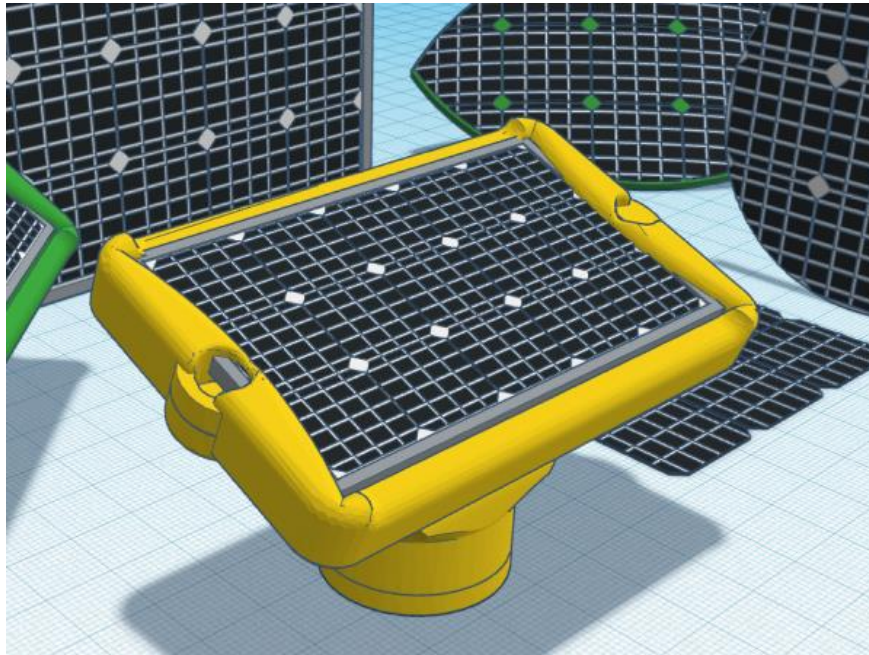




## Lesson Plan: Create a Solar-powered Invention



**Grades:** 5 – 12 (US)

**Duration:** 6h 30m

**Skills:**

- 2D design
- 3D design
- Mathematical computation
- Research
- Visual communication
- Problem solving
- Working with feedback

**Subjects:**

- Design
- Engineering
- Science
- Social Studies
- Math

### Lesson Plan Overview

Students create a solar-powered invention. First, they are given a brief overview of the invention process, including two key attributes of invention: The invention process does not have to be linear, and everyone is inventive! Although the process described here is linear, students may at times find it necessary to revisit each step in or out of order.

Students will begin by creating a detailed list of things they feel would be important when creating a solar-powered invention. As they move through the invention steps, they draw a 2D sketch of their invention and measure the dimensions, and then create their design in 3D using Tinkercad or art materials. Students are given a set of facilitative questions to help them evaluate their design. They then ask peers, friends, adults, or experts to provide feedback on their design. With this information in hand,



students go back and refine their invention designs. Once they're satisfied with their invention, students will prepare a short presentation to share their inventions with others.

### Learning Objectives

- Identify steps in the invention process.
- Use vocabulary words from this lesson that clearly express your ideas.
- Develop initial ideas on how you could solve a defined problem.
- Synthesize information and ideas based on research.
- Create a 2D representation of a solar-powered invention using art materials or digital resources.
- Create a 3D representation of a solar-powered invention within Tinkercad.
- Use the provided mathematical-computation and object-sizing tools to solve real-world problems.
- Review your ideas using the provided facilitative questions and direct feedback from others.
- Revise your invention based on input you feel is useful or valid.
- Present your finished invention to share your idea with others.

### Standards

- [ISTE Standard 4 | Innovative Designer](#): Students use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.
- [ISTE Standard 5 | Computational Thinker](#): Students develop and employ strategies for understanding and solving problems in ways that leverage the power of technological methods to develop and test solutions.
- [ISTE Standard 6 | Creative Communicator](#): Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats, and digital media appropriate to their goals.
- [CCSS, Grade 5, Geometric Measurements](#): Understand concepts of volume.
- [CCSS, Grade 6, Geometry](#): Solve real-world and mathematical problems involving area, surface area, and volume.



