4th Grade
Energy Transfer

Teaching the Science and Engineering Education (SEEd) Standards

UVU College of Engineering & Technology
UTAH VALLEY UNIVERSITY

UVU CREATIVE LEARNING STUDIO

UVU School of Education
UTAH VALLEY UNIVERSITY

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SEEd Strand 4.2: Energy Transfer

Energy is present whenever there are moving objects, sound, light, or heat. The faster a given object is moving, the more energy it possesses. When objects collide, energy can be transferred from one object to another causing the objects' motions to change. Energy can also be transferred from place to place by electrical currents, heat, sound, or light. Devices can be designed to convert energy from one form to another.

Standard 4.2.1 Construct an explanation to describe the cause and effect relationship between the speed of an object and the energy of that object. Emphasize using qualitative descriptions of the relationship between speed and energy like fast, slow, strong, or weak. An example could include a ball that is kicked hard has more energy and travels a greater distance than a ball that is kicked softly. (PS3.A)

Standard 4.2.2 Ask questions and make observations about the changes in energy that occur when objects collide. Emphasize that energy is transferred when objects collide and may be converted to different forms of energy. Examples could include changes in speed when one moving ball collides with another or the transfer of energy when a toy car hits a wall. (PS3.B, PS3.C)

Standard 4.2.3 Plan and carry out an investigation to gather evidence from observations that energy can be transferred from place to place by sound, light, heat, and electrical currents. Examples could include sound causing objects to vibrate and electric currents being used to produce motion or light. (PS3.A, PS3.B)

Standard 4.2.4 Design a device that converts energy from one form to another. *Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data from testing solutions, and propose modifications for optimizing a solution.* Emphasize identifying the initial and final forms of energy. Examples could include solar ovens that convert light energy to heat energy or a simple alarm system that converts motion energy into sound energy. (PS3.B, PS3.D, ETS1.A, ETS1.B, ETS1.C)

4.2.1: Sail Cars

Grade: 4th

Lesson Topic: Energy

Utah SEEd Standard:
Standard 4.2.1 Construct an explanation to describe the cause and effect relationship between the speed of an object and the energy of that object. Emphasize using qualitative descriptions of the relationship between speed and energy like fast, slow, strong, or weak. An example could include a ball that is kicked hard has more energy and travels a greater distance than a ball that is kicked softly. (PS3.A)

Lesson Performance Expectations:

- Students design and build a sail car to gather data on how changing the energy affects the car's motion.
- Students construct an explanation to describe why Changing the energy put into the sail cars affects the speed and the energy of that object.

Phenomenon: *When the wind blows I can hear the wind chimes.*

Video

Ask students to share what they observed? What did they see/ hear?

Gather

1. Students explore using their air to power the sail cars.
2. Students build a car to carry out an investigation on how changing the energy affects how fast the car goes.

Reason

3. Students analyze data from their investigation to find patterns to use as evidence that energy causes things to move.
4. Students discuss their findings related to energy.

Class Discussion:
Questions to initiate Discussion:

Q: How does having more wind affect the energy in the sail car? *Q: How do you know when an object has more energy?* *Q: What caused the sail car to move faster/slower?* *Q: What would happen if you took the car outside on a windy day/ calm day?* *Q: Why does the Sail car slow down or even stop after a while?* *Q: Where did the energy come from?* *Q: How does the energy change with different materials? (blow dryer, mouth)*
Communicate Reasoning 5. Students construct an explanation to describe why Changing the energy put into the sail cars affects the speed and the energy of that object.

Science and Engineering Practices Planning and carrying out an investigation Constructing Explanations and Designing Solutions	Plan and carry out investigations that generate evidence. Explain observations using evidence from investigation. Design solutions to get sail cars to move faster
Crosscutting Concepts Energy and matter Patterns Cause and affect	Use models or drawings to describe the transfer of energy Explain that changes in energy cause different effects Observe patterns in the investigation
Disciplinary Core Ideas Energy	Describe the cause and effect relationship between the speed of an object and the energy of that object. Putting more energy into a system will result in more energy being transferred out of the system.

Appendix A - Student Prompts for the Lesson

Phenomenon: When the wind blows I can hear the wind chimes.

Group Performances:

1. Students explore using their air to power the sail cars.
2. Students build a car to carry out an investigation on how changing the energy affects how fast the car goes.
3. Students analyze data from their investigation to find patterns to use as evidence that energy causes things to move.

Class Discussion

4. Students discuss their findings related to energy.

Individual Performances:

5. Students construct an explanation to describe why changing the energy put into the sail cars affects the speed and the energy of that object.

Lesson Steps:

1. *Introduce the lesson by talking about energy and energy transfer and their definitions. Then discuss the phenomenon video about wind chimes. (Vocabulary terms-- Energy: ability to do work, Energy Transfer: Movement of energy from one location to another, wind energy - energy powered by wind, renewable energy - Energy that comes from Earth's natural resources that do not run out) Be sure to mention that engineers study energy transfer.*
    a. *Suggestion: To make this lesson more relevant to the students you can give them a problem solving scenario to go with it. (E.g. You are stranded in a windy area of Antarctica and you only have one more day of food and water. Walking to the ship that brought you there will take you 10 days. Can you find a way using the following supplies to get you there faster?)*
2. *Students will then be put into groups to conduct and experiment using the sail cars and various forms of wind energy. Together they will discover that the faster the speed or stronger a force is the more energy it has.*
    a. *Demonstrate how to build the cars. Use the Sail Car Procedure card for step by step instructions. You can also see this video How to Build a Sail Car Video for instructions. (Have materials ready in sets to make teaching go faster).*
    b. *You can then provide the hand fans and hair dryers as sources of wind for students to use in their experiment. They can also experiment with blowing on the car. Hint: The angel you hold the hair dryer can affect how/if the car moves. Make sure students treat material with respect, and are used properly.*
    c. *After running several tests, have students revisit their sail type/shape and redesign it to see the changes.*
3. *After the investigation, have the class discussion to talk about their findings. For questions to initiate this discussion, see the "Reason" section above.*
4. *After the discussion, have students construct a written explanation for what worked well and what did not. Also for how the wind made the car move.*

