Arduino 101
Day 1: Outputs

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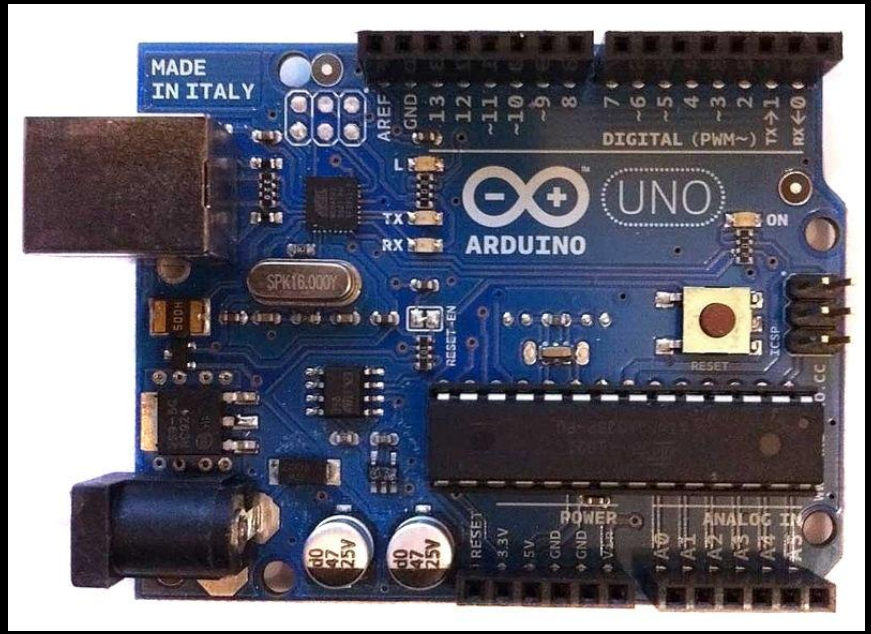
Let’s Get Set Up!

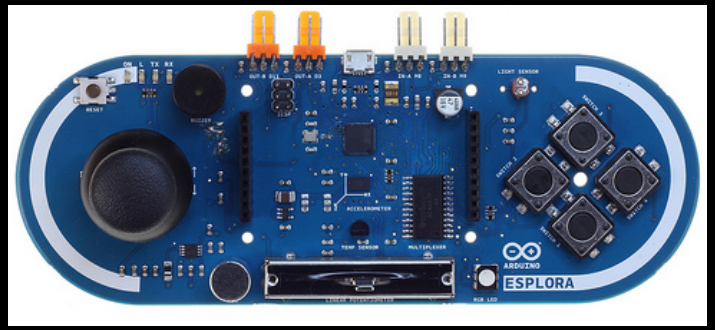
Download the Arduino software from arduino.cc

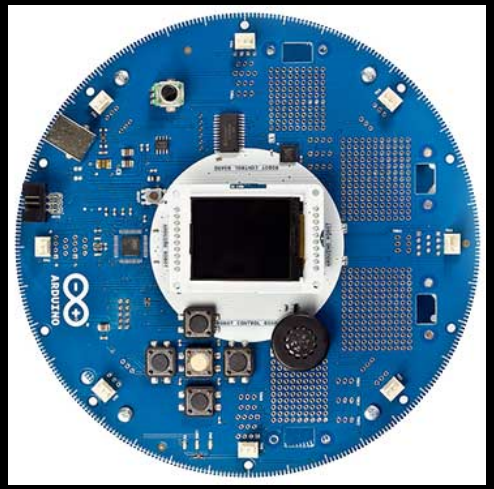
Next, we’ll look at what board everyone has.