For more information about standards used in this lesson plan, visit these websites:

- ISTE: <https://www.iste.org/standards/for-students>
- Common Core (Math): <http://www.corestandards.org/Math/Content/5/introduction/>

## Materials

This is a list of materials each student will need to complete this lesson.

- Computer or tablet with online access to the Internet and Tinkercad
- Paper for sketching
- Ruler
- Paper, markers, crayons, or colored pencils/pens
- Computer with slideshow software, like Google Slides, PowerPoint, or Keynote (optional)
- 3D printer and supplies (optional)

You'll find links below where you can directly download and print files from the [Tinkercad Lesson Plan page](https://www.tinkercad.com/lessonplans/create-a-solar-powered-invention) (<https://www.tinkercad.com/lessonplans/create-a-solar-powered-invention>) that your students will need for this lesson.

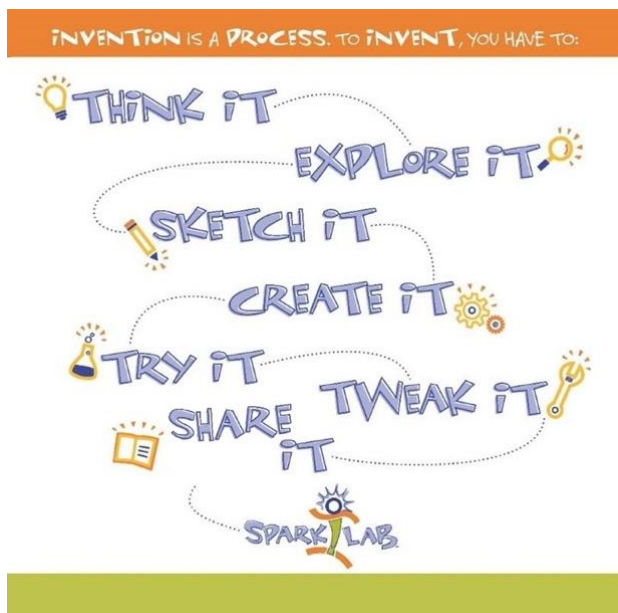
- [Evaluation Rubric](#) [PDF with fillable text fields]
- [Think It worksheet](#) [PDF]
- [Explore It worksheet](#) [PDF with fillable text fields]
- [Sketch It worksheet](#) [PDF with fillable text fields]
- [Try It worksheet](#) [PDF with fillable text fields]
- [Share It worksheet](#) [PDF]
- [Graph Paper](#) [PDF]

## Setting Up Your Class

If students are working remotely, ask them to use an online tool approved by your school, such as Zoom, to collaborate with each other. If students are working in a classroom, they can complete this lesson individually. Review the list of materials, and ask students to make sure they have them on hand when they need them.

## The Invention Process [45m]

### 1. Explore the Steps to Invention [45m]



#### Teacher Instructions

Have students review the invention process. Ask them to describe examples of when they've had to create a solution to a problem, and prompt them to think about how their problem-solving example fits into the invention process. Then, ask students to think about and share possible ways in which creating an invention may not go in the exact order of the steps outlined in the invention process.

#### Student Instructions

Explore the steps of the invention process and what happens at each step. Here are a few things to keep in mind as you invent a solar-powered device. You'll have a chance to explore these in more detail as you complete the lesson.

**1. The invention process is not always linear**, but inventors engage in these steps in some form or another.

- Think it: Get a great idea for an invention.
- Explore it: Investigate inventions and ideas of the past.
- Sketch it: Draw pictures and diagrams to figure out how your invention might work.
- Create it: Build a prototype or 3D model of your idea.
- Try it: Test your invention.
- Tweak it: Keep improving your idea.
- Share it: Market your invention to people who might buy it.



