RESOURCE Links

Physics Toolbox - downloads

Android - https://play.google.com/store/apps/details?id=com.chrystianvieyra.physicstoolboxsuite&hl=en_US
Apple - https://apps.apple.com/us/app/physics-toolbox-sensor-suite/id1128914250

Arduino Science Journal

Android - https://play.google.com/store/apps/details?id=cc.arduino.sciencejournal
Apple - https://apps.apple.com/us/app/arduino-science-journal/id1518014927

Classroom Ideas and Activ

Rakestraw's free curriculum, called Physics with Phones, provid
step-by-step directions plus written quizzes and other instructio
teaching when he took a sabbatical from Lawrence Livermore to
"I realized that the literature and the people working in this area
is possible," he say
RESOURCE - https://physicstoday.aip.org/news/teaching-physic

https://st.llnl.gov/sci-ed/Physics-with-Phones - Interested in hav
Physics with Phones activity in your classroom?

https://spark.iop.org/sites/default/files/media/documents/cla
rtphones_1.pdf

Ditch the Textbook - Matt Miller

1. Spin, spin, spin — To measure centripetal acceleration using the accelerometer app, students can hold their devices in front of them and spin around. They'll be able to notice how faster and slower spinning affects the data they gather. Rebecca had a ballerina in class once that provided some great data with pirouettes!

2. Motion in three dimensions — Again, using the accelerometer app, students can measure 3D motion — forward/backward, side/side and up/down — by just shaking a device. Rebecca suggests having students jump with the devices to see how taking off, being in mid-air and landing affect the readings. Taking a "field trip" to an elevator puts a new spin on the same activity.

3. Changing leaves — Although Vieyra Software doesn't have an app to do this yet, students could use the cameras on their devices to measure the change in leaf color on trees in the fall. Using an app that measures red/green/blue values in images, they could watch as the blue and green levels fall and the red levels rise as leaves change color. The changes could be correlated with average daily temperature, Rebecca said, and could be compared with data from students around the country or world.

4. Going down while going up — Using the barometer app, students can see how barometric pressure goes down as they go up in altitude. Rebecca measured that while riding the Sandia Peak Tramway, the longest tramway in North America. As the tram (kind of like an enclosed ski lift) went up in altitude, she watched the barometric pressure lower. As the tram connected with a tower, and then lowered briefly as it left the tower, the barometric pressure rose slightly. Students could take similar measurements on a trip where altitude changes.

5. Changing weather, changing pressure — When a warm or cold front blows through, the air pressure changes. Those changes can be measured using mobile devices using a barometer app.

6. Bright lights — Cell phones and tablets use light sensors to measure ambient light to adjust settings for digital photos. Those same sensors can be used to measure and compare light sources. Use camera flashes from cell phones, LED lights, flashlights or others and compare.

7. Can you hear me now? — A sound meter can do similar measurements with sound. "What we perceive as loud and soft isn't necessarily the same thing as actual sound intensity," Rebecca said. Some data can convince students that the "really loud sound" they just heard wasn't so much different from other quieter ones. Use another cell phone or anything with a speaker to produce sounds to measure.

8. Google Cardboard — This new product developed by Google is almost like a set of inexpensive virtual reality goggles. It gives users an "immersive experience" by showing them images that can be seen through Google Cardboard. Cardboard is made of a cardboard box that holds a cell phone with lenses for looking in. The phone uses its built-in sensors to tell when the user turns to look around, and it simulates that movement in the image it displays. It also uses the phone's magnetometer to create a button on the outside that users can use while their phone is encased in Cardboard (Rebecca explains this in better detail in the video!). Cardboard could be used to tour places around the world that are too expensive for students to visit.

9. Tick, tock — The proximeter in mobile devices can be used to measure the period of a pendulum. The device can sense when a pendulum passes in front and can help to mark the time.

10. How cold is it? — There are lots of options for measuring the ambient temperature and comparing it around your city, state, country or beyond.

11. Helicopter blades — A stroboscope is great for creating light effects at a dance party, but it can also help determine the lift of a toy helicopter (among other things). Rebecca has used the stroboscope app (which is currently being refined in beta testing) to sync the flash with the spinning frequency of the moving blades of the helicopter. That information, used in cooperation with an electronic balance, can determine the lift that the helicopter's blades can generate. (Leave it to the teacher placed with NASA Aeronautics to figure that one out!)

Unlock the Power of Mobile Science:

Science Toolkit for Tablets & Smartphones in Teaching K-12 Science

(Attendees Receive Certificate Verifing Attendance for PD)

Apps for Apple-Android-Chrome

Explore Free Apps Available or your own or school devices. Applicable in all grades!

- Revolutionize Science Teaching
- Increase Student Engagement
- Collect and Work with Real Data
- Make Complex Ideas Visual
- Address NGSS In All Grades

In Person or by Zoom

Recommend bringing a laptop or tablet

For Questions or Information
tsullivan@eiu.edu

Date: February 5th (Thursday)
Time: 4:30 to 5:30 pm
Location: Buzzard Rm 2445

Feb. 05, 2026
NGSS Science Labs
Collecting Data with Tablets or Phones

Science Exploration

Join Zoom Meeting

GROW YOUR OWN TEACHERS ILLINOIS

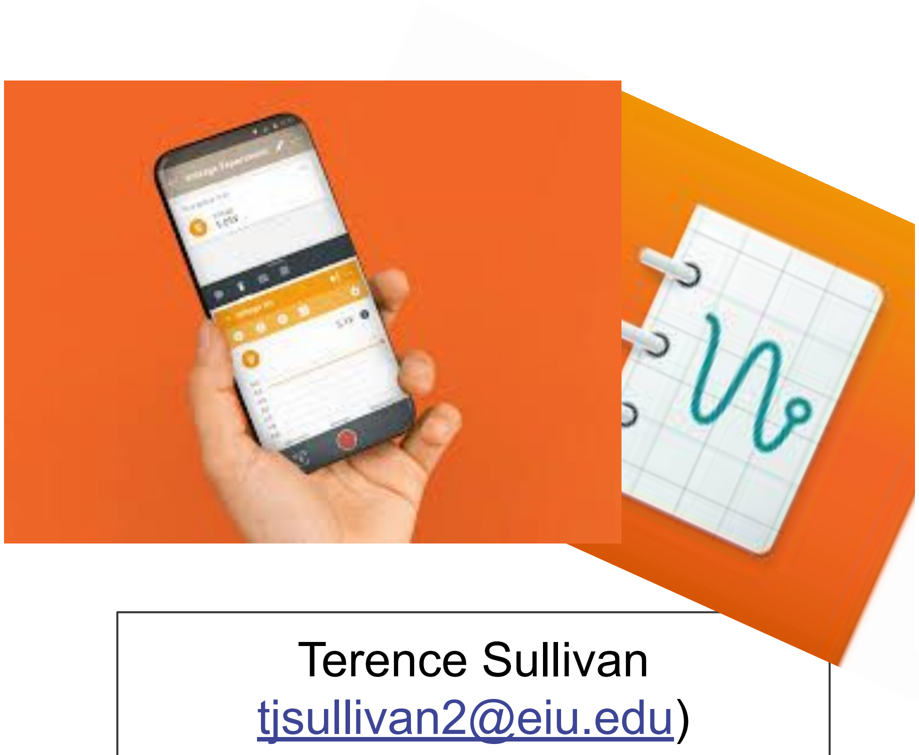
EIU - Rural Schools Initiative
G.Y.O - Grow Your Own Cohorts
Director Dr. Cecil Smith

