Educational Outreach Program

Nevjinder Singhota, CCMR Educational Outreach Director

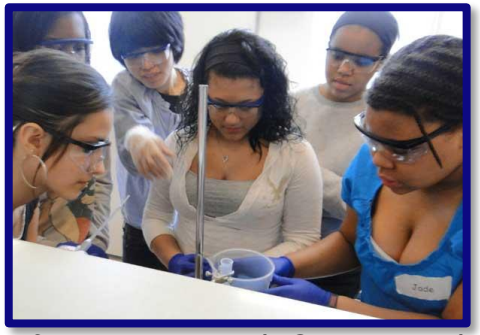
MRSEC Education Directors' Meeting 2016

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

Testing catapult mechanics on Prof. Katja Nowack

Prof. Chad Lewis in Washington DC

Prof. Will Dichtel in Puerto Rico

Prof. Itai Cohen in Harlem

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

New York State Standards Met

Vocabulary

Student Activity Sheets

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/ciai/)*
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 **Accuracy**
Estimate **Replication**
Predict **Variable**

Materials:

For Each Pair:
Tube
Foam†
Set of metal cubes
Spring scale
Ruler*
String
Stickers

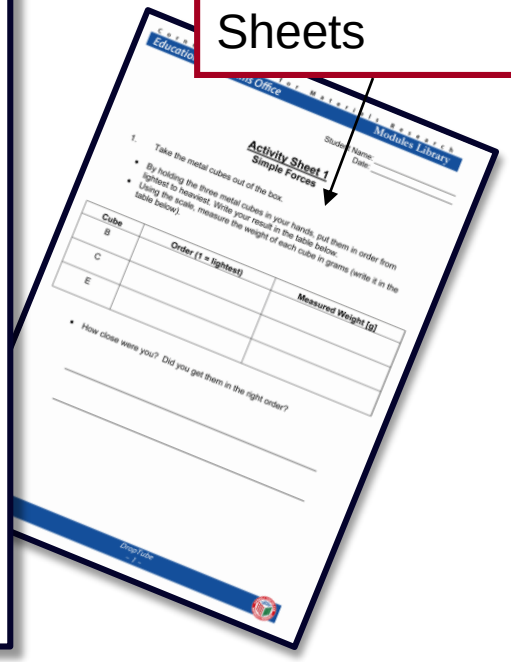
For Each Class:
One sponge
One lead brick

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.



Helping Teachers with Next Generation Science Standards

COMMON CORE
STATE STANDARDS INITIATIVE
PREPARING AMERICA'S STUDENTS FOR COLLEGE & CAREER

(English and Mathematics)

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NEXT GENERATION
SCIENCE
STANDARDS

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 expecta

Science and Engineeri

Developing and Using Models
Modeling in 3–5 builds on K–2 exp progresses to building and revising and using models to represent eve solutions.
- Develop a model using an ana abstract representation to desc principle. (4-PS4-1)
- Develop a model to describe p PS4-2)

Constructing Explanations and D Solutions
Constructing explanations and des 3–5 builds on K–2 experiences and use of evidence in constructing exp specify variables that describe and 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)

K-12 Science Education:

scutting Concepts

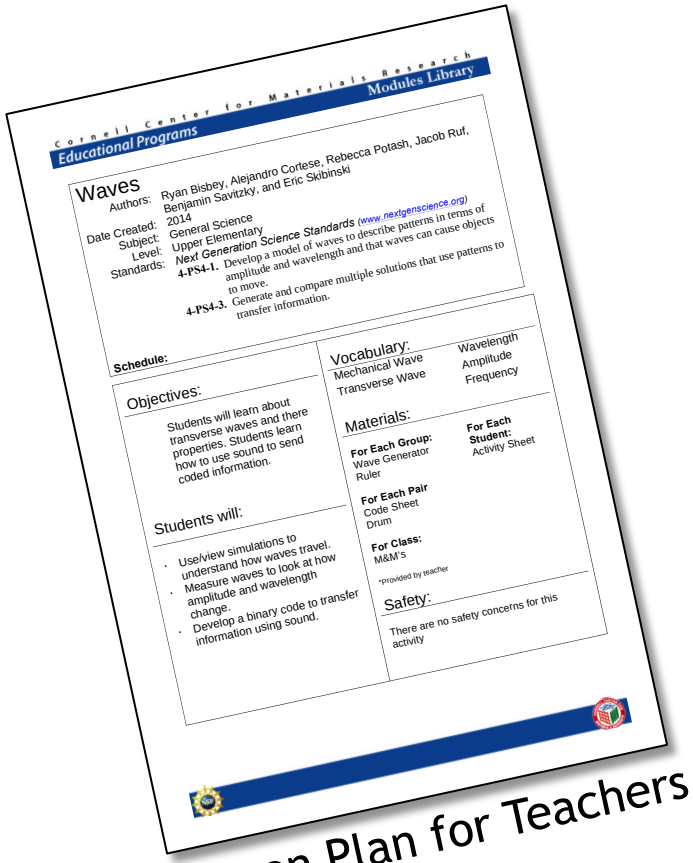
d differences in patterns can be lassify, and analyze simple rates of ural phenomena. (4-PS4-1)
d differences in patterns can be d classify designed products. (4-