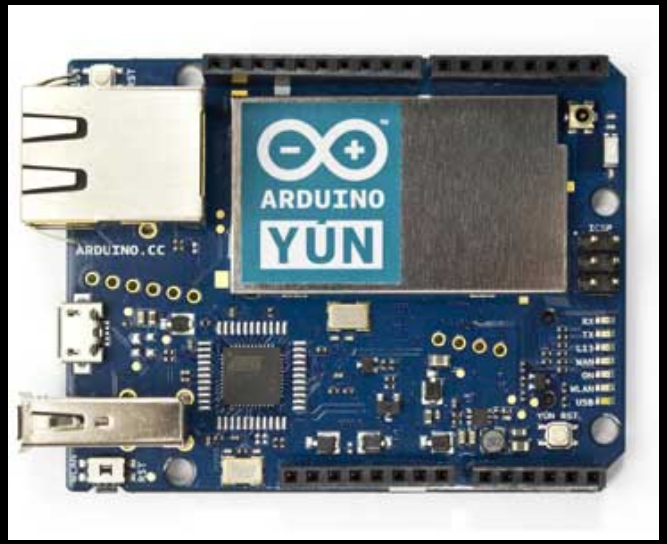


Picture from shallowsky.com

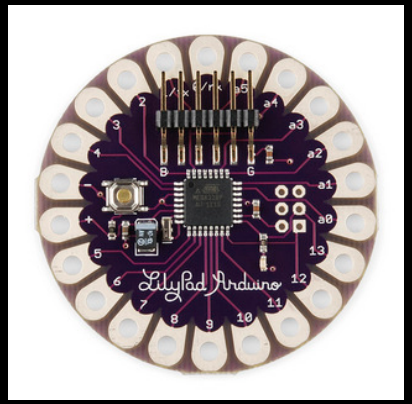
More examples of types of boards

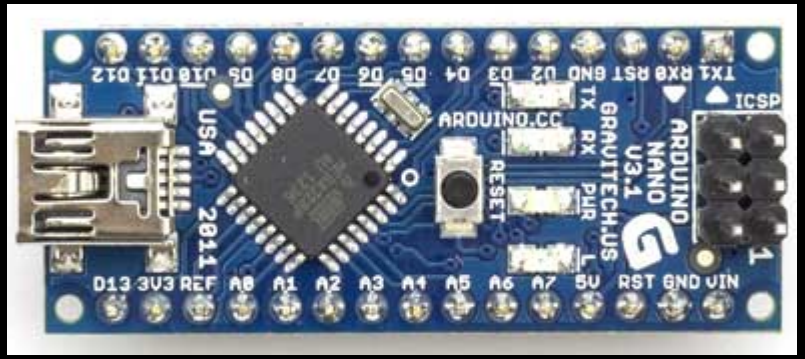


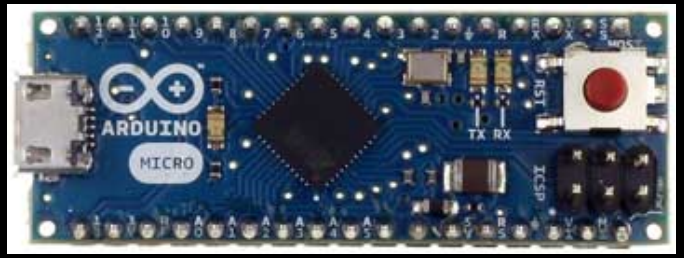




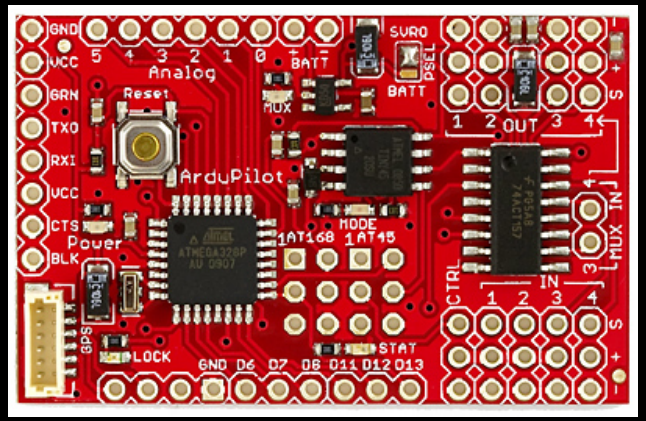
Pictures from arduino.cc

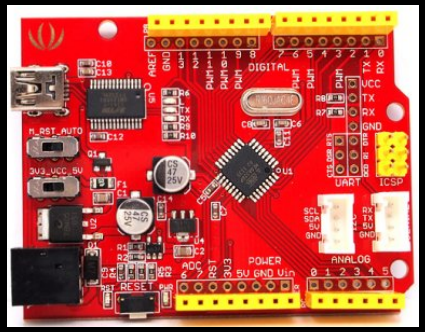


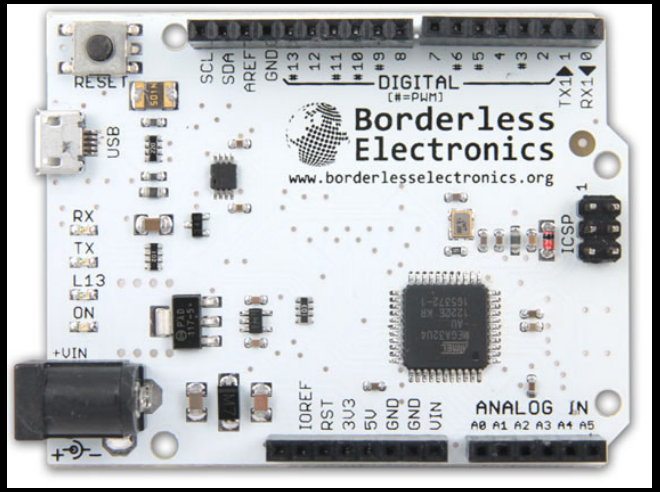


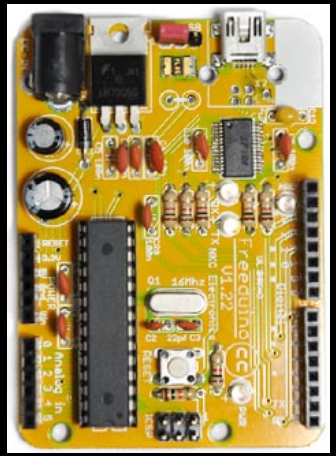


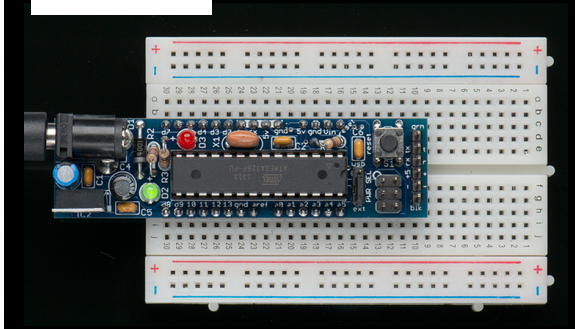
Attack of the Clones

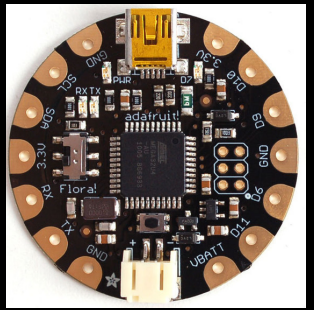






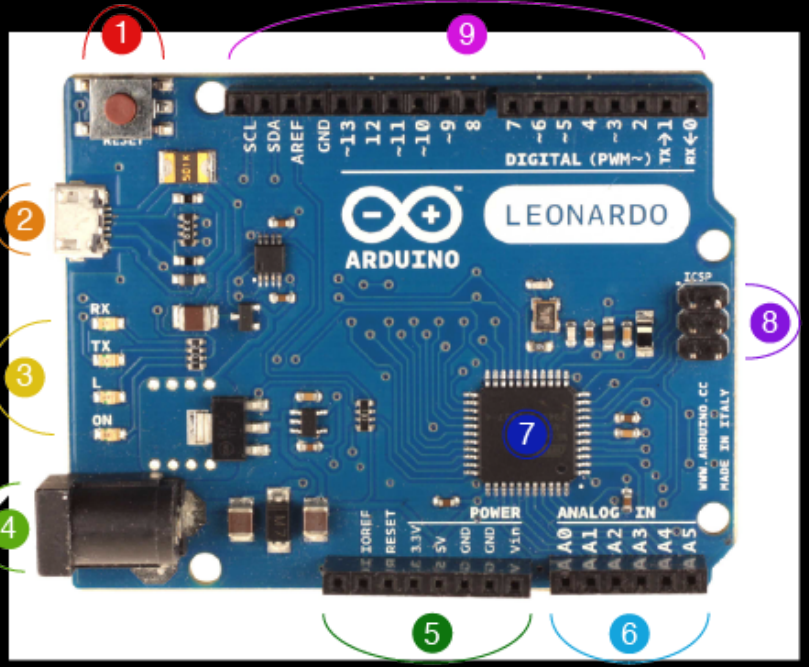






Arduino Board

Each board will have the same basic set of components, though they may be arranged differently.