Monthly Tech PD Sessions

EIU RURAL SCHOOL INITIATIVE

Terence Sullivan

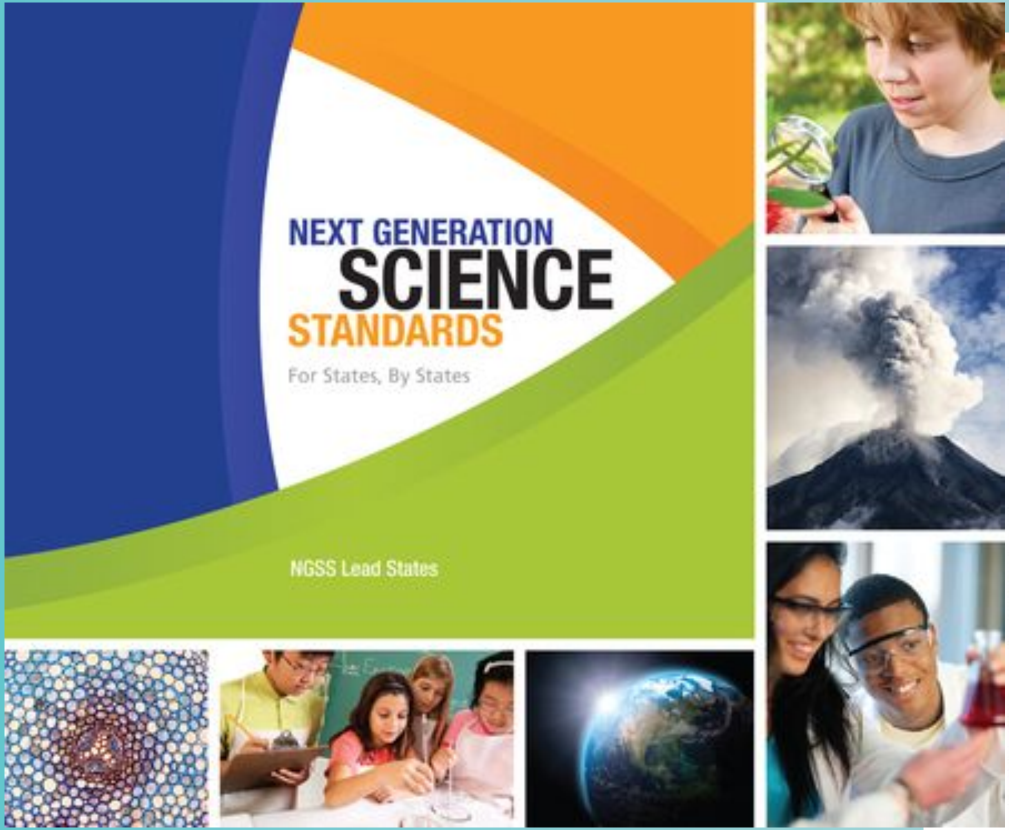
tjsullivan2@eiu.edu
Buzzard 2137

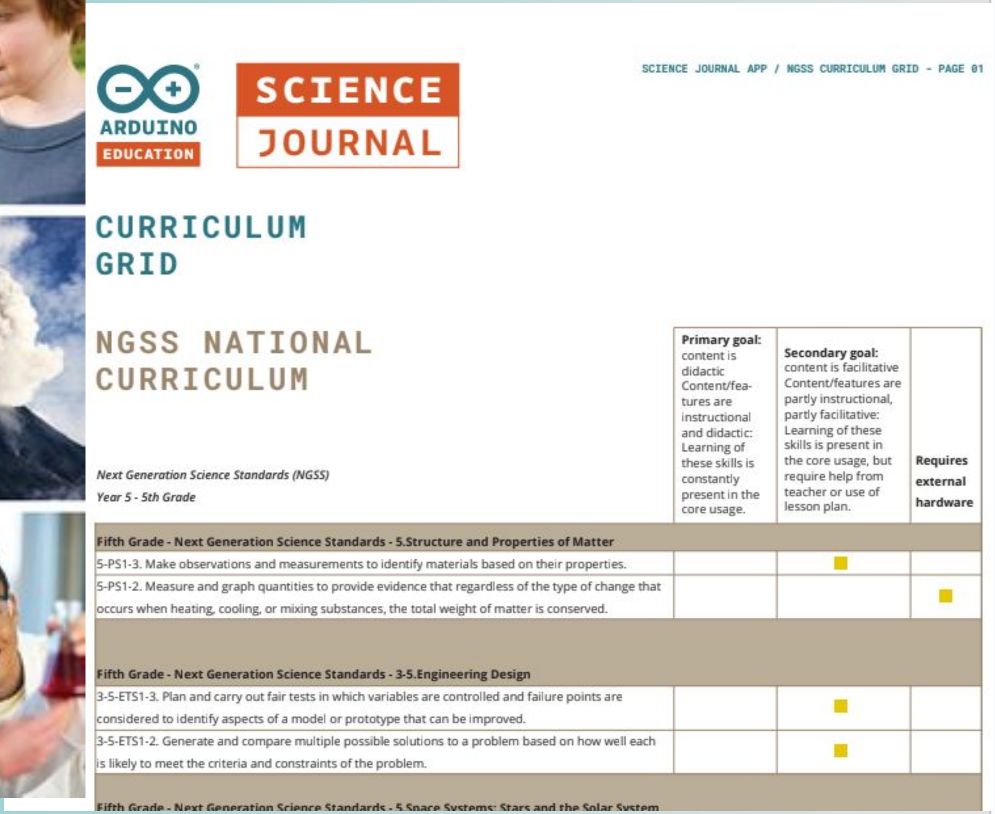


Terence Sullivan
tjsullivan2@eiu.edu)

Slides

Integrating Math and Science Skills





CURRICULUM GRID

NGSS NATIONAL CURRICULUM

Next Generation Science Standards (NGSS) *Year 5 - 5th Grade*	**Primary goal:** content is didactic Content/features are instructional and didactic: Learning of these skills is constantly present in the core usage.	**Secondary goal:** content is facilitative Content/features are partly instructional, partly facilitative: Learning of these skills is present in the core usage, but require help from teacher or use of lesson plan.	**Requires external hardware**
Fifth Grade - Next Generation Science Standards - 5.Structure and Properties of Matter			
5-PS1-3. Make observations and measurements to identify materials based on their properties.		■	
5-PS1-2. Measure and graph quantities to provide evidence that regardless of the type of change that occurs when heating, cooling, or mixing substances, the total weight of matter is conserved.			■
Fifth Grade - Next Generation Science Standards - 3-5.Engineering Design			
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.		■	
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.		■	
Fifth Grade - Next Generation Science Standards - 5.Space Systems: Stars and the Solar System			

https://content.arduino.cc/assets/Science%20Journal_NGSS%20curriculum.pdf

Welcome to Mobile Science Learning!

