



Simple Circuits

LaDawn Partlow, M.E.N.
J. 'Kemi Ladeji-Osias, Ph.D.

Department of Electrical and Computer Engineering, Morgan State University
& Verizon Innovative Learning Program for Minority Males @ Morgan State University



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Today's activities

- Introduce simple circuits using an online design tool from Autodesk
- Build simple circuits on a prototyping board
- Related NGSS Standards
 - Engineering, Technology, and Society: Engineering Design
 - Middle School Physical Science 3.B: Conservation of Energy and Energy Transfer
 - Cross-Cutting Concept 5: Energy and matter: Flows, cycles, and conservation



Presenters' Backgrounds

LaDawn Partlow

- Master's in Electrical Engineering
- Lecturer - Electrical Engineering
- Teaches courses in programming and engineering design
- Program Director - Verizon Innovative Learning Program
- Lab Manager - Engineering Visualization Research Laboratory

J. 'Kemi Ladeji-Osias, Ph.D.

- Ph.D. in biomedical engineering
- Associate Professor – Electrical Engineering
- Teaches courses in digital design and biomedical engineering
- Principal Investigator - Verizon Innovative Learning Program
- Research interests K-12 engineering and embedded systems.



Middle School Summer and Saturday Program

Circuits Activities



Engineering Disciplines

- Chemical Engineering - transforms raw materials into useful, innovative products for public and commercial consumption
- Civil Engineering – meets basic human needs by improving infrastructure and common utilities
- **Electrical Engineering** - utilize the principles of electricity (mathematical and physical science) to design power grids, computer circuits, software programs and power supplies
- Mechanical – improvement and modification of machines and systems



Questions for Students

1. What is electricity?
2. Name two electric devices we use daily and how they work.
3. Mention two devices that do not use electricity.
4. Name one common form of storing electrical energy.



Electricity

Have you ever wondered what makes a cell phone, refrigerator or a light bulb work?

One thing that all these devices have in common is they are all electronic devices, which means they work when charged with electricity.

So what is Electricity?

Electricity is flow of electrical charge through conductors.. Everything in the universe is made of atoms and atoms are made of even smaller particles called electrons, protons and neutrons, some of which are charged. Electricity is due to the flow of electrons that have gotten loose from atoms.



Electric Current

- Electricity is created by batteries.
- Electricity comes from outlets at home too
- Electric current passes through metals.

Example: Copper wire is a very good conductor of electricity, wood is a poor conductor of electricity.



Batteries



Electrical outlet



Copper Wire



Wood



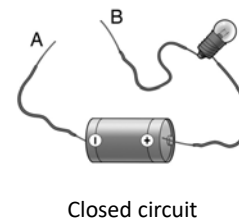
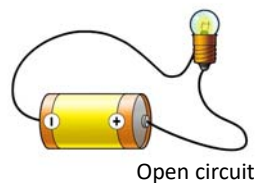
What is a battery?

- A source of electrical current.
- Stores chemical energy and converts to electrical energy when connected in a circuit.
- Batteries are of two types:
 - Primary: these cannot be recharged.
 - Secondary: these batteries can be recharged.
- Causes electrons (charged particles) to flow through conductors connected across the two terminals of a battery (one positive and one negative).



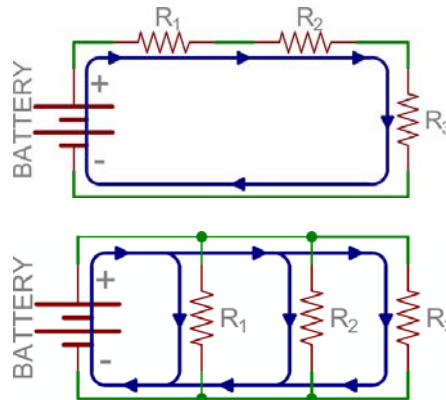
Electric Circuit

- Source of electricity connected to one terminal of one or more electrical devices using a wires
 - Source: Battery, outlet
 - Electrical devices: LED, resistor, bulb, motor, cell phone, etc
- Electric circuits are of two types:
 - Open circuit: the wire not connected back to the source.
 - Closed circuit: the wire connected back to the source.
- For electricity to flow, an electric circuit must be closed.



