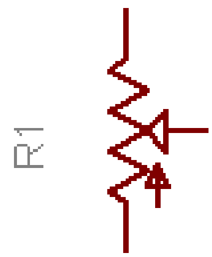
Lab 4: Name: Cohort: Date:

Pre-Lab Exercise – Potentiometers

DON'T SPEND MORE THAN 5 MINUTES ON THIS!

Component List:

- 100KΩ Potentiometer



Questions:

Work with a partner

1. Variable resistors have three terminals. Measure the resistance across the two outside terminals.

2. Record this resistance. R_T = __________

2. Use one multimeter to measure the resistance between one outside leg and the middle leg.

3. Connect the other multimeter to the middle leg and the other outside leg.

4. Vary the resistance of the potentiometer by turning the small dial with a screw driver or potentiometer tool.

4. What do you notice?

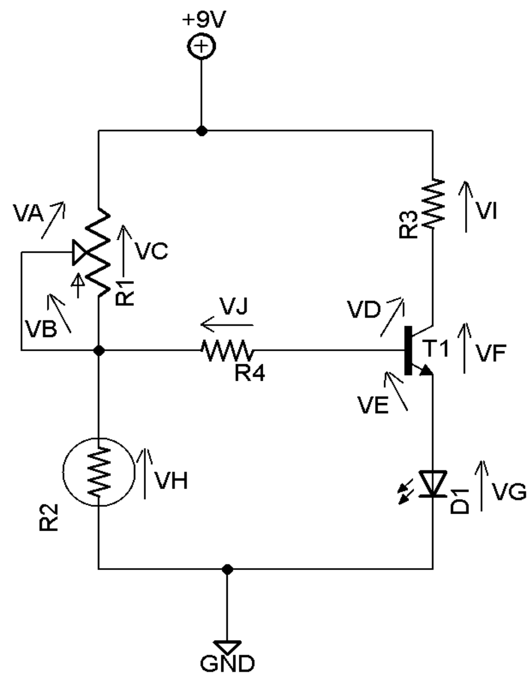
5. How is this a resistance divider?

"Tuning" Your Circuits

The sensor circuits used in this lab require some tuning before they will work. We have to adjust the potentiometer so that the ambient light in the room is accounted for. To adjust your circuit so that it works properly, turn your potentiometer so that the LED is on, and then turn it so that the light just turns off. Now, when you cover the sensor, you should see the light coming on to indicate that the circuit has sensed a dark condition. When you move your hand, the light should turn back off. Both of these circuits are dark sensing, but my changing the location of the photoresistor, they can both become light sensing circuits as well.

Lab 4: Name: Cohort: Date:

Circuit 1 – Analog Dark Activated LED



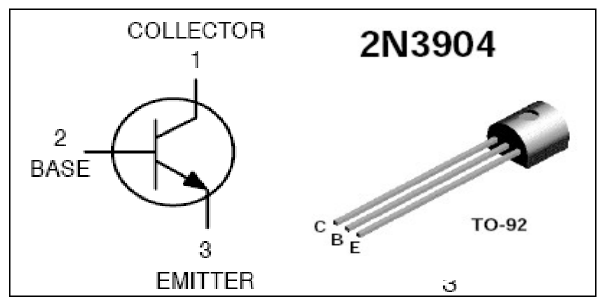
Component List:

- V1 = 9V
- R1 = 100kΩ Potentiometer,
- R2 = Photoresistor
- R3 = 360Ω
- P4 = 1κΩ
- D1 = LED
- T1 = 2N3904 (use the picture below the circuit diagram to carefully connect the transistor!)

Circuit Function:

By adjusting the value of the "variable resistor" (a.k.a. the potentiometer), you can adjust the sensitivity of this circuit to the room lighting conditions. When adjusted properly, you should be able to cover the photoresistor (R2) and the LED should turn on.

Questions:



1. Comment on the function of your circuit (how well did it work?)

2. With the LED on (dark photo resistor), use your DMM to measure voltages V_A through V_H shown in the diagram. Record your results in the table to the right, and calculate the current and power for any resistors. Are any resistor being over-powered?