	<p><b>2. Invention takes practice.</b> The more you practice, the easier it will become to think of invention ideas and solutions to the problems you want to solve.</p> <p><b>3. <i>Everyone</i> is inventive.</b> As you go through your day, you often come up with solutions for solving both small and large problems. You may not think of those things as being inventive, but they are. Ready to practice your inventive thinking on the problem in this activity? You'll try new ideas, take risks, and learn how to keep going when things don't go as planned.</p>
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**Outcomes:**

- Identify each step of the invention process.
- Articulate ways that people practice inventive problem solving in their daily lives.

## Plan Your Design [2h 15m]

### 2. Think It [45m]



#### Teacher Instructions

Share the Think It worksheet with your students. *(Please see the worksheet link below.)* Ask students to come up with ideas for a solar-powered invention and use the worksheet to organize their ideas. If you choose to have students share their brainstorm ideas with the class, consider making a running list considerations and thoughts that students share.

#### Student Instructions

What kind of solar-powered invention will you create? Will your invention be large or small? How will your invention use the solar energy it collects? Will your invention have a way to store the solar energy? Who will use your invention? Brainstorm ideas, and record your answers to the questions below to complete the “Think It” step. Type your responses if you’re using this worksheet as a digital file, or handwrite your responses if you’re using this worksheet as a printed document. It’s very important to document your thoughts and ideas while inventing. This documentation becomes a part of your invention record.



**Materials:**

- [Think It worksheet](#) [PDF] *(Please click the link to download the worksheet.)*
- Physical or digital means for recording ideas or thoughts

**Outcomes:**

- Use vocabulary words from this lesson that clearly express your ideas.
- Develop initial ideas on how you could solve a defined problem.

### 3. Explore It [45m]



#### Teacher Instructions

Share the Explore It worksheet with your students. *(Please see the worksheet link below.)* Have students explore the resource links in this step, and ask them to do independent research to discover other ways this problem has been solved in the past. Encourage them to learn from what others have already tried and make sure that their solutions are new or different.

#### Student Instructions

Humans have used the sun's light and heat to keep them warm and to grow crops throughout history. Usable solar energy can be in the form of heat, light or electricity. In 1954, Bell Labs produced the first practical solar cell. Today, solar cells are used with everything from cars, to toys, to decorative lighting around our homes.

Type your responses if you're using this worksheet as a digital file, or handwrite your responses if you're using this worksheet as a printed document.

Explore these links to learn more about the history and science of solar energy:

[Click here to explore the Solar on the Line exhibition website.](#)

[Click here to see a timeline of the history of solar power.](#)

[Click here to watch a video that explains how solar panels work.](#)





	<p><a href="#">Click here to learn about Maria Telkes, the "Sun Queen."</a></p>
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	<p>Your teacher will give you instructions for sharing your work.</p>
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**Materials:**

- [Explore It worksheet](#) [PDF] *(Please click the link to download the worksheet.)*
- Online access for research
- Physical or digital means for recording ideas or thoughts

**Outcomes:**

- Develop initial ideas on how you could solve a defined problem.
- Synthesize information and ideas based on research.

#### 4. Sketch It [45m]



##### Teacher Instructions

Share the Sketch It worksheet with your students. *(Please see the worksheet link below.)* Have the students explore invention sketches and how they are used in the invention process. If students aren't familiar with drawing in 2D, ask them to watch the video for an overview of the process, and to take notes. Some students may choose to sketch on paper, while others prefer to use a digital resource. Give them instructions for how to share their work.

##### Student Instructions

Inventors use sketching to organize their ideas. Drawing an idea allows inventors to imagine what their invention might look like and how it will work. Try sketching out your invention before building! Take some time to sketch your ideas, images, and thoughts about what your solar-powered invention will look like and how it might work.

You can use this worksheet to sketch your ideas with paper and pencil, or you can choose to use a digital format. Remember: Inventors rarely get it right on the first try. Whatever the method, you may need to erase and redraw your invention as you continue to think through how you want to solve the problem. As you go through the Invention process, you may find it useful to revisit this step as you create new sketches or edit the sketches you have already created.

