Simple Machines: 4.G.5

Gears and Complex Machines

Grade Level	4
Sessions	2 to 4 – 50 minutes each
Seasonality	N/A
Instructional Mode(s)	Whole class
Team Size	Whole class
WPS Benchmarks	04.SC.IS.01 04.SC.IS.02 04.SC.IS.03 04.SC.IS.04 04.SC.IS.06 04.SC.TE.01 04.SC.TE.02 04.SC.TE.03 04.SC.TE.06 04.SC.TE.08
MA Frameworks	3-5.IS.01 3-5.IS.02 3-5.IS.03 3-5.IS.04 3-5.IS.06 3-5.TE.1.1 3-5.TE.1.2 3-5.TE.1.3 3-5.TE.2.3
Key Words	Simple machines, Gears, Complex machines, Engineering Design Process

Summary

The students will learn about gears as simple machines. The students will design and build a simple gear system. The students will then be asked to solve a problem by using the engineering design process to create a solution. The students will have the option of creating a complex machine from multiple simple machines.

Learning Objectives

2002 Worcester Public Schools (WPS) Benchmarks for Grade 4

04.SC.IS.01 Ask questions and make predictions that can be tested.

04.SC.IS.02 Select and use appropriate tools and technology in order to extend observations.

04.SC.IS.03 Keep accurate records while conducting simple investigations or experiments.

04.SC.IS.04 Conduct multiple trials to test a prediction. Compare the results of an investigation or experiment with the prediction.
04.SC.IS.06 Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.
04.SC.TE.01 Identify materials used to accomplish a design task based on specific property.
04.SC.TE.02 Identify and explain the appropriate materials and tools to construct a given prototype safely.
04.SC.TE.03 Identify and explain the difference between simple and complex machines (e.g., hand can opener that includes multiple gears, wheel, wedge gear, lever).
04.SC.TE.06 Identify relevant design features for building a prototype of a solution to a given problem.
04.SC.TE.08 Apply the metric system in design projects and experiments.

Additional Learning Objectives

1. 3-5.IS.01 Ask questions and make predictions that can be tested.
2. 3-5.IS.02 Select and use appropriate tools and technology in order to extend observations.
3. 3-5.IS.03 Keep accurate records while conducting simple investigations or experiments.
4. 3-5.IS.04 Conduct multiple trials to test a prediction. Compare the results of an investigation or experiment with the prediction.
5. 3-5.IS.06 Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.
6. 3-5.TE.1.1 Identify materials used to accomplish a design task based on specific property.
7. 3-5.TE.1.2 Identify and explain the appropriate materials and tools to construct a given prototype safely.
8. 3-5.TE.1.3 Identify and explain the difference between simple and complex machines.

9. 3-5.TE.2.3 Identify relevant design features for building a prototype of a solution to a given problem.

Required Background Knowledge

1. Basic understanding of simple machines.
2. Basic understanding of the engineering design process.

Essential Questions

1. What is the purpose of gears?
2. Can simple machines be used to solve everyday problems?

Introduction / Motivation

Ask the students what a gear is and what it is used for. Display ***Gears*** and explain the definition to the students.

Procedure

The instructor will:

1. Ask the students if they could design a gear system. Ask them what materials they would want to use. The students can work individually or in groups.
2. Distribute or display ***Gear Basics*** then ***Building a Gear System***.
3. Guide the students through ***Building a Gear System***.
4. After the students have completed and tested their gear system, distribute ***Engineering Design Challenge***.

Materials List

Materials per student	Amount	Location
Scissors	1	Office Supply Store
Large Paper Plate	1	Grocery Store
Small Paper Plate	1	Grocery Store
Rivets	2	Office Supply Store
Ruler	1	Classroom
Pencil	1	Classroom
Compass	1	Office Supply Store
Cardboard	1	Grocery Store

Vocabulary with Definitions

1. *Complex Machine* – A complex machine is made up of simple machines to create a device that makes work easier.
2. *Force* - The capacity to do work or cause physical change.
3. *Gear* – This simple machine is a toothed wheel. Two toothed wheels fit together so that one wheel will turn the other. Gears are used to control speed and direction of motion.
4. *Simple Machine* – A simple machine is a device that makes work easier.
5. *Work* – Physical or mental effort or activity directed toward the production or accomplishment of something.

Assessment / Evaluation of Students

The instructor may assess the students in any/all of the following manners:

1. Check worksheets

Lesson Extensions

This lesson could be used with the other lessons in this unit.

Attachments

1. **Gears**
2. **Gear Basics**
3. **Building a Gear System**
4. **Engineering Design Challenge**

