

Force: Determining the force needed to tear different breads

Subject Area(s):	Physics, mathematics, measurement, and engineering
Associated Unit:	None
Associated Lesson:	None
Activity Title:	Determining the force needed to tear various types of breads
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 bread, and initializing the stop-watch

Caption: Students preparing the robot to pull bread

Image file name: breadpullingrobot_image1.jpg

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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 pulling the bread apart

Caption: Bread pulling robots

Image file name: breadpullingrobot_image2.jpg

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Insert Image3 here, centered



Image 3

ADA Description: A bread tied to a chair on one end and to a robot at the other end

Caption: Bread experimental set up

Image file name: breadpullingrobot_image3.jpg

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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 force that is required to break different kinds of breads. First, the students will assemble a robot that can pull the bread apart. Second, they will design a program in NXT MindStorm that will cause the robot to pull apart the bread. Third, using Image 3 as a guide, students will setup their experiment for pulling the bread apart. Fourth, using a physics-based formula, they will calculate the amount of force it takes to pull apart the bread to a given distance. Fifth, they will change the amount of power delivered by the bread-pulling robot and use the same physics-based formula to calculate the force it takes to pull apart the bread to a given distance. Sixth, they will determine the force needed to pull apart the bread to different distances. Finally, students will determine the amount of force it takes to pull apart different types of bread.

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 pull apart the bread. Moreover, using two strings they will attach the bread to the robot and a heavy object (e.g. a chair). They will use a physics-based formula, manipulate one variable at a time, and calculate the force.

Engineering Category

Relates physics equation concept to engineering

Keywords

Force, power, 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: Division, multiplication, and basic concept of a function

Learning Objectives

After this activity, students will be able to:

- Design a Lego robot that can be used to pull bread
- Program a robot with NXT MindStorm software

- Calculate force using the following physics-based formula

$$\text{Force} = (\text{Power} * \text{Time}) / \text{Distance} \quad (\text{Eq. 1})$$

- Change one variable at a time and examine its effect on the force, e.g., the power, the distance, and the bread it self

Materials List

Each group needs:

- Lego NXT Kit
- Different kind of bread (White, Wheat, Raisin)
- String (pieces cut to same size)
- Chair
- Tape
- Measuring Tape
- Stop Watch

To share with the entire class:

- Lego Robot
- Computer with NXT MindStorm programming software

Introduction / Motivation

The term force is often used to describe the push or the pull of an object. Here we will try to determine the amount of force required to pull different types of breads apart. We determine the amount of force required to pull a piece of bread apart using our measurement skills and the physics-based formula given in Eq. 1.

Students love pulling things apart or watching things break apart. In this experiment, they will learn about all the math and science that goes into pulling an object apart. They will make their own robotic creations and their own program that will cause the robot to pull the bread apart. 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 examine its effect on the force, e.g., the power, the distance, and the bread.

Vocabulary/Definitions

Word	Definition
Force	A push or pull on an object that is measured in newtons
Distance	The amount of space between objects

Power	The time rate at which work is done
Time	The duration over which an event of interest takes place
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 pull the bread apart.
2. Have the student program the robot and show that they will be able to pull apart the softest piece of bread.
3. Go over the physics-based formula given in Eq. 1 with the students.
4. Go over proper measurement skills with students and teach them how to measure distance and time.
5. Show students all the different types of breads and ask them to make a prediction on which bread will require the most force to pull apart.
6. Ask students what they think will happen to the force if the power is either increased or decreased.
7. Ask students what they think will happen if they increase or decrease the pull-apart distance.
8. Divide students into groups and assign each group member a task.
9. Make sure each student has the handout for the activity.

With the Students

1. Cut string into pieces of the same size
2. Get pieces of bread and poke holes in the center of the breads with a pencil. Make sure the holes are at least two inches apart from one another.
3. Take one piece of string and tie one end to the hole in the bread and the other to the object. Take the other piece of string and tie one end to the other hole in the bread and the other end to the robot. (Be sure to tie double knots)
4. Measure the distance from the robot to the object and be sure to set the power to 100% in the NXT MindStorm software.
5. Once the program has been set, turn the robot on and have the stopwatch ready.
6. Run the program of the robot and record the time it takes for the robot to pull the bread apart.
7. Now, change the amount of power in the NXT MindStorm software and determine the amount of force it takes to pull the bread apart.
8. Keeping the power constant at 100% vary the amount of distance and determine the amount of force it takes to pull the bread apart.
9. Do the same experiment keeping the distance the same and the power at 100% with the different breads.
10. Have the students discuss what they have learned from the experiment and have them fill out their conclusions in the lab report.

Attachments

TestingtheForceofbreadWorkSheet.doc
TestingtheForceofbreadWorkSheet.pdf
breadpullingrobot_image1.jpg
breadpullingrobot_image2.jpg
breadpullingrobot_image3.jpg

Safety Issues

- Be careful with pencil when poking hole in bread

Troubleshooting Tips

Make sure that the object is sturdy and does not wobble during the experiment.

Investigating Questions

Which bread had the greatest amount of force required to pull apart? Why?

What happened to the force when the power was decreased?

What happened to the force when the distance was increased?

Assessment

Pre-Activity Assessment

Guessing game: Tell the students what force is and go over the different types of forces that exist. Show them push/pull force with a piece of bread. Ask them to predict which bread will have the most pull force.

Activity Embedded Assessment

Design a robot: Ask students to design a robot that will be able to pull a piece of bread apart. Once they design it, have them test the different variables in the physics-based formula given in Eq. 1.

Post-Activity Assessment

Tuning the equation: Challenge the students and ask them why they think they got the results they got. Ask them what they learned about force and what they think are the optimal conditions for pulling bread apart. Then show them how other materials behave differently when you pull them apart.

Activity Scaling

- For lower grades: None
- For upper grades: Experiment with other materials besides bread to pull apart

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

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