

LESSON PLANS & ACTIVITIES

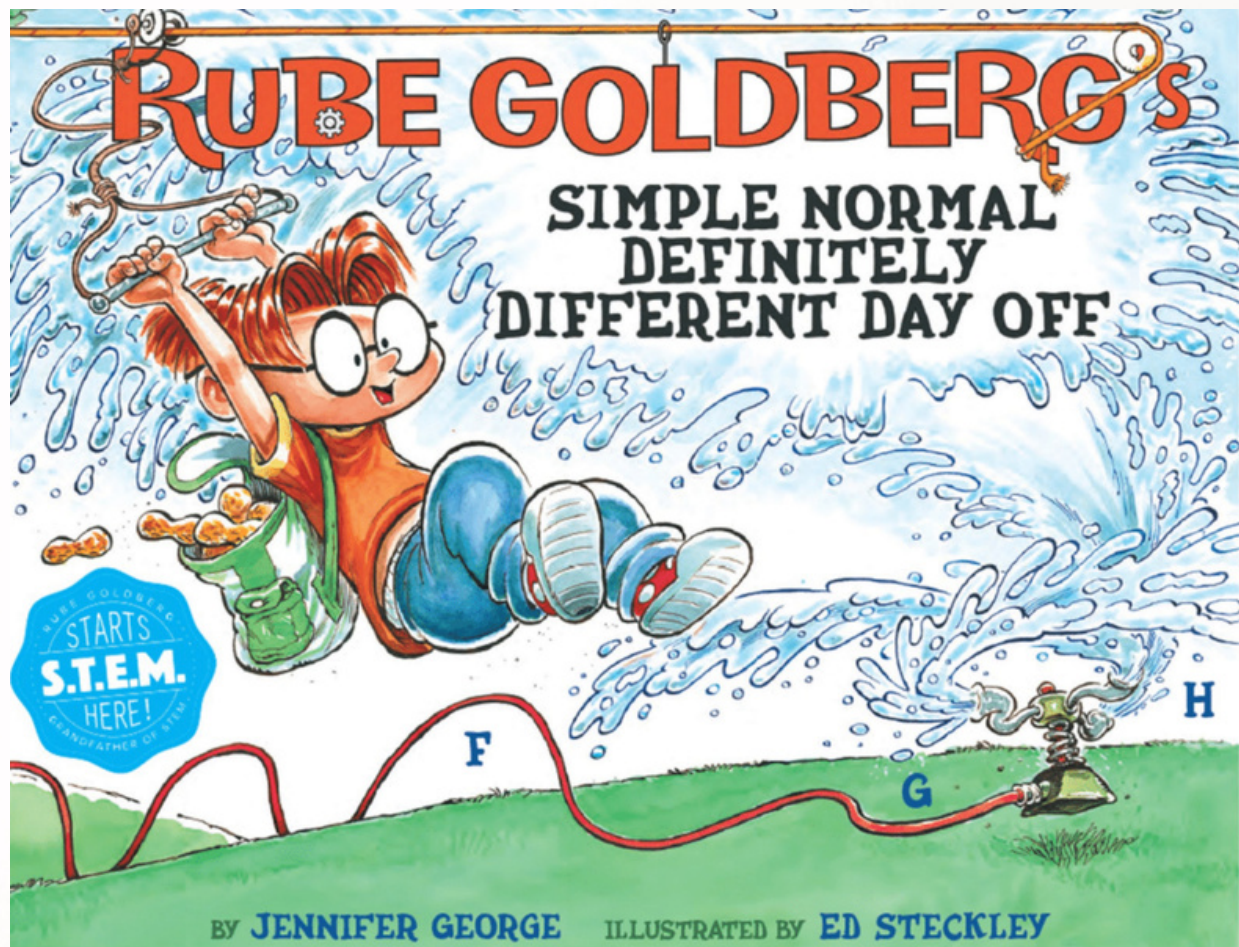


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INTRODUCTION

Rube Goldberg's Simple, Normal, Definitely Different Day Off was created by Jennifer George, Rube Goldberg's granddaughter. This picture book series introduces the intentionally over-engineered inventions of her grandfather to a new audience. The first book in the series, *Rube Goldberg's Simple, Normal, Humdrum School Day*, follows young Rube and the wacky machines he builds that get him through his day. The second book, *Rube Goldberg's Simple, Normal, Definitely Different Day Off*, once again follows our young inventor and his machines. George worked closely with Ed Steckley, the illustrator, and Charlie Kochman, Abrams Comic Arts Editor, to bring this book to fruition. The curriculum team at Teq, our partner edtech company, helped create the materials you will find at the back of this book—activities, projects, and lesson plans that focus on simple machines. We hope this book finds a place in your classroom, engaging students in STEM and arts education. Our mission is to inspire young minds through informed observation, creative thinking, artistic response, problem-solving, and laughter. We want students to believe that with curiosity and inventiveness, they can change the world. To learn more about the Rube Goldberg Institute for Innovation & Creativity and its free contests, programs, and resources, go to rubegoldberg.org.

This curriculum guide is meant to accompany the book *Rube Goldberg's Simple, Normal, Definitely Different Day Off* by Jennifer George and provide a framework for understanding simple machines. It is purposefully written to be adaptable to almost any grade level, ability, or background. These lessons can be used in succession, separately, or in any order that is appropriate for your school. The standards used to guide the creation of this curriculum are the Next Generation Science Standards (<https://www.nextgenscience.org/>).

Learning Outcomes:

1. Understand the basic simple machines.
2. Evaluate the mechanical advantage of simple machines.
3. Design simple and compound machines.

Time requirements have specifically been omitted from the following lesson plans as we understand every school has a different schedule and each teacher knows their students best. We estimate that the lessons are approximately one class period long, though they could be extended to two or more class periods long.