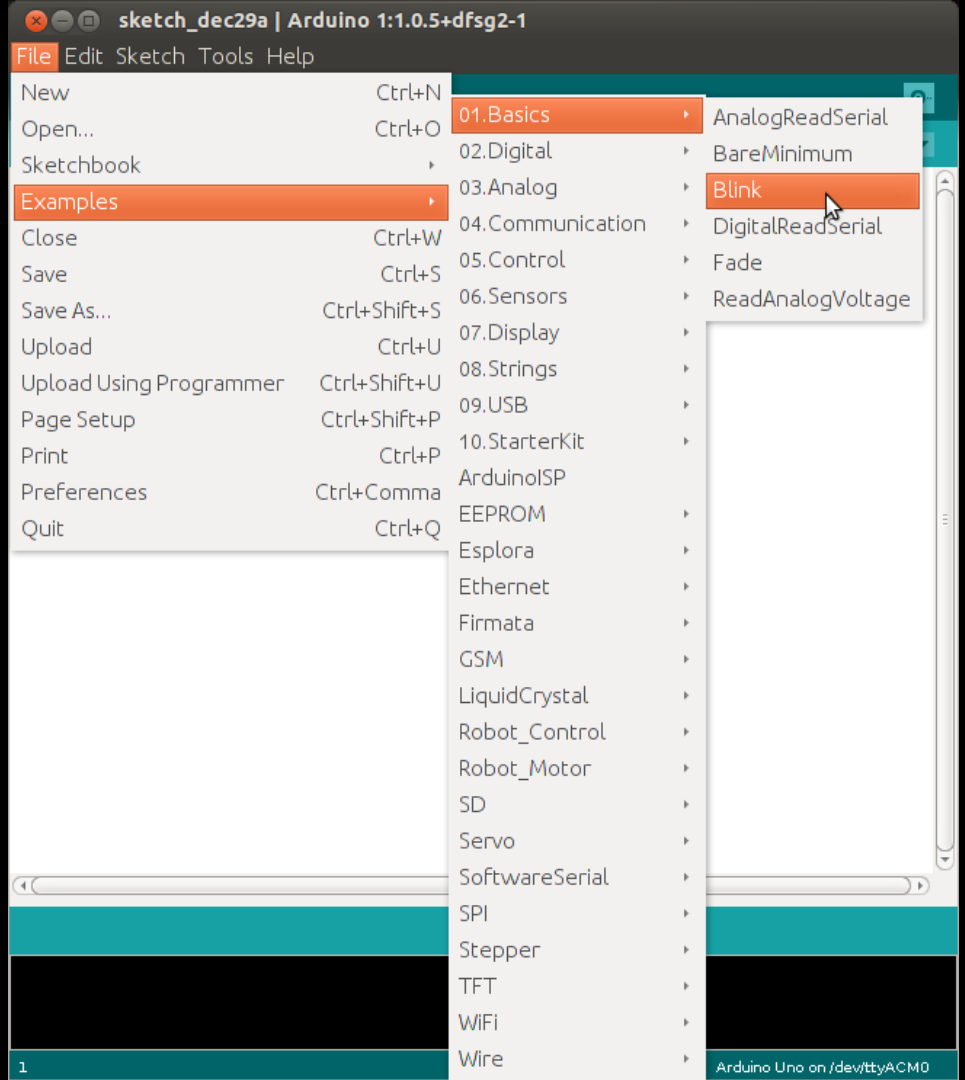


Color	Tech Name	What it does:
1	Reset Button	Restarts the Arduino
2	USB	Program your Arduino from your Computer
3	Indicator LEDs	Shows the user what the Arduino is doing
4	DC Power	Power your project - without USB
5	Power Pins	Connect power to your circuit
6	Analog Pins	Connect sensors to your Arduino
7	ATmega32u4	Brain of your Computer
8	ISP Connector	Update bootloader (software) on the Arduino
9	Digital I/O	Connect sensors or actuators to your Arduino

Picture from makezine.com

Let’s Blink!

```
//variable declarations
int led = 13;

// the setup routine runs once when you press reset:
void setup() {
  // initialize the digital pin as an output.
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop() {
  digitalWrite(led, HIGH);
  delay(1000);
  digitalWrite(led, LOW);
  delay(1000);
}
```



Some notes about Arduino coding...

Functions in EVERY Arduino sketch:

```
void setup( ){
        //code goes here
}
void loop( ) {
        //code goes here
}
```

Setting pin mode:

•input: A pin mode that intakes information.
•output: A pin mode that sends information.

Setting pin state:

•HIGH: Electrical signal present (5V or 3.3V for Uno). Also ON or TRUE in boolean logic.
•LOW: No electrical signal present (0V). Also OFF or FALSE in boolean logic.

The main four I/O functions:

•digitalRead: Get a HIGH or LOW reading from a pin already declared as an input.

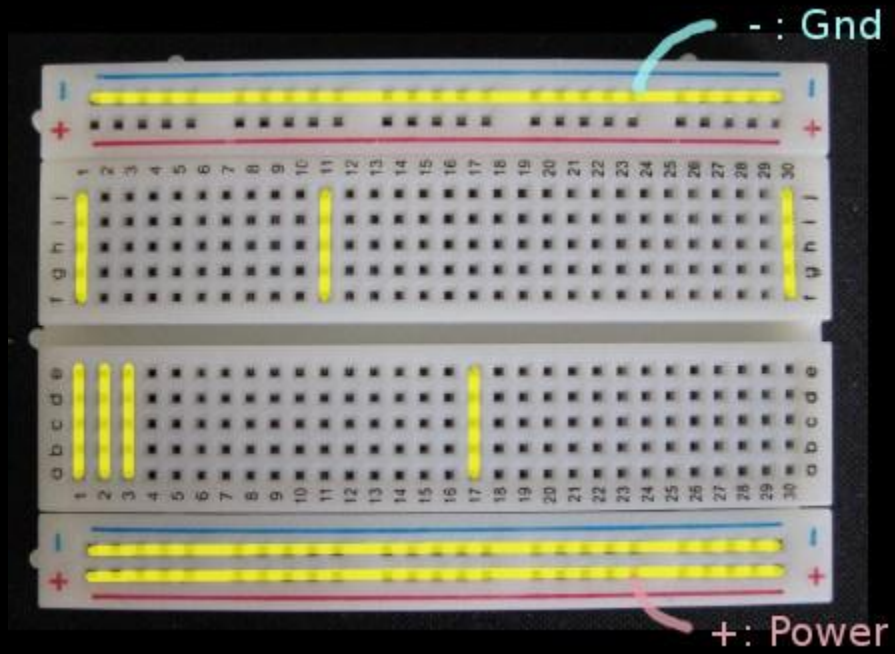
•digitalWrite: Assign a HIGH or LOW value to a pin already declared as an output.

