ELECTRONICS LAB #1

This lab is an introduction to the measurement of electrical quantities using a digital multimeter (DMM) as well as an introduction to fundamental electrical components, power supplies, and simple circuits. Record all measurements.

> ***NOTE: The power supply to the breadboard should be disconnected when altering the circuits on the breadboard.***
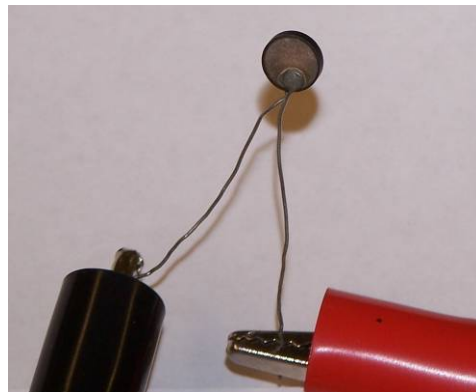
PART A - Resistance Measurements

Using the operator's manual of the DMM, prepare the DMM to make a resistance measurement. What is the DMM resistance response to "short circuit" (test leads connected together)? What is the resistance response to "open circuit" (test leads not connected together)?

Locate a thermistor and connect the DMM leads to the thermistor. Measure and record the resistance of the thermistor. Next, place the thermistor between your fingers to "heat" it. Record the new resistance value after stabilization. From the response curve for the thermistor, record the temperatures corresponding to the resistances you measured experimentally. Compare these values to the room temperature and your expected body temperature.

Calculate the change in thermistor resistance per degree change in temperature. Next, obtain the resolution of the DMM for a resistance measurement from the operator's manual. Calculate the temperature resolution for the thermistor.

The Digital Multimeter

Thermistor
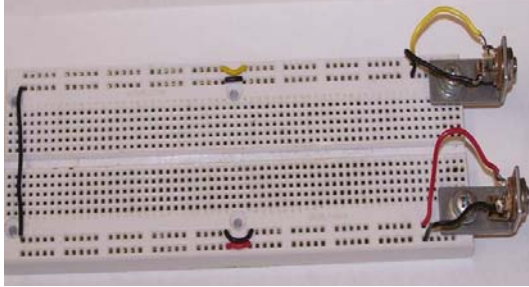
PART B - Voltage Measurement

A photodiode is a semiconductor device which produces an output current related to the intensity of light which strikes the photodiode. When connected to the DMM, a voltage is produced that can be measured and related to light intensity.

Prepare the DMM to make a DC voltage measurement. Connect the leads to the terminals of a photodiode and measure the voltage in room light. Assuming a DMM input resistance of 10 MΩ, what is the current generated by the photodiode?

Cover the photodiode completely and measure the voltage. Next, place a sheet of white paper over the diode and measure the voltage. How might a light intensity versus voltage relationship be established for the photodiode? How might a photodiode be used in an instrumental analysis application? How might a photodiode be used in an "everyday, non-chemical" application?

**Photodiode
(Colors may vary,
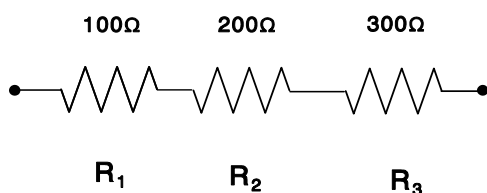typically red or yellow)**

Breadboard

PART C - Becoming Familiar with the Breadboard and Continuity Testing

       As positioned in the attached diagram, the breadboard contains 64 vertical columns of 5 interconnected contacts. Along the right and left edges of the breadboard, there are 4 long horizontal columns of interconnected contacts. These columns are called power bus strips because they will be connected to the power supplies to provide power over the length of the board. The instructor will offer further explanation regarding the breadboard connections. By strategically inserting wires into the board and by using the DMM in resistance mode, confirm the connection arrangement. It is important to understand this arrangement for future work.

PART D - Resistors

       Locate a 100Ω, a 200Ω, and a 300Ω resistor from the electronics kit, making sure that they are 1/4 watt resistors. Use the resistor codes on the last page of this lab to aid in identification. Insert each resistor into the breadboard and measure its resistance by connecting the DMM leads to wires that are connected to the resistor via the breadboard. Compare the measured resistances to the expected resistances.   Do the resistors meet specifications?

       Wire the resistors in series on the breadboard as diagrammed below and show your work to the instructor. Measure the resistance of the resistors in series and compare it to the calculated value for resistance. Next, measure the resistance of R_2 and R_3 (only) in series - do not disconnect R_1 when making this measurement. Compare your measured value with the expected value.

