**Electrical Engineer for a day**

Version 1

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**Unit Summary**

Electronic devices touch virtually every aspect of our lives.  This unit provides an introduction to Ohm’s Law and electronic components. Electronic components are the building blocks of many of the products we use every day, from computers to phones, from cars to jumbo jets, from refrigerators to hearing aids.  The unit exposes students to three different types of components, how to identify them and understand their capabilities, and and gives them a chance to use their knowledge to design, build, and test a simple circuit to light up an LED.

**At a Glance**

* **Grade:**9-12, 6-8
* **Subjects:**Computer Science &Technology
* **Topics:**Circuits, Electronics, Design
* **Higher-Order Thinking Skills:**Analysis, Experimental Inquiry
* **Key Learnings:**Types and uses of electronic components, Ohm’s Law
* **Content Type:**Unit Plan
* **Time Needed:**2-3 class periods, 50 minute class
* **Prerequisites:**Algebra, an elementary-school-level of understanding of science
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**Learning Outcomes**

* Students gain an appreciation for how engineers can create useful products by designing, building, and testing electric circuits
* Students gain an understanding of the different types of electronic components and how they might be used in products they are familiar with

**Things You Need**

For this unit, each group of 2-3 students will need each of the following:

* Computer   
  Students will need access to computers or tablets connected to the Internet in order to view an instructional video and do research. Although it is ideal to have the students work in teams in the classroom on these tasks, these research tasks may be completed at home.
* Electronics kits    
  Students will need a simple electronics kit containing enough parts such that each group of 2-3 kids can use (minimally) a half dozen parts including some resistors, capacitors, LEDs, and jumper wires (these can be made from telephone cables with a pair of wire strippers).  The design portion of this unit works best if each group of students has several resistors of different values in the 350-600 ohm range.
* Breadboards (optional)  
  A breadboard is not absolutely required, but is useful in the design portion of the unit.
* Batteries  
  The exercise is written for a 9-volt battery. It can be easily adapted for any alkaline battery, AA, AAA, C, D.

**Standards Alignment**

This unit is aligned to Common Core National and Next Generation Science Standards.

* Engineering Design:  define design problem, generate solutions, carry out tests and analyze resulting data
  + MS-ETS1-1, MS-ETS1-2, MS-ETS1-3, MS-ETS1-4
  + HS-ETS1-1, HS-ETS1-2, HS-ETS1-3, HS-ETS1-4
* ELA/Literacy:  conduct short research projects, build knowledge through investigation
  + W.6-8.7
  + WHST.6-8.9
* Mathematics:  operations and algebraic thinking; reason abstractly and quantitatively
  + MP.6-8

**Curriculum Framing Questions:**

* **Essential Question**  
  Why does the world need engineers?
* **Unit Question**  
  What kind of work does an electrical engineer do?

What kind of skills must they have to be successful engineers?

* **Content Questions**  
  What kinds of products are built with electronics?  
  What is a circuit?

What components are used in circuits and what functions do they perform?

What is Ohm’s Law and how is it applied in electronics design?  
How do engineers test their designs in a controlled laboratory setting before releasing their products to their customers?

**Assessment Processes**

The opening discussion around the framing questions helps teachers assess what students may already know about electronics, the work of engineers, and the design process.  During the activity, teachers may take notes with structured observations of students work habits, ideas, communication, and cooperation skills. Following the activity, teachers may use the wrap-up discussion as a final assessment of the unit.

**Instructional Procedures**

**Set the Stage (10-15 minutes)**

Ask the essential question, Why does the world need engineers?  Have a brief discussion about the man-made objects we come into contact with every day. A desk, a phone, a building, a car, a traffic light.  Where do these products come from?  Who thinks of them?  Who builds them?  Engineers have the wonderful job of thinking of, designing, testing, and building the products that we rely on every day.  It’s can be a lot of fun.  And it’s also a big responsibility.

Ask the unit question, What kind of work does an electrical engineer do?  What kind of skills must they have to be successful engineers? Explain that today you’re going to get an up-close look at some of the work an electrical engineer does.  You’ll be an electrical engineer for a day.  You might want to establish a science journal so that students can keep track of key scientific concepts as well as note any questions to revisit.  Another idea is to invite an electrical engineer to speak with the class about their work and how they use the concepts from this unit in the real world.

Post a chart of the key concepts discussed.  Tell students that they will continue to examine and answer these questions in the next activities.