Assessment Ideas:

1. Observe students' ideas, progress, and teamwork.
2. Observe students' understanding of the physical task of each simple machine.
3. Assign students open-ended questions for reflection through writing/talking/summarizing/journaling.
4. Have students think-pair-share before, during, and after the lesson.
5. Give students a one-question quiz on the main concept of the lessons.

RECOMMENDED NEXT GENERATION SCIENCE STANDARD CONNECTIONS

Kindergarten

- K-PS2-1. Plan and conduct an investigation to compare the effects of different strengths or different directions of pushes and pulls on the motion of an object.
- K-PS2-2. Analyze data to determine if a design solution works as intended to change the speed or direction of an object with a push or a pull.

Kindergarten-Second Grade

- K-2-ETS1-1. Ask questions, make observations, and gather information about a situation people want to change to define a simple problem that can be solved through the development of a new or improved object or tool.
- K-2-ETS1-2. Develop a simple sketch, drawing, or physical model to illustrate how the shape of an object helps it function as needed to solve a given problem.
- K-2-ETS1-3. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

Third Grade

- 3-PS2-2. Make observations and/or measurements of an object's motion to provide evidence that a pattern can be used to predict future motion.

Fourth Grade

- 4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide.

Third-Fifth Grade

- 3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Middle School

- MS-PS3-1. Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- MS-PS3-2. Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.
- 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.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

WHO IS RUBE GOLDBERG?



Rube Goldberg (1883-1970) was a Pulitzer Prize winning cartoonist best known for his zany invention cartoons. He was born in San Francisco on the 4th of July 1883 – and graduated from University of California, Berkeley with a degree in engineering. His first job at the San Francisco Chronicle led to early success, but it wasn't until he moved to New York City and began working for Hearst publications that he became a household name. Rube Goldberg is the only person ever to be listed in the Merriam Webster Dictionary as an adjective. It's estimated that he did a staggering 50,000 cartoons in his lifetime. For videos about Rube: <https://www.rubegoldberg.com/about/>.

A Rube Goldberg Machine is “a comically involved, complicated invention, laboriously contrived to perform a simple operation” (Webster’s New World Dictionary). Humor and a narrative are what separate a Rube Goldberg Machine from a chain-reaction machine. Each of Rube’s cartoons told a story and his entire goal was to get you to laugh.

Rube Goldberg, Inc. is a not-for-profit 501(c)3 dedicated to promoting STEAM education for students of all ages and to keeping laughter and invention alive through the legacy of its namesake. Annual competitions, image licensing, merchandising, and museum and entertainment opportunities continue to grow and enhance the brand. At the helm is Rube’s granddaughter, Jennifer George, with her recent book, *Rube Goldberg’s Simple, Normal, Definitely Different Day Off*.

For a “Skype in the Classroom” lesson with Jennifer, please email deb@rubegoldberg.com with your available dates and times.

For more information, go to: www.rubegoldberg.com

LESSON 1: WHAT ARE SIMPLE MACHINES?

Materials/Resources:

1. *Rube Goldberg's Simple, Normal, Definitely Different Day Off* book by Jennifer George
2. Simple Machines worksheets (pages 21 and 22)
3. Simple Machine Station Guide (pages 23) and Station Cards (pages 24-29)
4. Additional materials for simple machine stations:
 - a. 2 boards varying in length
 - b. String
 - c. Rubber bands
 - d. Heavy book
 - e. Paper
 - f. Craft dough or putty
 - g. Plastic knife/toy knife
 - h. Sewing spool
 - i. String
 - j. Pencil
 - k. Wire hanger (and wire cutters) - optional
 - l. Object to lift
 - m. Rulers
 - n. Tape
 - o. Can or toilet paper tube
 - p. Toy cars
 - q. Bolt and nut
 - r. Sticker
 - s. Tabletop

Book Connection:

All pictures!

Note: Throughout the lessons, we will pinpoint an example you can highlight for students. For even more fun, check out the “STEM Starts Here” section for additional examples. The list of simple machines extends far beyond what is listed.

Ask Students: Can you find simple machines in the pictures that *weren't* used in the Rube Goldberg Machines? Think of ways they could be incorporated and discuss!

Learning Standards:

NGSS: K-PS2-1; K-PS2-2; 3-5-ETS1-3

Guiding Questions:**1. What is a Rube Goldberg Machine?**

A Rube Goldberg Machine is “a comically involved, complicated invention, laboriously contrived to perform a simple operation.”

2. What are the 6 simple machines?

The 6 Simple Machines are: wedge, screw, lever, wheel and axle, inclined plane and pulley. (See following Resources worksheets for definitions and examples.)

3. What do simple machines do?

Simple machines make work easier for us by allowing us to push or pull over increased distances. They help humans increase and/or redirect the force applied to an object. The main benefit of machines is that they allow us to do the same amount of work by applying a smaller amount of force over a greater distance.

Activities:

1. Read *Rube Goldberg's Simple, Normal, Definitely Different Day Off* and give students some history of the original cartoons by Rube Goldberg.
2. Discuss the 6 simple machines and guiding questions with students.
3. Show an example of Goldberg's invention or an invention from the book and follow each segment to the completion of his designated task, highlighting each simple machine.
4. Find the six simple machines that are part of the inventions in the book. See the last page of the book (*STEM Starts Here*) for reference.
5. Complete the first two worksheets from the Resources section: page 21 "Label the 6 Simple Machines from Rube's Inventions," and page 22, "Circle and Label Simple Machines in Rube's Invention."
6. Assign students a "simple machine station" to start at and set a rotation schedule. (Students generally need at least 15 minutes at each station). Use the simple machines materials to help you organize the activity at each station.
7. Review with students in a large group, or at each station, what the experiment is.
8. After the students have had a chance to visit all six stations, ask one student from each station to give a quick summary explanation of that simple machine to the class.

