ENGINEERING GATORTRAX MATH EXCELLENCE PROJECT
ENGINEER-FOR-A-DAY LABORATORY MODULES

ELECTRICAL ENGINEERING
INTERMEDIATE LEVEL
BUILDING YOUR OWN LIE DETECTOR

Introduction

Electrical engineering is concerned with the uses of electrical energy. This energy is used in the various appliances, equipment, and instruments with which we come into contact on a daily basis. The key component of these appliances equipment and instruments is the electrical circuit.

Using this circuit electrical engineers are able to design

- Communications systems
- Computers
- Electronic components for computers, stereos systems and TVs
- Robots
- Aircraft and spacecraft controls
- Utility and industrial power systems
- Biological/medical systems

Electrical circuits general contains

- Switches
- Resistors
- Connecting wires

Objective

The objective of this lab is to demonstrate Boolean Algebra concepts through a lie detector

Goal

Link the use of classroom mathematics to the real world.

Activity Description/Problem Statement

Today we are electrical engineers who are responsible for determine which students from the high school is lying by using a lie detector.

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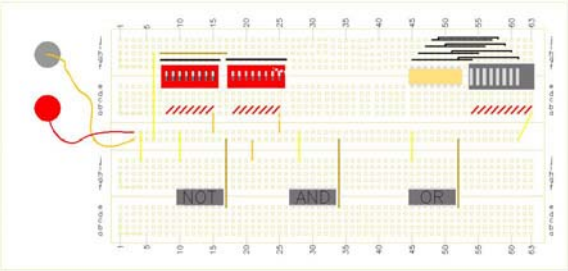
Materials for each Team

First, go through the material inside the box and make sure you have the following:

1. Designed board



2. Power supply

3. Multimeters

4. 3 Resistors (black and red)

5. 3 Resistors (red and red)

6. Wires

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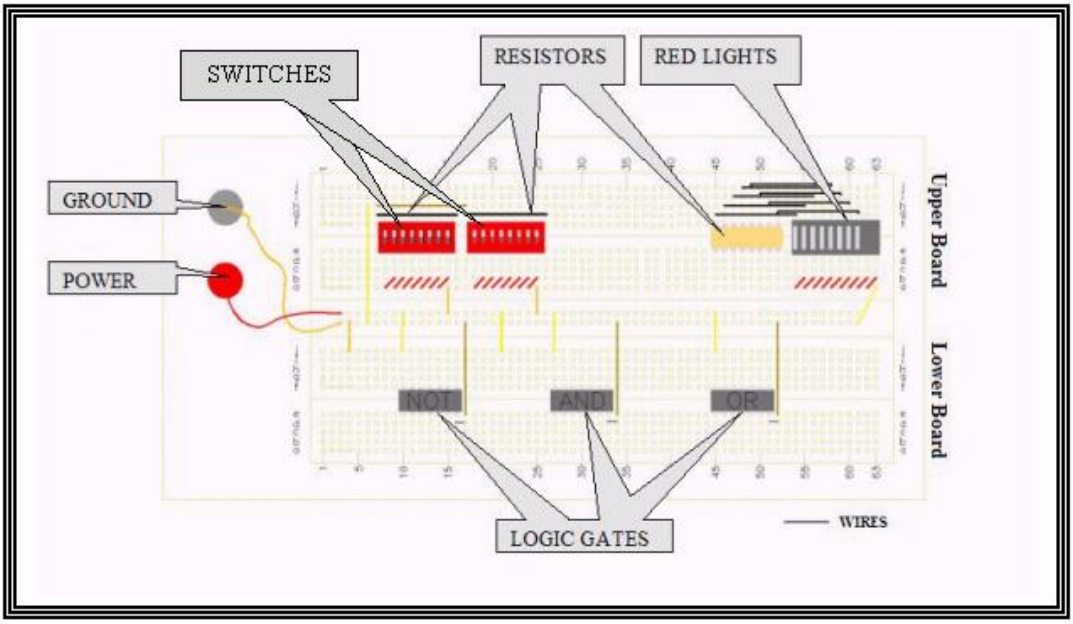
Second, check that your board is complete by comparing it to the picture below and checking with the check list below:



CHECK LIST	
	3 Resistors
	8 Red Lights (off)
	3 Logic Gates
	Power
	Ground
	Wires
	2 Set of Switches

- For the **CONNECTIONS SECTION** in each step you would be asked to place a wire from one point to another, this will be given in coordinates composed of one letter and a number. Also make the distinction between the upper and the lower board. The **BOARD SCHEMATIC** will show the wire you are connecting at the given step but may not show all the wire that are connected at the moment, this is for simplicity reasons. To check all the connections that are supposed to take place at the moment refer to the CONNECTIONS section.

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Pre-lab: Exercise

One very sunny Friday morning, 8 students from Goonesville High decided to skip school and head to the beach for a day of sunbathing, surfing and water-skiing. Unfortunately for them the school 's resource officer, Officer Doom decided to do a beach patrol on that day. He spotted the students, carefully noted who they were and reported them to the principal.

The following Monday the students were summoned to the principal's office to account for their absence from school on Friday. Some of them had time to meet before seeing the principal in order to establish what they would say. However, they could not find a couple of those who had skipped with them, and these were unaware of the story which had been agreed should be told to the principal.

The students were all kept apart from each other, and upon being questioned by the principal, the students answered as follows:

P: It was a sunny day
Q: Eight students skipped school
R: They went to the beach

Student 1: Eight of us went to the bowling due to the bad weather
Student 2: We had planned to skip but on seeing the rain the five of us decided to stay on campus.
Student 3: The three of us went to the zoo to enjoy such beautiful day.
Student 4: Six of us went to the beach earlier in the day, but due to the weather we returned to campus during the third period.
Student 5: On seeing how beautiful the day was, all eight of us decided we would go to the beach. The weather was perfect and we spent some time there.
Student 6: The eight of us had decided earlier to skip and go bowling since it was such beautiful day
Student 7: Eight of us went to the beach, but it was too cloudy and we returned to campus.
Student 8: All four of us went to the beach in the sunny morning, but returned to campus in the afternoon.

Get the corresponding truth-values for the table below:

	P	**Q**	**R**
Student 1:			
Student 2:			
Student 3:			
Student 4:			
Student 5:			
Student 6:			
Student 7:			
Student 8:			

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GENERAL LAB PROCEDURES

For every single step do the following:

CONNECTIONS:

1. Make the connections as listed in the **CONNECTIONS SECTION.** Use the **BOARD SCHEMATIC** to have a better view of where the connections take place. For an enlarge view of the **BOARD SCHEMATIC,** turn to the back of the page.

EXPERIMENT OBSERVATION:

2. After all the connections are made, use the circuit to find as many on/off combinations of the given switches. There will be eight combinations. Use a pen or pencil to move the switches easily.
3. With a red pen or marker, record in each row of Table1, all the on/off combination found when using switch 8, by coloring the red light picture with the different results of light combination shown by the board's red lights, on the left column of the **TABLE, Table 1.**
4. Now convert all the on/off combinations with True and False. You will replace ***on*** with True and ***off*** with False.

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ACTIVITY LEVEL 1

CONNECTIONS:

1. Make the connections as listed in the **CONNECTIONS SECTION, Table 1.** For an enlarge view of the **BOARD SCHEMATIC, Figure 1,** turn to the back of the page.

	CONNECTIONS SECTION	
1	Uh25 => Ud47	
2	Uh24 => Ud46	
3	Uh23 => Ud45	
U= upper board	B= lower board	

EXPERIMENT : OBSERVATION

2. After all the connections are made, use the circuit to find as many on/off combinations of the switch. Use a pen or pencil to move the switches easily.