- Explore how smartphones transform elementary science education
- Discover innovative ways to turn everyday technology into powerful learning tools
- Learn strategies for engaging young scientists through mobile sensor technology
- Establish clear scientific investigation guidelines
- Create data collection teams
- Assign specific roles:
  - Data recorder
  - Sensor manager
  - Research coordinator
- Emphasize accuracy and collaborative learning
- Focus - Exploratory Discovery Learning

Physics Toolbox - Vieyra Software

- Chrystian and Rebecca Vieyra: Innovators in mobile science education
- Founders of free and low-cost data analysis tools for education
- Mission: Empower students through mobile sensor technology

Connected with PhET Simulation - https://phet.colorado.edu/

Rebecca Vieyra

An award from the White House. A fellowship at NASA. A new job helping physics teachers across the U.S. - These are just a few of the recent, remarkable achievements in the young career of Rebecca (Wenning) Vieyra ’07, an Illinois State physics education alumna.

Former high school teacher completed her 11-month Albert Einstein Distinguished Educator Fellowship at NASA. And this summer, she was one of just 108 math and science teachers nationwide to receive the prestigious Presidential Award for Excellence in Mathematics and Science Teaching.

An Illinois State physics education alum, also attended University High School. Vieyra now lives in Washington, D.C., where she works as the first K-12 program manager for the American Association of Physics Teachers (AAPT). She supports activities and programs that AAPT offers to physics teachers around the nation, and works to strengthen AAPT’s positive impact in the K-12 physics teaching community. She also serves as a part time contractor to NASA.

Chrystian Vieyra

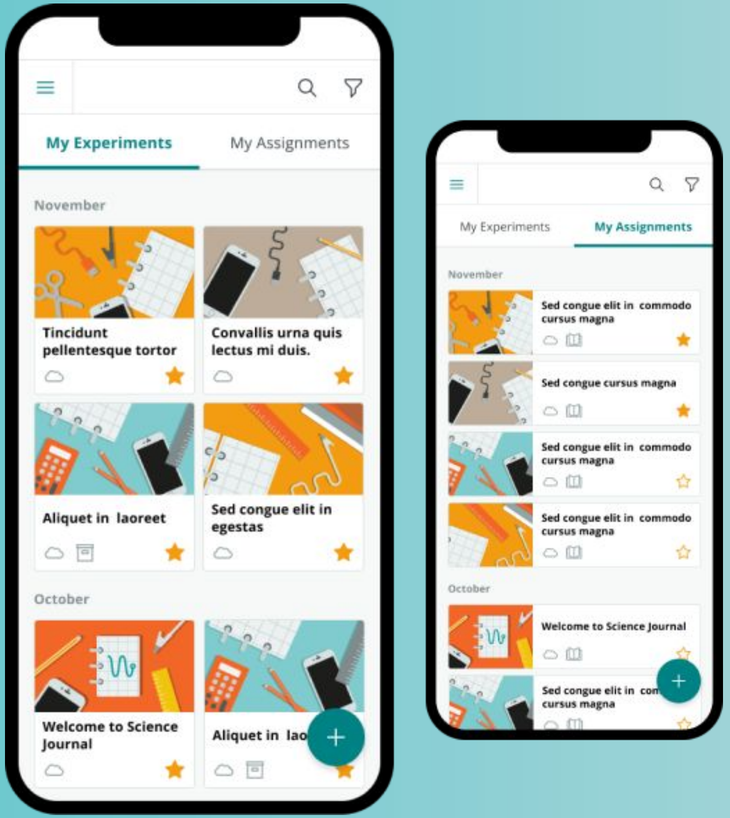
Engineering background - building and scaling mobile applications that impact millions of users. Currently serving as Director of Software Engineering at Thomson Reuters, leading a globally distributed mobile team working in the Reuters mobile app.

- Specialized in mobile infrastructure, performance optimization, and sensor-based applications
- Expert in AR mobile development, with published research in visualization technologies

Born in Celaya, Mexico, he immigrated to complete his B.S. in Computer Science from Western Illinois University.

Thomson Reuters is a global company that provides software, information, and technology to professionals in the legal, tax, accounting, and financial industries. It is also the parent company of the news organization, Reuters, which provides news to media organizations and directly to consumers.

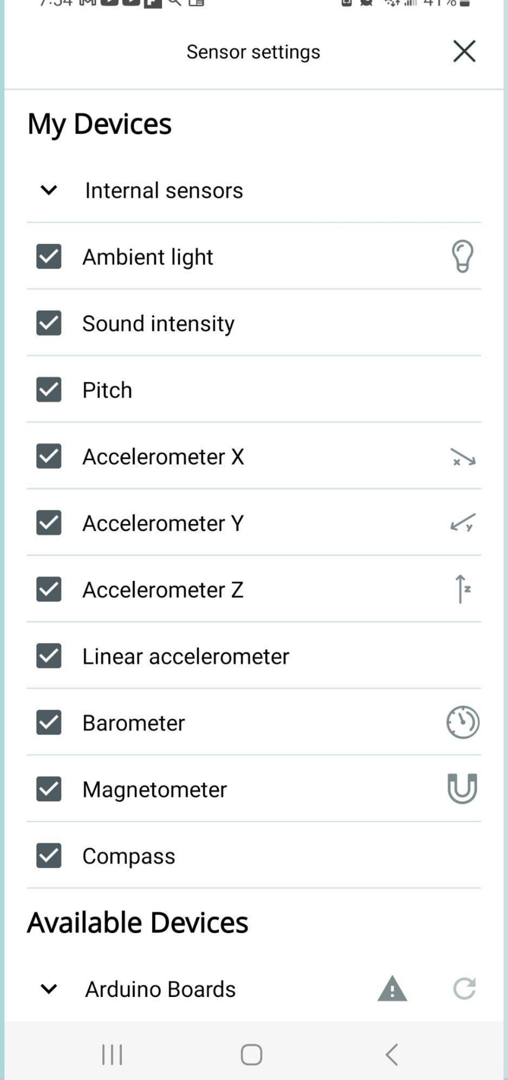
Arduino Science Journal (notebook model)



The Arduino Science Journal originated as the Google Science Journal, launched in 2016 as a project to use smartphones for hands-on science experiments. In August 2020, Google transferred the app to Arduino, which continued to develop it as the Arduino Science Journal. This transition leveraged Arduino's background in open-source educational tools, and the **new version enhances integration with Arduino's hardware and programs**.

Common Sensors

- Open Physics Toolbox.
  - What kinds of sensors does your device have?
  - What kinds of sensors are missing?



Common Sensors

- Accelerometer: Measures the phone's acceleration and helps detect its orientation, like tilt and shake.
- Gyroscope: Measures the device's rotational velocity, providing more precise data on how the phone is twisting and turning.
- Magnetometer (Compass): Detects magnetic fields, allowing the phone to determine its direction relative to the Earth's magnetic North.
- Barometer: Measures atmospheric pressure, which can be used to estimate altitude and improve GPS accuracy.
- Ambient Light Sensor: Adjusts screen brightness based on the surrounding light levels to save power and improve visibility.
- Proximity Sensor: Detects when an object is close to the screen, such as your face, to turn off the display during calls.
- Fingerprint Sensor: Scans and recognizes fingerprints for secure device unlocking and authentication.
- Facial Recognition System: Uses sensors, sometimes including infrared, to scan and recognize your face for unlocking.
- GPS Sensor: Uses the Global Positioning System to determine and track the device's location for navigation and location-based services.
- NFC Sensor: Enables short-range wireless communication for contactless payments and other features.

