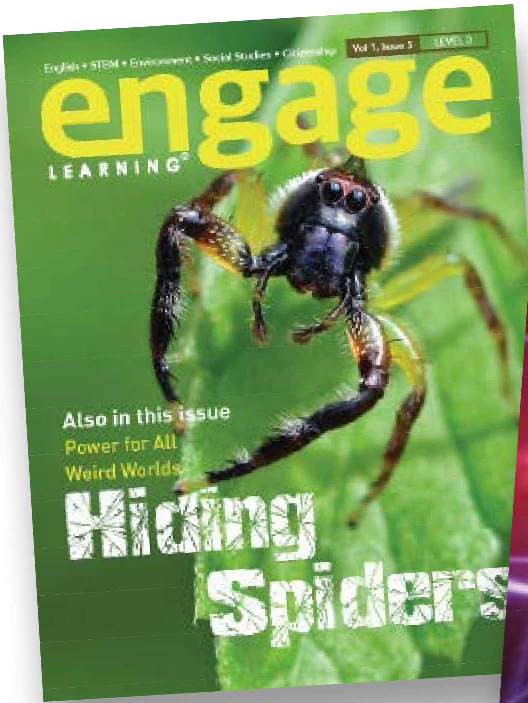
English • STEM • Environment • Social Studies • Citizenship

engage LEARNING



Level 3

Level 4

TEACHING GUIDE

Vol 1 • Issue 5 • Levels 3 & 4

Ages 9–13 years

Dear Educator,

Happy New Year! We are delighted to bring you the January 2018 issue of **Engage Learning** magazine. We are dedicated to offering you the best in educational value. With the previous issue, we had updated our teaching guide, and continue to do so with your constant feedback. We realise that this guide is vital to the success of **Engage Learning** in your classroom.

With this issue we continue our science instruction programme. Through the magazine, we have given students unparalleled depth in content, exposure to real scientists doing real science and connections to the real world. As important as reading about science is, it is not doing science.

The teaching guide will continue to give you an instructional plan that incorporates hands-on activities and experiments. You will find that these activities provide real-life experiences with science and will help your students become even more successful.

In this issue, you will find three new stories. The first story explores the conversion of energy. We have examined sources of energy and classified them as renewable and non-renewable sources. As part of the story you can teach students to be responsible consumers of energy, as all resources can cause pollution to the environment. In this story we look at solar energy in depth and you will have many opportunities for hands-on experiments.

The second story is about tiny creatures all around us – spiders. Are spiders scary? This will be an opportunity for you to study spiders and see how they survive in their natural habitats. We also clear some misconceptions about spiders.

The third story engages students in the fundamental question of whether there is life elsewhere in the universe. Scientists look at possibilities by trying to understand the physical environment which can support life as we know it. Or do we need to shift our own paradigms to understand that life can in fact exist in different forms? Meet astronomer, Priyanka Chaturvedi in an exclusive interview and understand how she uncovers the mysteries of the planets for us.

Note: There are three teaching guides, one each for Level 1 and Level 2, and a combined guide for Levels 3-4. You may look at all of them for more ideas and activities, which you can adapt for the class level you are teaching.

Your last issue of **Engage Learning** for the school year will be in February 2018.

CONTENTS

MEET THESE STANDARDS

Students will:

✓ **LANGUAGE ARTS**

— Connect visuals and textual material and learn to ask questions as they read.
— Read text like a scientist and critically analyse content.
— Critically analyse the title of an article and make connections between literary devices used and science writing.

✓ **LIFE SCIENCE**

— Explore the range of living things on Earth.

✓ **SCIENCE**

— Understand that energy can be converted from one form into another.
– Learn that there are planets beyond our solar system and that these planets are called exoplanets.

✓ **MATH**

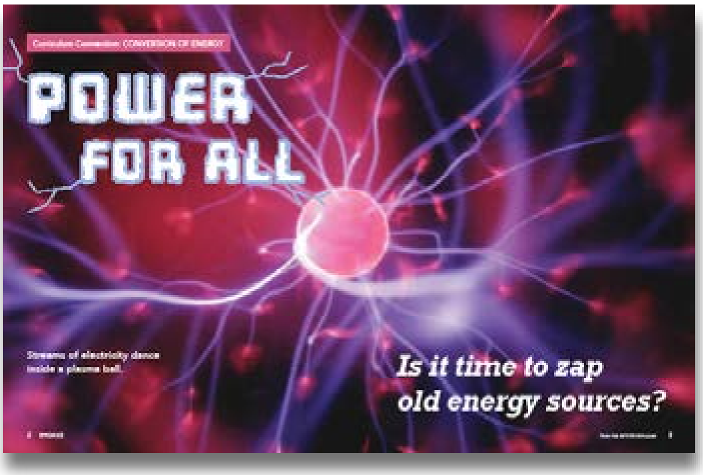
— Learn that quantities can convert from one system of measurement to another using a fraction as a conversion factor.

POWER FOR ALL

LANGUAGE ARTS OUTCOME: Students will connect visuals and textual material and learn to ask questions as they read.

SCIENCE OUTCOME: Energy can be converted from one form into another.

MATH OUTCOME: Quantities can convert from one system of measurement to another using a fraction as a conversion factor.



CURRICULUM CONNECTION

You teach that energy can be converted from one form into another. For example, you teach that the stored energy in food can be converted into energy that plants and animals use to survive. You also teach that other kinds of energy can be converted. In this article, students will read how people have harnessed energy from animals, wind and water, and used this energy to move and to make food. Students will also learn how light energy is converted into electrical energy.

