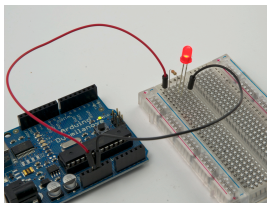
Living with the Lab

Using Your Arduino, Breadboard and Multimeter

Work in teams of two!



EAS 199A Fall 2011

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Your Multimeter

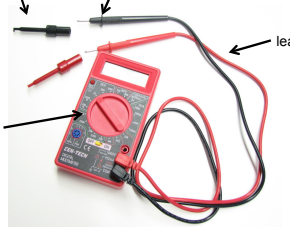
pincer clips – good for working with breadboard wiring

(push these onto probes)

probes

leads

Turn knob to select the type of measurement.



You will use the multimeter to understand and troubleshoot circuits, mostly measuring DC voltage, resistance and DC current.

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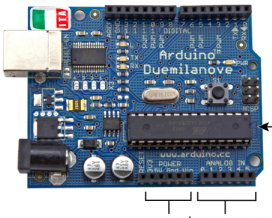
The Arduino Duemilanove

Duemilanove means "2009" in Italian

14 digital I/O pins

USB connector



AVR microcontroller

External DC power recepticle

power and ground

6 analog input pins

Power can be provided through the USB cable (+5V from the computer) or externally (7-12V supply recommended)

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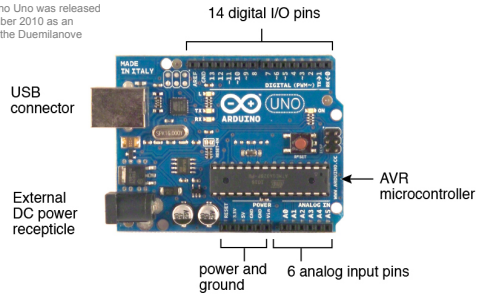
The Arduino Uno

The Arduino Uno was released in September 2010 as an update to the Duemilanove



Power can be provided through the USB cable (+5V from the computer) or externally (7-12V supply recommended)

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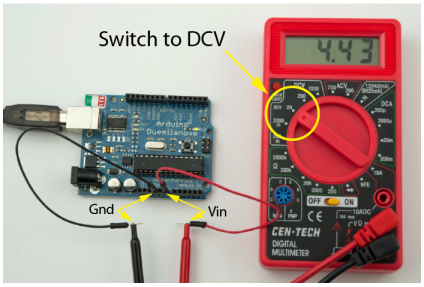
Measure Vin

Vin is the voltage of the power supply. The USB supplies a nominal 5V (4.43V was measured when this photo was taken)



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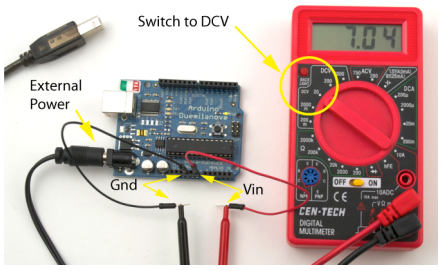
Change power source and measure Vin

In this photo, a 7V DC power supply was plugged into the power jack of the Arduino.



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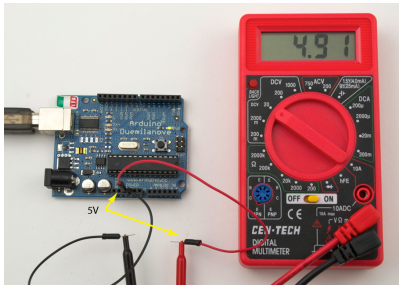
Check Voltage at 5V Power Pin

The on-board voltage regulator maintains the voltage on the 5V pin at about 5V



The measured voltage is close to 5V target.