Voltage	Current	Power
V_A =		
V_B =		
V_C =		
V_D =		
V_E =		
V_F =		
V_G =		
V_H =		
V_I =		
V_J =		

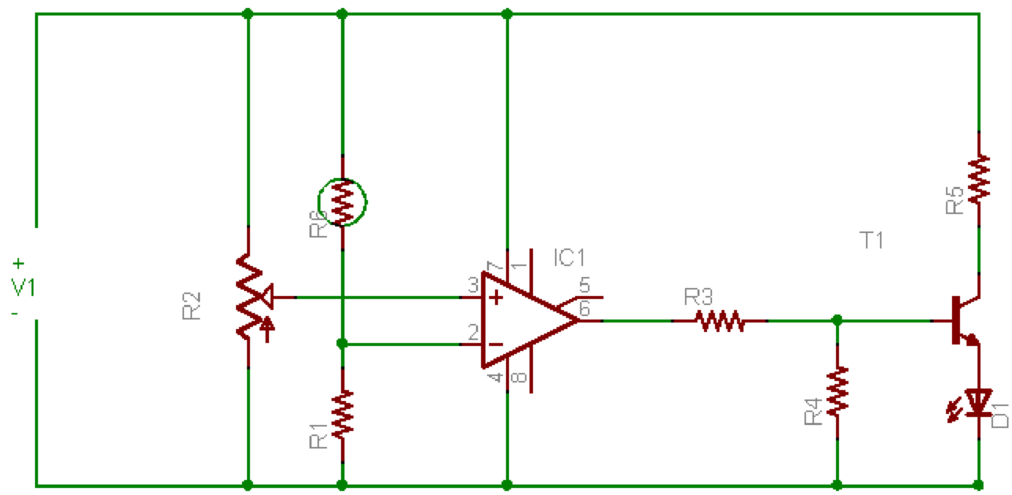
3. Compare your results for V_G and V_E with a couple other people. Are they approximately the same?

4. Draw <u>three</u> different loops (color code them) somewhere on the circuit above and make sure Kirchoff's voltage law holds. Show your three color-coded equations below:

5. Measure the current flowing through the LED when it is shining brightly. Does is exceed current we recommended for LEDs? (20mA)

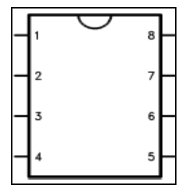
Lab 4: Name:	Cohort:	Date:

Circuit 2 – Digital Dark Activated LED



Component List:

- V1 = 9V
- R1 = 100kΩ
- R2 = 100kΩ Potentiometer
- R3 = 4.7kΩ
- R4 = 4.7kΩ
- R5 = 360Ω
- R6 = Photoresistor
- D1 = LED
- T1 = 2N3904
- IC1 = LM741
  - See dual in-line 8 pin "DIP-8" integrated circuit layout to the right for pin numbering pattern (similar for larger IC's as well!)
  - Visit the LM741 data sheet link on the wiki for more info (under "useful links")



Circuit Function:

We are using the LM741 operational amplifier ("op-amp") as a **comparator**: when the voltage on pin 3 (the "non-inverting input) is greater than the voltage on pin 2 (the inverting input), the output (pin 6) flips to turn "on" or "off" (high voltage or low voltage). If the output (pin 6) is "high", this causes the transistor, T1, to turn "on" **like a switch** (between leads 1 & 3 of the transistor), allowing a current to flow from R5 through the transistor, and on to the LED (D1), causing it to light up. On the other hand, if the LM741 output is "off" (low voltage, close to zero volts), the transistors remains "off", and acts like an open switch, preventing current flow through R5 and D1.

By adjusting the potentiometer you can "tune" the circuit to the room's ambient light. By passing your hand over R6, you should be able to turn the LED on and off.

Questions:

1. Identify TWO simple voltage dividers in the circuit above. (hint: they are on the left side of the circuit).

2. Once you have the circuit tuned, monitor the voltage at pins 3 (Non-inverting input) & 2(Inverting input) and the output (pin 6) as you change the light level incident upon the photoresistor.

