1 Lab 1: Ohm's Law and basic circuits

Objective: To explore Ohm's Law in various circuits, to build an AND and OR gates using diodes.

Provided: Two resistors, two diodes, digital multimeter (DMM), breadboard

Background Ohm's law states that the voltage across a resistor is directly proportional to the current flowing through it: $V = RI$, where V is the voltage across the resistor, R is the resistance and I is the current through the resistor.

If resistors R_1 and R_2 are connected in series, the total resistance is $R_s = R_1 + R_2$. If resistors R_1 and R_2 are connected in parallel, then the total resistance R_p is found using this relationship:

$$\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$$

Note using the multimeter: In a circuit resistances and voltages are measured "in parallel," whereas current should be measured "in series."

1.1 Ohm's Law and resistors in series and in parallel

1. Using the multimeter, measure and record the actual resistance of resistors R_1 and R_2 provided. (Values need not be exact.)

   $R_1 =$_____ $R_2 =$_____

2. Measure and record the resistance of the resistors in series using the multimeter.

   $R_s =$_____

3. Measure and record the resistance of the resistors in parallel using the multimeter.

   $R_p =$_____

4. Calculate the series and parallel resistances and compare with the measured values.

	Computed	Measured
R_s		
R_p		

5. Apply 5 volts to each of the two resistors (Figure 1, 2), the two resistors in series (Figure 3) and the two resistors in parallel (Figure 4) and measure the current through each using the multimeter.

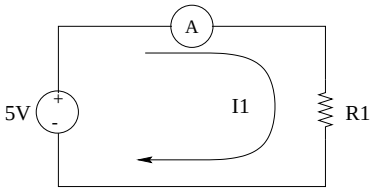

Figure 1.

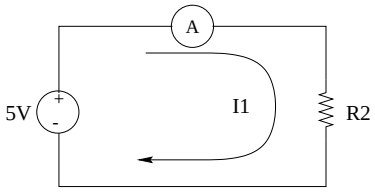

Figure 2.

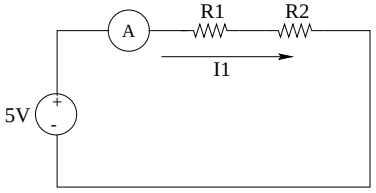

Figure 3.

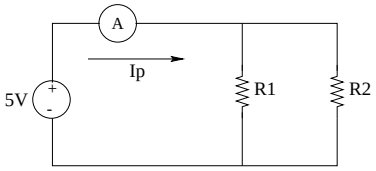

Figure 4.

6. Compare these values with the calculated ones by applying Ohm's law to each of these circuits.

	Computed	Measured
I_1		
I_2		
I_s		
I_p		

1.2 Diodes, the AND and OR gates

A diode is a two terminal device which behave like a switch: When voltage is applied with the polarity shown in Figure 5, it acts like a short circuit (that is, ideally; in reality there is some voltage drop across it); when the polarity is reversed, it acts like an open circuit. **Caution:** Never apply a voltage directly across a diode; make sure it is in series with resistance, e.g. a resistor.

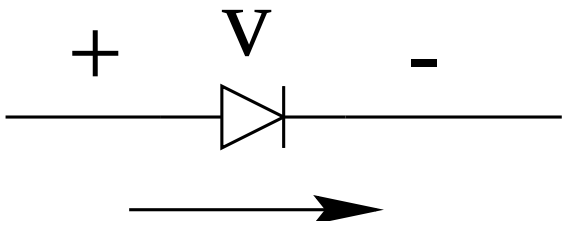

Figure 5.

1. Apply 5 volts to a diode in series with resistor R_1 1 and measure and record the voltage across the diode. (Figure 6)

   $V_0 =$_____

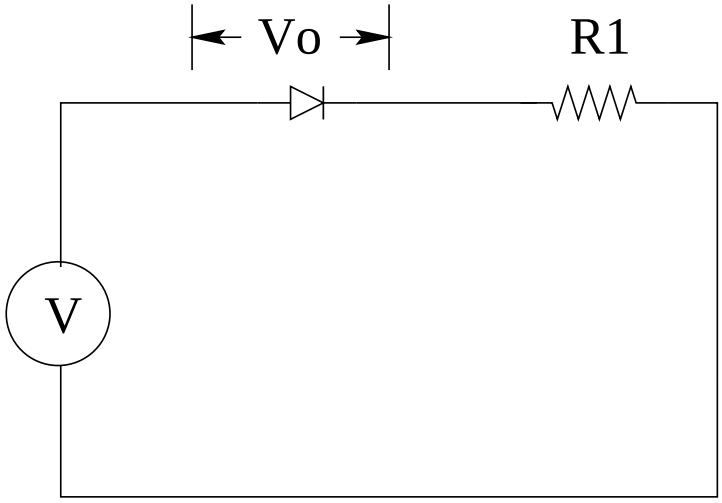

Figure 6.

