physcira

Physics in a Box ™

changing the paradigm of K-12 physics education

You know "WHAT" needs to be done. We know "HOW."

A groundbreaking, collaborative effort of advocates, supporters, educators, policy makers, business owners, advisors, strategic partners, and the Physical Science Research Associates (Physcira) team

www.physcira.com

European / Asian Physics Curriculum (mandatory required by law in all developed countries)

3rd Grade

15 lessons of Elements of Mechanics

4th Grade

15 lessons of Elements of Optics

5th Grade

15 lessons of Elements of Electricity & Magnetism

- Conceptual, reinforcing addition, subtraction, multiplication, division, reducing fractions, measurements.

- Teaching how to read and analyze.

(NGSS calls for **14** Benchmarks in Mechanics)

6th Grade

100 of Mechanics

(NGSS calls for **2** Benchmarks in Optics)

7th Grade

100 of Optics

(NGSS calls for **2** Benchmarks in Electricity)

8th Grade

100 of Electricity & Magnetism

Pre-Algebra based, Conceptual

9th Grade

10th Grade

Mechanics
Optics
Electricity & Magnetism
Thermal Physics

Algebra 1, 2 & Geometry based

11-12th Grades

M – Physics
Tu – Earth Science
W – Physics
Th – Life Science
F - Physics

100 lessons per AY

Why Physics?

Explains the world around us and connects science to everyday life:

Mechanics, Optics, Electricity & Magnetism, and Heat

Provides an application for math:

Pre-Algebra, Algebra 1, Geometry, Algebra 2, and later Pre-Calculus & Calculus

Increases reading proficiency of students:

Reading and following instructions, analyzing the text, working on wording problems, etc.

Builds critical-thinking skills (in different ways compared to other disciplines).

Prepares students for the jobs and challenges of the future.

Physics in a Box

Entire Physics curriculum is taught as hands-on classes: elementary school, middle school, high school

Provides a framework around which Math and other school subjects blossom

Loved by teachers and students

Guarantees immense growth of student success

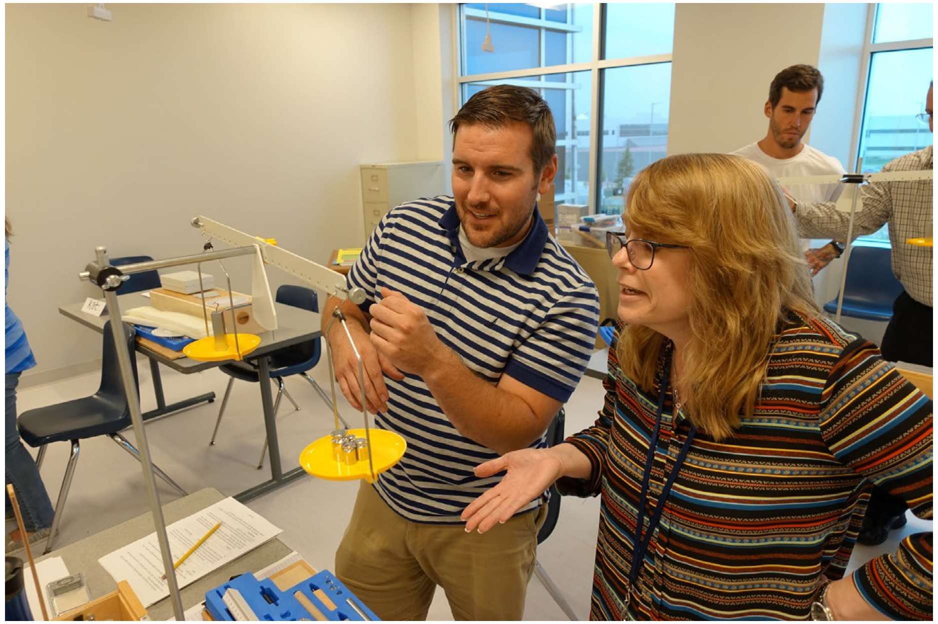
Mechanics

Optics

Thermal

Electricity & Magnetism

Year-Round Weekly Professional-Development Sessions for Teachers



No prerequisites or formal science background is needed to become a physics teacher! All it takes is participation once a week in Physcira's supportive teacher-training sessions.