Appendix B -

Sail Car Procedure card

How to Build Sail Car Video

Materials:

Provided materials:

- Sail car
- Blow dryer
- Foldable hand fan

Classroom materials:

- Tape
- ½ sheets of card stock Paper or other sturdy materials
- ½ Sheets of printer paper /notebook paper
- Scissors

4.2.2 Solar Powered Cars

Grade: 4th

Lesson Topic: Energy Transfer

Utah SEEd Standard:
Standard 4.2.2 Plan and carry out an investigation to gather evidence from observations that energy can be transferred from place to place by sound, light, heat, and electrical currents. Examples could include sound causing objects to vibrate and electric currents being used to produce motion or light. (PS3.A, PS3.B)

Lesson Performance Expectations:

- Students will develop a model to show the transfer and transformation of energy in the solar car system.
- Students can construct an explanation for how energy is transferred and transformed into the system of the solar car.

Phenomenon: **Candle Car***: What causes the car to move?*

Gather

1. Students investigate ways to gather evidence to support an explanation for how energy is transferred and transformed into the system of the solar car.

Class Discussion: - Discuss good question to investigate the energy

2. Use the questions to obtain information for how the solar car changes light energy into mechanical energy.

Reason

1. Develop a model to show the transfer and transformation of energy in the system of the solar car.
2. Construct an explanation for how energy is transferred and transformed into the system of the solar car.

Class Discussion:

Questions to initiate class discussion:

Q: How does energy move from the solar panel to the wheels of the car?
Q: Why does the brightness of the light source affect the speed of the car?
Q: How is the transfer of energy different from the transformation of energy?
Q: Why is it helpful to think of the solar car as a system?

Communicate Reasoning

1. Use your group's model to support a written explanation for how energy is transferred and transformed by the system of the solar car.

(Teaching Suggestion: Have students refer back to their model as they write a written explanation for how energy is transferred in the solar car.)

Science and Engineering Practices Developing and Asking Questions Using Models	Ask questions that require relevant empirical evidence. Develop a model to describe unobservable mechanisms.
Crosscutting Concepts Systems and System Models Energy	Models can be used to represent systems and their interactions—such as inputs, processes, and outputs—and energy and matter flows within systems. Energy is conserved.
Disciplinary Core Ideas Definitions of Energy Transfer of Energy	When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. Energy can be transformed or transferred but is always conserved.

Appendix A - Student Prompts for the Lesson

Phenomenon: Candle Car

Group Performances:

1. Students investigate ways to gather evidence to support an explanation for how energy is transferred and transformed into the system of the solar car.

Class Discussion: Good Questions to use

Group Performances:

2. Use the questions to obtain information for how the solar car changes light energy into mechanical energy.
3. Develop a model to show the transfer and transformation of energy in the system of the solar car.
4. *Construct an explanation for how energy is transferred and transformed into the system of the solar car.*

Class Discussion

Individual Performances:

5. Use your group's model to support a written explanation for how energy is transferred and transformed by the system of the solar car.

Lesson Steps:

1. *Start the lesson by showing the phenomenon video. Ask students to share their observations after watching. Emphasize that engineers work with different kinds of renewable energy so that they can help protect the environment. Go over vocab words-*
    a. ***Energy:*** *Ability to do work*
    b. ***Energy Transfer:*** *movement of energy from one location to another. Ex. electricity, moves through wall plug, through a charger, to a battery*
    c. ***Energy transformation:*** *Energy changes from one form to another. Ex. hydroelectric dam, kinetic energy of water into electrical energy, body converts food to energy.*
    d. ***Solar Energy****: energy that comes from the sun.*
    e. ***Renewable Energy****: Energy that comes from earth's natural resources that do not run out.*
2. *Students will work in pairs to build their own solar powered cars.*
    a. *After being given the car pieces, each person in the group explores the solar car and writes one question on a 3 X 5 card or sticky note that they wonder about the car (how it works, etc). Emphasize energy transfer and transformation to guide their questions in this direction. Take some time for a class discussion about good questions to obtain information.*
    b. *Students will work together to build their solar cars (INSTRUCTIONS TO COME)*
3. *When students are finished building their cars they will take them outside (or use the lamps if there's not enough light outside) and test them.*
4. *Have a class discussion talking about what students' observed. Be sure to focus students on how energy flows into and out of this system(Solar car). Be sure to discuss the idea that energy is conserved. - Energy is not created or destroyed. - This is an idea that engineers work with. Questions to initiate this discussion can be found above in the "Reason" section.*
5. *After having the class discussion, have each group create a written explanation for what*

is happening in the car system (Where is the energy coming from? What is it doing in the system? Why did the car work, when it didn't? etc.)

***Appendix B**:*
Phenomenon Video: **Candle Car**
Energy Conversion Explanation.
Solar Cars Procedures

Materials:

Provided materials:

- Solar cars

Classroom Materials:

- 3x5 cards or sticky notes

4.2.3 Collisions with Sports Balls

Grade: 4th

Lesson Topic: Energy in Collisions

Utah SEEd Standard:

Standard 4.2.3 Ask questions and make observations about the changes in energy that occur when objects collide. Emphasize that energy is transferred when objects collide and may be converted to different forms of energy. Examples could include changes in speed when one moving ball collides with another or the transfer of energy when a toy car hits a wall.

