Trebuchet: Determing how far each object will go

Subject Area(s):	Physics, mathematics, measurement, and engineering
Associated Unit:	None
Associated Lesson:	None
Activity Title:	Determining how far each object will travel when launched
Header:	Insert image 1 here, right justified to wrap

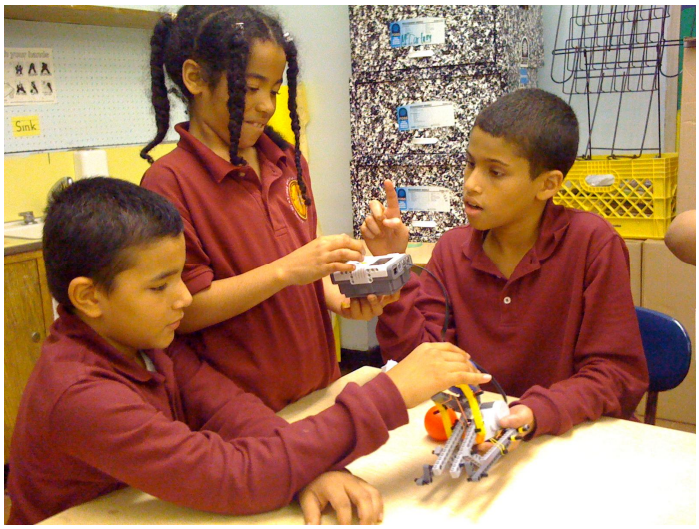
Image 1

ADA Description: Students getting their experiment ready, for example preparing the robot, measuring start distance, preparing the launcher

Caption: Students preparing the robot to launch

Image file name: launchingrobot_image1.jpg

Source/Rights: Copyright 2009 Jennifer S. Haghpanah. Used with permission.



Level:	5 (4 and 6)
Activity Dependency:	None
Time Required:	50minutes
Group Size:	Five
Expendable Cost per Group	US$10.00

Insert Image 2 here, centered

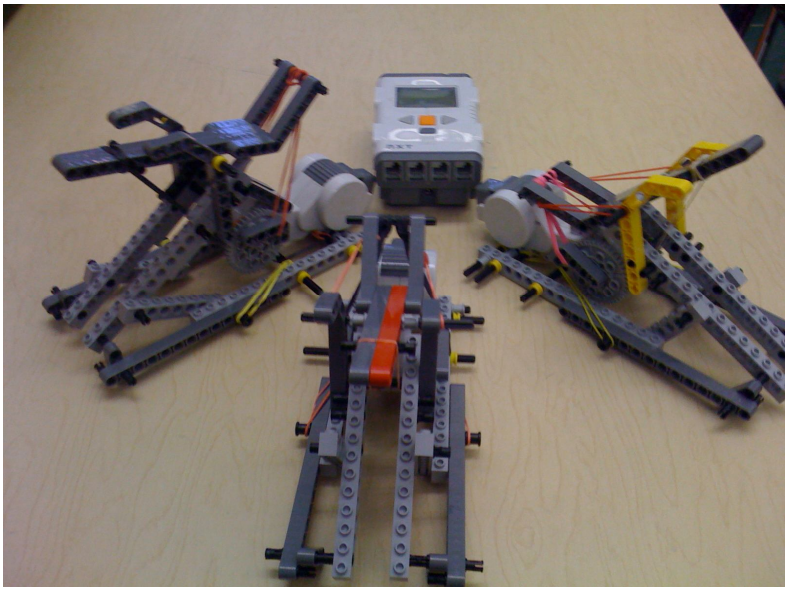


Image 2

ADA Description: One of the robot designs that will be used for launching objects

Caption: Launching robots

Image file name: launchingobot_image2.jpg

Source/Rights: Copyright 2009 Jennifer S. Haghpanah. Used with permission.

Insert Image3 here, centered

Image 3

ADA Description: An object placed on the launcher to launch

Caption: Launcher experimental set up

Image file name: launchingobot _image3.jpg

Source/Rights: Copyright 2009 Jennifer S. Haghpanah. Used with permission.

Summary
Students will work as engineers and learn to conduct controlled experiments by changing one experimental variable at a time and study its effect on the outcome of the experiment. Specifically, they will conduct experiments to determine the amount of weight need for an object to travel far. First, the students will assemble a robot that can launch objects. Second, they will design a program in NXT MindStorm that will cause the robot to launch objects. Third, using Image 3 as a guide, students will setup their experiment for launching objects. Fourth, they will launch objects of different weights and record their distance. Fifth, they will change the angle of the launcher and see how far the same objects travel. Sixth, they will manipulate the length of the arm and see how far the object travels. Finally, students will analyze all these factors and figure out which manipulation makes the object travel farther.

