Introduction to

ARDUINO

How to use electronics to make your projects better!

Guest wifi: HSNOTTS-guest Password: hackspacebiscuits
Presentation: http://wiki.nottinghack.co.uk/wiki/Arduino101
Software: http://arduino.cc/en/Main/Software

Welcome!

- Let's get programming!
- What did we just do? What is an “Arduino” anyway?
- Serial communications (making your Arduino talk to your laptop)
- Electrical Basics: Voltage, current, resistance
- More blinking LEDs
- Using switches

Welcome!

- Lunch?
- Structure and Decisions: Order out of chaos
- Your Arduino is a wimp: giving it some muscle!
- Life isn't digital: reading real-world values
- Putting it all together

Dive in: Blink an LED

You must have this. All initialisation goes here.

You must have this. The main code goes here.

```
int ledPin = 13;                  // LED connected to digital pin 13
void setup()                      // run once, when the sketch starts
{
  pinMode(ledPin, OUTPUT);        // sets the digital pin as output
}
void loop()                       // run over and over again
{
  digitalWrite(ledPin, HIGH);     // sets the LED on
  delay(1000);                    // waits for a second
  digitalWrite(ledPin, LOW);      // sets the LED off
  delay(1000);                    // waits for a second
}
```

Variables

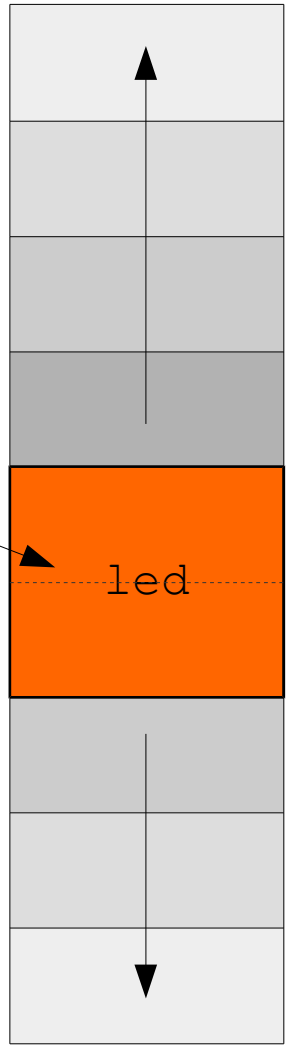
Named places to store your data

Think “labelled boxes” that can stores numbers, text, true/false.

“Declare” a variable by giving it a name and a datatype
(and optionally an initial value).

```
int led = 13;
```

Datatype Name Initial Value Semicolon



You can then read (get) and write (set) the value in this variable.

`char`	Character 'a', 'b', 'c'... or -128 to 127	1 byte
`unsigned char`	0 to 255	1 byte
`int`	-32768 to 32767	2 bytes
`unsigned int`	0 to 65535	2 bytes
`bool`	`true` or `false`	1 bytes
`String`	`String hello = “Hello!”;`	???

http://wiki.nottinghack.co.uk/wiki/Arduino101

Statements

Single lines of code that perform one job.

Reading the result of a function	`temperature = analogRead(3);`
Doing some maths: Multiply temperature by 2	`temperature = temperature * 2;`
Multiply x by *itself*	`x = x * x;`
Using a variable as an input to a function	`pinMode(led, OUTPUT);`
More complexity...	`temperature = analogRead(temp_pin) * 2;`

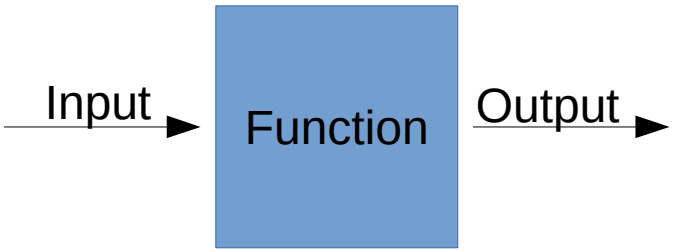
Functions

Named blocks of statements that perform a particular job

- Arduino library provides *loads* of them for you
- e.g. digitalWrite, pinMode
- Using a function is known as “calling” or “invoking” it

