The Tech
Museum of Innovation

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Animal Rescue

The Tech Challenge 2017 Lesson 1: English Language Arts

Developed by The Tech Academies of Innovation

I. Lesson Overview

Scientists often need to gather information in order to form a deeper understanding of the problem. Can your team gather scientific evidence to help inform the design of a device that will help move endangered animals from one protected area to another?

Lesson Description: This lesson connects the engineering design process with English Language Arts (ELA) reading, evaluating, and presenting skills. Students will obtain and evaluate scientific information through research that will support their engineering design decisions.

Grade Levels: 4-8

Education Outcomes:

Students will:

- Read informational text and identify the main idea and supporting details.
- Explain how evidence supports the main idea.
- Use age-appropriate research to support and justify design decisions.
- Present summarized design using researched evidence to support design decisions.

Education Standards

Met: (Note: bolded parts of the standards are fully met by this lesson)

NGSS Disciplinary Core Ideas (DCI):

3-5-ESTS1.B **Research on a problem should be carried out before beginning to design a solution.** Testing a solution involves investigating how well it performs under a range of likely conditions**.**

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NGSS Science and Engineering Practices (SEP):
Obtaining, evaluating, and communicating Information:
Scientist and engineers must be able to communicate clearly and persuasively the **ideas and methods they generate.**

Common Core Standards:
4th -5th Grades
CCSS.ELA-Literacy.W.4.9 and W.5.9 **Draw evidence from** literary or i**nformational texts to support analysis, reflection, and research.**

4-5th Grades:
CCSS.ELA-Literacy.RE.4.2 **Determine the main idea of a text and explain how it is supported by key details**; summarize the text.

CCSS.ELA-Literacy.RE.5.2 **Determine two or more main ideas of a text and explain how they are supported by key details**; summarize the text.

6-8th Grades:
CCSS.ELA-Literacy.RST.6-8.1 **Cite specific textual evidence to support analysis of science and technical texts.**

Addressed: (The following standards are practiced in this lesson but are not explicitly taught and assessed)

Next Generation Science Standards (NGSS) Performance Expectations (PE):
3-5-ETS1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

NGSS Disciplinary Core Ideas (DCI):
3-5 LS2.C: When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die.

3-5 LS4.D: Populations live in a variety of habitats, and change in those habitats affects the organisms living there.

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II. Advanced Prep & Set-Up for Lesson

Researching Simple Machine Advanced Set-Up

Materials (per approximately 30 students)

Note: Many of these materials are suggestions based on what students have found useful. This is not a limiting list – feel free to add other materials that you think may be useful to building the simple machines in this lesson. Think creatively and use materials you have on hand!

- A large and heavy object to use for demonstration [i.e. a box of books, heavy enough that it would be difficult to lift on their own]
- 6-8 rolls of masking tape
- 8 rulers
- 8 scissors
- 8 loads, 8 containers of play-doh (.6 oz.)
- 4-8 rolls of string or twine
- 10-30 feet of rope
- 10-20 sheets of cardboard, foam core board, and/or poster board, approximately 8.5 inches x 11 inches
- 10-12 large carabiners (rock climber coupling links), approximately 3-4 inches long
- 20-40 wooden blocks or scrap wood, approximately the size of 8 inch long sections of two-by-fours and/or various heavy books to stack
- 5-10 “over the door” hooks
- 15-20 various boxes or box lids that could be used to hold loads when building wheels or pulling loads
- 30-50 various round objects that can be used when building wheels or pulleys (e.g. ribbon or thread spools, cardboard tubes, plastic cups and/or lids of varying sizes, film canisters, corks, CDs etc.)
- 20-30 various objects that could be used for axles when building wheels or pulleys (e.g. straws of varying diameter, round dowels of varying diameter, chopsticks, pencils, etc.)
- 10-20 various stiff, flat, long pieces of wood, cardboard, plastic, or other material that could be used to build inclined planes, including some pieces that are at least 4 feet long

Set-Up

1. Set up the classroom so that students can work in groups of 4 students at 8 stations. There are 4 different station topics – one for each of the 4 simple machines (lever, pulley, wheel & axle, and inclined plane). In a class of 32 students you will need to have 2 of each station.

2. Put the heavy object you have prepared in a location where you can use it as a prop for the first design challenge. Make sure it is accessible so that students can come up and try to move it.

3. Prepare the handouts for each station: Lever, Wheel and Axle, Inclined Plane and Pulley. For each station, make sure that there are handouts printed with the descriptions for the simple machine of focus.
4. Place the materials in an area that is accessible by the students. Organize the materials so that it is easy for students to see what is available and how much of each item there is. Depending on the size of your class, it may be important to limit the traffic going up to the materials table. One idea is to only allow one student

from each team to come to the materials table. They can report back to the rest of the team what is available and they can make decisions together as to what materials the student will get for the team.

5. Prepare the handout for each team (see Appendix D: Research Simple Machine) to complete before building their simple machine.

Data and Observations:

Sample "Researching Simple Machines"

Researching a Simple Machine: Wheel and Axle

Research the simple machine assigned to your group. Make sketches and notes below. Include citations.

Sketch of **your simple machine** (Be sure to label key parts)

Sketches will be as varied as students' imaginations!

The way our simple machine works is: the axle goes through the center of the wheel and is attached. When the axle spins, it makes the wheel spin.

Citation: Wheel. Retrieved Sep. 16, 2016, from www.dkfindout.com/uk/science/simple-machines/wheels/

Two unusual real life examples of how our simple machine is used in the real world include: A door knob is an unusual example. The knob is attached to a rod that spins when you turn the know. Another unusual example is a windmill. The shaft rotates and that makes the stone that grinds the wheat turn.

Citation: Examples of Wheel and Axles. Retrieved Sep. 16, 2016, from www.mikids.com/SMachinesWheels/htm

From our testing, we learned that this simple machine is best for moving: heavy loads along a surface easily. The wheel is especially useful for moving things horizontally.

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Animal Rescue Advanced Set-Up

Materials (per approximately 30 students)

- 16 scissors
- 8 Loads (1 per team) All loads should be the same size and weight around 6-8 oz. (e.g. 6 oz Play-Doh, 3" X 3" stuffed animal, 20 linker cubes, blocks, 3" X 3" plastic toy animals, 8 oz water bottles, etc.)
- Various sizes and thickness of paper to make a platform (file folders, cardstock, cardboard, etc.)
- 30 small plastic cups (8 oz.)
- 15-20 various boxes or box lids that could be used to hold loads when building wheels or pulling loads
- 50 Rubber bands (size 64)
- 4-8 rolls of string or twine
- 100 Paper clips (jumbo size, 2 inches)
- 8 rolls of masking tape
- 40-60 various objects that could be used for axles when building wheels (e.g. straws of varying diameter, round dowels of varying diameter, chopsticks, pencils, etc.)
- 40-60 various round objects that can be used when building wheels (e.g. ribbon or thread spools, cardboard tubes, plastic cups and/or lids of varying sizes, film canisters, corks, CDs etc.)

