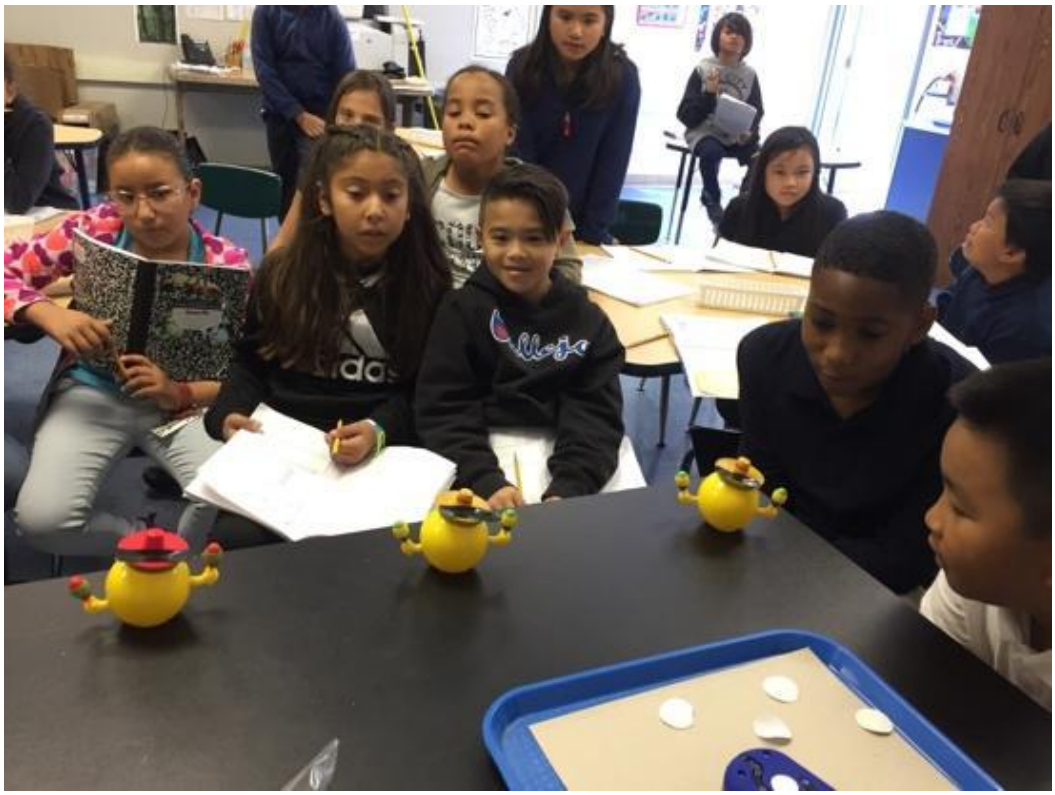
Energy Conversions

I think a solar powered toy works by _____

movement absorbing the heat. heat energy.
electricity


pendulum: weight suspended from a pivot so that it can swing freely
magnet: attracted to a magnetic field causing the moving of the level arm to which it is attached
voice coil: provides a conduit for electrical energy: a magnetic field is generated along its axis
photovoltaic (PV) cell: device that converts energy from light directly into electricity
electrical board: backboard for holding wires close to each other


Energy Conversions
Solar energy
electrical energy
PV cell
electrical energy
electrical board
holds electrical energy
capacitor
electro-magnetic energy
voice coil
magnet
Kinetic (movement) energy
pendulum
THE GIRL WHO SPUN GOLD
Gilberto 11



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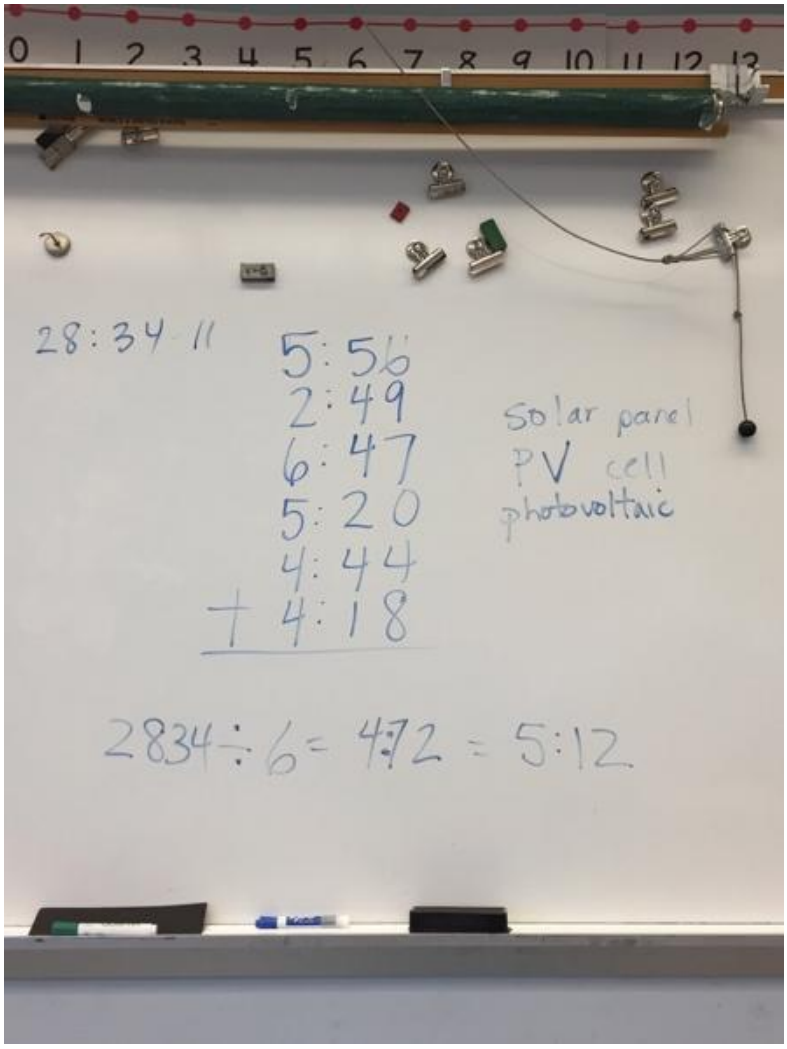
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5:56
2:49
6:47
5:20
4:44
+ 4:18
Solar panel
PV cell
photovoltaic
2834 ÷ 6 = 472 = 5:12