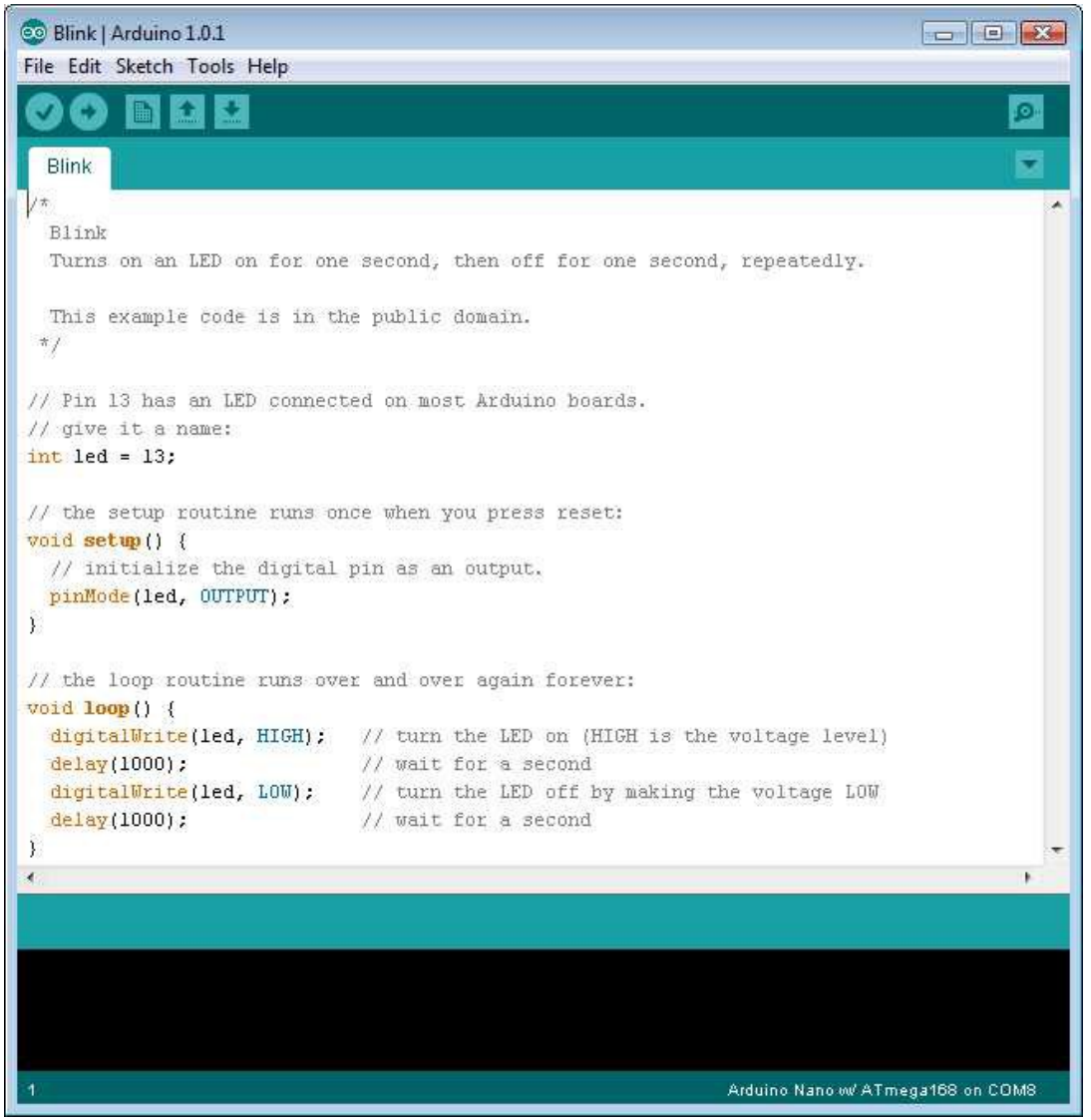
```
int getNewTemperature(void)
{
    int temp = analogRead(3);
    temp = temp * 4;
    return temp;
}

void loop()
{
    int temperature = getNewTemperature();
}
```



The Arduino IDE

- Arduino IDE (Integrated Development Environment)
- Program is called a “sketch”