•analogRead: Get a value between or including 0 (LOW) and 1023 (HIGH). This allows you to get readings from analog sensors or interfaces that have more than two states.

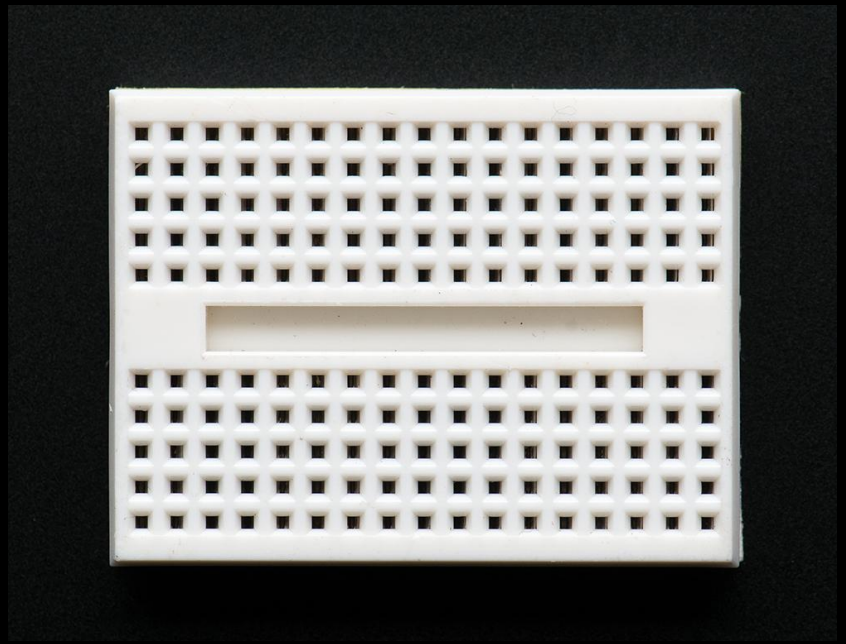
•analogWrite: Assign a value between or including 0 (LOW) and 255 (HIGH). This allows you to set output to a PWM value instead of just HIGH or LOW.

Text from sparkfun.com

Breadboards

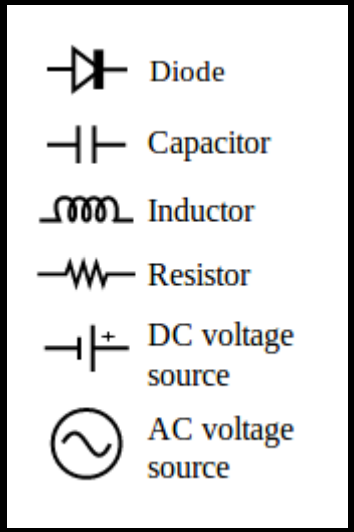


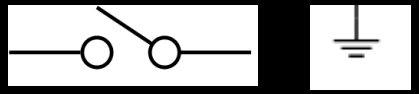
Picture from shallowsky.com



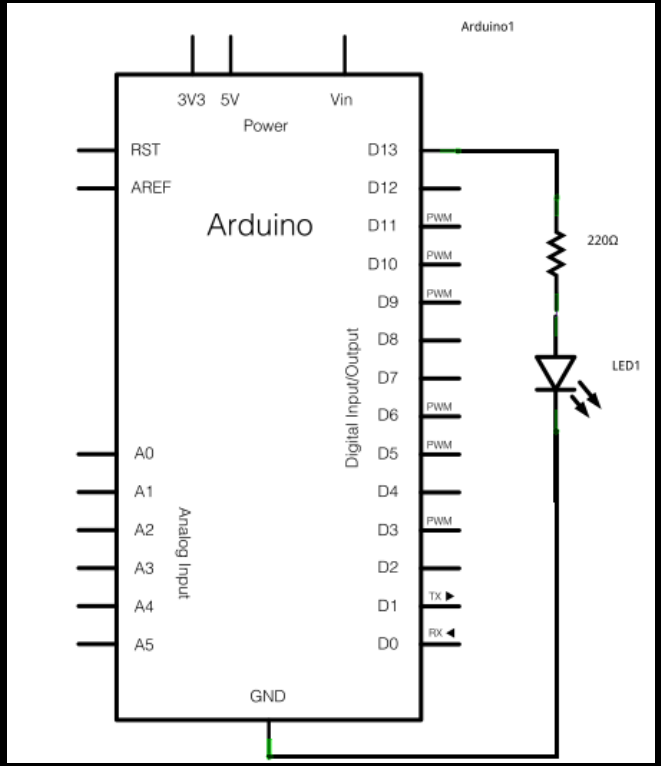
Picture from adafruit.com

Let’s review a bit about electricity!