3. With a red pen or marker, record in each row of Table1, all the on/off combination found when using switch 8, by coloring the red light picture with the different results of light combination shown by the board's red lights, on the left column of the **TABLE, Table 1.2.**

4. Now convert all the on/off combinations with True and False. You will replace on with True and off with False.

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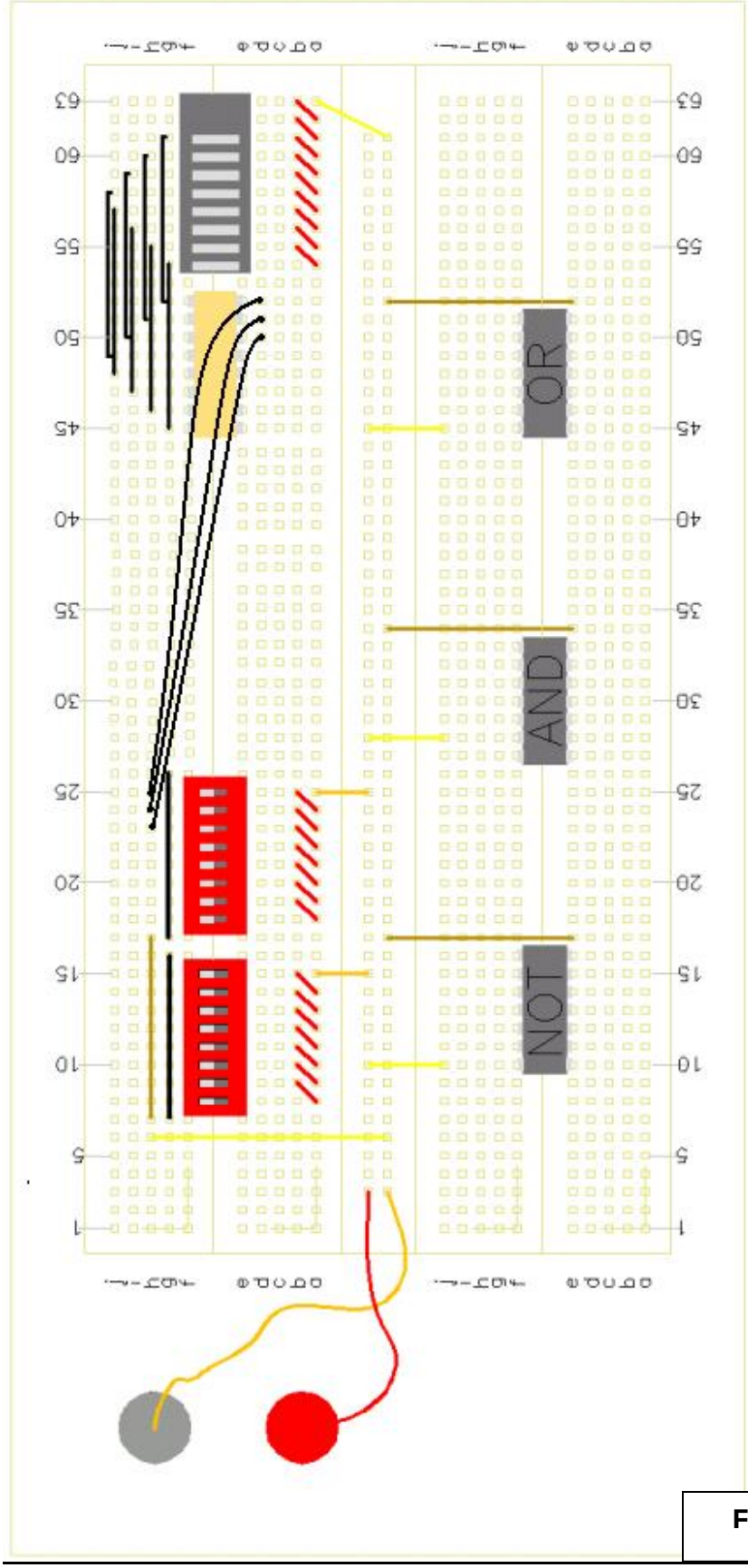

Figure 1

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DISPLAYING PROPOSITIONS

	P	Q	R					

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ACTIVITY LEVEL 2

CONNECTIONS:

1. Make the connections as listed in the **CONNECTIONS SECTION, Table 2.** For an enlarge view of the **BOARD SCHEMATIC, Figure 1,** turn to the back of the page.

