Energy Transfer:

Laboratory for Secondary Level Students

Teacher Manual

WOMEN SUPPORTING
WOMEN IN THE SCIENCES

Mission Statement

This laboratory will teach energy transfer concepts to a target audience of middle and high school/secondary-aged students (ages ~12-18) through experiments related to energy transformation, energy conservation, and thermodynamics.

Contents

1. Introduction to WS2 Laboratories

1.1. Information about WS2

Women Supporting Women in the Sciences (WS2), an international organization unifying and supporting graduate and professional-level women and allies in science, technology, engineering, and mathematics (STEM), was awarded an American Physical Society (APS) Innovation Fund in 2020 to form international teams to design and distribute low-cost physics and materials science lab kits to 5000 primary and secondary school students, predominantly in eastern Africa. The lab kits are intended to utilize local resources and include topics that are especially relevant to young girls in order to spur their interest in STEM subjects. The international teams, which designed the content found in these laboratory manuals, worked with WS2 Partners in eastern Africa in order to successfully deliver and teach the science lab kits to their local communities through 2022. WS2 gratefully acknowledges the hard work of the teams in the creation of this lab kit content. For more information about WS2, please visit our website at ws2global.org.

WS2 is sponsored by the APS Innovation Fund, Northwestern University Materials Research Science and Engineering Center, and Northwestern University Multicultural Student Affairs. WS2 Partners receiving lab kits are representatives from Makerere University (Uganda), Masinde Muliro University of Science and Technology (Kenya), Mbeya University of Science and Technology (Tanzania), Mkwawa University College of Education (Tanzania), Nelson Mandela African Institution for Science and Technology (Tanzania), University of Dar es Salaam (Tanzania), University of Dodoma (Tanzania), and University of Rwanda (Rwanda). The APS, Materials World Modules, SciBridge, and Projekt Inspire have provided valuable input on WS2 lab kit design. WS2 especially thanks WS2 Partner representatives (John Bakayana, Pendo Bigambo, Daudi Mazengo, Lawrence Robert Msalilwa, Celine Omondi, Marcellin Rutegwa), Tom Coon and students of Haile-Manas Academy (Debre Birhan, Ethiopia), and Carla Johnston and students of Frank Bergman Elementary School (Manhattan, KS, USA) for piloting the lab kits with small focus groups in late 2021. WS2 also tremendously thanks the virtual lab kit design team that created the content for this lab manual.

1.2. Using this Guide

This manual is to be used by the teacher of the laboratory, and it is similar in content to the student manual but may contain additional material, like: Overview, Fundamental Physics and Materials Science Concepts Covered, Practical Skills, Background on Main Topics, Summary of Experiments, Results, Teacher Pre-Lab, Troubleshooting. These additional sections are intended to provide the teacher with the background and foundation critical for successfully implementing this laboratory kit in the classroom. It is recommended that the teachers of this laboratory go through the guide from beginning to end to familiarize themselves with the laboratory content prior to teaching the laboratory to students. Questions about the laboratory content can be directed at any time to ws2global.org@gmail.com, using the subject line "Question about Lab Kit Content".

<u>IMPORTANT NOTES:</u>

- This laboratory is intended for use with secondary-level students (ages ~12-18), but depending on the specific students' educational background, the content may need to be modified by the teacher to be made simpler or more complex. The teacher is encouraged to also cover the laboratory content at the pace that works best for the students; some younger students may need more time and attention from the teacher and/or facilitator to go through the questions and experiments, while older students may be more independent and require less attention from the teacher and/or facilitator. Thus, the content covered, depth of coverage, and pacing are left to the teacher's and/or facilitator's discretion.
- The content in this lab manual may not fit into the specific curriculum of the school in which it is being taught. It is up to the facilitator(s) and teacher(s) whether they would like to introduce new content or skip certain sections that are not applicable to their classrooms.
- In certain areas, modifications to the supply list may need to be made depending on the availability of the supplies in the specific area in which the lab is being taught. We have attempted to list some alternatives in the supply list, but we understand this list of alternatives is not exhaustive.
- In the experiments, the students are split into groups of three to four. If supplies allow, students may instead be split into groups of two.

