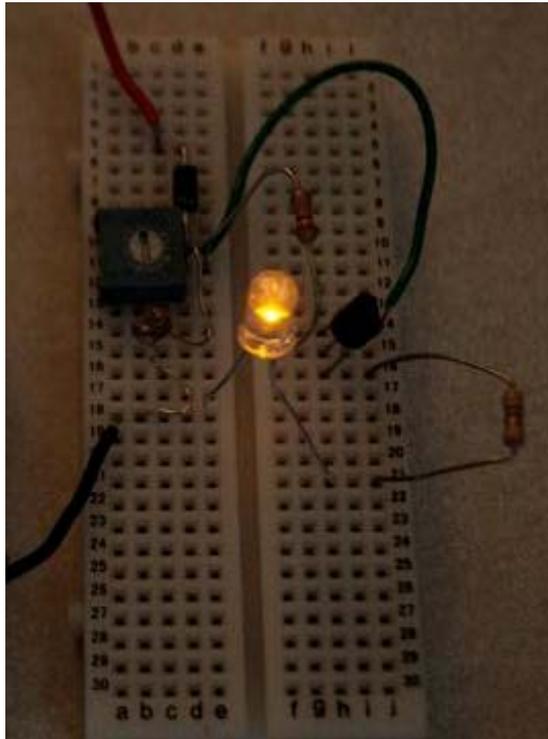


Henry Lin and Hani Mehrpouyan

Automatic Night Lite



Note: Do not look directly at LED with unshielded eyes or damage to retina may occur.

Introduction:

In this lab an LED is automatically turned on when the ambient light level falls below a threshold. The threshold is determined by adjusting a variable resistor (potentiometer). The circuit contains a transistor that amplifies the current coming into its base. This current controls the LED.

Parts:

LDR or PhotoCell 10K Ω -100K Ω (1M Ω Dark)
(DigiKey p/n: PDV-P9007-ND)

NPN 3904

1N400X Diode (optional)

100 K Pot

22 K Ω

470 K Ω

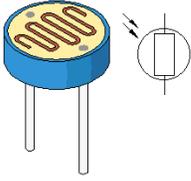
Bright LED (3000-4500 mCd)

9V Battery and battery straps

22 gauge wire

Solderless Breadboard

The LDR:

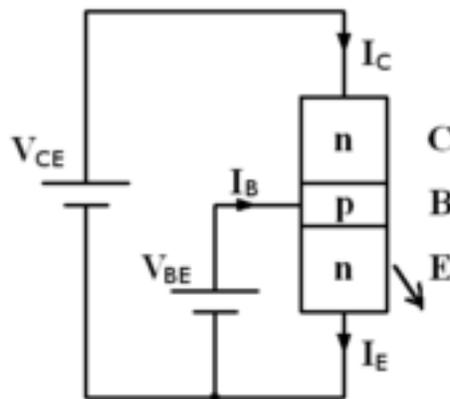


The Light Dependent Resistor (LDR) is made from a Cadmium-Sulfide compound (CdS). CdS is a semiconductor material. The resistance of the LDR changes as the light level changes. More light produces more electron – hole pairs in the material, making the material a better conductor in light. Resistance decreases (conductivity increases) as light levels increase because there are more charge carriers in the material. Note that $R = 1/G$ (G is conductance)