	CONNECTIONS SECTION	
1	Ui23 => Bd10	
2	Bd11 =>Ud48	
3	Ui24 => Bd12	
4	Bd13=> Ud49	
U= upper board	B= lower board	

EXPERIMENT :
OBSERVATION

2. After all the connections are made, use the circuit to find as many on/off combinations of the switch. Use a pen or pencil to move the switches easily.

3. With a red pen or marker, record in each row of Table1 all the on/off combinations found when using switch 8, by coloring the red light picture with the different results of light combination shown by the board's red lights, on the left column of the **TABLE, Table 1.2.**

4. Now convert all the on/off combinations with True and False. You will replace on with True and off with False.

5. Now negate all the eight combinations and record the answer in the next two columns in **TABLE, Table2.2.**

6. Check the Boolean logic with the circuit by turning the switches on and off.

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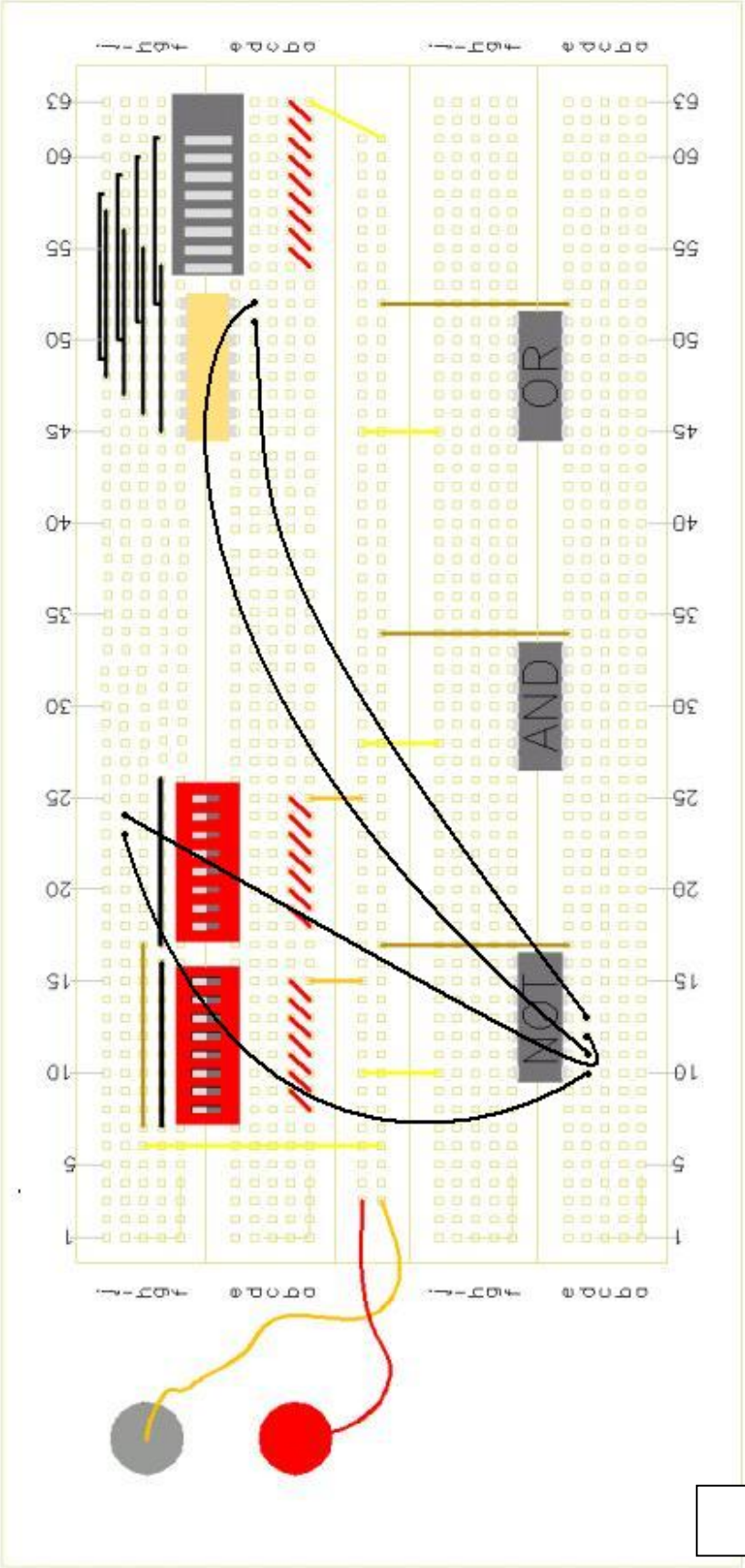