Series and Parallel Circuits

- Circuit components may be arranged in series or parallel
- Series Circuits
 - current is the same through any component in the circuit
 - one path for electrons to flow
- Parallel Circuits
 - the sum of the current through each path is equal to the total current of the circuit
 - several paths for electrons to flow

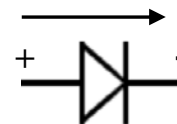


Light Emitting Diode (LED)

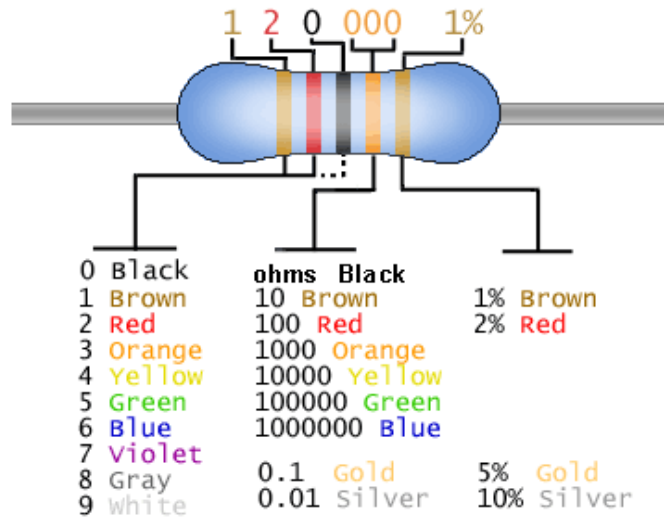
- Lights up when current flows through it
- Usually requires a resistor in series to limit current flowing through
- LED's only allow current to go through it in one direction
- LED's have 1 lead that is longer than the other. The longer lead is the positive side. Current flows from the longer lead to the shorter lead.
- Used to generate light (hence the light emitting part)
 - More efficient than incandescent bulbs
 - Difficult to break by dropping...
- Used anywhere where light needs to be generated
 - Bike lights
 - Car brake lights