Implementation is Easy and Customizable

As part of a core science curriculum (once a week, twice a week, or three times a week)

As an addition to your existing science program (plug-and-play)

As part of STEM activities

As an after-school program

As a supplement to your math curriculum

As part of other subjects (e.g., Engineering Design)

As a prerequisite to other programs (e.g., Robotics)

Implementation as a Part of a Core Curriculum is Seamless

6 Grade – Earth Science

Fall Semester, 18 Weeks

- Week 1, Physics Lesson 1
- Week 2, Physics Lesson 2
- …
- Week 18, Physics Lesson 18

Spring Semester, 18 Weeks

- Week 1, Physics Lesson 1
- Week 2, Physics Lesson 2
- …
- Week 18, Physics Lesson 18

Total 36 lessons of *Physics in a Box - Mechanics* = exceeding most U.S. academic standards requirements by 3 times and solidifying Pre-Algebra knowledge

7 Grade – Life Science

In a similar way, 36 lesson of *Physics in a Box - Optics* in 7th Grade = exceeding U.S. academic standards by 12 (!!!) times and solidifying Pre-Algebra and elements of Geometry

8 Grade – Physical Science

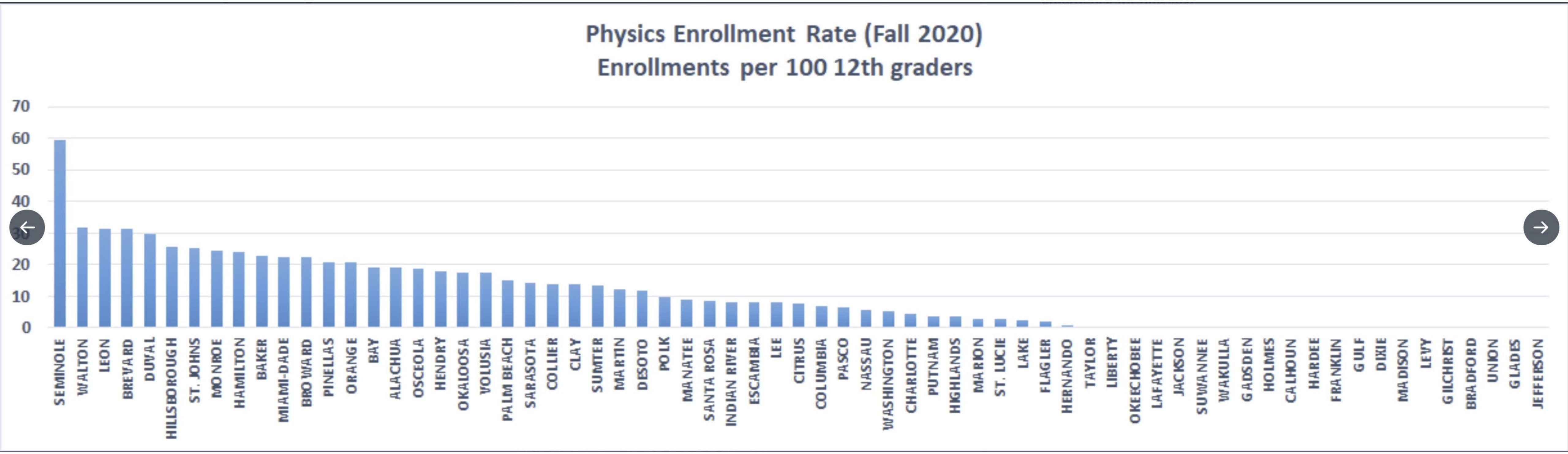
In a similar way, 36 lesson of *Physics in a Box Electricity y & Magnetism* in 8th Grade = greatly exceeding U.S. academic standards and solidifying Pre-Algebra, elements of Geometry, and elements of Algebra

Implementation as a Part of a Core Curriculum is Seamless

In case of the Integrated Science Approach at Schools

Providing Physics in a Box Lessons where units of Physical Science are scheduled

Results of the *Physics in a Box* Program: Seminole County (Florida) Public Schools were among the first districts to implement *Physics in a Box* in all middle schools. The result: an unprecedented jump in student enrollment in their high-school physics program – 60 percent compared to 30 percent or less for other Florida school districts.

