Unit Purpose, Objectives, Vocabulary, & Materials

Recommended Grade Level:
Grade 2 to Grade 8

Suggested Prior Learning:
- Completion of the Let’s Get Started, Simple Machines & Motion, Your First Robot, and Key Concepts units are suggested.

Unit Purpose:
The purpose of this unit is for students to learn about robotic mechanisms, their design, and the corresponding math and science concepts.

Learning Objectives:
- Students will learn about DC Motors
- Students will learn about and apply knowledge of Gear Ratio
- Students will learn about Drivetrains
- Students will learn about Object Manipulation
- Students will learn about Lifting Mechanisms
- Students will learn key terminology related to Mechanisms

Unit Vocabulary:
Accumulator Chassis      DC Motors               Degree of Freedom
Driven Gear              Driving Gear            Drivetrain Elevator
Friction Grabber         Gear Ratio              Gear Train
Idler Gear               Lifting Mechanism       Linkages
Motor Loading            Object Manipulator      Plow
Rotating Joint           Scoop                   Stall
Turning Scrub            Wheelbase

Unit Materials:
- Unit Content Material (G.1, G.2, G.3, G.4, G.5, G.6)
- Unit Written Exercises (G.7, G.9)
- Unit Build Instructions (G.8)
- Unit Written Exercises Answer Keys (G.t4, G.t5)
- Pencils or pens
- VEX IQ Kit Hardware (for Gear Ratio Simulator and other activities)
- Internet access for website use – optional
- Additional paper – optional
Unit Plan and Options

20 Minutes (for grades 4-8):
Provide students with Mechanisms DC Motors (G.2). Review information, terminology, and concepts related to DC Motors with the students. Additionally and optionally, use VEX IQ kit hardware to demonstrate as you review the handout.

20-45 Minutes (for grades 2-8):
Prior to learning about Gear Ratio, have students use the Gear Ratio Simulator Assembly Instructions (G.8) to build and experiment with the VEX IQ Gear Ratio Simulator. Separating out the parts required for this build prior to the activity will reduce build time. The amount of time you have to let students experiment with the simulator can also be used to adjust the time spent here.

20-45 Minutes (for grades 2-8):
Provide students with Mechanisms Gear Ratio (G.3). Review information, terminology, and concepts related to Gear Ratio with the students. Additionally and optionally, use VEX IQ Kit Hardware to demonstrate as you review the handout.
- For Grades 2-3: Use the Gear Ratio Basics section of this handout ONLY
- For Grades 4-5: Use the Gear Ratio Basics and Expressing Gear Ratio and Gear Reduction sections of this handout
- For Grades 6-8: Use ALL sections of this handout

20 Minutes – 1 Hour (for grades 2-8):
Provide students with Mechanisms Gear Ratio (G.3), the previously built Gear Ratio Simulator with extra gears, and Gear Ratio Exercise handouts 1, 2, 3, and 4 (G.9). Students should use the simulator and refer to "Mechanisms Gear Ratio (G.3)" as needed while they complete the Gear Ratio Exercises. Time will vary based on grade level and number of exercises used.
- For Grades 2-3: Use Gear Ratio Exercise 1 ONLY
- For Grades 4-5: Use Gear Ratio Exercises 1 and 2
- For Grades 6-8: Use ALL four Gear Ratio Exercises

20 Minutes (for grades 4-8):
Provide students with Mechanisms Drivetrains (G.4). Review information, terminology, and concepts related to Drivetrains with the students. Additionally and optionally, use VEX IQ kit hardware to demonstrate as you review the handout.

20 Minutes (for grades 4-8):
Provide students with Mechanisms Object Manipulation (G.5). Review information, terminology, and concepts related to Object Manipulation with the students. Additionally and optionally, use VEX IQ kit hardware to demonstrate as you review the handout.

