



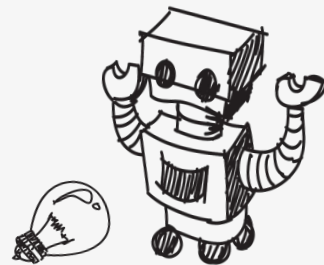
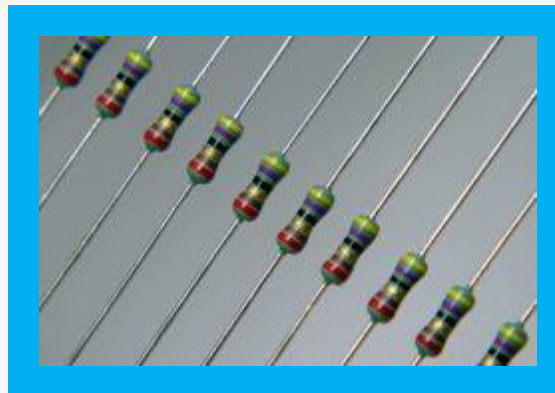
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TRYEngineering



Lesson Plan:

Using Ohm's Law to Build a Voltage Divider



The Design Challenge



The Design Challenge

You are part of a team of engineers given the challenge of understanding how Ohm's Law works and applying it. You'll learn how to read resistor codes, what a breadboard is and how to calculate resistor values. Then, your team will use a breadboard to build a voltage divider circuit that can illuminate a light emitting diode (LED bulb). You must predict and measure with a multimeter the output voltage values of your circuit.



Defining the Challenge: Criteria & Constraints

Criteria

- Use a breadboard to build a voltage divider circuit
- Use a multimeter to measure the output voltage values

Constraints

- Use only the materials provided.



Material

Materials – Required (Each team) - materials can be re-used

- Multimeter
- Breadboard with Wire Set
- Calculator
- LED – Super Red, Clear Lens
- 9V Alkaline Battery
- 9V Battery Holder with Wire Leads
- Resistor: 100 ohm, Carbon Film, 1/2W, 5%



Material

Materials – Required (Each team) - materials can be re-used

- Resistor: 150 ohm, Carbon Film, 1/2W, 5%
- Resistor: 220 ohm, Carbon Film, 1/2W, 5%
- Resistor: 330 ohm, Carbon Film, 1/2W, 5%
- Resistor: 470 ohm, Carbon Film, 1/2W, 5%
- Resistor: 560 ohm, Carbon Film, 1/2W, 5%
- Resistor: 680 ohm, Carbon Film, 1/2W, 5%
- Resistor: 820 ohm, Carbon Film, 1/2W, 5%
- Resistor: 910 ohm, Carbon Film, 1/2W, 5%
- Resistor: 1000 ohm, Carbon Film, 1/2W, 5%



Testing Materials and Process

Testing Material

- Use build materials

Testing Process

Students test their circuits by lighting up the LED bulb. Students must predict and then measure the output voltage values of their circuits using a multimeter

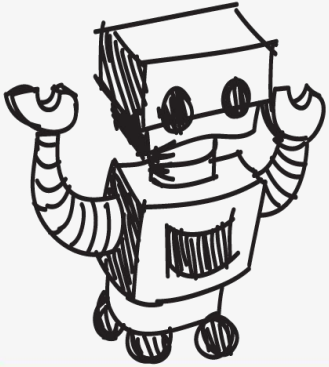


Consider...

- Before you get started building, consider how a circuit works. What happens when you flip a light switch on or off?



Reflect & Debrief



Engineering Design Process



The Engineering Design Process



Learn about the engineering design process (EDP). The process engineers use to solve problems.
(Video 1:47)



Source: TeachEngineering YouTube Channel <http://www.youtube.com/watch?v=b0ISWaNoz-c>

Engineering Design Process

- Divide into teams
- Review the challenge and criteria & constraints
- Brainstorm possible solutions (sketch while you brainstorm!)
- Choose best solution and build a prototype
- Test then redesign until solution is optimized
- Reflect as a team and debrief as a class

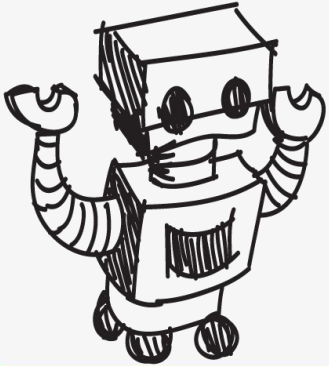


Productive Failure

- The engineering design process involves productive failure: test, fail, redesign. Iterate again and again until you have the best possible solution.
- It is important to document iterations to keep track of each redesign. Use the engineering notebook to sketch ideas, document iterations and any measurement and/or calculations.
- It's also important to showcase the fact that there can be multiple solutions to the same problem. There's no one "right" solution.