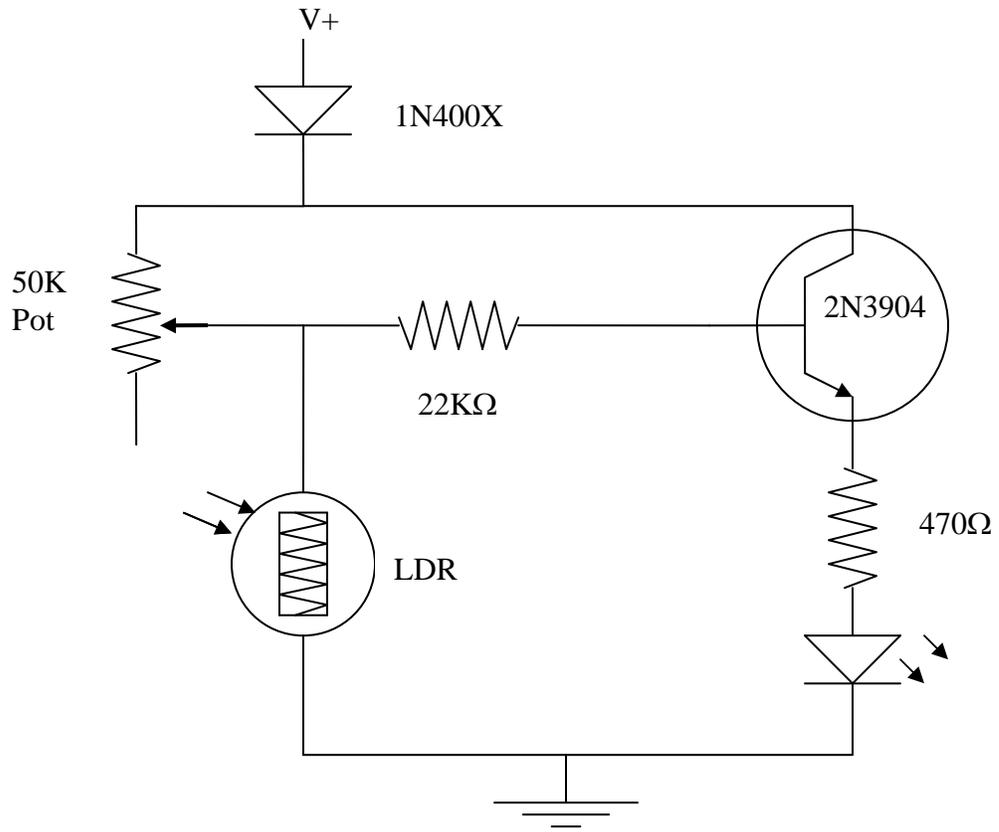
The LDR controls the voltage on the transistor's base. As it gets darker in the room, the voltage on the base will increase until the transistor is forward biased. This results in high current flowing from the transistor's collector to the base. This collector current flows to the LED and is responsible for turning the LED on.

The Bipolar Transistor:

The transistor in this lab is an NPN transistor. When the LDR's resistance increases in low light, the voltage on the transistor's base increases. When this occurs the base-emitter junction of the transistor becomes forward biased while the base-collector junction is reverse biased. This is called active-mode. In active-mode current flowing from the collector to emitter is about 100 times larger than the current flowing into the base of the transistor. Thus, the gain is roughly 100. Very small changes in current are used to control the LED.



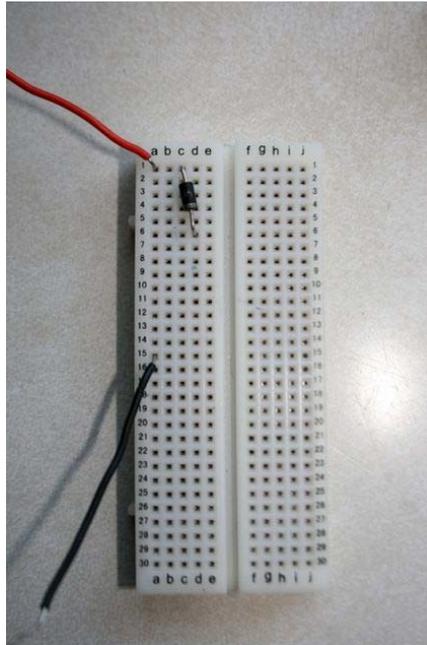
The Circuit:



Construction of Circuit:

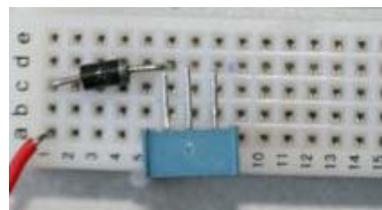
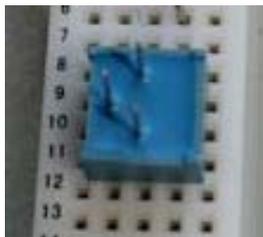
Step 1-

