

Educational Outreach Program

Nevjinder Singhota, CCMR Educational Outreach Director
MRSEC Education Directors' Meeting 2016



CCMR

Cornell Center for Materials Research

Cornell University, Ithaca, NY

<http://www.ccmr.cornell.edu>

We Teach Science *Anywhere and Everywhere!*



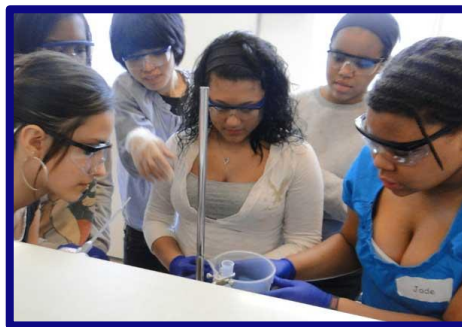
Prof. Neil Ashcroft & Marvelous Magnets



Prof. Dan Ralph at Ithaca Youth Bureau



Prof. Kyle Shen in Harlem



Prof. Yimon Aye with Geneva students



Prof. Chad Lewis in Washington DC



Prof. Will Dichtel in Puerto Rico



Prof. Itai Cohen in Harlem



Testing catapult mechanics on Prof. Katja Nowack



Many Educational Modules Developed by Cornell Faculty[†]

Marvelous Magnets (Imanes Maravillosos)	Jeevak Parpia	Physics	K-2
Liquid Crystals	Eun-Ah Kim	Physics	K-2/3-5
Drop Tubes & the Scientific Process (orig)	Joel Brock	Appl Phys	3-5
Launch Tubes & the Scientific Process (new)	Greg Fuchs & Lena Kourkoutis	Appl Phys	3-5
Electroplating & Electrochemistry	Héctor Abruña	Chemistry	6-8
Waves and Music	Nandini Ananth	Chemistry	6-8
Solar Cells from Blackberries	John Marohn & Dieter Ast	Chem/Mat Sci	9-12
Vitamin C and Titration	Geoff Coates	Chemistry	6-12
Nano What?	Richard Robinson & Tobias Hanrath	Mat Sci/Chem E	9-12
Name that Salt! (Thermodynamics)	Melissa Hines	Chemistry	9-12
Ice Cream & the States of Matter	Pete Wolczanski	Chemistry	All

Future Growth: Modules designed for *specific K-12 curricular needs*

[†]Partial list. Activities also developed by students, postdocs, and staff.



Modules Include Standardized Lesson Plans and Student Activity Sheets

Author
(faculty, grad students and teachers)

Time Required

Objectives

Materials List

Safety Concerns

Cornell Center for Materials Research
Educational Programs Modules Library

Drop Tube

Author: Joel Brock and Sue Henne
Date Created: 2006
Subject: Scientific Process, Physics
Level: 4th grade
Standards: *New York State- Intermediate Science* (www.emsc.nysed.gov/cial/)
Standard 1- Analysis, Inquiry and Design
Standard 4- The Physical Setting
Standard 6- Interconnectedness: Common Themes
Standard 7- Interdisciplinary Problem Solving

Schedule: One 40-minute class period

Objectives:
Be informally introduced to the concept of momentum and how it relates to force. Practice the scientific method through accurate data collection, graphing, and making predictions.

Students will:

- Take measurements
- Use graphs and tables to record data
- Make estimations
- Students will use collected data to make scientific predictions
- Replicate their results for accuracy
- Have a hands-on experience related to force
- Quantify their intuition about simple forces

Vocabulary:
Scientific Method
Estimate
Predict
Accuracy
Replication
Variable

Materials:
For Each Pair:
Tube
Foam[†]
Set of metal cubes
Spring scale
Ruler*
String
Stickers
For Each Class:
One sponge
One lead brick
For Each Student:
Activity Sheet 1:
Simple Forces

