**Subject Area(s)** **Physics, Computer Science**

**Associated Unit** **Newtonian Mechanics, motion**

**Lesson Title** **Using mechatronics to understand motion**

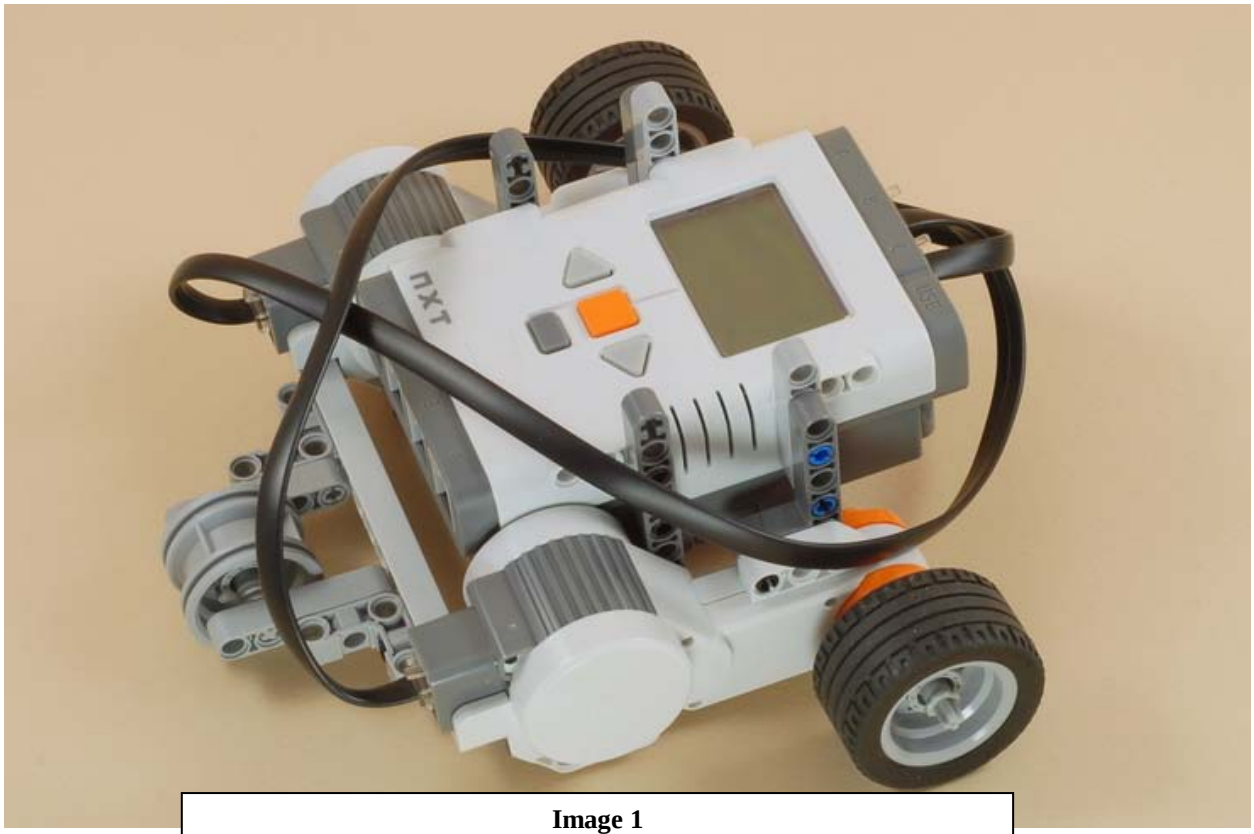



**Image 1**

Robot used to show relationship between displacement and time

**Grade Level** __ (_7_-_12_)

**Lesson #** __ 1 of 5__

**Lesson Dependency**

**Time Required** **1 hour**

**Summary**

Students will learn about vectors, velocity, and acceleration through physics modeling and using the NXT robot. Working in teams of three they will mark the distance the NXT robot travels. Once they collect their data they will represent the distance versus time relationship using different types of models. Through further exploration they will come up with the relationships between acceleration, displacement, velocity and time. All activities will involve the NXT robot but with each activity the robot will be moving at different rates. The cumulating activity and lab assessment will involve the students programming the NXT robot so that its velocity matches a particular velocity vs. time graph. To differentiate students will be allowed to program in either NXT mindstorms or robot c. Students can also take the challenge of programming a robot to move in a particular acceleration versus time graph.