1.3. Key Vocabulary

- Energy: The ability to do work; may exist in many forms (e.g., thermal, kinetic, chemical)
- Energy transfer: The movement of energy from one location or object to another
- Energy transformation: The change of energy from one form to another
- Energy conservation: The principle that the total energy of a system does not change, and energy can only be transferred or transformed
- Thermodynamics: The study of the movement of heat between different objects
- Updraft: An upward current of air
- Conductor: A material or substance through which heat moves easily
- Insulator: A material or substance through which heat does not move easily and often maintains its original temperature when exposed to heat

1.4. Key Questions

- What are different forms of energy?
  - Answer: There are many examples, including kinetic, mechanical, thermal, chemical, and solar.
- What is the law of energy conservation?
  - Answer: Energy can neither be created nor destroyed, but instead can only be transformed from one form into another.
- What are ways in which energy can be transferred and transformed between different objects?
  - Answer: Energy, for example, like heat, can be transferred by conduction (direct contact), convection (transfer through fluids), and radiation (transfer through space via waves). Energy transformation is the conversion of energy from one form to another. Examples of energy transformations include mechanical to thermal (rubbing your hands together) and chemical to mechanical (eating food that enables you to move around), among many others.

1.5. Purpose

The purpose of this lab is to demonstrate the power of energy transformations, or when energy changes from one form to another. Energy is part of our lives every day; it is constantly changing and moving. Like when we eat and digest food or when we burn wood for fire, energy is transformed for practical purposes all around us every day.

1.6. Overview

Through this laboratory, middle and high school/secondary-aged students (ages ~12-18) are going to be taught thermodynamics concepts and how one type of energy (solar) can be transformed to different types of energy (thermal and kinetic). They will also experiment with how changing different parts of their solar tower can change how well it works by taking into consideration what type of energy transformation or transfer they may be manipulating.

1.7. Fundamental Physics and Materials Science Concepts Covered

The laboratory introduces topics of thermodynamics and energy transfer and transformation. Whether the students are warming up outside in the sunlight or eating food so that they have the energy to run around and think about their studies, energy transfer and transformations are important and happen all around us. Types or forms of energy (i.e., mechanical, kinetic, thermal, solar, etc.) will be introduced and discussed. These basic concepts related to energy and thermodynamics are critical and relevant to numerous fields including Biology, Physics, Chemistry, Materials Science, and Engineering.

1.8. Practical Skills

- Students will learn how to construct a solar tower and work in groups to make and modify their design.

- Students will identify forms of energy needed/used in various scenarios in their lives.
- Students will connect energy transfer and thermodynamics concepts to everyday experiences at school and home (e.g., heating food).

2. Background on Main Topics

2.1. Energy and its Transfer and Transformation

The Sun is an extremely powerful source of energy; for centuries people have used the Sun as a source of reliable and renewable energy to cook food and warm themselves. Energy is the ability to do work or make something move or change in some way. Have you ever been chilly in the shade or indoors, but when you go outside you feel an instant warmth? That is the power of the Sun's energy! The Sun's energy gets to you by energy transfer, which is the movement of energy from one location or object to

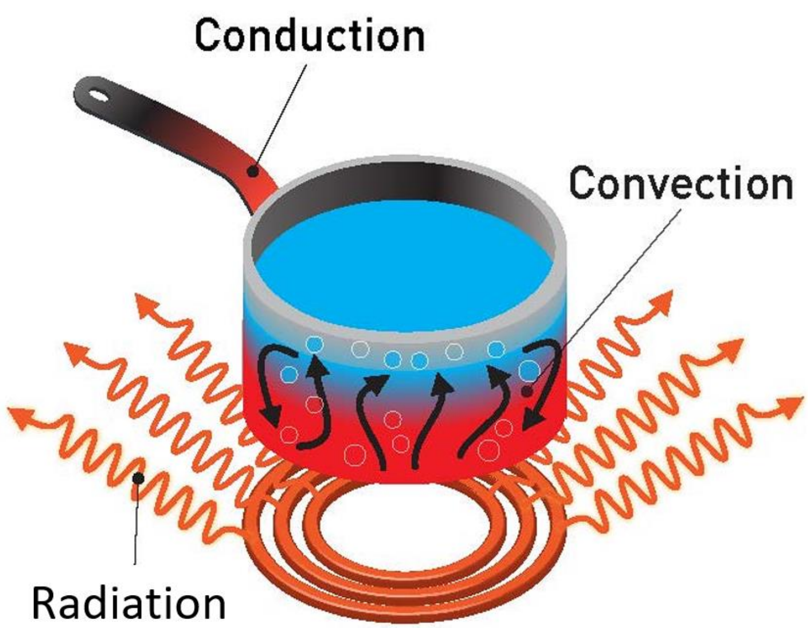

Figure 1. Heat transfer through conduction (direct contact with hot object), convection (flow of hot fluids), and radiation (transfer through space via waves) with a pot of liquid on a hot surface. This Photo by Unknown Author is licensed under CC BY.

