

# Robot Wheels!

## An Activity on Perimeters and Measurement

**Subject Area(s):** math, geometry, measurement, robotics  
**Associated Unit:** Properties of Water (Grade 4, NYC PS)  
**Activity Title:** Robot Wheels!



**Figure 1**

**ADA Description:** An image of a wheel used for lego robots – black flexible plastic tire, and hard white plastic rim and spokes

**Caption:** NXT Lego Wheel

**Image file name:** .jpg

**Source/Rights:** Copyright © 2010 The LEGO Group

**Grade Level:** 4 (3-5)  
**Activity Dependency:** None  
**Time Required:** 45 minutes  
**Group Size:** 2  
**Expendable Cost per Group:** US \$0

### Summary

Students will solidify their understanding of the geometry term “perimeter” through application of the concept to LEGO Mindstorms NXT robotics programming. Students will measure the perimeter of LEGO Mindstorms NXT robot wheels in order to determine how far the robot can travel during one rotation of an NXT motor. Students will also enhance their metric system measurement skills by having to precisely record the length of a wheel’s perimeter in centimeters, and fractions of centimeters. The importance of fractions of centimeters will be emphasized through this measurement process.

This lesson will help prepare students for state standards in mathematics, geometry, and science, while simultaneously entertaining students through hands-on interaction with LEGO Mindstorms NXT robots.

### **Engineering Connection**

The engineering connection of this lesson is primarily a result of the problem solving, and fundamental measurement and geometrical skills it builds. These skills help students see the possibilities of a set of materials, and apply their creativity to solve problems relating to materials.

- (1) Problem Solving Skills—students will have to brainstorm ways of solving a problem when presented with a given scenario.
- (2) Measurement Skills—students will improve their abilities to measure features using the metric system. They will see the importance of being able to read and record lengths to different degrees of precision.
- (3) Geometry Skills—students will become more familiar with common geometric terms such as perimeter and rotation

### **Engineering Category**

(#1) relates science concept to engineering

### **Keywords**

measurement, geometry, perimeter, rotations, robotics, metric system, problem solving, centimeters, decimals

### **Educational Standards** (New York City Public Schools)

State math: 4.PS.2, 4.PS.13, 4.PS.20, 4.CM.10, 4.N.10, 4.N.8, 4.N.27, 4.M.1, 4.M.2, 4.S.2

### **Pre-Requisite Knowledge**

Some exposure to geometric terms such as perimeter and rotation.

### **Learning Objectives**

After this lesson, students should be able to:

- Determine the perimeter of round and circular objects
- Measure objects to the nearest fraction of a centimeter using a ruler
- Understand the concept of rotation
- Brain storm ideas
- Understand how rotation of a circular object, and that object's perimeter are related

### **Materials List**

*Each group needs:*

- A ruler
- 1 NXT wheel (of any size)
- 1 piece of tape approximately 25 cm long
- 1 piece of 8.5"x 11" paper

- 1 pair of scissors
- 2 pencils

*Each entire class needs:*

- An NXT robot with spokes available for insertion of different sized wheels

## **Introduction / Motivation**

### Discussion & Lecture with Students

It is important to discuss the following concepts with students before the start of the lesson:

- Rotation
- Perimeter
- Measurement of lengths (to the nearest centimeter, and fraction of a centimeter)

### **Rotation:**

To illustrate the concept of rotation, first ask the students for their definitions of rotation. Then, illustrate the correct definition of rotation using your own body. Rotate around once a full time, and ask students to confirm that you have rotated once. Rotate around halfway, and ask students how far you have rotated. Rotate around a quarter turn, and ask students how far you have rotated. Repeat this as necessary until students understand the concept of body rotation.

Next, illustrate the concept of rotation using a large wheel attached to an NXT robot, with a clearly marked starting position place. Program the robot to rotate the wheel once around, bringing it to its starting position. Repeat and question as before to solidify this concept with respect to wheel rotation.

### **Perimeter:**

To illustrate the concept of perimeter, first ask the students for their definitions of perimeter. Then, illustrate the correct definition of perimeter by drawing several shapes on a blackboard and having students use their words to define the perimeter of these objects. Following demonstration of understanding, show the NXT wheel and ask what the perimeter of the wheel would be.

### **Measurement (using centimeters):**

Draw a large ruler on a blackboard, and go over with students what different distances on this ruler mean. Start with whole centimeters, and progress until students can demonstrate proficiency with both measurement to the nearest centimeter, and nearest fraction of a centimeter.