Insert wires for the power (+9V) and ground nodes. Connect the diode between power and another unused node. Make sure the diode's band is facing away from power as shown below:

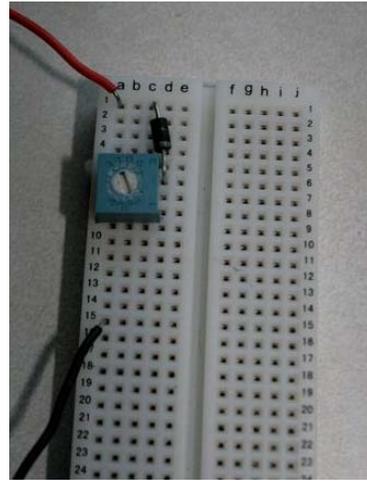
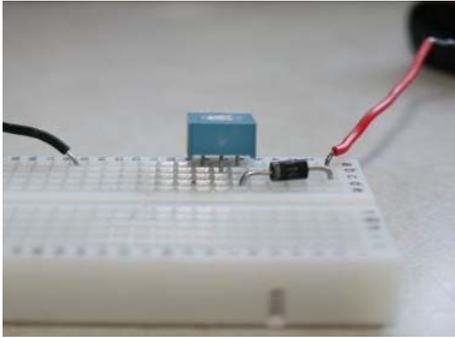


Step 2 –

Note that the potentiometer (pot) has three pins. Insert the potentiometer (pot) into the board. Make sure each pin is straight and placed in a separate node.

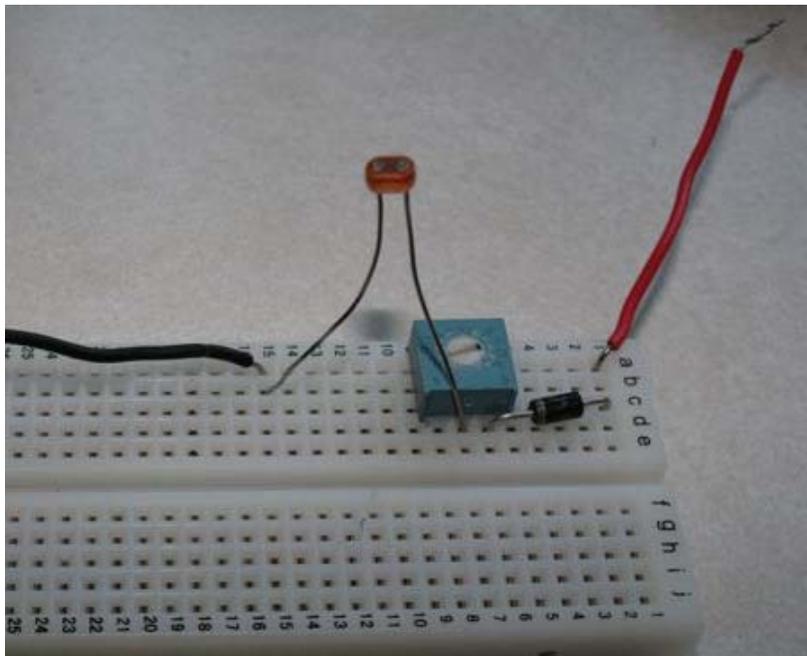


Insert the pot as shown. Make sure one end of the pot connects with the diode.