$$V = IR$$

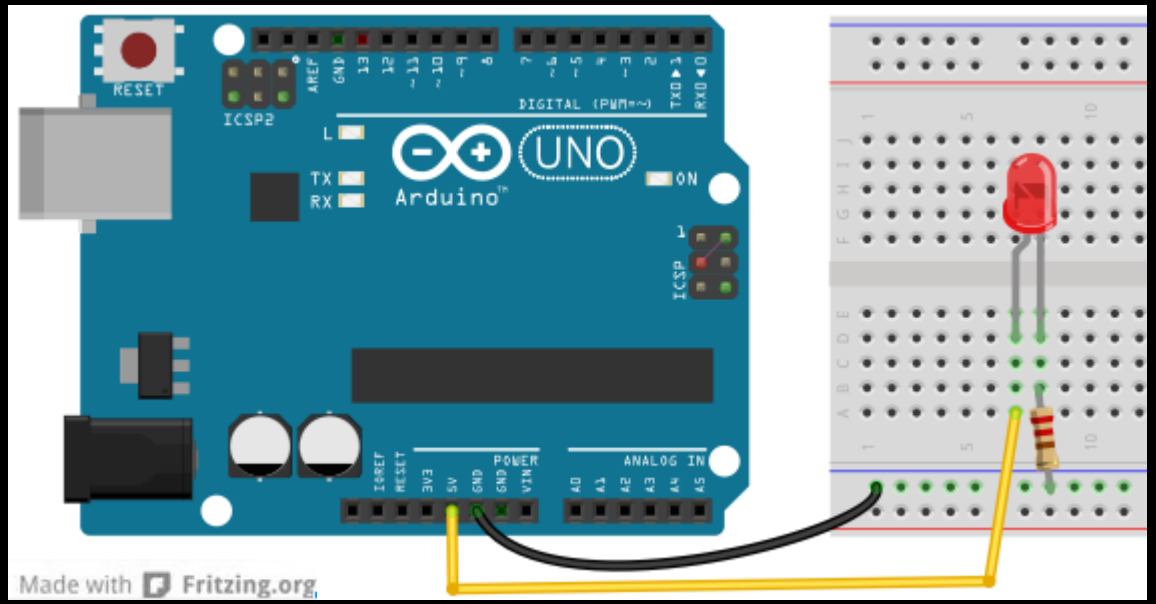


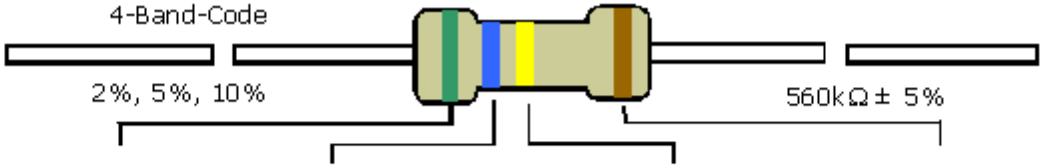
Pictures from http://en.wikipedia.org/wiki/Electronic_symbol and arduino.cc

LEDs and Resistors

LED = light emitting diode

LEDs are directional, resistors are not.





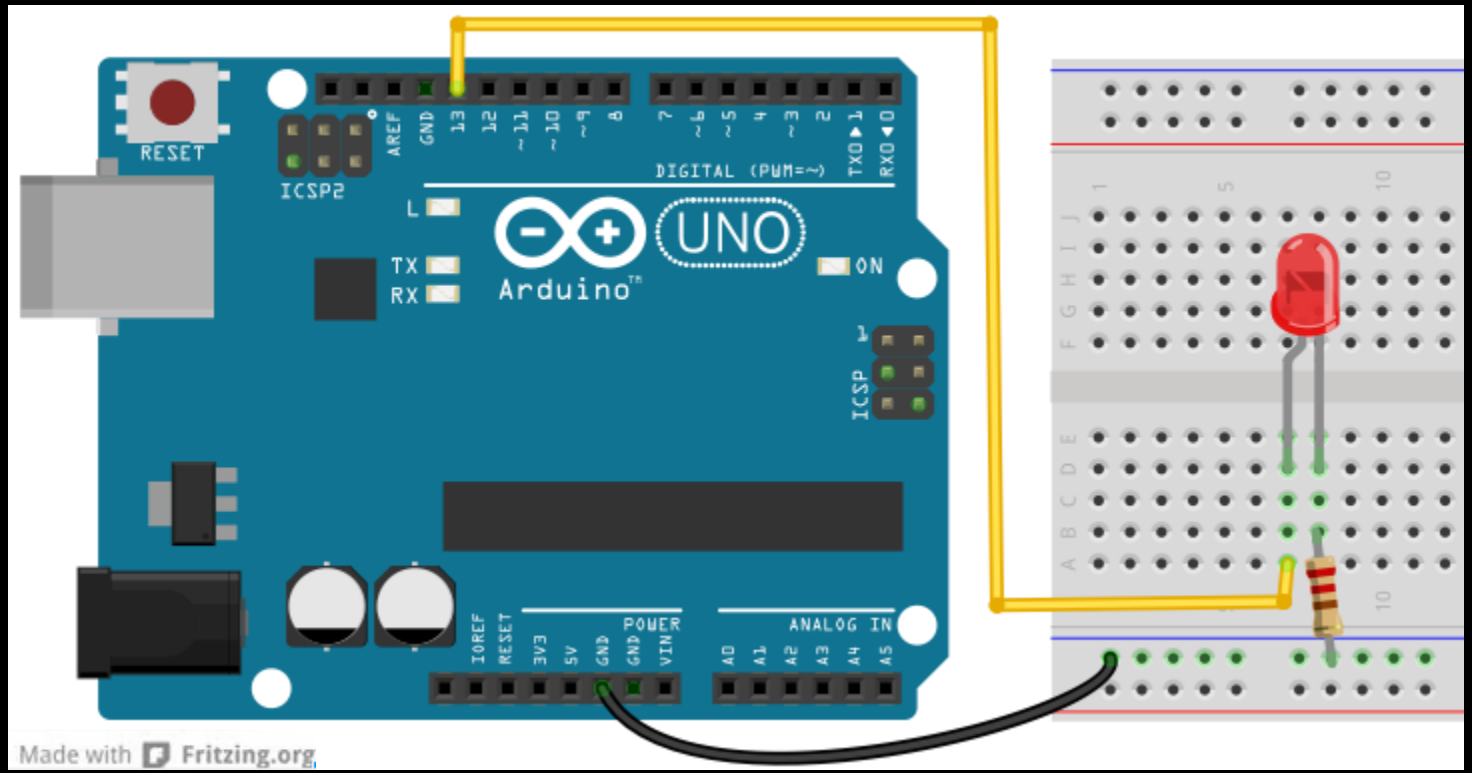
COLOR	1st BAND	2nd BAND	3rd BAND	MULTIPLIER	TOLERANCE	
Black	0	0	0	1Ω		
Brown	1	1	1	10Ω	± 1%	(F)
Red	2	2	2	100Ω	± 2%	(G)
Orange	3	3	3	1KΩ		
Yellow	4	4	4	10KΩ		
Green	5	5	5	100KΩ	±0.5%	(D)
Blue	6	6	6	1MΩ	±0.25%	(C)
Violet	7	7	7	10MΩ	±0.10%	(B)
Grey	8	8	8		±0.05%	
White	9	9	9			
Gold				0.1	± 5%	(J)
Silver				0.01	± 10%	(K)

