User's Guide

Physics Toolbox Play

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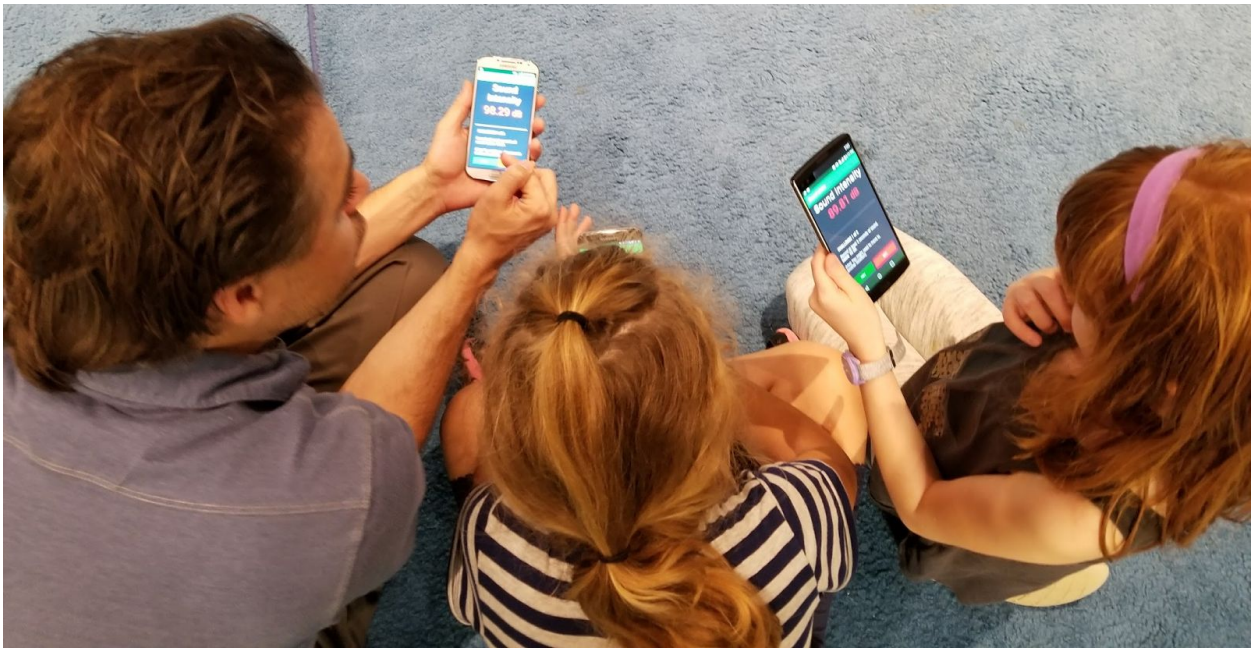
Introduction

Physics Toolbox Play was developed to introduce the public, ages 8+ in family groups, to physics and mobile sensors through educational outreach.

- **If you are a potential educational outreach organizer**, this guide will be helpful to prepare for a successful event.
- **If you are completing challenges**, use this guide for helpful tips by scrolling through specific challenge descriptions.

If you need support, please feel free to contact us at support@vieyrasoftware.net



Plan Your Event

Description

Physics Toolbox Play is a data-verified set of challenges using mobile sensors and minimal resources that may be appropriate for many educational environments, including after-school programs, libraries, community centers, STEM fairs, or even as an introduction to physics and sensors in the formal classroom. Participants who complete all of the challenges will be introduced to multiple sensors, fundamental physics ideas, and STEM careers that use physics.

Age

Physics Toolbox Play was designed for family groups with children as young as 8 years old. It is not recommended for use with children under age 8, or children younger than 14 without an adult. The most successful outreach events often include family groups, allowing children to talk with their parents about physics and potential careers.

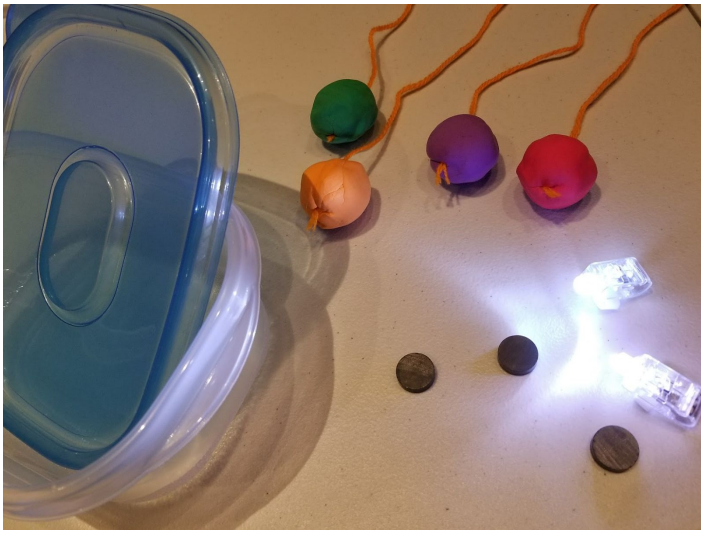
Duration

Completion of the challenges takes between 15-45 minutes for most participants.

Size of Audience

When running an event for the first time, consider limiting the number of active participants at any given time (perhaps to 5 or 10 family groups per organizer), as participants might need to seek support in completing the challenges, and materials might need to be monitored.

Materials



Each participant or group will need an Android device with the Physics Toolbox Play app, freely available from the Google Play store. Some outreach organizers might opt to have a set of mobile devices available to lend to participants. Additional materials that are required include the following:

- Magnets (for the Magnetometer challenge) *Medium-strength refrigerator and small ceramic*

magnets are sufficient. Avoid strong neodymium magnets that could pose a pinch risk to participants.

- Pendula (for the Proximeter challenge) *As small pendula are hard to center directly over the proximeter, consider using a medium-sized ball of clay or Play-Dough on a string.*
- Light Source (for the Light Meter challenge) *Optional - alternatively, encourage participants to collaborate by using the flash bulb on another phone as a light source.*
- Air-Tight Bin or Plastic Bag (for the Barometer challenge)

Safety/Liability

There are minimal hazards associated with this activity. However, warn participants of the risk of damaging their mobile devices, and ask them to avoid any activities that might unintentionally crack or otherwise damage them. Warn participants (especially parents of small children) about the risks associated with the ingestion of magnets, pinching by magnets, or suffocation from plastic bags. Medium-strength, everyday magnets provided by the organizers should not be so strong as to damage the mobile devices.

Incentives

Consider providing a small incentive to participants as a reward for completing some or all of the challenges. The physics challenge within the app are data-verified, ensuring that participants who work independently actually complete each challenge by doing the required tasks. (Successful completion of a challenge can be noted by a coordinator on the home screen, as the challenges “Challenge Complete!” bar will turn from green to gray.)

Run Your Event

Introduce Yourself

Introduce yourself and your role in the outreach experience. Begin the event with a whole-group welcome, and don't forget to share a bit about your own background in physics or STEM, education, etc. Although the app challenges are meant to be accomplished independently or in small groups, make participants aware that you are a resource for completing the challenges successfully.

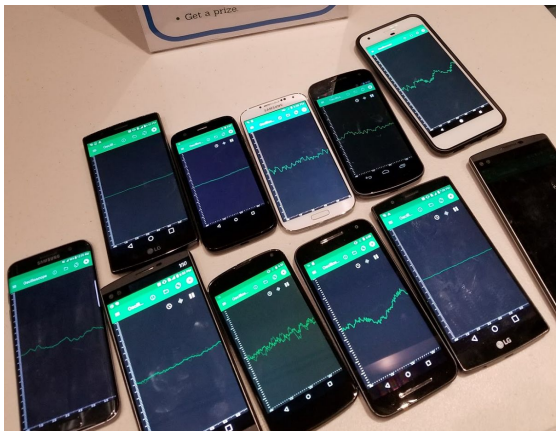
Introduce the Sensors

The following is a potential helpful sequence for introducing participants to the role of physics and sensors in our daily lives:

- Ask participants to explain how we know what is going on around us in our environment (i.e., if it is hot or cold, noisy or quiet, if our clothing is rough or soft, if the air smells sweet, or if the food we are eating is tasty, etc).
- Guide participants to **name the five human senses** (i.e., touch/feeling, sound/hearing, taste, vision/sight, and smell).
    - Other creatures often have other senses, including electrical charge sensed by many aquatic animals, polarization of light (although some humans do have this as well), non-visible light (infrared/heat vision, as well as ultraviolet light), supersonic and subsonic sound, and magnetic fields.
- Help participants to recognize that **sensors are essential for intelligent technology** to sense the world around them, just like living creatures. Encourage participants to think about the variety of sensors that they interact with on a daily basis. Note that not all sensors are electronic! The following are just a few possible examples:
    - Thermostat or thermometer (temperature sensor)
    - Credit card or ID reader (magnetic field sensor)
    - Home security system (often triggered by a magnetic field sensor)
    - Colored stripes on diapers (humidity sensor)
    - Smartphone and tablet sensors
- If appropriate, allow participants some "free play" with sensors on their smartphone. Consider using Physics Toolbox Suite to allow participants to see how **sensors can provide additional information to us**, such as the

Oscilloscope, which allows us to “see” representations of sound waves that we can only hear.

- The purpose of the Physics Toolbox Play challenges are to continue to introduce participants to sensors, physics that can be learned from the sensors, and careers that use physical sensors.



Introduce the Challenges

Introduce participants to the Physics Toolbox Play app and its multiple challenges. If participants are using their own smartphones, direct them to voluntarily download the app from the Google Play store. If participants are being lent smartphones, ensure that the users are responsible and careful with the devices, and that expectations for the return of the smartphones are clear.

During this time:

- Introduce the home screen of the app and explain that the challenges:
    - include three parts: (1) introductory material, (2) one or more challenges, and (3) career connections,
    - can be completed in any order, and
    - might require the use of some materials (made available by the organizer).
- Make participant expectations clear for completing the challenges successfully, and notify them if there are any external incentives (i.e., prizes, for doing so).
- Be aware that participants might not have access to all of the challenges, depending upon the hardware that is present in the smartphone.

Typically, participants do not need significant additional support! Tips for specific challenges can be found in the following section of this guide.

The Challenges

Sound Meter

Hints

- The first time this app is run, the app will ask to have permissions to the sound files. Click “allow.” The app does not record any sound, but must have access to read sound files in order to measure intensity.
- Challenge 1 of 2: A quiet environment is needed for measuring sound intensities below 50 dB. Encourage students to find a quiet place (if appropriate, an empty classroom, restroom, or other space).

G-Force Meter

Hints

- Participants often struggle with reading graphs. Help participants to first correlate the appropriate axis name with each plot line color on the graph, and then to relate the physical dimensions with each plot line.

Magnetometer

Hints

- Participants may find big changes in overall magnetic field strength due to nearby magnetic materials (including other smartphones).

Proximeter

Hints

- Pendulums can be fashioned from a ball of Play-Dough or clay attached to a string that it is up to 0.5 meters in length (to encourage experimentation with pendulum lengths).
- Because it can be difficult to consistently align a pendulum directly over and close to the proximeter, encourage participants to use some kind of support, such as a table ledge or an arm supported against a wall, from which to suspend the pendulum.
- If necessary, participants can oscillate a hand in front of the proximeter to simulate a pendulum.

Compass

Hints

- The current version of the compass is a bit glitchy. Encourage participants to rotate very slowly as they align the compass with the black line.

Light Meter

Hints

- Small “finger lights” are excellent, economical sources of bright light.
- Challenge 2 of 2: If participants are unable to get close to a bright light source already in the room room, encourage them to collaborate and use the camera flash of one smartphone as a light source.

Barometer

Hints

- Clear plastic bags can easily be filled with air and tied off or simple twisted shut to provide the airtight container that can be squeezed to accomplish this challenge.
- Airtight plastic containers large enough for a smartphone offer a very visual way for students to see atmospheric pressure change as they compress the container. However, many plastic containers crack and quickly lose their airtight quality.

Interacting with Participants

As with any educational activity, use good pedagogical strategies to encourage participants to think critically and creatively about the challenges at hand. The following are some specific guidelines from the developers who have used this app in a variety of environments:

- In booth/exhibit-type events, ensure that all participants are aware of the time commitment (15-45 minutes) to complete the challenges.
- Encourage whole family interaction. When younger children are interested in completing the challenges, ensure commitment from parents as active co-learners.
- Carefully monitor materials to ensure that they are returned, and provide clear limits to those who might be borrowing smartphones.
- Provide appropriate modifications to those who might be experiencing problems completing the challenges. (i.e., require the completion of fewer challenges depending upon the age of the participants or the limitations of the smartphone).
- Watch for “physics aversion” that is often prevalent among those who either are unfamiliar with physics or who have had prior negative experiences with physics. Encourage them to see physics in a new, positive light, and assure them that they can do physics!

Conclude Your Event

At the end of your event:

- Congratulate your participants on completing the Physics Toolbox Play challenges.
- Encourage them to visit the links at “Learn More” tab within the app to learn more about:
    - Sensors and physics at the Vieyra Software website:
        - Sensors
        - Lesson Ideas for Science Teachers and At-Home Experiments
    - Careers at American Physical Society and American Institute of Physics webpages:
        - Physicist Profiles (APS)
        - Careers Toolbox (AIP)