BUILD BACKGROUND

Hand out the magazine to students. Have **Level 4** students look at the cover. Have **Level 3** students turn to pages 2-3 in their copies of the magazine. Have students look at the picture of the streams of electricity which dance inside a plasma ball. Explain to students that electricity flows from the centre of the plasma ball forming streams of plasma that dance around the ball. Discuss with students that electricity is a form of energy. Discuss how people use electricity.

Bring the discussion about electricity to a general discussion about forms of energy. Ask students for different examples of energy in their lives.

Students may come up with several examples of what energy is. Make a list of students' responses. Some examples are listed below:

- heat (warming a house, warming up liquids such as water)
- mechanical work (moving things around)
- electrical (lighting, cooking, lightning)
- chemical (burning in engines, explosions)
- light (solar cells, solar heating)
- nuclear (power plants, atomic bombs)

Explain that energy causes things to happen around us. During the day, the sun gives out light and heat energy. At night, street lamps use electrical energy to make light energy. When a car drives by, it is being powered by petrol, a type of stored energy. The car's engine turns the stored energy into kinetic energy, the energy of motion. The food we eat contains stored energy. We turn that energy into kinetic energy and use it to work and play. For **Level 4** students, explain that stored energy is also called potential energy and the energy of motion is called kinetic energy. Guide the discussion for all students so that they understand the definition of energy: "Energy is the ability to do work."

Energy can be found in a number of different forms. It can be chemical energy, electrical energy, thermal energy (heat), radiant energy (light), mechanical energy, and nuclear energy. An important idea about energy is that energy can be converted from one form to another, and we call this conversion of energy.

Conversion of energy occurs when:

- Light energy converts into electrical energy in solar cells.
- Light energy converts into heat energy in solar heating.
- Chemical energy in a gas stove converts into heat energy.
- Rubbing hands, which is an energy of movement (friction) generates heat energy.

- An electrical bell uses electrical energy to create sound energy.
- A piano uses mechanical energy to create sound energy.

When students are satisfied that all the kinds of energy they know about can be converted from one form to another, they have a good idea about energy.

READY TO READ

- ➛ Hand out copies of **Engage Learning** magazine and have students turn to the story 'Power for All' on pages 2-3.
- ➛ Conduct a preliminary shared reading session where the students read in pairs.
- ➛ Ask the students to go through page 4 and list all the sources of energy they come across in their reading. Ask them about the differences between the energy sources. After a discussion, classify the sources into renewable and non-renewable sources of energy. Can they add more sources of energy to this list?

As students read the article, "Power for All," you will want to teach the diagram that shows how a solar cell converts light energy into electrical energy. Have students look at page 5, "Energy in Time". It shows some important developments in the history of how people harnessed sources of energy. The events are arranged in the chronological sequence in which they occurred. Historians call this a timeline.

Explain to students that when historians make a timeline of historical events, they create a graphic representation to help them link units of time with events. The sequence suggests a past, present and possible future. The direction says that time and history proceed in a line, not a circle. Portrayed in a line, events are unique in history and do not repeat themselves in exact ways.

Begin with a question for your students to enable them to become critical thinkers. ASK: Look at how a linear timeline has been created for energy in the magazine. Some events have occurred before others. Does this suggest that events exist in relationship to one another? Is there a cause and effect which lays the ground for an event to occur sequentially?

Ask students if they see any problems with the timeline. Guide the discussion so that students understand that because of limitations of space, the timeline is not designed to show the length of time between events. Tell the class that they will explore creating different kinds of timelines.

Have students look at the timeline again. Remind them that it has not been drawn to scale. ASK: If we were to draw the timeline once again using a scale, how would this change the way the events are positioned? Let us try it. Use the board or a long sheet of paper to develop a scale.

These are the steps we used to develop our timeline:

1. We first decided what the timeline will show: events related to energy. Think about how we chose which events to include and exclude.
2. We did research and noted the specific dates when the events that we wished to include occurred.
3. We listed the events in a chronology, a sequence of earliest to latest.
4. We chose the earliest and latest dates to include 3000 BC to 1980.
5. We used a unit of time such that one unit = 500 years
6. We calculated the number of segments for the timeline to be 10.
7. We drew a line and divided it into the number of equal segments that we needed.
8. We labelled the dates appropriately, taking care of plotting BC and AD accurately.
9. Can you see that the period between 1500 and 2000 had so many energy events that we had to we were unable to give each year equal space and collapsed the diagram.)

Using the same principles, can you create your own timeline, for example, to show the dates of the Big Bang and the earliest known humans. You can use the step by step instructions from https://www.wikihow.com/Make-a-Timeline

Now direct students to turn to page 6 and have them read all the pages through page 9. As they read, have them ask the following questions:

- ➛ Why did India begin to abandon the use of fossil fuels and turn to solar energy?
- ➛ What are sources of renewable energy?
- ➛ How does a solar cell work?
- ➛ How did scientists study nature and learn how to adapt designs and enhance solar energy by using biomimicry? *Biomimicry* is an approach

to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies.)

- How might a solar panel that looks like a panda help spread the use of solar power?
- Do you think such visual images add value?

After students finish reading the pages, discuss the questions and tell students their questions may be addressed after conducting the **After Reading Extension Activities**. Good students will then ask even more questions!

In order to understand how solar panels work, take a look at this video from energy.gov, entitled **Energy 101: Solar PV** for a breakdown of how solar panels convert sunlight into electricity. http://bit.ly/2CTW6kF

WHAT IS SOLAR ENERGY?

Here is some background information, which you can use for an enriching classroom discussion.