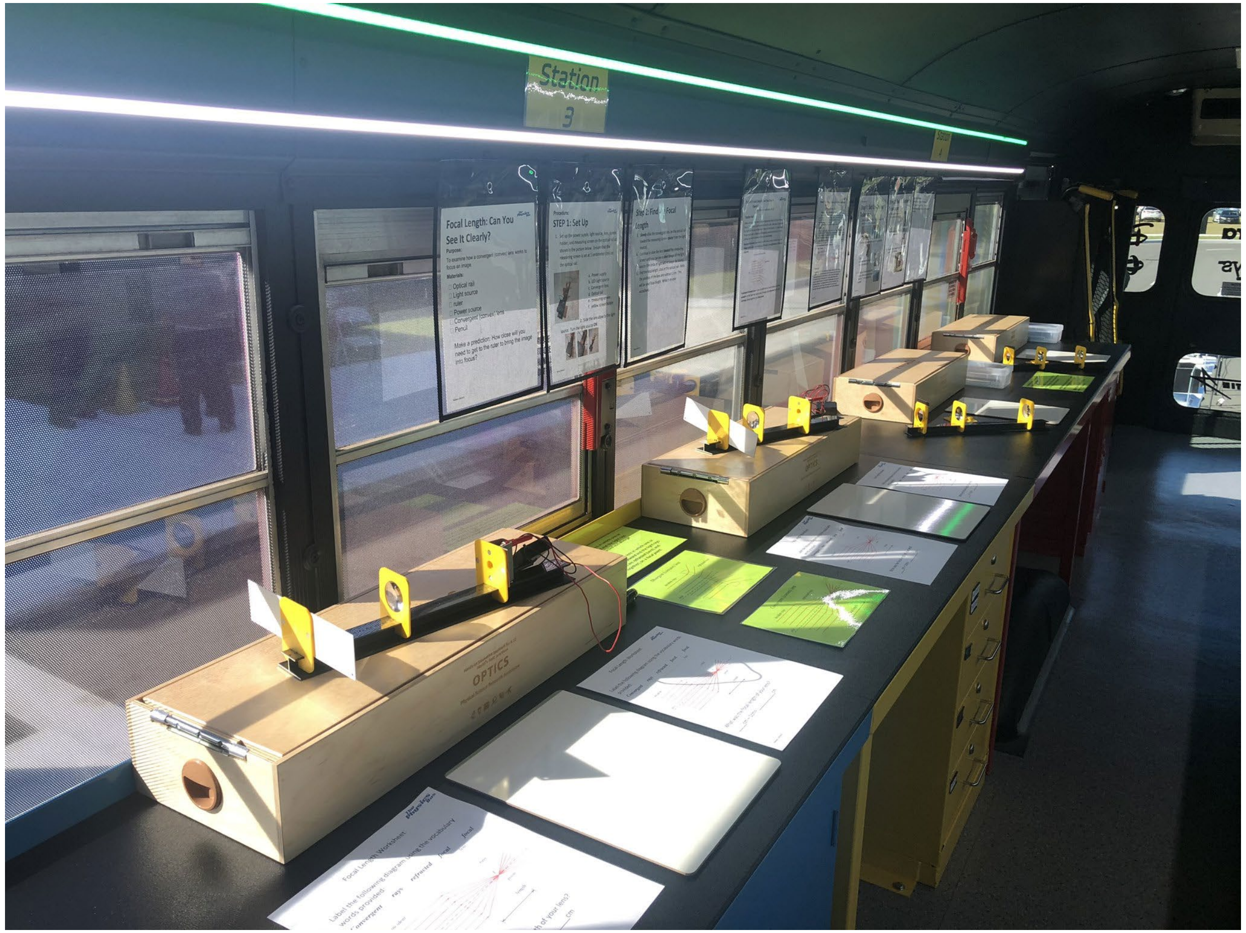


Other impactful initiatives run by the Physcira team:

- School buses, equipped with *Physics in a Box* stations
- National middle-school physics Olympiad
- Year-round, weekly teacher-training session on physics content and methodology
- Microcredential certifications for teachers
- Summer teacher professional-development programs

School buses, equipped with *Physics in a Box* stations, travel from one elementary school to another, delivering elements of physics to students:

Physics in a Box - Optics stations in the second physics bus



Ribbon-cutting ceremony for the second bus, equipped with *Physics in a Box - Optics*, on January 29, 2021.

The first bus, equipped with *Physics in a Box – Mechanics*, was launched one year earlier, in January 2020.

The third bus, equipped with *Physics in a Box – Electricity & Magnetism,* is launched on April 1st 2022.