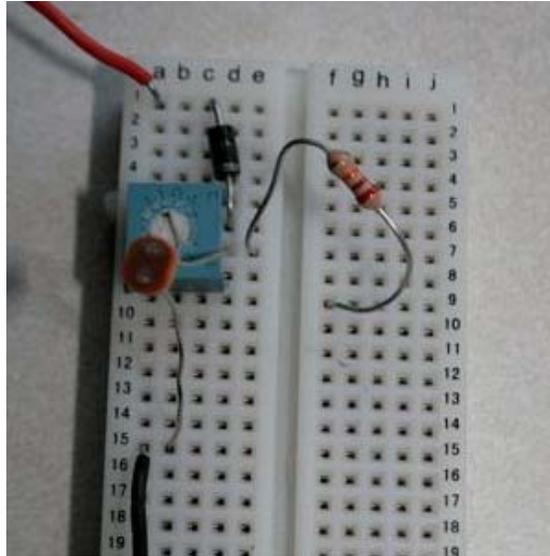
Step 3-

Next insert the LDR from the center pin of the pot to the ground node as shown below.



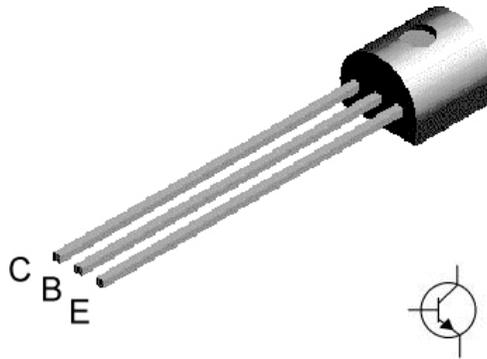
Step 4 -

Next insert the 22k Ω resistor from the center of the pot to another unused node as shown.

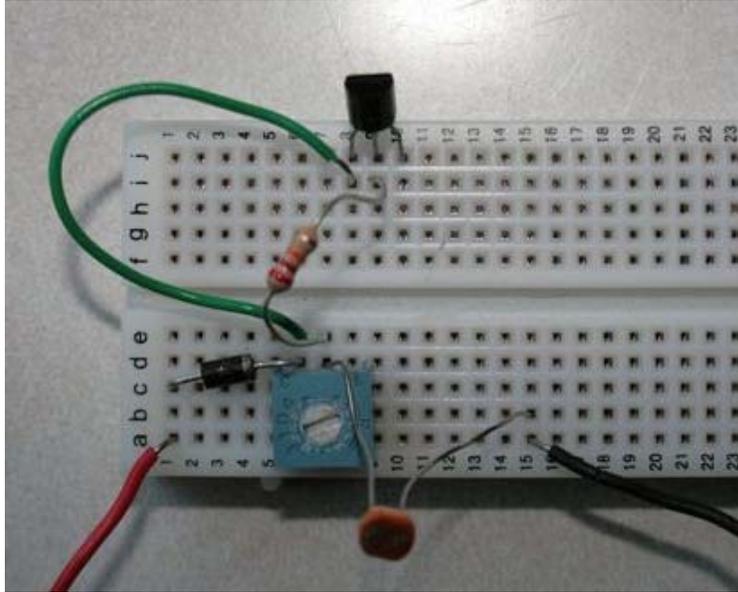


Step 5-

Insert the transistor into the board. The pin lay-out is:

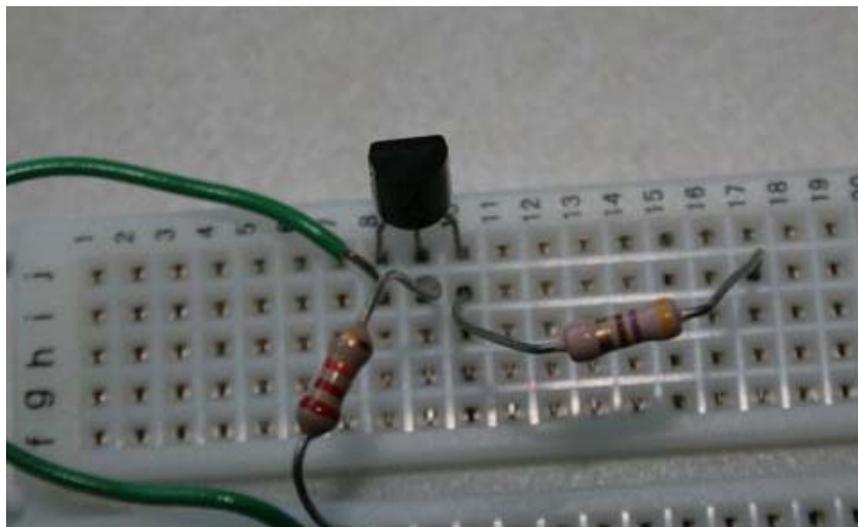


Make sure the base of the transistor (center pin) is connected to the 22k Ω resistor. Then add a wire so that the collector (C) is connected to the diode as shown.