100Ω	200Ω	300Ω

R_1	R_2	R_3

1/4 watt

1 watt

Resistors
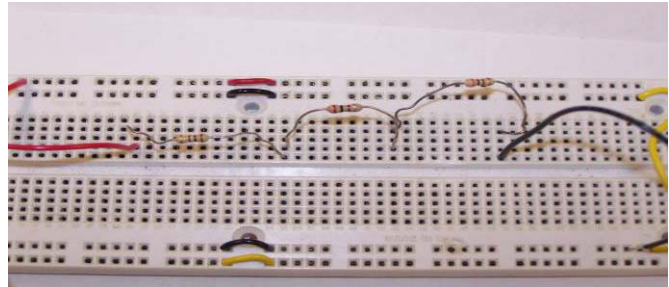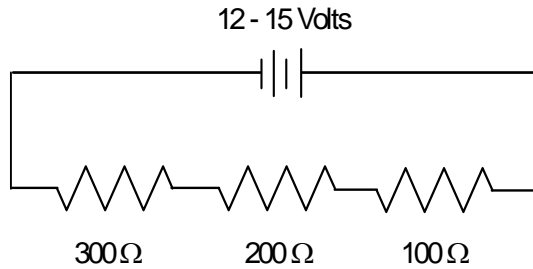
PART E - The Unregulated Power Supply

   Your electronics kit contains a step-down transformer that converts 120 V AC from the wall to a 12-15 V DC power supply for the breadboard. Notice how the power supply leads are wired. Connect the power supplies to each of the leads and measure (and record) the following potentials:

1. Between the red and black leads
2. Between the yellow and black leads
3. Between the red and yellow leads

The black leads are called a circuit common or system common.

PART F - The Voltage Divider

Construct the following series circuit using the resistors that you used in PART D.

12 - 15 Volts

300 Ω   200 Ω   100 Ω

Measure the voltage drop across the entire circuit and also across each resistor. Does the potential drop across the entire circuit equal the sum of the drops across each resistor?

PART G - Loading of an Unregulated Power Supply

Changes in the supply voltage of an unregulated power supply are often caused by variations in the load current. A high current drain from the supply causes a drop in the supply voltage.

Measure the DC output voltage of the positive voltage supply without any load (no significant current-drawing components).

Prepare to connect two, one watt 100Ω resistors in series between the 12 V power supply and ground as shown, but do not connect the 12 V supply until you are ready to measure the voltage. The one watt resistors are the larger-bodied resistors.

Connect the circuit to the power supply, and measure the output voltage of the power supply. *Carefully* check to see if the resistors are hot. Disconnect the circuit.

What are the effects of a large current drain on the unregulated power supply voltage? Calculate the power dissipated in each of the 100 Ω resistors.
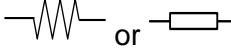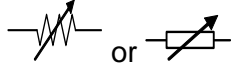

100 Ω
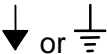1 Watt

100 Ω
1 Watt

PART H - Design and Construct Your Own Circuit

Design your own simple circuit (perhaps using resistors in parallel or in parallel and series. Considerations in this design include:

1. The circuit should not excessively load the unregulated power supply.
2. The power dissipated by the resistors should not exceed their power rating.
3. You must calculate the expected potential drops across each resistor and compare this with the experimentally-obtained value.
4. This part of the experiment can be performed with a partner.

Propose your circuit to the instructor before wiring the circuit, showing your calculated potential drops and power dissipation calculations. For your report, diagram the circuit you have constructed along with theoretical and experimental voltage drop values. Show all calculations.
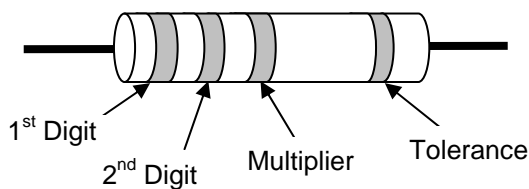
Common Electronic Components

Component	Schematic Representation	Component	Schematic Representation
Resistor	—/\/\/— or —▭—	Battery	—|⊢
Variable Resistor	—/\/\/— or —▱—	Diode	—▶⊢
Capacitor	—|⊢	Operational Amplifier	▷
DC Power Source	—||⊢	Ground or Common	▼ or ⏚

Resistor Codes

Most resistors have three colored bands close together at one end and one single band at the other. The three adjacent bands give the resistor value, while the single band indicates the tolerance of the resistor. The band closest to the wire indicates the first digit, the second band indicates the second digit, and the third band is a multiplier indicating the power of 10 with which to multiply the two digits to determine the value of the resistance.

The fourth band indicates the tolerance of the resistor, which is the expected agreement of its actual and nominal value when purchased. Tolerance is expressed as a percent of the nominal value. Therefore, a 100 kΩ, 1% resistor is within tolerance if it has a resistance between 99 kΩ and 101 kΩ, while a 5%, 100 kΩ resistor is within tolerance if its resistance is between 95 and 105 kΩ. There are four main categories of resistors: general purpose (± 5-20%), semi-precision (± 1-5%), precision (± 0.1-1%) and ultra-precision (± 0.01-0.1%).

1st Digit 2nd Digit Multiplier Tolerance

Resistor Color Codes			
Color	**Digit**	**Multiplier**	**Tolerance**
Black	0	$10^0 = 1$	--
Brown	1	$10^1 = 10$	± 1%
Red	2	$10^2 = 100$	± 2
Orange	3	10^3	--
Yellow	4	10^4	--
Green	5	10^5	± 0.5%
Blue	6	10^6	± 0.25%
Violet	7	10^7	± 0.1%
Grey	8	10^8	± 0.05%
White	9	10^9	--
Gold	--	0.1	± 5%
Silver	--	0.01	± 10%
No Band	--	--	± 20%

For example, the resistor at the right would have a value of 50 x 10^2 or 5000 Ω and a tolerance of 5%.

Green   Black   Red   Gold