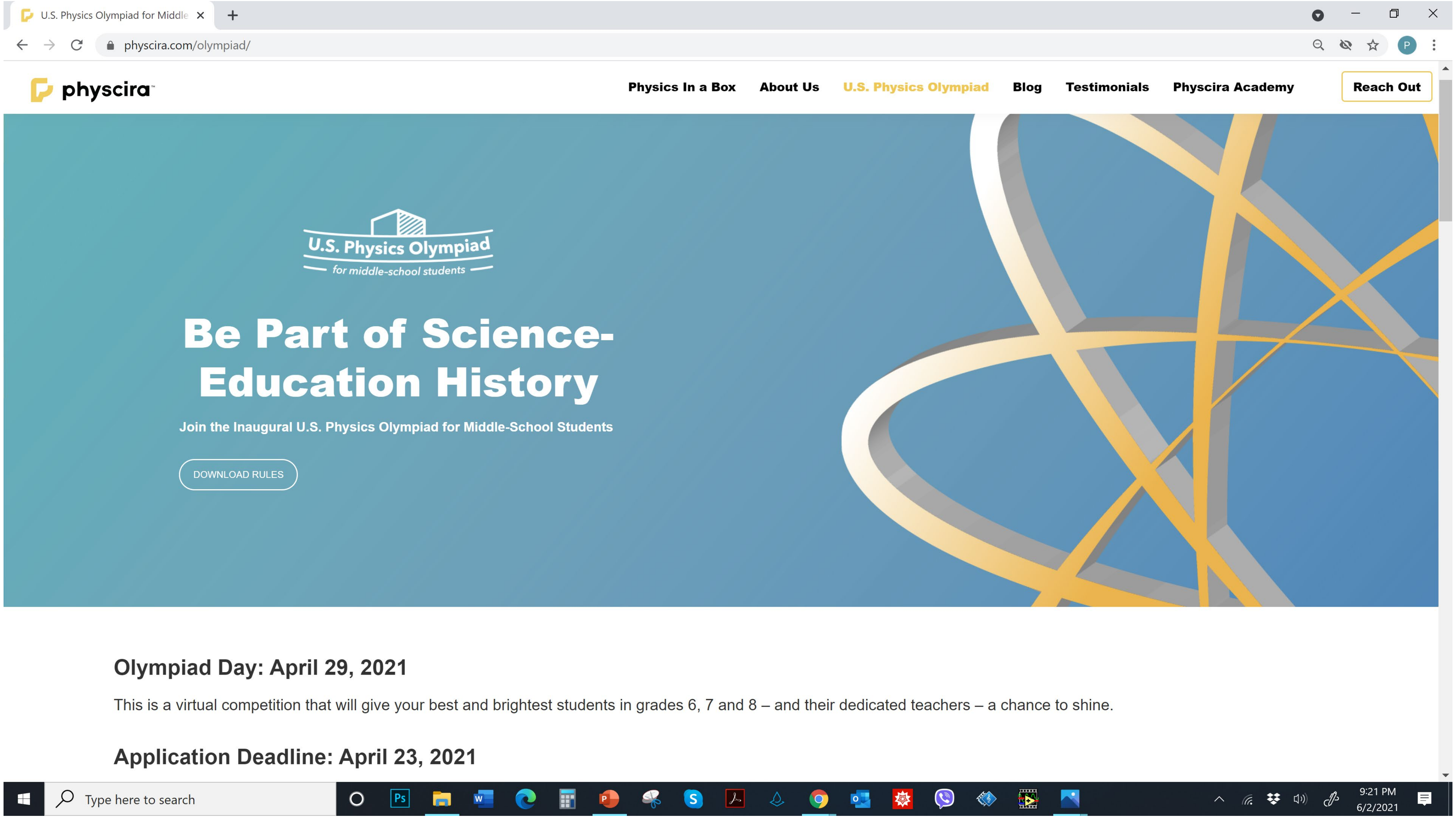
SCPS Info
@SCPSInfo

Today, we officially launched our 2nd Physics Bus: "The Optics Bus!" Thank you to all our sponsors who made this a reality!