ct relationships are routinely S4-2)

Engineering, Technology, plications of Science

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

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 Skibinski

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 there properties. Students learn how to use sound to send coded information.

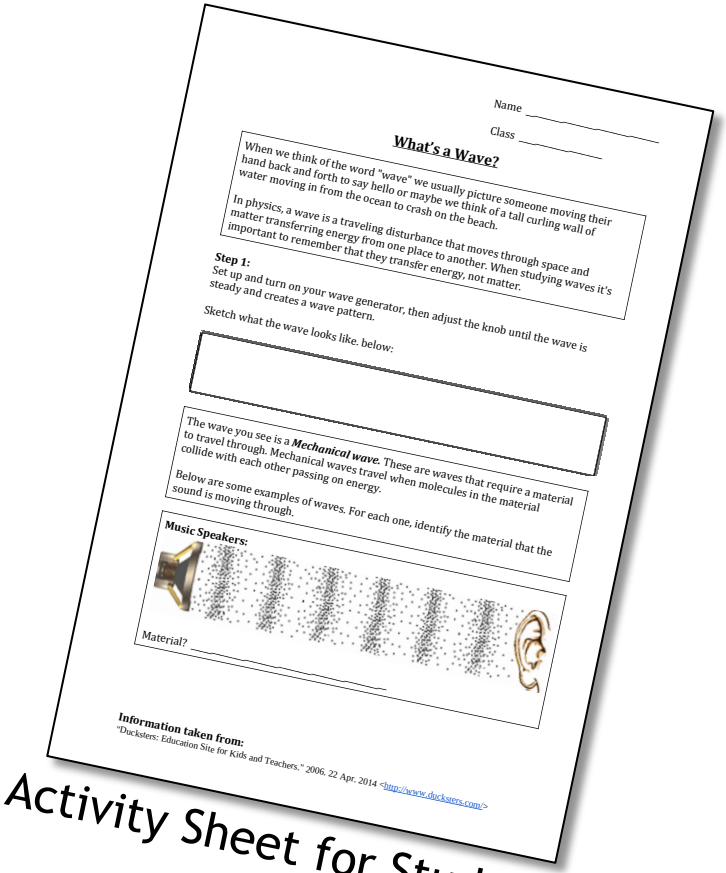
Students will:
- Use/view simulations to understand how waves travel.
- Measure waves to look at how amplitude and wavelength change.
- Develop a binary code to transfer information using sound.

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
*provided by teacher

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.

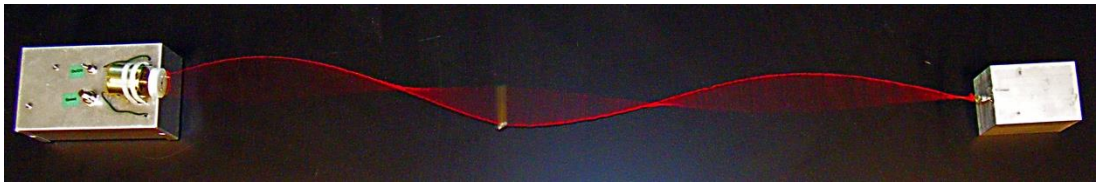
Below are some examples of waves. For each one, identify the material that the sound is moving through.