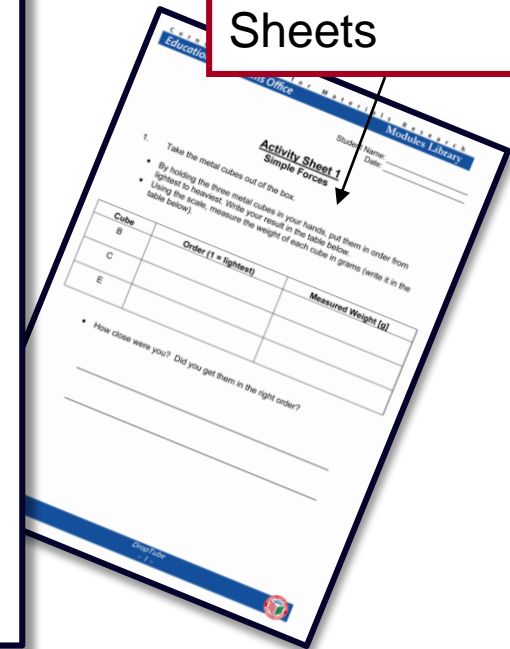
*Provided by the teacher
[†]Foam #22 is the standard used for this lesson, other foams are of increasing density as reflected by their number

Safety:
Do not remove covering from lead cubes.

New York State Standards Met

Vocabulary

Student Activity Sheets



Activity Sheet 1: Simple Forces

Student Name: _____ Date: _____

1. Take the metal cubes out of the box.

- By holding the three metal cubes in your hands, put them in order from lightest to heaviest. Write your result in the table below.
- Using the scale, measure the weight of each cube in grams (write it in the table below).

Cube	Order (1 = lightest)	Measured Weight [g]
B		
C		
E		

How close were you? Did you get them in the right order?

Helping Teachers with Next Generation Science Standards



(English and Mathematics)



Released March 2013

Emphasizes critical thinking & hands-on expts.,
but no curricular materials available

Our first target: Waves at multiple grade levels



4-PS4 Waves and Their Applications in Technologies for Information Transfer

3rd-5th grade

CCMR's Targeted Learning Objectives

4-PS4-1: Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move

4-PS4-3: Generate and compare multiple solutions that use patterns to transfer information

The performance expectations are:

Science and Engineering Practices

Developing and Using Models
Modeling in 3–5 builds on K–2 experiences and progresses to building and revising models and using models to represent even solutions.

- Develop a model using an analog or abstract representation to describe a principle. (4-PS4-1)
• Develop a model to describe a phenomenon. (4-PS4-2)

Constructing Explanations and Designing Solutions

Constructing explanations and designing solutions in 3–5 builds on K–2 experiences and progresses to use of evidence in constructing explanations and specifying variables that describe and predict phenomena and in designing multiple solutions to design problems.

- Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the design solution. (4-PS4-3)

Connections to Nature of Science

Disciplinary Core Ideas

PS4.A: Wave Properties

- Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. (Note: This grade band endpoint was moved from K–2.) (4-PS4-1)
• Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1)

Instrumentation

- Digitized information can be transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information—convert it from digitized form to voice—and vice versa. (4-PS4-3)

Technology

- Knowledge of relevant scientific concepts and research findings is important in engineering. (4-PS4-3)

K-12 Science Education:

Cutting Concepts

Differences in patterns can be classified, and simple rates of natural phenomena. (4-PS4-1)

Differences in patterns can be used to classify designed products. (4-PS4-2)

Object relationships are routinely used. (4-PS4-2)

Engineering, Technology, and Applications of Science

of Science, Engineering, and Technology



Graduate-Student-Developed Educational Module

Cornell Center for Materials Research
Educational Programs Modules Library

Waves
 Authors: Ryan Bisbey, Alejandro Cortese, Rebecca Potash, Jacob Ruf, Benjamin Savitzky, and Eric Skolinski
 Date Created: 2014
 Subject: General Science
 Level: Upper Elementary
 Standards: Next Generation Science Standards (www.nextgenscience.org)
 4-PS4-1. Develop a model of waves to describe patterns in terms of amplitude and wavelength and that waves can cause objects to move.
 4-PS4-3. Generate and compare multiple solutions that use patterns to transfer information.

Schedule:

Objectives:
 Students will learn about transverse waves and their properties. Students learn how to use sound to send coded information.

Students will:

- Use/view simulations to understand how waves travel.
- Measure waves to look at how amplitude and wavelength change.
- Develop a binary code to transfer information using sound.