Current Flows



Resistor Codes

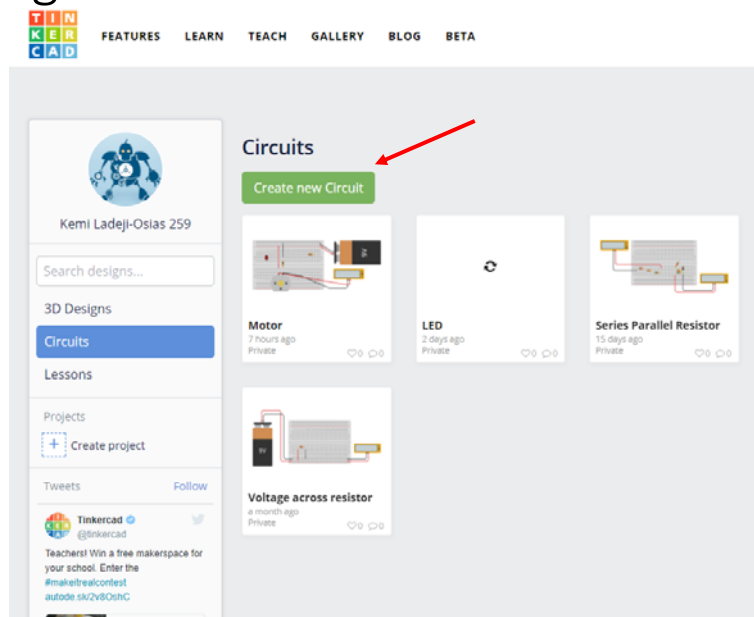


Safety Procedures when working with circuits

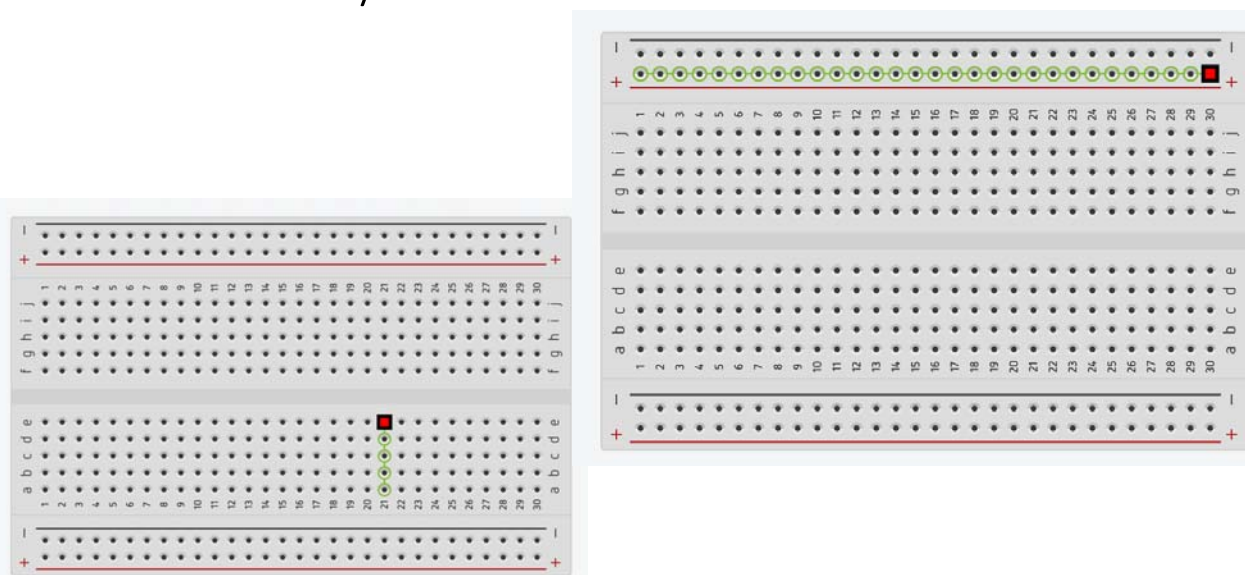
- Handle wires, bulbs and other electrical component with care - sharps - can cut or scratch/puncture skin/eyes.
- Use caution in working with batteries or other electrical sources to prevent shock, heat or chemical burns.
- Recommended safety equipment: safety glasses meeting the ANSI/ISEA Z87.1 standard and eyewash station (bottle)

Online Circuit Design Tool – TinkerCAD Circuits

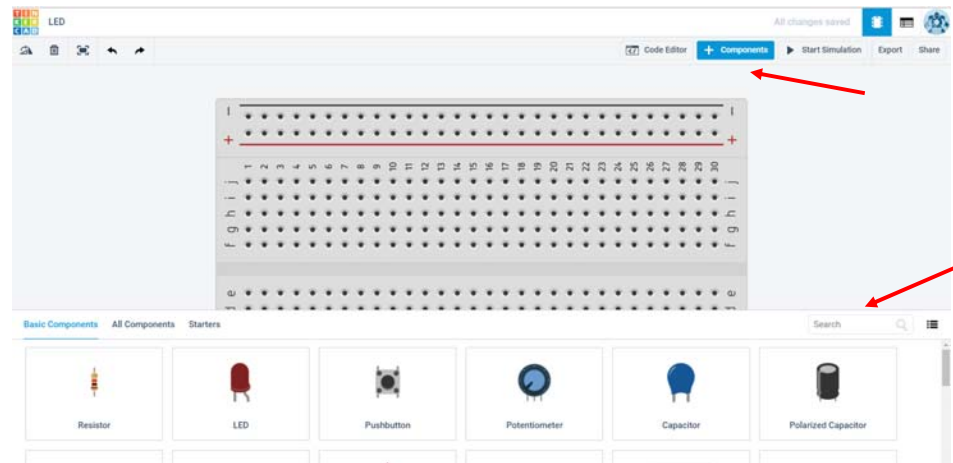
- www.tinkercad.com
- Create circuits and use measurement instruments