The sun is a gigantic star, which like other stars is a gaseous mixture of mostly hydrogen (H) and helium (He) atoms. The sun makes energy in its inner core in a process called nuclear fusion. During nuclear fusion, the high pressure and temperature in the sun's core cause hydrogen atoms to come apart. Four hydrogen nuclei (the centers of the atoms) combine, or fuse, to form one helium atom. During the fusion process, radiant energy is produced.

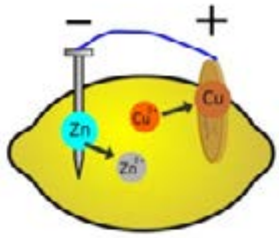
Every day, the sun radiates an enormous amount of energy. It radiates more energy in one second than the world has used since time began. It takes millions of years for the radiant energy in the sun's core to make its way to the solar surface, and then just a little over 8 minutes to travel the 150 million kilometres to earth.

Only a small portion of the energy radiated by the sun strikes the earth, one part in two billion. Yet this amount of energy is enormous. Every day enough energy strikes the United States to supply the nation's energy needs for one and a half years. About 15 percent of the radiant energy that reaches the earth is reflected back into space. Another 30 percent is used to evaporate water, which is lifted into the atmosphere to produce rainfall. Radiant energy is also absorbed by plants, the land and the oceans.

Have students look at the diagram of the solar cell on page 7. Tell them that it shows how a solar cell converts light energy into electrical energy. Explain to students that light is made of particles called photons. When photons strike a solar cell, the energy in the photons is transferred to atoms in the solar cell. The energy rips electrons off of some of the atoms in the cell. The electrons move from the top of the cell to the bottom of the cell. The moving electrons generate electrical energy that can be used to light homes. The solar cell does not destroy the energy in the photons, it converts it into another form of energy.

ACTIVITY: Lemon Battery

Turn to pages 10 and 11 of the magazine. Explore how students can make electricity from a simple lemon.



Here is some supporting material for the teacher when this activity is conducted in the classroom.

The science behind this energy conversion is the process of electrolysis or how a lemon battery produces electricity by converting chemical energy to electrical energy.

In a conventional battery, the two electrodes are two different metal pieces (usually copper and zinc), submerged in an acidic solution (electrolyte) and connected through an external wiring. For a "lemon battery" experiment, two different metals in the form of a zinc nail and a copper coin are inserted into a juicy lemon.

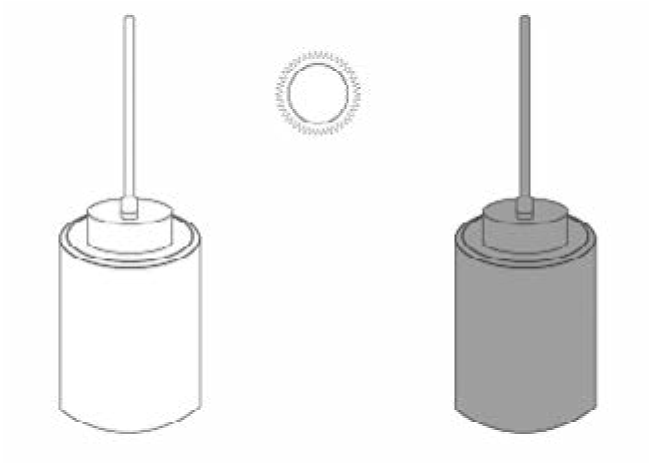
The juice of lemon is acidic in nature and works as an electrolyte. When the two electrodes, copper and zinc, are suspended in the acidic lemon juice, a potential difference is created and electrons are produced by the atoms.

The copper acts as the positive electrode and the zinc acts as the negative electrode. This experiment demonstrates that electricity can be generated just by a chemical reaction.

RADIATION CANS

When radiant energy hits objects, some of the energy is reflected and some is absorbed and converted into heat. Some objects absorb more radiant energy than others.

PURPOSE: To explore the conversion of radiant energy into heat.



YOU NEED:

- 2 thermometers
- silver and black cans
- solar and artificial light
- air and water
- cold and hot water

Step 1: Put thermometers into the black and silver cans and position the stoppers so they are not touching the bottoms of the cans. Record the temperatures of both cans.

Step 2: Place the cans in a sunny place. Predict what will happen. Record the temperatures after five minutes.

Step 3: Open the cans and allow the air inside to return to the original temperature.

Step 4: Place the cans in a bright artificial light, such as an overhead projector. Predict what will happen. Record the temperature of both cans after five minutes.

Step 5: Fill both cans with 200 ml of cold water and record the temperatures.

Step 6: Place the cans in a sunny place. Predict what will happen. Record the temperatures after five minutes.

Step 7: Fill both cans with 200 ml of hot water and record the temperatures.

Step 8: Place the cans in a sunny place. Predict what will happen. Record the temperatures after five minutes.

RECORD THE DATA

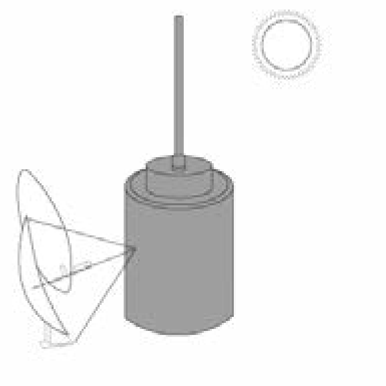
	AIR						COLD WATER				HOT WATER			
	Original		In the Sun		In the Light		Original		In the Sun		Original		In the Sun	
	C	F	C	F	C	F	C	F	C	F	C	F	C	F
BLACK CAN														
SILVER CAN														

CONCLUSIONS: Look at your data. What have you learned about converting radiant energy into heat? What have you learned about reflection and absorption of radiant energy?

SOLAR CONCENTRATION

Concave mirrors can be used to collect solar radiation and concentrate it on an object.