Testing area:

- Create different testing surfaces to simulate terrain on endangered animal's habitat, For example,
  - 3' x 1' Smooth surface (like a tabletop) to simulate ice
  - 3' x 1' Semi-rough surface (low pile carpet square or cloth) to simulate dirt or sand
  - 3' x 1' Rough surface (shaggy carpet, Legos, small blocks, rocks etc.) to simulate grass and rocky terrain
- Long rectangular table or open floor space
- Targets for the devices to try to land on (can cut out 8" diameter circles, houses, trees, etc. out of construction paper)
- Landing target (made with tape)

Set-Up

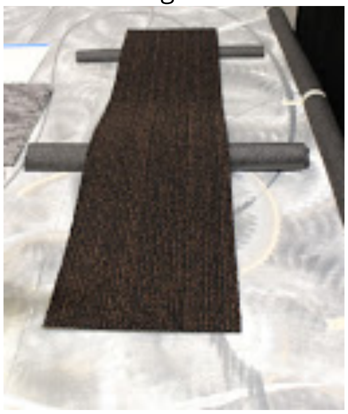
1. Set up the classroom so that students can work in groups of 4 students at 8 stations

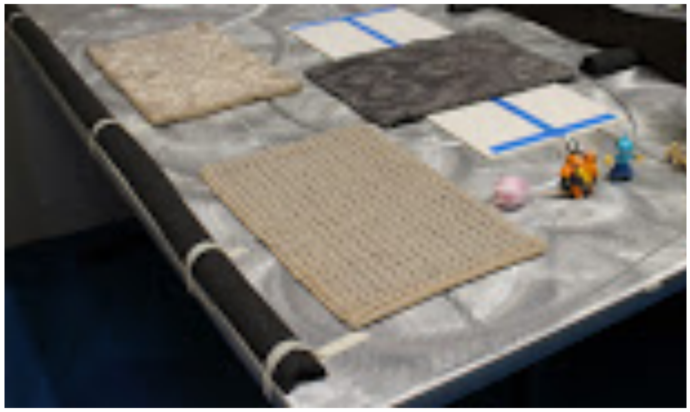
2. Place the materials in an area that is accessible by the students. Organize the materials so that it is easy for students to see what is available and how much of each item there is. Depending on the size of your class, it may be important to limit the traffic going up to the materials table. One strategy is to only allow one student from each team to come to the materials table. They can report back to the rest of the team what is available and they can make decisions together as to what materials the student will get for the team.

3. Set up the terrains on the floor or rectangular table away from the work space and materials if possible to help with the flow of traffic.

4. The target area should be placed about 4 ft. from the starting point at the end of the terrain.

Examples of terrain testing areas:





Data and Observations:

Sample "Researching Simple Machines"

Animal Research: Summary

Sketch of **Final Design Decisions** (Be sure to label key design decisions)

Sketches will be as varied as students' imaginations!

A key design decision we made is: to include a tree trunk so that the sloth can hang on.

We made this decision based on the following evidence: Sloths spend most of their time hanging upside down from tree branches and like to nest in the tops of trees

Citation: Sloth, Retrieved Sep. 16, 2016, from animalcorner.co.us/animals/sloth

Another key design decision we made is: to move the tree to the center of our device.

We made this decision based on the following evidence: When we tested the device, it was unbalanced and the device would tip over. When we moved the tree to the center, it stayed upright.

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III. Animal Rescue Lesson Guide

Guiding Question: Can your team use scientific evidence to inform the design of a device that will help move endangered animals from one protected area to another?

A. Introduction (40 minutes)

1. Introduce to students that they will be working together as engineers to solve a problem that is taking place right now. Show PBS Wild Ways introduction as part of this discussion.
   - [4-5th] Suggested discussion questions and video to draw on/build students' prior knowledge co-develop a problem statement include:
     - *Have you heard of any animals that might be **endangered** or **threatened**? Which ones?* [Possible answers include: Monarch butterflies, burrowing owls, pandas, gorillas, polar bears, orangutans, whales.]
     - *Do you know why they are endangered?* [Possible answers include: Loss of land, loss of food, human development, and human appetite.]
     - *These animals need our help! As we watch this video together, I want you to identify the animals that need help and why they need help. What's the problem?*
   - Show PBS's Wild Ways introduction from the beginning until 1:40.

> **Levels of Endangerment:**
>
> In the US, the Fish and Wildlife Lands is responsible for determining status of endangerment:
> - **Endangered Species**: species that are likely to become extinct throughout all or a large portion of their range.
> - **Threatened Species**: species that are likely to become endangered in the near future.
> - **Critical Habitat**: an area that is vital to the survival of endangered or threatened species.
>
> Globally, the International Union of Conservation of Nature (IUCN) determines the status of animals considered to be endangered.

   - Discuss and define the problem as a class:
     - *Which animals are endangered or threatened? [*Large mammals such as lions, elephants, bison, wolves, bears and migrating herding animals like deer, zebra, etc.]
     - *Why are they threatened? What's happening to them?* (Preserves are not big enough. [Their land is shrinking and becoming separated because of human development such as freeways, railroads, and housing. They cannot migrate to find food.]
     - *You are going to be engineers helping to solve this problem! We need your help to design solutions to help move threatened animals from one park to another.*
   - [6-8th]: Suggested discussion questions and video to draw on/build students' prior knowledge and co-develop a problem statement include:
     - *Have you heard of any animals that might be **endangered** or **threatened**? Which ones?* [Possible answers include: Monarch butterflies, burrowing owl, panda, polar bears, frogs, Florida panthers.]
     - *Do you know why they are endangered?* [Possible answers include: Loss of land, loss of food, human development, and human appetite.]

> **Visualizing the problem:**
>
> - It may be helpful to look at maps as a class that show the land set aside for Wildlife Refuges, Fish and Wildlife Lands, National Wilderness Areas, etc. Some places to find maps and illustrations are:
>   - California Department of Fish and Wildlife Lands Map
>   - National Wildlife Refuge System Map
>   - Wilderness.net Map of Wilderness Areas and Management

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- Show PBS's Wild Ways introduction from the beginning until 1:40.

- Discuss and define the problem as a class:
  - *Which animals are endangered or threatened?* [Large mammals such as lions, elephants, bison, wolves, bears and migrating herding animals like deer, zebra, etc.]
  - *Why are they threatened? What's happening to them?* [Preserves are not big enough. Their land is shrinking and becoming separated because of human development such as freeways, railroads, and housing. This process is called habitat fragmentation and is preventing animals from inter-breeding so that they are forced to mate with close relatives.]
  - *What is genetic diversity and why is it important?* [Genetic diversity is the passing on of genetic characteristics and serves to help species adapt to changing environments. Animals gain genetic diversity when they breed with others who are not in the same family. When animals are confined to smaller areas they have less chance of producing healthy offspring.]
  - *You are going to be engineers helping to solve this problem! We need your help to design solutions to help move threatened animals from one park to another.*

2. Tell students that we will be engineers during this project, and we're going to create (or engineer) a solution/device to help endangered animals move from one land reserve to another.
   - *But what is an **engineer**?* [Possible answers students might give: builders, construction workers, artist or scientists.]
   - *What do engineers do? / What kind of projects or objects might engineers work on?* [Possible answers students might give: build things, make engines, vehicles, electronics or buildings. Less obvious examples can include: software design, city planning, developing new medications, creating new materials or systems.]
   - There are many types of engineers in the world, but what they all have in common is that they design or create solutions to some type of challenge or real-world problem.

Vocabulary:

Engineer: An engineer is a person who designs and builds complex products, machines, systems, or structures to solve a problem or meet a need. Engineers want to know how and why things work. Engineers are changing the world all of the time. They think up creative, practical solutions, and work with other people to invent, design, and create solutions to real-world problems.

Engineering: Engineering is the process that engineers go through to create, design, test, and build a solution.

At The Tech we talk about engineering and innovation being about creative problem solving. When students practice solving problems through the design process it helps them to apply problem solving skills and perseverance to other problems they encounter.