Vocabulary



Vocabulary

- Circuit: A complete path around which electricity can flow
- Constraints: Limitations with material, time, size of team, etc.
- Criteria: Conditions that the design must satisfy like its overall size, etc.
- Engineers: Inventors and problem-solvers of the world. Twenty-five major specialties are recognized in engineering ([see infographic](#)).
- Engineering Design Process: Process engineers use to solve problems.
- Engineering Habits of Mind (EHM): Six unique ways that engineers think.
- Iteration: Test & redesign is one iteration. Repeat (multiple iterations).
- LED: Light Emitting Diode. A semiconductor device that produces light from electricity.

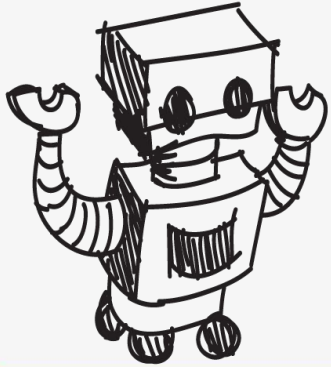


Vocabulary

- Multimeter: Electronic measuring tool that is a combination of several tools in one unit.
- Ohm's Law: The way current flows through a resistance when a different electric potential (voltage) is applied at each end of the resistance.
- Prototype: A working model of the solution to be tested.
- Resistor: Part of an electrical circuit that resists, or limits, the power of an electrical current in a circuit.
- Voltage: Name for the electric force that causes electrons to flow. It's the measure of potential difference between two points in the circuit.
- Voltage Divider: An electrical circuit which creates an output voltage which is proportional to an input voltage



Dig Deeper



Dig Deeper into the Topic

Internet Connections

- IEEE Global History Network (www.ieeeghn.org)
- ITEA Standards for Technological Literacy: Content for the Study of Technology (www.iteaconnect.org/)
- National Council of Teachers of Mathematics Principles and Standards for School Mathematics (www.nctm.org/standards)
- National Science Education Standards (www.nsta.org/publications/nses.aspx)



Dig Deeper into the Topic

Recommended Reading

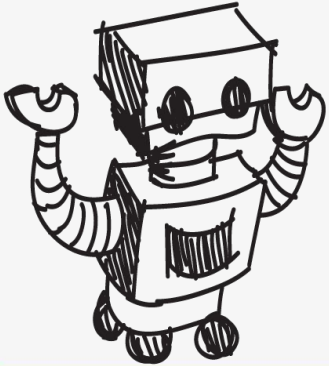
- Ohm's Law, Electrical Math and Voltage Drop Calculations by Tom Henry. (ISBN: 978-0945495260)
- Teach Yourself Electricity and Electronics, Fourth Edition (Paperback) by Stan Gibilisco. (ISBN: 978-0071459334)
- Electrical Engineering 101: Everything You Should Have Learned in School but Probably Didn't by Darren Ashby. (ISBN: 978-1856175067)

Writing Activity

Research the life and work of Georg Ohm and write a page on how his discoveries have impacted modern electronics.



Engineering Fields



What is Engineering?



Learn about engineering and how engineers are creative problem solvers and innovators who work to make the world a better place.