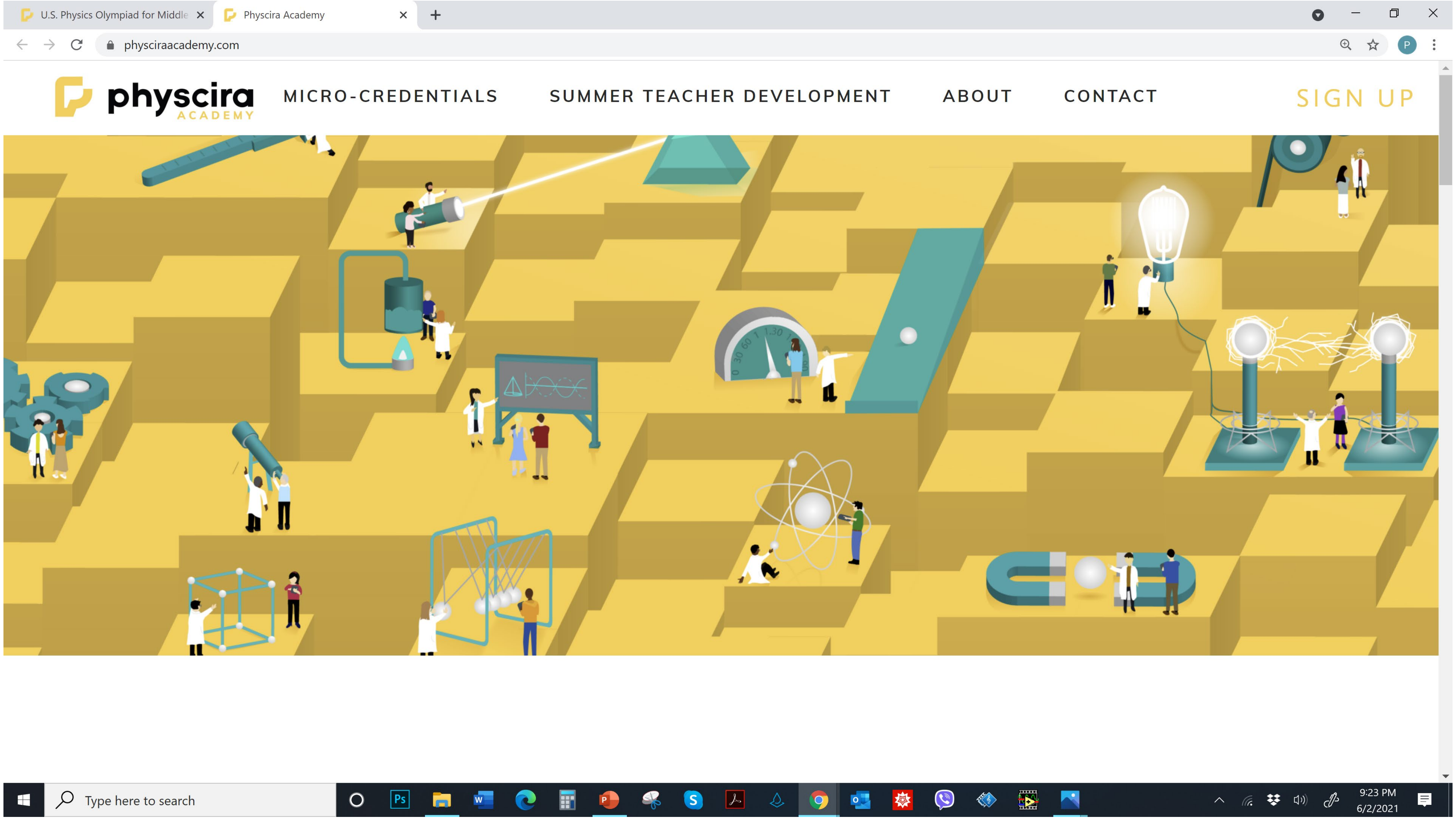
12:16 PM · Jan 29, 2021 · Twitter Web App

The third bus, equipped with *Physics in a Box – Electricity & Magnetism*, is launched on April 1st 2022.

The inaugural national middle-school physics Olympiad, organized and hosted by Physcira on April 29, 2021, brought together more than 1,000 students from 48 states.



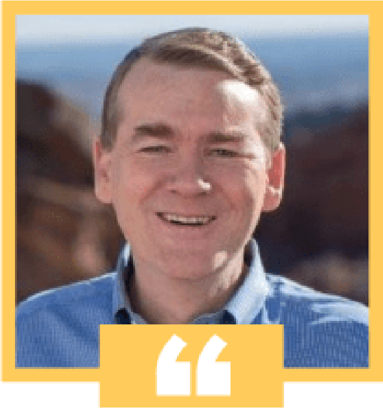
Physcira is committed to developing a new generation of world-class K-12 math and science teachers



I have not found anything that would have the potential impact that *Physics in a Box* program could have, and there is nothing that would even come close from a cost-benefit stand point.

