

## Lesson Plan

Assessment	AFL, simulation
Cross-curricular	

### 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

- Explore and learn about the advantages gears provide by doing different simulations.
- To make gears out of cardboard and explore how they can be used
- Become aware that there are many different types of gears.

### 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
- 3.7** explain how the gear system on a bicycle works (e.g., by using the largest gear on the front chain ring and the smallest gear on the rear wheel, we can move quickly along a flat surface)

### Description:

This is the **third** of five lessons on the topic of elevators. Note: This lesson could easily be broken up into two days (or may have to be if time runs out) – one day to look at GearSketch and making cardboard gears on the second day.

### Materials/Resources:

GearSketch online gear simulator (computers)  
 Gear Templates  
 Cardboard (the thicker the better)  
 Glue  
 Scissors or Exacto knives

### Safety Notes

Be careful when cutting with Exacto knives. This might not be something to use in class with the students.

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## Introduction

Today we will shift our focus from pulleys to gears. We will make our own gears out of cardboard. But first let's just play with gears a bit

- As you will find out it's a bit hard to make really nice gears, so we are going to start by using a really cool program to play with them. You can draw gears with it and then make them spin to see what they do.
  - Take students to the computer lab. Students can work individually or in a small group if necessary.
    - NOTE: If you do not have access to a computer lab you can use an interactive whiteboard to demonstrate the GearSketch Challenges (<http://www.gearsketch.ch/>) activities to the class.
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## Action

### Drawing Gears with GearSketch

#### Note:

Science North did not develop GearSketch. We therefore cannot guarantee that it will still be available. However it is by far the best and easiest tool we could find to play with gears without having to own an expensive classroom set. We therefore decided to include it in this lesson.

If you own a set of real gears for the classroom you can easily do these demos with them instead of using the program. Pictures of all the suggested activities are included below.

GearSketch is very easy to use and you can just let the students explore what they can do with it after showing them the basics. See what they can come up with! Another option is to walk the students through some specific examples that build up gear systems from simple to more complicated. We are including this second option here as a useful reference.

1. Instruct students to watch the **GearSketch tutorial** or show them the things they can do. The tutorial shows how to draw a gear, move the gear, place two wheels on the same axle, place a belt around a number of gears, deleting an element, and finally how to animate the gears.
2. One large gear, one small gear.
  - a. Create two gears of different sizes and place them next to each other.
  - b. Spin the large gear and observe what the small one does. Try it the other way around.
  - c. What does this setup allow you to do in terms of changing the SPEED of rotation?
  - d. Which direction does each wheel spin in? (The direction reverses)
3. Add a third gear.
  - a. Draw another gear and place it beside the first two gears
  - b. What direction does this third gear spin in?
    - i. Each time you add a gear it changes the direction of spin.
4. Compound gear

- a. Draw a large gear, **then place a small gear on top of it**
  - b. Draw another **large gear** and connect it to the SMALL gear. (TIP: Make this gear big enough that its centre lies OUTSIDE the first large gear once you connect it to the small gear. Otherwise it won't work)
  - c. Spin the small gear, then spin the second large gear you drew (that is now attached to the small gear)
    - i. You will notice how you can make things spin pretty fast. Let's take it a step further
5. Double compound gear
- a. Draw another **small gear** and place it on top of the second large gear (that didn't have a small gear on top of it already)
  - b. Draw another **large gear** and connect it to the small gear.
    - i. This is a way to rapidly increase speed
    - ii. OR going the other way you increase FORCE. Meaning if you spin the last large gear, that first small gear would be VERY hard to stop.
6. Optional: The Bike
- a. Draw a **VERY large gear**. This will represent your bike wheel.
  - b. Now draw a **very small gear** and place it on top.
  - c. Draw a **medium sized gear** and place it a distance away
  - d. Draw a **belt** (chain) from the medium wheel to the small wheel.
  - e. Make the medium wheel spin.
    - i. This is like you riding a bike. Note how fast the "wheel" turns.
  - f. Now delete the belt and the small wheel.
  - g. Draw a **new small gear, but make it bigger than before**. Place it at the centre of the "wheel" again.
  - h. Draw another **belt** (chain) and make the medium wheel spin again.
    - i. How fast does the "wheel" go now? You should see that it goes slower with the same speed of the medium wheel. This is how you change gears on a bike!
  - i. Keep trying different combinations
7. Have fun.
- a. Come up with the craziest/most interesting system you can. Use belts, multiple gears, etc.

### Making Gears

- Time for the students to make their own gears now. Work in the groups from the previous days.
- Give each student a template (attached and can also be created on the website given in resources). **Make sure that each group of students makes at least one larger gear and one smaller gear.**
- Glue template onto a piece of cardboard.
- Cut out the gear, one tooth at a time!
  - It is very important that the gears are made as accurately as possible. Take your time cutting them out!
  - Poke a hole or mark the centre of the gear while the template is on it

- Time permitting; get the student to make a **second large gear**. This will be useful to create compound gears in the next class.

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### **Consolidation/Extension**

- To be continued in lesson 4, when students will use their cardboard gears to make the elevator move.