Overview:
In this lesson, students will learn how to create reciprocating motion using Kid Spark engineering materials. Students will build a mechanism that converts rotary motion to reciprocating motion. Then, students will work as a team to create a custom design that produces reciprocating motion.

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Learning Objectives & NGSS Alignment:
- Define reciprocating motion.
- Build a mechanism that converts rotary motion to reciprocating motion.
- Create a custom design that produces reciprocating motion.

Scientific/Engineering Practice - Developing and using models
Crosscutting Concept - Scale, proportion, and quantity

Convergent Learning Activity:
1. Exploring Reciprocating Motion
Reciprocating motion is motion that moves back and forth in a straight line. Some examples of reciprocating motion are a piston that moves back and forth in an engine, or using a saw to cut wood.

Instructions: As a team, discuss some other real-world examples of reciprocating motion.
Instructions
Follow the step-by-step instructions to assemble a mechanism that converts rotary motion to reciprocating motion.
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Follow the step-by-step instructions to assemble a mechanism that converts rotary motion to reciprocating motion.

**Step 1:** Power on the Maker ROK-Bot.
**Step 2:** Sync the ROK-Star Controller to the Maker ROK-Bot.
**Step 3:** Press the X/Y buttons on the ROK-Star Controller to activate the mechanism.
**Step 4:** Observe how the mechanism converts rotary motion to reciprocating motion.
Divergent Learning Activity:

Scenario:
Kid Spark Engineering is currently accepting proposals for new and creative product inventions or innovations.

Design & Engineering Challenge:
Develop a new product or design that produces reciprocating motion. See example below.

Specifications/Criteria:
1. Students will work in teams of up to 4 to design and engineer a new product or design that serves a specific purpose. Teams can invent something completely new or improve an already existing product.
2. Teams must work through each step of the design & engineering process to design, prototype, and refine their design. Teams will demonstrate and present their designs to the class when they are finished.
3. The product or design must be powered by the Maker ROK-Bot.
4. The design must produce reciprocating motion.
5. Teams must determine the overall dimensions (length, depth, and height) of the product or design, as well as any detailed specifications that are relevant to the design.
6. With each building component costing $2, determine the total cost of the design.

Example Idea:

Product Innovation/Invention: Soccer game

Purpose: Fun and enjoyment

Design Notes: This soccer-style game features a goalie that moves back and forth (reciprocates) across a goal. If you have good speed and aim, you can try and flick a ball into the goal when the goalie is out of position.

Dimensions: 36 cm x 16 cm x 14 cm (L x D x H)

Material Cost: 41 components x $2 = $82
Challenge Evaluation
When teams have completed the design & engineering challenge, it should be presented to the teacher and classmates for evaluation. Teams will be graded on the following criteria:

- **Design and Engineering Process**: Did the team complete each step of the design and engineering process?
- **Design Specification**: Did the team complete a design specification?
- **Team Collaboration**: How well did the team work together? Can each student describe how they contributed?
- **Design Quality/Aesthetics**: Is the design of high quality? Is it structurally strong, attractive, and well proportioned?
- **Presentation**: How well did the team communicate/explain all aspects of the design to others?

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<th>Grading Rubric</th>
<th>Advanced 5 Points</th>
<th>Proficient 4 Points</th>
<th>Partially Proficient 3 Points</th>
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<tr>
<td>Design &amp; Engineering Process</td>
<td>Completed all 5 steps of the process</td>
<td>Completed 4 steps of the process</td>
<td>Completed 3 steps of the process</td>
<td>Completed 2 or fewer steps of the process</td>
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<td>Design Specification</td>
<td>Complete/well-detailed and of high quality</td>
<td>Complete/opportunities for improvement</td>
<td>Incomplete/opportunities for improvement</td>
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<td>Team Collaboration</td>
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<td>Most members of the team contributed</td>
<td>Few members of the team contributed</td>
<td>Team did not work together</td>
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<td>Design Quality/Aesthetics</td>
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<td>Good design/average aesthetics</td>
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<td>Presentation</td>
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<th>Points</th>
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<tr>
<td>Total Points</td>
<td>4 Points</td>
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Building Basics
The following tips will be helpful when using Kid Spark engineering materials.

Connecting/Separating ROK Blocks:
ROK Blocks use a friction-fit, pyramid and opening system to connect. Simply press pyramids into openings to connect. To separate blocks, pull apart.

Connecting/Disconnect Smaller Engineering Materials:
Smaller engineering materials use a tab and opening system to connect. Angle one tab into the opening, and then snap into place. To disconnect, insert key into the engineered slot and twist.

Snapping Across Openings:
Materials can be snapped directly into openings or across openings to provide structural support to a design. This will also allow certain designs to function correctly.

Attaching String:
In some instances, string may be needed in a design. Lay string across the opening and snap any component with tabs or pyramids into that opening. Be sure that the tabs are perpendicular to the string to create a tight fit.

Measuring:
The outside dimensions of a basic connector block are 2 cm on each edge. This means the length, depth, and height are each 2 cm. To determine the size of a project or build in centimeters, simply count the number of openings and multiply by two. Repeat this process for length, depth, and height.
The Maker ROK-Bot:

The Maker ROK-Bot is a remote-controlled, robotic vehicle that can be used in a variety of ways when designing robotic systems. It is powered by (3) AA batteries that can be replaced by removing the cover on the bottom of the vehicle. A small Phillips screwdriver is required to open the bottom cover. To power on/off the Maker ROK-Bot, simply press the “R” power button until you hear a chime.

The ROK-Star Controller:

The wireless ROK-Star Controller is used to control the Maker ROK-Bot. The ROK-Star Controller is powered by (3) AA batteries that can be replaced by removing the cover on the bottom of the controller. A small Phillips screwdriver is required to open the bottom cover.

Syncing the ROK-Star Controller to the Maker ROK-Bot

Step 1: Power on the Maker ROK-Bot.
Step 2: Aim the ROK-Star Controller at the Maker ROK-Bot.
Step 3: Press and hold the “R Select” button on the ROK-Star Controller. The Maker ROK-Bot will produce a chime when it is successfully synced with the ROK-Star Controller.
Step 4: Press the buttons on the ROK-Star Controller to control the Maker ROK-Bot.

Motors & Cables:

Motor Modules can easily be connected to the Maker ROK-Bot to provide additional functionality to a robotic design.

Connecting Motor Modules to the Maker ROK-Bot

Step 1: Connect one end of the cable to the port on the Motor Module.
Step 2: Connect the other end of the cable to the A/B or X/Y port on the Maker ROK-Bot.
Step 3: Press the A/B or X/Y buttons on the ROK-Star Controller to rotate the Motor Module clockwise or counter-clockwise.

Note: make sure cables are firmly pressed into connecting ports to ensure a good connection.