[Video Testimonial]

Mark Lautman
Founder CELab
World-Renowned Thought Leader and Economic Architect



“Your groundbreaking move exemplifies all three areas for change that will lead us out of an era where a child’s zip code determines the quality of his or her education. Success starts with attracting and retaining talent to teaching, increasing local flexibility and spurring innovation by creating opportunities for people on the ground to try different things.”

Senator Michael Bennet
Colorado

"...What I would say to chief state school officers having sat in that chair and as a former superintendent: I truly believe that this product [*Physics in a Box*] is a game changer. And while I typically don't give testimonials – as a matter of fact, this is the only one I've ever done for a curriculum ever in my entire career...."

[Video Testimonial](#)

Dr. Veronica C. Garcia
Former Cabinet Secretary of Public Education, State of NM
Former Superintendent of Santa Fe Schools, State of NM

"For superintendents looking at this, here's what I would say: I would challenge you to find another mechanism to deliver this many labs or experiments [*Physics in a Box*] for the dollars you're going to spend. In fact, I'm going to say it doesn't exist. And being a former math teacher, I've searched for it."

Video Testimonial

Travis L. Dempsey
NMSSA Superintendent of the Year 2020-2021

For more testimonials for *Physics in a Box* program

>>> Click here

"For me, I learn best when I can actually do hands-on things, when I can try and fail, and then try again. *Physics in a Box* helps that, because you can see what to change or where you may have gone wrong."
Andrea, 10th grade student,
Colorado Early Colleges Colorado Springs

"I would say, any school on the fence about getting the P*hysics in a Box* curriculum, if you want to reach every single one of your kids in your physics classes, this is your solution."
Video Testimonial
Danielle Springston, MTSS Coordinator, Science Department
Physics Teacher, Colorado Early Colleges, Colorado Springs

"We want to build a program where students want to be there, and that's what we are seeing with the *Physics in a Box* program. Our kids want to go to class, they want to do the experiments, they want to learn. This is always exciting!"
Video Testimonial
Jennifer Daugherty, Head of Schools
Colorado Early Colleges, Colorado Springs

"This is a beautiful set of materials (*Physics in a Box* was demonstrated). I think teachers and students will take this more seriously and learn more with materials like this."
Senator Mimi Stewart
New Mexico – Bernalillo

"We want to open Physics for ALL students. The *Physics in a Box* program gives something very unique to our students, because it is real!"
Video Testimonial
Dr. Anna-Marie Cote
Deputy Superintendent
for Instructional Excellence and Equity
Seminole County Public Schools

"Why is *Physics in a Box* so awesome? I think for me it was the connection between physics and math. […] I love how my struggling-in-math students are working on math in a fun and interactive way, without even knowing they are doing math."
Video Testimonial
Craig Johnson
Principal
Indian Trails Middle School

2.1 Measuring the density of regularly shaped solid bodies: cube and rectangular prism. Unit transformations: $\frac{g}{cm^3}$ and $\frac{kg}{m^3}$.

Objectives:

Students will become familiar with the concept of density and master the equation $\rho = \frac{m}{V}$. Students will determine the density of three blocks with the same volume but made of different materials. To determine what material the blocks are made of, students will compare the calculated densities to those in a density chart.

Materials:

Physics notebook / lab paper / pencil / calculator / three blocks with a hook from mechanics box, caliper, digital scale, and metric ruler.

Background information:

Opening discussion: What is heavier - a metric ton of feathers or a metric ton of bowling balls? Neither-they both have the same mass, (1,000 kg) but have different volumes.

What is density? Density describes a physical property of matter that explains how tightly packed particles are in a substance. Different substances have different densities. A particular substance under certain conditions will always have a specific density regardless of size or shape. For example, copper will always have a density of 8.96 $\frac{g}{cm^3}$ at room temperature.

There are many examples of density. Brainstorm with your students to assess prior knowledge. Follow with a discussion of the examples below.

1. When **oil and water** meet each other (such as an oil spill in the ocean), oil will rise to the surface because it is less dense than water.

2. **Party balloons** are filled with helium. The balloons rise in the air because helium is less dense than air.