3. Explain to students what engineering is, isn't, how it is connected to science. Introduce research as a critical part of science and engineering.
   - Identify times students have worked as engineers and solved problems in their own lives.
   - *Tell me about a time when you had to solve a problem or fix something that was broken?* [Examples might include fixing a bike or making a birthday gift for someone.]
   - *Whenever you work to create a solution, you are an engineer!*
   - *How are engineers and scientists different?* [Science is about finding knowledge about how and why the world works. **Engineering** is about using that knowledge to create a solution to a problem. Science uses a method to experiment and observe to verify knowledge. Engineering uses a process to build, test and create. Both science and engineering use math, modeling, and reading/writing.]

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4. Activate students' prior knowledge of engineering concepts and vocabulary.
   - *Since we will be engineers in this project, we should review important engineering rules and language. Although engineering is a field that is very diverse, all engineers have to understand what criteria and constraints are.*
   - Ask students if they know criteria and constraints are, or if they have an educated guess.
     - Criteria: The requirements or desired features of a design problem often describing the purpose and standards that a system or device must meet. Have students provide examples of criteria.
       - Purpose
       - Goal of the product
       - How well it will perform
       - Reliability
       - Aesthetics
       - Materials
     - Sample student definition: Criteria are things that you MUST have to have in your design. For example, a bridge must stand up and not fall apart.
       - Example: if you are making a car what are some things it MUST do? [A car must move. That is a criterion.]
     - Constraints: The limitations of a design problem which typically include budget and schedule limitations but may also include other limitations such as maximum size and restrictions. Have students provide example of constraints.
       - Budget (cost)
       - Schedule (time/ deadlines)
       - Practical real-world physical constraints (size, weight, power)
       - Environmental and human impacts (legal codes / ethical considerations)
     - Sample student definition: Constraints are things that restricts how you can design a device. Or constraints are rules that restrict how you can design.
       - Example: if you are making a car and you didn't have anything to use as a wheel.
       - Example: If the rules is do everything in one minute, it restricts your time, and is a constraint.

Criteria and Constraints in NGSS:

- For grades 3-5, Next Generation Science Standards (NGSS) defines criteria as desired features or criteria for success. Constraints are defined as available materials/ resources (time/cost).
- For grades 6-8 NGSS expands the definition of constraints to include human and environmental impacts as well as science knowledge.

5. Explain to students that research is a part of both science and engineering. Research exists in two forms: 1. scientific literature (books, magazine, and articles) and 2. Research also includes your own experiments and results.
   - *One of the most important things engineers do is to research information to help inform their solutions. This researching part is very important so that engineers can learn and improve on what other engineers have already discovered. Engineers read books and articles that other engineers or scientists have written. This writing and reading is an important part of how engineers communicate to share the knowledge they learned.*
   - *Why is it important for engineers to do research?* [Possible answers include: to learn; to make better designs; to understand the problem; to be knowledgeable; because it's fun.]
   - *How can researching about a topic help us become better engineers?* [Possible answers include: to build on and improve upon an existing solution; to avoid solutions that don't work; to understand the problem deeper.]
   - *What are some important points to keep in mind when we do research?* [Possible answers include: Finding reliable sources; citing information we find interesting; using safe search practices; highlighting or noting anything we find important; remembering the original goal of your research.]
   - Introduce the first Design Challenge for today and that one component of it will be doing research.

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Broadening the Problem

To allow for more creativity, broaden the problem as much as possible by using generic vocabulary such as device, vehicle or structure instead of more specific words such as: robot, boat or high-rise which might imply a specific solution.

For this lesson, you could broaden this problem beyond simple machines from "device" to "solution" and ask students for other innovations that might help to solve the problem. These might include innovations such as tunnels and bridges, which might also be researched and integrated into the final design.

B. Researching Simple Machines (2-4 class periods)

1. Review that research in science and engineering consist of two parts: 1) Reading what others have written about the subject. 2) Recording your own data through tests and observations. Explain that the class will be divided into groups and each group will research, build a model, then present information on their topic.
   - *As engineers we need to constantly take in new information, and one of the most important areas for us is to understand is simple machines—what simple machines are, how simple machines work, and how people have used them throughout history.*
   - Introduce the first design challenge to the students by telling them they are going to make some machines that humans use all over the world to make work easier in different ways.
   - Explain that each group will build a **simple machine** with the materials provided, and will use it to lift the same load 1 foot.
   - Explain that a simple machine is a category of tools that humans use to do work.
     - A **simple machine** is a tool to make work easier by changing the direction or amount of force you have to use.
     - They are called "simple," because they have very few moving parts. Most mechanical machines are made up of a combination of simple machines.
     - There are 6 classical simple machines: **inclined plane, lever, wheel and axle, pulley, wedge,** and **screw**
     - **Load** is another word for force, or what the structure has to hold up to. In a machine doing work, like simple machines, a load is the weight or mass being supported and/or moved.
   - We are going to focus on four types of simple machines that help to move loads: inclined plane, lever, wheel and axle, and pulley

Failure Leads to Success!

- One important aspect about engineering that is vital to how engineers solve problems but is very difficult for students is the importance of failure when working towards a solution.
- As engineers (and students) work on creating solutions and improvements, it is important to remember that failure is not only part of the process, it is necessary in order to improve and find success.
- It is important to celebrate the failures that students may experience during the design process so they can practice perseverance. Instead of "Oh no, that doesn't work!" try:
  - *Now you know what happens when you try that! You have more information!*
  - *What did you learn from that?*
  - *What will you try next to improve your design?*

2. Review Citation with the class.
   - Prompt: *As we research, we will find information that will be very useful or interesting. That's fine. We can use it, but we have to tell others where that information came from. This is calling citing.*
   - *Citing is important to give credit to the person or people who wrote the information you found and to help persuade others of the strength of your work. It's important to include the title, date and location of the video, article, or source to allow you or others to find that information again.*

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3. Introduce the research project and design challenge.
   Design Problem:
   - Moving animals can be challenging, like any heavy object, it might require machines to help us. Research simple machines to understand how they can make it easier to move heavy objects.

   Criteria (Design Requirements/Desired Features):
   - Using the guide, research how your assigned simple machine works.
   - Find 3 examples (picture, video, realia, article, etc.) of your simple machine used in the real world.
   - Draw your engineering innovation and label the parts.
   - Build a small-scale model of your simple machine.
   - Demonstrate how your simple machine works in a presentation
   - Cite three sources where you found your information.

   Constraints (Design Limitations):
   - Budget: You may only use the materials provided
   - Schedule:
     - You have 3 class periods to research, build and plan your presentation
     - You have 5 minutes to present your research.
   - When lifting the load, you may only touch the load with the materials, not your body.

   Budget and Schedule
   Adapt the budget and schedule to fit your students and unique situation. These might include:
   - You may want to expand the budget by allowing students to use "pre-approved" materials brought from home.
   - You will want to adapt schedule constraints to the amount of time your students will need for the project.

   Testing:
   - Your team will test your designs at your tables as you go to see how well you can move a load using only your assigned simple machine.
   - Fill in your data sheets with your observations as you build and test. Be sure to notice and take notes on the direction of movement your simple machine supports the best.
   - Be prepared to share with the class about your simple machine.