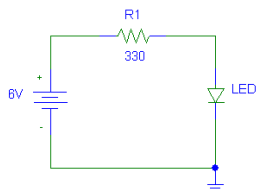
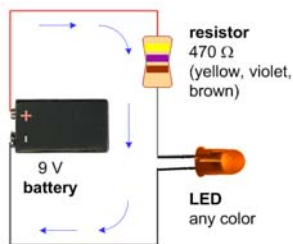
Breadboard/Protoboard



Adding Components



Activity: Building a Simple Series LED Circuit

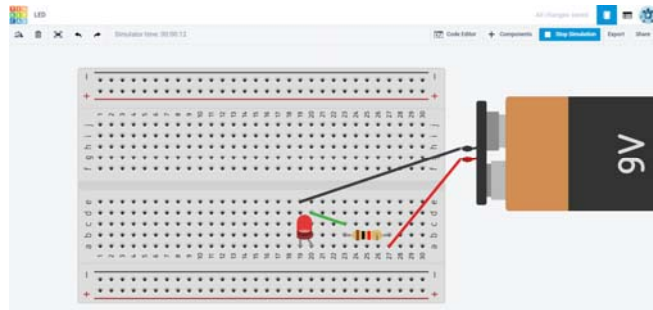
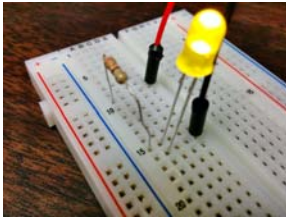


- Components needed:
 - Bread board
 - Resistor
 - Battery
 - Battery Clips
 - Light Emitting Diode (LED)



Today's Activity

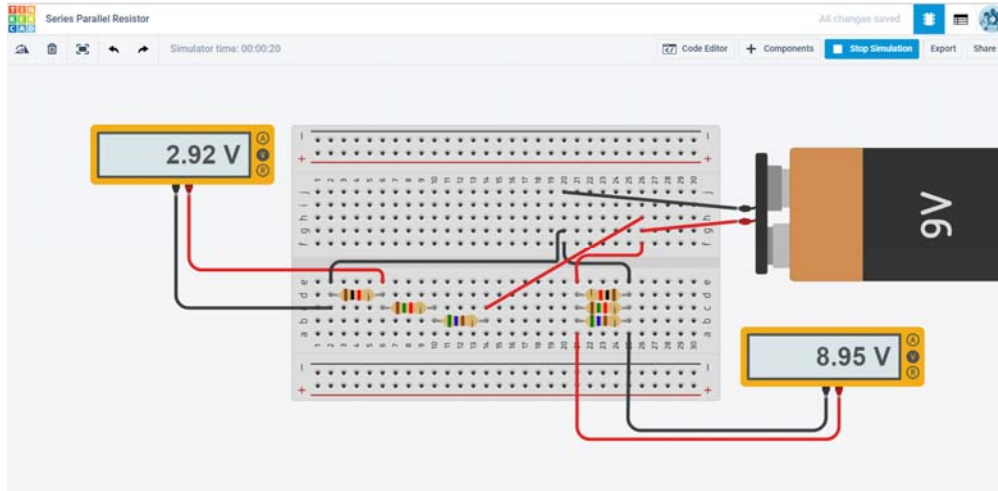
- Build a simple circuit with the LED in series with the resistor.
- Questions to consider:
 - Will the LED light up? What happens as you change the resistor?
 - What will happen if you add a second LED in the circuit (in series)?
 - What happens as you add more LEDs?
- What is happening?