Lesson Performance Expectations:

- Students Investigate how the speed of an object affects the size of a collision.
- Students will Construct an explanation for how the speed of a moving object affects the amount of energy transferred to another object in a collision.

Phenomenon: *When playing a game of pool, your first shot of the game is called a "break" where the colored pool balls previously racked together in a stationary position on the table, collide with a cue ball sending them all over the table.* *Pool ball break*

Gather

1. Students will use computational thinking as they evaluate and obtain information for how energy is transferred from objects in collisions.
2. Students plan an investigation to measure how the speed of an object affects the amount of energy transferred from one object to the next in collisions.

(Teaching Suggestions:. After that they will then be able to explore what is happening in the videos through their own investigation. Students will be in groups. they will pick two objects to use. One needs to roll (balls, toy car, bouncy balls...etc.) They will then have them collide fast and slow as they record their observations. Make observations of what you see the pool balls doing, and ask- What changed? What caused the colored pool balls to speed across the table in all different directions?
(Find images In 4th grade Seed Book. Link below)

Reason

3. Students analyze data to find patterns in how the speed of an object affects the amount of energy it transfers to another object.
4. Students will obtain information about colliding objects to help them develop a model to explain how energy is transferred during collisions.
5. Students develop a model to show how energy is transferred when one object collides with another.

Class Discussion:
Questions to initiate Discussion:
Q: How did energy transfer in your investigation?
Q: How do you cause objects to have more or less energy?
Q: What variable did you change in your investigation? Did it make a difference?
Q: What causes a moving object to move another object?
Q: What type of energy caused the largest/ smallest collision?
Q: What are other examples of collisions that transfer energy? changes in the system …..
Q: Why does the input of energy cause different outcomes?
Q: What patterns did you see in the data?

(Teaching Suggestions: Students will analyze their data, and share their findings through a group discussion. Have students read the following Collision article to help them better create a model to demonstrate collisions (you can watch a video but you will need an account to watch the whole video). Focus some of the discussion on the idea that the energy is transferred. Most of the discussion should be to get students to begin to say that the faster the object is moving the more energy that is transferred. Create a model together as a class for students to refer back to later if needed. You can also have students write on sticky notes other examples of collisions that transfer energy to put on the board.)

Communicate Reasoning

6. Students will Construct an explanation for how the speed of a moving object affects the amount of energy transferred to another object in a collision.

(Teaching Suggestions: Have students refer back to the model if needed. Instruct them to draw pictures and label things to add to their explanation.)

Science and Engineering Practices	Ask questions about what you are observing. Use computational thinking as they evaluate information Conduct and investigation to gather and analyze data
Asking Questions using computational thinking Carrying out investigations	
Crosscutting Concepts	Describe the transfer of energy in collisions Energy transferred from one object to another object can cause changes.
Energy transfer	
Disciplinary Core Ideas	When objects collide, energy can be transferred from one object to another changing the object's motion.
Transfer of energy in collisions	

Appendix A - Student Prompts for the Lesson

Phenomenon: *When playing a game of pool, your first shot of the game is called a "break" where the colored pool balls, that were previously racked together in a stationary position on the table, collide with a cue ball sending them all over the table.*

Group Performances:

1. Students will use computational thinking as they evaluate and obtain information for how energy is transferred from objects in collisions.
2. Students plan an investigation to measure how the speed of an object affects the amount of energy transferred from one object to the next in collisions.
3. Students analyze data to find patterns in how the speed of an object affects the amount of energy it transfers to another object.
4. Students develop a model to show how energy is transferred when one object collides with another.

Class Discussion

Individual Performances:

5. Students will obtain information about colliding objects to help them develop a model to explain how energy is transferred during collisions.
6. Students will Construct an explanation for how the speed of a moving object affects the amount of energy transferred to another object in a collision.

Lesson Steps:

1. *Watch the phenomenon video about pool, and discuss the statement. Emphasize that engineers test collisions of objects (cars, trains, etc.) to know how much damage would occur to objects at given speeds, etc. Review the vocabulary:*
    a. ***Energy:*** *Ability to do work*
    b. ***Energy Transfer:*** *movement of energy from one location to another. Ex. electricity, moves through wall plug, through a charger, to a battery*
    c. ***Energy transformation:*** *Energy changes from one form to another. Ex. hydroelectric dam, kinetic energy of water into electrical energy, body converts food to energy.*
    d. ***Renewable Energy****: Energy that comes from earth's natural resources that do not run out.*
2. *Next, show students the collision videos in appendix B. They will be able to use their*

computational thinking skills as they answer questions about what they observed. Ask the following questions: What are you noticing? What are you wondering?

3. *Students will get in groups of 2-3 to complete their investigation.*
    a. *Students will experiment with balls to see how the collisions transfer energy.*
    b. *Have students create a "course"/goal (e.g. one of their chairs). They will then use two balls, one to collide and one that is trying to reach the goal.*
    c. *Students will experiment with different types of collisions, (force, speed, angle) to try and knock one ball through the goal.*
4. *Hold a class discussion about their findings and observations from the investigation. Questions to initiate discussion can be found above in the "Reason" section. Have students write a hypothesis for what they believe is happening when they collide the balls. Then read the collision article as a class that explains more about collisions and have them revise their hypothesis according to what they learn.*

Appendix B -

Phenomena Pictures: In 4th grade Seed Textbook -p.g. 59 & 62

Collision Evaluation Videos:

1. *Racquetball serve in slow motion*
2. *Kicking a ball*
3. *Toy car collision*

Collision Evaluation Q's: Answer both questions for all three videos

1. *What are you noticing?*
2. *What are you wondering?*

Collision Article

Materials:

Provided materials:

- *small balls*

Classroom materials:

- *Videos/articles*

4.2.4 - Renewable Energy Conversion

Grade: 4th **Time:** Two 45 minutes Lessons
(This lesson would be best done over the course of a week, the building and testing of the products takes a while.)

