**KEY - LESSON 2: Introduction to Resistance**

**Activity 1: Resistors in Series & Parallel**

**Build Project 7 – Light Emitting Diode**

1. Turn on the switch and describe the brightness. Very bright
2. Reverse the direction of the LED in the circuit. What happens to the light? It does not light up

Explain why? In a diode, the electrons flow in only one direction

1. Replace the LED (D1) with a lamp (L1). Turn on the switch. Describe what happens. Explain this result.

The lamp does not light because there is too much resistance and not enough current. With this in mind, which uses more electric power (watts) a LED or incandescent light? Incandescent

1. Replace the lamp (L1) with the LED (D1). The resistor in this circuit is 100 Ω. Remove the R1 resistor and replace it with the 10K Ω resistor (R4). Describe what happens to the light when the switch is turned on. Compare it to the brightness from part a. It is very dim Why does this happen? There is more resistance.

**Build Project 276 – LED Fan Rotation Indicator**

1. Is this circuit wired in series, parallel or both? Both
2. Which way (clockwise or counter clockwise) does the fan turn when you turn on the slide switch (S1)?

clockwise The positive side of the battery is connected to the positive side of the motor. The polarity on the motor determines the way it rotates.

1. Why does only one LED light turn on? The LED’s are diodes. In this set up, they are in opposite directions. Only the green LED is connected with the polarity required when the slide switch (S1) is on.
2. Push the press switch (S2). The motor rotates counter clockwise (clockwise or counter clockwise) and the red (red or green) LED lights up.
3. Now place the fan on the motor and turn on one of the switches but not both. One of the lamps lights as the motor spins but now the LED is dim. The motor needs a lot of current to spin the fan but only a little without it (less resistance). In this circuit, a lamp lights when the motor current is high, and an LED lights when the motor current is low. Which has a higher resistance, the LED or lamp? lamp

**Build Projects 98 & 99 – Simple Water Alarm & Simple Salt Water Alarm**

1. Build the circuit but leave the jumper wires out of the cup. What happens when you turn on the switch? nothing Why? The circuit is still open or incomplete
2. Place the jumper cables in a cup of water. The circuit is now closed. (open or closed)
3. Based on this activity, is water an insulator or conductor? conductor
4. Add about 1 teaspoon of table salt to the cup of water and stir. Insert the ends of the jumper cables.

Compare the sounds from the speaker without the salt and with the salt in the water. The sounds get louder because salt water is a better conductor than tap water.

**Activity 2: Resistors in Series & Parallel**

**Build Project 173 – Current Controllers**

1. With the circuit complete, turn on the slide switch (S1). Describe the brightness of the LED. Medium brightness This circuit is in series. The 5.1K Ω controls the resistance. Trace the path of the electrons with your finger.
2. Turn off the slide switch (S1) and turn on the press switch (S2). Compare the brightness of the LED with just the press switch (S2) on. Dim, not as bright as with the slide switch on. Trace the path of the electrons in this circuit with your finger.

Placing resistors in series increases the total resistance, so the current is decreased to the LED.

R1 + R2 = Resistance series or in this circuit, 1KΩ + 10K Ω = 11K Ω

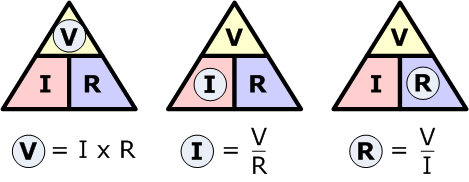
1. Turn on both switches. Compare the brightness with both switches on compared to only one switch. It is much brighter.

Placing resistors in parallel decreases the total resistance, so the current is increased to the LED.

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R1 + R2 = Resistance parallel  or in this circuit, 1/1KΩ + 1/5.1K = 1.2 k Ω

When you decrease the resistance you increase the current so in this parallel circuit, the LED is brighter. The relationship between voltage, current and resistance is Ohm’s Law.



At times, you may not want the full amperage or voltage to your load. Just as a faucet can control the flow of water, an adjustable or **variable resistor** can control the flow of electrons in a circuit.

**Build Project 172 – Red and Green Control**

Describe what happens in each part:

1. With the slide switch **on** and the variable resistor set to the **left** which LED is illuminated? red
2. With the same set up as in part a, describe what happens when you also turn **on** the press switch (S2)? No change
3. With the slide switch (S1) **on** and the press switch (S2) **on**, what happens when you slide the variable resistor to the **right** side? The green LED is bright and the red LED turns off.
4. Turn **off** the slide switch (S1) and turn the press switch (S2) **on**. With the variable resistor slide on the **right**, describe what happens to the green LED. The green LED lights up.
5. When the variable resistor is on the **left** and the slide switch (S1) is **on**, explain why the red light brightens. Use the terms *current* and *resistance* in your answer. When the variable resistor switch is to the left, there is low resistance to the red LED. This allows higher current so the light is bright.
6. Describe two places in your home where you may find a variable resistor in a circuit. A lamp with a dimmer switch or a fan with variable speeds.

**Activity 3: Photoresistors**

Some materials, such as cadmium sulfide, change their resistance when light shines on them. Electronic parts made with these light-sensitive materials are called **photoresistors**. Their resistance decreases as the light becomes brighter.

**Build Project 272 – Photoresistor Control**

1. With the switch on, describe the brightness of the LED. Not too bright
2. Describe the brightness of the LED when you limit the light entering the photoresistor with your finger. The light goes out.
3. Shine a flashlight directly on the photoresistor. What happens to the brightness of the LED? It gets brighter.
4. What is happening to the resistance and current as you cover the photoresistor? With less light to the photoresistor, the resistance is increased and the current is decreased.

**Build Project 107 – Automatic Street Lamp**

In this project, you will use a variable resistor and photoresistor. You will also use parts Q1 PNP and Q2 NPN. These pieces are transistors. A **transistor** can be described as a current amplifier. It uses a small amount of current to control a larger amount of current. They allow current to flow in one direction, like in an LED. The arrows on the parts Q1 and Q2 indicate the direction of current flow.

1. Press the press switch (S2) on and set the variable resistor so the lamp (L2) is just on. Slowly cover the photoresistor with your finger. Describe what happens to the lamp. The lamp gets brighter
2. Explain what is happening to the current to the lamp when the photoresistor is covered. The current increases because the resistance is decreased.