Further Ideas/ Differentiation:

- Have a scavenger hunt to look for the 6 simple machines around your house, neighborhood, or school.
- Recreate some of the depictions of the 6 simple machines from the book using household materials.
- Scaffold for younger students by making a recording of the directions for the stations.

LESSON 2: CREATE A CHOICE SPINNER WITH A WHEEL AND AXLE

Materials/Resources:

1. *Rube Goldberg's Simple, Normal, Definitely Different Day Off* book by Jennifer George
2. Paper plates
3. Ruler
4. Paper fastener
5. Paper clip
6. Index card, poster paper, or popsicle stick
7. Tape
8. Coloring tools (markers/pens/colored pencils)

Book Connection:

"A Perfect Way to Pretend to Take Your Cough Syrup" -
Example: Dump Truck (A), Gears (H)

Learning Standards:

NGSS: K-PS2-1; K-PS2-2; 3-PS2-1; 3-PS2-2; 3-5-ETS1-1; 3-5-ETS1-3; MS-ETS1-1; MS-ETS1-2

Guiding Questions:

1. What is a wheel and axle?

A machine made of a wheel and a stick that goes through the center of the wheel. It allows a heavy load to be pushed and reduces friction.

Synonyms: Axis, shaft.

2. How is a spinner an example of a simple machine?

In the spinner, the "wheel" is the paperclip, and the "axle" is the paper fastener around which the paperclip spins.

Activities:

1. Using the ruler, find the center of your paper plate and mark it with a pen or pencil
2. From the center point, draw lines going away from the center every 1-2 inches. The lines should be angled in a way that a triangle or wedge shape is created (i.e., closer at the center and further away towards the edge).
3. Write a choice or draw a clear image on each section of the spinner. Encourage students to choose a theme, such as "lunch choices" or "screen time activities".
4. Use a pen to puncture a small hole in the center of the plate.
5. Take a paper fastener and push it through the opening. Secure on the back side. Be sure not to fasten the clip too tight. Place a piece of tape over the fastener arms on the back side.
6. Attach the paper clip to the front of the paper fastener and pinch the paper clip slightly so that the clip will not come off as it moves around the fastener.
7. On the index card/poster paper, draw a long rectangle (1 cm x 4cm x 1cm x 4cm). On one end of the rectangle, draw a triangle to create a needle. Cut out the full shape you just created.
8. Secure the needle to the paper clip using tape or hot glue if preferred.
9. Spin the needle and make your choice!

Further Ideas/ Differentiation:

1. Use whatever size plates you have available.
2. What other materials could you use to make a wheel and axle for your spinner?
3. How might the size of the needle affect the speed at which it moves around the axle?
4. Does the force used to push the needle affect its speed?
5. Investigate other wheels and axles: bikes, cars, analog clocks, electric fans, windmills, etc.
How do these simple machines make work easier?

LESSON 3: PUTTING LEVERS IN ACTION - DESIGN A CATAPULT

Materials/Resources:

1. *Rube Goldberg's Simple, Normal, Definitely Different Day Off* book by Jennifer George
2. 10-15 craft sticks
3. 5-7 rubber bands
4. 1 plastic spoon
5. Miniature marshmallows or other small soft objects to launch

Book Connection:

"An Easy Way to Pick Your Favorite Doughnut" -

Example: Handlebars (A), Helping Hand Flicking Doughnut (H)

Learning Standards:

NGSS: K-PS2-1; K-PS2-2; 3-PS2-1; 3-PS2-2; 3-5-ETS1-1; 3-5-ETS1-3; MS-ETS1-1; MS-ETS1-2

Guiding Questions:

1. What is a lever?

A lever is a bar resting on a support, or fulcrum. It is used to help move a heavy or firmly fixed object with one end when pressure is applied to the other end. There are 3 types of levers:

- A first-class lever has weight on one side and the energy moving the weight on the other side. Examples: see-saws, crowbars, pliers
- A second-class lever has a fulcrum at one end, you push on the other end, and the weight is in the middle of the stick. Examples: doors, staplers, wheelbarrows, and can openers.
- A third-class lever has a fulcrum at one end, you push on the middle, and the weight is at the other end. Examples: broom, hoe, fishing rod, baseball bat, and our own human arms.

2. How does a lever make work easier?

A lever makes work easier because less force is required to lift the object than would otherwise be needed. The true mechanical advantage of each lever depends on the distances between the load, fulcrum, and effort.

3. How is a simple catapult an example of a lever?

A simple catapult has the bar (single popsicle stick) resting on top of the fulcrum (the tall stack of popsicle sticks). When effort is applied to the top of the bar, the load is able to be launched.

Activities:

1. Take 8-13 craft sticks and stack them into a pile.
2. Secure both ends of the craft stick pile using a rubber band (1 for each side)
3. Take two sticks stacked together and secure one end with a rubber band. Slide the 8-13 craft stick bundle between the two craft sticks so that 1 stick is on the bottom of the stack and 1 is on top.
4. Add another rubber band around the 2 sticks and adjust as need so that the stack is secured between the 2 sticks (you may want to put the bottom stick between the bottom 2 layers of the

stack). If you place the bundle closer to the front of the two sticks, your catapult will have more leverage.

5. Secure the plastic spoon on top of the top stick, facing upwards using as many rubber bands as necessary. Try to only have the head of the spoon beyond the edge of the stick.
6. Place your marshmallow, pull back the spoon and see how far you can make it fly!
7. Adjust the position and/or height of the craft stick bundle and see if that has any impact on the distance your marshmallow travels.

Further Ideas/ Differentiation:

1. There are many types of catapults that exist. What other catapult types are there?
2. How do more complex catapults form compound machines? What other simple machines can be found in these catapults?
3. Investigate other levers: seesaw, scissors, pliers, hammer, door hinge, balance scale, etc.