another. This transfer of energy, especially thermal energy like heat, can occur in different ways like through conduction, convection, or radiation. Conduction is the transfer of energy through a material, so if you touch something very hot, like a pot on the stove, the heat moves through the pot to your finger. Convection is the transfer of energy through fluids (i.e., moving water or air), like blood moving through your body to regulate your body temperature or a breeze that forms near an ocean or lake. Radiation is the transfer of energy through space by waves, like the transfer of the Sun's energy to you (this happens through light waves). Examples of these types of heat transfer are shown in Figure 1.

Of course, the Sun provides more than just heat, as it helps give plants the energy to grow and then we get energy from plants by eating them! This is called energy transformation, which is the process by which one type of energy (solar) is changed into another type (chemical energy), resulting in sugar or food that we can eat. There are multiple forms of energy, including kinetic/mechanical, thermal, electrical, chemical, radiant, and nuclear (Figure 2). The ways that these different forms of energies transform into each other is very useful in understanding cooking, animal growth, movement, and more! In recent years, there have been many technologies trying to use solar energy and transform it to electricity. This type of solar energy transformation,

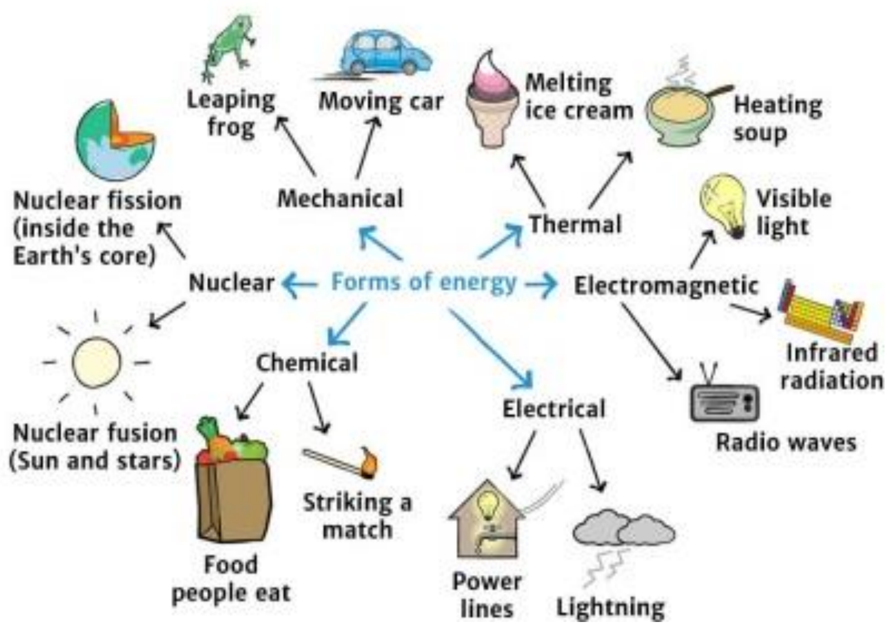

Figure 2. Many examples of forms of energy, including thermal, electrical, and chemical, and examples from everyday life, including lightning, food, and moving cars. Source: solarschools.net.

a technology called a solar panel, could help reduce carbon emissions that result from making electricity from fossil fuels by providing an alternate pathway to producing electricity.

One important scientific law, which is a description of observed phenomenon, is that energy cannot be created or destroyed. Instead, energy can only be transformed from one form to another. This is called energy conservation. The law based on the principle of energy conservation is known as the first law of thermodynamics. Thermodynamics is an important field of study that investigates the movement of heat between objects. Another important law related to thermal energy transfer is the second law of thermodynamics, which states that heat will flow from a hot object to a cold object. At some point, both objects will reach a balance of temperature, called a temperature equilibrium.