Vocabulary:
 Mechanical Wave
 Transverse Wave
 Wavelength
 Amplitude
 Frequency

Materials:

For Each Group: Wave Generator Ruler	For Each Student: Activity Sheet
For Each Pair: Code Sheet Drum	
For Class: M&M's <small>*Provided by teacher</small>	

Safety:
 There are no safety concerns for this activity

Lesson Plan for Teachers

Name _____
 Class _____

What's a Wave?

When we think of the word "wave" we usually picture someone moving their hand back and forth to say hello or maybe we think of a tall curling wall of water moving in from the ocean to crash on the beach.

In physics, a wave is a traveling disturbance that moves through space and matter transferring energy from one place to another. When studying waves it's important to remember that they transfer energy, not matter.

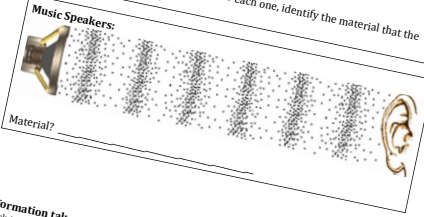
Step 1:
 Set up and turn on your wave generator, then adjust the knob until the wave is steady and creates a wave pattern.

Sketch what the wave looks like, below:

The wave you see is a **Mechanical wave**. These are waves that require a material to travel through. Mechanical waves travel when molecules in the material collide with each other passing on energy.

Below are some examples of waves. For each one, identify the material that the sound is moving through.

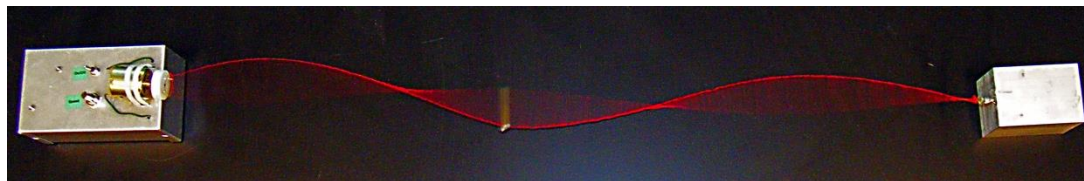
Music Speakers:



Material? _____

Information taken from:
 "Ducksters: Education Site For Kids and Teachers." 2006. 22 Apr. 2014 <<http://www.ducksters.com>>

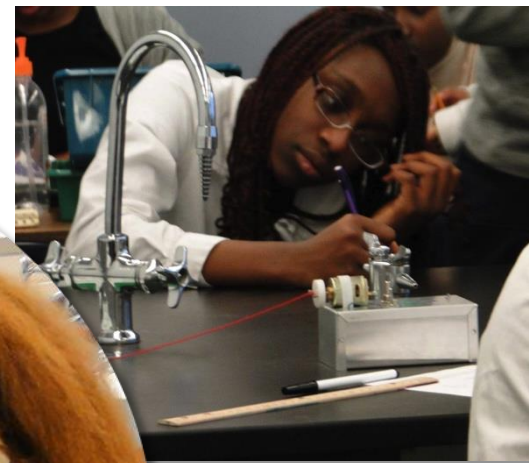
Activity Sheet for Students



\$25 battery powered wave generator



Field Testing the Wave Module with Partner Schools





Online Lending Library of Educational Modules

CCMR Cornell Center for Materials Research: An NSF MRSEC

Home Research Facilities Education Industry News About Admin

Educational Resources

- Lending Library of Experiments
 - Chemistry Kits
 - Physics Kits
 - Earth Science Kits
 - NGSS Kits
- Ask a Scientist
- Teacher Developed Lesson Plans
- Lesson Plans PDF's

Education Contact

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Director of EPO
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 **Mark Walsh**
Extension Support Specialist
t. 607.255.9547
[e-mail us](#)

