Use this space to write down any extra notes, questions, or ideas you have.

CreositySpace

Connecting Kids to STEM Through Entrepreneurship

My STEM Explorer Notes™

Solar Energy

Sun Catchers

Can we harness the power of the sun?

STEM Explorer:

What Is Solar Energy?

Did you know that in ONE HOUR enough energy from the sun hits Earth to supply all the power we need for things like heating our homes, running our electronics, and powering our schools and hospitals?

Solar power is all about harnessing energy from the sun's light. This can be done in two ways: either as passive solar thermal or as active solar power. Passive solar thermal uses the heat from the sun's light to increase the temperature of a place or object. A familiar example is a green house. Active solar power uses the sun's light or heat in one place to deliver electricity or heat to another place. Some examples include solar panels or solar heating tubes you see on the roofs of some houses. In the Solar Electric section we will see how solar panels convert the sun's light into electricity.

But what's actually happening?

It's one thing to KNOW that we get energy from the sun, but it's another thing to KNOW HOW we get energy from the sun. By knowing the HOW we can design and develop new innovations that harness the sun's power—helping both our communities and the planet.

Solar Energy Interactions

Pick an example of solar energy that is most interesting to you and use the space below to draw out a model of how you think the energy from the sun is used in that application. It doesn't need to be perfect, just what you're thinking now. Over the course of this unit update your model as you learn more.

Checklist:

- ✓ Sun
- ✓ Object/application interacting with the sun
- ✓ How energy is transferred
- ✓ What is responsible for that energy transfer (for example heat or light)

Solar Sleuthing

Welcome to Solar Sleuthing!

Over the next few weeks it is your job to uncover various properties of the sun and the stars, to understand what they do, what they are made of, and how that impacts our life on Earth (along with the lives of every other living organism on Earth).

As you are completing your investigations remember to ask yourself questions such as *Why is this important?* and *How can I apply this information to solve a problem or make something better?*

Light. Heat. Motion!

Radiometers help us to put some of the solar thermal phenomena from ***Some Like It Hot!*** into action. Literally!

The space inside the bulb of the radiometer is a partial vacuum (similar to outer space but with a little bit of air). The bulb must be made out of something strong and something that can let light and heat in but not air. Can you think of why this is important?

Shine your flashlight on the radiometer first so that the light hits the white sides of the **rotor vanes.** Then reverse it so that the light hits the black side of the **rotor vanes**.

If you have time, try a different light source.

What happens when you shine the light on the white side?

What happens when you shine the light on the black side?

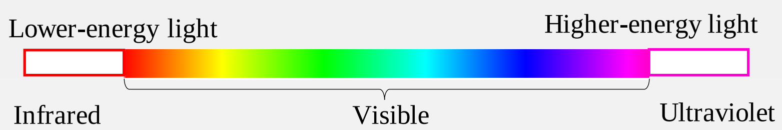
Why do you think this is happening? Why do you think it is important that there is a partial vacuum inside the radiometer bulb?

Write or draw your key takeaways from **Heat. Light. Motion!** If you remember, include the observations and learnings from **Some Like It HOT!**

What were your **observations?** 	
What did you **learn?** 	
Why does that **matter?**  How could you **APPLY** what you've learned?	

Solar Chemical

Light is made of very small pieces of energy called **photons**. The energy of the light determines its color. The color of the light determines if we can see it.



Light people can see is called **visible light.** The highest energy color of visible light is **violet** (or purple) and the lowest energy color of visible light is **red**. There is also light that is higher energy than **violet**, called **ultraviolet (UV)**, and lower energy than red, called **infrared (IR)**.

Even though people can't see **ultraviolet** light, there are a lot of chemicals that can absorb the **ultraviolet** energy and will glow a different color.

Discussion prompt: If people can't see **ultraviolet** light, why do you think you can see the light from your UV flashlight?

Color Creations

Objective

Using the UV flashlights, blocking materials, and UV beads, determine what happens to the beads when they are exposed to UV light and which materials can stop that from happening.

Materials needed:

- UV flashlight
- beads, string, key ring, other art supplies (optional)
- Blocking materials (foil, waxed paper, white cloth, dark cloth)

What others can you think of?

Before you do anything make a guess as to what will happen during the experiments. This guess is called your **hypothesis**.

What will happen to the beads when we shine UV light on them?	
Which materials will stop that change from happening (by blocking the UV light)?	
Which materials will allow that change to happen (by letting the UV light pass through)?	