Troubleshooting Tips

None

Safety Issues

None

Additional Resources

None

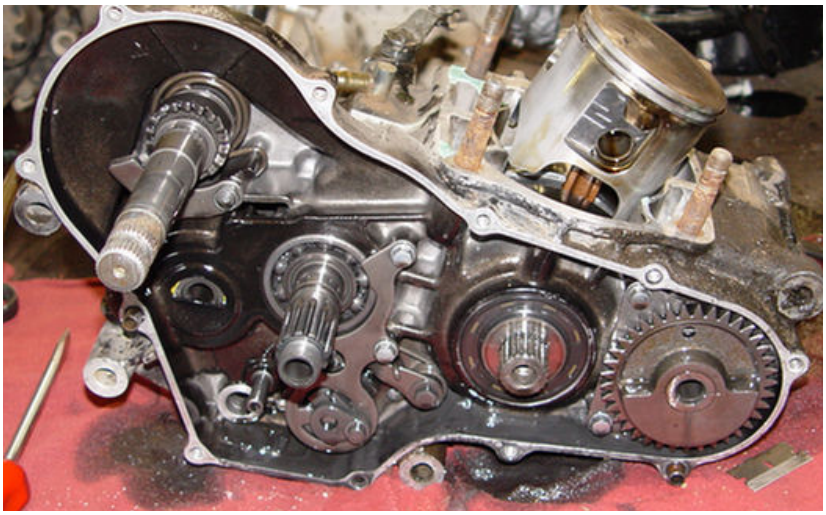
Key Words

Simple machines, Gears, Complex machines, Engineering Design Process

Gears

http://www.horologist.com/repair_notes

www.exo.net



www.off-road.com

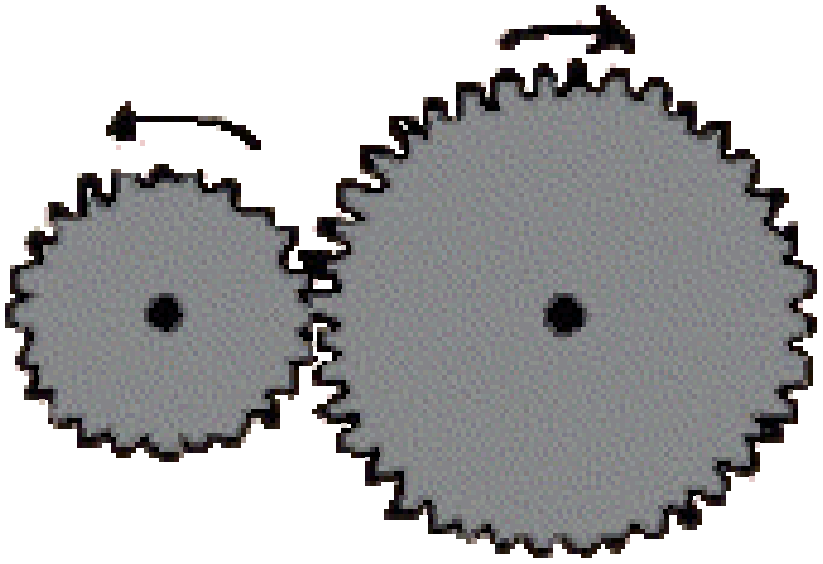
Gear Basics

Gears are a type of simple machine.

They help to control speed and direction of motion.

To design a gear system (also called a gear train) you need to consider the following:

- The teeth must be uniform.
- The teeth must be evenly spaced.



www.fi.edu

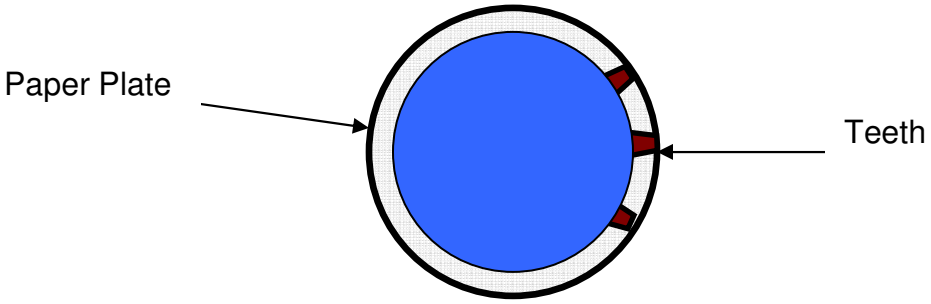
Building a Gear System

You will need these supplies to build your gear system:

Scissors	Compass
One large paper plate	Ruler
One small paper plate	Pencil
2 rivets	Piece of Cardboard

Step 1: Find the centers of both plates and mark the center with a pencil mark.

Step 2: Decide how large you want each tooth to be.



Step 3: You need to figure out the following:

- How do you evenly space out the teeth on the gears? (hint: use your compass)
- How do you figure out how to make the teeth the same height. (hint: draw a smaller circle inside the larger circle)

Step 4: After you have drawn the gears on each of the paper plates, carefully cut them out.

Step 5: Place both gears on the piece of cardboard so that the teeth interlock. Use the rivets to secure the gears on the piece of cardboard.

Test the gear system! What do you think? How could you make it work better?

Name: _____ Date: _____

Engineering Design Challenge

You are asked to invent a way of doing one of the following tasks:

- Closing the refrigerator door with a switch
- Feeding a dog or cat
- Setting the table
- Making your bed

You can include as many simple machines as you want. As a reminder, here is a list of all of the simple machines.

1. Gear
2. Inclined Plane
3. Lever
4. Pulley
5. Screw
6. Wedge
7. Wheel and Axle

Name: _____ Date: _____

Engineering Design Task

Step 1: **Identify the need or problem**

Which of the tasks have you chosen?

_____

Step 2: **Research the need or problem**

Think about ways that you have seen simple and complex machines used.

Step 3: **Brainstorm**

Draw three different possible solutions on the back of this paper.

Step 4: **Select the best possible solution**

Circle the solution in Step 3 that you select. Why did you select that solution?

_____

_____

_____

Step 5: **Construct a prototype**

Instead of constructing a prototype, write down the steps you would take in building your prototype. Include the types of materials and tools you would use.

_____

_____

_____

Name: _____ Date: _____

Engineering Design Task

Step 6: **Test and evaluate the solution**

Consider what would happen if your designed prototype were to be used in an area with lots of people? Would it be safe? Could you improve it to be used in that kind of environment? Write down what you think below.

Step 7: **Communicate the solution**

Present your chosen design to the members of your group.

Step 8: **Redesign**

Draw a picture of your new and improved design below or on the back of this paper.