For example, many devices have:

- an **accelerometer** that measures acceleration forces
- a **magnetometer** that measures magnetization/magnetic fields
- a **light sensor** that measures the strength of light
- a **gyroscope** that measures orientation
- a **hygrometer** that measures moisture in the atmosphere
- a **thermometer** that measures ambient temperature
- a **barometer** that measures atmospheric pressure
- a **proximeter** that detects when something is close

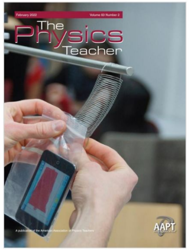
Try to put a series of instruments together like that in your classroom and the price tag will make it next to impossible.

Smartphones in Science - Research Supporting

What does the research say?

- Smartphones are precise & accurate data collection tools.
- Smartphones can support student inquiry:
  - Data is more accessible
  - Replace/supplement commercial probeware
  - Mobile → easy use "in the field."

Volume 60, Issue 2
February 2022



< Previous Article   Next Article >

IPHYSICSLABS | FEBRUARY 01 2022

Experiments with mobile devices — A retrospective on 10 years of iPhysicsLabs

Jochen Kuhn; Patrik Vogt

Check for updates

Phys. Teach. 60, 88–89 (2022)
https://doi.org/10.1119/10.0009416

Split-Screen Views PDF Share Tools

The *TPT* column "iPhysicsLabs," which describes an experiment using mobile devices in each article, has been around for exactly 10 years now. We would like to take this anniversary as an opportunity to take stock and to thank the colleagues without whom the column would not be possible in this form.

Volume 90, Issue 5
May 2022

< Previous Article   Next Article >

RESOURCE LETTERS | MAY 01 2022

Resource Letter MDS-1: Mobile devices and sensors for physics teaching

Martín Monteiro; Arturo C. Martí

Check for updates

+ Author & Article Information
Am. J. Phys. 90, 328–343 (2022)
https://doi.org/10.1119/5.0073317   **Article history**

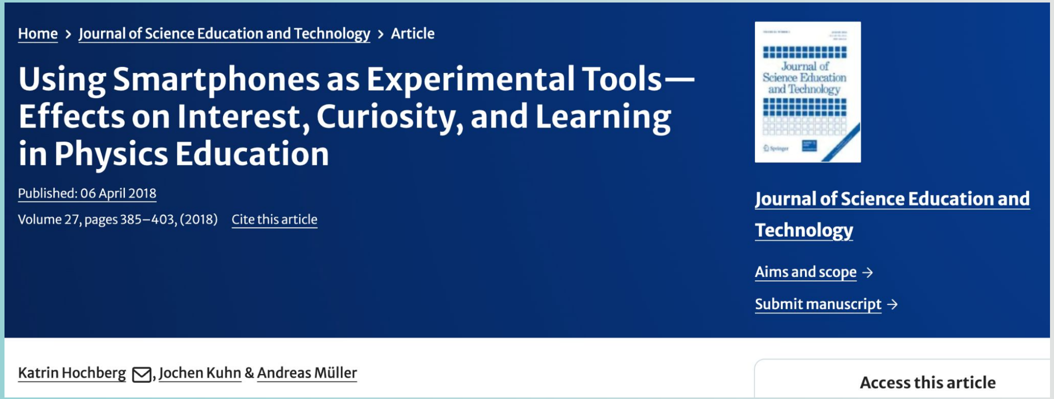
Share Tools

This Resource Letter provides a guide to the literature on teaching experimental physics using sensors in tablets, smartphones, and some specialized devices. After a general discussion of hardware (sensors) and software (apps), we present resources for experiments using mobile-device sensors in many areas of physics education: mechanics, oscillations and waves, optics, electromagnetism, matter, modern physics, and astronomy.

Smartphones in Science

What does the research say?

- Can increase student:
  - **Interest**
  - **Curiosity**
- Limited research on conceptual understanding.
- Some studies demonstrate no major difference when comparing similar methods with or w/o smartphones.

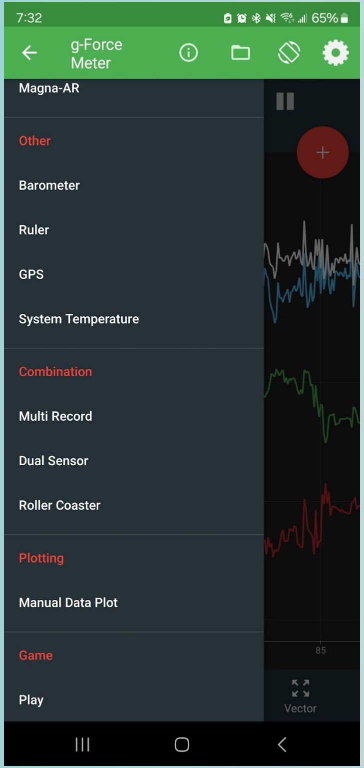


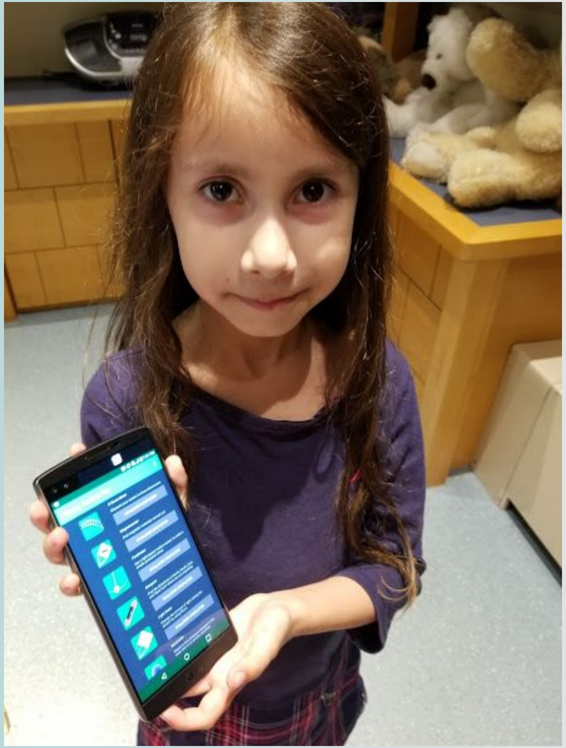
Common Sensors

Play Time!

- Open Physics Toolbox.
  - What kinds of sensors does your device have?
  - What kinds of sensors are missing?

- Menu ⟶ Game ⟶ Play
  - Complete 5+ challenges.



