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| **Lesson Title:** Ancient Machines | |  |
| **Grade Level:** 4 | **Quarter:** 2 |
| **Standards:**  **Science:**  S4P3a. Identify simple machines and explain their uses (lever, pulley, wedge, inclined plane, screw, wheel and axle).  S4CS5. Students will communicate scientific ideas and activities clearly.  b. Make sketches to aid in explaining scientific procedures or ideas.  c. Use numerical data in describing and comparing objects and events.  **MATH:**  **MCC.4.MD.3** Apply the area and perimeter formulas for rectangles in real world and mathematical problems. *For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.*  **MCC.4.MD. 4** Make a line plot to display a data set of measurements in fractions of a unit (1/2, ¼, 1/8). Solve problems involving addition and subtraction of fractions by using information presented in line plots. *For example, from a line plot find and interpret the difference in length between the longest and shortest specimens in an insect collection.* | | |
| **Lesson Essential Question:**  How are the machines used today like the simple machines used to construct the ancient civilizations?  How can I determine the area and perimeter of a polygon?  How can I create a line plot showing class data? | **Vocabulary:**  Lever, fulcrum, pulley, wheel and axel, screw, simple machine, wedge, inclined plane, line plot | |
| **Lesson Materials**  Simple Machine Kits (if available)  Various simple machines  Rocks of various sizes  Empty cereal boxes, cylinders, toilet paper tubes, paper towel tubes, string, craft sticks  Ruler | **Lesson Assessment:**  STEM Student Journal  Writing Extension  Teacher Observations | |
| **STEM Challenge Overview:**  After several experiences with simple machines and their uses, students will design and create a mode of transportation in which to transport rocks from a quarry to a construction site. | | |
| **Teacher Background:**   * Students will need experiences with simple machines and their uses before beginning this STEM challenge. * Students will need open floor space or table space to test their vehicles. * Collecting materials a few days in advance is suggested. * Set out a pile of rocks to act as a quarry. One yard away, place an “X” to denote the construction site. | | |
| **INSTRUCTION** | | |
| 1. **Ask/Engage** | | |
| Read the book: The Great Wonder: The Building of the Great Pyramid (Smithsonian Odyssey) by [Annabelle Howard](http://www.amazon.com/Annabelle-Howard/e/B001K8OP3O/ref=dp_byline_cont_book_1) and / or share the video: <http://www.pbslearningmedia.org/resource/phy03.sci.phys.energy.moai/levers-raising-the-moai-on-easter-island/> Ask students to think about how the rocks were moved from a quarry (the stone supply) to their final building place. Ask the students if the size of the rocks make a difference when moving it.  Give students an opportunity to discuss with their elbow partners the methods used in the book or video. Feel free to allow the students to look back to the video throughout the challenge, if needed.  Introduce the challenge.  **Challenge:**  Students will design a mode of transportation to move the rocks from the quarry to their transportation site using various materials to create simple machines or a functioning simple machine utilized in an appropriate way.   * Students can use: (Having these displayed will provide your students a visual for designing their mode of transportation.   Empty cereal boxes  cylinders, toilet paper tubes, paper towel tubes  Dowel rods, sticks, or other like items  Pulleys  Levers  String  Bottle Caps  Craft sticks (small)  Tape or glue  Wooden blocks  Rocks  Various other materials which the teacher feels appropriate | | |
| 1. **Imagine/Brainstorm** | | |
| **Criteria:**  **Your machine must be able to:**  1. Transport rocks to construction site one yard away  2. Withstand repeated uses  3. Utilize one or more simple machines  **You must be able to:**  4. Determine area and perimeter of your machine (the part that carries the rocks)  5. Create a class line plot displaying the area of all of the machines.  6. Create a class line plot displaying the perimeter of all of the machines.  Take a few minutes to let the students investigate all available materials. Have them share thoughts about how they might use each material. Which would be best for carrying the rocks? What can be used as a pulley, lever, inclined plane, etc? | | |
| 1. **Plan/Design** | | |
| Each student shares their ideas with their team. Student teams collaborate to develop a final design plan. Students draw the final plan in their journals and make a list of needed supplies. Make sure the design plan only utilizes the available materials. After you have reviewed and discussed the plan with the team, they may gather their supplies (or you can get them the supplies they have listed). Let the students know that once their machine is constructed to the team’s satisfaction, students must calculate the perimeter and area of the load bearing space. This MUST be done PRIOR to their “official” test. Record this information and use it to create a class line plot. | | |
| 1. **Create / Test** | | |
| Student teams build their design according to their design plan. Student teams should mini-test their mode of transportation at their table before bringing it for the “official” test (you can provide them with a few rocks for this purpose). Will your design effectively/efficiently carry the building materials? Can your design withstand repeated use? | | |
| 1. **Evaluate/Improve –** and repeat Steps 1-5 | | |
| Students evaluate their design for success. Did it meet the established criteria? Did their final design match their planned design? How would students improve their design? Did you see any ideas from other groups that you would like to include? Even if your machine worked well, how could you improve it to a) carry a heavier load, b) move faster or c) require less human effort to load/unload? If time and materials allow, students should be given the opportunity to improve/re-engineer their machines.  Extensions:   * When students have completed the challenge, write a persuasive article in which they convince the Pharaoh to purchase their mode of transportation in order to speed up construction of the pyramid. * Challenge students to build the smallest machine that can be used to transport the materials, as well as the largest machine. The size of the machine will be determined by its area. | | |