3. **A styrofoam cup** is less dense than water, but a ceramic cup has greater density. The Styrofoam cup floats in water while the ceramic cup will sink.

4. **Wood** will float on water because wood is less dense than water.

5. **Icebergs** – Generally, the density of a liquid substance is usually slightly less than its density as a solid. For example, the density of solid iron at room temperature is 7.87 $\frac{g}{cm^3}$ but when it becomes heated to a fluid its density becomes 6.98 $\frac{g}{cm^3}$. Water is the exception. The density of water is 1 $\frac{g}{cm^3}$, while the density of ice is 0.9340 $\frac{g}{cm^3}$. This explains why part of an iceberg floats above the water level while much of the iceberg is below.

The equation for density can be written two ways:

$$\rho = \frac{m}{V} \text{ or } d = \frac{m}{V}$$

In the first equation, the symbol ρ (*pronounced ROW*) is Greek and stands for density; in the second equation d stands for density as well. In K-12 school systems throughout the United States, we use the notation d for density. In college literature and international practice density is represented by the symbol ρ. In this physics course students will be introduced to the Greek alphabet symbols and we will use the density equation $\rho = \frac{m}{V}$. In both formulas, m stands for mass and V stands for volume. Mass is measured in kg and volume is measured in m^3 therefore the proper units for density are $\frac{kg}{m^3}$. We write

$$[\rho] = \frac{kg}{m^3}$$

Here square brackets show that we talk about the units of measurements for density.

On occasion, we need to measure m in grams and V in cm^3. Density is expressed in $\frac{g}{cm^3}$ in this situation:

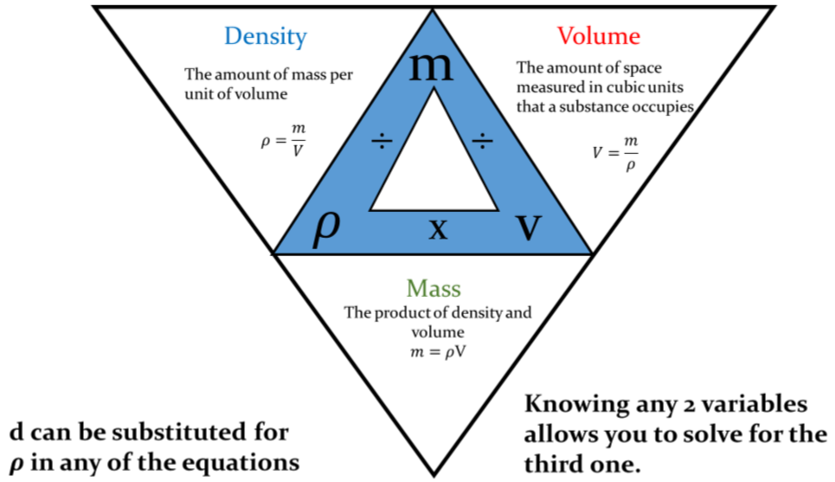
$$[\rho] = \frac{g}{cm^3}$$

We will teach students to transform the units of density from $\frac{g}{cm^3}$ into $\frac{kg}{m^3}$ and back.

The relationship between mass, volume & density

Mathematically, density is a ratio of mass over volume: $\rho = \frac{m}{V}$.

Starting with the equation for density, it is tempting to say density is proportional to mass and inversely proportional to volume. Under the same conditions of temperature and pressure, density of a material remains constant. If you double the mass, volume must double as well to keep the density ratio the same. Density is a material property determined mathematically as a ratio of mass to volume. The increase/decrease of mass must correspond to the change of volume.



Students solve density problems using the equation:

$$\rho = \frac{m}{V}$$

Knowing mass and volume allows us to calculate density. When students know density and volume, they can determine mass using the equation:

$$m = \rho V$$

If mass and density are known, volume is calculated using the equation:

$$V = \frac{m}{\rho}$$

Name: ______________________________ Date: __________ Period: _________

Mechanics Lab 2.1

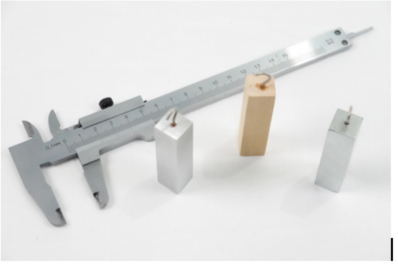
Investigate density of a rectangular prism

Objectives: Students will determine the density of three blocks which have the same volume but made of different materials. Students will compare the obtained densities with a density chart to determine the material of the blocks.

