

Basic Electronics

Electrical Power

Background:

Power is defined as the rate at which energy is used, transferred, or transformed. Power is energy (Joule) divided by time and its unit is the Watt (J/s). Electrical power is the rate at which electrical energy is used. The electrical power used or dissipated by a resistor connected to an energy source such as a battery is equal to the voltage across the resistor multiplied by the current through the resistor. Why? Well, voltage is the electrical potential energy per unit charge and the unit, volt, is the same as Joules/Coulomb. Joules is the unit for energy and Coulomb is the unit for charge. Current on the other hand is defined as the flow of electric charges and its unit is the Ampere, which is the flow of electric charges through a surface at the rate of one Coulomb per second. So basically the voltage across the resistor tells us how much energy there is for each charge going through the resistor and the current tells us how many charges are flowing through the resistor in one second. By multiplying the two together we get how much energy is used or dissipated by the resistor.

Power (P) = Voltage (V) x Current (I)

P (Watts) = V (Volts) x I (Amperes)

Watts (Joules/second) = Volts(Joules/Coulomb) x Amperes(Coulomb/second)

Joules/Second = (Joules/Coulomb)x(Coulomb/second) = Joules/Second = Watts = Power

The brightness of a light emitting diode (LED) depends on how much current flows through it, the more current the brighter the LED will be. Too much current will result in the LED burning out. The current rating for a standard miniature LED is around 20mA, which means that if more than 20mA of current is applied through the LED, you risk the possibility of burning it up. Since an LED is a diode a certain threshold voltage is required to activate or turn it on. This voltage varies depending on what type and color the LED is, but is typically around 2V. In a circuit, an LED must be paired with a resistor to control the current so that the LED doesn't burn up and to control the brightness of the LED. If no resistor is used the current through the LED is theoretically infinite and the LED will burn up, but in reality it depends on the very small resistance of the LED and the voltage source connected to the LED. In either case the current through the LED will be much greater than 20mA and the LED will burn up.

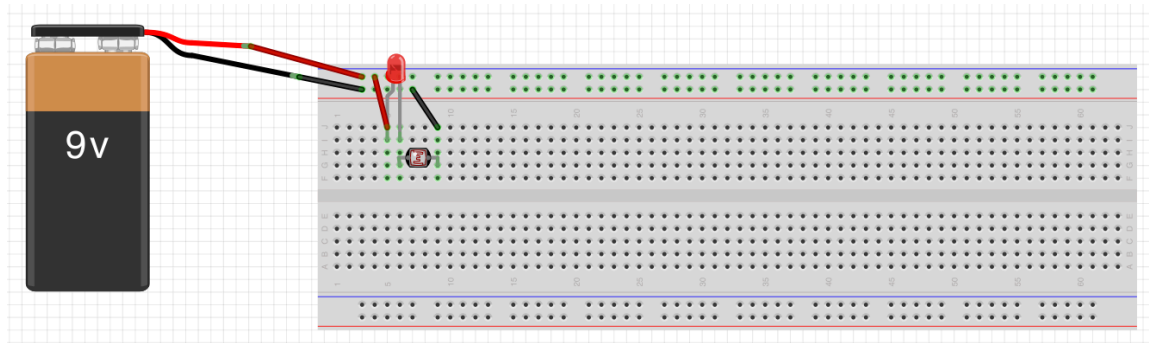
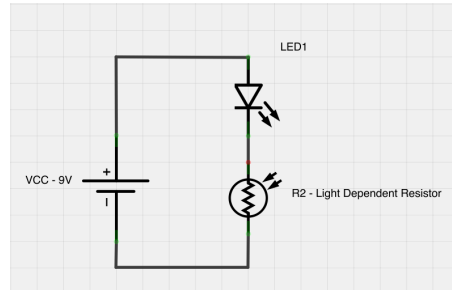
Equipment:

1. Digital Multi-meter
2. Breadboard
3. Resistors
4. LEDs
5. Light dependent resistors (LDR)
6. Jumper wires
7. Windmill/Generator

Procedure:

Part I. Constant voltage source.

Connect the following circuit on the breadboard.



Take the following measurements and record in the table below.

Voltage Measurement

1. Without covering the LDR, measure the voltage across the LED.
2. Without covering the LDR, measure the voltage across it.
3. Cover the LDR with a finger and measure the voltage across the LED.
4. Cover the LDR with a finger and measure the voltage across the LDR.

Current Measurement

1. Remove the wire connecting the LDR and the negative terminal of the battery. Connect the leads of the DMM to this point (Ask the Instructor about how to setup the DMM).
2. Without covering the LDR, measure the current through the circuit.
3. Cover the LDR with a finger and measure the current through the circuit.

	Voltage (V) LDR Covered	Voltage (V) LDR Not Covered	Current (A) LDR Covered	Current (A) LDR Not Covered
LED				
LDR				

How much power does the LED use when the LDR is not covered?

How much power is dissipated through the LDR when it isn't covered?

How much power does the LED use when the LDR is covered?

How much power is dissipated through the LDR when it is covered?

Explain why the brightness of the LED changes when the LDR is covered and uncovered.

Part II. Variable voltage source.

1. Remove the battery from the circuit and replace it with the windmill/generator.
2. Replace the LDR with a 330Ω resistor.
3. Connect the probes of the DMM across the output terminals of the windmill/generator to measure the output voltage.
4. Observe what happens to the voltage readings and the LED brightness when the rotation speed of the windmill changes.

Was the LED brighter or dimmer when the windmill rotor spun faster?

Was the output voltage of the windmill larger or smaller when the windmill rotor spun faster?

Summarize your observations.