LESSON 4: DUAL SURFACE INCLINED PLANE RACE

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| Materials/Resources: |
| <ol style="list-style-type: none"> 1. <i>Rube Goldberg's Simple, Normal, Definitely Different Day Off</i> book by Jennifer George 2. Two small toy cars of the same weight and size 3. Materials to create a ramp surface such as cardboard, thin wood, thin hard covered books, etc. This surface should be wide enough for two cars move down the same ramp at the same time. 4. Materials to hold the ramp up such as cardboard boxes, large textbooks, blocks, etc. 5. A sheet of sandpaper long enough to cover the full length of the ramp 6. Double sided tape or another adhesive 7. Measuring tape |
| Book Connection: |
| <p>"A Simple Way to Play Fetch Without Leaving Your Bedroom" - Example: Metal Gutter (A), Crumbs Down Ramp (J), Netting, and Ramp to Staggered Shelves (N)</p> |
| Learning Standards: |
| NGSS: K-PS2-1; K-PS2-2; 3-PS2-1; 3-PS2-2; 3-5-ETS1-1; 3-5-ETS1-3; MS-ETS1-1; MS-ETS1-2 |
| Guiding Questions: |
| <p>1. What is an inclined plane? A plane inclined at an angle to the horizontal; sloping ramp up which heavy loads can be raised. Synonyms: ramp, slant, gradient.</p> <p>Note: The steeper an inclined plane is, the faster the object will travel over a greater distance.</p> <p>2. How would sandpaper affect an object moving down an inclined plane? The rough surface of sandpaper increases the friction on the inclined plane. This increased friction increases the opposition to the motion of the object moving down the inclined plane. This in turn affects the speed at which the object moves as well as the distance traveled.</p> |
| Activities: |
| <ol style="list-style-type: none"> 1. Have students set up an inclined plane by setting aside a cardboard box or stacking textbooks/ blocks to achieve the desired height and resting the cardboard, wood, or thin book on the box/stack. Be sure to leave enough space at the end of the ramp for the car to travel. 2. Affix the sandpaper to one side of the ramp going the entire length of the ramp using double sided tape or other adhesive. Make sure there is enough room on both the sandpaper and smooth sides for each car to sit in the middle of that space. 3. Assign two students, one to each side of the ramp, with their own toy cars. Have students hold their car at the top of the ramp, then release the cars at the same time. You may find it helpful to mark the start point on the top of the ramp using tape. 4. Let the cars stop rolling on their own and use the measuring tape to determine the distance each car traveled. 5. Repeat this process 2-3 more times. 6. Plot the distances on a graph to visualize the difference between the two surfaces. Have students discuss the impact friction had on the distance the car traveled. |
| Further Ideas/ Differentiation: |
| <ol style="list-style-type: none"> 1. Repeat the challenge using sandpaper of different roughness. 2. Investigate other inclined planes: slides, accessibility ramps, hills, stairs, etc. |

LESSON 5: TEST YOUR STRENGTH WITH PULLEYS

Materials/Resources:

1. *Rube Goldberg's Simple, Normal, Definitely Different Day Off* book by Jennifer George
2. Sewing spool or similar object
3. String
4. Pencil or wire hanger and wire cutters
5. Object to lift

Book Connection:

"A No-Nonsense Way to Avoid Nosy Neighbors"
Example: Bag of Peanuts Lowered (F)

Learning Standards:

NGSS: K-PS2-1; K-PS2-2; 3-PS2-2; 3-5-ETS1-1; 3-5-ETS1-3; MS-ETS1-1; MS-ETS1-2

Guiding Questions:**1. What is a pulley?**

A wheel with a grooved rim and a rope that goes around the wheel inside the groove. It acts to change the direction of the force and is used to raise heavy weights. Synonyms: sheave, drum.

2. How does a pulley make work easier?

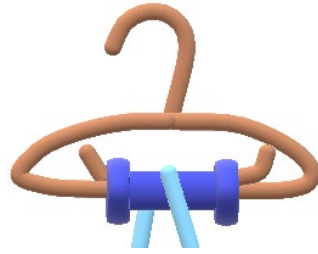
Pulleys help make work easier because when you pull down on the rope, you are moving with gravity, making the motion more efficient. More pulleys in a system multiplies the force used.

3. What are the different types of pulley systems?

A fixed pulley's wheel and axle stay in one place. A good example of a fixed pulley is a flag pole: When you pull down on the rope, the direction of force is redirected by the pulley, and you raise the flag. A movable pulley is a pulley that is free to move up and down and is attached to a ceiling or other object by two lengths of the same rope. Examples of movable pulleys include construction cranes and modern elevators. A compound pulley consists of combinations of fixed and movable pulleys.

Activities:

1. Have students make a pulley with a sewing spool, string, wire hanger or a pencil.
2. Slide the spool onto the pencil and then rest the pencil between two desks. Alternatively, cut the bottom of a hanger so that you can slide the spool onto the bottom wire.
3. Once the spool is on, you can secure it using the two edges of wire (see picture).
4. Hang the hanger on a rod and then loop a string over the top of the spool.
5. Attach your object/ weight to one end of the string, and then pull with the other.
6. Try lifting the option without the pulley. Discuss which method requires more work and why.



Further Ideas/ Differentiation:

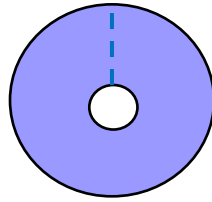
1. Discuss who uses pulleys to make their work easier.
Sailors (sail rigging), people at the gym (weight machines), and people using fishing rods (reel).
2. Compare and contrast using different sized pulleys, different materials, longer or shorter rope lengths, compound pulleys, etc.