PURPOSE: To explore the concentration of solar radiation.



YOU NEED:

- 2 thermometers
- 1 silver radiation can
- 1 black radiation can
- 400 ml water
- 2 concave mirrors

Step 1: Fill the silver and black radiation cans with 200 ml of cold water.
Step 2: Put thermometers into the cans and position the stoppers so that the thermometers are not touching the bottoms of the cans. Place the cans in a sunny place.
Step 3: Position the mirrors as follows:
Group A: The control without mirrors.
Groups B&C: Position one concave mirror behind each can so that the mirrors focus sunlight onto the cans. The mirrors should be about 7 cms from the cans. Use pieces of clay to hold the mirrors in the correct position.
Groups D&E: Position two concave mirrors behind each can as described above.
Step 4: Record the temperature of the water in all the cans. Predict what will happen.
Step 5: Record the temperature of the water in the cans after five minutes.

RECORD THE DATA

	WITHOUT MIRRORS				WITH 1 MIRROR				WITH 2 MIRRORS			
	Original		5 mins		Original		5 mins		Original		5 mins	
	C	F	C	F	C	F	C	F	C	F	C	F
BLACK CAN												
SILVER CAN												

CONCLUSIONS: Look at your data. What have you learned about concentrating solar radiation?

SOLAR COLLECTION

Solar collectors absorb radiant energy, convert it into heat and hold the heat.

PURPOSE: To explore solar collection.

You need: (*for two ovens*):

- 1 sheet each of white and black construction paper
- 4 plastic containers
- water
- clear plastic wrap
- rubber bands

Step 1: Cut two circles each of white and black construction paper 5 cm in diameter. Place the circles in the bottoms of four plastic containers and cover with 40 ml of cold water. Record the temperature of the water.

Step 2: Cover one black and one white container with clear plastic wrap held in place with rubbers bands.

Step 3: Place the containers in a sunny place so that the sun is directly over the containers. Predict what will happen. Record the temperature of the water after five and ten minutes.

Step 4: Calculate and record the changes in temperature.

RECORD THE DATA

	WHITE NO COVER				BLACK NO COVER				WHITE WITH COVER				BLACK WITH COVER			
Original Temperature (C)																
Temperature After 5 mins (C)																
Temperature After 10 mins (C)																
Change in Temperature After 5 mins (C)																
Change in Temperature After 10 mins (C)																

CONCLUSIONS: Look at your data. What have you learned about collecting and storing solar radiation?

MAKE A SOLAR OVEN

PURPOSE: To explore cooking with solar energy.

You need: (*for two ovens*):

- tri-fold presentation board
- wide, heavy-weight aluminium foil
- clear plastic bags
- food to cook
- sharp knife or scissors to cut board
- glue stick and clear packing tape
- cooking pot with lid

Optional: use pizza boxes covered with foil or cans of Pringles to make mini ovens.

Step 1: Cut board according to the diagram on the next page.

Step 2: Lightly score new fold lines before folding.

Step 3: Use tape to reinforce folds and to straighten pre-fold on wings.

Step 4: Cover entire board front with aluminium foil, taping or gluing securely.

Step 5: Slide points of wings into slits as shown in the diagram below.

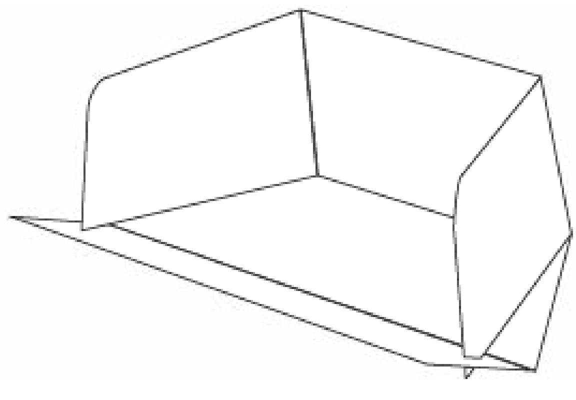
Step 6: Put food in cooking pot and cover.

Step 7: Enclose cooking pot in plastic bag and place in middle of oven.