NOTES

\*Working as individuals, pairs, or groups is entirely up to the classroom teacher.

\*While the goal is for the students to build their machine independently, if you see a student struggling it is always a good idea to help guide their thinking. What’s going wrong? What are you trying to do? What might help fix this problem? Once they verbalize these things, you can offer a few suggestions for what might help.

\*As for the “official” testing, it is up to the classroom teacher to decide whether to allow the groups to test their machines whenever they are ready or wait for all to be completed to allow the whole class to watch the tests. You may also want to consider setting up 2 or 3 “Quarry areas” so that multiple groups can test simultaneously.

\*The improvement step is very important to the STEM process. It is the step that teaches students to stick with it, “if at first you don’t succeed…” and all that. If their machine worked great the first time, this step pushes them into a higher level of thinking about their invention. If their machine failed the first time, this step teaches them to continue thinking, evaluate their own work, and possibly change strategies. This is what we are trying to get to transfer over to their academics.

\*Student journal pages are attached to this lesson. Feel free to alter them to suit your needs.

\*Your team may decide on another “hook” or “wrap up”. Video clips, introductory activities, closing activities, etc. Totally up to you and your team. Study the lesson to decide how to break up your day.

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**Ancient Machines STEM Challenge**

**4th Grade**

**Challenge**:

Using your knowledge of simple machines, you are to design a mode of transportation that will move rocks from the quarry to a construction site one yard away.

**Criteria:**

1. Transport rocks to construction site one yard away

2. Withstand repeated uses

3. Utilizes one or more simple machines

4. Determine area and perimeter of the simple machine. 5. Create a class line plot displaying the area of all of the simple machines. 6. Create a class line plot displaying the perimeter of all of the simple machines.

**Constraints:**

1. Must be built in one class period

**Materials:**

Cereal Boxes Bottle Caps Pulleys Levers String

Inclined Plane Screws Wedge Cylinders Blocks

1. **ASK / ENGAGE:** What is the problem you are being asked to solve?

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1. **IMAGINE/BRAINSTORM:** What are some possible solutions to the problem that you are trying to solve? After you brainstorm, draw and label your ideas below.

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| **Idea #1** | **Idea #2** |

1. **PLAN/DESIGN:** Share your ideas with your group and collaborate to decide on a final design plan. Draw your team’s design below and make a list of the materials that you will need to complete your design.

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| **Team Design Plan** | **Materials List** |

1. **CREATE/TEST**: Use your Final Design Plan to create and build your solution. Test your design. Did it work? Why or Why not?

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1. **EVAULATE/IMPROVE:**  How well did your design work? Did your solution solve the problem within the given constraints?

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How can you improve your design? How can you make it better? Draw and label your improved design below.

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| **Improved Design Plan** |