LESSON 6: DRAW A RUBE GOLDBERG MACHINE CARTOON WITH A WEDGE

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| Materials/Resources: |
| <ol style="list-style-type: none"> 1. <i>Rube Goldberg's Simple, Normal, Definitely Different Day Off</i> book by Jennifer George 2. Draw Your Own Rube Goldberg Machine worksheet (see Resources, page 30) 3. Pencil 4. Coloring tools (markers/pens/colored pencils) |
| Book Connection: |
| "A Surefire Way to Fake Being Sick" - Example: Cheese Wedge (D) |
| Learning Standards: |
| NGSS: K-PS2-1; K-PS2-2; 3-PS2-1; 3-PS2-2; 3-5-ETS1-1; 3-5-ETS1-3 |
| Guiding Questions: |
| <ol style="list-style-type: none"> 1. What is a wedge? A piece of wood, metal, or some other material having one thick end and one thin edge, that is driven between two objects or parts of an object to secure or separate them. Synonyms: doorstop, chock. 2. What are some examples of wedges you use at home or in school? Scissors (2 wedges and a lever), screwdriver, axe, shovel, knife, etc. |
| Activities: |
| <ol style="list-style-type: none"> 1. Discuss the job of a wedge and Guiding Questions with students. Question 2 might even lead to some debate! 2. Show an example of a Rube Goldberg Machine from <i>Rube Goldberg's Simple, Normal, Definitely Different Day Off</i>, such as "A Surefire Way to Fake Being Sick" and follow each segment to the completion of his designated task, highlighting each simple machine. 3. Explain that students will decide on a simple chore or task and devise a 'Rube Goldberg way' to accomplish this activity using at least three simple machines, one of which should be a wedge. 4. Have students draw a cartoon of their machine labeling each step and making sure to include humorous elements. 5. Have students present their cartoon to the class explaining how it would work to accomplish their chosen task. |
| Further Ideas/ Differentiation: |
| <ol style="list-style-type: none"> 1. Students can work alone, or in larger groups, on their cartoon. 2. Students can draw larger cartoons on rolls of paper. 3. Students can collage pictures of objects into their cartoons instead of drawing them. 4. Challenge students to include 3 different wedges in their machine. 5. Have students cut their drawing out of the worksheet; scissors blades are two wedges. |

LESSON 7: MOVING GRAIN WITH A SCREW CONVEYOR

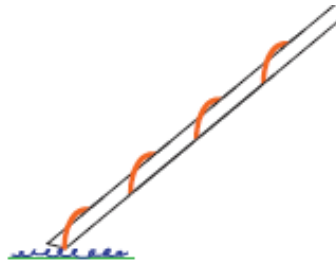
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| Materials/Resources: |
| <ol style="list-style-type: none"> 1. <i>Rube Goldberg's Simple, Normal, Definitely Different Day Off</i> book by Jennifer George 2. Plastic bottle 3. Cardstock/ cardboard 4. Skewer or straw for creating auger 5. Scissors/ craft knife 6. Tape 7. Ruler/ compass 8. Material to raise, such as cereal grains. A container to catch the grains, such as a bowl or plastic bin |
| Book Connection: |
| "A Simple Way to Play Fetch Without Leaving Your Bedroom" - Example: Turning Tether Ball Post (F) |
| Learning Standards: |
| NGSS: K-PS2-1; K-PS2-2; 3-PS2-1; 3-PS2-2; 3-5-ETS1-1; 3-5-ETS1-3; MS-ETS1-1; MS-ETS1-2 |
| Guiding Questions: |
| <ol style="list-style-type: none"> 1. What is a screw? An incline plane wrapped around a rod in a spiral shape. Synonyms: bolt, fastener. 2. What is a screw conveyor? Screw conveyors are also sometimes called "auger conveyors". They are mechanisms for moving liquid, semisolid, or granular materials, such as grains, using a rotating screw blade, typically housed within a tube. You can even find them inside snowblowers! 3. What is an Archimedes screw? An Archimedes screw is a type of screw conveyor that can be used to transfer water from a lower body of water into elevated irrigation ditches; water is pumped by turning a screw-shaped surface inside a pipe. |
| Activities: |
| <ol style="list-style-type: none"> 1. Discuss the job of a screw and Guiding Questions with students. 2. Show students a video of a screw conveyor in action or demo one already made. (Like this one: https://www.youtube.com/watch?v=w2_OmTYmnOw) 3. Discuss the history of screw conveyors and Archimedes screw and have students explore both historical and modern uses of these contraptions. 4. Remove the top and bottom from the plastic bottle. 5. Measure the diameter of the bottle and create about 6 circles of this size from cardstock/cardboard. 6. Cut a slit into each circle as pictured, and then tape the circles together to form a spiral around the skewer/straw. (You can adjust a hole in the circle to fit the center you are using, e.g. skewer or straw, etc.) Be sure to tape the top and bottom circle to the skewer, then insert the screw into the bottle. Make sure the skewer sticks out of the top opening far enough that it can be easily grasped and turned. |



7. Test it out with a bowl of grain/cereal or other small, light objects. Insert one end of the bottle (bigger end if the openings are different sizes) into the grain, turn the screw so that the grain moves up and comes out of the top of the bottle.
8. Refine and modify until the mechanism works effectively. Try different sized bottles, number of circles, etc. (This is a great way to practice the Engineering Design Process!)

Further Ideas/ Differentiation:

1. Students can work alone or in larger groups on their contraption.
2. Create an Archimedes screw that can pump water from a lower to higher basin using clear plastic tubing, a pipe or stick, and tape.
3. Students can make different sized Archimedes Screws with longer and/or wider sticks and tubing to compare and contrast their function.



LESSON 8: BUILD YOUR OWN RUBE GOLDBERG MACHINE

Materials/Resources:

1. *Rube Goldberg's Simple, Normal, Definitely Different Day Off* book by Jennifer George
2. Random junk: cups, boxes, toy cars, balls, tape, paper clips, string, tubing, pipes, sticks, plastic recyclables, paper/cardboard, scissors, rubber bands, safety pins, etc.