Figure 2

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NEGATING PROPOSITIONS

	P	Q	R	NOT P	NOT Q			

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ACTIVITY LEVEL 3

CONNECTIONS:

1. Make the connections as listed in the **CONNECTIONS SECTION, Table 3.** For an enlarge view of the **BOARD SCHEMATIC, Figure 3,** turn to the back of the page.

	CONNECTIONS SECTION	
1	Bc11 => Bd45	
2	Bc13 => Bd46	
3	Bd47 => Ud50	
U= upper board	B= lower board	

EXPERIMENT : OBSERVATION

2. After all the connections are made, use the circuit to find as many on/off combinations of the switch. Use a pen or pencil to move the switches easily.

3. With a red pen or marker, record in each row of Table1, all the on/off combination found when using switch 8, by coloring the red light picture with the different results of light combination shown by the board's red lights, on the left column of the **TABLE, Table 3.2.**

4. Now convert all the on/off combinations with True and False. You will replace on with True and off with False.

5. Now negate all the eight combinations and record the answer in the next two columns in **TABLE, Table3.2.**

6. Check the Boolean logic with the circuit by **turning** the switches on and off.

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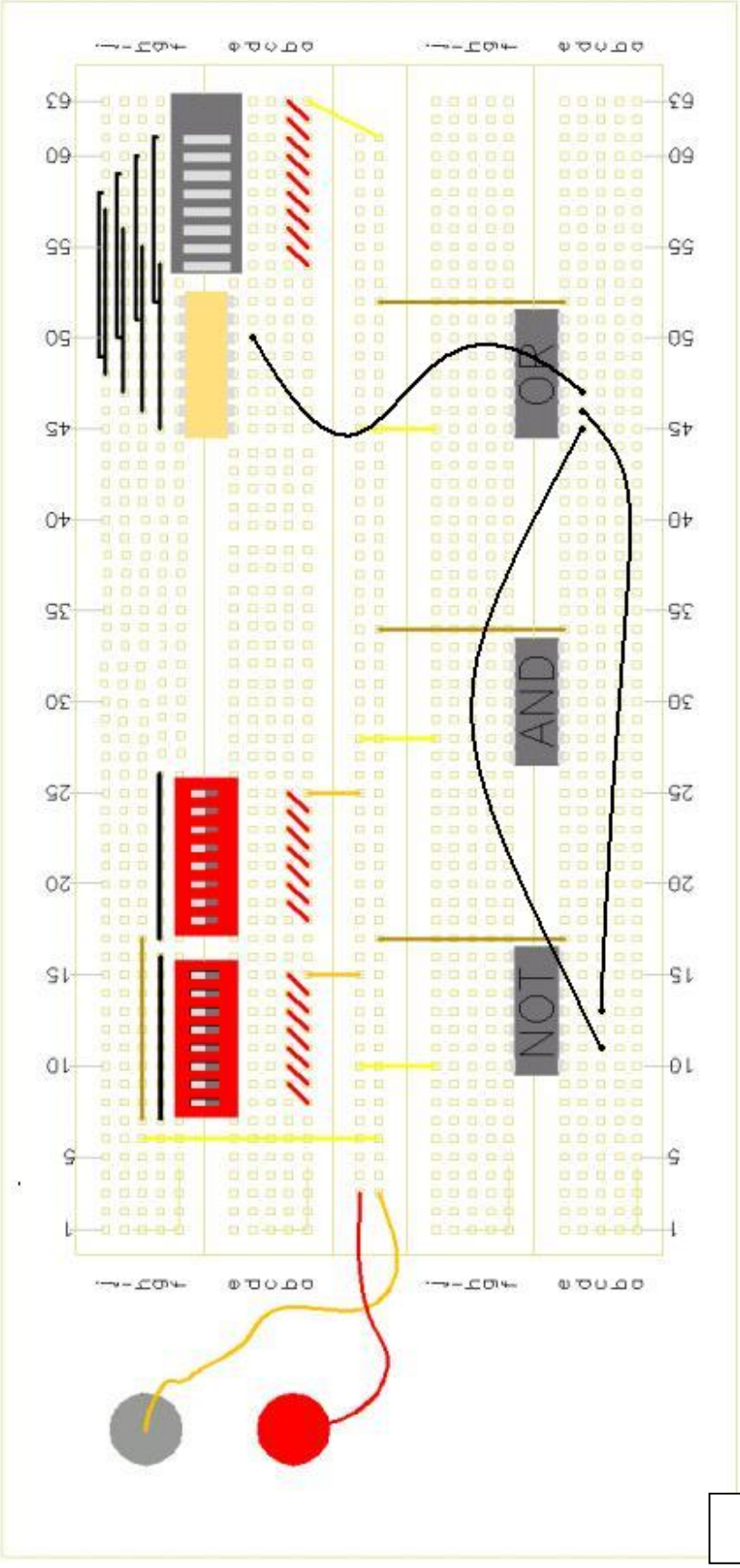

