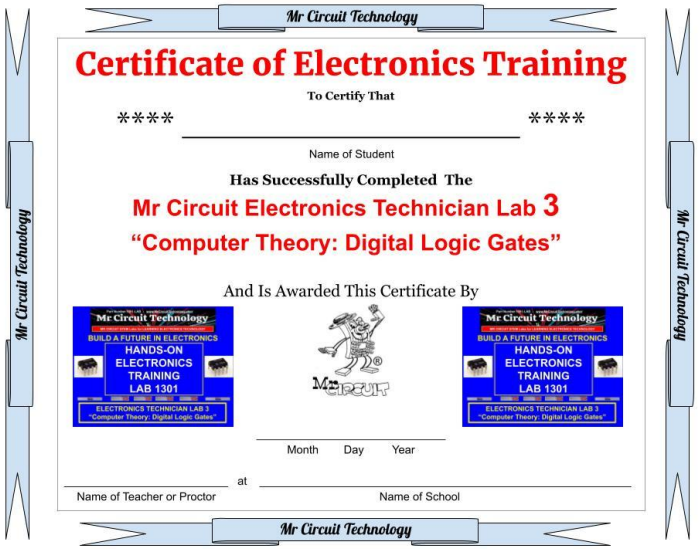
COVER

This is the *SEVENTH* lesson in the

MR CIRCUIT LAB 3.



COMPLETE THIS LAB 3 AND EARN A CERTIFICATE OF ELECTRONICS TRAINING

LAB 3: Computer Theory: Digital Logic Gates

07 00 COVER 1301-SL7

Basic Electronics
LAB 3
Digital Logic Gates for future Engineers and Techs

Lesson 7

The 'XOR' Logic Gate

INPUTS  OUTPUT

There are 3 pages. Start with Page 1 at the center of this booklet.

Booklet Number 1301-SL7

MR CIRCUIT ELECTRONICS TRAINING LAB

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Introduction to Digital Logic Gates "The 'XOR' Logic Gate"

The **'XOR' Logic Gate** has two inputs. The 'XOR' Gate has a HI output when either input is HI but not both inputs are HI.

(The way you can remember it is that the curved line to the left of the symbol means "not both". Either but not both.

There are 4 possible combinations on these inputs as shown in the Truth Table below. Notice that on the 'XOR' Gate, when both input are the same, the output is LO. Here are the Truth Tables for the 'OR' Gate and the "XOR' Gate so you can compare.

Truth Table for the 'OR' Gate

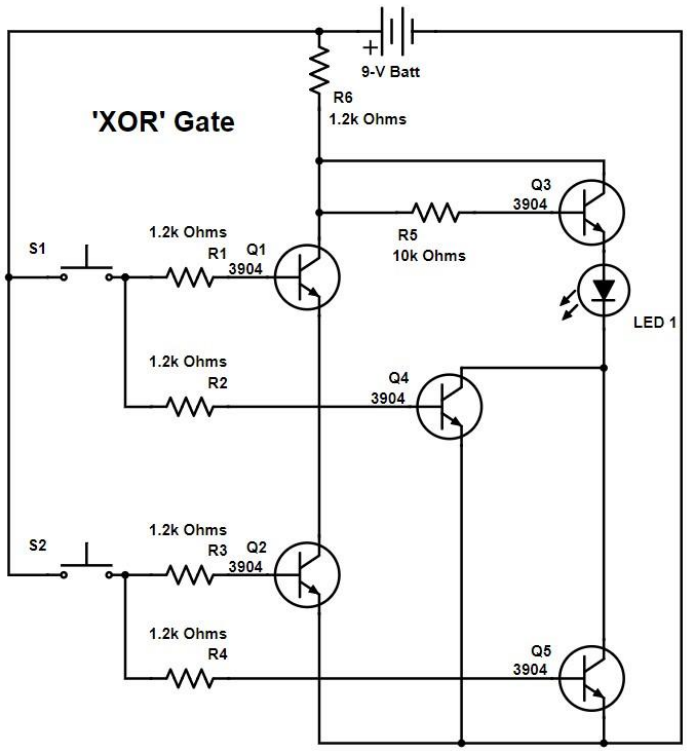
Input A	Input B	Output Q
0	0	0
0	1	1
1	0	1
1	1	1

Truth Table for the 'XOR' Gate

Input A	Input B	Output Q
0	0	0
0	1	1
1	0	1
1	1	0

LAB 3: Computer Theory: Digital Logic Gates

Here is a schematic of an electronic circuit that performs the function of a **'XOR' Logic Gate**.