In various parts of our lives, we use specific materials for different purposes, especially when we want to transfer heat. When cooking, a pot made of metal is used because metal is a good conductor of heat. Something that conducts heat well means that the temperature equilibrium is reached quickly (i.e., there is no net flow of heat) when that object is placed near another object of differing temperature. A material that behaves opposite to a conductor is an insulator. An insulator does not transfer heat very well and thermal equilibrium is reached slowly when placed next to an object of differing temperature. Plastic is a good example of an insulator. Different materials have these varying properties, and we can use those properties to move heat more efficiently (or less) depending on the application for which we plan to use them.

In this lab kit, we are going to make use of energy transfer and thermodynamics concepts, which will end in the building of a solar tower. In a solar tower, energy is converted from solar energy to thermal energy to kinetic energy. First, solar energy hits the tower, which causes the air inside to heat up. Hot air rises, so the hotter air moves to the top of the tower. This updraft, or upward motion of air, causes the pinwheel to spin. The tower that is built in this experiment is a small demonstration of real technology, a solar thermal collector, which could be used for renewable energy conversion in the future.

2.2. Sources

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3. Summary of Experiments

This lab consists of two experiments and one design challenge to understand the concepts of energy transfer. This investigation starts with an experiment that reinforces the second law of thermodynamics, namely that heat flows from hot to cold objects, using differing materials and conduction of heat. Having this basis, students engage in building a solar tower and perform experiments and design iterations that teach the student about energy transformations. A design challenge asks students to consider how to cook food using energy transfer and transformation using what they have learned in the experiments. The goals of the experiments and design challenge are the following:

Part I: To demonstrate that heat flows from a hot object to cooler object via conduction and the impact of materials on this conduction.

Part II: To build a solar tower by stacking tin cans and creating and placing a pinwheel on top of the tower. The construction of the tower is successful if the pinwheel on top starts to spin. If students are successful in building the tower, they are then asked to manipulate parts of the tower to see what changes occur. Though students are encouraged to come up with their own ideas on what variables to manipulate, examples are provided.

Design Challenge: To design two ways to cook food focused on energy transfer and transformation.

3.1. Supplies List

- Paper cups
- Plastic or Styrofoam cups (alternative: ceramic cups)
- Metal cans (should be empty and clean, some will require the tops and bottoms taken off per the experiment)
- Water, cool or chilled
- Tape
- Wire
- Needle/pin/thumbtack (alternative: sharpened pencil)
- Paper
- Books of similar heights
- Pen or pencil
- Scissors
- Black paint (optional)
- Paintbrush (optional)
- Thermometer (optional)

3.2. Safety Information

Before the students begin the laboratory, please take into consideration the following safety concerns:

- The needle/pin/thumbtack used can be sharp, so students should use caution when handling it so they do not accidentally prick themselves.
- Cutting the bottom and top of the metal cans can also be dangerous. Take caution if using a sharp razor. It is recommended that the teacher or facilitator perform this task for students ahead of time, if possible. Instead of a razor,

teachers can use a can opener to remove the top and bottom of the cans or try another metal can, like aluminum, that is easier to cut.

3.3. Teacher Pre-Lab

Teachers can organize the supplies for the experiments ahead of time for each student or groups of 2-4 students (it is encouraged to have students work together):

Experiment 1:

- Try to use similarly sized cups/cans and place cups/cans in the sunlight to heat up
- Place water for class (it does not need to be potable) in the shade or a cool location
- Each group should have: 1 metal can, 1 plastic/Styrofoam/ceramic cup, and 1 paper cup

Experiment 2:

- Remove the tops and bottoms of metal cans to be used (use caution with razor or another tool)
- Cut wire into 15 cm (~6 inch) strips
- Cut paper into 13x13 cm (~5x5 inch) squares
- Each group should be supplied with 3 metal cans, 1 piece of 15 cm wire, one thumbtack/pin/needle, 1 piece of paper, 2 books, and tape

4. Experiments

4.1. Part I. Heat Transfer

4.1.1. *Summary*

In this experiment, we are going to test how heat from cups/cans is transferred to water poured into the cups/cans and the impact of the cup/can materials in this transfer.

