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step by step

How Mand Labs KIT-1 Experiments Align with NGSS Standards?

Mand Labs KIT-1 is a versatile DIY Kit for teaching electronics, electricity and magnetism. Using the kit, learners engage in a journey of hands-on experiments and projects covering a wide gamut of topics, including but not limited to:

Basics of Electrical and Electricity, Charge, Battery, Voltage, Current, Resistance, Ohm's Law, Series and Parallel Combination, Variable Resistors (Potentiometer, Preset and LDR), Switches, Capacitors, Relay, Introduction to semiconductors, Diode and its types, Digital Logic Gates, Zener diode, DC Motor, Transistors, Sensors- Temperature (NTC thermistor), IR (Infrared), Inductors, Lenz's Law, Principle of EMI.

While doing the projects, users gain technical skills and test fundamentals. Users take readings of voltages and currents using a digital multimeter, run continuity tests, verify equations, do the math, visualize the path of currents and try to understand how each component works, and the physics behind the components. These same components are used to construct complex products and technologies in the real world. For example, digital logic gates are the building blocks of computing. Users build different gates- OR, AND, NOR, NAND, etc. using diodes, transistors and resistors and understand how they can be used to compute and build logic.

KIT-1 bridges the gap between theory and practice. The emphasis is both on understanding the core idea and concept, and application, how it is relatable to the real world we live in. From robotics to electrical devices that we use in our homes, users comprehend the factors which control the functioning of these devices and how they work. This helps them build **Contextual Understanding**.

KIT-1's content also helps students in preparing for AP Physics and college-level engineering courses, including Electrical Engineering. Fifty questions are included in the kit and several questions are taken from the previous AP tests.

Given below is a bird-eye view of how Mand Labs KIT-1 is aligned with NGSS Standards. For any questions, please send us an email at support@mandlabs.com.

Standard	Description	Experiments
P-PS4-1	Plan and conduct investigations to provide evidence that sound is produced by vibrating materials.	Use a piezoelectric buzzer to produce a 4.2K HZ frequency in a circuit. The piezoelectric vibrates at this frequency when voltage is provided to it which in turn produces beep sound.
1-PS4-2	Make observations (firsthand or from media) to construct an evidence-based account that objects can be seen only when illuminated.	Make an automatic night lamp using a light dependent resistor. The LED turns ON in the dark and one can see that the LED can be only seen when it is lit. Additionally, when the LED turns bright, it illuminates nearby objects in the dark area so they can be seen. The intensity with which the LED glows can be controlled using a variable resistor called Potentiometer (or preset). Learn to use a potentiometer with an LED to control the intensity of light.

1-PS4-4	Use tools and materials to design and build a device that uses light or sound to solve the problem of communicating over a distance.	A) Learn to work with different colored LEDs- red, green, blue and amber. Red can be used as a stop sign and green can be used as a GO signal. B) Make a burglar alarm that activates when a thief accidentally steps on a switch to produce a continuous sound signal to alert property keepers. C) Make an LED Flasher/ Blinker using a transistor which is often used in mines and underground tunnels to give indication. D) Use relay as an Oscillator or transistors in alternate blinking mode to create two flashing LED lights to create a warning signal which can be seen from a distance. The speed of flash can be controlled using a combination of resistors and capacitors. E) Use an Infrared Light (which cannot be seen by naked eyes) to create a Security Alarm System. When an intruder breaks the line of sight between the transmitter and the receiver, the alarm turns ON, producing a continuous sound signal.

Mand Labs
step by step

2-PS1-1	Plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.	Learn to differentiate between conductors, insulators and semiconductors while you work on circuits. Resistivity is a property of material. Different materials offer different resistivity. Wood, ceramic and plastics offer higher levels of resistivity and hence they do not conduct current in a circuit. Carbon resistors are made up of graphite and offer different levels of resistivity. Use a color band table to calculate resistance offered by different value resistors. Use different value resistors in a circuit and observe how current changes. Measure the current in the circuit using a digital multimeter, and observe how the intensity with which an LED glows changes when different resistors are used. Learn to use an LDR (light dependent resistor) to control light or sound. LDR is made up of Cadmium Sulfide which is a photo-sensitive material. Its resistance changes inversely in proportion to the amount of light falling upon its surface. Create a circuit using an LDR and LED and see how the intensity of the LED changes when the circuit is placed in light or dark. Measure the resistance of the photocell in both light and dark environments.
2-PS2-2	Analyze data obtained from testing different materials to determine which materials have properties that are best suited for an intended purpose.	
5-PS1-3	Make observations and measurements to identify materials based on their properties.	

3-PS2-3	Ask questions to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other.	Demonstrate how the relay works as a switch. When electric current is given to the coil, it generates a magnetic field of its own. A small piece of magnet is attached to the lever of the switch. The induced magnetic field pulls the small magnet piece and brings the lever down and thus, the switch changes its state, producing a click sound. Further use a 12 volt Relay to control the switching action of two LEDs and understand how Electromagnetism works in real life.