Sketches are meant to express the general size, shape, and parts of your invention idea. Sometimes they include measurements and sometimes they do not. Some inventors make very detailed and neatly drawn sketches while others make rough and messy sketches which still show the details of their invention idea. Make



	<p>sure that your sketch can help others to understand your invention idea.</p> <p>Your teacher will give you instructions for sharing your work. Review the following links for more information about sketching:</p> <p><a href="#">Learn more about inventors' sketches in the Smithsonian Collection.</a></p> <p><a href="#">Explore a blog post and video about the basics of 2D drawing.</a></p>
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**Materials:**

- [Sketch It worksheet](#) [PDF] *(Please click the link to download the worksheet.)*
- Physical or digital means for recording ideas or thoughts

**Outcomes:**

- Create a 2D representation of your invention idea using art materials or digital resources.
- Use mathematical computation to solve real-world problems.

## Design in Tinkercad [2h 15m]

### 5. Create It [45m]



#### Teacher Instructions

Students will access a basic set of digital materials on Tinkercad. Encourage students to not only use the materials in the set but to also change these materials and create new shapes. Their invention should reflect how they would solve this invention challenge.

Having basic knowledge of Tinkercad will help students with this lesson. If your students aren't yet familiar with Tinkercad, guide them through or have them independently complete the [brief tutorials](#). Encourage students to use the software to explore how to place, view, move, rotate, resize, group, copy, duplicate, hide, and align different shapes.

#### Student Instructions

##### [Create a Solar-powered Invention Tinkercad File](#)

Ready to build a prototype of your design in Tinkercad? A prototype is defined as an original model on which later stages or forms are based or developed. In this step, inventors get to see their idea turn into something real. Building a model can also help you learn about any issues there are with their invention design. Your prototype will show the size, shape, and form of your solar-powered invention.

How can you use these virtual materials to create a solar-powered invention? How will your invention make use of solar energy? Who will use your invention? What will your invention do?

During this step you can also make physical models, using materials you have on hand, based on your sketches and 3D design. If you make a model it does not need to be functional. 3D designed models and physical models help



	<p>you to better understand and express your invention idea.</p> <p>If you're not yet familiar with Tinkercad, review the <u><a href="#">brief tutorials</a></u> to explore how to place, view, move, rotate, resize, group, copy, duplicate, hide, and align different shapes.</p>
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**Materials:**

- Online access to Tinkercad
- Physical or digital means for recording ideas or thoughts
- [Create a Solar-powered Invention Tinkercad File](#) *(Please click the link to access the Tinkercad file; login required.)*

**Outcomes:**

- Create a 3D representation of your invention idea using Tinkercad.
- Use mathematical computation to solve real-world problems.

## 6. Try It [45m]



### Teacher Instructions

Share the Try It worksheet with your students. *(Please see the worksheet link below.)* Encourage your students to thoughtfully consider the facilitation questions in the worksheet along with feedback they receive from others. Let students know that feedback is not criticism of their ideas; it's a valuable critique that can help to make their invention better. Have students record their answers to the facilitative questions. Also have students take notes the feedback they receive along with any important pertinent information about the person giving feedback (such as "potential user of my invention," "friend," "career inventor," "teacher," "family member," or "artist.")

Most importantly, emphasize that the students are the inventors. It is up to them to decide how they will tweak their invention in the next step. Students have full and final authority to decide which facilitative answers and which feedback will or will not be used in the creation/design of their invention. The outcome of the invention activity is 100% student driven.

### Student Instructions

Now that you have created your 3D model, take some time to imagine how people would use your solar-powered invention. [Use the worksheet](#) (printed or digitally) to record your ideas, share them with others, and take notes on the feedback you receive.



**Materials:**

- Online access to Tinkercad
- Physical or digital means for recording ideas or thoughts
- [Try It worksheet](#) [PDF] *(Please click the link to download file.)*

**Outcome:**

- Review your ideas using provided facilitative questions and direct feedback from others.

## 7. Tweak It [45m]



### Teacher Instructions

Have students make a copy of their original design before making tweaks. This will serve to illustrate and preserve the iterative process that is inherent to invention. Suggest adding a “V2” or “version 2” to the name of copy that gets tweaked.

