Note to the teacher
On this page, students will use word problems to learn about gear ratios. Gear ratio is defined as the number of times the driving axle must revolve in order to make the driven axle revolve exactly once. In this exercise, students will learn to determine the gear ratio for gears by dividing the number of teeth on the driven gear by the number of teeth on the driving gear. They will also learn to determine the gear ratio for pulleys by dividing the diameter of the driven gear by the diameter of the driving gear. Students will have to use both fractions and decimals to make these calculations, and convert between them. They will also have to reconstruct and manipulate equations. While the worksheet is designed to help students learn how to determine gear ratio and may be successfully completed by students with little background in this area, the existing ability to multiply decimals and fractions, and the ability to manipulate equations, will be necessary to successfully complete the worksheet. Teachers may wish to review any or all of these skills depending on their students’ background. Note that the first two questions test students’ conceptual understanding by asking them to create high and low gear ratios. Students lacking conceptual understanding of gear ratios may need guidance.

Students are expected to use the following procedure on questions 1 and 2:
• Understand that “high gear ratio” and “low gear ratio” mean the largest possible driven gear and the smallest possible driving gear, or vice versa
• Choose the largest possible gear for the driven gear and the smallest possible gear for the driving gear, or vice versa
• Divide the number of teeth on the driven gear by the number of teeth on the driving gear to determine the gear ratio

Students are expected to use the following procedure on questions 3-5:
• Reconstruct the equations provided as an example
• Enter the data provided into these equations
• Manipulate the equation
• Solve the equation to answer the question
Approximate classroom time: 10-20 minutes depending on students' background

Students successfully completing the worksheet will be able to:
1. Define gear ratio
2. Identify gear size by counting the teeth on gears
3. Identify gear size by measuring the diameter of pulleys
4. Determine gear ratio from gear ratios of different sizes
5. Determine gear ratio from pulley combinations of different sizes
6. Multiply decimals and fractions
7. Reconstruct equations
8. Identify data provided in word problems
9. Manipulate these equations and solve them

Standards addressed:
Math Standards
Numbers and Operations
Algebra
Geometry
Measurement
Problem Solving
Connections

Technology Standards
The Nature of Technology Standard 1
Design Standards 8, 9
Abilities for a Technological World Standard 12
Using Technology to Design the Future Standards 16, 18, 19

Science Standards
Content Standard B
Content Standard E

Note: Workbook answers begin on the next page.
**Gears Ratios / Word Problems**

**Instructions**
Christine and Tim are designing robots with different gear ratios to complete various tasks. Use the formulas below to determine what gears and gear ratios they should use.

1. Christine and Tim want to design a robot with as high a gear ratio as possible in order to climb the greatest possible slope. They have 40, 24, 14, 12 and 8 tooth gears available.

   - What gear should they choose as their driven gear?

   To get the highest gear ratio possible, you want the most possible number of teeth on the driven gear, since that is the numerator in the fractional gear ratio. So the gear with the highest possible number of teeth is the **40 tooth gear**.

   - What gear should they choose as their driving gear?

   To get the highest gear ratio possible, you want the fewest possible number of teeth on the driving gear, since that is the denominator in the fractional gear ratio. So the gear with the fewest possible number of teeth is the **8 tooth gear**.

   - What would be the gear ratio of this robot?

   *The gear ratio of this robot would be 40/8, which simplifies to 5/1.*
2. Christine and Tim want to design a robot with as low a gear ratio as possible so that it can reach the greatest possible speed. They have pulleys with diameters of 3.5, 2.3 and .6 centimeters available.

- What diameter pulley should they choose as their driven pulley?

To get the lowest gear ratio possible, you want the smallest possible diameter driven pulley, since that is the numerator in the fractional gear ratio. So the smallest possible diameter pulley is the .6 centimeter pulley.

- What diameter pulley should they choose as their driving pulley?

To get the lowest gear ratio possible, you want the largest possible diameter driven pulley, since that is the denominator in the fractional gear ratio. So the largest possible diameter driving pulley is the 3.5 centimeter pulley.

- What would be the gear ratio of this robot?

The gear ratio of this robot would be .6/3.5, which reduces to .17/1.

3. Christine and Tim want to design a robot with a gear ratio of 2, using a 16 tooth driven gear. They have 40, 24, 16, 14 and 8 tooth gears available. What gear should they choose as their driving gear?

Since the gear ratio is equal to the number of teeth on the driven gear divided by the number of teeth on the driving gear, we would have the equation: \(16 \text{ (number of teeth on the driven gear)}/y \text{ (number of teeth on the driving gear)} = 2\). If we solve for \(y\), we find that \(y = 8\). So they should use the 8 tooth gear.

4. Christine and Tim want to design a robot with a gear ratio of 1.52, using a 3.5 cm driven pulley. They have pulleys of 3.5, 2.3 and .6 centimeters diameter available. Which should be their driving pulley?

Since the gear ratio for a pulley is equal to the diameter of the driven pulley divided by the diameter of the driving pulley, we would have the following equation: \(3.5 \text{ (diameter of the driven pulley)}/y \text{ (diameter of the driving pulley)} = 1.52\). If we solve for \(y\), we find that \(y = \text{approx. 2.3}\). So they should use the 2.3 centimeter diameter pulley.

5. Christine and Tim want to design a robot with a gear ratio of .6, using a 40 tooth driving gear. They have 40, 24, 16, 14 and 8 tooth gears available. What gear should they choose as their driven gear?

Since the gear ratio is equal to the number of teeth on the driven gear divided by the number of teeth on the driving gear, we would have the equation: \(y \text{ (number of teeth on the driven gear)}/40 \text{ (number of teeth on the driving gear)} = .6\). If we solve for \(y\), we find that \(y = 24\). So they should use the 24 tooth gear.