4. Pass out Researching Simple Machines handout *(see Appendix D, "Researching Simple Machines")* with instruction on researching, sketching, and presenting. Assign a different simple machine to each group (Wheel, Lever, Inclined Plane, Pulley, Wedge or Screw.) While students are researching, ask facilitative questions to help guide students to practice critical thinking, and engineering concepts. Some examples of facilitative questions include:
   - *What are the critical parts of your simple machine? What can you can add to your sketch that shows how your simple machine works?*
   - *How does your assigned simple machine make work easier?*
   - *How might this simple machine be useful in moving an animal? What kind of animal? Why?*
   - *What materials might you use to make a model of this simple machine? Why?*
   - *Why do you think it's important to cite the information you have found in your research?*
   - If resources are available, have students put together a presentation on Google Slide, or PowerPoint. If technology is not available, have students use a tri-fold or poster to present.

5. Introduce build time to make a replica of their simple machine to demonstrate during presentation.
   - Prompt: *Now that you have finished researching how your simple machine works, we are going to build a model that you can use in your presentation. The data you collect from your testing of your model is another form of research for supporting your design decisions.*

- Assign a supply coordinator to bring back supplies for the group.
- While students are building, teacher should ask facilitative questions about physics and building:
  - *Why did you choose those particular materials?*
  - *How did your research help you decide how to build this model?*
  - *What did you learn from testing?*
  - *How will you communicate what you learned to the class?*

Gender Equity and Team Roles

Often, without realizing it, we notice girls and boys falling into certain roles on mixed teams. We've noticed that girls tend to be recorders and that it may be assumed that certain individuals "aren't leaders."

Instead of allowing students to volunteer for certain roles, ensure that everyone experiences every role. You might have team members rotate recording responsibilities for each iteration, for example.

Leadership skills should be taught to all students. Help them to practices ways other than delegating to facilitate input and involvement of all team members. Good leaders ask questions and make sure everyone's ideas are heard.

6. Have students reflect on the process of research. Present the engineering design process *(see Appendix D, "Engineering Design Process")*, and have them identify the unique paths each team took.
   - Prompt*: Researching and sharing is essential to the work of engineers and scientists, by reading and sharing what they learned and the results of their experiments, they are able to work together and build. What were some things that you learned from researching and sharing today?*
   - Show engineering design process visual and explain to students that as engineer we are participating in a process that almost all engineers use. Have students identify where in the process researching and sharing took place.
   - Ask students questions to help hem reflect on the process they went through before introducing the process fully.
     - *Looking at this diagram, where did your team start? Why did you start there?*
     - *Did all the groups start in the same spot?*
     - *Does it matter where you start? Why or why not?*
     - *What is an example of something your group needed to try more than once?*
     - *How did going through the cycle more than once help your team?*
   - Ask students to explain how the diagram illustrates what they were doing while they were working on their simple machines. Help guide a conversation about how they solved their problems as engineers while using the diagram as a guide. Explain to students that this is called the **design process**, which is the process that engineers use to solve problems creatively as they do their work every day. Some aspects of the design process to make sure students emphasize:
     - The process is iterative – engineers test their solutions and make changes and test again, just like they did when building their simple machines
     - There is no one way to follow the design process – different engineers solve problems in different ways, the same way they did in their groups.
     - Students are following the same process as adult engineers, because they are real engineers as well!
   - As your students work through the design process, you'll want to be flexible and receptive to the different approaches your students may try.
   - Ask students to notice where they are in the design process and even to trace their path through the steps, so they can see how messy it can be.

C. Content Learning (90-120 minutes)

1. Recap research challenge, remind students we are engineers in this lesson. As engineers, researching allows us to be better-informed and to set better criteria in our design.
   - Prompt: *Now that you've learned how to do research from written sources, we'll work on how engineers use research to help them inform and justify their design. This is all a part of the process that engineers go through to learn, test, build, and communicate.*

2. Lead discussion on the importance of reading and writing in the field of science and engineering.
   - Emphasize the importance of communication between engineers and ways in which it is vital to solving problems and creating solutions in the real world.
     - *Communication is perhaps the most important aspect of science and engineering. By communicating, we are able to share ideas and build a body of knowledge that leads to new discoveries and inventions.*
   - Display visuals of important inventions in history and connect inventions to other key scientists and engineers.
     - The Wright brothers' flight was built on knowledge of mechanics in bicycles and machinery.
     - Modern computer languages today are built on mathematics of binaries and computations.
     - Wildlife conservation comes from the knowledge of ecology, biology, anthropology and more.

Teaching History of STEAM:

Teaching the history of science and engineering is a strategy to engage students to historical contributions, progression as field of study, and connections to various fields. It is recommended to use visuals such as timelines, and have supplementary reading materials. Below are some reliable recourses.

- http://www.historiatimelines.com/shop/timeline-history-wall-charts/history-of-science-timeline/
- Recommended literature:
  Smithsonian's "Timelines of Science"
  Smithsonian's "Visual Timelines of Inventions"

3. Conduct a guided practice of identifying main idea and details in text as a class.
   - Prompt: *As we read the following article together, we are trying to answer the question "What is this article mainly about?"*
   - As a whole class chorally read an online article about wheels such as *Wheels* article found on the *DK findout!* Website.
   - Conduct the following discussion to draw out main idea and supporting details while developing whole class understanding of the wheel—an important simple machine for later lessons.
     - *What would you say this article is mainly about? What specifically does it tell us about wheels?* [It tells us how wheels make work easier.]
     - Have students highlight or underline the main idea in one color.
     - *What are some specific examples of evidence that support this main idea that wheels make work easier?* [Wheels reduce friction by rolling instead of dragging along the ground. A small push at the edge of the wheel makes the middle of the wheel turn faster.]
     - Have students underline each example of evidence in a different color than they used for the main idea.
   - *As researchers, we have our own main idea that we need details for. As engineers, we need to know* ***how to build a wheel*** *so that it will work properly. Put your finger on anything in this article that might help you know how to build a wheel.* [Students might point to the diagram, or the caption below the diagram that describes how the wheels are attached to axles, which spin round and round.]

Learning Vocabulary

It's critical for all students and especially our English Language Learners to learn new vocabulary within context and to infer definitions from that context.

As students read, encourage them to circle unfamiliar words and terms. Ask them to give you their best guess of the meaning of these words based on the context before looking up the definition. Point out how words like "effort" might have a different meaning in science and engineering than they do in everyday context.

As a class, write age-appropriate definitions for key words (e.g. axle). Post these vocabulary in the room with a picture or object, when appropriate.

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- *Using evidence from this article, what recommendations would you make to someone who is going to build a wheel?* [A wheel needs an axel which is a pole. The axel goes through the wheel and spins the wheel around?]
- *Does the wheel spin freely on the axle?* [No. The axle spins the wheel around.) Refer back to the wheel model that the wheel group built to verify that the wheel is fixed on the axle. If not this would be a recommended iteration for this group to improve their design.]
- Demonstrate how a wheel reduces friction by reducing the surface area that makes contact with the ground. Using the carpet square, have students try dragging the across classroom carpet or floor. Demonstrate how much of the carpet comes in touch with the floor when it is flat. By rolling it into a circle, demonstrate and compare how much surface area comes into contact with the floor as a cylinder.
- As a whole class, model how to cite this article: (Article title. Date retrieved, from URL)
  - Wheels. Retrieved September 16, 2016, from http://www.dkfindout.com/uk/science/simple-machines/wheels/

4. Assign groups of four and introduce new research on creating a transportation device for an endangered animal. Assign an animal and pass out Animal Research handouts *(see Appendix D, "Animal Research")* to each group.
   - Prompt: *Remember at the very start of our lesson, we had a real life situation as engineers to help solve. That situation is that we need to find a way to move threatened animals from one preserve to another? That will be your job as engineers. But like engineers you must first research your endangered animal and learn as much as you can about them to create the best device.*
   - Divide class into groups of 4, and pass out a specific Animal Research handout with each group's assigned animal and a generic Animal Research: Summary sheet to every group. Explain that in our next project, they'll design devices to share in class and will need to justify their design choices with details or evidence from research as well as from their testing data.
   - While students are researching, ask facilitative questions and provide reminders to cite.