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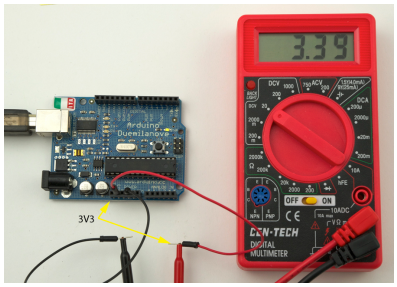
Check Voltage at 3.3V Pin

The FIDI chip on the Arduino, which helps the microcontroller talk with your computer through the USB cable, also has an on-board voltage regulator that outputs 3.3V.



If you need less than 5V for a project, you can use the 3.3V pin, Which provides about 3.3V. The current draw from the 3V3 pin is limited to 50mA.

max power = V·I
= 3.3V·0.05A
= 0.165W
= 165mW

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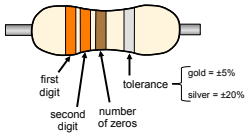
Select Resistors

Find the 330Ω and the 10kΩ resistors from your parts kit .

color	digit
black	0
brown	1
red	2
orange	3
yellow	4
green	5
blue	6
violet	7
gray	8
white	9



Example: 330Ω resistor:

3 = orange
3 = orange
Add 1 zero to 33 to make 330, so 1 = brown

So, 330 = orange, orange, brown

Now, find the 10kΩ resistor.

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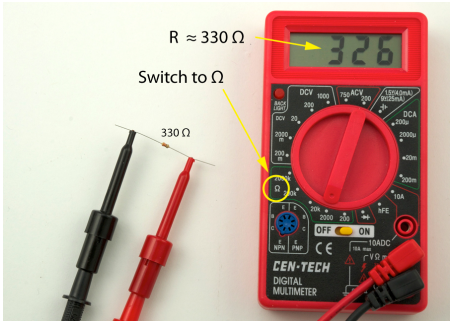
Check Resistance of Resistors



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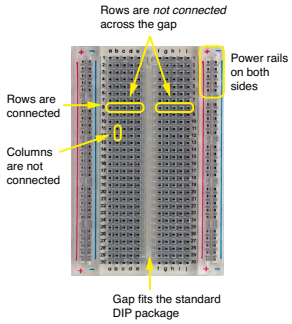
Building a circuit on a breadboard



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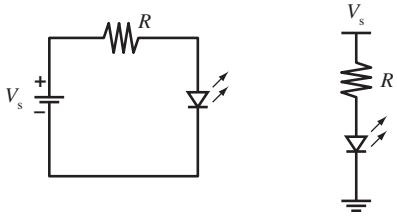
LED circuit: Two equivalent pictures



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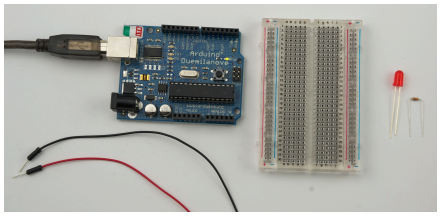
Building an LED Circuit

Supplies:

- *2 two jumper wires – colors don't matter, but red is usually used for positive, and black is used for negative*
- *LED*
- *330 Ω and 10kΩ resistors*
- *Arduino*
- *Breadboard*
- *USB cable from your computer)*



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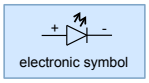
LEDs

LED = Light Emitting Diode



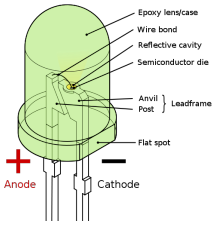


Diagram from Wikipedia description of an LED

Electricity can only flow one way through an LED (or any diode).
The flat spot on the LED must be connected to ground (GND).