Explanation of the circuit: This circuit has five transistors. This is quite an ingenious circuit. Q3 is forward-biased as soon as you connect the battery but it will not conduct any current unless either Q4 or Q5 are forward-biased. So, if you press S1, which forward-biases Q4, the LED will light up indicating an HI on the output. A similar thing happens when you press S2.

But, if you press both S1 and S2 at the same time, which forward-biases Q1 and Q2 which will remove the forward-bias voltages from Q3 by basically shorting Q3's Base to ground and the LED will not light up.

Now, use the QR Code to watch video Lesson 7. Then, using pages 2 and 3 in this booklet, build a 'XOR' Logic Gate circuit.

Step-by-Step Assembly Guide for "The 'XOR' Logic Gate"

Step 1: Follow these steps carefully to build the **'XOR'** Logic Gate.

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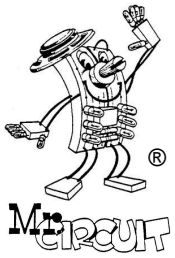
Step 2: Find the Experiment Parts Bags for the Mr Circuit Lab 3

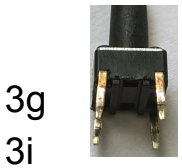
Step 3: Take out the following parts needed to build the **'XOR'** Logic Gate:

- one Solderless Circuit Board
- one 9-Volt Battery Snap
- one LED (Light Emitting Diode)
- one 1k Ohm resistor (Brown, Black, Red, Gold)
- five 1200 (1.2k) Ohm resistors (Brown, Red, Red, Gold)
- ten Jumper Wires
- five NPN Transistors (3904)
- two Normally-Open Pushbutton Switches

Step 4: Now, using the Pix of the Assembled Circuit on Page 3, install all the parts on the Solderless Circuit Board in this order.

__ **Install** the NPN transistor **Q1** Emitter in 9i, Base in 10i, Collector in 11i
__ **Install** the NPN transistor **Q2** Emitter in 9d, Base in 10d, Collector in 11d
__ **Install** the NPN transistor **Q3** Emitter in 21i, Base in 22i, Collector in 23i
__ **Install** the NPN transistor **Q4** Emitter in 12i, Base in 13i, Collector in 14i
__ **Install** the NPN transistor **Q5** Emitter in 12d, Base in 13d, Collector in 14d
__ **Install** the LED, Anode in 20g, Cathode in 21g
__ **Install** a 1000 Ohm resistor **R6** from 27g to Positive Buss
__ **Install** five 1200 Ohm resistors: **R1 from** 5j to 10h, and **R2 from** 5f to 13h, and **R3 from 5e to 10c,** and **R4 from** 5a to 13c, and **R5 from** 22h to 27f
__ **Install** a Jumper Wire in Positive Buss to 3i **and another** in 3f to 3e
__ **Install** a Jumper Wire in 9a to 12a **and another** in 9j to 11e
__ **Install** a Jumper Wire in 11j to 27h **and another** in 12j to Negative Buss
__ **Install** a Jumper Wire in 14j to 20h **and another** in 14e to 20f
__ **Install** a Jumper Wire in 23j to 27i **and another** in 12b to Negative Buss
__ **Install** the Battery Snap, Red in Positive Buss, Black in Negative Buss
__ **Install** the two Normally-Open Pushbutton switches with 4 legs. Install the legs as shown here.





Switch S1

Switch S2

Step 5: Lightly touch the battery to the Battery Snap (Note: do not connect it, just touch it lightly.) The LEDs should not light up. If it does, then please check your wiring carefully and try again.

Step 6: With the battery connected, press Switch S1. Did the LED light up? ____

Step 7: Press Switch S2, did the LED light up? ____

Step 8: Now, press both switches, at the same time, forward-biasing all the transistors except Q3. Did the LED light up?_____ .

Step 9: Conclusion: You should have observed that this circuit works like an **'XOR' Logic Gate.**

When Switch S1 puts a HI on the Base of Q1, the LED turns on indicating a HI on the output. And, when Switch 2 puts a HI on the Base of Q2, the LED turns on. And, when you press both switches at the same time, the transistors are all forward-biased except Q3 and the LED does not light up.