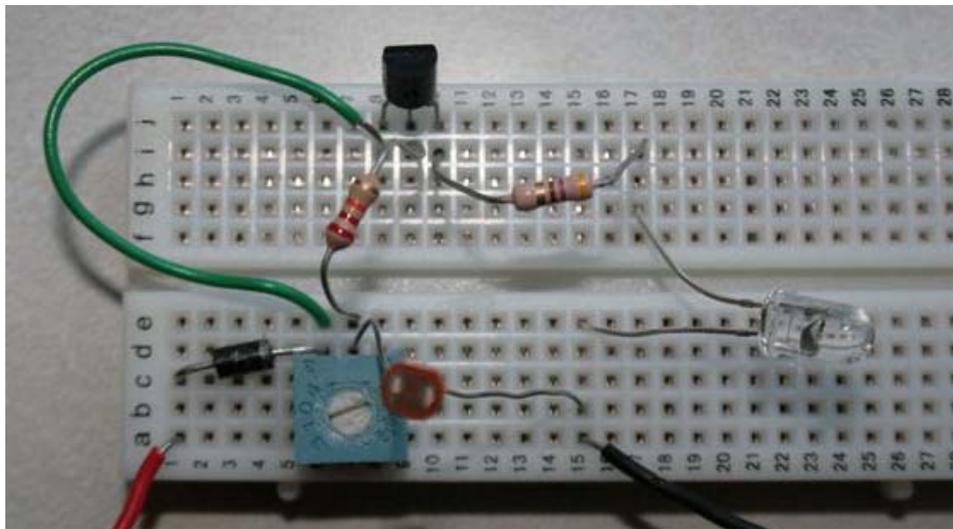
Step 6 -

Connect the 470 Ω resistor between the emitter of the transistor and another unused node.



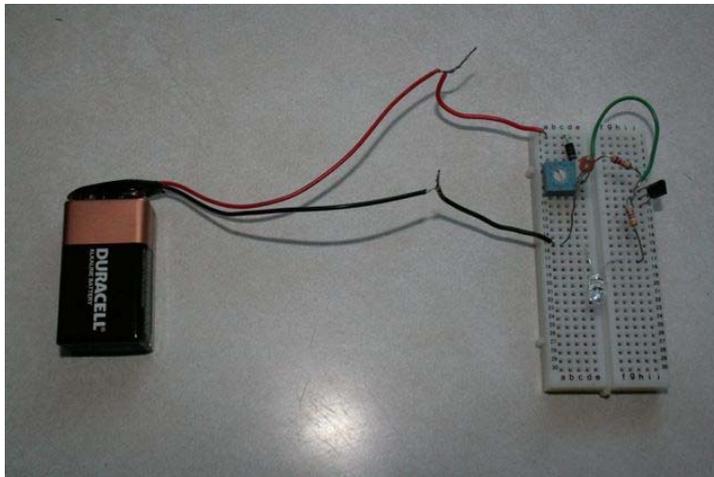
Step 7-

Next insert the LED between the 470 Ω resistor and ground. Make sure the long lead is connected to the 470 Ω resistor.