D. Animal Rescue Device (3-5 class periods)

1. Re-introduce the challenge, and provide time table to finish and present.
   - *Now that we have done our research on our animals, we are going to design, build, test, and present.*
   - [6-8th] *First, let's look back at your research on animals and ask yourself what are some criteria that must be true for this device to support the survival of the animal? What are some constraints that you will have to deal with?*

   Design Problem:
   - Use your knowledge of both simple machines and animals to design a device that will transport animals safely over different simulated terrains.

   Criteria (Design Requirements/Desired Features):
   - Device must be able to move a 6-8 ounce load across all of the terrains.
   - [4-5th] Must provide at least 2 pieces of evidence with at least 2 citations from your research to support at least 2 design decisions.
   - [6-8th] Must provide at least 3 pieces of evidence with at least 3 citations from your research to support at least 3 design decisions.
   - [4-5th] Must provide at least 1 pieces of evidence from your testing data to support at least 1 design decision(s).

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- [6-8th] Must provide at least 2 pieces of evidence from your testing data to support at least 2 design decision(s).
- Must include a sketch of your final design that includes labels of key design features.
- All team members must contribute to the design, sketching, building, recording results on data sheets, and presentation.

Constraints (Design Limitations):
- Budget: Use only the materials provided.
- Schedule: You have ___ class periods to complete the challenge.
- Presentation will be limited to 10 minutes.

Testing:
- Your team will test your design by releasing your model down the ramp and measuring how far it travels over each terrain.

2. [6-8th] Guide students in defining animal-specific criteria for their solution. In this case, students may end up with somewhat different criteria and constraints. Some questions to guide this discussion may include:
   - *What does your assigned animal need to survive?*
   - *What are some unique characteristics of your animal that might need to be considered when thinking about transport?* (e.g. size, tendency to be social or alone, specific temperature needs etc.)
   - *Given these needs, what will they need during transport?*
   - Sample responses might include: Elephants will need something that can support their weight. Bears need to be able to move alone. Herds need to move with their herd.

3. Have students sketch, design, create, test and iterate models of their solution. Explain that designs will be tested on simulated environments like carpet for dirt, bumps for hills, etc.
   - Prompt: *Because our animals are in different habitats, we will simulate how well the device works by testing the device on different surfaces. The smooth table surface will represent ice. The table with Legos will represent a rocky surface. The carpet will represent a grassy habitat. The carpet with Legos will represent a very harsh terrain with rocks and vegetation.*
   - While students are building, ask facilitative questions:
     - *What kind of terrain will this device go over?*
     - *Which survival needs are you meeting with your solution? How?*
     - *If this was built in real life, how big would it be? How heavy would it be?*
     - *How did your research inspire your design? What did you learn from your research that helped you decide on this solution?*

4. Have groups present and include:
   - Sketch
   - A recitation of their assigned animal, the criteria, and the constraints.
   - Demonstration of their model, and results of their tests on those simulated environments.
   - Ask facilitative questions:
     - *Which animal are you moving and why?*
     - *What design decisions did you make? What evidence from research (both written and from your testing) supports these design decisions?*
     - *How does your design meet the challenge of the terrain?*
     - *Can you explain the features you put into your design to meet the criteria?*

E. Evaluation (45-60 minutes)

Formative assessments and evaluation of student learning is integrated throughout the lesson. This section summarizes suggestions for implementing summative evaluations, as well as creating authentic experiences for the students around the design challenges and their learning by making work public.

Having students participate in an authentic presentation or discussion of their work is a great way to reinforce the idea that they too are engineers, and that their work should be shared with community and the public in similar ways. Finding some way to bring students' work to a larger audience also helps to build on the idea that engineers help people in creative ways and are part of something larger than themselves.

> **Claim Evidence Reasoning**
>
> Claim Evidence Reasoning is a helpful framework for students to justify their design decisions. Included in this lesson is a worksheet that may help facilitate the construction of these arguments. (See Appendix D, *Claims, Evidence and Reasoning Worksheet*).
>
> For more information on this framework, see the *Formulating scientific explanations using the Claim, Evidence, and Reasoning framework. – A resource for teachers to understand the CER framework from NSTA.* http://static.nsta.org/files/sc1503_32.pdf

1. Consider allowing students to select the project they want to do to demonstrate how devices can transport animals. There are many options for this, and this section will focus on some specific examples. Some ideas are:
   - "Youtube" style video explaining how wheel and axle works
   - Museum exhibit or demonstration of their design
   - Use designs to teach younger students about the endangered animals.
   - Write a sales pitch to sell the design to the animal rescue teams.
   - Newscast of the problem facing animals in their reserves.
   - Other ideas students come up with.

2. Review the rubric with students at the introduction of the project so they know what their learning goals are. It is important to allow students to "begin with the end in mind," just as teachers backwards plan, using standards and assessments to inform units, topics, and day-to-day activities.

3. The rubric included in this lesson guide is designed to evaluate student mastery of the "met" standards using the categories *Below Standard, Approaching Standard, Meeting Standard,* and *Above Standard.* This allows teachers to give individual feedback particularly for the students who are Below Standards or Above Standard in particular areas.
   - In the Below Standards and Above Standards sections of the rubric, the idea is that no student should be receiving these scores without personalized attention from the teacher – either as remediation or as extension to reach students where they are.
   - With that in mind, the descriptions and observations in these two sections are simply examples of what you might see for students performing at that level. The comments and notes in these sections should be tailored to the specific student and should accompany individualized support and conversations.

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4. At the end of a project or design sequence, engineers (and indeed all scientists) share their work with an audience, whether that is the client or other stakeholders. For students, this type of presentation is just as important. Connecting students with an authentic audience is key to driving engagement and helping students relate what they are learning to the real world. Our goal here is to ensure that our budding engineers feel the interconnectedness of what they are doing and experience the "why" behind problem solving.
   - Some ways to do this are:
     - A mini conference
     - A panel
     - Teach back to younger students
     - Recommendations/ proposal to important constituents
     - A letter to the editor
     - A multimedia presentation to post on the Internet
   - Think through what you want students to gain from the interaction:
     - If it's technical feedback, think about inviting experts for a pitch session or judging panel
     - If it's response or action, think about having students make presentations to a community group or decision-making body (such as a school board, city council, or neighborhood association)
     - If it's a celebration, think about inviting community members whose talents or contributions are being honored or recognized in student projects
   - Try to connect to who the audience would be for the "real-world" version:
     - If students are producing documentaries, plan a red carpet screening event
     - If students are making sense of history, set up a museum-style exhibition
     - If students are producing literature, plan a book release party, author chat, or poetry slam

5. When students have completed the design challenge and have reflected as a class, remind them that they will be completing self-reflections on how they did throughout the design challenge and the design process. Review the parts of the self-reflection with them, and remind them that reflection is part of the process and is how we improve. Just like during the engineering process, we have to be honest with ourselves and others about what went well and what we still need to improve.