## **Vocabulary / Definitions**

Word	Definition
Perimeter	The path around the border of a two-dimensional shape
Rotation	The movement of an object about itself

## **Procedure**

### Before the Activity

- Administer the pre-lesson assessment to the students
- Collect the exams for later use in lesson effectiveness determination
- Discuss the concepts of (1) rotation, (2) perimeter, and (3) measurement to the nearest centimeter, and fraction of a centimeter.

### With the Students

- Instruct the students to write the following daily heading in their science notebooks:  
Science Question: How can one measure the perimeter of a wheel?

	Predicted	Measured	Observed
Perimeter (cm)			

- Instruct the groups to complete the following procedure:

#### **PROCEDURE:**

##### Part 1: Prediction

1. With your partner, estimate the perimeter of the wheel you've been given
2. Record this estimate in the box marked "predicted" on the table you've made
3. Brainstorm ways to accurately measure the perimeter of the wheel

##### Part 2: Measurement

1. Using the piece of masking tape, wrap the wheel around its perimeter one rotation
2. Mark where one rotation has occurred on the tape
3. Pull off the masking tape from the wheel, and cut it at the mark made in Part 2, Step 2
4. Measure the length of this cut tape to the nearest tenth of a centimeter
5. Record this measurement in the box marked "Measured"

##### Part 3: Observation

1. Place the wheel used for measurement, along with a matching wheel on an NXT robot
2. Place the robot on the sheet of 8.5"x 11" paper
3. Mark the starting position of one of the wheels on the paper using a pencil
4. Have the robot move forward one rotation of its motors
5. Mark the final position of the same wheel used in step 3 on the paper using a pencil
6. Using a ruler, measure the length between the mark made in step 3 and step 5 to the nearest fraction of a centimeter
7. Record this length in the box marked "observed"

*After parts 1-3 have been completed, instruct the students to write a reflection regarding the 3 values of wheel perimeter they've recorded in their tables.*

### Attachments

None

### Safety Issues

None

### Troubleshooting Tips

None

### Investigating Questions

- How can one determine the perimeter of round and circular objects?
- How can one measure objects to the nearest fraction of a centimeter using a ruler?
- What does the word “rotation” mean, and why is this term important to wheel movement?

### Assessment

#### Pre-Lesson Assessment

1. What does the word “perimeter” mean?

- The distance around a shape
- The area inside of a shape
- The area outside of a shape
- The distance between two shapes

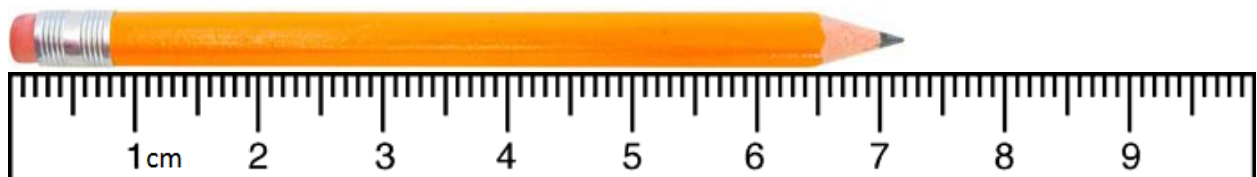
*Use the images at the bottom of the page to complete the next questions!*

2. Using the ruler displayed, what is the length of the pencil shown to the nearest **whole** centimeter?

- 5 centimeters
- 6 centimeters
- 7 centimeters
- 8 centimeters

3. Again, using the figure shown, what is the length of the pencil to the nearest **tenth** of a centimeter?

- 7.5 centimeters
- 8.1 centimeters
- 7.2 centimeters
- 8.0 centimeters



**Figure 2**

**ADA Description:** An image of the assessment administered to students, including a pencil and metric ruler (not to scale)

**Caption:** Assessment

**Lesson Summary Assessments**

- Science notebook recorded reflection following parts 1-3 of the procedure
- Administration of the Pre-Lesson Assessment Quiz to students to determine skill enhancement

**Activity Extensions**

None

**Activity Scaling**

- For lower grades, emphasize the concept of rotation in place of perimeter if the concept of perimeter has not yet been introduced.
- For upper grades, include questions regarding how many rotations of a wheel with a known perimeter it would take to move a specified distance (multiplication and division problems).

**Additional Multimedia Support**

None

**References**

None

**Other**

None

**Redirect URL**

None

**Contributors**

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None

**Supporting Program**

*School:*

Polytechnic Institute of NYU

*Grant:*

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