Cutting Edge: Design to Prototype

Application of Laser Cutters

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Grade Level	6th – 9th Grade	**Time Frame**	125 minutes
Subject	Science	**Duration**	2-3 class periods
Course	Physical Science		

Essential Question

How do laser cutters use light and technology to precisely cut and engrave materials? What factors influence their effectiveness and accuracy?

Summary

In this technology lesson, students will learn about the technical details behind laser cutters like Glowforge, xTool, or the Beamo. Students will develop safety rules, examine the inner workings of the machines, review the science of lasers, and make a tangram puzzle using a laser cutter. The lesson will end with students critiquing their classmates' puzzles and reflecting on the creation process.

Snapshot

Engage

Students review prior knowledge and develop safety rules using the Partner Speaks strategy.

Explore

Students complete a Card Sort activity on the inner workings of a laser cutter at two different levels of complexity.

Explain

Students learn about the laser parameters and how that impacts the different cutting techniques and materials, then watch video examples of laser cutting.

Extend

Students draw tangram puzzles and scan them so teachers can create them using a laser cutter.

Evaluate

Students critique each others' puzzles and reflect on the real-world applications of the process.

Standards

ACT College and Career Readiness Standards - Science (6-12)

SIN202: Understand the tools and functions of tools used in a simple experiment
SIN401: Understand a simple experimental design
SIN701: Understand precision and accuracy issues
SIN702: Predict the effects of modifying the design or methods of an experiment

Next Generation Science Standards (Grades 6, 7, 8)

MS-PS1-5: Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

Next Generation Science Standards (Grades 6, 7, 8)

HS-PS3-3: Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Oklahoma Academic Standards (7th Grade)

7.PS1.5 : Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.
7.PS1.5.2: In a chemical process, the atoms that make up the original substances are regrouped into different molecules, and these new substances have different properties from those of the reactants.
7.PS1.5.3: The total number of each type of atom is conserved and thus, the mass does not change.Laws are regularities or mathematical descriptions of natural phenomena.

Oklahoma Academic Standards (7th Grade)

PS.PS3.1.3: Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.
PS.PS3.4.1: Energy cannot be created or destroyed, but it can be transported from one place to another and transferred between systems.

Attachments

- Card Sort—Design to Protoype.docx
- Card Sort—Design to Protoype.pdf
- Laser Cutter Diagram—Design to Protoype.docx
- Laser Cutter Diagram—Design to Protoype.pdf
- Lesson Slides—Design to Protoype.pptx
- Safety Practices Teacher Guide—Design to Protoype.docx
- Safety Practices Teacher Guide—Design to Protoype.pdf
- Tangram Frame—Design to Protoype.docx
- Tangram Frame—Design to Protoype.pdf

Materials

- Lesson Slides (attached)
- Laser Cutter Diagram handout (attached; one per group)
- Card Sort cards (attached; one set per group)
- Tangram Frame handout (attached; one per group)
- Safety Practices Teacher Guide (attached; one per teacher)
- Electronic devices
- Access to a laser cutter engraver
- Laser cutter and materials
- Pens/Pencils

Teacher's Note - Preparing the lesson

Card Sort - Explore

Print one Card Sort handout for each group and cut out all of the cards. Keep each set of the "Label Cards" and "Function Cards" separate either paper clipped or in zipped sandwich bags. We suggest laminating the cards and Laser Cutter Diagram handout for longevity and durability.

Google Slides - Extend

For the Extend activity, you will use our tech tool Google Slides and set it up. Before you begin, select the provided link:

- English version
- Spanish version

This will create a copy of the Google Slides in your My Drive. You will need to share the link with your students. Add your new URL as a link (either in full or as a shorter Bitly link) and/or QR code to **slide 15**. If you need help use our QR Code tech tool to find instructions. We suggest making one copy per class period since students will be editing on the slides during the lesson. Also, make sure there are enough blank slides based on the amount of small groups your class will have. Just right click any blank slide and select "Duplicate Slide."

25 minutes

Engage

Teacher's Note - Introducing the Lesson

The following lesson is the second in a series focusing on providing an introduction and application of laser cutters (see Cutting Edge: Science of Precision). While the term "laser cutter engraver" is the industry name for this type of machine, we will shorten it to "laser cutter" for the sake of clarity and flow throughout this lesson. See our linked Tech Tool card for more information.

Use the attached **Lesson Slides** to facilitate the lesson. Have students get into partners, display **slide 3**, and introduce the Partner Speaks strategy. Explain that students will talk with their partner about what they know already about lasers. They should use their conversations to develop safety rules. Remind students that they need to listen closely as after the timer goes off they will summarize what answers their partner gave. Start the four minute timer and have students start their conversations. After two minutes announce that if students haven't switched yet they should have the next person talk.

After the timer goes off, ask for at least three volunteers to share what they talked about. On your whiteboard or on a new Word Doc, write some of the rules students share. After you have all the rules written, as a class finalize which rules should be followed. Use the **Safety Practices Teacher Guide** as a supplemental resource to either check the rules created or to add more.