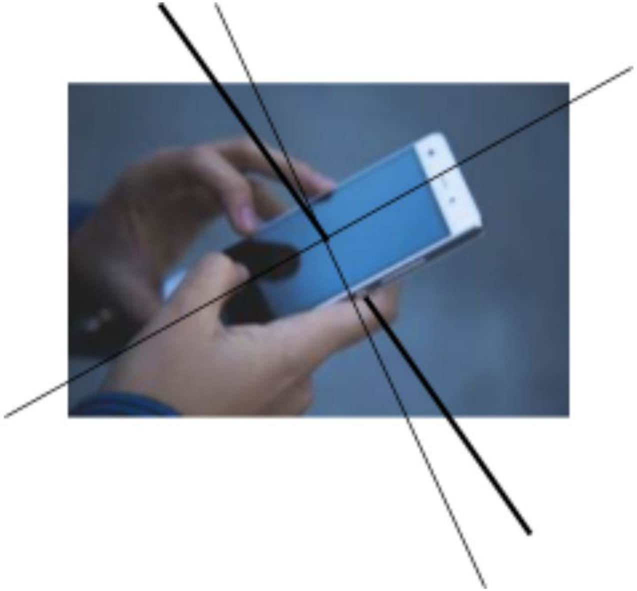


Theme Park - STEM Day

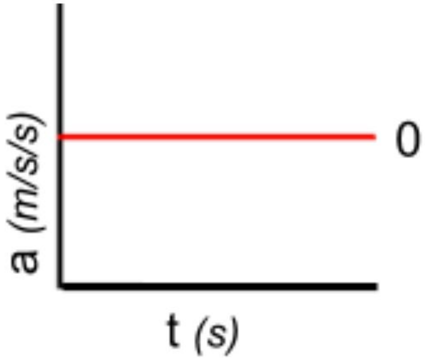
Accelerometer

Free Fall → a_g

1. Mark each axis (x, y, z).



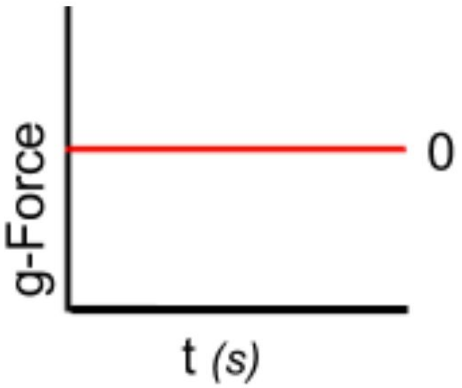
2. How much is the acceleration due to gravity? Explain how you determined it.



Smartphones in Science

Force of a Jump

1. How does the force acting on your body change during a jump?



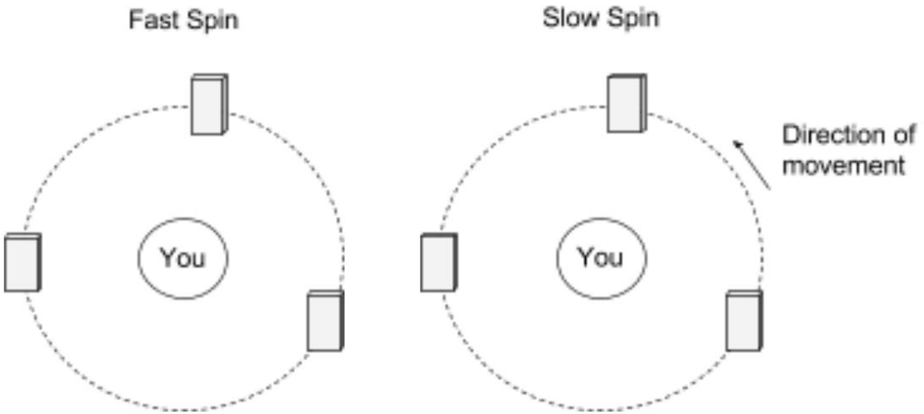
2. Draw force diagrams for each instant during the jump.

Take off (touching ground)	Moving up (in air)
Moving down (in air)	Landing (touching ground)

Centripetal Acceleration

Centripetal Acceleration

1. Which way does the sum of forces point in circular motion?



2. How does this force compare with a fast/slow spin?

3. Draw the forces on the images.

4. Measure your arm. Calculate the tangential velocity of the smartphone during a spin.

5. Weigh the smartphone. Calculate the centripetal force acting on the smartphone during a spin.

Sound Addition - wave superposition

Beats

1. Using two smartphones, generate a tone of 261 Hz and another of 263 Hz. How do they sound?

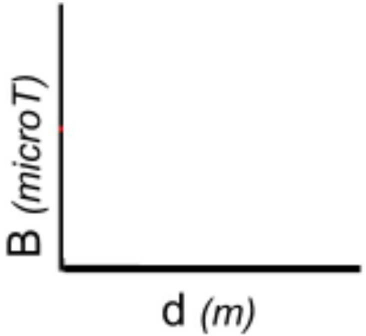
2. Using a third smartphone as an oscilloscope, visualize the combined sound wave produced by the two smartphones. What is happening to the total wave when producing beats?

Magnetic Field

Magnetism / Electromagnetism

1. Using a magnet, look for the location of the magnetic field sensor in the smartphone.

2. What is the relationship between the strength of the magnetic field strength and the distance from the sensor?



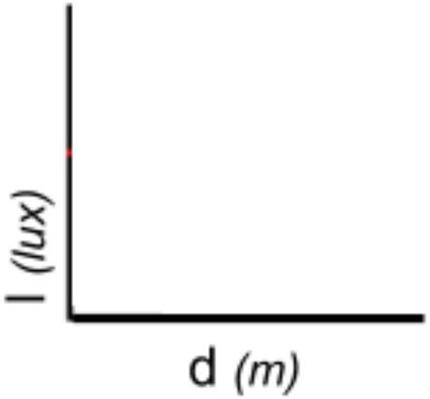
3. What effect does flowing current near a magnetic field sensor have on it?

Light Intensity and Distance

Light Intensity

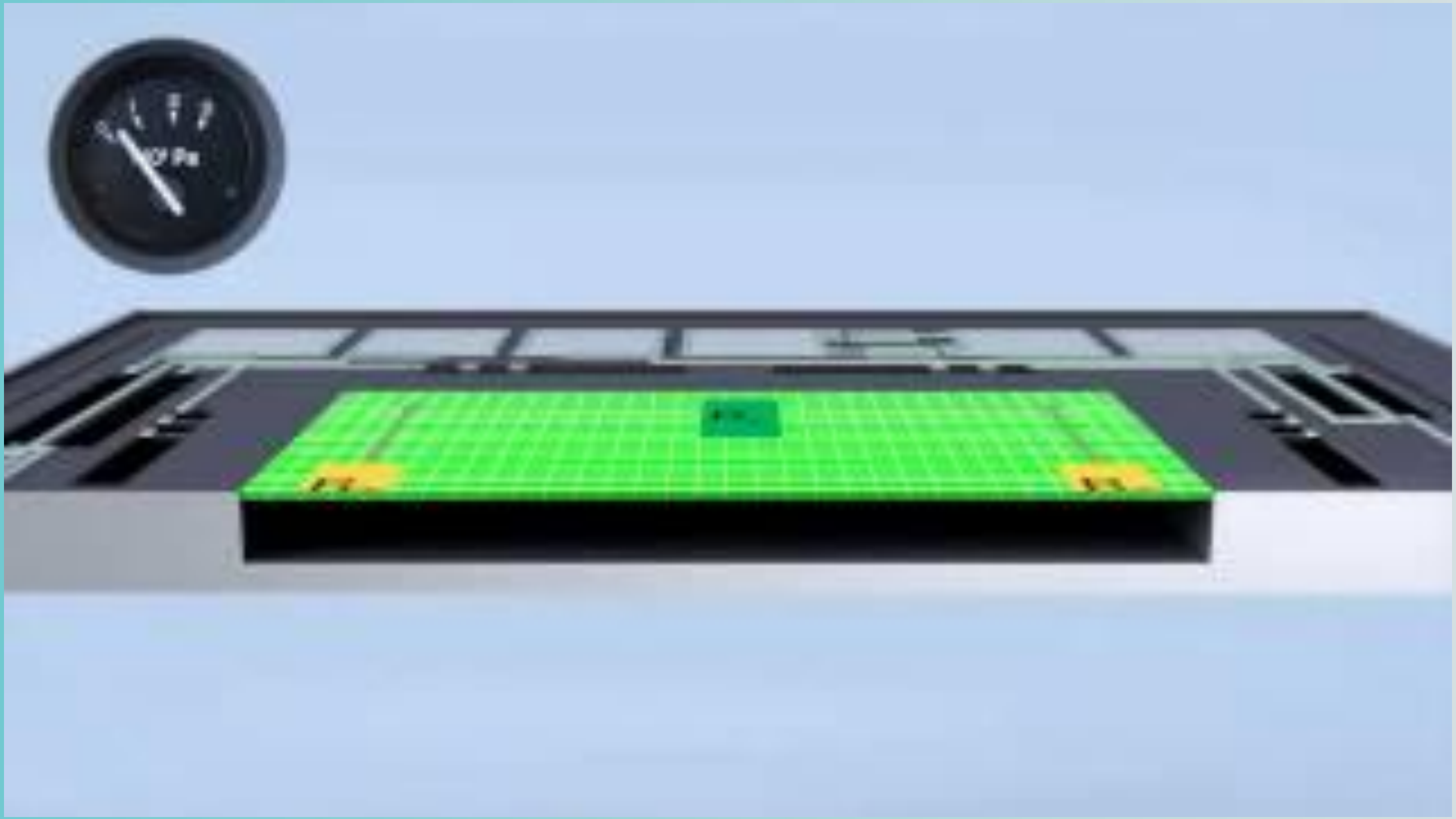
1. Using a small light source (or the flash from a second smartphone), look for the location of the light sensor.