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

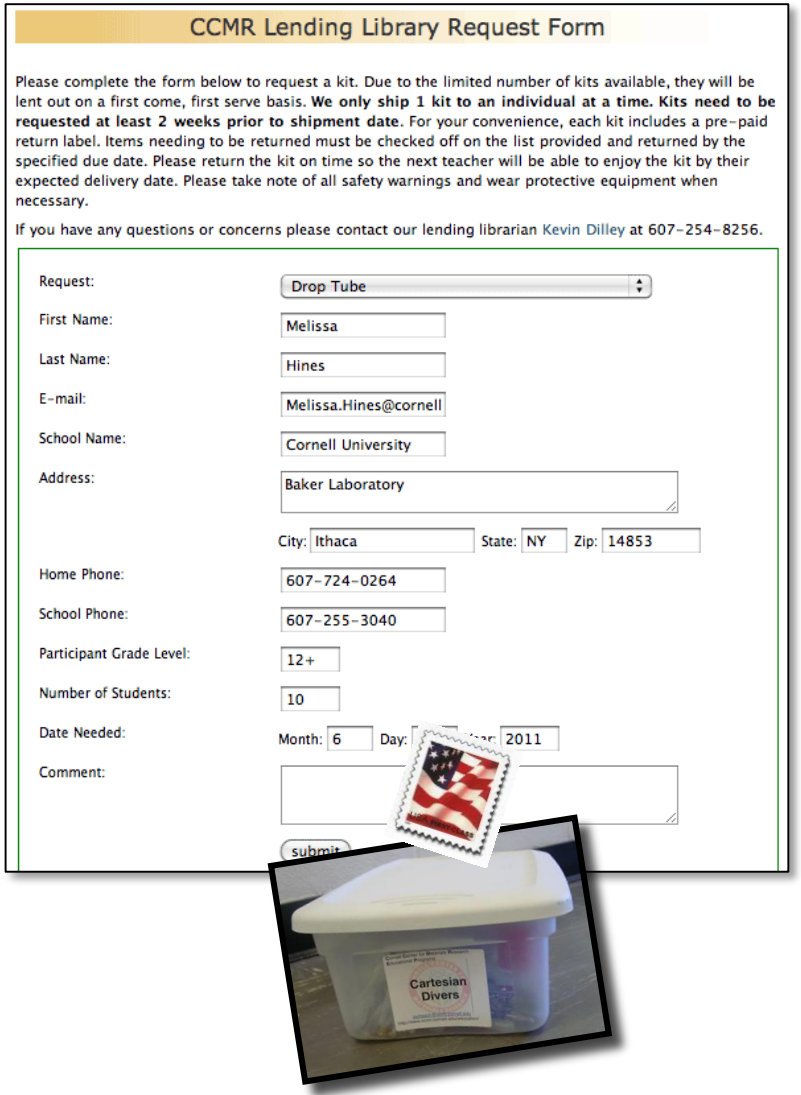


$25 battery powered wave generator

Field Testing the Wave Module with Partner Schools

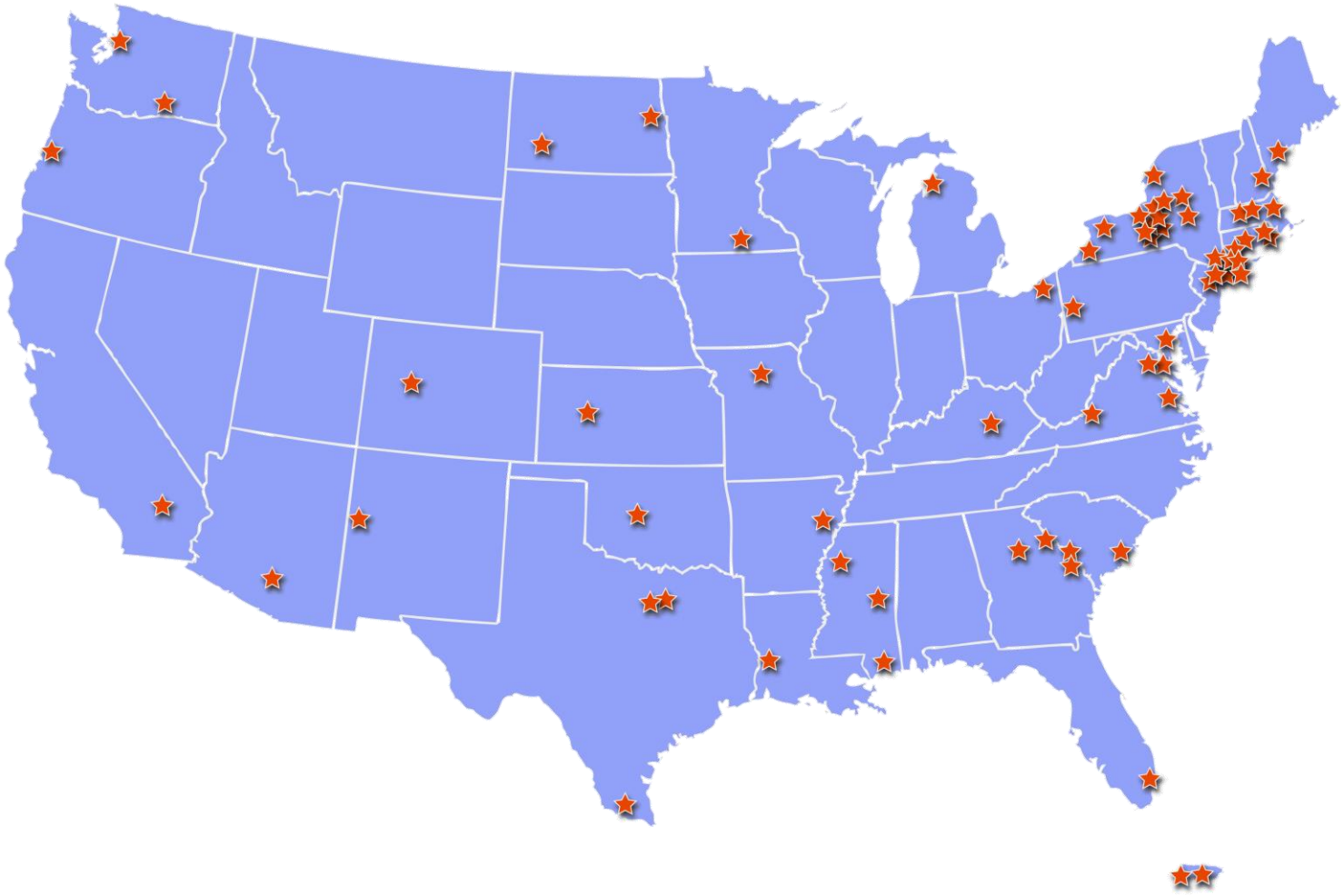
Field tests at Enfield Elementary, Harlem Children's