4-PS3-2	Make observations to provide evidence that energy is conserved as it is transferred and/or converted from one form to another.	A) Glowing an LED and Verifying Kirchhoff's Voltage Law Use a 9 volt battery, an LED and a resistor to create a circuit. As the current starts to flow, electrical energy stored inside the battery in the form of chemicals is converted to heat energy (joule heat) and light energy (LED glowing). Further, to understand the conservation principle, measure the voltage across the battery, the resistor and the LED. Add up the voltage drops across the resistor and the LED and check whether the sum is equal to the source voltage (V). Verify Kirchhoff's Voltage Law and how it follows the energy conservation principle. B) Beeping a Buzzer Use a 9 volt battery, an LED and a buzzer to create a circuit that produces a beep sound. It demonstrates how electrical energy is converted into heat energy (the resistor gets hot) and sound energy. C) Charging and Discharging a Capacitor Charge a capacitor using a 9 volt battery. The electrical energy stored inside the battery is converted into an electric field. The same charged capacitor is then used to light up an LED in the discharging process. Use different value capacitors to understand how the charge varying capacity differs with form and structure.

4-PS3-4	Apply scientific ideas to design, test, and refine a device that converts energy from one form to another form.	A) DC Motor as Generator- Use motion/mechanical energy to produce electricity/electrical energy. Rotate a DC motor to produce EMF (electromotive force) that in turn charges a capacitor. The stored electrical energy inside the capacitor is then used to light up an LED.
4-PS4-3	Generate and compare multiple solutions that use patterns to transfer information.	We use the language of bits 0 and 1 to communicate with a computer. Digital Logic Gates are the building blocks of all computing devices. We can design complex intelligent systems using logic gates. Implement different logic gates (OR, AND, NOR, NAND, NOT) using a combination of diodes and resistors to understand how they work and realize their respective truth tables in the real world, using LED as the final output. If the LED glows, it means 1/HIGH and if the LED is OFF, it means 0/LOW. Use voltage levels as inputs; 1 means VCC (positive rail) and 0 means Ground (negative rail).

MS-PS2-4	Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.	Establish relationship between Voltage and RPM in a DC motor. What factor controls the speed of a DC motor? Is it the voltage or current? Keep the voltage constant, vary the current and check how the speed of the motor is affected by increasing current. In the second phase, vary the voltage using a voltage divider and check whether the speed of the motor changes with respect to change to the applied voltage.
MS-PS3-6 K-2-ETS1-3	Make observations to provide evidence that energy can be transferred by electric currents. Analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.	A) Construct a series combination of LEDs and resistors and verify Kirchhoff's Voltage Law B) Construct a parallel combination of LEDs and resistors and verify Kirchhoff's Current Law Both series and parallel circuits can be used to light up the LEDs; however, both combinations have their strengths and weaknesses based on the application. In our households, electrical wiring is done in parallel. This means all appliances are connected in parallel. If one appliance goes out of order, it does not affect the functioning of others.

Mand Labs
step by step

HS-PS1-1	Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms.	Discover how N-Type and P-Type semiconductors are formed utilizing Boron's and Phosphorus's atomic structure and the number of electrons they carry in their outermost level. Understand the properties and applications of diode, zener diode and bipolar junction transistors.
HS-PS2-5	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.	Demonstrate how electromagnet works inside a Relay. When electric current is passed through the coil, it generates a magnetic field and attracts iron pieces. In the DC Motor as a Generator experiment, demonstrate how the rotation of the motor shaft causes a change in magnetic flux which in turns produces an EMF (electromotive force). The same EMF can be stored inside a capacitor to create an electric current.
HSPS3-3	Design, build and refine a device that works within constraints to convert one form of energy into another form of energy.	Use the DC motor as a generator and convert kinetic energy of the motor shaft into electric potential energy.
HS-PS3-6	Analyze data to support the claim that Ohm's Law describes the mathematical relationship among the potential difference, current and resistance of an electrical circuit.	Verify Ohm's law in a circuit built using an LED, a resistor and a 9 volt battery. Using a digital multimeter, we take readings of current and voltage with different value resistors and then calculate the ratio of V/I.

3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.	A) Make Staircase Lighting to control an LED using either of the two switches B) Construct a circuit using transistors to control the direction of rotation of a motor C) Construct a circuit that can control the sequence in which different colored LEDs glow. D) Construct a circuit that can utilize the remaining energy in a dead cell and light up an LED
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.	A) Establish a relationship between the RPM of a DC motor and voltage. Vary the voltage across the motor and check whether the motor RPM increases, decreases or remains constant. B) Construct a temperature sensor which activates and lights up an LED after a certain temperature threshold limit is reached.