Figure 3

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ORing PROPOSITIONS

	P	Q	R	NOT P	NOT Q	NOT P OR NOT Q		

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ACTIVITY LEVEL 4

CONNECTIONS:

1. Make the connections as listed in the **CONNECTIONS SECTION, Table 4.** For an enlarge view of the **BOARD SCHEMATIC, Figure 4,** turn to the back of the page.

	CONNECTIONS SECTION	
1	Bc47 => Bd14	
3	Bc15 => Ud51	
U= upper board	B= lower board	

EXPERIMENT : OBSERVATION

2. After all the connections are made, use the circuit to find as many on/off combinations of the switch. Use a pen or pencil to move the switches easily.

3. With a red pen or marker, record in each row of Table1, all the on/off combination found when using switch 8, by coloring the red light picture with the different results of light combination shown by the board's red lights, on the left column of the **TABLE, Table 4.2.**

4. Now convert all the on/off combinations with True and False. You will replace on with True and off with False.
5. Now negate all the eight combinations and record the answer in the next two columns in **TABLE, Table4.2.**
6. Check the Boolean logic with the circuit by turning on and off the

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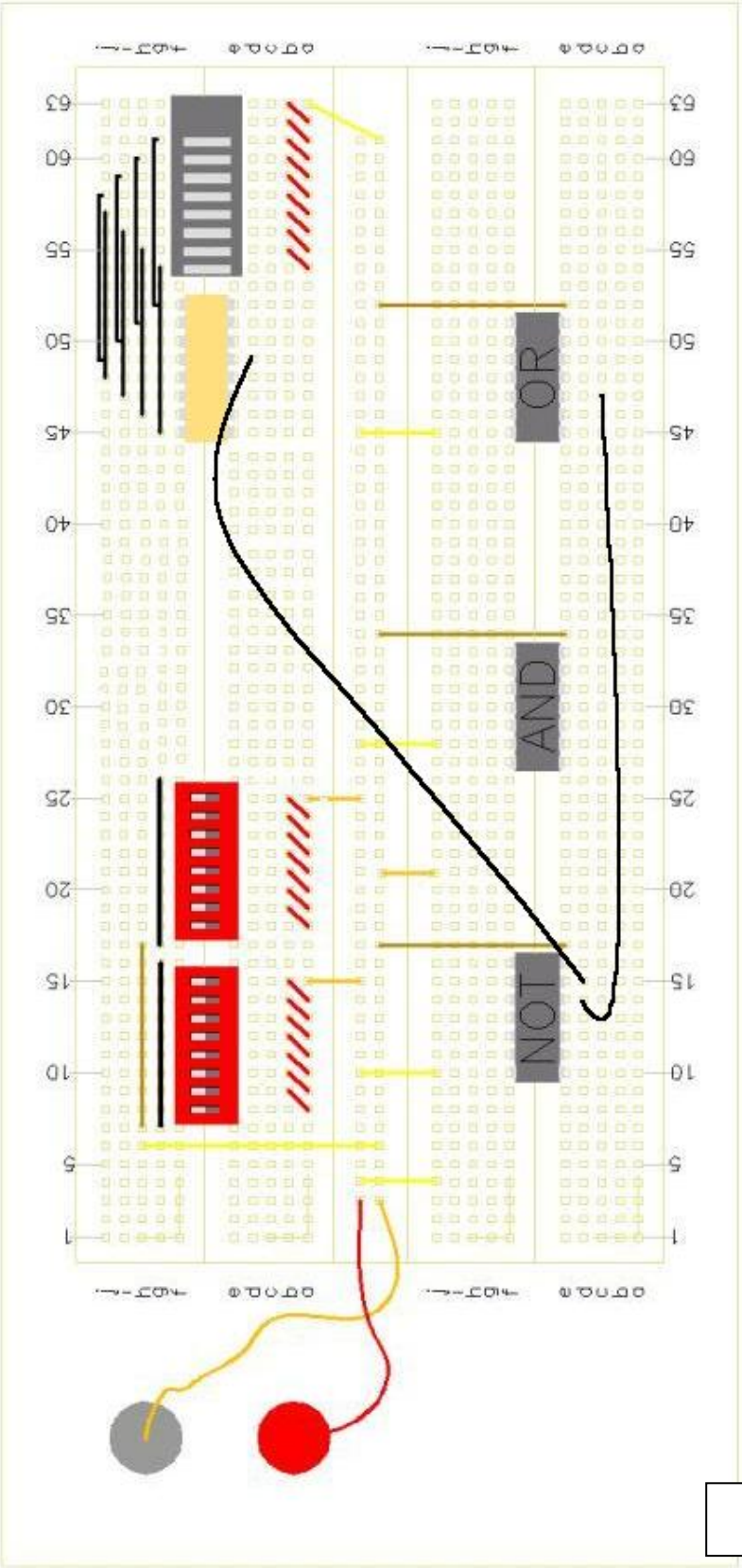

Figure 4

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NEGATING A COMBINED PROPOSITIONS

	P	Q	R	NOT P	NOT Q	NOT P OR NOT Q	NOT (NOT P OR NOT Q)	

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ACTIVITY LEVEL 5

CONNECTIONS:

1. Make the connections as listed in the **CONNECTIONS SECTION, Table 5.** For an enlarge view of the **BOARD SCHEMATIC, Figure 5,** turn to the back of the page.

	CONNECTIONS SECTION	
1	Ui25 => Bd28	
2	Bc15=> Bd27	
3	Bd29=> Ud52	
U= upper board	B= lower board	

EXPERIMENT : OBSERVATION

2. After all the connections are made, use the circuit to find as many on/off combinations of the switch. Use a pen or pencil to move the switches easily.