Materials: Physics notebook / lab paper / pencil / calculator, three blocks with a hook from mechanics box, caliper, digital scale, and metric ruler.

Procedure:

1. Measure the mass *m* of each bar using the digital scale.

2. Measure the length, width and the height of the block (without the hook) in cm using a caliper or a ruler, then record in Table 2.1.2.
3. Calculate the volume of the block (a): $V = l \cdot w \cdot h$ and record it in Table 2.1.2. Multiply all three dimensions measured in centimeters to provide the volume in cm^3.
4. Calculate the density of the block by dividing mass by volume $\rho = \frac{m}{V}$. Round to the hundredths place.
5. Repeat steps #1-4 for blocks b and c.
6. Research online for a chart of densities of different materials expressed in $\frac{g}{cm^3}$. Compare the values for densities of all three blocks with the data in the chart to determine what the material the blocks are made of.

   Another option is to refer to the data in Table 2.1.3 to find the closest match.

Name: ______________________________ Date: __________ Period: _________

Mechanics Lab 2.1 (page 2)

Table 2.1.2

Objects	Mass, *m* (g)	Measure-ments (cm)	Volume (cm^3) $V = l \cdot w \cdot h$	Density ($\frac{g}{cm^3}$) $\rho = \frac{m}{V}$	Closest value for density from chart	Identify Material
a) dull 		$l =$ $w =$ $h =$				
b) shiny 		$l =$ $w =$ $h=$				
c) brown 		$l =$ $w =$ $h=$				

Name: ______________________________ Date: _________ Period: _________

Mechanics Lab 2.1 (page 3)

Identification by density

If online data is not available, use the data in Table 2.1.3 to identify the substance of bars a, b, & c. (*Your answer may not be exact-- look for the closest match).*

Table 2.1.3

Common Metal Densities			Other Densities	
Metal	**Density ($\frac{g}{cm^3}$)**		**Substance**	**Density ($\frac{g}{cm^3}$)**
Aluminum	2.70 $\frac{g}{cm^3}$		Wood (average)	0.5 $\frac{g}{cm^3}$
Zinc	7.14 $\frac{g}{cm^3}$		Water	1.0 $\frac{g}{cm^3}$
Iron	7.87 $\frac{g}{cm^3}$		Ice	0.93 $\frac{g}{cm^3}$
Brass	8.73 $\frac{g}{cm^3}$		Concrete	2.3 $\frac{g}{cm^3}$
Copper	8.96 $\frac{g}{cm^3}$		Basalt	3.00 $\frac{g}{cm^3}$
Gold	19.30 $\frac{g}{cm^3}$		Limestone	2.71 $\frac{g}{cm^3}$
Platinum	21.45 $\frac{g}{cm^3}$		Pyrite	5.01 $\frac{g}{cm^3}$

Name: ______________________________ Date: _________ Period: ________

Mechanics Lab 2.1 (page 2) Answers

Table 2.1.2

Objects	Mass, m (g)	Measure-ments (cm)	Volume (cm^3) $V = l \cdot w \cdot h$	Density $(\frac{g}{cm^3})$ $\rho = \frac{m}{V}$	Closest value for density from chart	Identify Material
a) dull 	36.54 g	l=6.06 cm w=1.52 cm h=1.52 cm	6.06·1.52·1.52= 14.0 cm^3	$\frac{36.54\ g}{14.0\ cm^3} = 2.61 \frac{g}{cm^3}$	$2.70 \frac{g}{cm^3}$	Aluminum
b) shiny 	104.22 g	l=6.06 cm w=1.52 cm h=1.52	6·1.5·1.5= 13.5 cm^3	$\frac{104.22\ g}{14.0\ cm^3} = 7.44 \frac{g}{cm^3}$	$7.87 \frac{g}{cm^3}$	Iron
c) brown 	8.29 g	l=6.06 cm w=1.52 cm h=1.52	6·1.5·1.5= 13.5 cm^3	$\frac{8.29\ g}{14.0\ cm^3} = 0.592 \frac{g}{cm^3}$	$0.5 \frac{g}{cm^3}$	Wood

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Physics in a Box ™

Powered by the Physcira Team

Three components in one package:

- Tools for Mechanics, Optics, and Electricity & Magnetism
- 100+ lessons for each program
- Teacher training every week

info@physcira.com / www.physcira.com