Book Connection:

All pictures!

Learning Standards:

NGSS: K-PS2-1; K-PS2-2; K-2-ETS1-1; K-2-ETS1-2; K-2-ETS1-3; 3-PS2-1; 3-PS2-2; 3-5-ETS1-1; 3-5-ETS1-2; 3-5-ETS1-3, 4-PS3-3; MS-PS3-1, MS-PS3-2, MS-PS3-5, MS-ETS1-1, MS-ETS1-2, MS-ETS1-4

Guiding Questions:**1. Who is Rube Goldberg?**

Rube Goldberg (1883-1970) was a Pulitzer Prize winning cartoonist best known for his zany invention cartoons. He was born in San Francisco on the 4th of July, 1883 – and graduated from U. Cal Berkeley with a degree in engineering. His first job at the San Francisco Chronicle led to early success, but it wasn't until he moved to NYC and began working for Hearst publications that he became a household name. Rube Goldberg is the only person ever to be listed in the Merriam Webster Dictionary as an adjective. It's estimated that he did a staggering 50,000 cartoons in his lifetime.

2. What is a Rube Goldberg Machine?

Rube Goldberg Machine is “a comically involved, complicated invention, laboriously contrived to perform a simple operation” (Webster's New World Dictionary). Humor and a narrative are what separate a Rube Goldberg machine from a chain-reaction machine. Each of Rube's cartoons told a story and his entire goal was to get you to laugh.

Activities:

1. Review cartoons by Rube Goldberg. Examples here: <https://www.rubegoldberg.com/gallery>
2. Review each simple machine with class. Have students brainstorm ways to connect simple machines to make compound machines.
3. Show students videos of Rube Goldberg Machines: <https://www.rubegoldberg.com/rube-tube/> Students can also use their previous drawings of RGMs from lesson 6 as inspiration.
4. Set parameters for each step, what “counts” as a step, such as an energy transfer, plus size allotment for each machine (a tabletop or a few desks pushed together is recommended for each group of students).
5. Break students into groups of 2-4 each.
6. Assign a task for the machine to complete, or let the students choose their task, and decide how long they will have to build their machine. We recommend “Pop A Balloon” or “Trap A Mouse.”
7. Have students build a three step Rube Goldberg Machine. The teacher may assign materials from the or let students choose.

8. Students will use the materials to build a machine to complete the task. They should be testing and improving the machine as they go to make sure each component works.
9. After the allotted period of time, each team of students should “run” their machine to see if it works. You may want to have each group run their machine a certain number of times and count the successes.

Further Ideas/ Differentiation:

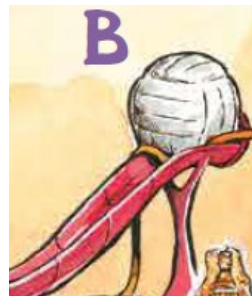
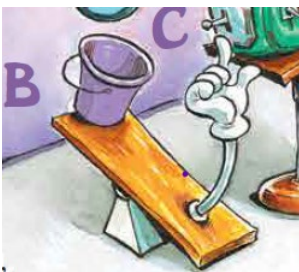
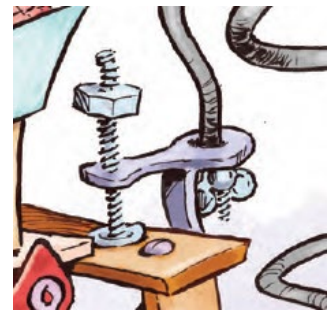
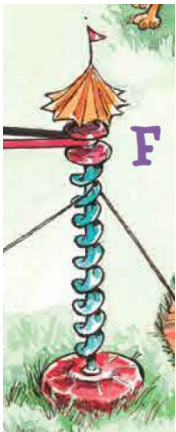
1. Have students write a machine task description like Rube Goldberg (A. The palm tree falls over, knocking into parrot B.... etc. See Resources for examples of text accompanying cartoons).
2. Have students present their machines to the rest of the class with the task description serving as a narrative.
3. Have students judge the machines on a rubric you create or for funniest, most creative, etc.
4. Have students create machines with more steps or include all of the simple machines.