If your students become frustrated at any point during the invention process, encourage them and remind them that it’s ok if things don’t work perfectly, or at all, at first. Achieving their goals may take many tries.

### Student Instructions

Now that you’ve created your solar-powered invention, thought about how it would work, and shared your idea with others, it’s time to tweak your invention! Now is the time to ask yourself, “What changes can I make to improve my solar-powered invention?”

Inventors typically don't succeed with an invention on the first try. Inventors make changes to their prototypes to make them work better. Usually, they tweak their idea many times before it is finished. Once tweaks are made, inventors test their inventions again. It’s ok if things don't work perfectly, or at all, at first. It can take many tries to get it right.

Go back to your design in Tinkercad and tweak it based on what you learned in the “Try It” step of this activity.

### Materials:

- Computer with online access to Tinkercad
- Saved invention activity design
- Answers to facilitation questions
- Feedback notes from the “Try It” step of this activity





**Outcomes:**

- Review your ideas using provided facilitative questions and direct feedback from others.
- Revise your invention based on input you feel is useful or valid.

## Share Your Design [1h]

### 8. Share It [45m]



#### Teacher Instructions

Depending on the structure of your class, ask students to present their inventions to you or to the entire class. This can be done in person or on a remote learning environment. Students should be prepared to explain:

- The ideas generated during the Think It step
- What they learned about past and current inventions in the Explore It step
- How the Sketch It step help them further explore their ideas
- Some of the process they used while creating a 3D model during the Create It step
- What they learned from the facilitation questions and feedback, during the Try It step
- How they changed their invention during the Tweak It step
- What it was like to share out their idea during the Sell It step
- How they might use the invention process in their everyday lives

#### Student Instructions

The final step of the invention process is to “share” your idea, or persuade others of its usefulness and value. This usually happens after you have made your final tweaks. Be ready to explain the components and features of your invention. It is also helpful to express how your thinking about your invention progressed or changed as you worked your way through the invention process.

Keep in mind that usefulness isn’t always related to monetary value. Can you explain your creation to others and persuade them that it does the job in the most effective way?

Use this worksheet to plan how you want to share your work. Your teacher will give you further instructions.



<p>Share the Share It worksheet with your students. <i>(Please see the worksheet link below.)</i> Make sure students have access to any digital tools that might be helpful in presenting their work.</p>	
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**Materials:**

- Computer with online access to Tinkercad
- Sketches
- Try It facilitation answers and feedback
- Tinkercad “tweaked” design
- Slideshow software (optional)
- [Share It worksheet](#) [PDF] *(Please click the link to download file.)*

**Outcome:**

- Present your finished invention to share your idea with others.



## 9. Expand Your Ideas [15m]

### Teacher Instructions

As time allows, encourage students to expand upon their ideas and designs to add more depth to their inventions. In alignment with privacy guidelines for your school or district, consider sharing the story of your project work from this activity on social media with Tinkercad using the hashtag #TinkercadLearning:

- Tinkercad on [Twitter](#)
- Tinkercad on [Instagram](#)
- Tinkercad on [Facebook](#)

To share your project work with Spark!Lab use the hashtag #sparklab:

- Spark!Lab on [Instagram](#)
- Spark!Lab on [Twitter](#)
- Spark!Lab on [Facebook](#)

### Student Instructions

Congratulations on completing your project! Spend a few minutes thinking about ways you could share your invention ideas further:

- Make your invention design from this activity “public” on Tinkercad.
- Think about ways you can use the invention process for other ideas or other inventions.
- Use your inventive thinking to make things better other people.
- Use your inventive thinking to keep solving everyday problems that come your way.
  - Who will use your invention?
  - What makes your invention unique?
  - How does your invention work?

Here are some ways to make your invention ideas real:

- Create a working or representational physical model using a 3D printer, laser cutter, CNC, or other tools, OR
- Create a model using papercraft materials such as cardboard, paper, glue, tape, scissors, markers, etc.