4.1.2. *Pre-Experiment Questions*

1. How does heat from a fire or the Sun warm you (or something else) up? Explain in your own words as best as you can.
    a. Answer: Heat is transferred from something that is hot (so the Sun or the fire) in different ways. Some students may say conduction, radiation, or convection. The point is that heat travels from something hot to something cold, in that direction. This is the basis of the second law of thermodynamics.
2. How well does heat flow through different materials? Does heat flow through metals faster than plastics?
    a. Answer: Conductors (like metals) allow heat to flow through them well. These materials are often used in cooking because they heat up very well. Insulators (like plastic and ceramic) do not allow heat to flow through them as well. These materials can be used to keep items around them hot or cold because they do not allow heat to dissipate through them.
3. What types of objects would you want heat to flow through quickly and easily?
    a. Answer: There are many examples of objects that we want to conduct heat quickly and easily. Some examples include pots and pans for cooking, electrical wires, and radiators for heating a room.

4.1.3. *Materials*

- 1 plastic/Styrofoam cup
- 1 metal can (empty and clean)
- 1 paper cup
- Water, chilled or cool, enough to fill cups/cans
- Optional: thermometer
- Optional: 1 additional metal can, black paint, paintbrush

4.1.4. *Procedure (work in groups of 2-4)*

If you have the optional additional metal can, black paint, and paintbrush, paint the outside of one metal can with black paint and let dry.

1. Place cups/cans ("vessels") outside in the direct sunlight on their sides or upside down. Leave the vessels in the Sun for at least ~10 minutes.
2. Measure the temperature of the cool water either with a thermometer or with your finger and record the temperature/description of temperature in Results. If you are using your finger, use descriptive words such as hot, warm, cool, cold, or rate the temperature on a scale from 1 to 10 where 1 is cold and 10 is hot.
3. Feel the outside of the vessels in the sunlight and record the description of temperature in Results.
4. Remove vessels from the sunlight and add the same amount of water to each cup/can.
5. Return the vessels to the sunlight.
6. After 1 minute in the Sun, measure with a thermometer or with your finger:
    - the temperature or description of temperature of the water
    - the temperature or description of the temperature of the outside of the vessel
7. Repeat the measurements in step 6 after 5 minutes in the Sun. Record all your results below.

4.1.5. *Results*

Vessel material	Water temperature before adding to vessel	Vessel temperature before adding water	Water temperature after 1 min	Vessel temperature after 1 min	Water temperature after 5 min	Vessel temperature after 5 min
Paper						

Plastic/Styrofoam						
Metal						
Metal with black paint						

4.1.6. *Post-Experiment Questions*

1. Which vessel caused the water to heat up the fastest? Which vessel was the slowest to heat up the water? Why do you think this was?
    a. Answer: The metal can (especially the one with the black paint) heated the water the fastest. This is because the metal is a good conductor, so it transferred the heat from the can to the water the best. The vessel that heated the water up the slowest was the Styrofoam cup, because this material is a good insulator, so the heat did not transfer as quickly to the water.
    b. Extension question: Did the initial temperature of the outside of each vessel impact which vessel heated the water the fastest or heated the water the most at the end of 5 minutes? Especially consider the color of the outside of the vessel and what you know about light absorption.
        i. Answer: Answers may vary depending on the vessels. If the cans or cups were black, the material could absorb more light and so it could heat the water more than a cup or can that was a lighter

color, like white, and reflected some sunlight. The metal can that is painted black both absorbs more light because of its color and conducts heat better than a light-colored insulating cup. One key is getting the students to recognize that this experiment may have multiple variables that impact the result, including the color of the vessel and the material the vessel is made of.

2. At the end of 5 minutes, what do you notice about the temperature of the water and the feel of the outside of the vessels? Describe your observations in terms of heat flow (thermodynamics).
    a. Answer: The temperature of the water and the outside of the vessels should start to become more similar over time. Heat flows from the hot object (vessel) to the cold object (water), and over time both objects become the same temperature as they reach equilibrium.
    b. Extension question: What ways are the flow of heat in this experiment conducting? Radiating? Convective?
        i. The heat from the vessel to the water is conducting because the vessel is in direct contact with the water. The heat from the vessel is also radiating heat from its outside to the air surrounding it. It is also possible there is some convective heating of the water heating itself if, for instance, one part of the vessel is hotter than another part.
3. Consider a future experiment that only tests one variable about the vessel and this impact on the heating of the water. Describe what this experiment could be.
    a. Answer: Answers will vary. Students could describe using only one material, like metal, paper, or plastic, and investigating the impact of the color of the vessel (i.e., by painting the vessel) on heating the water. Students could also describe painting three vessels of different materials black and investigating the impact of the material on heating the water.