Lesson Topic: Energy Conversion

Utah SEEd Standard:
Standard 4.2.4 Design a device that converts energy from one form to another. *Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data from testing solutions, and propose modifications for optimizing a solution.* Emphasize identifying the initial and final forms of energy. Examples could include solar ovens that convert light energy to heat energy or a simple alarm system that converts motion energy into sound energy.

Lesson Performance Expectations:
- Engineer and build a device to change (convert)energy.
- Construct an explanation for how energy is transferred throughout the system they build.

Phenomenon: *Wind can power my house.* Spanish Fork Utah Windmills

Gather
1. Students obtain information from the reading on how renewable energy is changed into other types of energy.
2. Students engineer and build a device that converts a renewable energy source to something usable. (power, light, heat, electricity...etc.)

Reason
3. Students develop a model to show the transfer and transformation of energy in the system they build.
4. Students construct an explanation that energy is transferred and transformed in the device they build and use the model to present the explanation.

Class Discussion:
Questions to initiate Discussion:
Q: How are the machines alike and different?
Q: What are some real life examples of renewable energy conversions?
Q: What caused more energy to be transferred?
Q: Why does the input of energy cause something to happen?
Q: Does all of the energy get transferred?
Q: Where does energy come from in your model?

Communicate Reasoning 5. Students construct an explanation for how energy is converted throughout the system they built.	
Science and Engineering Practices Developing and using models Engineer and build	Develop models to describe the transfer and transformations of renewable energy Use engineer skills to build a renewable energy conversion machine
Crosscutting Concepts Energy and Matter Systems	Describe the transfer of energy. Use energy flow to explain changes in the system. Describe energy inputs to systems that cause changes.
Disciplinary Core Ideas Energy Transfer	Energy can be transferred from one form to another

Appendix A - Student Prompts for the Lesson

Phenomenon: Wind can power my house.

Group Performances:

1. Students obtain information from the reading on how renewable energy is changed into other types of energy.
2. Students engineer and build a device that converts a renewable energy source to something usable. (power, light, heat, electricity...etc.)
3. Students develop a model to show the transfer and transformation of energy in the system they build.

4. Students construct an explanation that energy is transferred and transformed in the device they build and use the model to present the explanation.

Class Discussion

Group presentations of models with explanation. Discuss after

Individual Performances:

5. Students construct an explanation for how energy is converted throughout the system they built.

Lesson Steps:

1. *Introduce the lesson by showing the phenomenon video of the windmills up spanish fork canyon and talking about the statement. Emphasize that engineers work with renewable energy to power things. Review the following vocabulary:*
    a. ***Energy:** Ability to do work*
    b. ***Energy Transfer:** movement of energy from one location to another. Ex. electricity, moves through wall plug, through a charger, to a battery*
    c. ***Energy transformation:** Energy changes from one form to another. Ex. hydroelectric dam, kinetic energy of water into electrical energy, body converts food to energy.*
    d. ***Renewable Energy**: Energy that comes from earth's natural resources that do not run out.*
2. *Do the 4th grade textbook reading (attached below) together as a class, then discuss other types of renewable energy.*
3. *Complete the investigation*
    a. *Put students in groups of 4. Students will be assigned to work on a specific machine using different types of renewable energy (water, solar, wind, etc.)*
    b. *They will be tasked to work together using the instructions from the K'nex kits to build the machine.*
4. *After students have completed their machines, they will test them out. They can do this inside or outside, whichever is easiest.*
5. *The class will participate in a class discussion to talk about their experiences and findings together. Questions to initiate the discussion can be found above in the "Reason" section. Be sure to emphasize how energy is transformed in their models to help them better understand this concept in their machines.*
6. *Students will present their machines to the class and explain what type of energy it uses and how energy is transformed.*

Lesson context suggestion : you live in a very windy city. Electricity is hard to transport due to the high amount of wind your city experiences. Can you find a different way to power your city? Introduce each type of renewable energy in the context of need, each type would have different natural resources that would promote one type of renewable energy (i.e desert city - solar, city located near an large river - water). This could be done with real cities that the students research to find the best source of energy in or could be given in sentence prompts like above.

Appendix B -

Phenomena video: Spanish fork windmills

Student reading: 4th grade Textbook pg. 75 - 77 (renewable energy)

Appendix C -

Materials:

Provided Materials:

- *K'nex Kits*

Classroom Materials:

- *Hole punch*
- *Tape*
- *Scissors*
- *Paper or cardstock*

4.2.2/4.2.4 - Solar Ovens

Grade: 4th **Time:** 1-2 Days

Lesson Topic: Energy Conversion

Utah SEEd Standard:
Standard 4.2.2 Plan and carry out an investigation to gather evidence from observations that energy can be transferred from place to place by sound, light, heat, and electrical currents. Examples could include sound causing objects to vibrate and electric currents being used to produce motion or light.