2. What is the relationship between light intensity produced by a light source and its distance from the sensor?



Which Way is Up?

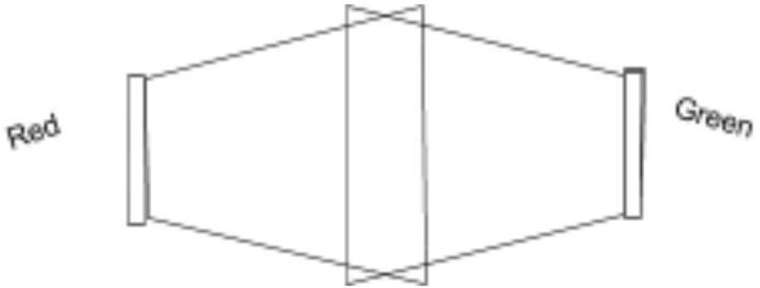
Pressure



Light Addition (v. paint addition)

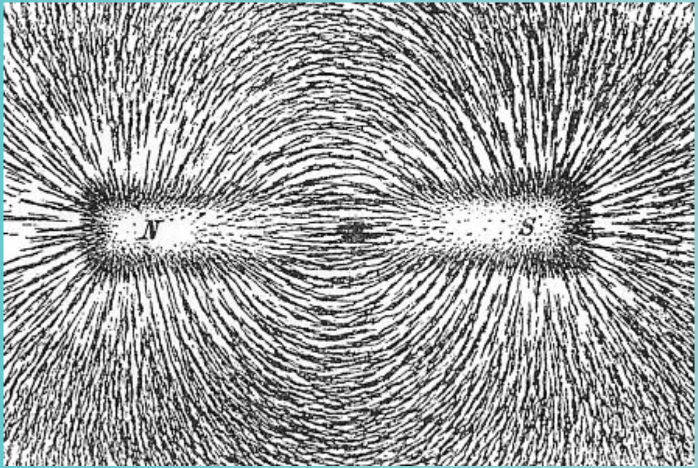
Color by Addition

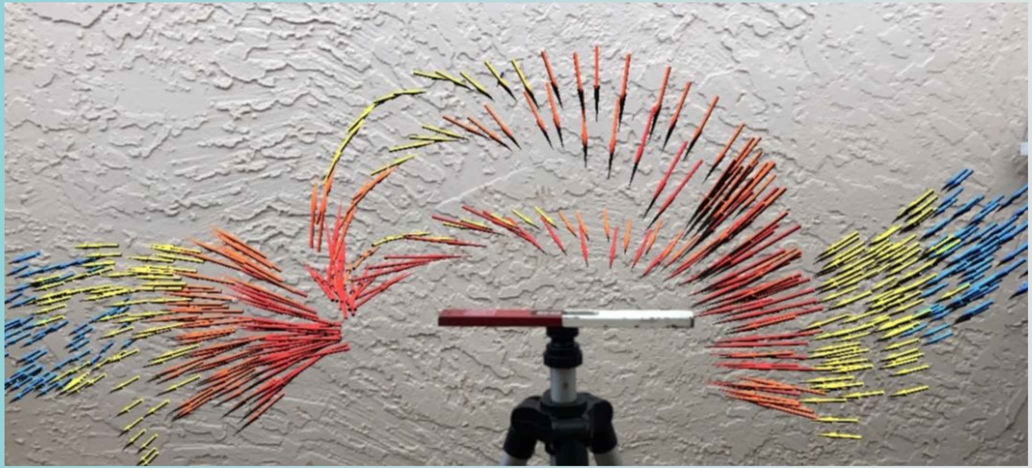
1. What color is produced when mixing red and blue light? Red and green? Blue and green? Blue, green, and red?