4.2. Part II. Solar Tower

4.2.1. *Summary*

In this experiment, we are going to show how energy transformations take place in a solar tower that you build.

4.2.2. *Pre-Experiment Questions*

1. Rub your hands together really quickly. What do you observe? Describe how energy is being transformed and transferred.
    a. Answer: The kinetic energy from the motion of rubbing your hands together is transformed into thermal energy in the form of heat that you can feel. This heat is transferred between the hands through conduction since the hands are touching.
    b. Extension question: Based on what you know about energy and thermodynamics, what can you say about the total energy of this process? Was thermal energy created?
        i. Answer: Energy is not created or destroyed, so thermal energy was not created but instead transformed from kinetic energy of the hands in motion. The idea that energy is not created or destroyed is known as the conservation of energy.
2. Look at the solar tower you will build in this experiment (see Figure 3). Once placed in the Sun, what impact do you think the Sun's energy will have on the solar tower? Consider the flow of energy from the Sun to the solar tower. What will happen next?
    a. Answer: The Sun's heat is transferred to the solar tower by radiation. The sunlight will hit the solar tower and cause the air in the tower (in the cans) to heat up. Hot air rises, and so here the hot air will rise to the top of the tower. This updraft of wind will cause the pinwheel to turn.

4.2.3. *Materials*

- 3 metal cans (should be empty and clean, with the top and bottom removed)
- Tape
- 15 cm (~6 inches) of wire
- 1 needle/pin/thumbtack (alternative: sharpened pencil)
- 13x13 cm (~5x5 inch) piece of paper
- 2 books (alternative: any two items of the same height that can be used as a platform to rest the tower on)
- Scissors
- Optional: black paint and paintbrush

4.2.4. *Procedure (work in groups of 2-4)*

1. Stack 3 tin cans vertically and tape them together. Make sure that the tape completely covers the gaps in between cans.
2. Lay two books side by side, leaving around 2.5 cm (1 inch) of gap in between them. Place them in an area that has sunlight.
3. Place the stack of 3 tin cans onto the books, so that the 2.5 cm (1 inch) gap is directly underneath the tower (see Figure 3a).
4. Bend wire into the shape of a semicircle.
5. Tape one end of the wire to the edge of the top metal can, tape the other end to the opposite edge of the same can.
6. Tape thumbtack onto the highest part of the wire with the point facing upward (see Figure 3b).
7. Fold paper into a pinwheel.
    a. Cut a piece of paper into a 13x13 (~5x5 inch) cm square.
    b. Mark the center of the square with a pencil.
    c. Cut 4 diagonal lines from each corner, stopping about 2.5 cm (1 inch) from the center of the square.
    d. Fold outer points of the square into the center of the square. Secure with a small amount of tape. See Figure 4 for reference.
8. Place the center of the pinwheel onto the thumbtack but do not push the thumbtack all the way through the pinwheel. The pinwheel should freely spin if you blow on it. The pinwheel should be perpendicular to the thumbtack. A completed solar tower is shown in Figure 3c.
9. Wait for several minutes while the solar tower is in sunlight and observe what happens. If the pinwheel turns, record the number of turns in one minute.