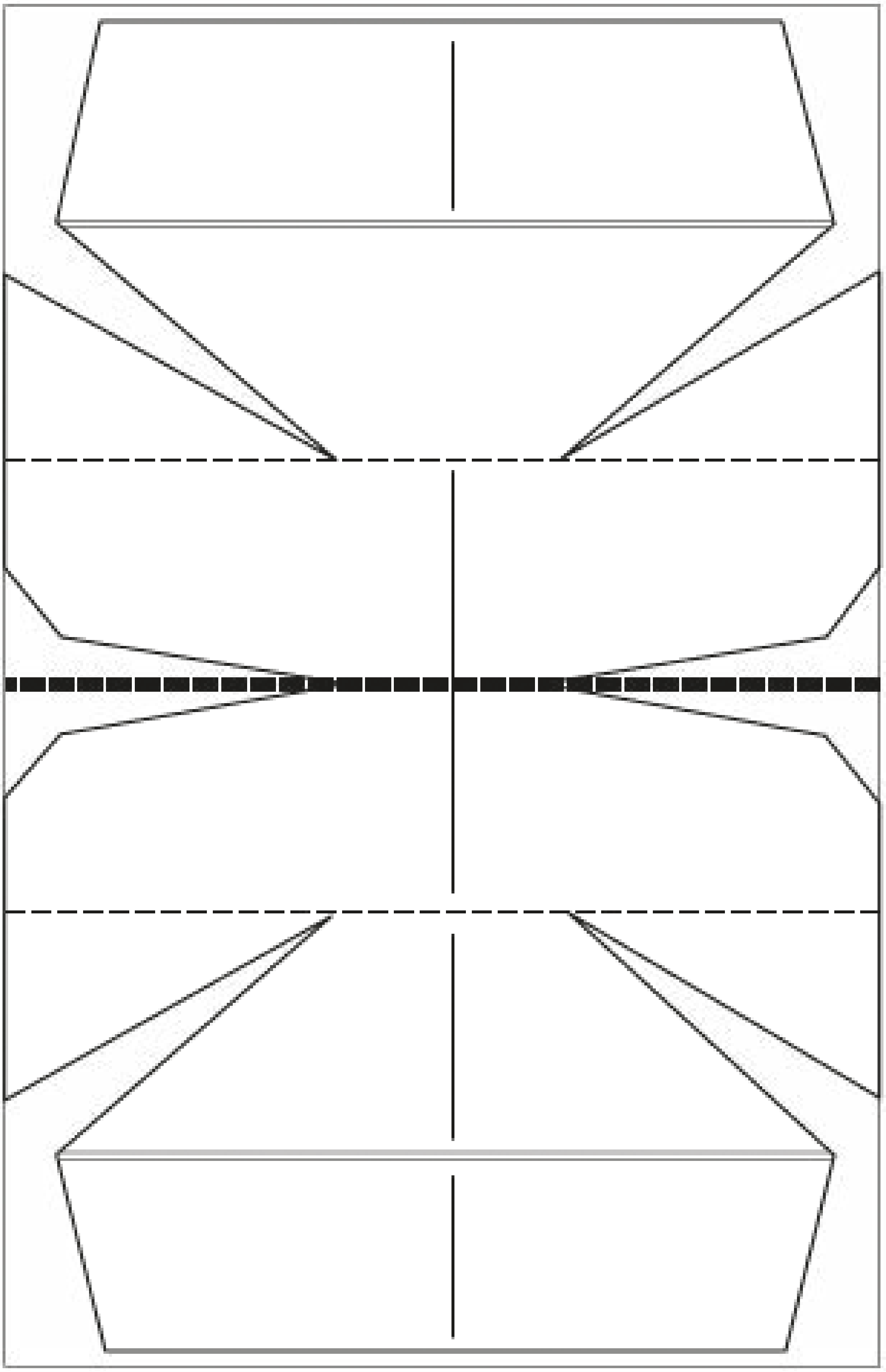
Step 8: Place oven with the sun shining on the pot.

SOLAR COOKING HINTS:

- Use black metal pans and dark brown glass dishes. Never use light coloured cookware. A canning jar painted flat black works fine to boil water.
- Use black cast iron if you're cooking something that must be stirred. It won't lose heat when you open it.
- Don't add water when roasting vegetables. They'll cook in their own juices.
- When baking potatoes, rub with oil and put in a pot with a lid. Don't wrap with aluminium.
- Bake bread in dark glass dishes with lids.
- When baking cookies, chocolate cooks fastest, then peanut butter, then sugar cookies. Use a dark cookie sheet.
- Marinate meats in advance. Place on a rack in a cast iron pot.
- One pot meals are great! Cut everything up, throw into the pot, and put on the lid. Food won't burn in a solar oven. It might lose too much water, though, if you cook it too long.



BI-FOLD DISPLAY BOARD MAKES TWO SOLAR OVENS



THREE TEMPERATURE SCALES

You can have Level 4 students, and if appropriate Level 3 students, to do this activity that explains the three scales that scientists use to tell temperature. Explain that heat is a form of energy, and temperature is used to measure the amount of heat. There are three scales: Fahrenheit, Celcius and Kelvin. The devices used to measure temperature are called thermometers. There are different thermometers spanning different ranges of temperature created to measure body temperature, the temperature in an oven, or the temperature of liquid oxygen.

FAHRENHEIT IS THE CLASSIC

Fahrenheit is the classic English system of measuring temperatures. Water freezes at 32° F and boils at 212° F. The scale was created by Gabriel Daniel Fahrenheit in 1724 and divides the difference between the boiling point and freezing point of water into 180 equal degrees.

CELSIUS BASED ON WATER

Celsius is the modern system of measuring temperature. It fits in with much of the metric system. In Celsius, the freezing point of water is calibrated at 0° C, and the boiling point at 100° C. Then the scale is divided into 100 equal degrees between those two points. The scale used to be known as centigrade but the name was changed several years ago.

KELVIN TO ABSOLUTE ZERO

Kelvin is an important scale used in science. The big difference is that it is based on a single point (absolute zero) which is given a value of 0 degrees. From there, the scale increases by degrees that are the same size as Celcius degrees. It is a scale that is based on energy content, rather than on arbitrary temperature values like the other two scales (based on water). Water freezes at the value 273.15 and boils at 373.15 Kelvin. The word ‘Kelvin’ comes from Lord Kelvin.

FAHRENHEIT/CELSIUS CONVERSION

On the Fahrenheit scale, the freezing point of water is 32º and the boiling point of water is 212º – a range of 180º.

On the Celsius scale, the freezing point of water is 0º and the boiling point of water is 100º – a range of 100º.