Engineering Connection
Students will learn to design a setup for engineering experimentation. Specifically, they will design their own robot and write their own programs for the robot to launch various objects. Moreover, by changing the design of the robot they will figure out what design features will help the object go farther when launched. They will change parts to optimize the distance the object travels.

Engineering Category

Relates physics to engineering

Keywords
Length, Angel, variable, distance, robot

Educational Standards
- New York State Standards
  - New York science: 4.4, 4.5
  - New York math: 3.1, 3.2, 3.3, 3.5
  - New York Technology 5.1, 5.3, 5.4

Pre-Requisite Knowledge: basic concept of a function

Learning Objectives
After this activity, students will be able to:
- Design a Lego robot that can be used to launch objects
- Program a robot with NXT MindStorm software
- Determine the distance each object travels and relate it to their respective weight
- Change one variable at a time and examine its effect on the distance the objects travel

Materials List

Each group needs:

- Lego NXT Kit
- Eraser
- Chap stick
- Tennis Ball
- Crumbled paper ball
- Peach/ plum
- Big gum ball
- Tape
- Measuring Tape

To share with the entire class:

- Lego Robot
- Computer with NXT MindStorm programming software

Introduction / Motivation

The term launch is often used to describe how far an object can travel. Here we will try to determine how far each object will travel based on its weight. Then, we will adjust the angle and the length of the arm and determine how far each of the different objects will travel. Students will determine the optimal type of trebuchet to launch their objects.

Students love watching objects fly in the air. In this experiment, they will learn about all the math and science that goes into flying an object in the air. They will make their own robotic creations and their own program that will cause the robot to fly objects in the air. Students will also learn the importance of each variable in the outcome of the experiment. Thus, they will change one variable at a time and determine which variable will make the object travel farther.

Vocabulary/Definitions

Word	Definition
Length	The measure of how long something is from one end to another
Distance	The amount of space between objects
Angle	The amount of rotation that separates two vectors
Variable	The quantity that changes in a given equation
Constant	The quantity that remains constant in a given equation

Procedure

Before the Activity

1. Have the students design their own robot that will be used to launch the object.
2. Have the student program the robot and show that they can launch different objects.
3. Go over proper measurement skills with students and teach them how to measure distance.
4. Show students all the different types of objects and ask them to make a prediction about which one will travel the farthest.
5. Ask students what they think will happen to the object's travel-distance when they change the angle and the length of the arm.
6. Ask students what they think will happen if they increase/decrease the angle or increase/decrease the length of the arm.
7. Divide students into groups and assign each group member a task.
8. Make sure each student has the handout for the activity.

With the Students

1. Show the students the objects and have them determine the weight of each object.
2. Have the students design their launching robot along with their Mindstorms program.
3. Take one object and place at the end of the arm and launch the object of interest.
4. Measure the distance from the robot to the object and be sure to know the weight of each object. (Be sure to correctly record the object distance, which is where the object first hits the ground)
5. Once all data has been obtained, begin to change the variables, one at a time.
6. First, change the angle of the arm and determine how far each object will travel.
7. Next, change the angle of the object back to its original setting and change the length of the arm. Now determine how far each object will go with the different length of the arm.
8. Have the students discuss what they have learned from the experiment and have them fill out their conclusions in the lab report.

Attachments

Trebuchet.dox
launchingrobot_image1.jpg
launchingrobot _image2.jpg
launchingrobot _image3.jpg

Safety Issues

- Be careful not to get hit with the launching object

Troubleshooting Tips

Make sure that the object can launch and that all launches are precise

Investigating Questions

Which object went the farthest? Why?
What happened when the length of the arm was changed?
What happened when the angle of the arm was changed?

Assessment

Pre-Activity Assessment
Guessing game: Tell the students to weigh the object. Ask them to predict which object will go the farthest.

Activity Embedded Assessment
Design a robot: Ask students to design a robot that will be able to launch the object. Ask them if they can show you how the launcher launches objects?

Post-Activity Assessment
Tuning the equation: Challenge the students and ask them to change the length of the arm and the angle of the arm. Ask them how far the object goes when these two variables are manipulated.

Activity Scaling
- For lower grades: None
- For upper grades: Experiment with other materials, and launch them with different angles and arm lengths

Additional Multimedia Support
None

References
Hewitt, Paul. Conceptual Physics. New Jersey: Prentice Hall, 2002.

Zitzewitz, Paul. Physics Principles and Problems. Ohio: McGraw-Hill, 2002.

Other

None

Redirect URL

http://gk12.poly.edu/amps/

Owners
Jennifer S. Haghpanah

Contributors
Jennifer S. Haghpanah

 The development of this activity was supported by Project AMPS under a GK-12 Fellows grant 0741714 from the National Science Foundation.

Version: January 2010