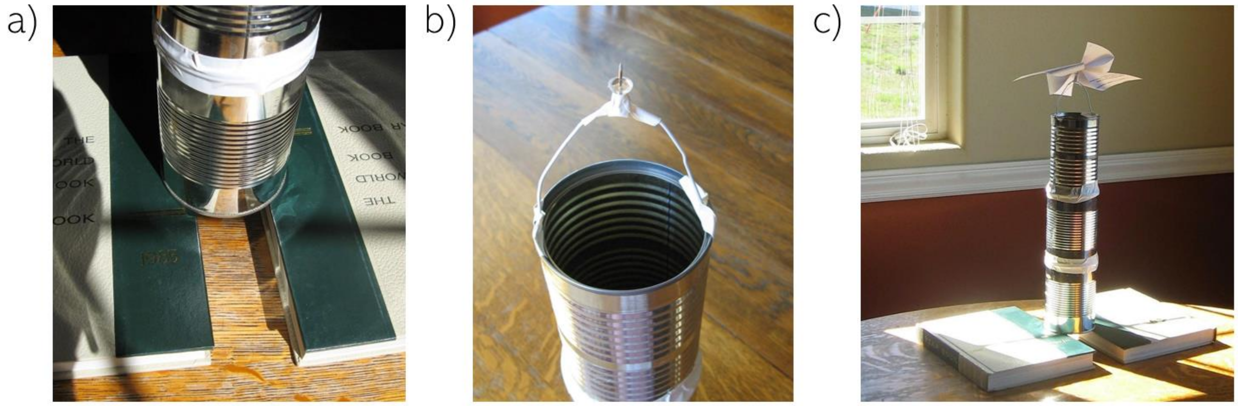

Figure 3. Solar tower construction. (a) Placement of tower on books. (b) Securing thumbtack to the top of the solar tower. (c) Final solar tower. Source: almostunschoolers.blogspot.com.

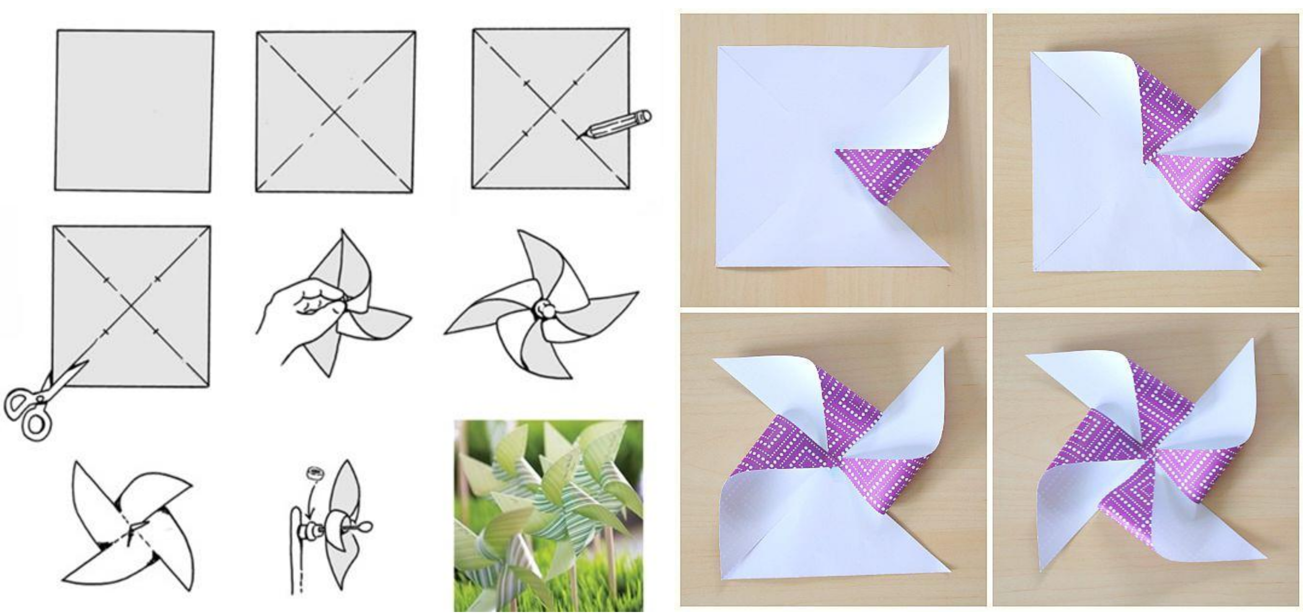

Figure 4. Construction of pinwheel by folding square piece of paper and securing points with tape. Sources: wonderfuldiy.com and buggyandbuddy.com.

4.2.5. *Results and Further Investigation*

Record your observations from the original solar tower configuration. Then, pick 3-4 questions to investigate the solar tower further. Before you change anything on your solar tower, make a prediction of what will happen.

Note for teachers: Different groups can choose different questions to investigate and then groups can share their results with the class. Students are encouraged to ask questions and to manipulate different parts of the tower to see what different results occur due to their changes. Having students write down their observations is key for this exploratory section.

Note: If the box has an "X" in it, you don't need to fill anything in.

Scientific Question?	How will energy transfer/transformation be changed?	Prediction of what will occur	Observations	Number of Pinwheel Turns per Minute
Original configuration	X	X		
What would happen if the tower was not on the books?				
What would happen if the tower was taller?				
What would happen if the tower was shorter?				
What would happen if the tower was not made from cans? What other material would be good to use?				