**Steps**

Step 1 – What is a Circuit? (15-20 minutes)

Have the class read [this short piece](https://engage.intel.com/external-link.jspa?url=https%3A%2F%2Flearn.sparkfun.com%2Ftutorials%2Fwhat-is-a-circuit) for a simple introduction to electric circuits. Discuss the reading as a class. Ask the class what electronic components were discussed in the introduction and what roles they perform. Do not correct their answers; just have them suggest their ideas and thoughts, and perhaps write them up on the board.  The students will learn more about these components in the next step.

Step 2 – Understanding the Types of Electronic Components (15-20 minutes)

For each of the three common electronic components below, ask students to go online to do research in order to complete the research worksheet.  They may do this individually, or working in groups of 2-3 students each.  Discuss the findings as a class.

Electronic components:

1. Resistor
2. Capacitor
3. Light-Emitting Diode (LED)

Research questions:

1. What is this component?  Give a brief definition and description of the function it performs.
2. What is the symbol used in a circuit diagram to represent this component?  Draw the symbol.
3. Can there be different levels of performance for this type of component?  If so, what units are used to measure its performance/capabilities?  (For example, some batteries provide, say, 9 volts of electricity, while others provide only 1.5 volts.)
4. In the case of the resistor, how is a resistor marked to indicate how much resistance it offers?  (Try a Google Image Search for “resistor markings”.

Note:  Although we suggest performing steps 1 and 2 in small groups in the classroom, in the interest of time some teachers may opt to assign these steps as homework assignment, leaving a 10-minute discussion for class time.

Step 3 – Identifying the Physical Components (10 minutes)

Provide a set of random components, ideally including 2-3 of each of the three common components listed above, to each group of 2-3 students.  Ask the students to identify the components as one of the five types.  Encourage them to use Google Image Search if they get stuck. Discuss the findings as a class. Share photos from Google image search of circuit boards for various products and have the students point out components they now recognize.

Step 4 – Reading the Markings on Resistors (15 minutes)

Now that each group has sorted their components by type, ask the students to pick one of the resistors and use what they learned about how resistors are marked to indicate their resistance value to decipher the resistance value.  Have them make a chart that shows the color bands and the translation to resistance. They should end up with a chart that looks something like [this](https://engage.intel.com/external-link.jspa?url=http%3A%2F%2Fwww.azega.com%2Fhow-to-read-a-resistor-color-code%2F).

Step 5 – Ohm’s Law

Have the students watch this 11-minute [video overview of Ohm’s Law](https://engage.intel.com/external-link.jspa?url=https%3A%2F%2Fwww.khanacademy.org%2Ftest-prep%2Fmcat%2Fphysical-processes%2Fcurrent-and-resistance%2Fv%2Fcircuits-part-1).  Discuss Ohm’s Law with the class.

Step 5 – Designing a Circuit (20-40 minutes)

Have the students get back in their groups of 2-3 and apply what they’ve learned so far in this unit by designing a circuit. The circuit they must design needs to provide enough electricity to an LED to cause it to glow, but not so much that it damages or burns up the LED.  Explain to the students that this type of problem is typical of the kind of work electrical engineers do in their jobs – that is, using laws of physics and mathematics to design something that accomplishes a task while avoiding the risks of something going wrong, and then testing it in a controlled laboratory setting before delivering the product to customers.

Hand out to the students this worksheet, which will help them understand the assignment and offers some guidance.  When finished, discuss the designs with class.  What were the challenges? Did something go wrong?  Did they understand why and correct the design. Explain that this is part of the process, and that sometimes the greatest inventions and discoveries are made when something goes wrong in a design or experiment!

**Conclude the Lesson (15 minutes)**

After discussing the designs, conduct a comprehensive debriefing session that revisits the Unit Questions.  Then, as a final journal entry, pose the Essential Question:  How do electronic products work?

**Prerequisite Skills**

* Basic algebra
* An elementary-school-level of understanding of science

**Differential Instruction**

**Resource Student**

* Locate and distribute research materials that are appropriate for their reading ability.
* Distribute an outline for students to complete to help organize their research and report work.

**Gifted Student**

* Have students collect, graph, and draw conclusions based on data related to their circuit.
* Have students research Ohm’s Law, and discuss its relevance to the circuit they build.
* Have students play with different resistors and LEDs and observe the effect on brightness.  Why might that be the case?
* Ask students why they think different colors of LEDs require different levels of current to glow?

**English Language Learner**

* Allow the student to complete work in their first language and then have it translated into English later.
* Have a more proficient bilingual student help the English language learner.
* Use the talking text feature in word processing software to assist in editing the student work.

Students learn about electrical components and circuits, and use Ohm's Law to design, build, and test a circuit, much like professional engineers do.