Magna AR

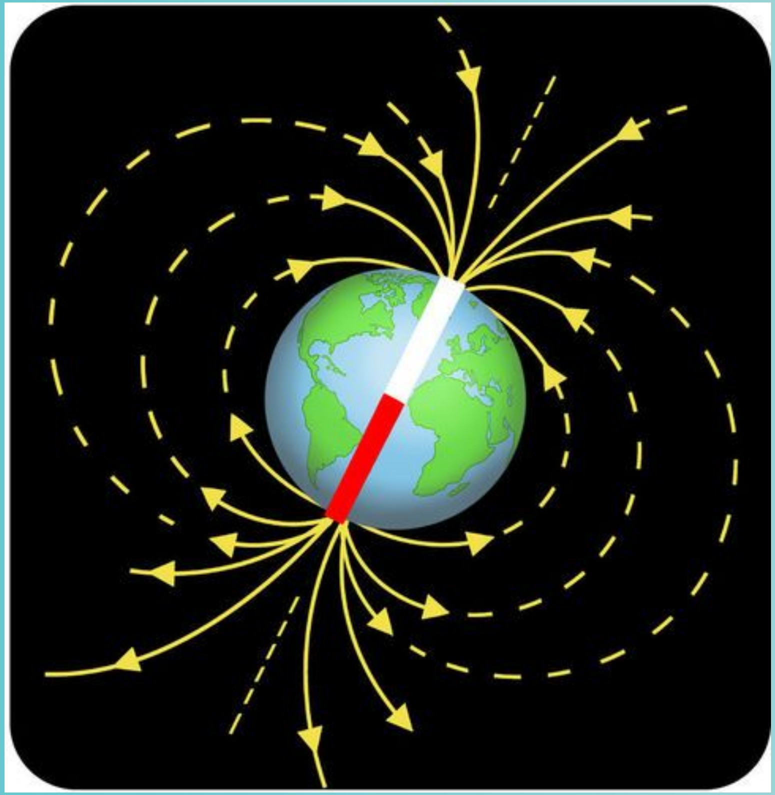
Special Features: Magna AR





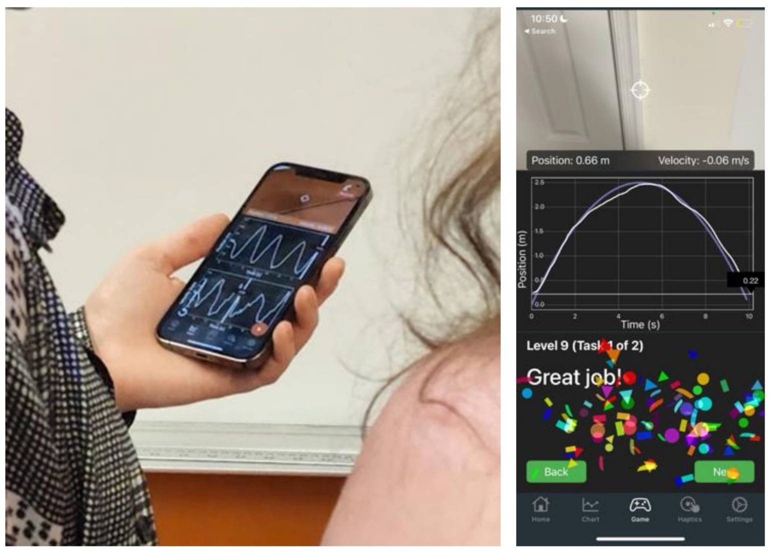
https://www.vieyrasoftware.net/magna-ar-education

Earth’s Magnetic Field



LIDAR (TOF work alike)

Special Features: LiDAR Motion Visualizer



This work is funded by NSF Grant #2114586. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

AMTA Transforming STEM Education

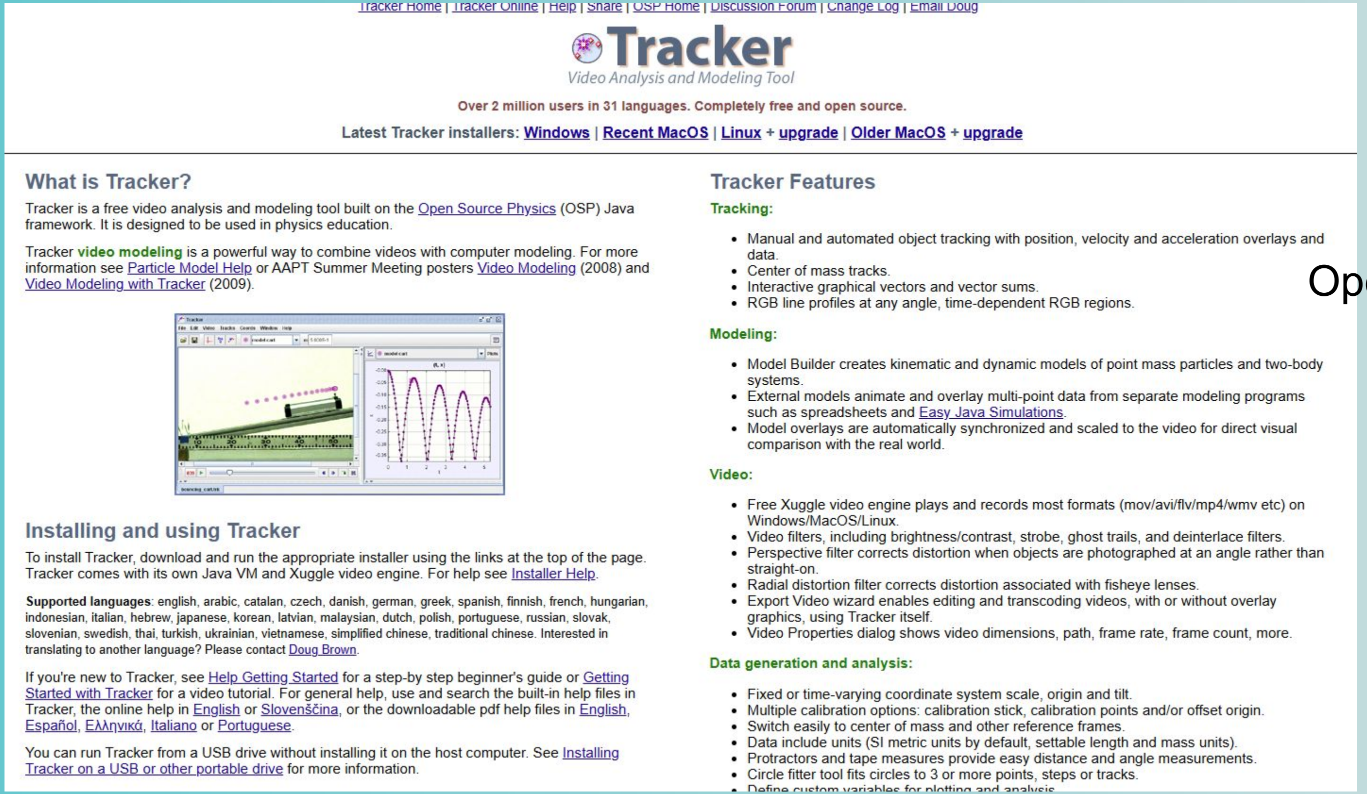
Physics Toolbox Vieyra Software

In collaboration with:
- **Arizona State University**
- **Georgetown University**

NSF

https://www.per-central.org/items/detail.cfm?ID=16587

Tracker - Video Analysis and Modeling Tool


Tracker Home | Tracker Online | Help | Share | OSP Home | Discussion Forum | Change Log | Email Doug

Tracker
Video Analysis and Modeling Tool

Over 2 million users in 31 languages. Completely free and open source.

Latest Tracker installers: **Windows** | **Recent MacOS** | **Linux** + **upgrade** | **Older MacOS** + **upgrade**

What is Tracker?

Tracker is a free video analysis and modeling tool built on the Open Source Physics (OSP) Java framework. It is designed to be used in physics education.

Tracker **video modeling** is a powerful way to combine videos with computer modeling. For more information see Particle Model Help or AAPT Summer Meeting posters Video Modeling (2008) and Video Modeling with Tracker (2009).

Installing and using Tracker

To install Tracker, download and run the appropriate installer using the links at the top of the page. Tracker comes with its own Java VM and Xuggle video engine. For help see Installer Help.

Supported languages: english, arabic, catalan, czech, danish, german, greek, spanish, finnish, french, hungarian, indonesian, italian, hebrew, japanese, korean, latvian, malaysian, dutch, polish, portuguese, russian, slovak, slovenian, swedish, thai, turkish, ukrainian, vietnamese, simplified chinese, traditional chinese. Interested in translating to another language? Please contact Doug Brown.

If you're new to Tracker, see Help Getting Started for a step-by step beginner's guide or Getting Started with Tracker for a video tutorial. For general help, use and search the built-in help files in Tracker, the online help in English or Slovenščina, or the downloadable pdf help files in English, Español, Ελληνικά, Italiano or Portuguese.

You can run Tracker from a USB drive without installing it on the host computer. See Installing Tracker on a USB or other portable drive for more information.

Tracker Features

Tracking:

- Manual and automated object tracking with position, velocity and acceleration overlays and data.
- Center of mass tracks.
- Interactive graphical vectors and vector sums.
- RGB line profiles at any angle, time-dependent RGB regions.

Modeling:

- Model Builder creates kinematic and dynamic models of point mass particles and two-body systems.
- External models animate and overlay multi-point data from separate modeling programs such as spreadsheets and Easy Java Simulations.
- Model overlays are automatically synchronized and scaled to the video for direct visual comparison with the real world.

Video:

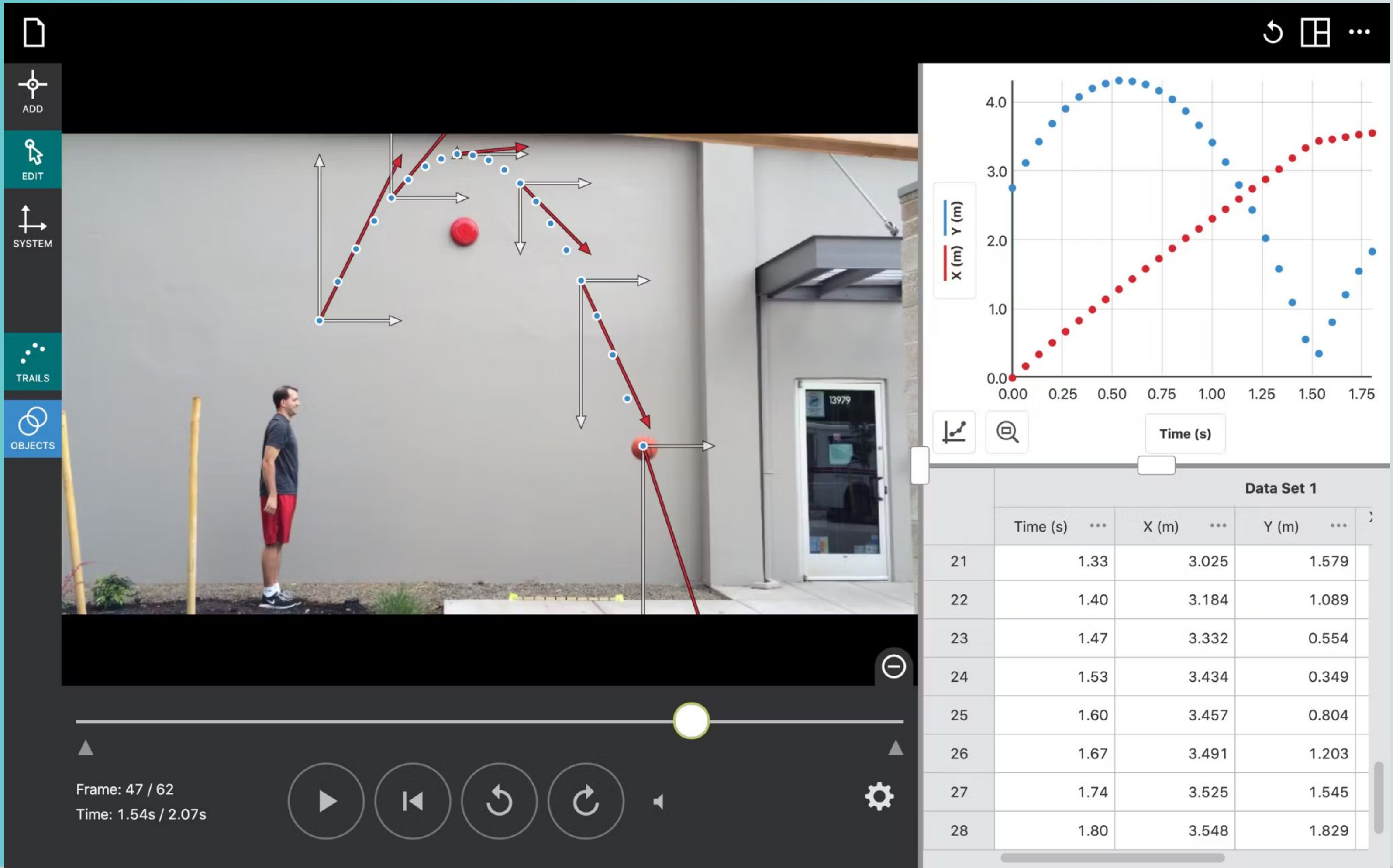
- Free Xuggle video engine plays and records most formats (mov/avi/flv/mp4/wmv etc) on Windows/MacOS/Linux.
- Video filters, including brightness/contrast, strobe, ghost trails, and deinterlace filters.
- Perspective filter corrects distortion when objects are photographed at an angle rather than straight-on.
- Radial distortion filter corrects distortion associated with fisheye lenses.
- Export Video wizard enables editing and transcoding videos, with or without overlay graphics, using Tracker itself.
- Video Properties dialog shows video dimensions, path, frame rate, frame count, more.

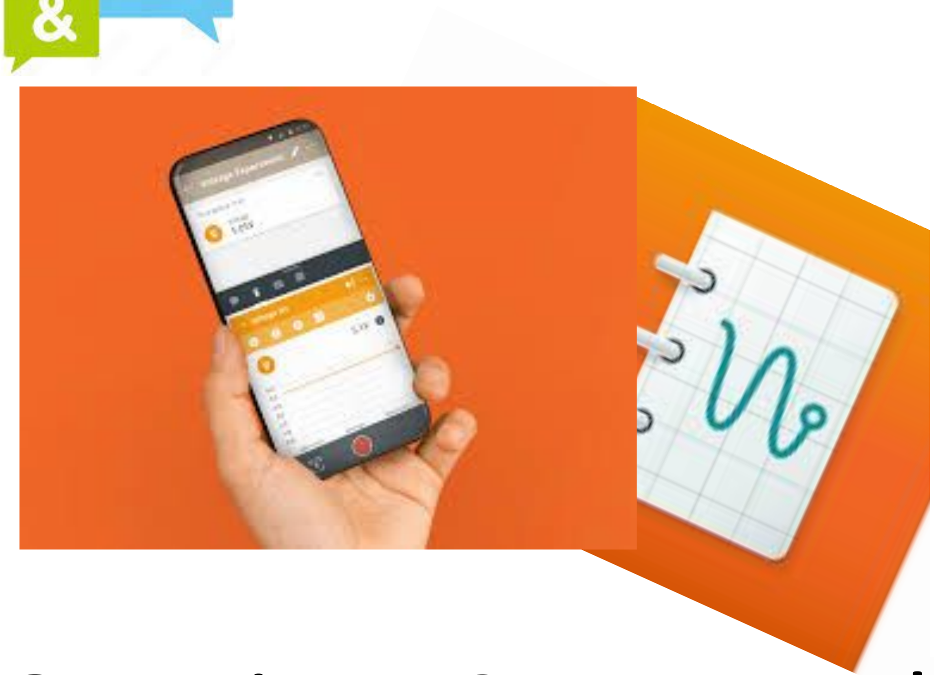
Data generation and analysis:

- Fixed or time-varying coordinate system scale, origin and tilt.
- Multiple calibration options: calibration stick, calibration points and/or offset origin.
- Switch easily to center of mass and other reference frames.
- Data include units (SI metric units by default, settable length and mass units).
- Protractors and tape measures provide easy distance and angle measurements.
- Circle fitter tool fits circles to 3 or more points, steps or tracks.
- Define custom variables for plotting and analysis.

Project of
Open Source Physics

Tracker - Projectile Motion analysis





Questions-Comments!

tsullivan@eiu.edu

Slides

Slides

Questions-Comments!

Terence Sullivan (tsullivan@eiu.edu)