Procedure:

1. Take the beads (7-10 of each kind), string, key ring, and any other art supplies you want and make something with them. Some examples are a bracelet, necklace, key chain charm, or anything else you can think of that will let you investigate what happens when you shine light on the beads. For these experiments you will need to be able to separate the beads into two groups, so make sure you are able to do that. Record what the beads look like at the beginning.
2. Cover one group of beads with one of the blocking materials.
3. Shine the UV flashlight over the beads for about one minute.
4. Remove the blocking material and record your observations of both groups.
5. Wait until all beads return to how they looked originally.
6. Repeat until you have tested all the blocking materials.
7. Summarize your observations and draw some conclusions about the properties of the blocking materials.

Experimental Observations

Initial observations

What do the beads look like before any experiments?

Blocking Material	Covered Beads	Uncovered Beads

What did you discover about materials and their ability to block UV light?

____

____

____

____

Can you propose a pattern or trend to help predict which materials will block UV light?

____

____

____

____

____

Some materials, like the UV beads, change color when exposed to light. Think of a new or improved product that could use materials that change color with light.

____

____

____

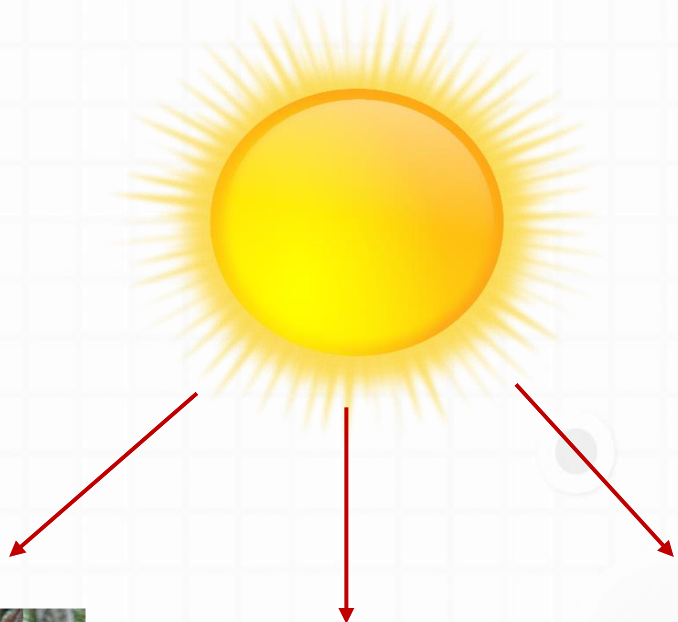
____

Write or draw your key takeaways from **Color Creations**.

What were your **observations?** 	
What did you **learn?** 	
Why does that **matter?**  How could you **APPLY** what you've learned?	

Follow the Energy

The sun provides energy for almost everything on Earth, either directly or indirectly. Determine the energy transformations as it moves from the sun to creatures and devices on Earth.



Write or draw your key takeaways from **Follow the Energy**.

What were your **observations?** 	
What did you **learn?** 	
Why does that **matter?**  How could you **APPLY** what you've learned?	

Star Light, Star Bright

The sun is the star at the center of our solar system, which makes it the most important star to us. However, it is far from the only star in the sky. The universe is filled with other stars and other interesting **celestial objects**, which have interesting properties and possible impacts on the world as we know it.

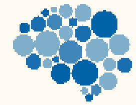
In Star Light, Star Bright you must research a ***celestial object*** of your choice and compare it to the sun. Make sure you compare at least five different properties. Some examples of things you can compare include:

- Size
- Composition
- Distance from Earth
- Apparent size from Earth (approximate)
- Key features (color, heat, interesting properties)
- Some reason why understanding this phenomenon has helped Earth or could help Earth

The sun

Write or draw your key takeaways from **Star Light, Star Bright**.

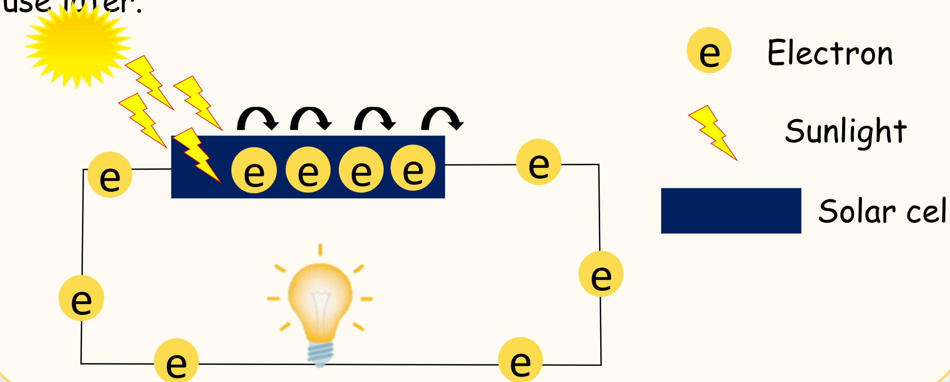
What were your **observations?** 	
What did you **learn?** 	
Why does that **matter?**  How could you **APPLY** what you've learned?	