Standard 4.2.4 Design a device that converts energy from one form to another. *Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data from testing solutions, and propose modifications for optimizing a solution.* Emphasize identifying the initial and final forms of energy. Examples could include solar ovens that convert light energy to heat energy or a simple alarm system that converts motion energy into sound energy.

Lesson Performance Expectations:

- Develop a model to show the transfer and transformation of energy in the system of the solar oven. (From light energy to heat energy)
- Construct an explanation for how energy is transferred into the system of the solar oven.
- Engineer and build a device to *change* (convert) solar *energy* into heat energy.

Phenomenon: *I can use the sun to cook my food.*
Engineering Challenge: Build a solar oven that uses sunlight to cook food.

Solar Oven Video

Gather

1. Students obtain information from the reading on how sunlight is changed into heat energy.
2. Students design and build a device that increases the amount of sunlight that is transformed from light into heat energy. (change)
3. Students test and redesign their device and use a table to record time and temperature to determine the design that produces the most heat.

Reason

4. Students develop a model to show the transfer and transformation of energy in the system of the solar oven.
5. Students construct an explanation that energy is transferred and transformed in the oven and use the model to present the explanation.

Class Discussion: - Presentation of Models by Groups

Questions to initiate Discussion:
Questions about Model
Q: Where is light energy shown in your model? Where is heat energy shown in your model?
Q: Where does it show energy being transferred?
Q: Where does it show energy being transformed?
Q: Does all of the energy from the sun get transferred?

Questions during Class Discussion (after presentations of models)
Q: Does the brightness of the sun affect the amount of heat in the oven?
Q: How is the transfer of energy different from the transformation of energy?
Q: Why is it important to think of an oven as a system?
Q: How is energy flowing through the system? Inputs and outputs?
Q: What materials used cause heat energy to be absorbed?

Communicate Reasoning

6. Students create an explanation for how the evidence they gathered about light and heat supports the design of their oven.

Science and Engineering Practices Developing and Using Models Carry out Investigation	Carry out an investigation to show that solar energy can be transferred into heat energy Develop models to describe the transfer and transformation of energy in the oven.
Crosscutting Concepts Energy and Matter System and System Models	Energy transfers into, out of, and within a system (the sun's light becomes heat energy to cook the food in the oven). Energy is transferred among components of systems.
Disciplinary Core Ideas Energy Transfer	Energy can be moved from place to place by moving objects or through sound, light, or electrical currents. Light also transfers energy from place to place. Energy can also be transferred from place to place by electrical currents, which can then be used locally to produce motion, sound, heat, or light. Energy can be transformed from light to heat.

Appendix A - Student Prompts for the Lesson

Phenomenon: *I can use the sun to cook my food.*
Engineering Challenge: *Build an oven that uses sunlight to cook food.*

Group Performances:

1. Develop questions to obtain information on the transfer and transformation of energy in the oven.
2. Obtain information from the reading on how sunlight is changed into heat energy.
3. Design and build a device that increases the amount of sunlight that is transformed (change) from light into heat energy.
4. Test and redesign your device and record temperature and time data on a chart.
5. Develop a model to show the transfer and transformation of energy in the system of the solar oven. (Label inputs and outputs of energy and each transfer and transformation.)
6. Construct an explanation that energy is transferred and transformed in the oven and use the model to present the explanation.

Class Presentation of models with Discussion After

Individual Performances:

1. Students create an explanation for how the evidence they gathered about light and heat supports the design of their oven.

Lesson Steps:

Prior to teaching Lesson: Watch the How-to video so that you are able to better guide students in their own solar oven designs.

1. *Introduce the phenomenon by showing this Solar Oven Video and discussing the statement. Remind students that engineers design and build things that are powered by renewable energy. Review the following vocabulary words:*
    A. ***Energy:*** *Ability to do work*
    B. ***Energy Transfer:*** *movement of energy from one location to another. Ex. electricity, moves through wall plug, through a charger, to a battery*
    C. ***Energy transformation:*** *Energy changes from one form to another. Ex. hydroelectric dam, kinetic energy of water into electrical energy, body converts food to energy.*
    D. ***Renewable Energy****: Energy that comes from earth's natural resources that do not run out.*

2. *Hold a class discussion stressing why solar ovens are needed, what the positive benefits are, how they can help people, etc.*
3. *Students will gain information from the reading about how sunlight is transformed into heat energy.*
4. *In small groups of 3-4 students will discuss possible designs to maximize the amount of energy that is transformed from light energy into heat energy to heat water in their solar ovens.*

    Lay out materials provided so students can see what they will be working with. Students should draw a Model that includes labels to show the transfer and transformation of energy. Some key ideas should include: solar energy, heat energy, transfer, and transformation) (5ish minutes)
5. *When students have drawn and planned their model, they can build their solar ovens as a group.*

    They will test out their solar ovens. Use the provided lamps if there isn't enough sun outside. They will use 100ml of water with a thermometer inside and track it's progress as they let it cook under the light. Have them record the temperature changes over time. (for best results these ovens need to be left out for a couple of hours to allow time for it to heat up.)
6. *After their testing of the solar ovens, students will discuss the results. Questions to initiate discussion can be found above in the "Reason" section. Discuss strengths and weaknesses of each of their designs and what can be modified to make it better.*
7. *Students can then modify their designs and retest them. If time doesn't allow for this, they can draw a model of their modifications instead.*
8. *Students will present their models to the class, what they decided to do, how it worked, and why.*

Appendix B -

Student Reading:

Light energy and Heat energy

*Light energy travels over 90 million miles from the sun as light. When it hits something like you or a rock or a blade of grass it is **transformed** into heat.*

*When you go to the beach and walk on the stand the sand feels warm. Heat energy in the sand is being **transferred** to your feet. In the morning the sand is not as hot as at noon. From morning to noon more light energy from the sun is being transformed into heat. The longer the sun is shining on the sand the hotter the sand becomes.*

We use heat to cook our food. Your stove changes electrical energy into heat energy to cook your food. The heat in your stove is the same as the heat on the beach. Heat is heat.