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IV. Appendices

A. Vocabulary

The following is the start of a suggested list of words to discuss as you read and discuss with students.

term	**student-friendly definition**
claim	a short answer to the question you are trying to investigate
constraint	the limitations of a design problem which typically include budget and schedule limitations but may also include other limitations such as maximum size restrictions
criteria	the requirements or desired features of a design problem often describing the purpose and standards that a system or device must meet
design problem	The identified challenge, goals, or needs that a design addresses. What you are trying to solve.
design process	a series of steps that engineers use to guide them as they solve problems. The process is nonlinear but cyclical, meaning that engineers repeat the steps as many times as needed, making improvements along the way of imagining, creating, reflecting, testing and iterating. These are steps used to come up with solutions: [design process graphic goes here]
drag	force is always opposite to the object's motion, and unlike friction between solid surfaces, the drag force increases as the object moves faster
effort	the force apply on to a machine
endangered species	animals a species of animal or plant that is seriously at risk of extinction
engineer	a person who designs and builds innovative solutions (machines, systems, or structures) to solve a problem or meet a need
engineering	the process that engineers go through to create, design, test, and build a solution
evidence	data and/or facts that supports the claim statement
fact	a statement that can be verify to be true or false
failure point	a place where the design or system failed
friction	the resistance that one surface or object encounters when moving over another.
force	strength or energy as an attribute of physical action or movement

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habitat fragmentation	the process by which habitat loss results in the division of large, continuous habitats into smaller, more isolated remnants.
iteration	when you try different solutions (create, test, reflect, imagine) over and over
mechanical advantage	the ratio of the force produced by a machine to the force applied to it, used in assessing the performance of a machine.
opinions	statements that are based on feelings
load	another word for force, or what the structure has to hold up to; in a machine doing work, like simple machines, a load is the weight or mass being supported and/or moved
optimal design	the design or device that best meets the criteria and constraints
prototype	the models that you build to test before you get to your final solution
reasoning	an explanation of how and why evidence supports claim in an informational text
structure	the material or arrangement of parts in an object to make up the whole
trade-off	a situation in which you must choose between or balance two things that are opposite or cannot be had at the same time

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B. Resources and Background Information

Resources:
Part A: Setting up the Problem

- PBS Nova's Wild Ways Video – A documentary on habitat fragmentation highlighting real world problems and engineering solution. http://www.scienceforkidsclub.com/wheel.html
- World Wildlife Federation website – A useful directory of endangered animals with quick facts and pictures. https://www.worldwildlife.org/species/directory?sort=extinction_status&direction=desc
- 500 Elephants Are Being Moved By Crane- Article about cranes being used to relocate elephants. https://www.buzzfeed.com/jasonwells/500-elephants-are-being-moved-by-crane?utm_term=.ueOqyGKJl5#.htrN35JmwB
- 500 Elephants moved to new home- Story about elephants being relocated. https://www.thestar.com/news/world/2016/07/19/500-african-elephants-moved-to-new-home.html
- Animals who are on the brink of extinction-This resource is to assist students on animals close to extinction. http://www.worldanimalfoundation.net/wildlife.html
- CITES Safe transport of live animal recommendations-This a resource that describes the guidelines for transporting animals. https://cites.org/eng/resources/transport/index.php
- Human impact on animal migration-Student friendly article on the impact of human development on animal migration. Would be a good mini-lesson on reading non-fiction text as it relates to our design challenge problem. http://www.takepart.com/article/2015/03/31/migration-and-threats
- Human impact 'footprint-Video describes how humans affect animal ecosystems. Explains the problem of human encroachment on animals and the need for transport devices to preserve the animals. Great video to show students as a follow up to the design challenge problem. http://study.com/academy/lesson/human-impacts-on-the-environment.html

Part A and B: Engineering Resources

- Types of Engineers:-Resource with pictures and descriptions of real life engineers to present to students. Shows career opportunities in the field of engineering. http://www.nacme.org/types-of-engineering
- The Engineering Design Process-Worksheet for the students to document design engineering process from start to finish. http://teachers.egfi-k12.org/wp-content/uploads/2010/05/Post-lesson-Student-Activities-Engineers-and-the-Engineering-Design-Process.pd

Part B and C: Researching Simple Machines Resources

- Wheel Facts from Science for Kids – An online resource with kid friendly information on simple machine. http://www.scienceforkidsclub.com/wheel.html
- Mocomi Kid's video on wheel and axle – A short video and article explaining how the wheel and axle works. http://mocomi.com/wheel-and-axle/

- Tools and simple machines-Describes basic simple machine, including real-life examples and diagrams. Can be used for teacher background information and/or can be presented to students as an introduction to simple machine design and function. http://www.explainthatstuff.com/toolsmachines.html
- Dirtmeister's Science Reporters – A student-friendly website that explains simple machines and how they work. http://teacher.scholastic.com/dirtrep/simple/invest.htm
- Buzzle, Simple Machines: Pulley Systems – Background information on pulleys, pulley systems, and the forces and physics that they involve. http://www.buzzle.com/articles/simple-machines-pulleys-system.html
- Buzzle, Simple Machines – Background information on simple machines including facts, history, and working mechanisms. http://www.buzzle.com/articles/simple-machines/
- Science Trek Simple Machines Facts – A student-friendly website that explains simple machines, how they work, and gives history of each one. http://idahoptv.org/sciencetrek/topics/simple_machines/facts.cfm
- Tools and simple machines-Describes basic simple machine, including real-life examples and diagrams. Can be used for teacher background information and/or can be presented to students as an introduction to simple machine design and function. http://www.explainthatstuff.com/toolsmachines.html

Part D: Researching Animals Resources

- Top 10 animals in danger of extinction due to human impact-Teachers can use this to show students some animals to be used as possible research topics. http://www.biologicaldiversity.org/programs/population_and_sustainability/species.html
- Animals across the globe-Panda/China- This animal can be chosen as a possible research topic for students. http://www.worldwildlife.org/species/giant-panda
- Elephant-This animal can be chosen as a possible research topic for students. http://www.worldwildlife.org/species/elephant
- Gorilla-This animal can be chosen as a possible research topic for students. http://www.worldwildlife.org/species/gorilla
- Kitfox-This can be chosen as a possible research topic for students. http://www.worldwildlife.org/places/chihuahuan-desert
- San Joaquin Kit Fox-This can be chosen as a possible research topic for students. https://www.wildlife.ca.gov/Keep-Me-Wild/Kit-Fox
- Kitfox-This can be chosen as a possible research topic for students. https://www.fws.gov/sacramento/es_kids/san-joaquin-kit-fox/es_kids_san-joaquin-kit-fox.htm

Extension Resources

- Formulating scientific explanations using the Claim, Evidence, and Reasoning framework. – A resource for teachers to understand the CER framework from NSTA. http://static.nsta.org/files/sc1503_32.pdf

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Background Information:

The Engineering Design Process:

Introduce the engineering design process graphic with students to show how engineers engage in fun, creative, problem-solving that is core to their work *(see Appendix ___ for more background information).*

- Explain to students that as engineers go about solving problems and coming up with creative and innovative solutions to challenges, they follow the **design process.**
  - **Design Process**: a series of steps that engineers use to guide them as they solve problems. The process is non-linear but cyclical, meaning that engineers can follow the steps in no particular order, repeat the steps as many times as needed, and make improvements along the way of imagining, creating, reflecting, testing and iterating.
- We represent this process with a graphic that shows the main steps someone goes through as they solve a problem.
  - Define your problem: What is the problem you are trying to solve? What are the **criteria** (design requirements that will determine the success of your solution)? What are the **constraints** (real-life limitations like budget and schedule) that you have to work within?
  - Test/reflect – imagine – create: This is the main part of the process that is cyclical. This is where engineers go through multiple designs as they have ideas, try something out, test it, have new ideas, and incorporate it all into more building and testing. This process can go through many rounds as an engineer gets more information from each test and design that is tried.
  - Share your solution: Engineering is about teamwork, and engineers frequently learn from each other as they solve problems. It's important for students to communicate and share throughout the process so that just like real engineers, they can learn from each other and improve their solutions. It's particularly important to culminate a project with a formal sharing of solutions and perhaps even a showcase or other authentic way to share lessons learned with the broader community (e.g. community members, family members, principal, younger students etc.)
- When you see the design process in action, you'll notice that it's rarely the smooth succession of steps that the diagram implies. The steps often overlap and blur, and their order is sometimes reversed—it's a creative, fluid way of working that has to be adapted to each individual situation.
- As you guide students through the design process, you'll want to be flexible and receptive to the different approaches your students may try.
- Ask students to notice where they are in the design process and even to trace their path through the steps, so they can see how messy it can be.