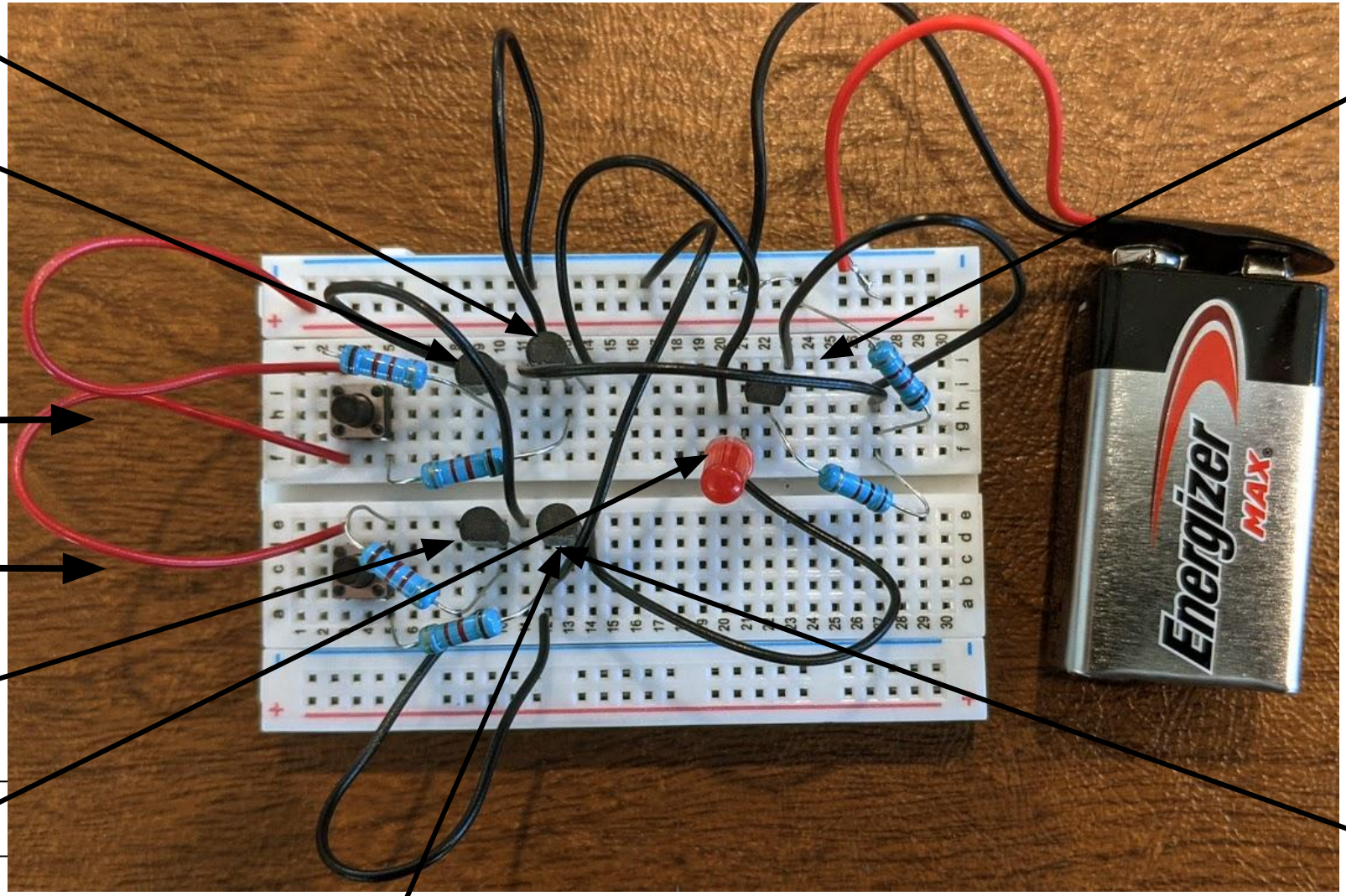
You have now learned how an 'XOR' Logic Gate works and how to build one using electronic components. These are the same type of components used in today's digital circuits.

Step 10: Now, disassemble the circuit and put all the parts back into the plastic bag and go to the next lesson in this lab.

LAB 3: Computer Theory: Digital Logic Gates

PAGE 2

Assembly Pix for Lesson 7 “The ‘XOR’ Logic Gate”



Lesson 3 - The ‘XOR’ Gate

LAB 3: Computer Theory: Digital Logic Gates