Transition through **slides 4-5** and discuss the Lesson Objectives and Essential Questions in as much detail as you feel necessary.

25 minutes

Explore

Teacher's Note

See the above **Teacher's Note: Preparing the Lesson** for help creating the different sets of cards.

Transition to **slide 6**. Students will now complete a Card Sort involving the components of a laser cutter. First, pass out a set of the "Label Cards" and **Laser Cutter Diagram** handout one per group. Have them use these cards to label the components of a laser cutter on the diagram. Once students have completed labeling the diagram, check their work before moving on.

Next, transition to **slide 7** and pass out the "Function Cards." These cards describe what each component does in the laser cutter. Students should now match their label cards to the function cards for each component of the laser cutter.

20 minutes

Explain

Navigate to **slide 8**. Go over the correct answers to the card sort as a class and ensure the students are on the same page about a laser cutter's design and the major components.

Display **slide 9**. Discuss with students the acronym for laser. Light is a type of radiation and lasers amplify the light to produce high energy beams. Lasers have mirrors to amplify the light and lens to focus the beam.

Move to **slide 10.** Explain to students that different lasers are used for different things. The lasers are determined by different parameters. These parameters are power, wavelength, cutting speed, and pulse frequency. Discuss how the parameters impact the materials used and cuts that are made.

Display **slide 11.** Show students the time lapse video laser engraving and laser cutting.

Use **slide 12** to explain the types of cutting that the lasers do. Each type is used for different types of materials and smoothness of the cuts. Define any unfamiliar terms such as sublimation: transition from solid to vapor and vapor: gas.

Navigate to **slide 13** and tell students about the Law of Conservation of Matter and the Law of Conservation of Energy. Discuss with students how laser cutters might follow the laws.

Teacher's Note - Sample student responses

Law of conservation of matter: the material that is being burned doesn't disappear, it gets converted into gases and smaller particles.

Law of conservation of energy: the energy from the laser is transferred into thermal energy to break apart components.

Teacher's Note - Additional resources

If you are interested in exploring more things a laser cutter can produce:

- Instructables - Laser Cutter
- GlowForge
- XTool (additional ideas under the "Learn & Explore" tab)

40 minutes

Extend

Move to **slide 14** and tell students they will now design a tangram puzzle that will be printed with a laser printer. Explain that the puzzle will be contained within a 6x10 frame, use 5-7 shapes with at least three different ones, and that all spaces need to be filled. Pass out one copy per group of the **Tangram Frame** handout. Explain that they will work with a group drawing the puzzle first using the handout, then either submit their drawing to be scanned into the printer or transcribe it to a different program first (see **TN: Alternative to Uploading Drawing**).

Teacher's Note - Alternative to drawing activity

If your Laser Cutter Engraver does not have the capability to scan a drawing, then have students take their drawing and transcribe it to Google Slides. Unhide **slide 15** and have students access the provided **Tangram Template** slides. After they have completed their drawing, have them follow the steps on the slide and export as an SVG file to send to you.

Teacher's Note - Optional Activity

Should time allow, you can use the cutter to make each of the puzzles in class and have students work on solving each other's puzzles. This is not necessary, but can make this process more exciting.

15 minutes

Evaluate

Ask students to set aside their materials and get out a sheet of notebook paper and a writing utensil. Display **slide 16** and instruct them to place all of the group members' names at the top of the paper. Using the Triangle-Square-Circle instructional strategy, ask students to answer the following questions:

1. For the *triangle,* think of three points (ideas, topics, etc.) that came up during this lesson that have direct real-world applications. How does one's knowledge of laser cutters address these problems?
2. List four things that *squared* with your thinking, meaning you found them to be interesting or relatable.
3. Are there any questions about laser cutters still *circling* your mind? Record at least one here.

When the students have completed their answers, if time allows, have a few students share out. Afterward, have each group turn in their papers.

Resources

- *Complement woodworking with laser*. (2021). Xtool.com. https://www.xtool.com/pages/woodworking
- Glowforge. (n.d.). *Bring your ideas to life.* Glowforge. https://glowforge.com/discover/
- Johnston, R. (n.d.). *Laser Cutting Video* [Video]. YouTube. https://www.youtube.com/watch?v=BFoRgz9tVsM
- K20 Center. (n.d.). Card sort. Strategies. https://learn.k20center.ou.edu/strategy/147
- K20 Center. (n.d.). Laser cutter engraver. Tech Tools. https://learn.k20center.ou.edu/tech-tool/4451
- K20 Center. (n.d.). Partner speaks. Strategies. https://learn.k20center.ou.edu/strategy/62
- K20 Center. (n.d.). Triangle-square-circle. Strategies. https://learn.k20center.ou.edu/strategy/65
- *Laser cutting projects*. (2017). Instructables. https://www.instructables.com/workshop/laser-cutting/projects/
- Lee, C. (2024, October 10). *What is laser cutting technology: Definition, process and how does a laser cutting machine work*. ACCURL. https://www.accurl.com/blog/laser-cutting/