## Engineering Connection

Mechanical engineers need to keep speed constraints in mind when designing land, water and air vehicles. With the integration of electronics and microcontrollers into mechanical systems mechanical engineers need to have some knowledge of programming as well.

## Engineering Category

Category 1: Relating science and/or math concept(s) to engineering
Category 3: Engineering design process

## Keywords

NXT lego robot, velocity, acceleration, dot motion diagrams, slope, graphs, displacement

## Educational Standards

New York State Physics Standards Met:

**STANDARD 1—Analysis, Inquiry, and Design**

Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.

**STANDARD 2**

Students will access, generate, process, and transfer information, using appropriate technologies.

**STANDARD 4**

*Key Idea 5:*

Energy and matter interact through forces that result in changes in motion. 5.1 Explain and predict different patterns of motion of objects (e.g., linear and uniform circular motion, velocity and acceleration, momentum and inertia).

i. construct and interpret graphs of position, velocity, or acceleration versus time
ii. determine and interpret slopes and areas of motion graphs

**STANDARD 6—Interconnectedness: Common Themes**

Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.

## Learning Objectives

After this lesson, students should be able to:

- **Explain how the slope of the displacement vs. time describes the velocity of the robot**
- **Explain the motion of an object described in a dot motion diagram and a line graph.**
- **Identify the relationship displacement and time have with velocity**

## Introduction / Motivation

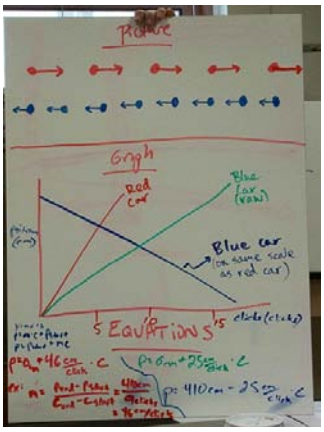
"Today we are going to investigate the movement or robot. This robot is special. Every one second it moves it stops and beeps and continues to move. You are going to have to describe the movement of this robot with a picture and then a graph. For today's activity you will be in groups of 3. You will have a robot, a whiteboard, and 3 markers. Lets think of possible ways we can show the robot's motion with a picture as a class?"

## Lesson Background & Concepts for Teachers

Students are introduced to the mission of the activity in the beginning of class. Teachers are to try to refrain from using and defining the term velocity until the end of the lesson.

Students are to place the robot on top of the white board. They should turn on the robot. They will draw a dot wherever the robot stops when it beeps. It is best if the teacher leads a discussion on what is the best way to capture the robots movement. If students come up with other methods that's fine but before you begin the activity make sure the class has one way of capturing the motion of the robot. While students are working on capturing their robot's motion put some guiding questions on the board:

Once they finish capturing their motion on the white board they should compete the graphing worksheet.




Once they draw their dot diagram students. They are to fill out their graph worksheet and copy their graph onto their whiteboard. On the white board they need to have a dot diagram and graph.

**Vocabulary / Definitions**

| Word | Definition |
|---|---|
| Velocity | The displacement over time. |
| Slope | The change of the dependent over the independent. The ratio of the dependent to independent. |

**Associated Activities**

**Lesson Closure**

Once they finish their white board they must present their white boards the class will come together and share. Their should be some confusion over the graph. The teacher should talk through the thinking of graphing the velocity. At the end of the lesson the teacher should make sure students understand that the slope of the graph is the velocity and that velocity is a ratio of displacement and time.

## Assessment

Graph worksheet (completed by everyone)

White board (completed by group)

Group discussion

## Attachments

5-minute robot schematics

graphing worksheet

mindstorms code

## Contributors

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## Supporting Program

**Version: September 2010**