To convert from Celsius to Fahrenheit, multiply the C number by $\frac{180}{100}$ or $\frac{9}{5}$, then add 32, as shown in the formula below.

$$F = (\frac{9}{5} \times C) + 32$$

If C = 5 $F = (\frac{9}{5} \times 5) + 32$ F = 9 + 32 = 41

To convert from Fahrenheit to Celsius, subtract 32 from the F number, then multiply by $\frac{100}{180}$ or $\frac{5}{9}$, as shown in the formula below.

$$C = \frac{5}{9} \times (F - 32)$$

If F = 50 $C = \frac{5}{9} \times (50 - 32)$ $C = \frac{5}{9} \times 18 = 10$

PROBLEMS TO ANSWER:

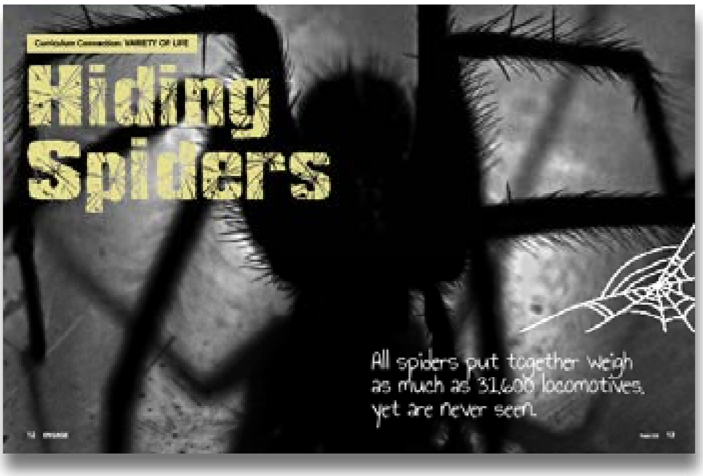
If C is 50º, what is the temperature in Fahrenheit?

If F is 100º, what is the temperature in Celsius?

HIDING SPIDERS

LIFE SCIENCE OUTCOME: Students will explore the range of living things on Earth.

LANGUAGE ARTS OUTCOME: Students will read text like a scientist and critically analyse content.



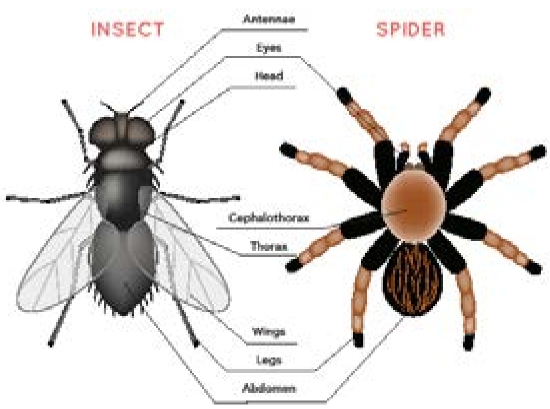
CURRICULUM CONNECTION

You teach that there is a variety of living organisms on Earth. This story looks at the many different kinds of spiders and the different adaptations that help them survive. It also classifies spiders as a kind of arachnid. After students finish reading, they will do an activity that will test their knowledge of arachnids.

BUILD BACKGROUND

Begin the lesson by engaging the students. First, have them turn to pages 12-13 of the magazine. ASK: What kind of animal do you see? (*Spider.*) THEN ASK: Where do you see spiders (answers will vary)? Then discuss what they already know about spiders.

Show this video: https://www.youtube.com/watch?v=WUx2qqPUyOI to build background. You can also share the information from this link: http://www.burkemuseum.org/blog/myth-spiders-are-insects to dispel some misconceptions students might have about spiders.



Share this information with **Level 4** students and advanced **Level 3** students. The scientific name for what most of us consider bugs is arthropods. Arthropods include insects and spiders (called arachnids). An arthropod is defined as an animal having a hard exoskeleton with joints and paired, jointed legs. An exoskeleton is like a hard shell that covers an arthropod.

ASK: What makes an insect an insect? (*An insect has a hard, external covering made of something called chitin. This forms its exoskeleton. Its body is made up of three sections called the head, the thorax and the abdomen. All insects have a pair of antennae on their head. They all have six legs connected to the thorax. Some insects have wings connected to the thorax and can fly.*)

Explain to students that the word arachnid comes from a Greek word meaning spider. As a result, arachnids are commonly called spiders. However, animals such as scorpions and tricks are also arachnids. THEN ASK: What makes an arachnid an arachnid? (*An arachnid has two main body sections called the cephalothorax and the abdomen. They have eight legs. They have simple eyes versus the insect's compound eyes. Unlike insects they do not have antennae or wings. They have an exoskeleton and lay eggs.*)

READY TO READ

READ LIKE A SCIENTIST
Scientific articles are different from a novel or a story. Hence encourage students to read pages 14–19 differently.

Tell students, do not read in a linear way (from beginning to end); instead, try and develop a critical mindset, question your understanding and the findings. Sometimes you will have to go backwards and forwards and take notes. The end goal of this exercise will be to identify the arachnids on page 20.

Here are some tips for reading and understanding:

1. **Skim**: read the main headings of the article and underline the key words. This will tell you about the matter in the article. Focus on the headings and sub-headings, and make a note of the words you do not understand.
2. **Read diagrams**: Diagrams, such as the one on page 15 communicate information in a visual format. Students should pause and study the information presented in diagrams. In this case, the diagram shows the parts of a female spider. Students should study the diagram and then compare the spider's body to their body and the bodies of other animals. They should think about how the spider is like other animals and how it is different.
3. **Re-read**: read the article again and raise questions. Some sample questions for students (not meant to be a prescriptive list) may be:
    a. What is the article about?
    b. Are the statements supported by evidence?
    c. Are the ideas unique?
    d. What do the pictures tell you?
    e. What is the gist of each sub-heading?
4. **Interpret**: look for the key issues and new findings. Pair the students with one another and ensure that they have all collected the main points of the article.
5. **Summarise**: take notes. Make the pairs into fours, and have the groups summarise the essence of the article. Are you now ready for the activity on page 20?
6. **Glossary**: make a list of all the new scientific terms that the students come across in the course of the reading. Classify these terms based on some categories that the students are able to come up with. For example, the most obvious would be insect and arachnid, people and spiders, hunter and prey. Students may be creative in this approach, allow for flexibility.
7. **Give a writing assignment**: you have met Dhruv Prajapati, who is called India's Spider-Man. Using the scientific terms from the glossary above, write one page putting yourself in the same position as a spider-boy or spider-girl. What are you fascinated by? What would you like to tell others about the knowledge you have acquired?