ADDITIONAL RESOURCES

Name: _____ Date: _____

LABEL THE 6 SIMPLE MACHINES FROM RUBE'S INVENTIONS

Keywords: pulley, lever, inclined plane, screw, wedge, wheel and axle



Name: _____ Date: _____

CIRCLE AND LABEL SIMPLE MACHINES IN RUBE'S INVENTIONS

Keywords: pulley, lever, inclined plane, screw, wedge, wheel and axle



SIMPLE MACHINE STATION GUIDE

| INCLINED PLANE | LEVER |
|--|---|
| <p><u>Materials:</u> 2 Boards varying in lengths, String, Rubber bands, Ruler, Heavy Book, Inclined Plane Worksheet</p> <p>The students will make inclined planes with boards and will vary the slope of the board. There will be rubber bands around the book. The students will tie the string to the rubber bands and pull the books up the different inclined planes. They will also pull the books straight up without using the inclined planes. The students will find that it takes more work to move an object up an inclined plane with the steepest slope.</p> <p><u>Hint:</u> Look at the stretch of the rubber bands straight up compared to different inclined planes.</p> | <p><u>Materials:</u> Wooden ruler, object to lift, tape, can or toilet paper roll, lever worksheet</p> <p>The students will make a lever out of the given materials and explore the relationship of the fulcrum to the load. The students will discover that it is easier to move an object when the fulcrum is closer to the load.</p> <p><u>Hint:</u> Move the fulcrum closer to the load. Move the fulcrum away from the load.</p> |
| WEDGE | WHEEL AND AXLE |
| <p><u>Materials:</u> Craft dough or putty, plastic knife/toy knife, wedge worksheet</p> <p>The students will make a cylindrical shape out of the dough (can be flat or raised) and use the plastic knife to cut the dough in half. The students will find that the wedge easily separates the material into two pieces.</p> <p><u>Hint:</u> How does a knife make cutting slices of bread easier?</p> | <p><u>Materials:</u> 2 small toy cars, rulers, wheel and axle worksheet</p> <p>The students will push one car on its side and the other on its wheels. They will note the difference in distance traveled.</p> <p><u>Hint:</u> Try one of the cars on its side.</p> |
| PULLEYS | SCREW |
| <p><u>Materials:</u> Two long rods (such as broom handles), a 10' piece of rope, pulley worksheet</p> <p>Students will create pulleys and compare how looping the rope affects the users' strength based on the directions on the worksheet.</p> <p><u>Hint:</u> Compare using the pulley and not using the pulley.</p> | <p><u>Materials:</u> Bolt and nut, sticker, screw worksheet</p> <p>Students will place a sticker on the bolt and secure the tip of the screw to illustrate how the screw is able to move the bolt quickly and easily. If students need more help visualizing that a screw is an inclined plane wrapped around a cylinder, have students cut a square of paper diagonally to make an inclined plane. Tape one of the short edges of the triangle to a pencil. Wrap the triangle around the pencil.</p> <p><u>Hint:</u> What is a screw made out of? How does the screw make work easier?</p> |

INCLINED PLANE

in-clined plane, *noun*

Definition: a flat surface at an angle to the horizontal. 2. a sloping ramp up which heavy loads can be raised. **Synonyms:** Ramp, slant, gradient.



Task: Make inclined planes with boards varying the slope of the board. Try leaning the board against objects of different heights. Tie rubber bands around the book. Tie the string to the rubber bands and pull the books up the different inclined planes. Also pull the books straight up without using the inclined planes.

Materials: 2 boards varying in lengths, string, rubber bands, ruler, heavy book

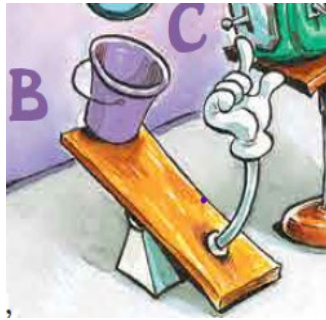
Guiding Questions:

1. Is it easier to pull the book straight up in the air, or up the inclined plane? Why?
2. Look at the stretch of the rubber bands during the straight up pull compared to different inclined planes. During which is the rubber band longer?
3. What is an example of an inclined plane in your every-day life?

LEVER

lev·er, 'levər, 'lēvər/, noun

Definition: a lever is a bar resting on a support, or fulcrum. It is used to help move a heavy or firmly fixed object with one end when pressure is applied to the other end.



Task: Make a lever out of the given materials and explore the relationship of the fulcrum to the load. Discover that it is easier to move an object when the fulcrum is closer to the load.

Materials: wooden ruler, object to lift, tape, can or toilet paper roll

Guiding Questions:

1. Does the lever make it easier to lift the load?
2. Move the fulcrum closer to and away from the load. Which is easier to lift?
3. What other types of levers are there? (*Hint: think about the position of the fulcrum, force, and object*).

WEDGE

wej/, noun

Definition: a piece of wood, metal, or some other material having one thick end and one thin edge, that is driven between two objects or parts of an object to secure or separate them.

Synonyms: Doorstop, chock.



Task: A knife's blade is a wedge made up of two inclined planes that come together to form a point. Students will cut a piece of craft dough/ putty in two using a plastic or toy knife and observe how the knife makes it easier to cleanly cut the dough into pieces.

Materials: craft dough, plastic/toy knife

Guiding Questions:

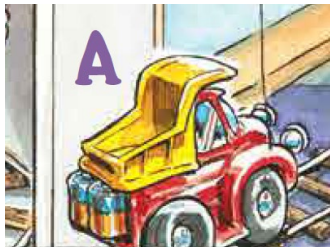
1. Why does a knife do a better job at separating materials rather than tearing?
2. How would a knife make it easier to cut a piece of dough into even pieces?

WHEEL AND AXLE

wheel and ax·el, *noun*

Definition: a machine made of a wheel and a stick that goes through the center of the wheel. It allows a heavy load to be pushed and reduces friction.

Synonyms: Axis, shaft.



Task: Push one car on its side and the other on its wheels. Note the difference in distance traveled.

Materials: 2 toy cars (i.e. Hot Wheels or Matchbox), rulers

Guiding Questions:

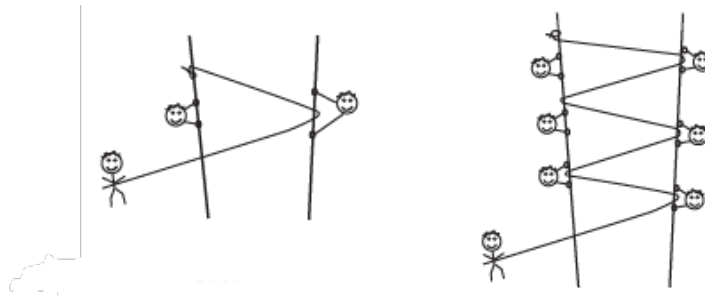
1. Which car moved easier, the one on its' wheels or the one on its' side?
2. If cars did not have wheels, how might they move? Would it be harder this way?

PULLEYS

pul·ley, 'pōōlē/, **noun** a wheel with a grooved rim and a rope that goes around the wheel inside the groove. It acts to change the direction of the force and is used to raise heavy weights.



Task: Work in groups of three. Tie the rope to one end of one rod, and then place the second rod parallel to the first. Loop the loose end of the rope around the second rod and back to the first. As illustrated, two people should hold the rods horizontally, while the third pulls on the rope. Explore what happens when this person pulls on the rope. Does anything change when the rope is looped five or six times? What happens if more students hold the poles?



