

Building Circuits with Logic Gates to Demonstrate Mathematical Logic (P12 Resource Exchange)

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Joshua Coriell is a Curriculum Development Specialist at the Cyber Innovation Center's National Integrated Cyber Education Research Center. He graduated from Louisiana Tech University in with a B.S. in Mathematics and a Master of Arts in Teaching. He is currently getting his Ph.D. in Computational Analysis and Modeling while working on K-12 STEM curriculum and teacher professional development.

Sara Hahler, Louisiana Tech University

Sara Hahler is a graduate student at Louisiana Tech University. She received her Bachelor of Science in mathematics education in 2012 from Louisiana College and is currently enrolled in the Computational Analysis and Modeling PhD program at Louisiana Tech. During her time as an undergraduate, she served as a tutor for the mathematics department at Louisiana College. In 2015 she earned her Masters of Mathematics and Statistics from Louisiana Tech. Currently, she is performing research in the area of mathematics education exploring the connection between high school ACT mathematics scores and freshmen mathematic/engineering class grades.

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The National Integrated Cyber Education Research Center's (NICERC) Advanced Math for Engineering and Science (AMES) is a fourth year high school math curriculum geared towards students that anticipate pursuing a career in a STEM field. The topics in AMES provide a strong foundation for future math, science, and engineering courses. Concepts covered in the curriculum include the Cartesian coordinates system, polar and complex planes, vectors, matrices, three dimensional coordinate systems, and logic. The content is presented in a project-based nature including introductory projects for each unit, various small projects throughout to explain concepts, and capstone projects for each topic to apply and solidify understanding.

Logic Gate Activity

The logic section fosters foundational critical thinking and problem solving skills for any STEM student. However, mathematical logic is a difficult concept for many students to understand due to its abstract nature. In AMES, students learn about different logical operations such as and, or, nand, and xor. Then, they apply these operators with different applicable integrated circuits. Students use the circuits to develop logic tables and deduce the type of logic gate used in the circuitry.

This activity helps students associate a tangible and visual activity with an otherwise abstract concept. Additionally the use of logic and logic gates can be directly connected to disciplines like software engineering, systems engineering, electrical engineering, computer engineering, computer science, and others.

K12 and Precollege Resource Exchange

At the resource exchange full versions of the logic lessons will be available along with the materials to build and test different logic gate circuits. Provided below is an abbreviated lesson on building and testing the logic gates that starts at the point in the lesson where students are ready to build the circuits. At this point they have already learned about logical statements, logic operators, and truth tables.

Lesson Information

Contents

- Logic Review
 - » Statements
 - » Negation
 - » Conjunctions
 - » Disjunctions
 - » Exclusive Or
 - » Truth Tables
- Logic
 - » Practice with Testing
 - » Building the Circuit
 - » Testing the Samples

Materials Per Group

- Breadboard
- 1 LED
- 5 Jumper Wires
- 2 Push Button Switches
- 3 Resistors (220 Ohm)
- 2 Logic Gates
- 9 Volt Battery
- 9 Volt Battery Clip

Contact Information

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LOGIC GATES

Complete the following exercises to understand how the circuit will function and how the activity is performed.

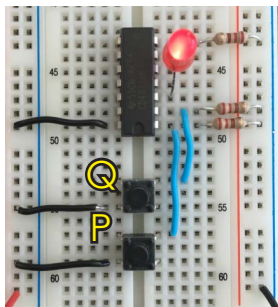
Exercise 1

Build the circuit pictured below.

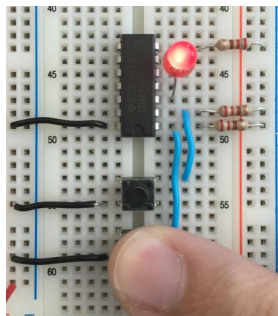
Key	
	Wire
	Push Button Switch
	LED
	Logic Gate
	220 Ohm Resistor

Exercise 2

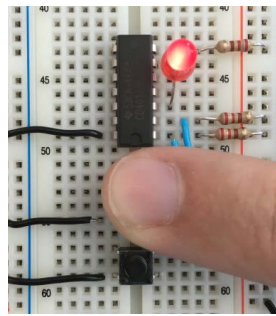
As practice with logic gates, you will need to identify all the Ts and Fs for the logic gate as well as determine what type of logic gate it is (i.e., AND, OR, XOR, NOR, NAND, XNOR) in the provided truth table. Note, if the light is on, then the statement is true. If the light is off, then the statement is false. Pictures for each stage have been included. Switch P & Switch Q are labeled on the first picture.



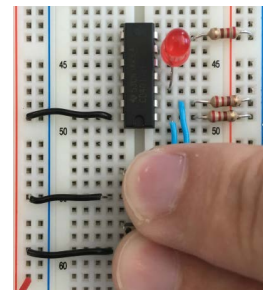
Both Switch P and Switch Q are not pressed



Only Switch P is pressed



Only Switch Q is pressed



Both Switch P and Switch Q are pressed

<i>p</i>	<i>q</i>	
T	T	
T	F	
F	T	
F	F	

Exercise 3

Determine the type(s) of gate(s) you were given.

Exercise 4

Repeat exercises 1-3 with different logic gates.