2. Apply 5 volts to a diode in series with both resistors R_1 and R_2 and measure and record the voltage across the diode.

$V_0 =$_____

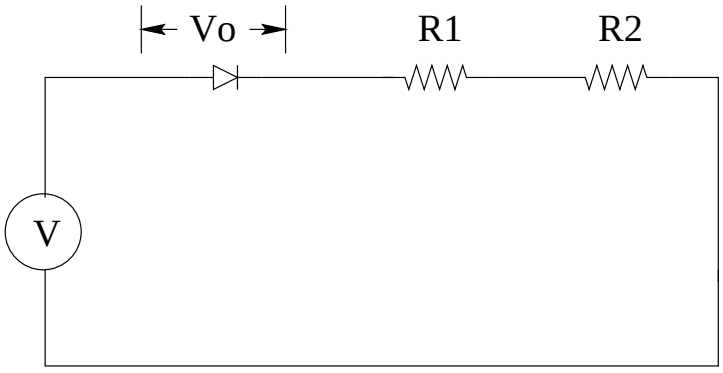

Figure 7.

Note: voltage drop should be constant in both cases about 0.7 volts. Ohm's law applies to "linear" devices, whereas diodes and transistors are "non-linear" devices, described by no simple law, but by "characteristic curves" (which we will not study).

Construct an AND and an OR gate using diodes

1. The circuit below (Figure 8) is an AND gate using diodes. A and B are the inputs and Out is the output. Construct the circuit and then fill the table below.

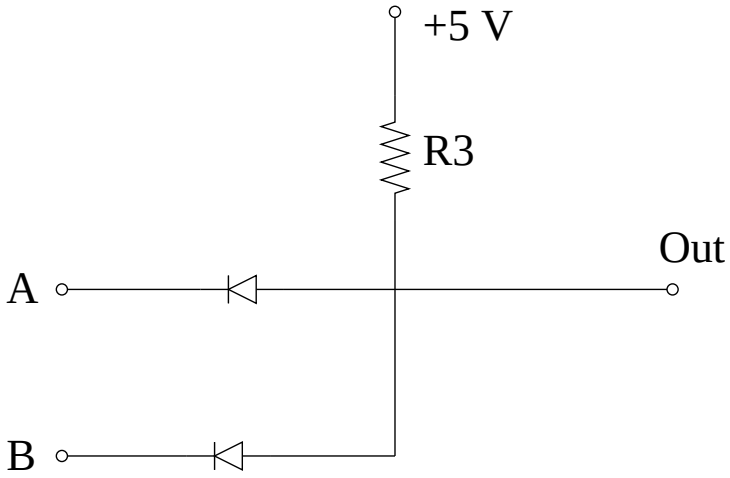

Figure 8: AND gate

A	B	Out
0 V	0 V	
0 V	5 V	
5 V	0 V	
5 V	5 V	

2. The circuit below (Figure 9) is an OR gate using diodes. A and B are the inputs and Out is the output. Construct the circuit and then fill the table below.

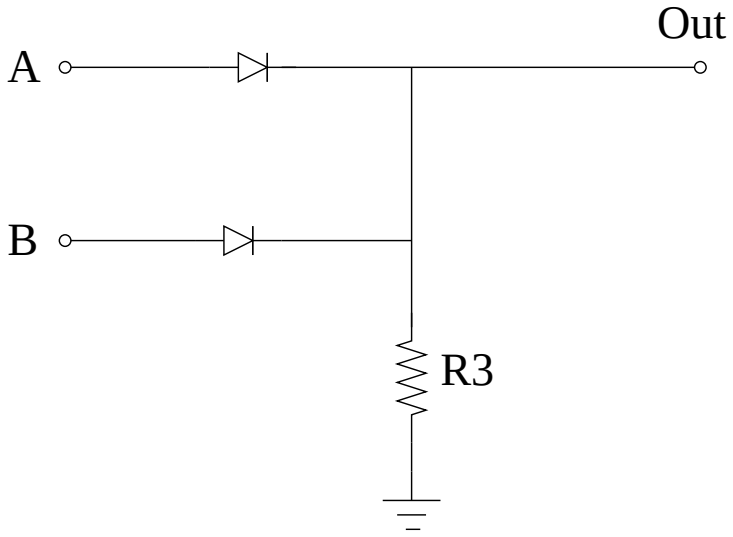

Figure 9: OR gate

A	B	Out
0 V	0 V	
0 V	5 V	
5 V	0 V	
5 V	5 V	