

## Lesson Plan

Assessment  
Cross-curricular

AOL - test

### Big Ideas

- Pulleys and gears change the speed, direction, and motion of, and force exerted on, moving objects. Sound is created by vibrations
- Pulleys and gears make it possible for a small input force to generate a large output force

### Learning Goals

- To see how you can use pulleys and gears TOGETHER to perform a task.
- To reinforce everything that the students learned over this set of lessons.

### Specific Expectations:

- 2.2** use scientific inquiry/experimentation skills to investigate changes in force, distance, speed, and direction in pulley and gear systems
- 2.3** use technological problem-solving skills to design, build, and test a pulley or gear system that performs a specific task
- 2.4** use appropriate science and technology vocabulary, including pulley, gear, force, and speed, in oral and written communication
- 3.1** describe the purposes of pulley systems and gear systems (e.g., to facilitate changes in direction, speed, or force)
- 3.2** describe how rotary motion in one system or its components (e.g., a system of pulleys of different sizes) is transferred to another system or component (e.g., a system of various gears) in the same structure

### Description:

This is the **fifth** lesson in a unit of five on the topic of pulleys and gears as applied to elevators.

### Materials/Resources:

Materials from previous lessons  
Extra pieces of skewers  
Masking tape  
Test and Solutions  
Images

### Safety Notes

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## Introduction

We have spent the last few days discussing pulleys, gears, and how they can be used to make elevators. Today we will make an elevator using both pulleys and gears together! After that we will summarize what we've learned.

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## Action

### Pulleys AND Gears Elevator

The task is to use a gear system to wind up the string after it has passed through a pulley system. Here is an approach:

- Set up the elevator again using a pulley.
  - Choose how many loops you want to make with your string (i.e. how many wheels your pulley has).
  - Remember that the more wheels you have the easier it is to pull the pulley up, but the string also has to be pulled in farther. Can you compensate for this with the right gear setup? (If you use a large gear that drives a small gear, then that small gear spins fast and can be used to pull in the string rapidly)
- Set up the gears in such a way as to allow winding up the string.
  - Make sure that the axle of the gear you will be using to wind up the string sticks out far enough so you can attach and wind the string (See image 1 from Reference Images).
  - You are using a pulley to make it easier to pull up a heavy load. Use the gears to speed up the process. In this way you can combine the benefits of two systems to get a superior result! So:
    - Use a LARGE gear as your drive gear and a small gear as your load gear
- Turn your drive gear to wind up the string.
  - Is this easier than when you pulled up the elevator with this gear setup without a pulley? (Yes!)
  - How could you speed things up?
    - You could use compound gears.
    - You could also place a wheel on the axle, around which you wind up the gear.
- Try speeding up the elevator.
  - Instead of a wheel you can just make your axle thicker. Do this by taping a few more pieces of skewer to the axle that you use to wind up the string (See image 2).
  - How well does the elevator work now?

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## Consolidation/Extension

Use the attached sheet as a review or unit test.

### Extension: Space Elevators!

This is a really cool concept that can be used to wrap up the lessons on elevators with something a bit futuristic but not totally unrealistic. It really shows you the limits of what an elevator could maybe be one day.

We are no longer talking about just going up a tall building. Now we are talking about reaching space!

- What is a space elevator?
  - The idea is to run a cable straight up from the Earth right into space. An elevator can then use the cable to ascent into space along it. No rockets needed!
- How does it work?
  - If you go far enough away from the Earth you get to a distance where an object that orbits around the earth goes at the same speed as the Earth's rotation. This is where we put TV satellites – so we can always point our satellite dishes at the same point in the sky. These orbits are called geostationary.
  - For a space elevator we would place a large weight in geostationary orbit. We would then attach a cable to this weight that is also attached to the ground. Now as the Earth rotates (once every day) you can imagine this weight as flinging around the Earth, keeping tension in the cable.
  - Easy demonstration:
    - Spin a yoyo (or other weight) on a string around your head. The string is always under tension.
- Why would we want that?
  - Rockets are very expensive and use a lot of fuel.
  - This could work without rockets and it would be much cheaper once it's set up. You could send up much more stuff.
  - It would be very useful if we were trying, for example, to build a space ship IN space to then send to other planets (such as Mars). If you build a space ship in space you can make it much larger and heavier as you won't have nearly as much of Earth's gravity to overcome.
- Videos on space elevators:
  - SciShow: [https://www.youtube.com/watch?v=\\_2M73aXuORI](https://www.youtube.com/watch?v=_2M73aXuORI)
  - Neil DeGrasse Tyson on NOVA: <https://www.youtube.com/watch?v=vktd3-MKh-U>