AFTER READING

ACTIVITY 1: Biodiversity
After students finish reading, build their undertraining of biodiversity by showing them this video: https://www.youtube.com/watch?v=OITeTrLu-PM Watching the video, students will follow scientist Norman Platnick and his team into the forest in Ecuador. The team collects and identifies scores of tiny goblin spiders, revealing how much more there is to learn about the breadth of global diversity.

After watching the video, lead a discussion on biodiversity. ASK:
- What is biodiversity?
- Why is biodiversity important in natural habitats?
- Why is biodiversity important to people?

We are expecting that the teacher does an activity with the class in order to look at scale and also create a "hanger web" so that the students realise the complexity of building a web as well as the strength of a web structure.

ACTIVITY 2: Spider Science – Exploring the World of Webs
Introduce the activity by telling students to look at the photographs in **Engage Learning** magazine. Ask students to pay special attention to the webs shown in the photos. ASK: Spider webs seem pretty complex, don't they? How much bigger do you estimate the web to be compared to the spider that spun it? Can we estimate between five to ten times the size of the spider? Would you be able to make something that was five or ten times your own size? Tell students that they will do an activity that will help them understand the scale involved in making a spider web.

You need:
- measuring tape
- notebook
- pencil
- globe
- wall map
- chalk or stick

To do:
1. Divide students into pairs.
2. Use the measuring tape to measure your own height in centimetres. Record it on the board.
3. Then have students work in their pairs to measure their height in centimetres and record it in the science notebooks.
4. Tell students that a spider web can be ten times larger than a spider. Ask them to multiply their height by 10. You can do the same to demonstrate what you expect from students.
5. ASK: how large is your spider web. They should give the size in centimetres.
6. Explain to students that their spider webs are too large to draw on a sheet of paper. So instead of trying to find a really large sheet of paper, they will need to develop a scale. You might point out a map or a globe and explain that each is a scale model. You might point out the scale on the map and tell them what the scale is.
7. Help students choose a scale such as 60 cm = 1 cm. ASK: Using this scale, what is your height? (*A student 120 cm high would be 2 cm.*) THEN ASK: How large would your spider web be? (*20 cm*)
8. Have students draw their scaled spider webs on sheets of paper. After students finish their drawings, ask them to explain how developing scale models helps scientists. In developing their responses, you might direct students' attention to the globe or wall map.
9. After completing the discussion, you might take students outside and have them work together to draw one spider web on the ground. Depending on the material available outside the school, they can use chalk or a stick to draw the web.

ACTIVITY 3: How Strong is a Spider Web?

Explain to students that they will do an activity in which they will build a spider web. Before they do the activity, show them this website: https://www.smithsonianmag.com/smithsonian-institution/ask-smithsonian-how-do-spiders-make-webs-180957426/. It has a one minute video, plus a very simple explanation for how spiders make webs.

You need:
- dental floss
- a hanger
- a pair of scissors
- pipe cleaners
- several flat stones of different weights

To do:
1. Tie one end of the dental floss to the hanger.
2. Weave the floss across the hanger so, such that the floss is taken over and under other threads of the web.
3. Finish the web by cutting the other end of the floss from its container and tying it to the hanger.
4. Make "spiders" out of the pipe cleaners. Make sure that each spider has two main body parts and eight legs. Place the spider on the web.
5. Wrap a pipe cleaner around each flat stone. Form a hook, like a coat hanger at one end.
6. Have students develop a hypothesis about which parts of the web they think are the strongest. They might think the middle, the sides or the corners of the hanger are strongest. Have them explain why they think the part they chose is strongest. Remind students that a hypothesis is an explanation of a natural phenomenon. After a scientist develops a hypothesis, he or she tests it to see if it is correct or not. If not, they adjust the hypothesis and test it again. The process continues until the scientists find the correct hypothesis.
7. Hang the stones on various parts of the web to see if the web supports them. You might try placing the stones in different parts of the web to see which parts are strongest.
8. If the stones damage a part of the web, have students use more dental floss to repair it.
9. Have students adjust their hypothesis as needed. They may need to repeat hanging the stones. They may also need to hang heavier stones.

WEIRD WORLDS

SCIENCE OUTCOME: Students will learn that there are planets beyond our solar system and that these planets are called exoplanets.

LANGUAGE ARTS OUTCOME: Students will critically analyse the title of an article and make connections between literary devices used and science writing.

CURRICULUM CONNECTION

You already teach the different objects students can find in space. This article will develop a deeper understanding of what a planet is and how planets vary.

TAP PRIOR KNOWLEDGE

Distribute or have students take out their copies of issue 1 of **Engage Learning** magazine and turn to the two spreads that show the eight planets in our solar system. If the issue is not available, direct students' attention to a map of our solar system or another resource that shows the eight planets. Have students discuss how the planets are alike and different.

READY TO READ

➛ Direct students to turn to "Weird Worlds" on pages 22-23 of their copies of **Engage Learning** magazine. Have students look at the artist's drawing of a planet on the pages. Ask them if it reminds them of any of the planets in our solar system. (Most will probably say Saturn, but some may also mention Jupiter, Uranus or Neptune. All these responses are fine.) Ask them if they think the drawing really is of any of the planets they mentioned (*No.*) Explain that it shows a planet that is far from our solar system.