3. With a red pen or marker, record in each row of Table1, all the on/off combination found when using switch 8, by coloring the red light picture with the different results of light combination shown by the board's red lights, on the left column of the **TABLE, Table 5.2.**

4. Now convert all the on/off combinations with True and False. You will replace on with True and off with False.

5. Now negate all the eight combinations and record the answer in the next two columns in **TABLE, Table5.2.**

6. Check the Boolean logic wit h the circuit by **turning** the switches on and off.

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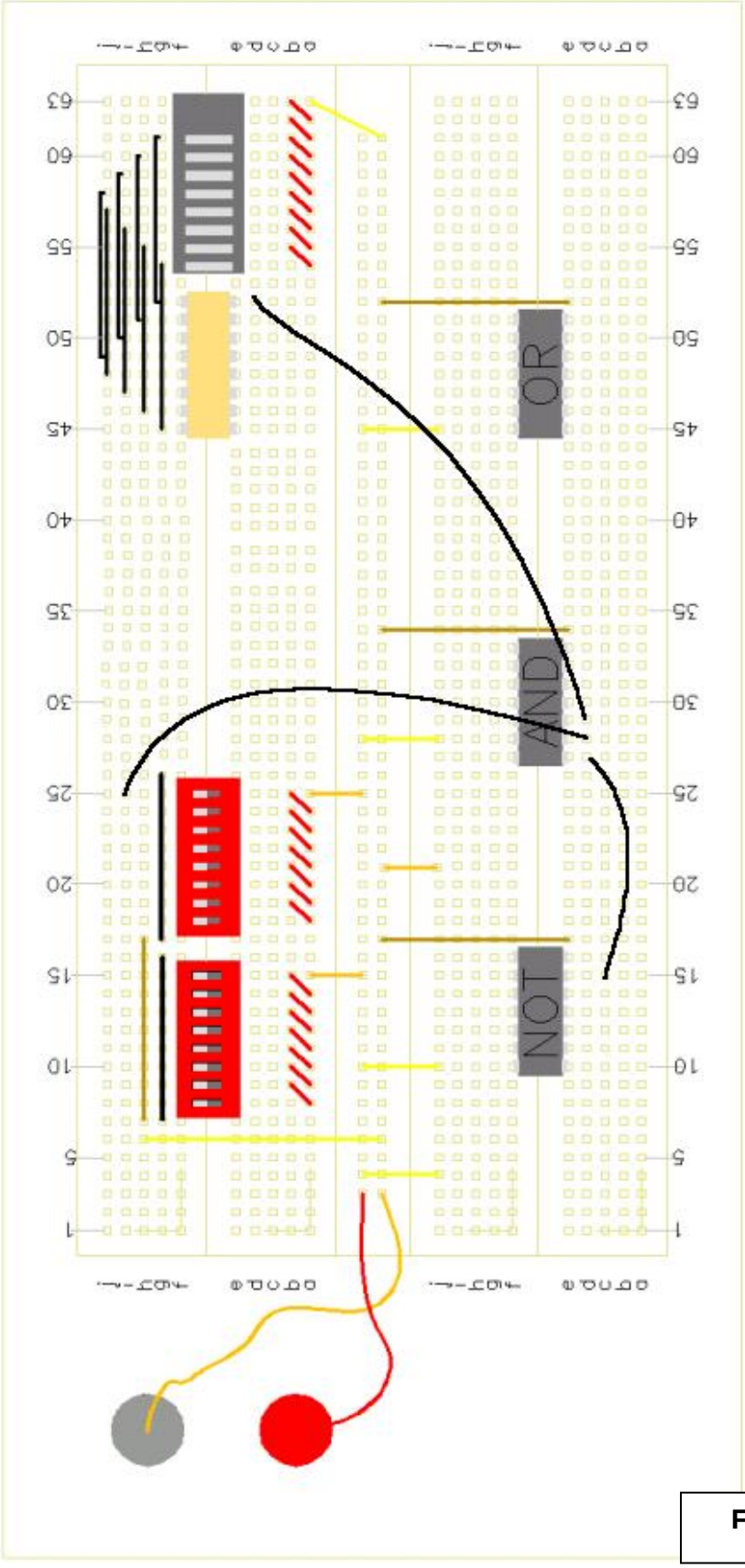

Figure 5

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ANDing PROPOSITIONS

	P	Q	R	NOT P	NOT Q	NOT P OR NOT Q	NOT (NOT P OR NOT Q)	NOT (NOT P OR NOT Q) AND R

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