30 Minutes (for grades 4-8):
Provide students with Mechanisms Lifting Mechanisms (G.6). Review information, terminology, and concepts related to Lifting Mechanisms with the students. Additionally and optionally, use VEX IQ kit hardware to demonstrate as you review the handout.
30 Minutes – 1 Hour (for grades 2-8):
Provide students with Matching Exercise handout for the unit. Students match terms with appropriate definitions and phrases in groups, alone, and/or for a quiz grade. Time may vary based on grade level, how many sections of the exercise you choose to have students complete, and/or how many of their resources the students are allowed to use while completing the exercise.

1+ Hour (Optional Activity for grades 4-8):
Using VEX IQ Hardware, have students build and test drivetrains, object manipulators, and/or lifting mechanisms according to specifications of activities you develop. Other build activities in subsequent units can/will suffice for this same purpose as well.

### Unit Standards Connections:
Next Generation Science Standards (NGSS)

<table>
<thead>
<tr>
<th>Grade</th>
<th>Category</th>
<th>PE Code</th>
<th>Performance Expectation (PE)</th>
<th>Unit Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Motion and Stability: Forces and Interactions</td>
<td>3-PS2-2</td>
<td>Make observations and/or measurements of an object’s motion to provide evidence that a pattern can be used to predict future motion.</td>
<td>- Object Manipulation - Lifting Mechanisms</td>
</tr>
<tr>
<td>3-5</td>
<td>Engineering Design</td>
<td>MS-ETS1-3</td>
<td>Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.</td>
<td>- Gear Ratio Simulator and Gear Ratio Exercises</td>
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### Standards for Technological Literacy (STL)

<table>
<thead>
<tr>
<th>Code</th>
<th>Grade</th>
<th>Standard</th>
<th>Benchmark</th>
<th>Unit Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.F</td>
<td>3-5</td>
<td>Students will develop an understanding of the core concepts of technology.</td>
<td>A subsystem is a system that operates as a part of another system.</td>
<td>- Drivetrains - Object Manipulators - Lifting Mechanisms</td>
</tr>
<tr>
<td>2.K</td>
<td>3-5</td>
<td>Students will develop an understanding of the core concepts of technology.</td>
<td>Tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.</td>
<td>- Drivetrains - Object Manipulators - Lifting Mechanisms</td>
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<tr>
<td>2.S</td>
<td>6-8</td>
<td>Students will develop an understanding of the core concepts of technology.</td>
<td>Trade-off is a decision process recognizing the need for careful compromises among competing factors.</td>
<td>- Gear Ratio and relationship between Speed and Torque</td>
</tr>
<tr>
<td>3.C</td>
<td>3-5</td>
<td>Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.</td>
<td>Various relationships exist between technology and other fields of study.</td>
<td>- Gear Ratio Simulator use and calculations - Scientific principles in unit content materials</td>
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<tr>
<td>Domain #</td>
<td>Grade</td>
<td>Cluster</td>
<td>Standard</td>
<td>Unit Activities</td>
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<tr>
<td>4.OA</td>
<td>4</td>
<td>Operations and Algebraic Thinking</td>
<td>Gain familiarity with factors and multiples</td>
<td>Gear Ratio and Reduction</td>
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<td>4.NBT</td>
<td>4</td>
<td>Number and Operations in Base Ten</td>
<td>Use place value understanding and properties of operations to perform multi-digit arithmetic.</td>
<td>Gear Ratio and Reduction</td>
</tr>
<tr>
<td>4.NF</td>
<td>4</td>
<td>Number and Operations - Fractions</td>
<td>Extend understanding of fraction equivalence and ordering.</td>
<td>Gear Ratio and Reduction</td>
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<tr>
<td>6.RP</td>
<td>6</td>
<td>Ratios and Proportional Relationships</td>
<td>Understand ratio concepts and use ratio reasoning to solve problems.</td>
<td>Gear Ratio and Reduction</td>
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<tr>
<td>6.NS</td>
<td>6</td>
<td>The Number System</td>
<td>Compute fluently with multi-digit numbers and find common factors and multiples.</td>
<td>Compound Gear Reduction</td>
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