

Pulleys & Gears

Materials:

- 2 clothesline pulleys!
- Gear set (K'Nex makes a good addition if catering to large groups)!
- Set of small pulleys!
- Rope!
- Water bottles (or other weights)!

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Introduction:!

1. What do scientists do?!
2. Where do you find scientists?!
3. What is a scientist? What is a physicist?!
4. How does this type of science affect your life? What about other types?!

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What's a Pulley?

1. Have you seen one before? *Likely you'll hear about clotheslines, window-washers, cranes, etc.!*
2. How do they work? *Pulleys are **simple machines** that help us do **work**. You can do work on an object at a distance, and depending on if the pulley is a free pulley, you cut your work in half.!*
3. Where do you find them? *Often construction, but answers will vary.!*
4. Do you think they are helpful? *Try to illustrate doing work at a distance by making use of a really long rope, and sending a student even outside the room with the rope end while you support the pulley and weight. !*
5. Have a student compare using a pulley to lift a weight versus doing it themselves. Have them explain their experience to the group. *Some will say the pulley is harder, but we can explain that it's actually the same or easier, depending on the pulley's orientation.!*

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Playing With Pulleys:

1. Single big pulley system:!
 - a. This is a **fixed** pulley. You feel the entire force of the weight's mass as you pull.!
 - b. This is a **free** pulley. You feel half the weight of the mass as you pull, since half goes up to the ceiling and half goes to your hand through the rope. Try to illustrate this for students.!

2. Double pulley system: Ask students if they think having more than one pulley is helpful. *Helps change direction without having the rope go off the track, makes the system stronger (as a crane does), prevents slack,...!*
 - a. Ask students which **compound pulley system** is easier to pull: A or B on the slide. *A is easier since it has a free pulley. The weight would be halved there, and the rope passing over the fixed pulley and into your hand would transmit that as it is.!*

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What's a Gear?

1. Have you seen one before? *Clocks, motors, bicycles...!*
2. What's a gear? *A rounded plate or cylinder with teeth that can interlock to form a system.!*
3. How do gears work? *Gears are also **simple machines** that help us do work. The teeth interlock and the gears act on one another to spin.!*
4. Where would you find one? *Factories, vehicles, locks...!*
5. What's the difference between pushing and pulling? *Point out that a pulley uses a "pulling" applied force, while a gear pushes another gear.!*

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Playing with Gears:

1. Do you think a gear can be useful by itself? *The gears can't really do useful work on their own.!*
2. Do the size of the gear's teeth matter? *Not really; smaller teeth might have less friction and wear.!*
3. Should the teeth match up? *Yes; they have to be able to interlock somehow.!*
4. Does the direction a gear turns matter? *We had one of us demonstrate with two gears how they turn it this point. They made it clear to the students that the two gears turn in opposite directions.!*

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Rotation Activity:

1. Give each student a number (1, 2, or 3)!
2. Explain that you've set up 3 stations in advance in three different areas of the room (try to get a bigger table for the gears)!
3. Show them where the 1's will go (big pulley station), 2's will go (small pulley station) and 3's will go (gear station).!
4. We mostly let kids play around with the different pulleys and gears, but we tried to prompt them with different observations or ideas they could use at each station. See the "Stations Activity" document for more ideas.!

5. After about 10 minutes, we rotated the stations through. The entire activity takes about a half-hour.!

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Acting Game:

1. We didn't ever have time for this, but it's here as a filler if necessary, or for a very excitable group.!

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Debate:

1. Show students the picture of a bike and its chain system. Ask them to think silently about what they are seeing, and to decide whether it is a gear system or a pulley system.!
2. Do a vote by show of hands. If you prefer, have them close their eyes for this as they usually all vote the same.!
3. Someone will always give the idea of a bike being an example of BOTH pulleys