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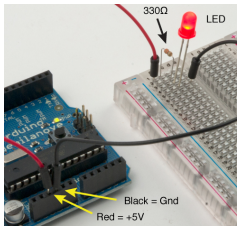
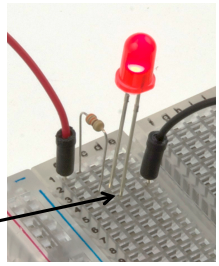
Building an always-on LED Circuit



Short leg of LED connects to ground wire



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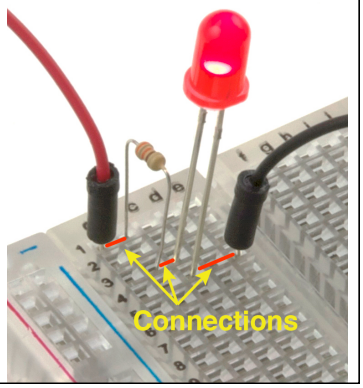
Breadboard LED circuit



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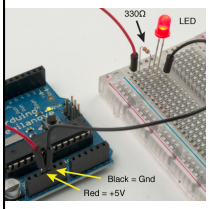
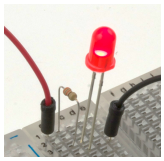
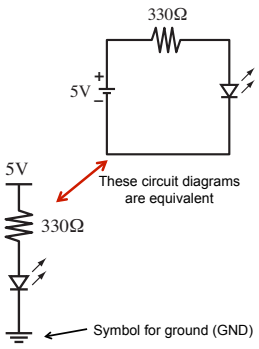
The Circuit







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Replace the 330Ω Resistor with the 10kΩ Resistor

What happens and Why??

ANSWER: The smaller resistor (330Ω) provides less resistance to current than the larger resistor (10kΩ). For the same applied voltage, increasing the resistance decreases the current.

Therefore, replacing the 300Ω resistor with the 10kΩ resistor reduces the current and causes the LED to glow less brightly.

What would happen if you forgot to put in a resistor? You would probably burn up your LED.

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Arduino program to blink an LED

- Build the circuit on the breadboard
  - A slight modification to always-on LED circuit
- Write your first Arduino program
- Use the digital (on/off) output to turn LED on and off

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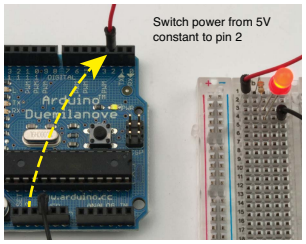
Connect the Power Wire to Pin 2

(Use P2 as a digital output)



Enter and run the following program:

```
void setup() {
  // initialize pin as an output:
  pinMode(2, OUTPUT);
}

void loop() {
  // turn the LED on
  digitalWrite(2, HIGH);
  // wait 1 second = 1000 ms
  delay(1000);
  // turn the LED off
  digitalWrite(2, LOW);
  // wait for 500 ms
  delay(500);
}
```

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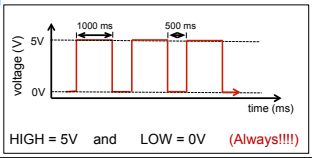
How the Program Works

```
void setup() {

pinMode(2, OUTPUT);
}

void loop() {
 digitalWrite(2, HIGH);
 delay(1000);
 digitalWrite(2, LOW);
 delay(500);
}
```

infinite loop

initialize pin 2 as an output

set pin 2 to HIGH (5V)
wait 1000 ms
set pin 2 to LOW (0V)
wait 500 ms



HIGH = 5V and LOW = 0V (Always!!!!)

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Now Experiment on Your Own!

(1) Try changing the time to 1.5 seconds on and 1 second off

(2) Connect the resistor to digital pin 5 and change the program to match

(3) Blink out SOS in Morse code (dot-dot-dot-dash-dash-dash-dot-dot-dot)
   a. three short pulses (0.25 seconds each) followed by . . .
   b. three long pulses (0.75 second each) followed by . . .
   c. three short pulses (0.25 seconds each) followed by . . .
   d. a brief pause (1 second)
   e. repeat a through d using an infinite loop

Show your instructor when you have completed exercise (3)

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Find the each command in the reference section of arduino.cc

(discuss each command with others at your table)

```
void setup() {
  // initialize the digital pin as an output:
  pinMode(2, OUTPUT);
}

void loop() {
  digitalWrite(2, HIGH);   // set the LED on
  delay(1000);             // wait for a second
  digitalWrite(2, LOW);    // set the LED off
  delay(500);              // wait for 500 ms
}
```