Solar Electric

Sometimes we use the sun's energy for **heat**. Other times we use it to start a **chemical reaction**. In this section we will explore using the sun to make **electricity**.

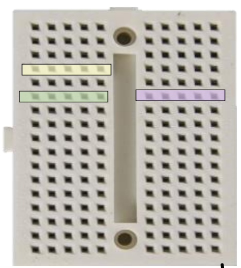
Solar electric (also known as solar photovoltaic) is the action of turning sunlight into electrical energy. To do this we need special equipment called **solar cells**. How do solar cells turn sunlight into electricity? They are made of materials called **SEMICONDUCTORS** that have special properties. Semiconductors are a mix between a **conductor** (like metal) and an **insulator** (like rubber). When sunlight hits a semiconductor, some of the electrons get pushed out (like too many people sitting on a bench) and they flow through the wires making electricity. At this point the electricity can be used to run a device (like a light or buzzer) or it can be stored in a battery to use later.



Solar Circuits

Breadboard

A breadboard makes circuit building easier.



All the spots in a row are connected to each other but each row is separate.

In the picture, spots that are the same color are connected but spots that are different colors are separate.

Solar cells

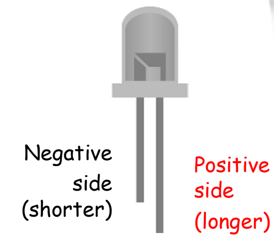
The solar cell is the power supply for your circuit. When it is exposed to light the solar cell can generate electricity. The wired solar cells can plug directly into the breadboard. **Red is positive, black is negative.**

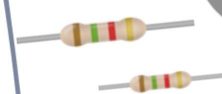
LEDs

An LED is a light source that gets its color from the type of material inside.

An LED must always have a resistor in the circuit to control the amount of current—if not, you will break the connections inside.

An LED has a positive side (longer) and negative side (shorter), so it must be connected in the correct direction.





Resistors

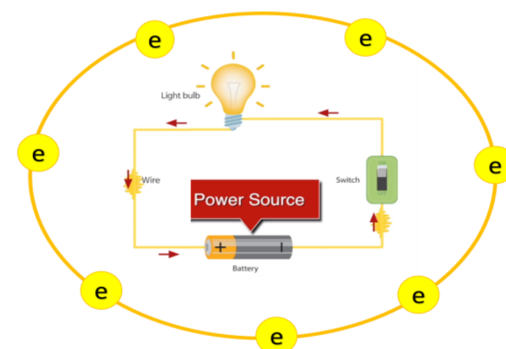
A resistor is like a sponge that soaks up extra current. **You need one of these to protect the LED.**

Buzzers

Like the LEDs the buzzers must be hooked up in the correct direction. **Red is positive, black is negative.**

What is a CIRCUIT?

When you connect all the parts of circuit you are completing a LOOP so that electrons can flow from one side of the power source (in this picture a battery) to the other.



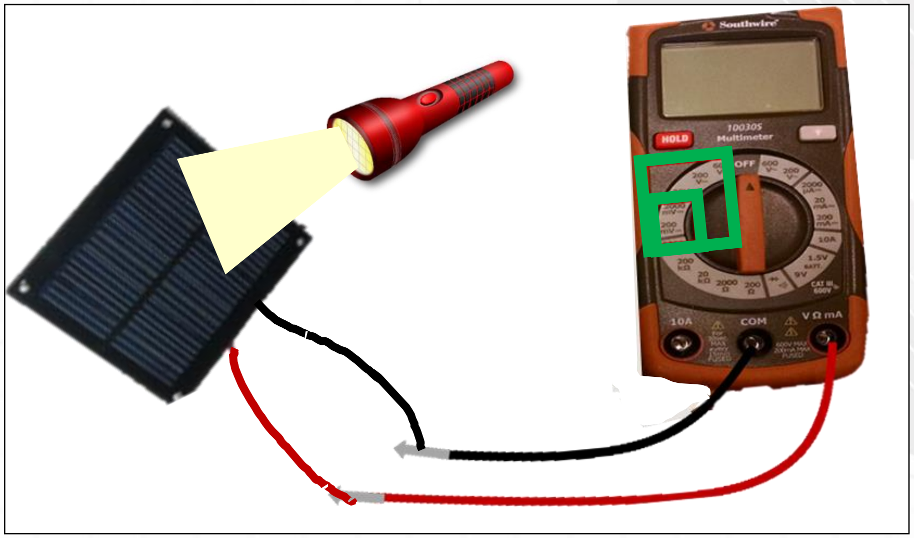
Measuring Your Solar Cell

A **multimeter** can be used to measure the voltage (or strength) of your solar cell. Here's how:

1. Make sure the dial is turned to 200 mV or 2 V/2000 mV (top left). The readout is the voltage in V.
2. The red lead/wire needs to be hooked into the V/Ω mA port, and the black wire/lead hooked into the COM port.
3. Attach the black wire of your solar cell to the black wire of the multimeter and the red wire of the solar cell to the red lead of the multimeter.
4. Shine various light sources on your solar cell and measure the power (voltage).
5. Record your results in the table on the next page.