Electronix Express / RSR
http://www.elexp.com

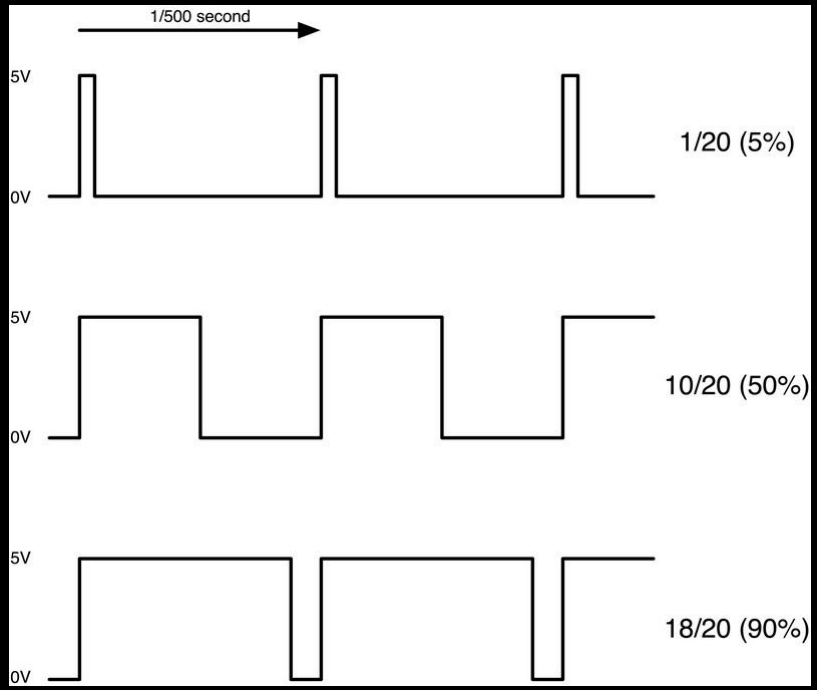
1-800-972-2225
In NJ 732-381-8020

Picture from elexp.com

Blink Hardware Setup

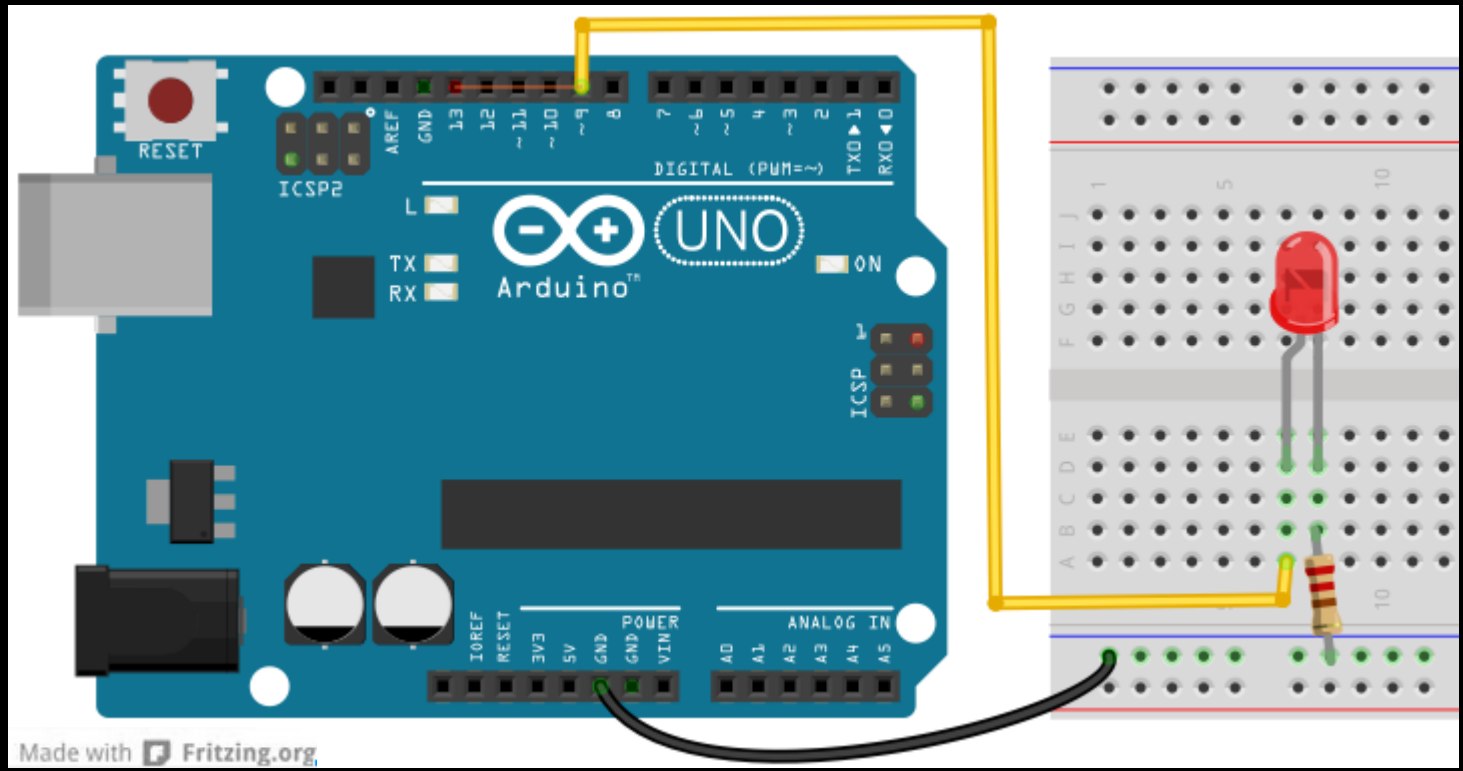


Pulse Width Modulation - PWM



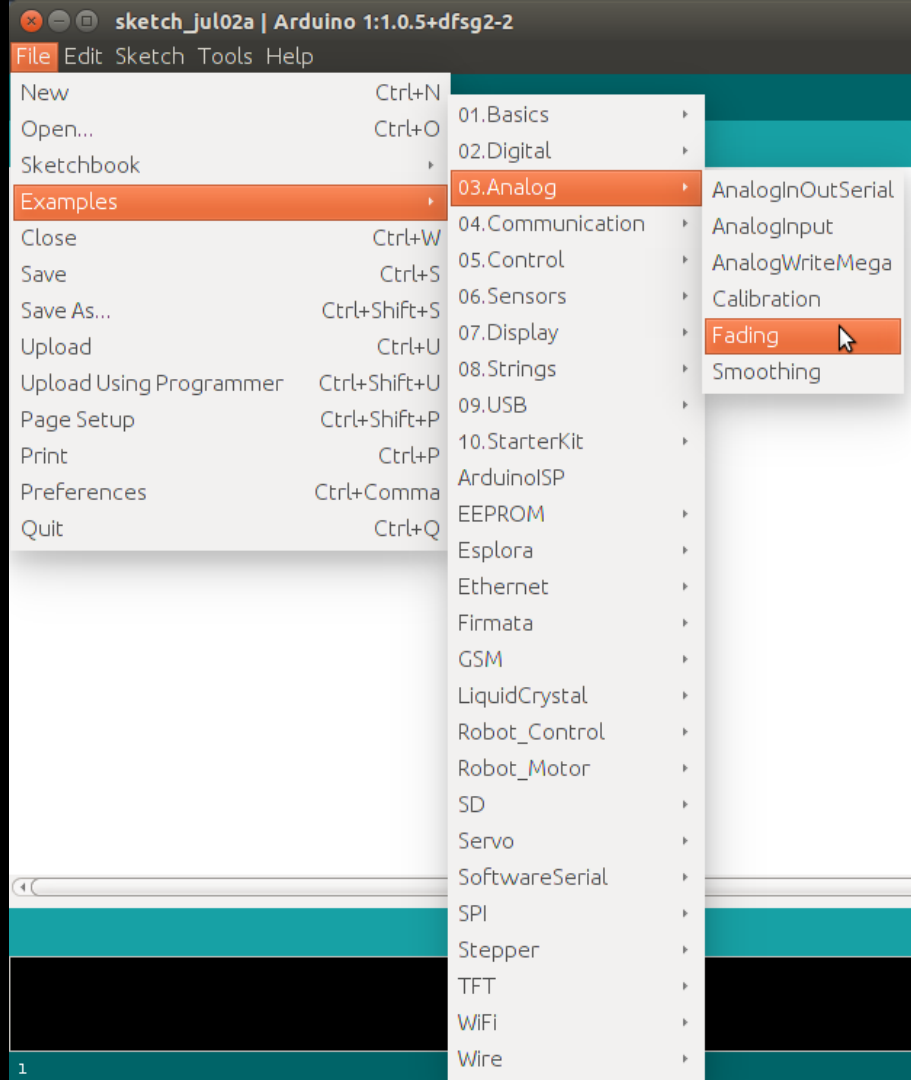
Picture from learn.adafruit.com

Fade Hardware Setup



Let’s Fade

```
int led = 9;           // the pin that the LED is attached to

int brightness = 0;    // how bright the LED is
int fadeAmount = 5;    // how many points to fade the LED by

// the setup routine runs once when you press reset:
void setup()  {
  // declare pin 9 to be an output:
  pinMode(led, OUTPUT);
}

// the loop routine runs over and over again forever:
void loop()  {
  // set the brightness of the LED on pin 9:
  analogWrite(led, brightness);

  // change the brightness for next time through the loop:
  brightness = brightness + fadeAmount;

  // reverse the direction of the fading at the ends of the fade:
  if (brightness == 0 || brightness == 255) {
    fadeAmount = -fadeAmount ;
  }
  // wait for 30 milliseconds to see the dimming effect
  delay(30);
}
```



Fade variables...

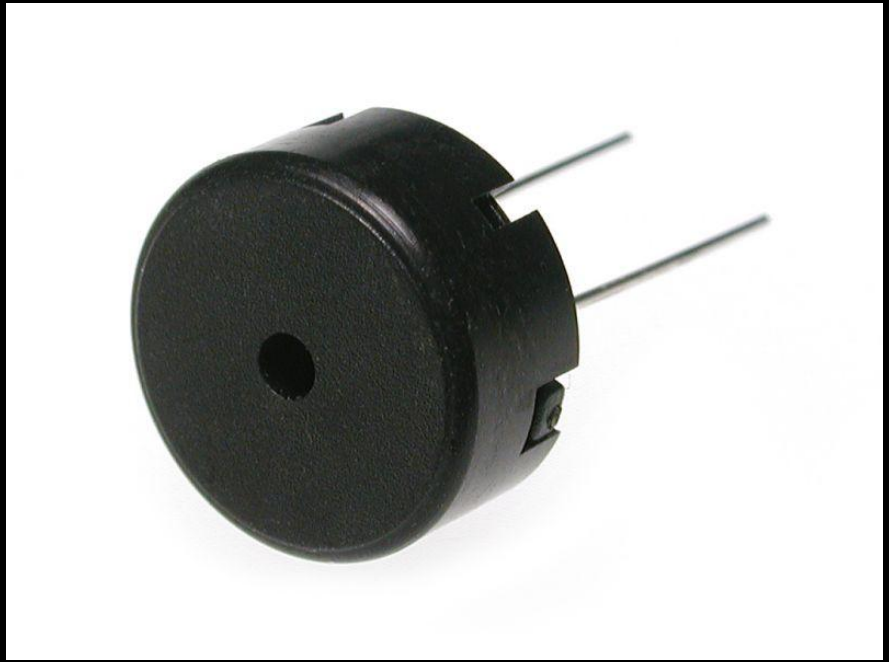
	A	B
1	brightness	fadeAmount
2	0	5
3	5	5
4	10	5
5	15	5
6	20	5
52	…	…
53	250	5
54	255	-5
55	250	-5
56	245	-5
103	…	…
104	10	-5
105	5	-5
106	0	5
107	5	5
108	10	5
109	…	…

Let’s Make Some Noise!