Light from the sun can be changed into heat to cook our food. Can you think of a way to use heat from the sun to cook the food?

Student Recording Table:

Time	*Water temperature in the oven*
0 minutes	
10 minutes	
20 minutes	
30 minutes	
40 minutes	
50 minutes	
60 minutes	

Appendix C -

Pizza Solar oven video tutorial

Materials:

Provided *materials:*

- Pizza box or other cardboard box
- Plastic wrap
- Aluminum Foil
- Thermometer
- Tin pan
- Lamps for the sun

Classroom materials:

- scissors/box cutter
- Sunny day
- Black construction paper
- Glue
- Black marker
- ruler
- Tape

- Water
- straw, stick or skewer to prop lid up

Materials List by Lesson

4.2.1 - Sail Cars

Provided materials:

- Sail car (30)
- Blow dryer (7)
- Foldable hand fan (2)

Classroom materials:

- Tape
- ½ sheets of card stock Paper or other sturdy materials
- ½ Sheets of printer paper /notebook paper
- Scissors

4.2.2 - Solar Powered Cars

Provided materials:

- Solar cars (20)
- Lamps (5)

Classroom Materials:

- 3x5 cards or sticky notes

4.2.3 - Collisions with Sports Balls

Provided materials:

- *Beach Balls (5)*
- *Stress Balls (96)*
- *Ping Pong Balls (100)*
- *Pumps (3)*

Classroom Materials:

- Videos/articles

4.2.4 - Renewable Energy Conversion

Provided material:

- K'nex Kits (1)
- Sill Birds (2)

- Lego Solar (2)

Classroom Materials:

- *Hole punch*
- *Tape*
- *Scissors*
- *Paper or cardstock*

4.2.4 - Solar Ovens

Provided materials:

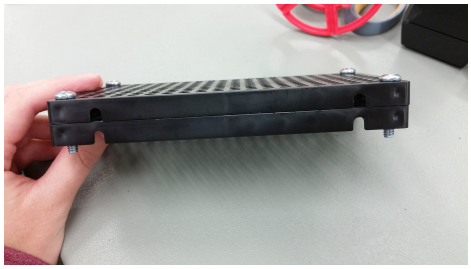
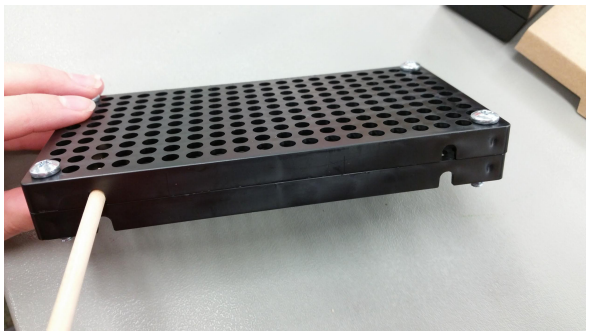
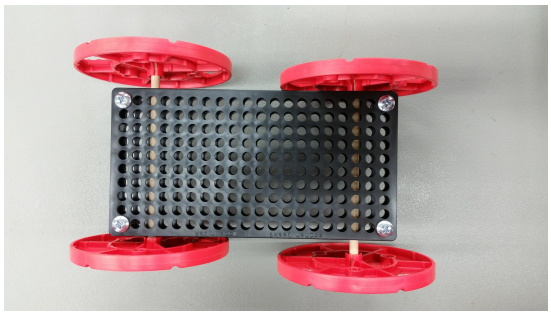
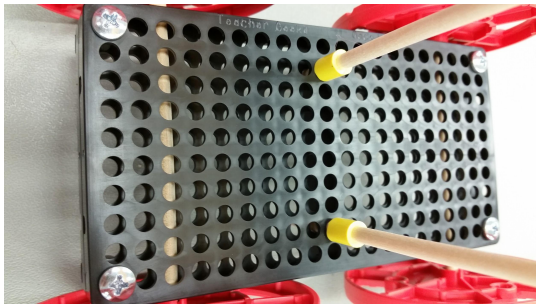
- Pizza box or other cardboard box (6)
- Plastic wrap (2)
- Aluminum Foil (2)
- Thermometer (22)

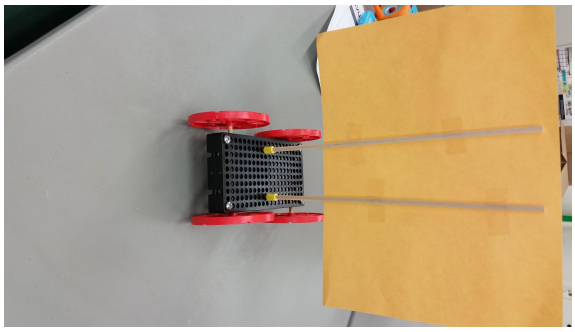
Classroom materials:

- scissors/box cutter
- Sunny day
- Black construction paper
- Glue
- Black marker
- ruler
- Tape
- Water
- straw, stick or skewer to prop lid up if needed