NGSS Kits

Experiment	Objective	Grade Levels	Subjects
Alka-Seltzer Rockets	Launch a rocket using a film canister and an alka-seltzer tablet. Students will be able to observe and understand how the laws of motion apply to their rocket. They will also investigate how a variable might affect the flight of it.	6-8 3-5	Physics
Atomic Bonding	What is surface area? How do chemicals bond? What affects properties of materials on the macro- and nano-scale, and why this is important to scientists? Students will do some hands-on activities to find these out.	6-8 9-12	Chemistry
Batteries	How does a battery work? Students will figure this out as well as see how energy is transformed by building a wet cell battery. They will also test a variable to find out how it affects the strength of a battery.	3-5	Chemistry
Boat Building	How do boats float? Classify different materials and see which ones float or sink. Use this knowledge of materials to engineer your own boat and see how much weight you can carry. Students can be introduced to the concept of buoyancy.	K-2	Physics
Bridge Building	How is a bridge able to support all that weight on it? Students examine the forces that affect bridges, learn the advantages and disadvantages between different types of bridges, and build their own bridge to meet certain specifications.	6-8 3-5	Physics
Buoyancy	What is Archimedes' Principle and how does it apply to me? Learn about this famous discovery and why objects are able to float. Students will also work on their measuring skills for mass and volume. They will apply these concepts by constructing a Cartesian diver.	6-8 3-5	Physics
Catapult	How does a catapult work? Students will build a basic catapult that hurls marshmallows at targets. Introduce potential and kinetic energy, while also having students test out variables to engineer the most accurate catapult.	6-8 3-5	Physics

CCMR Lending Library Request Form

Please complete the form below to request a kit. Due to the limited number of kits available, they will be lent out on a first come, first serve basis. We only ship 1 kit to an individual at a time. Kits need to be requested at least 2 weeks prior to shipment date. For your convenience, each kit includes a pre-paid return label. Items needing to be returned must be checked off on the list provided and returned by the specified due date. Please return the kit on time so the next teacher will be able to enjoy the kit by their expected delivery date. Please take note of all safety warnings and wear protective equipment when necessary.

If you have any questions or concerns please contact our lending librarian Kevin Dilley at 607-254-8256.

Request:

First Name:

Last Name:

E-mail:

School Name:

Address:

City: State: Zip:

Home Phone:

School Phone:

Participant Grade Level:

Number of Students:

Date Needed: Month: Day: Year:

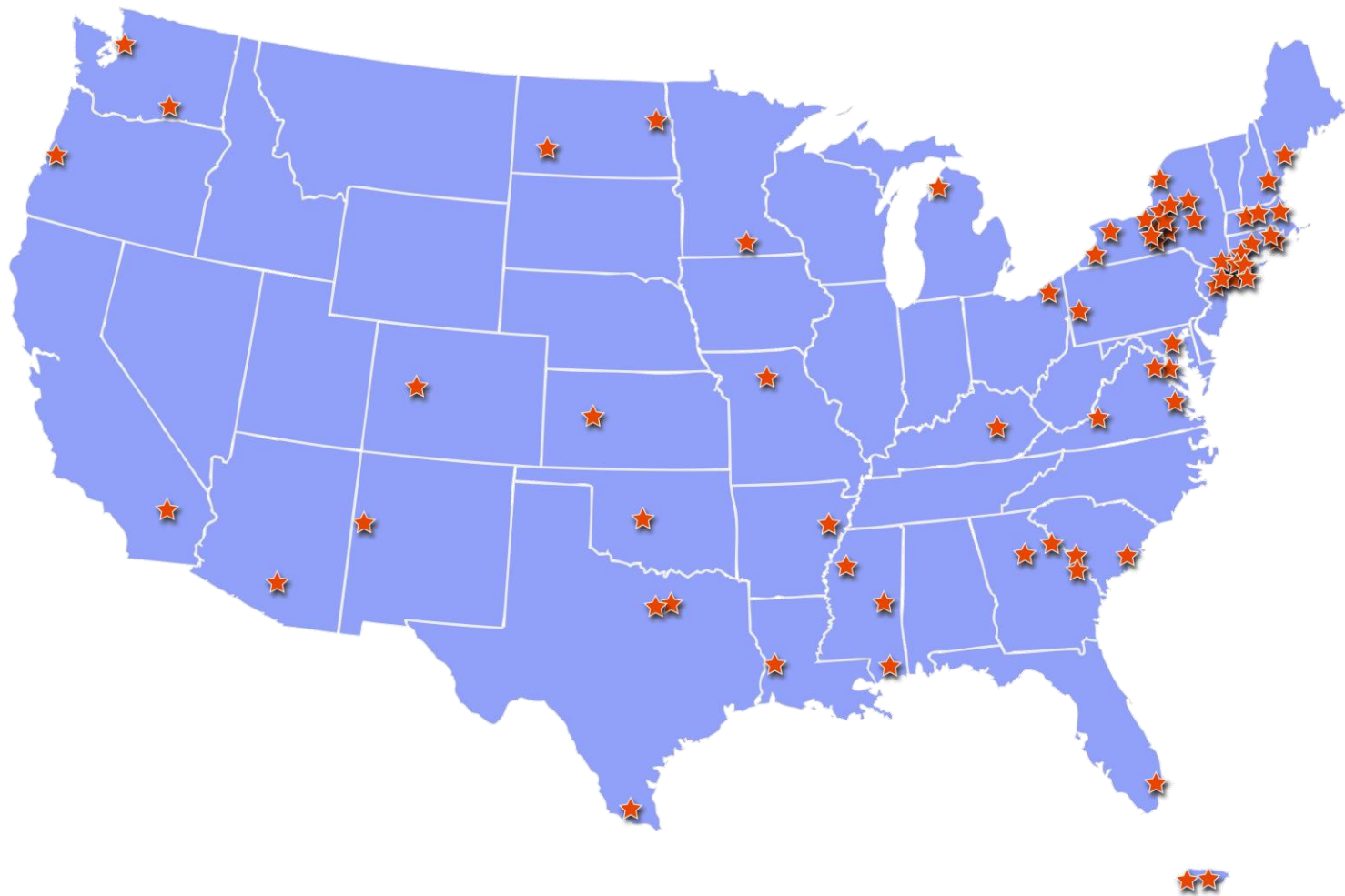
Comment:



We ship to any teacher in the US!



Lending Library used by 1288 Students Last Year

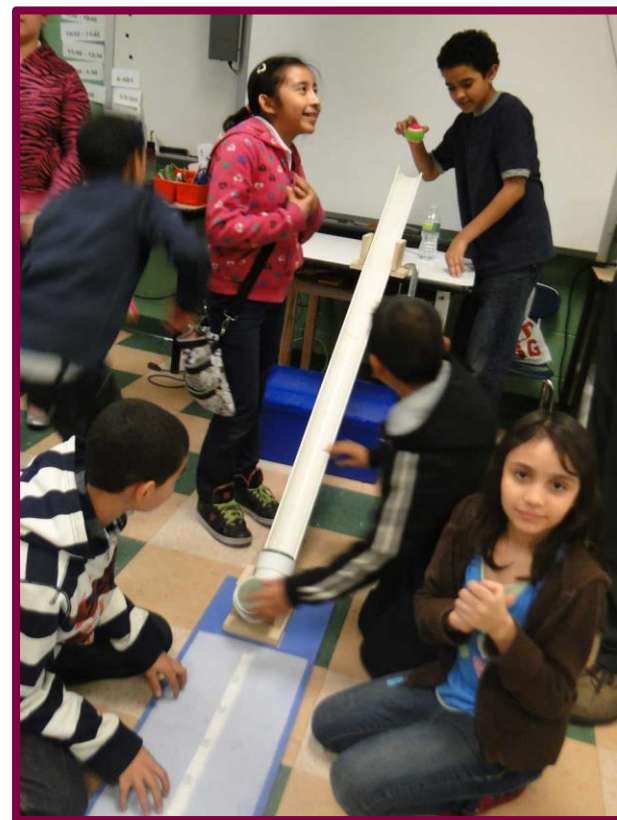


Map of the 71 schools that borrowed lending library materials in 2014

Revising Drop Tube to Improve Student Engagement



Drop Tube: Predicting the compression of foam in a desktop activity.



Launch Tube: Predicting the trajectory of a ball in a multi-student experiment.

Goal: Maintain quantitative aspects and module transportability while improving student engagement and interaction.