Name: _____ Date: _____

Applying Newton's Laws of Motion

READ

In the second column of the table below, write each of Newton's three laws of motion. Use your own wording. In the third column of the table, describe an example of each law. To find examples of Newton's laws, think about all the activities you do in one day.

Newton's laws of motion	Write the law here in your own words	Example of the law
The first law		
The second law		
The third law		

PRACTICE

1. When Jane drives to work, she always places her purse on the passenger's seat. By the time she gets to work, her purse has fallen on the floor in front of the passenger seat. One day, she asks you to explain why this happens in terms of physics. What do you say?

2. You are waiting in line to use the diving board at your local pool. While watching people dive into the pool from the board, you realize that using a diving board to spring into the air before a dive is a good example of Newton's third law of motion. Explain how a diving board illustrates Newton's third law of motion.

3. You know the mass of an object and the force applied to the object to make it move. Which of Newton's laws of motion will help you calculate the acceleration of the object?

4. How many newtons of force are represented by the following amount: 3 $kg \cdot m/sec^2$?
   Select the correct answer (a, b, or c) and justify your answer.

   a. 6 newtons b. 3 newtons c. 1 newton

5. Your shopping cart has a mass of 65 kilograms. In order to accelerate the shopping cart down an aisle at 0.3 m/sec^2, what force would you need to use or apply to the cart?

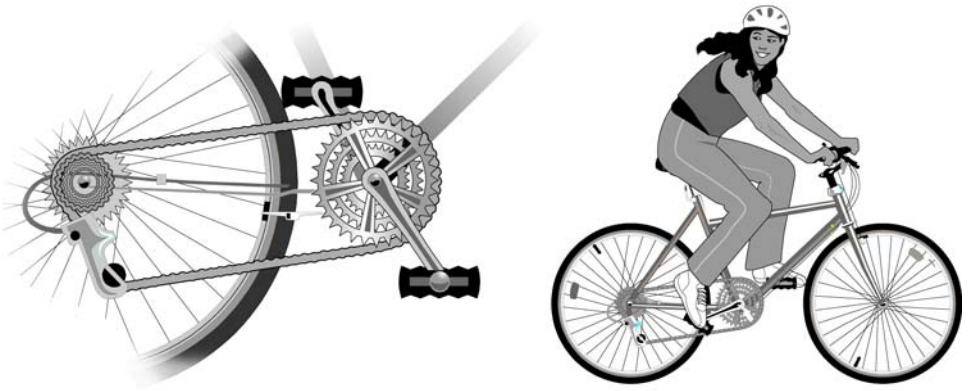
6. A small child has a wagon with a mass of 10 kilograms. The child pulls on the wagon with a force of 2 newtons. What is the acceleration of the wagon?

7. You dribble a basketball while walking on a basketball court. List and describe the pairs of action-reaction forces in this situation.

Calculating Bicycle Gear Ratios

How many gears does your bicycle really have?

Bicycle manufacturers describe any bicycle with two gears in the front and five in the back as a ten-speed. But do you really get ten different speeds? In this project, you will determine and record the gear ratio for each speed of your bicycle. You will then write up an explanation of the importance (or lack of, in some cases) of each speed. You will explain what the rider experiences due to the physics of the gear ratio, and in what situation the rider would take advantage of that particular speed.



MATERIALS

- Multi-speed bicycle
- Simple calculator
- Access to a library or the Internet for research
- Access to a computer for work with a spreadsheet (optional)

DIRECTIONS

1. On a multi-speed bicycle, there are two groups of gears: the front group and the rear group. You may want to carefully place your bicycle upside down on the floor to better work with the gears. The seat and handlebars will keep the bicycle balanced.

2. Draw a schematic diagram to show how the gears are set up on your bicycle.

3. Now, count the number of teeth on each gear in each group. Record your data in a table on paper or in a computer spreadsheet. Use these questions to guide you.

   a. How many gears are in the front group?

   b. How many teeth on each gear in the front group?

   c. How many gears are in the rear group?

   d. How many teeth on each gear in the rear group?

4. Now, calculate the gear ratio for each front/rear combination of gears.
   Use the formula: front gear ÷ rear gear.
   Organize the results of your calculations into a new table either on paper on in a computer spreadsheet.
   How many different gear ratios do you actually have?

5. Use your library or the Internet to research the development of the multi-speed bicycle. Take careful notes while you do your research as you will use the information you find to write a report (see step 7). In your research, find the answers to the following questions.

   a. In what circumstances would a low gear ratio be helpful? Why?

   b. In what circumstances would a high gear ratio be helpful? Why?

6. Write up your findings and results according to the guidelines below.

Your final project should include:

- **A brief (one page) report** that discusses the evolution of the bicycle. What was the first bicycle like? How did we end up with the modern bicycle? Why was the multi-speed bicycle and important invention?
- **A schematic diagram** of your bicycle's gears. Include labels.
- **An organized, professional data table** showing the gear ratios of your bicycle.
- **A summary report** (one page) in which you interpret your findings and explain the trade-off between force and distance when pedaling a bicycle in each of the different speeds. Include answers to questions 5(a) and 5(b). In your research, you should make a surprising discovery about the speeds—what is it?
- **Reflection:** Finish the report with one or two paragraphs that express your reflections on this project.