➛ Have students turn to pages 24-25 and read the first subhead. Explain to students that according to the Bible, Methuselah lived 969 years. This is a lifespan much beyond current human longevity and thus the subject of speculation. According to the New World Encyclopaedia (http://www.newworldencyclopedia.org/) "Modern science puts the natural limit on current human longevity below 130 years. The oldest person documented beyond reasonable doubt, Jeanne Calment, died at age 122. This being the case, Methuselah's lifespan has been a source of much speculation."

➛ After students finish reading the spread, ask them why scientists might have chosen to name a planet Methuselah. (*It is the oldest known planet*.) Then ask them if they can think of a mythical Indian figure who could have been used instead of Methuselah.

➛ After students have finished reading the article, ask them to discuss Chaturvedi's experiences and what she needed to learn to search for exoplanets. Explain that she had to learn more than just astronomy. She also had to know something about biology. Then ask students what other sciences might other astronomers need to study to gain a better understanding of our universe?

Have students turn the page and read the rest of the article.

AFTER READING

After students finish reading, discuss the following questions:

- What are exoplanets?
- How do scientists measure large distances in

the solar system? Why do you think this unit of measurement is used?
- How do we define a solar system and the possibility of the existence of life, based on our current understanding of life as we know it?
- Since we cannot directly see exoplanets, what is one of the ways that scientists have used for the discovery process? (There are three methods outlined in the article – eclipse, gravity and reflection of light. This may be an opportunity for the teacher to reinforce all three concepts already in the school curriculum.)
- What do you think drives an astronomer such as Priyanka Chaturvedi to carry out her quest?
- This article asks the question, "are we alone?" This can be a good way to initiate students' discussion about life and man's desire for understanding the unknown. The class can have a panel discussion using material from the magazine. The suggested roles for the panel may be a scientist, a government representative, a millionaire, an average middle class person, a student and an investment banker. The students may also add roles they think would be appropriate. Let them do a little research on space travel.

You might want to share the following videos with students.

From Richard Branson: https://www.youtube.com/watch?v=5KDXkILHbak
From The Economist: https://www.youtube.com/watch?v=-R2x02n-o64
How can India become a star in space tourism (*from Huffington Post*): http://www.huffingtonpost.in/anirudh-rastogi/space-tourism-and-the-ind_b_8524542.html

ACTIVITY 1: Design a Planet

Tell students to imagine that they are astronauts from Earth visiting an exoplanet. Explain to students that they are going to write a letter home about their experiences. **Level 3** students should write a paragraph describing the planet and **Level 4** students should write three paragraphs describing the planet. Direct students to use proper punctuation including commas, full stops and question marks where appropriate. Also remind students to use adjectives, adverbs and active verbs in their writing. After students have finished their writing, ask them to draw their world. Select students to read aloud their writing and show their drawings to the class.

ACTIVITY 1: Habitable Planets

Have students take out issue 1 and issue 5 and reread the space story in both issues of **Engage Learning** magazine. After students finish reading, split students into small groups of three to five. Tell them that they are scientists looking for habitable exoplanets. Ask each group to make a list of criteria that a planet needs to support life as we know it. Students should include distance fro the star, planet size, density, atmospheric composition, geology and other factors. After students finish, have them share their lists and discuss the criteria as a whole class. Keep a master list of criteria on the board.

ACTIVITY 2: Habitable Zone

In this activity, students will learn how a planet's distance from its sun affects whether or not it can support life. It also shows how the amount of light a planet reflects can affect whether life can exist on it. Do this experiment as a demonstration with the whole class. You can have students take turns moving the thermometers and telling the other students what the temperature readings are.

You need:
- 250 W infrared light bulb mounted in a lamp or portable socket
- a thermometer with a shiny bulb. (You can coat the thermometer with pieces of aluminium foil or leaf, if necessary.)
- a thermometer with a blackened bulb. (You can use soot to darken the bulb, if necessary.)
- 2 stands with clamps that can hold the thermometers.
- a metre stick
- a sheet of blank paper for each student
- a sheet of graph paper for each student
- 2 different coloured pencils for each student

To do:
1. Mount each thermometer in a clamp. Each thermometer should be positioned so that it is standing straight up and down. The bulb of each thermometer should be at the same height.
2. Place a thermometer on either side of the infrared bulb so that each is 80 cm from the bulb. **DO NOT allow students to hold the thermometers. Radiation from the bulbs will damage skin.**
3. Switch on the bulb and wait for the temperature reading from each thermometer to

stabilise. Record the distance and temperature of each bulb.

4. Move each thermometer 5 cm closer and wait for the temperature to stabilise. Record the distance and temperature of each bulb
5. Keep moving the thermometers closer in 5 cm increments and then record the temperature reading from each thermometer. Stop when you read 5 cm.
6. Use the graph paper to draw how the temperature changed with distance. Distance should be on the x-axis and temperature should be on the y-axis. Use different coloured pencils to draw the temperature for each thermometer.

Explain to students that if life as we know depends on liquid water for survival. Water is in a liquid state between 0º C and 100º C. This is called a star's habitable zone. Direct students to use a pencil to shade in the habitable zone on their graphs. Then use the graphs to discuss these questions as a whole class:

1. How did temperature change with distance?
2. How did temperature vary between the two thermometers? Explain why.
3. What does this experiment tell you about a star's habitable zone?
4. What would happen if a planet's temperature dropped below 0º C?
5. What would happen if a planet's temperature rose higher than 100º C?
6. What does the experiment tell you about how much light a planet reflects?
7. Use what you learned from this experiment to explain why many exoplanets cannot support life as we know it.