How would you change the pinwheel to spin faster?				
What if you used a smaller pinwheel?				
What if you used a larger pinwheel?				
What if the tower was painted black? White?				
What happens if you change how many books the tower sits on?				
What do you think would happen if you change the width of the tower to be smaller or larger?				
Your own question:				

4.2.6. *Troubleshooting*

Here are a few tips for getting the solar tower to work well:

- Make sure there are no gaps in between cans.
- There should be a small gap in between the two books.
- Pinwheel should be lightly resting on top of the thumbtack. If the pinwheel can't stay on the thumbtack, make a slight indentation in the center of the pinwheel (this will allow the pinwheel to balance better on the thumbtack). The thumbtack should not be pushed through the pinwheel.
- If it is a cold day or not very sunny, it may take some time for the pinwheel to turn, so be patient.

4.2.7. *Post-Experiment Questions*

1. What forms of energy were involved in this experiment? Explain how the energy was transferred and transformed. Was any energy created or destroyed?
    a. Answer: There were several forms of energy in this experiment: solar energy (sunlight), thermal energy (heat), and kinetic energy (spinning pinwheel). The radiative sunlight contacted the solar tower and some of this heat was absorbed, causing it to heat up. The heated air inside the tower rose, creating an updraft which caused the pinwheel to spin. Energy was not created or destroyed because of conservation of energy; instead, it was transformed between several forms.
2. What was the purpose of placing the tower on top of the two books? What happens if you don not have a gap between the table and the book?
    a. Answer: This allowed for air to enter the tower. This is important because, for the pinwheel to move, the Sun needs to heat up a continuous flow of air in order to create an updraft. If there was no gap, the air wouldn't be able to continually enter the tower.
3. When you modified the experiment, what happened? Why did this happen?
    a. Answer: Answers will vary. The important thing to look for in the students' answers is if they bring up what they are manipulating and how this impacts energy transfer and transformation.

4. If this solar tower were a large-scale item (say, the size of a house or several houses), how could you imagine the spinning pinwheel could be used to do important tasks?
    a. Answers: Answers will vary, and you should encourage student creativity. The turning pinwheel could be used to turn something else, like two wheels that grind grain or move items on a conveyor belt or a large screw that drills into something. The turning pinwheel could be connected to a generator to produce electricity; at its root, this is a very common mechanism to produce electricity across the globe.
5. What are some other examples of the transformation of energy that you have seen in everyday life?
    a. Answer: Answers will vary. Some examples include eating food so that we have the energy to move our bodies (chemical to kinetic energy transformation), plants using sunlight in order to grow (radiant solar to chemical energy transformation) and plugging in an iron or toaster into an electrical outlet and heating it up (electrical to thermal/heat transformation).

5. Design Challenge

The Challenge: Now that you have learned a bit more about energy transformation and transfer, let's consider a practical application: cooking! Since we know that the Sun is a powerful source of energy and have learned about ways to manipulate its energy into other forms, you can consider ways to use solar energy to cook food. Typically cooking requires some form of fuel: burning wood, gas, or using electricity. Since you learned a lot about how to transform energy and how energy is transferred, we want you to think about how to design a cooker!

5.1 Design Questions

1. If you were going to design a way to cook food, how would you build it? Think about two different ways you can do it.
    a. Consider:
        i. What materials would you use?
        ii. What form(s) of energy would you need?
        iii. How would you transform the energy?

iv. Is there a way to not use typical means of cooking? (i.e., no wood, gas, electricity)
v. Where would you want the heat to come from?

2. Will this design be useful for cooking food for a single person or family? Could it be used to cook food at larger scale for communities? How could you modify your design?

Possible answers to the questions above:

The possibilities are endless. Some options could be using solar energy and converting it to thermal energy, and the student could describe using metal or dark-colored materials to absorb heat. Another option could be transforming mechanical energy to thermal energy since friction can help to create heat. Encourage the students to think creatively and ask them: Did they consider the materials? Show one form of energy transformation? Will different forms of energy work better or worse? How could their design be modified?

5.2 Design Sketch

Try out your designs by sketching it on paper. You can also color it in with markers, pens, pencils, and crayons. Be creative!

My methods for cooking food: