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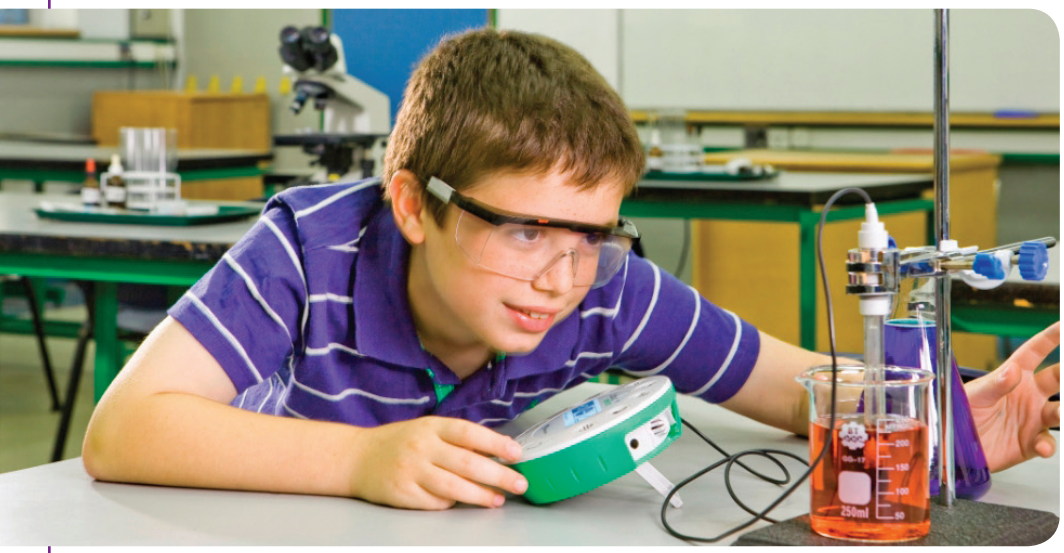
Labdisc K–12 Science Solution



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What K-12 Science Students Learn

Manual science experiments

Most K-12 students perform science by recording data manually—a very different thing from experiencing science hands-on. Take chemistry for example, where litmus paper changes color when immersed in acidic or basic liquids. The paper must be removed immediately, kept in good conditions, and the color scale read accurately. Any number of mistakes can be made, ruining the outcome of the experiment.

When studying Newton's laws of motion, students are tasked with calculating complex concepts such as velocity and acceleration. Yet, students often only have a marble, stopwatch, measuring tape, and graph paper to reach a solution. It's the same story when studying a pendulum, where the sophisticated concept behind the experiment shows how the earth completes one rotation a day, proving the mass of the Earth and acceleration due to gravity. However, by the time students have repeatedly collected and recorded data manually, there's not much of the 45-minute lesson left to understand the real science behind the experiment.

Above, we've described some typical experiments where data can be collected manually. But what about all the exciting science concepts that can only be explored with digital data collection, such as recording a sound wave or a transient response in an electrical circuit? These experiments are beyond the reach of most K-12 school science experiments, simply because in order to measure such fast-changing phenomena, students would need to collect thousands of samples per second. Equally, very slow-acting phenomena which require data collection over an extended period of time are not feasible for manual data collection. A typical example of this would be changes in temperature, humidity, light, and sound over a 24- or 48-hour period.

Students find collecting data manually boring

The challenge for teachers to engage science students goes beyond the limitations of which activities they can explore. Teachers must consider the inconvenient, time-consuming, and tedious experiment processes, as well as the disorganized methods for a typical class of 30+ students—not to mention how inaccurate and imprecise experiment results often are.

The biggest problem is that K-12 science students are bored and convinced that science has no relevance in their lives.

Many schools find that time and budget limitations have focused education on a narrower set of learning outcomes, and as a result, most children are dropping out science and math. Research shows the number one reason students drop out is because they're bored. The Bill and Melinda Gates Foundation's study supported this, and showed students feel these classes are not relevant to their lives or career aspirations.

The fact is, these same students are very technologically savvy, which can be used to science and math learning's advantage, helping to cultivate in students the desire to learn. Hand-held technology tools help science students make real-world connections so they understand how science and math concepts are relevant to their lives and futures.

Data Logging Technology Revolution

Twenty-five years ago, data logging technology began to enter school systems, offering educators ways to make science experiments easier and cheaper to perform. Today, data loggers and sensors are highly featured and able to take thousands of measurements per second—critical in performing simple or complex experiments within the parameters of a 45-minute science lesson. Data logging technology has made a huge contribution to science education, saving students from the tedious and time-consuming tasks involved in manual data collection. Instead, science educators have been able to focus on the two elements which hold the greatest pedagogic value for any science activity: experiment design and data analysis.

However, time constraints have limited how widely data loggers are used by school science teachers. Typically one data logger is used by a pair of students and connects to two sensors, with two sensor cables and one communication cable to each pair's computer. So, a typical class uses 15 data loggers with 30 sensors and 45 cables.

On average, it takes teachers 1.5 hours to test, calibrate, and position a total of 90 items before every lab lesson, then collect and put everything away afterwards.

Rejecting hands-on teaching practices

The pressure of standardized governmental tests, together with technology setup and maintenance, means they don't have time to use data loggers. That's assuming the teacher even feels confident enough to use complicated technology successfully in the classroom. These factors all contribute to perfectly good teaching tools wasting away in lab closets, far from the hands of science students.

In today's science learning environment, the critical features in data logging are immediacy, connectivity, and ease of use.

Labdisc: It's Time for Something New!

Boxlight has listened to educator needs with the Labdisc, applying the latest 21st century technology to resolve the limitations of current data logging solutions for K-12 students, right up to university-level science. Five models, with up to 15 built-in sensors, enable science investigation in various fields including environmental science, physics, biology, and chemistry.

Boxlight has packed a complete laboratory into a single small disc.

The Labdisc replaces a big box of more than 20 individual items—data loggers, sensors, sensor cables, and communication cables—with a single device. Since all built-in sensors are automatically tested and calibrated, the Labdisc saves teachers hours of setup and calibration time every week.

The Labdisc is a truly "plug and play" solution as it:

- Delivers a complete lab on a disc with up to 15 built-in sensors
- Offers very high accuracy, high sampling resolution, and fast recording—essential for K-12 science studies
- Saves teachers lab setup time, requiring only 15 Labdisc units to be handed out
- Ensures lessons run smoothly and calmly as teachers don't need to manage between 60 and 100 different items on the lab table
- Saves precious school resources being wasted on multiple small items (like sensors and cables), which inevitably get mislaid and lost during the lab learning session

Configurations for Every Science

The Labdisc K-12 line includes **5 unique models** dedicated to the broadest range of school science, with 7 to 15 built-in sensor configurations.

Labdisc for elementary school science

Built-in sensors include:
Ambient Temperature, Distance (motion), External Temperature, GPS, Heart Rate, Light, Microphone (sound level)

- Typical activities include: Temperature around us, day and night temperature, microclimate, distance, speed and time, and heart rate before and after exercise.

Labdisc for environmental studies

Built-in sensors include:
Ambient Temperature, Barometer, Colorimeter, Dissolved Oxygen, External Temperature, GPS, IR Temperature, pH, Relative Humidity, Sound Level, Turbidity, Universal Input, UV

- Typical activities include: Temperature/light over 24 hours, acid rain, turbidity, water quality, temperature/RH in urban areas using GPS, altitude and air pressure, heat absorption, and cloud warming effects.

Labdisc for general science

Built-in sensors include:
Air Pressure, Ambient Temperature, Current, Distance (Motion), External Temperature, GPS, Light, Microphone, pH, Relative Humidity, Sound, Universal Input, Voltage

- Typical activities include: Traveling speed with GPS, Newton's Laws, sound waves, electrical currents, pH titration, endothermic and exothermic reactions, Boyle's Law, specific heat, and microclimate.

Labdisc for biochemistry, biology, and chemistry

Built-in sensors include:
Air Pressure, Ambient Temperature, Barometric Pressure, Colorimeter, Conductivity, Dissolved Oxygen, External Temperature, GPS, Heart Rate, Light, pH, Relative Humidity, Thermocouple, Turbidity, Universal Input

- Typical activities include: Skin temperature; pulse rates before and after activity; sweat production and photosynthesis; solid, liquid, and gas phase changes; and pH titration.

Labdisc for physics

Built-in sensors include:
Accelerometer, Air Pressure, Ambient Temperature, Current, Distance (Motion), External Temperature, Light, Microphone, Universal Input, Voltage

- Typical activities include: Lenz's and Boyle's laws, resistor networks, light source efficiency, light vs. distance, sound beat and wave superposition, Newton's Second Law, and free-fall acceleration.

Labdisc Features and Benefits

All-in-one disc

Teachers' preparation time for lab work is dramatically reduced, no longer having to deal with cables and sensors. Preparing for class couldn't be more convenient.

BEFORE
90 DIFFERENT ITEMS (15 LOGGERS + 30 SENSORS + 45 CABLES)

NOW
ONLY 15 LABDISCS

Wireless

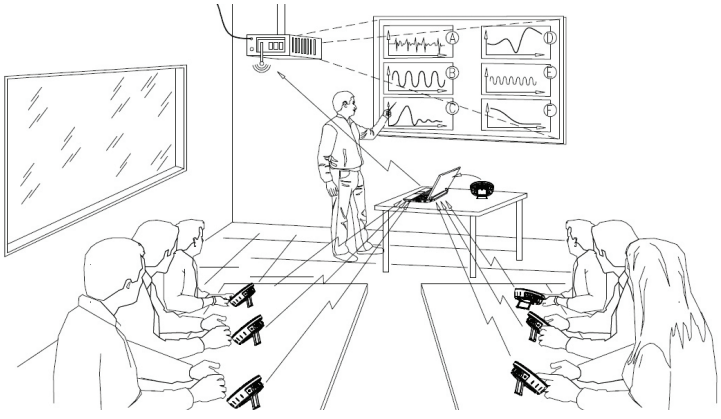
The hand-sized Labdisc data logger is a single, cable-free device that acts as a complete lab with up to 15 built-in wireless sensors. Bluetooth wireless communication fully integrates with all key school technologies and appliances. Connecting to computers, netbooks, interactive white boards, and tablets, the system delivers increased mobility in a cable-free lab environment.

Technology consolidation

For schools with interactive board technology already a part of the classroom, up to 8 Labdiscs—measuring real scientific reactions—can wirelessly communicate with class interactive boards via a single teacher's computer. This opens the door to collaboration, hands-on, and inquiry-based learning, while saving the cost of many computers.

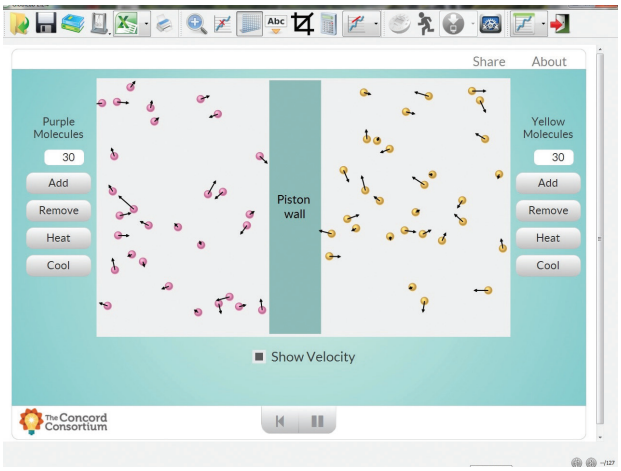
High-resolution accurate data recordings

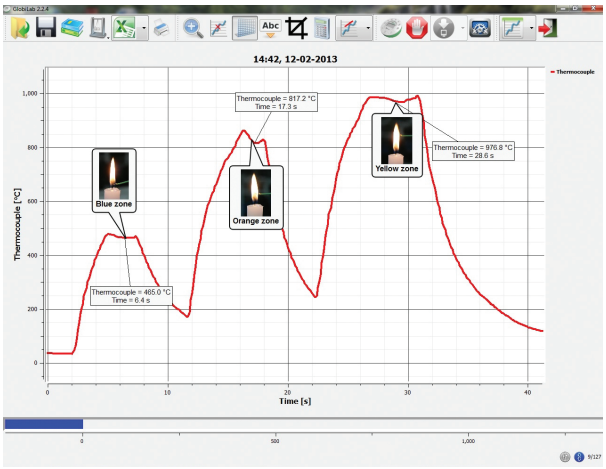
Measuring data at a very high resolution of 12-bit enables a wealth of experiment experience previously unavailable to students. K-12 students can digitally perform classic experiments in sound waves, electricity, mechanics collisions, and more. The Labdisc also has high sensor accuracy at ±2% on most sensors, many of them digital, which are much more accurate than analog.

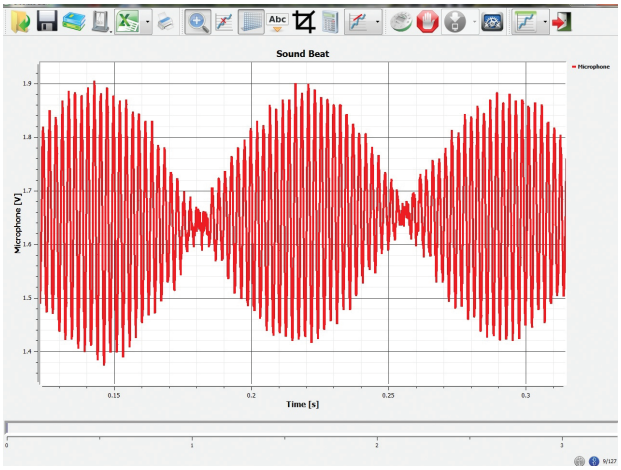


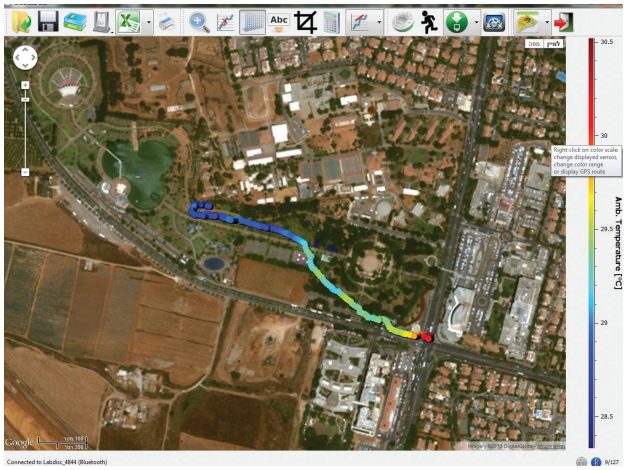
Unique analysis software

The Labdisc data analysis software carries all standard features, including multiple displays, Labdisc setup, functions for mathematic manipulations, and export to spreadsheets, as well as some unique features such as integration with Google Maps, markers, data annotation tools, and sophisticated data analysis features. Using the software simulation module, students can compare mathematical simulation to real measurements done by the Labdisc sensors.









Broadening the Labdisc Offering

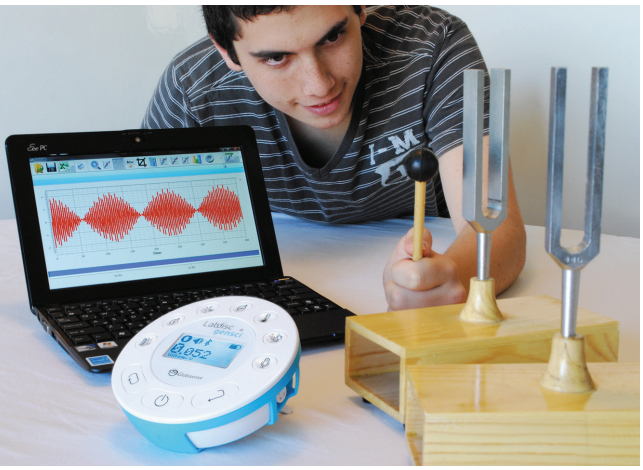
Boxlight strongly believes in delivering an all-in-one wireless science laboratory. However, some key sensors require large casing, and to maintain the compact and portable nature of the Labdisc, they cannot be included in the Labdisc housing. As a result, Boxlight has completed the Labdisc built-in sensor range with some carefully selected external sensors to broaden the range of possible experiments for inquiry-based learning. Among the new and high-accuracy, quality sensors are: Force, Magnetic Field, Respiration, CO2, Voltage, and Heart Rate.

Force is one of the key sensors required for experiments in physics. For many sensors, wireless communication is an important feature for enabling mobility. However, for a Force and Acceleration sensor, wireless is a must—it allows students to connect to moving objects without the need to connect a cable to the sensor, which can interfere with the object's motion.

By incorporating the Force sensor as a stand-alone unit, wirelessly sending data measurements directly to the GlobiLab software, Boxlight has made a world of experiments possible in mechanics and physics. The sensor measures force at a range of ±50N, 3-axis acceleration at a range of ±8g, and has a sampling rate fixed at 500 samples per second. Whether exploring simple harmonic motion, friction, collision, impact and momentum, or centripetal force, students can easily attach the unit to portable lab trolleys and dynamic carts.

The additional external sensors ensure any curriculum requirement can be satisfied by combining the Labdisc models with a wireless external sensor. It also maintains the unmatchable Boxlight price point per sensor. The Labdisc automatically identifies external sensors, displaying data measurements in the relevant sensor units both on the LCD display and in the GlobiLab data analysis software.

Experiment Materials and Kits



As a single multi-meter device, the Labdisc replaces all traditional meters and sensors in the lab. Yet, the Labdisc does not replace experiment materials and accessories such as glassware, chemicals, tuning forks, weights, etc.

As part of the Boxlight mission to provide complete science solutions to schools, a series of science kits have been created. These kits contain all the experiment materials needed to cover the K-12 science curriculums. Using our experiment cookbooks, students are able to conduct experiments, connect the Labdisc to the experiment materials, and measure parameters such as temperature, air pressure, speed, light level, and sound waves, to name just a few.

Physics Science Kit

Includes all below materials for 1 to 2 students covering electricity, waves, magnetism, and Newton mechanics.

- Set of two tuning forks with wooden resonance box
- Electricity board with: 0.47 uF,100 uF, 1000 uF capacitors, 100 Ω, 1000 Ω, 10,000 Ω resistors, diode, SPST switch
- Set of 6 x 10 cm black banana cables
- Set of 6 x 10 cm red banana cables
- 3 x 1.5 V, D type battery holder
- Electric coil with 1600 turns and max current of 100 mA.
- Equipped with 2 banana sockets
- Air core solenoid has an inner diameter > 3 cm and a length of 15 cm, equipped with 2 banana sockets
- Bar magnet length 100 mm
- Set of 3 metal springs with springs ranging from 4 N/m to 14 N/m
- 10 x 1 N slotted mass set
- Ping pong ball
- Rectangle lab stand with aluminum rod 12 mm diameter x 500 mm length
- Aluminum rod 12 mm diameter x 200 mm length
- Right angle holder clamp
- 2 x 60 mL syringe with luer lock

PH-KIT-GENERAL

Chemistry and Biology Science Kit

BC-KIT-GENERAL

Includes all glassware and non-consumables for 1 student or a team of 2 students to perform high school chemistry and biology experiments.

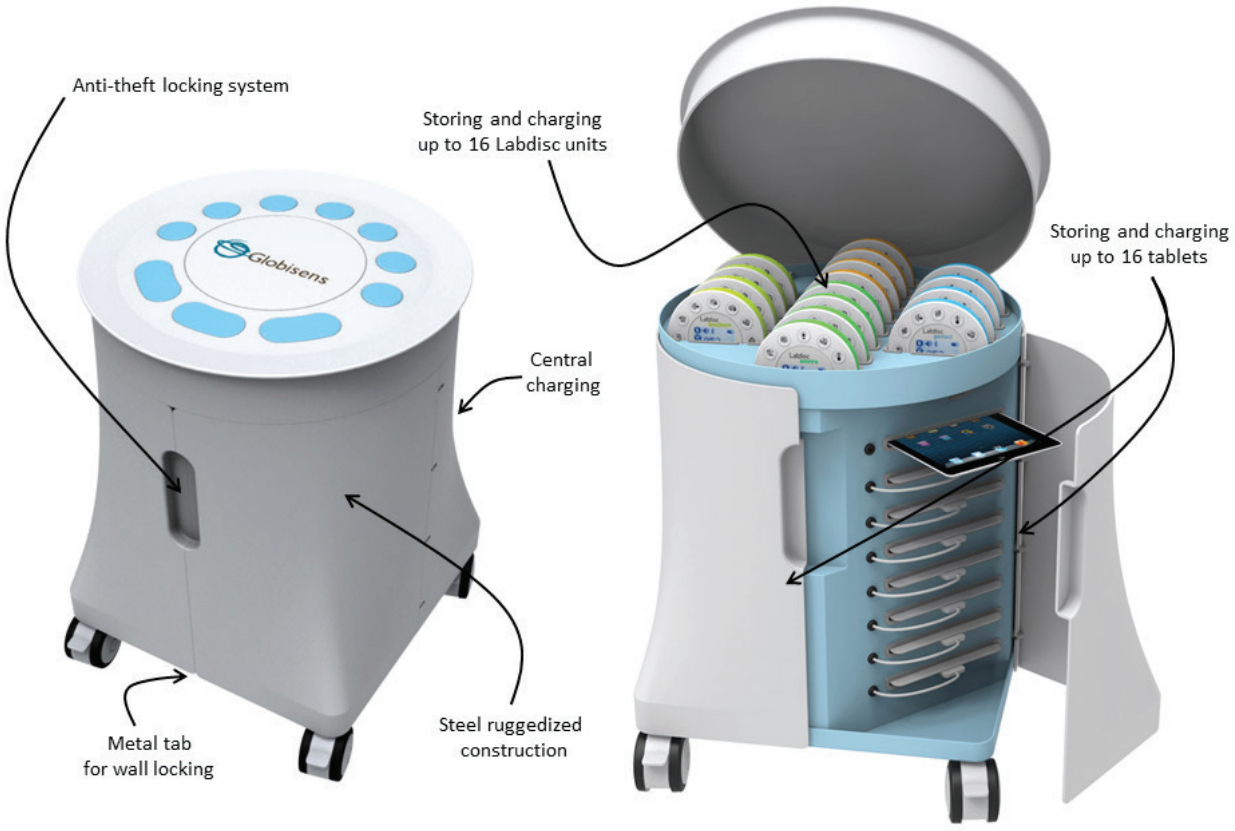
- Beakers (10 mL & 30 mL & 150 mL)
- Erlenmeyer flasks (10 mL & 25 mL)
- Hirsch funnel
- Filter flasks (25 mL)
- Test tubes (6 x 50 mm)
- Wintrobe tube
- Wire mesh with ceramic center
- Pipette, with tips
- Volumetric flasks (10 mL & 25 mL), with stopper
- Funnel
- Watch glass
- Rubber tubing
- Pipette bulb
- Periodic chart
- 2 x 60 mL syringe with luer lock
- Test tube holder (clear Perspex)
- Pack of straws
- Alcohol burner, 3.5 oz/100 mL (P/N
- Tripod, burner, 15 cm x 9 cm x 4 cm (P/N 6346800)
- Candles & matches

A Complete Mobile and Modern Science Laboratory

Boxlight has expanded the concept of a condensed wireless science laboratory to introduce the Science Mobile Cart, bringing science to K-12 students wherever they are in school.

Now schools can develop ICT skills and bring real inquiry-led experimentation to students, delivering a complete, consolidated, and clean digital science learning environment to every class throughout the school.

The mobile cart solves the limitations on science learning in school. Teachers no longer need to be dependent on mobilizing students to congested and cluttered science labs outfitted with thousands of dollars worth of equipment. Storing and charging up to 16 Labdiscs and 16 tablets, this mobile laboratory delivers digital inquiry-based science to every class.



Appendix 1: K-12 Science Experiment Table

SUBJECT	FIELD	LESSON HOURS	GRADE LEVEL	LABDISC	SENSORS
"Light Intensity" Measuring and comparing the luminosity of a candle, a flashlight, and natural daylight.	Physics	2	Middle School	Physio, Gensci	Light
"Day and Night" Recording the variations of temperature and light during a period of 24 hours to establish relations between them.	Environment/ Biology	2	Elementary/ Middle School	Gensci, BioChem, Physio, Primo	Light, Temperature
"What Do We Drink?" Measuring the pH of different soft drinks.	Chemistry	2	Middle School	Gensci, BioChem, Enviro	pH
"Water Bodies" Measuring temperature and humidity near rivers or other water bodies to determine their effect on temperature and humidity.	Environment/ Biology	5	Middle School	Enviro, Gensci, BioChem	Temperature, Humidity
"How Loud is Sound" Measuring the decay of sound level over distance.	Environment/ Physics	2	Elementary	Gensci, Physio, Primo	Microphone
"Walk in the Park" Measuring temperature changes at a busy city junction and in a nearby park or garden.	Environment	2	Elementary	Gensci, Primo, Enviro	Temperature, GPS
"Traveling Speed" Using the GPS sensor to measure walking speed, running speed, and/or biking speed —a great activity for creating a contest between students.	Physics	5	Middle School	Gensci, Enviro, BioChem	GPS

SUBJECT	FIELD	LESSON HOURS	GRADE LEVEL	LABDISC	SENSORS
"Our Heart Rate" Measuring the heart rate before and after exercise and recording useful information to determine physiological parameters.	Biology	2	Middle School	BioChem (or Gensci with external Heart Rate)	Pulse
"The Laws of Motion" Determining the relationship between speed, time, and distance as part of understanding Newton's mechanic principles.	Physics	2	Middle School	Gensci, Physics	Distance
"Altitude and Air Pressure" Using the Barometer and GPS sensors to travel from high to low places, measure the change in air pressure and altitude.	Environment	5	Middle School	Enviro	GPS, Barometer
"What is Distance" Examine the relationship between speed, time, and distance. Explore graphs of distance versus time.	Physics	2	Elementary	Primo, Gensci, Physio	Distance
"The Temperature Around Us" Recording the temperature of different substances.	Physics	2	Elementary	All	Temperature
"Absorption of Heat" Measuring and comparing the internal temperatures of different colored containers full of water after being exposed to sunlight.	Physics	2	Middle School	All	Temperature
"Lenz's Law" The connection between electric and magnetic fields.	Physics	2	High School	Physio, Gensci	Voltage
"The Principle of Resistor Networks" Measuring the current and voltage of two simple electric circuits (in series and parallel) and determining the differences between them.	Physics	3	High School	Physio (or Gensci with external Voltage)	Voltage, Current
"Light Versus Distance" Recording light intensity while moving away from the light source.	Physics	2	High School	Physio, Gensci	Light

SUBJECT	FIELD	LESSON HOURS	GRADE LEVEL	LABDISC	SENSORS
"Acid Rain" Collecting rain in different areas and verifying the acidity of the rain as it relates to pollution.	Environment/ Biology	2	High School	Gensci, BioChem, Enviro	pH
"Sweat Production" Covering a hand with a plastic bag while measuring temperature and relative humidity to explain the principle of the body's cooling system—sweat.	Biology	2	High School	Enviro, Gensci, BioChem	Temperature, Humidity
"Boyle's Law" Measuring the connection between volume and pressure (PV=NRT) by by using a syringe to show the linear relation between volume and air pressure.	Chemistry	2	High School	Gensci, BioChem, Physio	Air Pressure
"Photosynthesis" Recording air pressure and light level—while using an Elodea water plant sealed in a test tube—to measure the effect of photosynthesis and the relation between light intensity and oxygen production by the plant.	Biology	3	High School	Gensci, BioChem, Physio	Air Pressure
"City Microclimate" Measuring the changes in noise, temperature, and humidity in different urban areas.	Environment/ Biology	4	High School	Enviro, Gensci, BioChem	GPS, Temperature, Humidity
"Beer-Lambert Law" Determining the relationship between a solution's concentration and its light absorbance.	Chemistry	3	High School	Enviro, BioChem	Colorimeter
"Free Fall" Measuring free-fall acceleration using a ping pong ball.	Physics	2	High School	Gensci, Physio	Distance
"Sound Level Versus Distance" Measuring the sound level decay over distance.	Physics	2	High School	Gensci, BioChem, Enviro	Distance, Microphone
"Sound Waves" Recording sound waves and sound wave interference.	Physics	3	High School	Gensci, Physio	Microphone

SUBJECT	FIELD	LESSON HOURS	GRADE LEVEL	LABDISC	SENSORS
"Cloud Effect on a Winter's Day" Measuring the sky's temperature on a clear day and on a cloudy day and explaining how clouds keep ground heat from radiating into the atmosphere.	Environment	3	High School	Enviro	IR Temperature
"Candle Flame" Exploring the temperature zones of a candle flame.	Chemistry	2	High School	BioChem	Thermo-couple
"Photosynthesis" Using a DO2 sensor to check the photosynthesis rate of an Elodea plant in different light intensities.	Biology	3	High School	BioChem	Dissolved Oxygen
"Phase Changes: Solid, Liquid, and Gas" A classic activity measuring the freezing and boiling points of water.	Chemistry	3	Middle School	All	Temperature
"Impact and Momentum" Using the Distance sensor to measure the speed of two carts before and after a plastic collision.	Physics	3	High School	Physio, Gensci	Distance
"UV & Sun Block" Measuring and comparing the level of ultraviolet radiation, resulting from the intervention of a beam of sunlight through different types of filters such as sunglasses and sun blocks.	Environment/ Chemistry	3	Middle School	Enviro	UV
"Hooke's Law" Using a metal spring to investigate the spring coefficient K and the equation F = -kx.	Physics	2	High School	Dymo	Force
"Newton's Second Law" Using a cart pulled by a constant weight to prove Newton's law of motion (F = ma).	Physics	3	High School	Dymo	Force, Acceleration
"Water Quality" Comparing drinking water turbidity to other water taken from lakes and ponds.	Environment/ Biology	4	High School	Enviro, BioChem	Turbidity
"Friction" Investigating the static and dynamic friction of a body moving on different surfaces.	Physics	3	High School	Dymo	Force

SUBJECT	FIELD	LESSON HOURS	GRADE LEVEL	LABDISC	SENSORS
"Harmonic Motion" Investigating the motion of a mass on a spring.	Physics	3	High School	Dymo	Force
"Endothermic and Exothermic Reactions" Performing different measurements to examine which reactions release or consume heat	Chemistry	3	High School	All	Temperature
"pH Titration" Classic acid-base titration measuring pH and also temperature change (using an external Temperature sensor).	Chemistry	3	High School	Gensci, BioChem, Enviro	pH, Temperature
"Specific Heat" Heating different liquids to the same temperature (70˚C) and comparing the cooling curves of these liquids to explain which has the higher specific heat.	Chemistry	3	High School	All	Temperature
"CO2 Production During Respiration" Investigating bean seeds respiration using the CO2 sensor.	Biology	2	Middle School	All (with External CO2)	CO2
"Earth's Magnetic Field" Using the Magnetic Field sensor to check the magnetic field of Earth's poles.	Physics	2	Middle School	All (with external Magnetic Field)	Magnetic Field
"Magnetic Field of a Coil" Using the Magnetic Field sensor to check the magnetic field inside a long coil.	Physics	2	High School	All (with external Magnetic Field)	Magnetic Field
"Mammal Effect" Decreasing the heart rate in cold water to preserve body heat.	Biology	3	Middle School	Primo, BioChem	Temperature, Heart Rate
"Doppler Effect" What happens to a sound harmonic while in motion.	Physics	4	High School	Gensci	Microphone

Want to learn more about the Labdisc solution? Visit **mimio.boxlight.com/labdisc**.

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