   (a) When the voltage at the non-inverting input is greater than the inverting input's, what happens to the output?

   (b) What happens for the opposite situation?

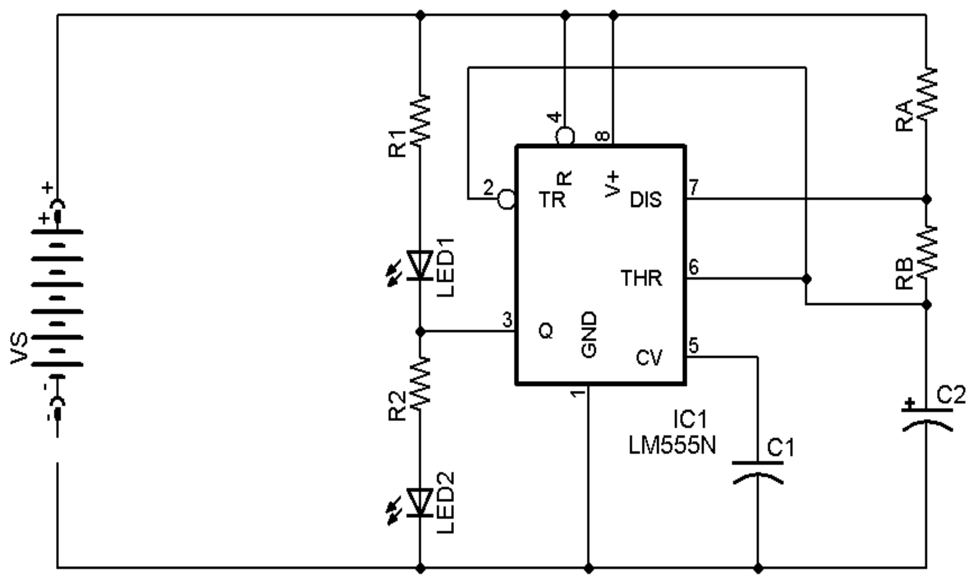
3. With the LED "on", measure the voltages at R3, R4, and R5 and calculate the corresponding currents. Use Kirchoff's Current Law to determine the current flowing through each "leg" of the transistor (label your result on the circuit diagram).

Lab 4: Name: Cohort: Date:

Circuit 3 – 555 Timer driving a power hungry load

Component List:

- VS = 9V
- RA = 47kΩ
- PB = 20κΩ
- R1 = 360Ω
- R2 = 360Ω
- C1 = 0.01uF Ceramic
- C2 = 10uF Electrolytic
- LED1 = Red LED
- LED2 = Green LED



Circuit Function:

We are using a circuit that you already breadboarded to drive a large load. The 555 Timer in this case is in astable mode with a period that is easily visible with the naked eye.

Questions:

1. Measure the voltage present at pin 3 when the chip is activated(Green light on). If an LED "drops" about 2V, how much will the V2 be? (Show calculations).

2. Measure voltage V2 to confirm your calculations.

3. Calculate the current through R2. If a diode should have about 20mA flowing through it, are we overdriving the LED? (Again, be sure to show your work.)

4. Using a multimeter, measure the resistance of the coil on the relay. R_{coil} = ______ If you want 5V dropped across this resistance when the circuit is activated, what resistance should you connect in series with the coil? (Show calculations and draw a picture on the diagram above showing where the coil and resistor need to be located.)

5. Using your multimeter, measure the resistance of the pins on the relay to determine which contacts are normally closed and which are normally open. (Note that there are one set of switches on the right side and another set of switches on the left side. There is a picture on the bottom of the relay that will give you a hint about which terminal is the common terminal.) Draw a sketch of how the switches in the relay are set up.

6. Using a KEST 5V relay, can you setup the circuit so that a gearhead motor runs in one direction when the circuit is not activated and in the other direction when the circuit is activated? Draw on the diagram of the relay where you made your connections.