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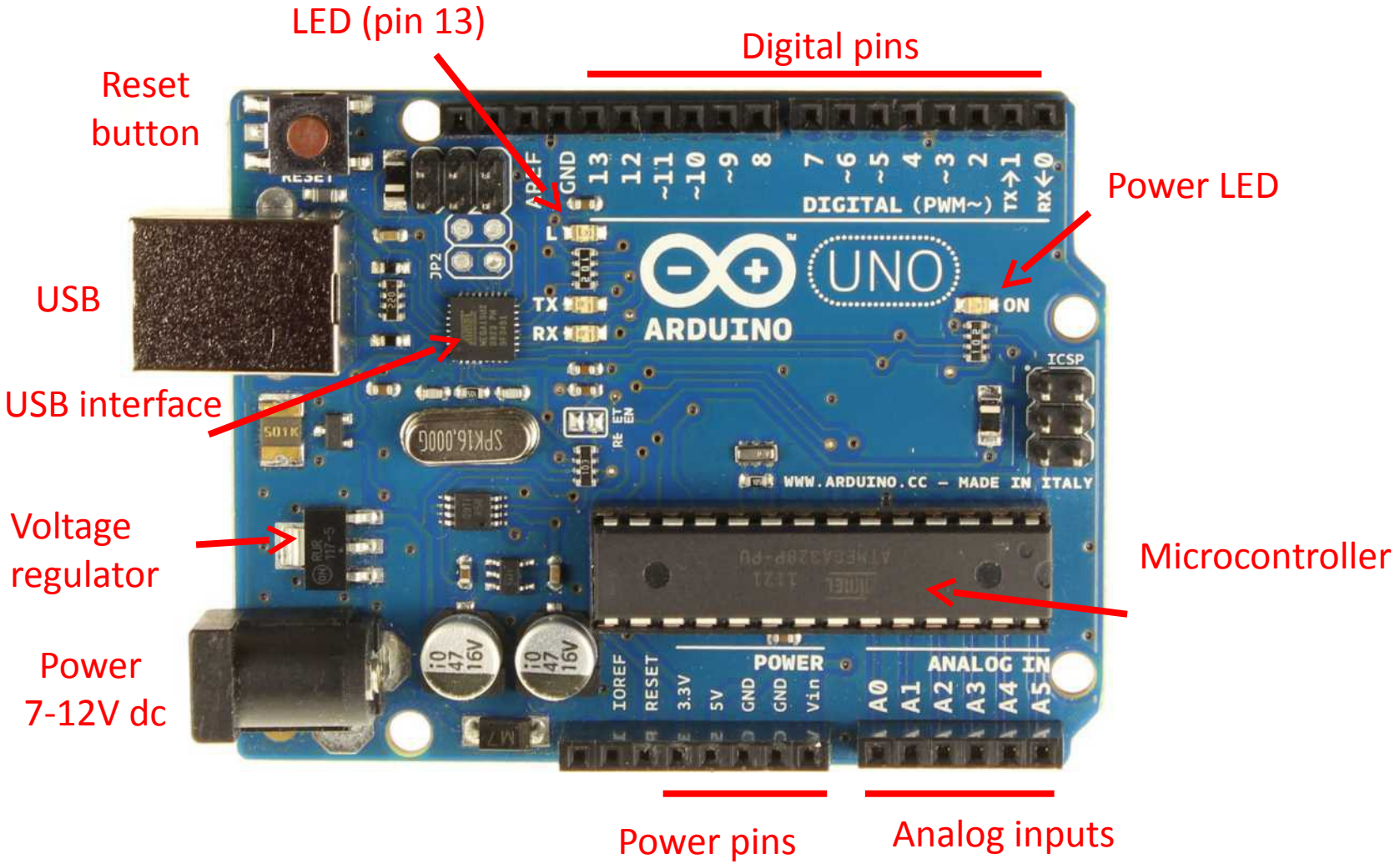
Serial Monitor

```
int ledPin = 13;                // LED connected to digital pin 13
void setup()                    // run once, when the sketch starts
{
  pinMode(ledPin, OUTPUT);      // sets the digital pin as output
  Serial.begin(9600);           // starts the serial port at 9600 baud
}

void loop()                     // run over and over again
{
  digitalWrite(ledPin, HIGH);   // sets the LED on
  Serial.println("LED on");
  delay(1000);                  // waits for a second
  digitalWrite(ledPin, LOW);    // sets the LED off
  Serial.println("LED off");
  delay(1000);                  // waits for a second
}
```

