Unit 4 (Mechanisms):
Rotary Motion: Exploring with Gears

Concept
Rotary motion is movement in a circular direction; rotary motion can be transmitted through a system with gears.

Content objective
Explore how gears work in various combinations to change direction and size of motion.

Language objectives
Students will be able to orally describe some characteristics of gears *using adjectives*.

Standards

- **NGSS:**
  - **K-2-ETS1-1.** Ask questions, make observations, and gather information about a situation that people want to change to define a problem that can be solved with a new or improved object or tool.
- **TEKS**:
  - **6A** Students will differentiate among forms of energy, including mechanical, sound, electrical, light, and heat/thermal.
  - **6D** Students will test the effect of force on an object such as a push or a pull, gravity, friction, or magnetism.

ELPS:

- **1C** Students will use strategic learning techniques, such as concept mapping, drawing, memorizing, comparing, contrasting, and reviewing to acquire basic and grade-level vocabulary. [Metacognitive Strategies]
- **1D** Students will speak using learning strategies, such as requesting assistance, employing nonverbal cues, using synonyms and circumlocution (conveying ideas by defining or describing when exact English words are not known). [Making Meaning]
- **2F** Students will listen to and derive meaning from a variety of media, such as audiotape, video, DVD, and CD ROM to build and reinforce concept and language attainment. [Listening Across Contexts]
- **2I** Students will demonstrate listening comprehension of increasingly complex spoken English by following directions, retelling or summarizing spoken messages, responding to questions and requests, collaborating with peers, and taking notes commensurate with content and grade-level needs. [Demonstrate LC in Context]

Materials:

- Purchased plastic gear systems
- Gear picture cutouts
- Lesson handouts **4.4.1- 4.4.2**

Literature Connections

Gears in My World by Joanne Randolph

Day 1: Engage/Explore:

Teacher Says/Does	Student Says/Does	Language Requirements
1. Start a discussion about gears. Ask the students: a. Does a bike have gears? b. Do you know examples of gears used at home (e.g., manual egg beaters	Students share what they know about gears	Gear Gear teeth
2. Show students the gear pictures in handout **4.4.1**, and/or the following animations, have them pair share, and then share out with the rest of the class: • http://bestanimations.com/Science/Gears/silver-two-gear-cogs-animation-7.gif • https://upload.wikimedia.org/wikipedia/commons/2/22/Spur_gears_animation.gif • https://upload.wikimedia.org/wikipedia/commons/c/c3/Worm_Gear.gif	Students do a pair share to discuss gear pictures and animations	
3. Give each team of students a set of gears and ask them to color one tooth on each gear with a marker for a reference point (if gears are not already so marked). Ask students to count the number of teeth on the small, medium, and large gears and record the results on paper.		A (small/medium/large) gear has _____ teeth.
4. Ask students to predict how many turns of the small gear it will take to make the large gear turn one time. If possible, have them use a pegboard or gearboxes to test their prediction.	Students make predictions using plastic gears	_____turns of the small gear are needed to make the large gear turn one time.

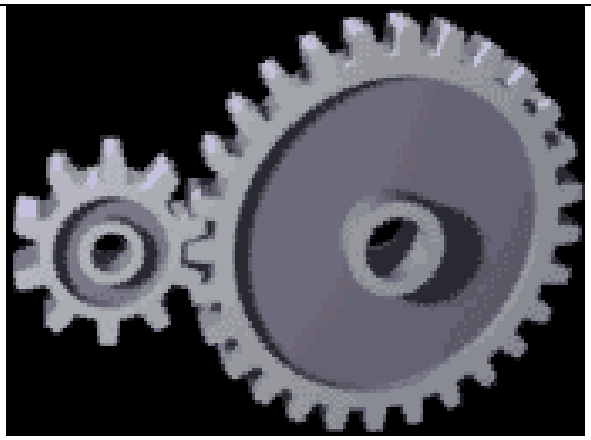
Day 2: Explore/Explain

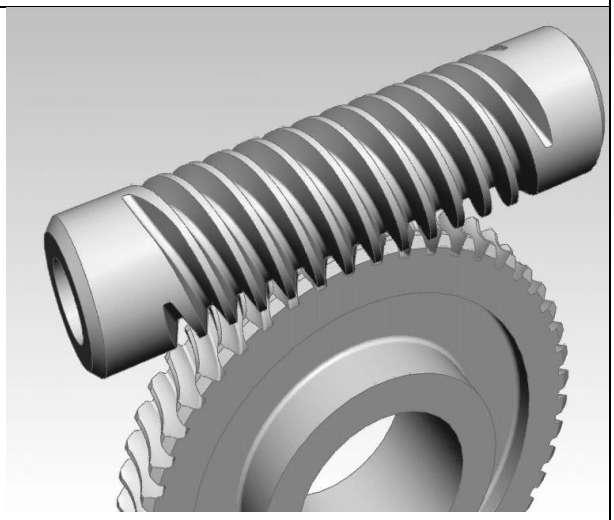
Teacher Says/Does	Student Says/Does	Language Requirements
1. Show students the Black Box System in handout **4.4.2**, reminding them of basic ideas behind this model. 2. Form students into groups so that each is assigned one of the three Black Box Systems in the handout: • one where one gear turns clockwise and the output is another gear turning clockwise • one where the input is one gear making turns clockwise and the output is the other gear turning counter-clockwise • one where the input is 3 turns of a big gear and the output is a little gear making 9 turns 3. Give teams a few minutes to explain what they are going to do and to resolve any introductory questions. 4. Let the teams work with the gears to try to devise systems that will create each model, using their gears and the gearboxes. 5. Ask each team to share their results and record briefly what they have found. Ask the students to make a rule about gear movements (adjacent or touching gears turn opposite directions).	Students talk and discuss with their teammates Students build a system using black box thinking	Adjacent gears Touching gears

Day 3: Elaborate and Evaluate

Extensions into the Disciplines	Student Says/Does	Language Requirements
Challenge each team to make a "mystery system" of gears, using a cover or a piece of paper to hide all but their input crank and output gear movement. When teams present their puzzle to the class, the others should use the gear picture cut-outs to infer the gears and their placement inside the system.	Students present and discuss their puzzles with their classmates	Input crank Output gear

Engage/Explore





Black Box Systems