Troubleshooting:

- Check dial position.
- Check wire connections (both into the multimeter and on the power source).
- Make sure multimeter batteries are working—use a AA 1.5 V battery as a test.



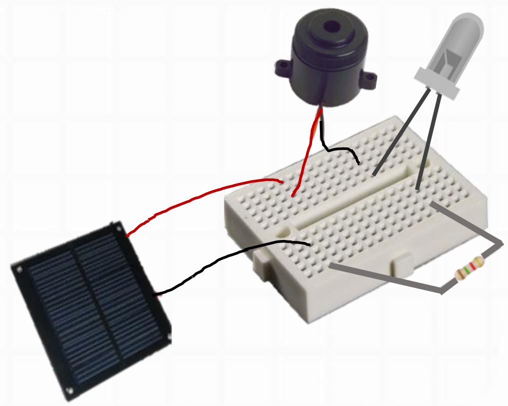
Light or Power Source	Voltage	Notes

Solar Circuits

Now it's time to design your circuits.
Draw and describe the circuit you create.

Example:

Solar circuit:



Light source: Window

Voltage: 3.5 V

Observations: Both the blue and white LEDs lit up
(both blue and white)
Buzzer went off.

Solar circuit

Light source:

Voltage:

Observations:

Solar circuit

Light source: ______________________

Voltage: ______________________

Observations: ______________________

____

____

____

____

Write or draw your key takeaways from **Solar Circuits**.

What were your **observations?** 	
What did you **learn?** 	
Why does that **matter?**  How could you APPLY what you've learned?	

Active vs. Passive

One cool thing about solar energy is that it can provide power to us in two forms—active or passive. What do you think the key difference is between active solar energy and passive solar energy? You can use the space below to do some brainstorming or write your thoughts.

Active Solar Energy	
Passive Solar Energy	

Active vs. Passive

Identify which of the following activities are **active solar** and which are **passive solar**. Provide a short explanation to justify each of your selections.

A photovoltaic system turning sunlight into electricity.	
Sunlight shines through a window. You sit next to it to warm up.	
Hanging clothes out to dry.	
Pumping hot water from panels into your house.	
A greenhouse letting light in for plants to grow.	
Using mirrors to reflect sunlight to a spot on the wall.	
A car heats up in the sun.	
Circulating pool water through panels to warm up a swimming pool.	
A solar cooker that concentrates sunlight to make cookies.	

WATTs Cooking?

For WATTs Cooking you will be working in teams to design a solar oven. Before you dive into your design, it's best to do a little research on solar ovens, how they work, and their critical design criteria. Use the space below to keep notes on your research.

Design Criteria

The table below lists possible design criteria. Add or remove criteria that are relevant to your design and then complete the table.

Parameter	Key Considerations
Box size (absolute)	
Box size (relative)	
Insulation	
Internal lining	
External lining	
Cooking container	
Lid	

Draw a detailed picture of your solar oven design and explain your design choice for key parameters. Be sure to clearly indicate the dimensions of your solar oven.

Determining Testing Conditions

To determine how you will run your solar oven, test the temperature and light intensity at various times and places around the school.

Location	Date and Time	Temperature	Light Intensity

Use your data to determine your testing conditions.
Describe your testing conditions below.

Solar Oven Testing

Weather conditions	
Cooking container	
Cooking material	

Observations

Time to heat up	
Time to cook	
Describe your visual observations.	

Describe your thoughts on your observations.

Class Data

Tabulate class oven heat-up times	
Tabulate class oven cook times	
Plot out class heat-up times	0
Plot out class cook times	0

Discuss how your heat-up and cooking times compare with the other ovens in the class (average and individually). Why do you think that is?

Solar Energy Interactions

It's time to revisit your model from page 3. Look back through your notes (including those in this notebook). What adjustments should you make to your model? Detail out your updated model below.

Checklist:

- ✓ Sun
- ✓ Object/application interacting with the sun
- ✓ How energy is transferred
- ✓ What is responsible for that energy transfer (for example heat or light)