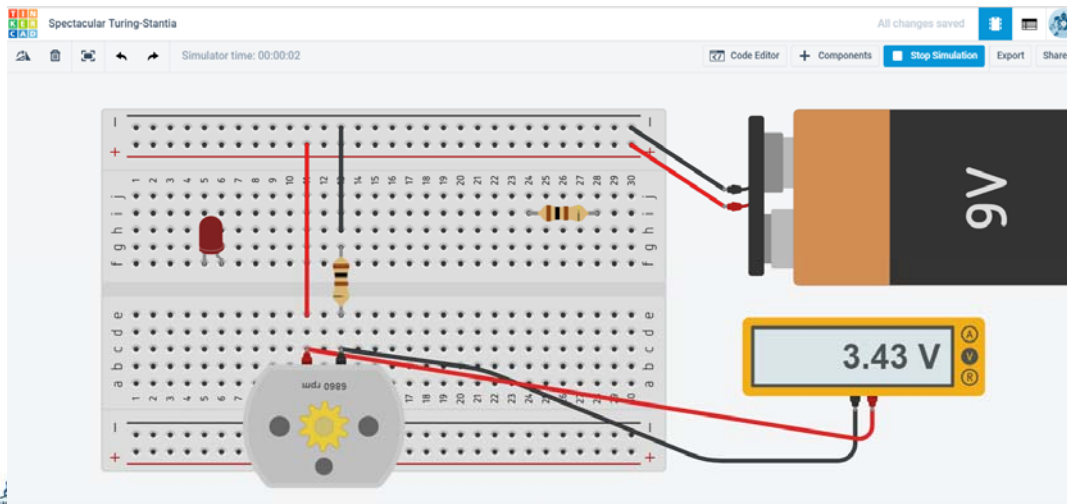
Conservation of Energy in Electric Circuits

- Sum of voltages in a closed loop is 0 (Kirchhoff's Voltage Law)
 - Illustrate using LEDs in series in a circuit.
 - Each LED requires about 1.8 V with about 15 mA.
 - As more LEDs are added in series, the LEDs get dimmer.
 - Illustrate using virtual multimeter in software
- Sum of currents into a node is 0 (Kirchhoff's Current Law)

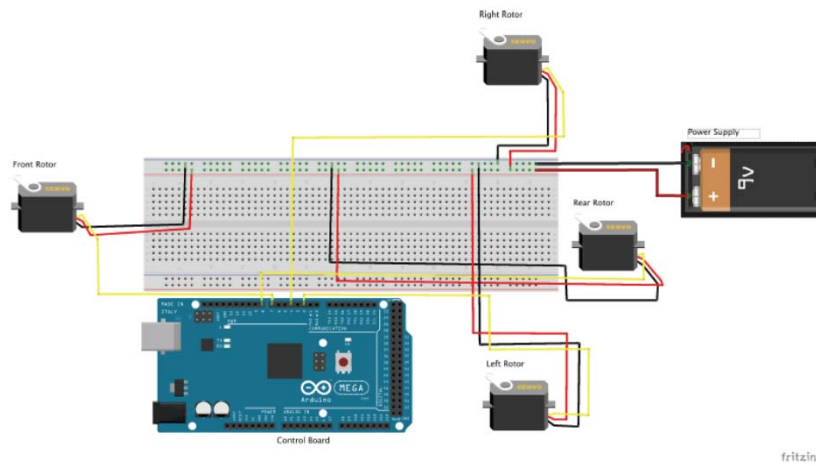
Using Multimeter



Simple motor circuit



Quad Copter



Acknowledgements & Contact

- Funding provided by The Verizon Foundation
- Kemi Ladeji-Osias: Jumoke.Ladeji-Osias@Morgan.Edu
- LaDawn Partlow: LaDawn.Biddle@Morgan.Edu

- Resources: <https://www.tinkercad.com/learn/>