Zone and Howard Univ. Middle School of Science

Online Lending Library of Educational Modules



We ship to any teacher in the US!

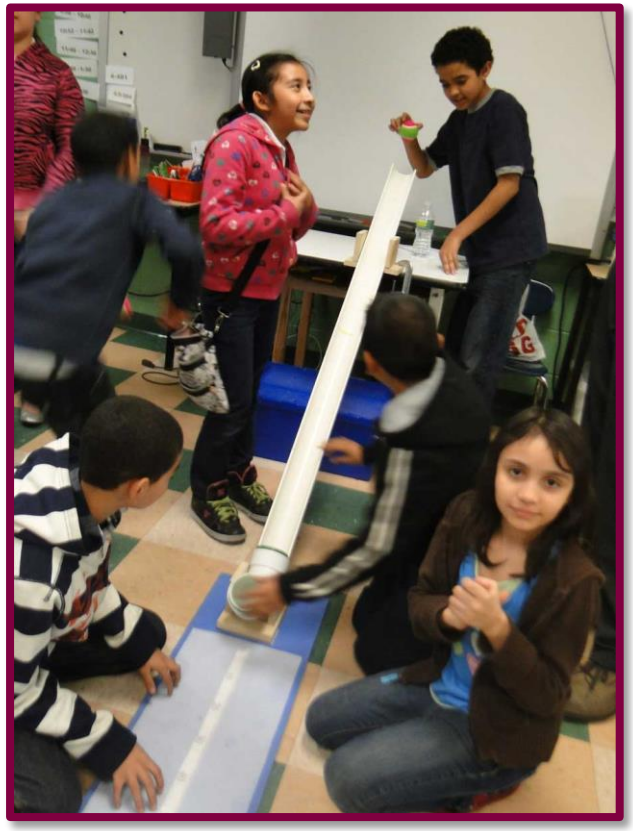
Lending Library used by 1288 Students Last Year



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.