Failure

One important aspect about engineering that is vital to how engineers solve problems is the importance of failure to learn and improve solutions.

- As engineers work on creating solutions and improvements, it is important to remember that failure is not only part of the process, it is necessary in order to improve and find success.
- Every time an engineer fails to solve a problem completely, s/he learns a new piece of information about how the design functions and how to make it better.
- When engineers find a part of the design that doesn't work, it is called a **failure point**.
  - A **failure point** is a design element that can cause an unsuccessful result. This is the point in a system that if it fails, the whole system fails.
- It is important to celebrate the failures that students may experience during the design process. Instead of "Oh no, that doesn't work!" try

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- *Now you know what happens when you try that! You have more information!*
- *What did you learn from that?*
- *What will you try next to improve your design?*

- Failure is an important part of the design process and should be celebrated as a positive way to learn. It is important to remind students that there is no single “right” answer in engineering; one problem can have many solutions.

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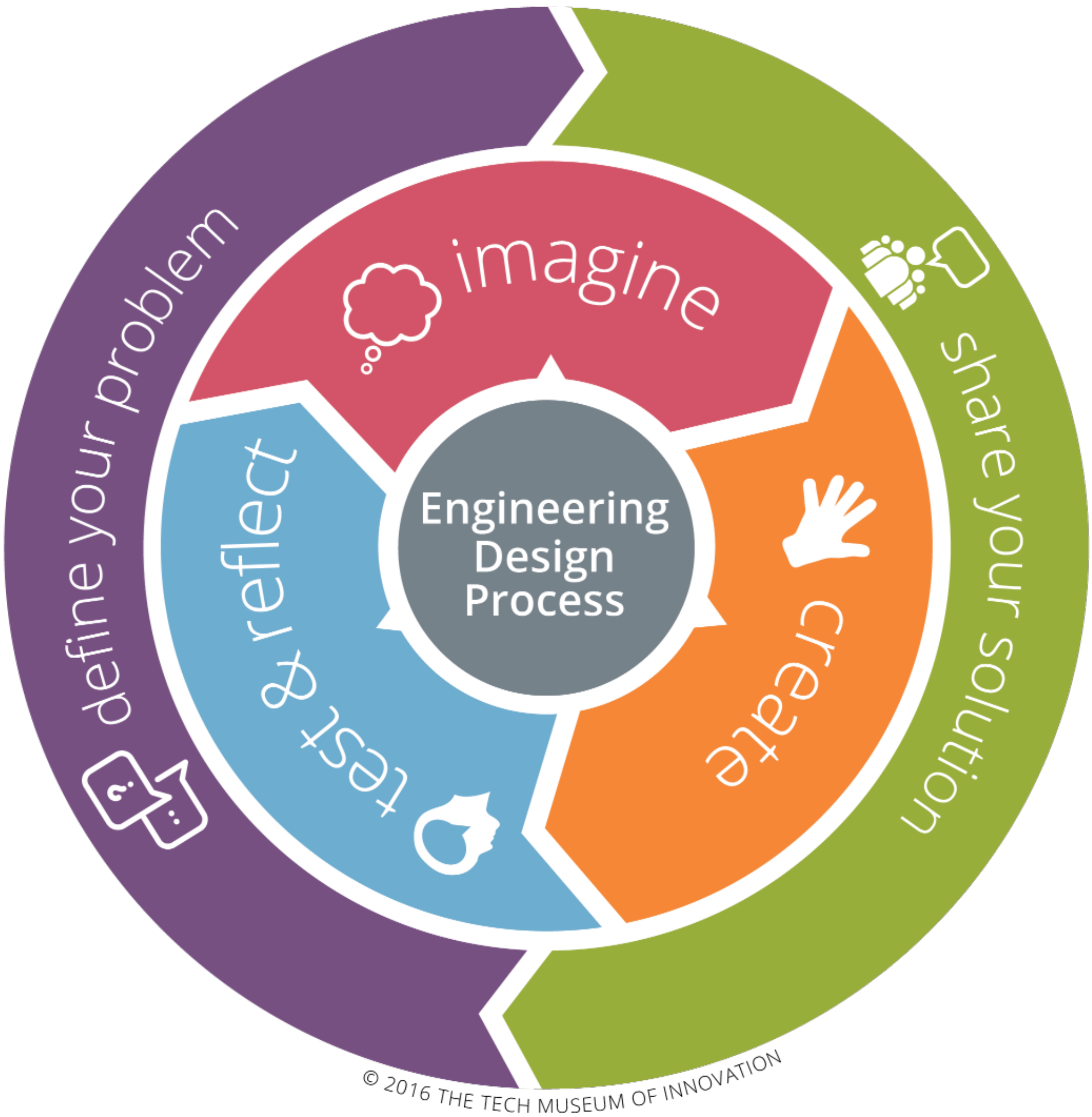
D. Lesson Handouts

Name: ___________________________________

Date: ____________ Class: _________________

Engineering Design Process



Name: ______________________________

Date: ___________ Class: _______________

Researching a Simple Machine: _______________

Research the simple machine assigned to your group. Make sketches and notes below. Include citations.

Sketch of **your simple machine** (Be sure to label key parts)

The way our simple machine works is: ____

____

____

____

____

Citation:____

Name: ____________________________________

Date: ____________ Class: __________________

Two unusual real life examples of how our simple machine is used in the real world include:

____

____

____

____

____

Citation:____

From our testing, we learned that this simple machine is best for moving: ___________________

____

____

____

____

____

Any other important information about building or using this simple machine: _______________

____

____

____

____

____

____

Name: ______________________________

Date: __________ Class: ______________

Animal Research:
Ethiopian Wolf

The Ethiopian Wolf *(scientific name: Canis simensis)* is critically endangered. Find some important information about the Ethiopian Wolf to help you build a device to transport it to safety.

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Habitat & Climate			
Food			

Name: ______________________________

Date: __________ Class: ______________

Ethiopian Wolf (Continued)

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Size & Weight			
Anything else important to survival			

Name: ____________________

Date: __________ Class: ____________

Animal Research:
Pygmy Three-Toed Sloth

The Pygmy Three-Toed Sloth *(scientific name: Bradypus pygmaeus)* is critically endangered. Find some important information about the Pygmy Three-Toed Sloth to help you build a device to transport it to safety.