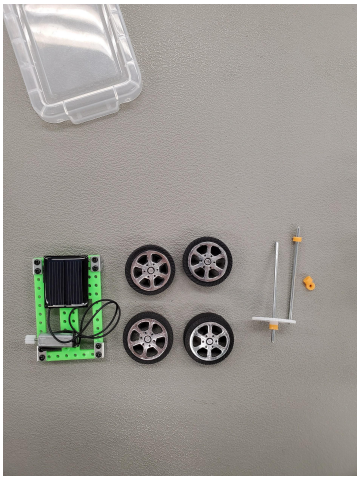
Procedure Cards

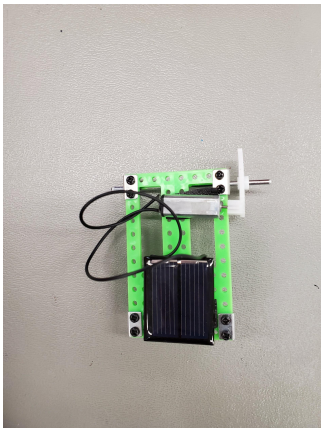
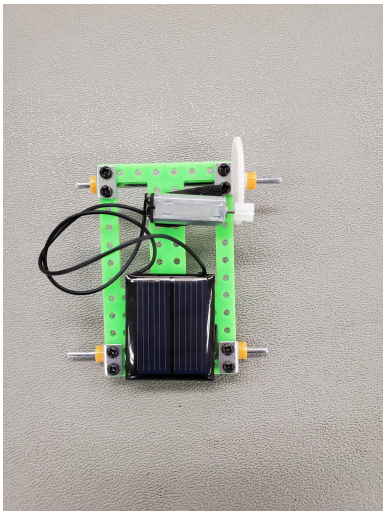
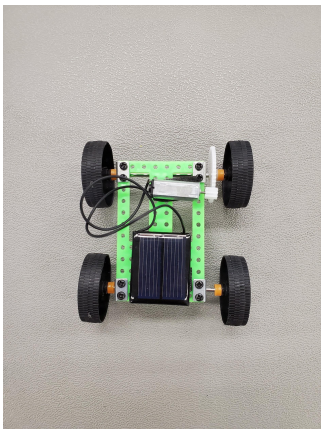
Sail Cars

1. To build the base grab two black hole plates to stack together. They have two sides, and place the flat sides so they both face up. Put 4 screws in each corner	
2. Next we will put together the axel and wheels. Grab a pre-cut 11cm wooden dowel. Wiggle the wooden dowel into one red wheel leaving the smooth side out.Place the wooden dowel in the top hole on the balck base. Wiggle the other wheel onto the axle. Repeat for other wheel/axle	 
3. Now to make the masks to hold a sail grab two 12in. Wooden dowels, and two 1cm yellow rubber things.Place the yellow rubber stopper on one end of your mask/dowl.Place the mask and rubber stopper on top of the top of your car. (The yellow rubber stop is to make sure the masks don't fall through the whole.	

4. Next you will build a sail of your choice out of paper or other recyclable materials. Tape your sail to your mask.Pull out your hairdryers and test it.(Hint: the angle to hold the hair dryer can help it move). Happy sailing! To see a video of how to build and other helpful videos visit this Website.	

Solar Cars

1. Grab a solar car kit	
2. Pull out the materials	

3. Place the gear and rod at the front of the car by the gear, making sure it goes through the top hole, and the two gears line up.	
4. Now place the other axle on the back of the car under the solar panel, adding orange stoppers to the outside of the axles. Be careful not to put them on too far. About 0.5cm should be good.	
5. Place all 4 wheels on their axles. Make sure all of the nuts on the back of the screws are tightened	

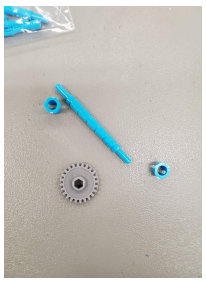
Sillbird Robots

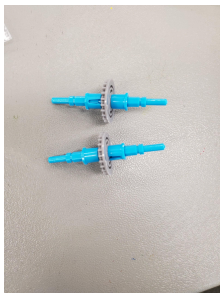
Turtle Bot	
Step 1 - collect parts	
 	 

Step 2 - Assemble gears part 1

With parts E7, E3, and B8.
Slide grey wheel (B8) into the middle section of the blue rod (E3).
Slide blue holders (E7) on either side of the grey wheel(B8) on blue rod E3).

Do this step twice!





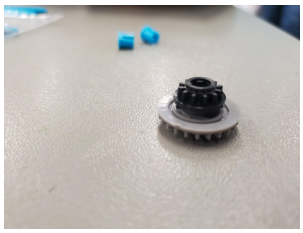
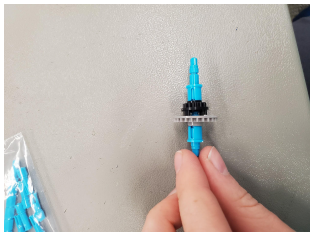
Step 3 - Assemble gears part 2

With parts E1, E8, B8, C2.

1. Place part C2 (black gear) in the slots on the back of part B8 (Grey Wheel).
2. Slide one blue holder (E1) on the last section of the blue rod (E8), next slide Grey wheel and black gear (B8 and C2) to the second to last section on the blue rod (E8). Place the remaining blue holder (E1) on the other end of the Grey wheel and black gear piece.

This piece will be off center.