Step 8 -

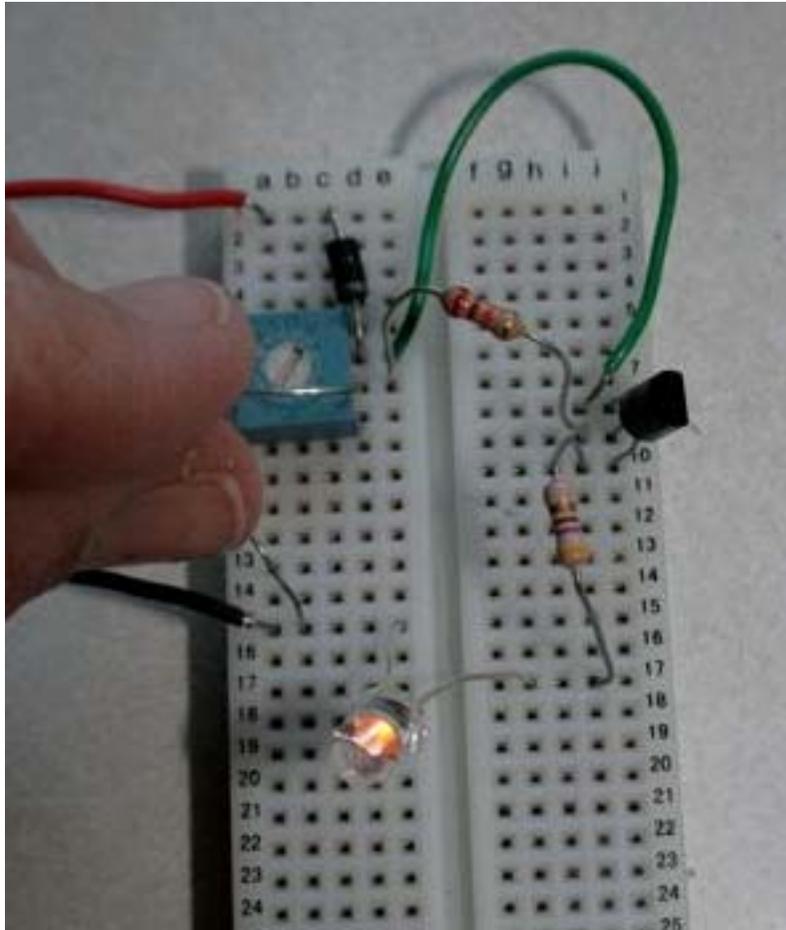
Finally attach the battery straps to the +9V battery. Connect the red wire to +V on the board and the black wire to ground on the board.



Step 9-

Working in normal indoor light conditions, get a small flathead or trim pot tool. Adjust the pot until the LED comes on. Then slowly go back the other direction and stop turning as soon as the LED goes off.

Cover the LDR with your hand. The LED should come on. Take the circuit into a dark place such as a closet. Again the LED should come on.



Step 10 -

You did it! Test your light in various light conditions.

Commercial uses for LDRs:

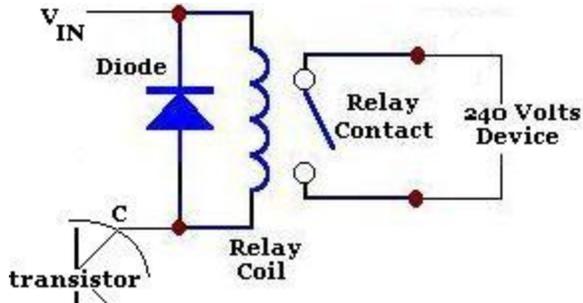
Where is this technology used? LLBean recently sold electric candles that automatically come on in low light conditions. The circuitry is almost identical to this lab.



CdS Light Dependent Resistor is visible at the base of the fixture.



Using a Relay with an LDR to Switch on 120V appliances:



Other Applications:

- Auto Flash for Camera
- Industrial Control
- Photoelectric Control
- Photoswitch
- Electronic Toys

Questions:

1. What is another application for a LDR controlling a light source?
2. What is another use for a LDR besides turning on and off a light? Explain how this application works. (see ideas above)
3. Research the material used in the LDR and explain how a LDR works.
4. The circuit in this lab could be adapted to control other things. For example, a Thermistor could replace the LDR and the circuit could then be used as a thermostat to control a fan or heater. What does a thermostat do and how does a thermostat work?

Sources:

<http://www.reuk.co.uk/Light-Dependent-Resistor.htm>