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Habitat & Climate			
Food			

Name: ______________________

Date: ________ Class: __________

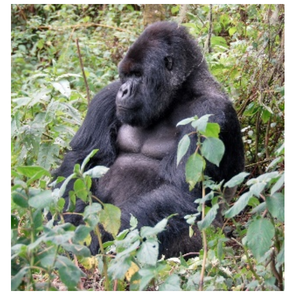
Pygmy Three-Toed Sloth (Continued)

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Size & Weight			
Anything else important to survival			

Name: ____________________

Date: __________ Class: ____________

Animal Research: **Western Gorilla**



The Western Gorilla *(scientific name: Gorilla gorilla)* is critically endangered. Find some important information about the Western Gorilla to help you build a device to transport it to safety.

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Habitat & Climate			
Food			

Name: ____________________

Date: __________ Class: ____________

Western Gorilla (Continued)

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Size & Weight			
Anything else important to survival			

Name: ______________________

Date: __________ Class: ______________

Animal Research:
Amur Leopard

The Amur Leopard *(scientific name: Panthera pardus orientalis)* is critically endangered. Find some important information about the Amur Leopard to help you build a device to transport it to safety.

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Habitat & Climate			
Food			

Name: ______________________

Date: __________ Class: ______________

Amur Leopard (Continued)

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Size & Weight			
Anything else important to survival			

Name: ____________________

Date: __________ Class: ______________

Animal Research:
Sumatran Rhinoceros

The Sumatran Rhinoceros *(scientific name: Dicerorhinus sumatrensis)* is critically endangered. Find some important information about the Sumatran Rhinoceros to help you build a device to transport it to safety.

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Habitat & Climate			
Food			

Name: ______________________________

Date: __________ Class: ______________

Sumatran Rhinoceros (Continued)

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Size & Weight			
Anything else important to survival			

Name: ______________________

Date: __________ Class: __________

Animal Research:
Asian Elephant

The Asian Elephant *(scientific name: Elephas maximus)* is endangered. Find some important information about Asian Elephant to help you build a device to transport it to safety.

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Habitat & Climate			
Food			

Name: ______________________________

Date: __________ Class: ______________

Asian Elephant (Continued)

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Size & Weight			
Anything else important to survival			

Name: ______________________

Date: __________ Class: ____________

Animal Research: ______________________

The ____________________ *(scientific name: __________ __________)* is endangered. Find some important information about this animal to help you build a device to transport it to safety.

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Habitat & Climate			
Food			

Name: ______________________________

Date: ____________ Class: ________________

________________ (Continued)

	Evidence Research and document specific survival needs of this animal.	**Citation** • Where did you find this information? • Who wrote or published it? • When?	**Ideas** How can we use this information in our transportation device?
Size & Weight			
Anything else important to survival			

Name: ______________________________

Date: __________ Class: ______________

Animal Research: Summary

Sketch of **Final Design Decisions** (Be sure to label key design decisions)

A key design decision we made is: ____

____

We made this decision based on the following evidence: ______________________________

____

____

____

Citation:____

Name: ______________________________

Date: ____________ Class: ________________

Another key design decision we made is: ____

____

We made this decision based on the following evidence: ____________________________

____

____

____

____

Citation:____

Another key design decision we made is: ____

____

We made this decision based on the following evidence: ____________________________

____

____

____

____

Citation:____

Name: ______________________________

Date: __________ Class: ______________

Claims Evidence and Reasoning (CER) Worksheet

The QUESTION: ____

____

CLAIM: When you start your response to the question, state your claim. ____________________

____

____

____

	Evidence Support your claim with your facts, data, science literature, graphs, and other forms of research.	**Reasoning** State what the evidence means. How and why does this evidence help to support your claim? Be specific. Use words such as demonstrates, shows, tells us, etc.
Evidence #1		
Evidence #2		
Evidence #3		

Name: ___________________________

Date: __________ Class: ______________

Complete your scientific explanation by restating your claim, evidence, and reasoning in the space below.

[Claim] ____

____

____

____

[Evidence] ____

____

____

____

____

____

____

____

____

[Reasoning] ____

____

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____

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Name: ____________________________

Date: __________ Class: ______________

Animal Rescue 4-5th Grade Rubric

Standard and Topic	Below Standard	Approaching Standard	Meeting Standard	Above Standard
(CCSS.ELA-Literacy w.4.9 - 5.9) ***Draw evidence from*** *literary or* ***informational texts to support analysis, reflection, and research.*** *CCSS.ELA-Literacy.RE.4.2* ***Determine the main idea of a text and explain how it is supported by key details****; summarize the text.* *CCSS.ELA-Literacy.RE.5.2* ***Determine two or more main ideas of a text and explain how they are supported by key details****; summarize the text.* *(Practice 8 of NGSS)* *Obtaining, evaluating, and communicating Information:* ***Scientist and engineers must be able to communicate clearly and persuasively the ideas and methods they generate.***	*Areas that individual students may need one-on-one support with*: • Differentiating opinions vs facts in text. • Identifying the main idea of a text. • Identifying supporting details within a text. • Explaining why detail supports main point.	• Justifies 1 design feature with evidence in informational text • Documents 1-2 pieces of evidence that support these design decisions. Reasoning is clear, but may lack detail or the logic may not always be clear. • Only 1 citation is included or citations may be missing some parts but do include the title and URL.	• Justifies 2 or more design features with evidence in informational text • Justifies 1 or more design features with evidence from testing. • Documents 3 or more pieces of evidence that clearly and logically support these design decisions. • Accurate and complete citations are included from at least 2 sources of evidence documented.	*Areas where students may exceed:* • Quickly finds multiple, salient points of evidence. • Summarizes evidence in their own words. • Makes strong arguments. • Regularly uses citation in writing and presentation. • Supports every main idea with supporting evidence *Ideas for next steps for growth:* • Incorporate CER framework into writing scientific arguments. • Encourage student to research a topic around which they are passionate or to write a persuasive letter to someone on an issue of interest.

Name: ______________________________

Date: __________ Class: _______________

Animal Rescue 6-8th Grade Rubric

	Below Standard	Approaching Standard	Meeting Standard	Above Standard
Standard and Topic *CCSS.ELA-Literacy.RST.6-8.1* ***Cite specific textual evidence to support analysis of science and technical texts.*** ***Standard and Topic*** *(Practice 8 of NGSS)* *Obtaining, evaluating, and communicating Information:* ***Scientist and engineers must be able to communicate clearly and persuasively the ideas and methods they generate.***	*Areas that individual students may need one-on-one support with*: • Differentiating opinions vs facts in text. • Identifying the main idea of a text. • Identifying supporting details within a text. • Explaining why detail supports main point.	• Justifies 1-2 design features with evidence in informational text • Documents 2-3 pieces of evidence that support these design decisions. Reasoning is clear, but may lack detail or the logic may not always be clear. • Only 1-2 citations are included or citations may be missing some parts but do include the title and URL. • Arguments presented for design decisions aren't entirely clear which makes it difficult to be persuasive.	• Justifies 3 or more design features with evidence in informational text • Justifies 2 or more design features with evidence from testing. • Documents 4 or more pieces of evidence that clearly and logically support these design decisions. • Accurate and complete citations are included from at least 3 sources of evidence documented. • Arguments presented for design decisions are clear and persuasive.	*Areas where students may exceed:* • Quickly finds multiple, salient points of evidence. • Summarizes evidence in their own words. • Makes strong arguments. • Regularly uses citation in writing and presentation. • Supports every main idea with supporting evidence *Ideas for next steps for growth:* • Incorporate CER framework into writing scientific arguments. • Encourage student to research a topic around which they are passionate or to write a persuasive letter to someone on an issue of interest.