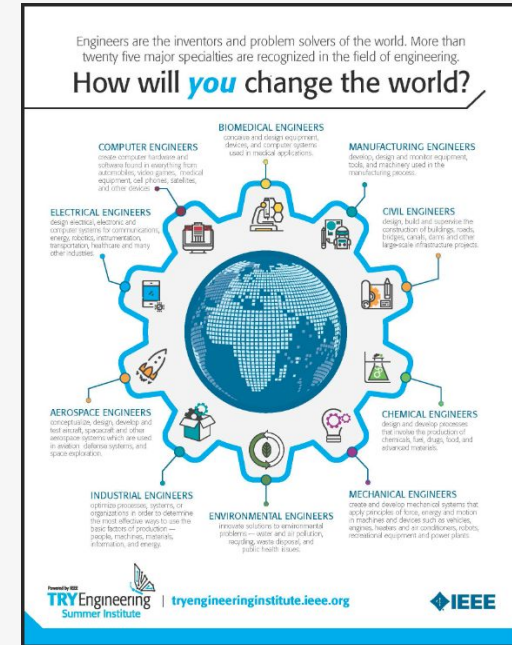
(Video 3:43)



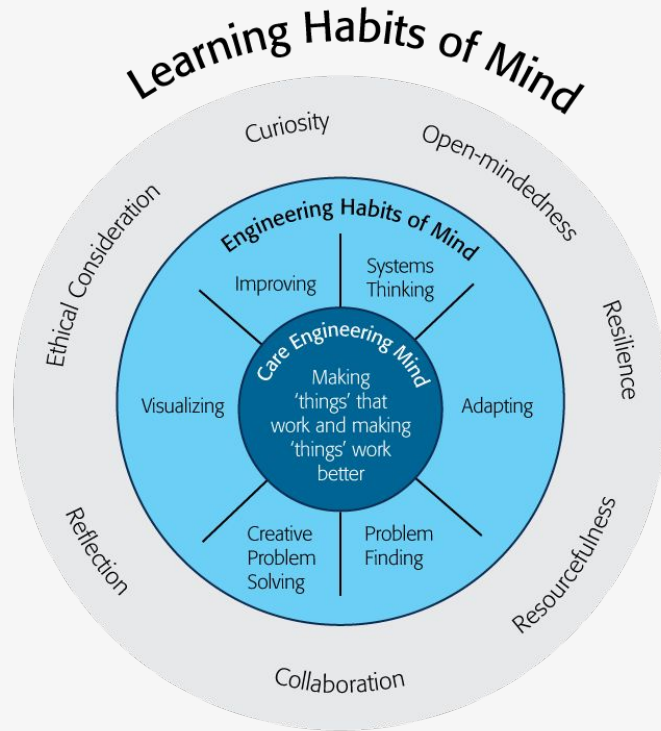
Source: TeachEngineering YouTube Channel - <http://www.youtube.com/watch?v=H9VDkvGmVo>

Related Engineering Fields

- There are several types of engineering fields that are involved with voltage dividers. Here are just some of the related engineering fields.
 - [Electrical Engineering](#)
- Download the [Engineering Fields Infographic](#)
How will **YOU** change the world?



Engineering Habits of Mind



Engineering Habits of Mind (EHM) is about how engineers think everyday. The Core Engineering Mind is about making things that work and making them work better.

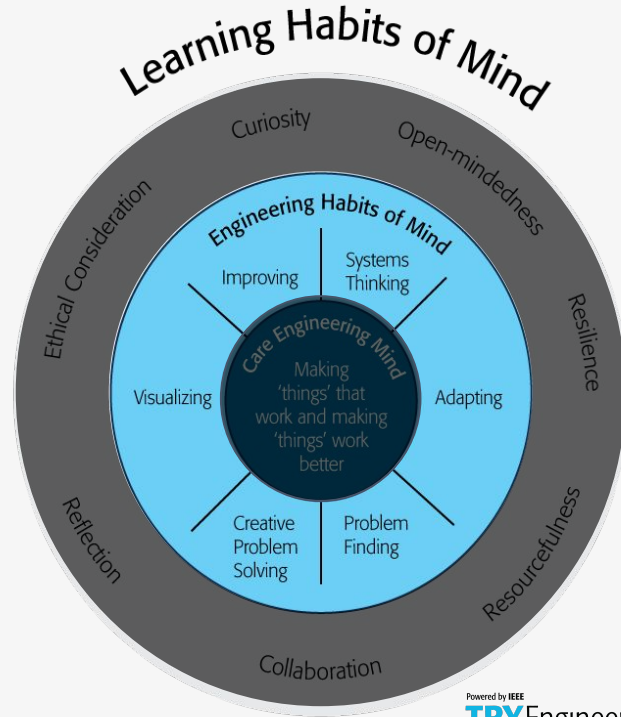
Source:

<https://online-journals.org/index.php/i-jep/article/view/5366>



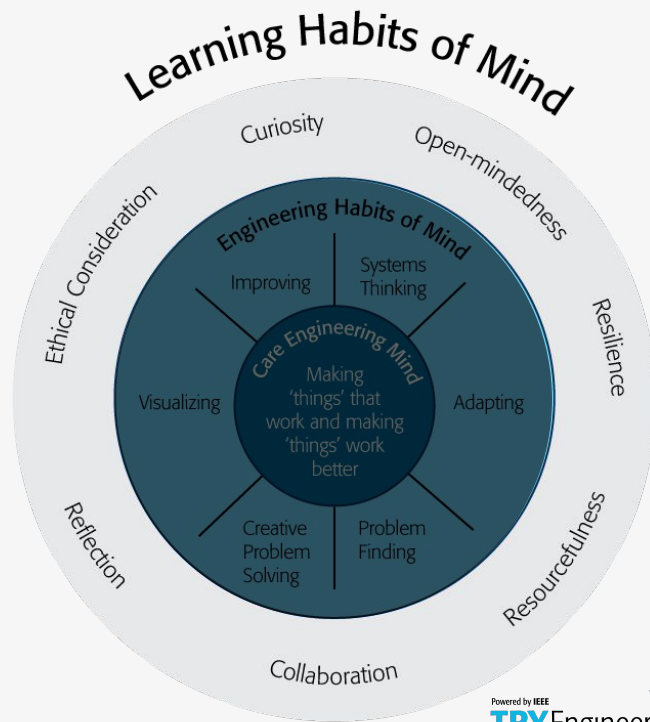
Engineering Habits of Mind Checklist

- ❑ Systems thinking
- ❑ Problem-finding
- ❑ Visualising
- ❑ Improving
- ❑ Creative problem-solving
- ❑ Adapting



Learning Habits of Mind Checklist

- ❑ Open-mindedness
- ❑ Resilience
- ❑ Resourcefulness
- ❑ Collaboration
- ❑ Reflection
- ❑ Ethical Consideration
- ❑ Curiosity



Greatest Engineering Achievements of the 20th Century



Greatest Engineering Achievements OF THE 20TH CENTURY

Welcome!

How many of the 20th century's greatest engineering achievements will you use today? A car? Computer? Telephone? Explore our list of the top 20 achievements and learn how engineering shaped a century and changed the world.

1. Electrification
2. Automobile
3. Airplane
4. Water Supply and Distribution
5. Electronics
6. Radio and Television
7. Agricultural Mechanization
8. Computers
9. Telephone
10. Air Conditioning and Refrigeration

11. Highways
12. Spacecraft
13. Internet
14. Imaging
15. Household Appliances
16. Health Technologies
17. Petroleum and Petrochemical Technologies
18. Laser and Fiber Optics
19. Nuclear Technologies
20. High-performance Materials

LinkEngineering



Source: <http://www.greatachievements.org/>

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Learn more about how engineers make the world a better place



The banner features the NAE logo (three interlocking puzzle pieces in blue, green, and yellow) and the text "NAE GRAND CHALLENGES FOR ENGINEERING" and "NATIONAL ACADEMY OF ENGINEERING". Navigation buttons for "Challenges", "News", and "Community" are in green. The main visual is a green puzzle piece with a nuclear fusion icon, set against a background of glowing green lines and dots. Below the puzzle piece, the text "Provide energy from fusion" is displayed, followed by a paragraph about scaling up fusion. A row of 14 diamond-shaped icons represents various engineering challenges, including VR, brain, laptop, padlock, and others.

NAE GRAND CHALLENGES
FOR ENGINEERING
NATIONAL ACADEMY OF ENGINEERING

Challenges News Community

Provide energy from fusion

Human-engineered fusion has been demonstrated on a small scale. The challenge is to scale up the process to commercial proportions, in an efficient, economical, and environmentally benign way.



For more engineering lesson plans and
resources like games, engineering careers,
and STEM opportunities visit IEEE's
[TryEngineering.org](https://www.tryengineering.org)

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