Materials: Two long rods (such as broom handles), a 10' piece of rope

Guiding Questions:

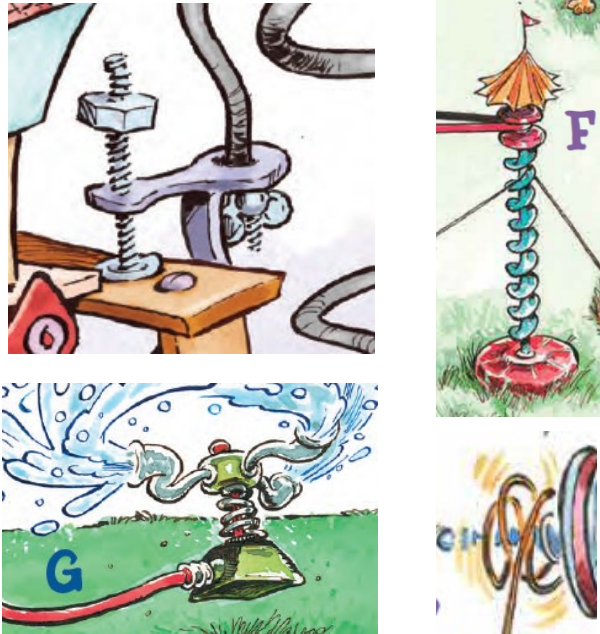
1. Who is doing more work? Why can the student pulling the rope move the students holding the rods?
2. Where do we use pulleys in our every-day life?
3. Draw an example of a pulley system using more than one pulley.

SCREW

skrōol, *noun*

Definition: an incline plane wrapped around a rod in a spiral shape.

Synonyms: Bolt, fastener.



Task: Take a nut and place a sticker on top. Fasten the nut on the bolt and move the nut to secure it to the top of the bolt. Students will see how a screw functions.

Materials: Nut, bolt, sticker

Guiding Questions:

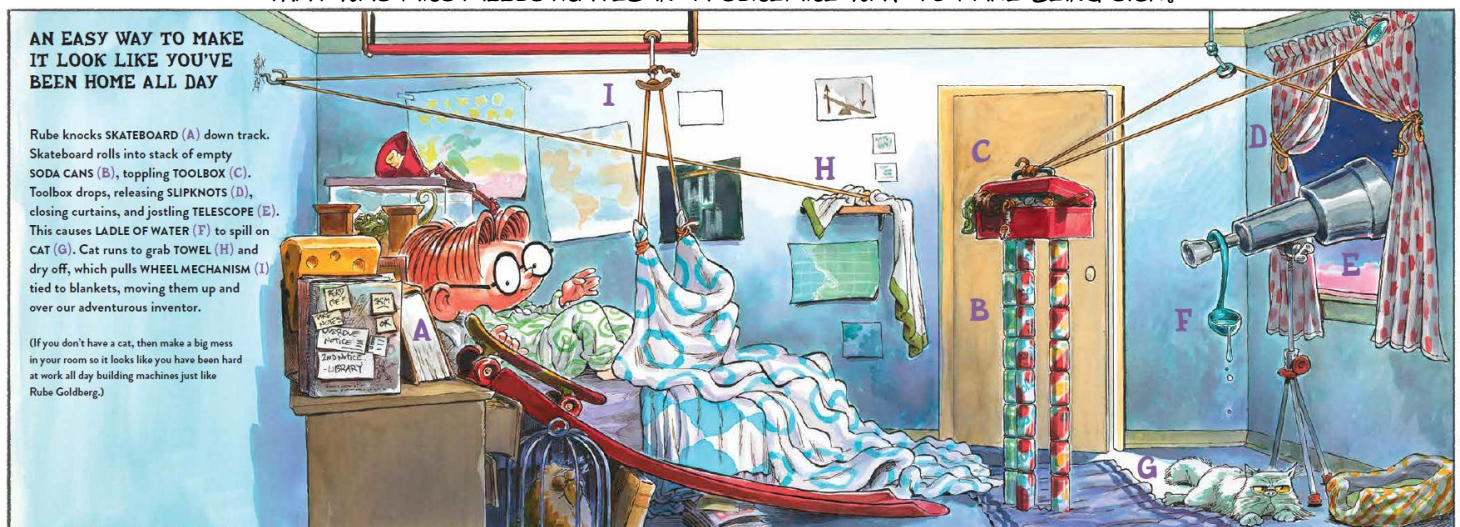
1. What is a screw typically made out of?
2. What do we use screws for in every-day life?
3. What tool do we use to get a screw into a piece of wood? Why?

Name: _____ Date: _____

DRAW A RUBE GOLDBERG MACHINE!



CHALLENGE: CAN YOU FIND THE WEDGE IN THIS PICTURE THAT WAS FIRST ILLUSTRATED IN "A SUREFIRE WAY TO FAKE BEING SICK?"



NEXT STEPS



LEARNING ISN'T A STRAIGHT LINE, AND THE RUBE GOLDBERG MACHINE IBLOCK IS AN EXCITING WAY TO TEACH STUDENTS EVERYTHING FROM IMPORTANT STEAM CONCEPTS TO SKILLS LIKE PROBLEM-SOLVING AND PERSEVERANCE.

The content in this project-based learning experience is a great way to support the creation of your machine, and all the investigation, invention, and innovation that go along with it.

The **iBlock** guides your students through the engineering design process. First, students will research and understand Rube Goldberg, simple machines, and how they come together in a Rube Goldberg Machine. Then they will plan, design, and construct a machine of their own. Next, they'll test and evaluate their machine, learning the importance of refining, remixing, and redesigning. Finally, they will share what they have learned, their process, and their machines in a showcase event.

Download a Sample at: <https://iblocks.com/rube-goldberg-machine-iblocks/>

...and check out our Rube Goldberg video series on OTIS for educators: <https://otis.teq.com/>