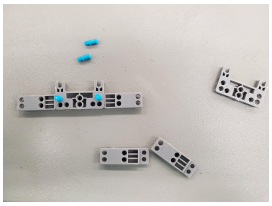
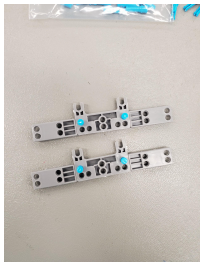
Step 4 - Create body Cage part 1

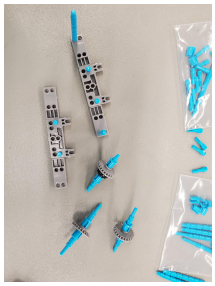
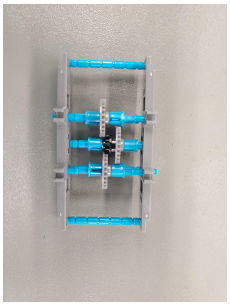
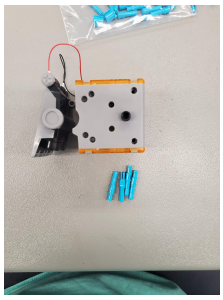
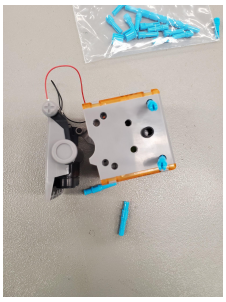
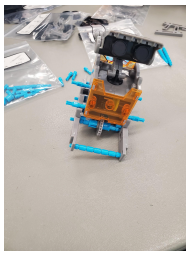
Pieces - B4,B3,E6

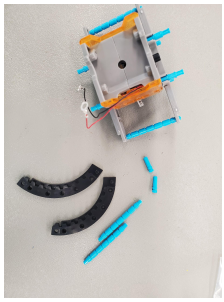
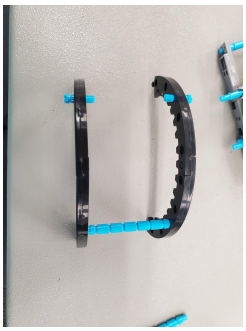
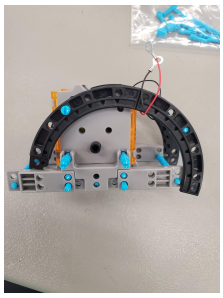
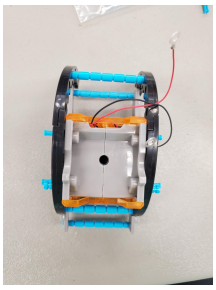
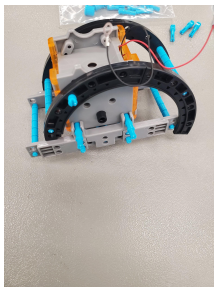
With piece B4 (the grey one that looks like a U) place B3 (the other grey piece) on either side of B4 so that the holes line up with each other. When put together this piece should be flat.

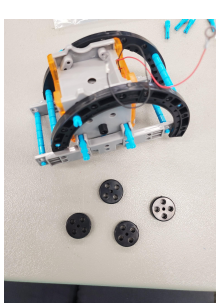
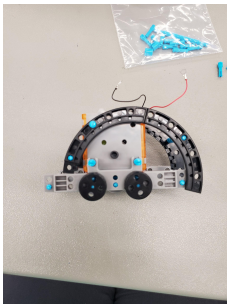
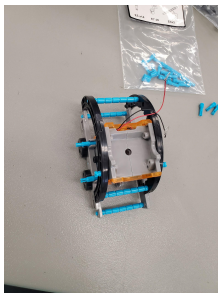
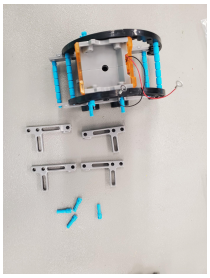
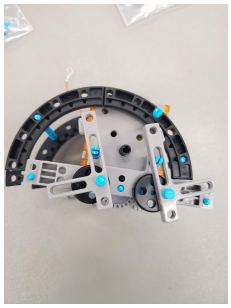
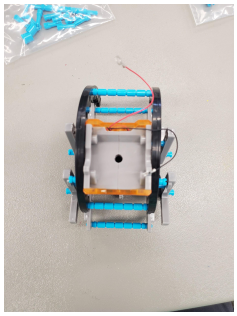
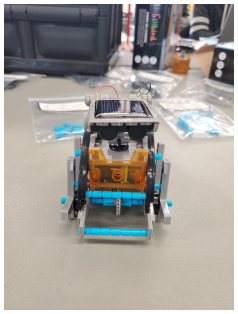
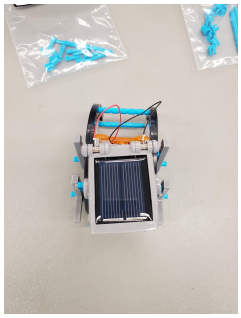
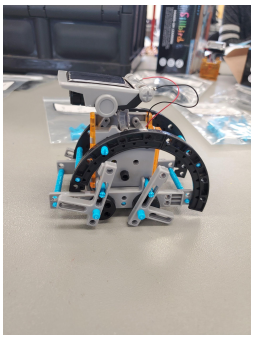
In the top hole of piece B4 insert blue peg (E6) and push in until you hear a click or the blue lip around the middle of the ring has gone into the hole. Repeat this step on each side of B4.

Do this procedure twice!

Step 5 - Create Body Cage part 2 Pieces - part from step 2,3,4 and part E8 With part assembled in step 4	   
Step 6 - Placing sillbot body on cage	    

Step 7 - Creating the Shell	      

Step 8 - Adding Feet	    
Step 9 - Put head back on	   

Step 10 - Clean up When students are done with the robots, have them take apart everything except the body (main part of the robot) and place the pieces in their proper bags. ● Note: some of the smaller pieces may be a little difficult to get out if this is the case students may use a pen or a dull pencil to push out the pieces.	