Piezoelectricity

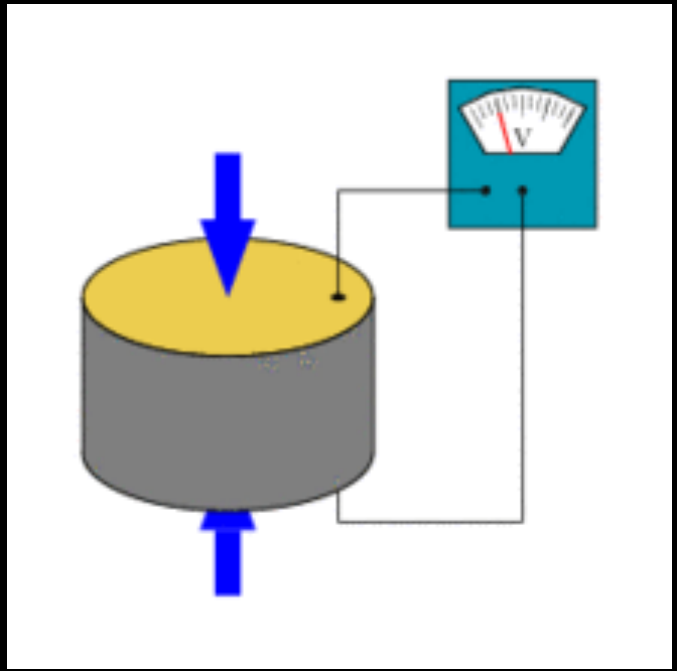
* electricity generated from mechanical stress

* process works both ways!



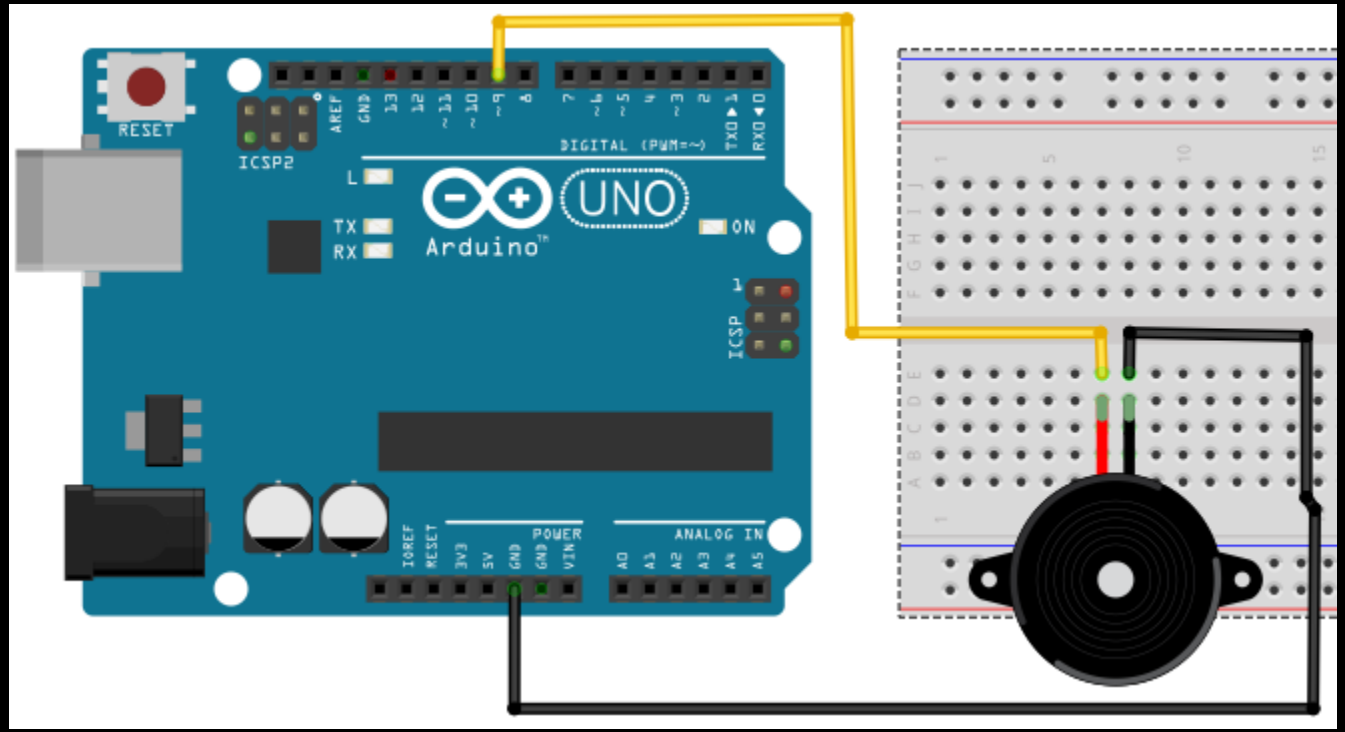
Picture from solarbotics.com

How does a piezo work?



http://en.wikipedia.org/wiki/Piezoelectricity

Try your Fade sketch with the Piezo



http://www.arduino.cc/en/Tutorial/PlayMelody

Play some notes!

```
int speakerPin = 9;

int length = 15; // the number of notes
char notes[] = "ccggaagffeeddc "; // a space represents a rest
int beats[] = { 1, 1, 1, 1, 1, 1, 2, 1, 1, 1, 1, 1, 1, 2, 4 };
int tempo = 300;

void playTone(int tone, int duration) {
  for (long i = 0; i < duration * 1000L; i += tone * 2) {
    digitalWrite(speakerPin, HIGH);
    delayMicroseconds(tone);
    digitalWrite(speakerPin, LOW);
    delayMicroseconds(tone);
  }
}

void playNote(char note, int duration) {
  char names[] = { 'c', 'd', 'e', 'f', 'g', 'a', 'b', 'C' };
  int tones[] = { 1915, 1700, 1519, 1432, 1275, 1136, 1014, 956 };

  // play the tone corresponding to the note name
  for (int i = 0; i < 8; i++) {
    if (names[i] == note) {
      playTone(tones[i], duration);
    }
  }
}
```

```
void setup() {
  pinMode(speakerPin, OUTPUT);
}

void loop() {
  for (int i = 0; i < length; i++) {
    if (notes[i] == ' ') {
      delay(beats[i] * tempo); // rest
    } else {
      playNote(notes[i], beats[i] * tempo);
    }

    // pause between notes
    delay(tempo / 2);
  }
}
```

http://www.arduino.cc/en/Tutorial/melody

Further Explorations With Outputs

Some Ideas:
* Find out how to play songs with your piezo speaker
* Change how the LEDs fade
* Have your LEDs flash out messages in morse code or patterns
* Have your program generate a random number in setup().

```
random(10);  //number will be between 0 and 9 (10 numbers total)
```

Make the output do different things based on the number

What else did people bring in addition to LEDs and speakers?