The Arduino Uno



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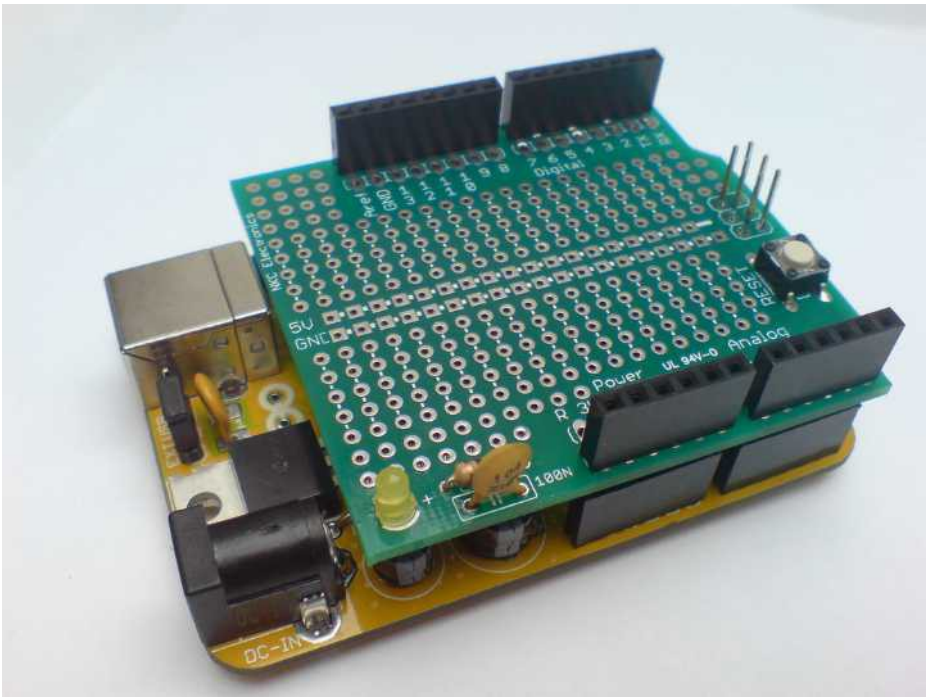
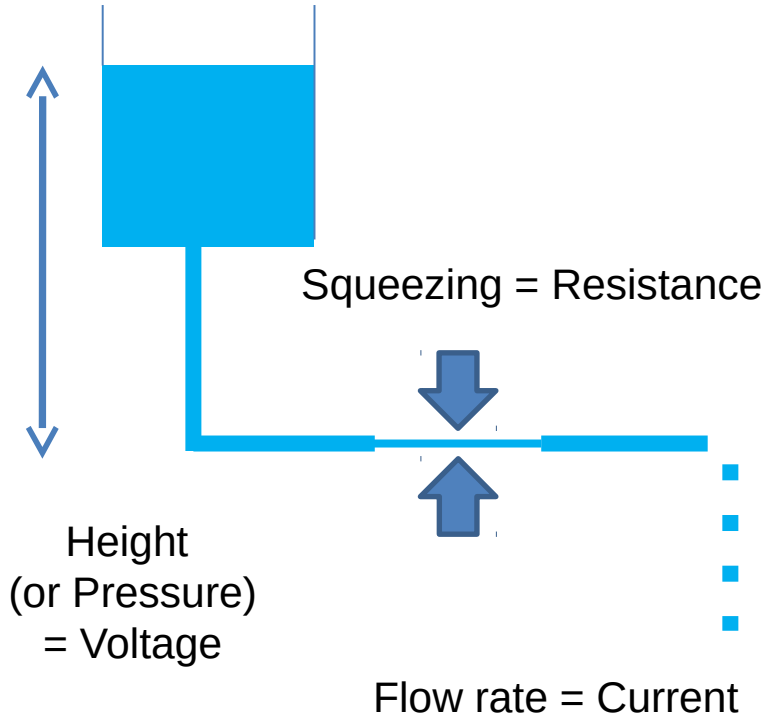
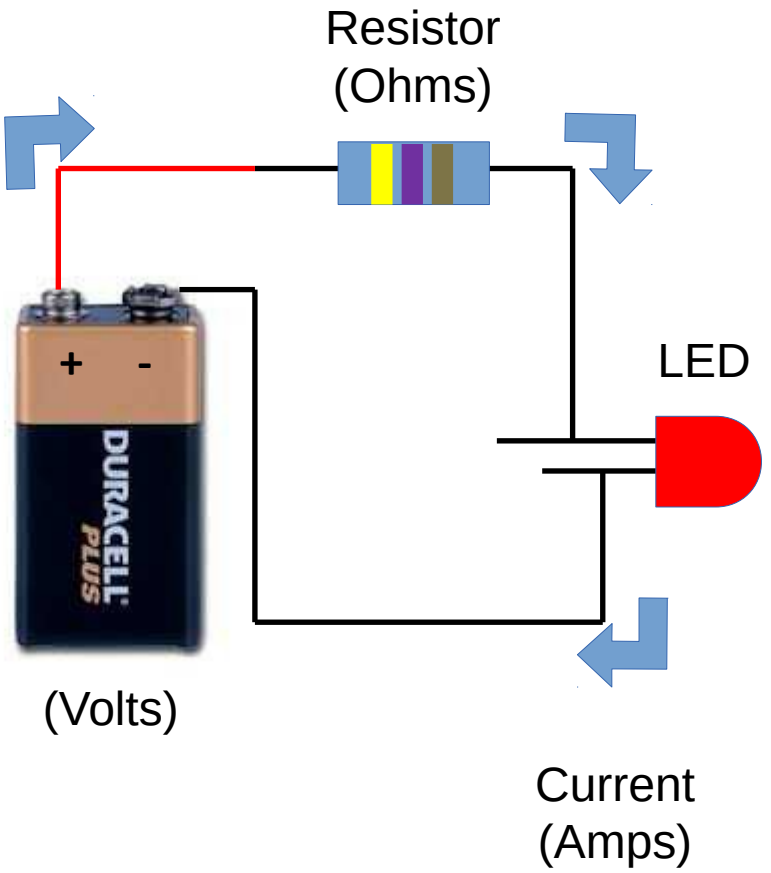
Shields Up!

Plug-in boards that expand the capabilities of your Arduino

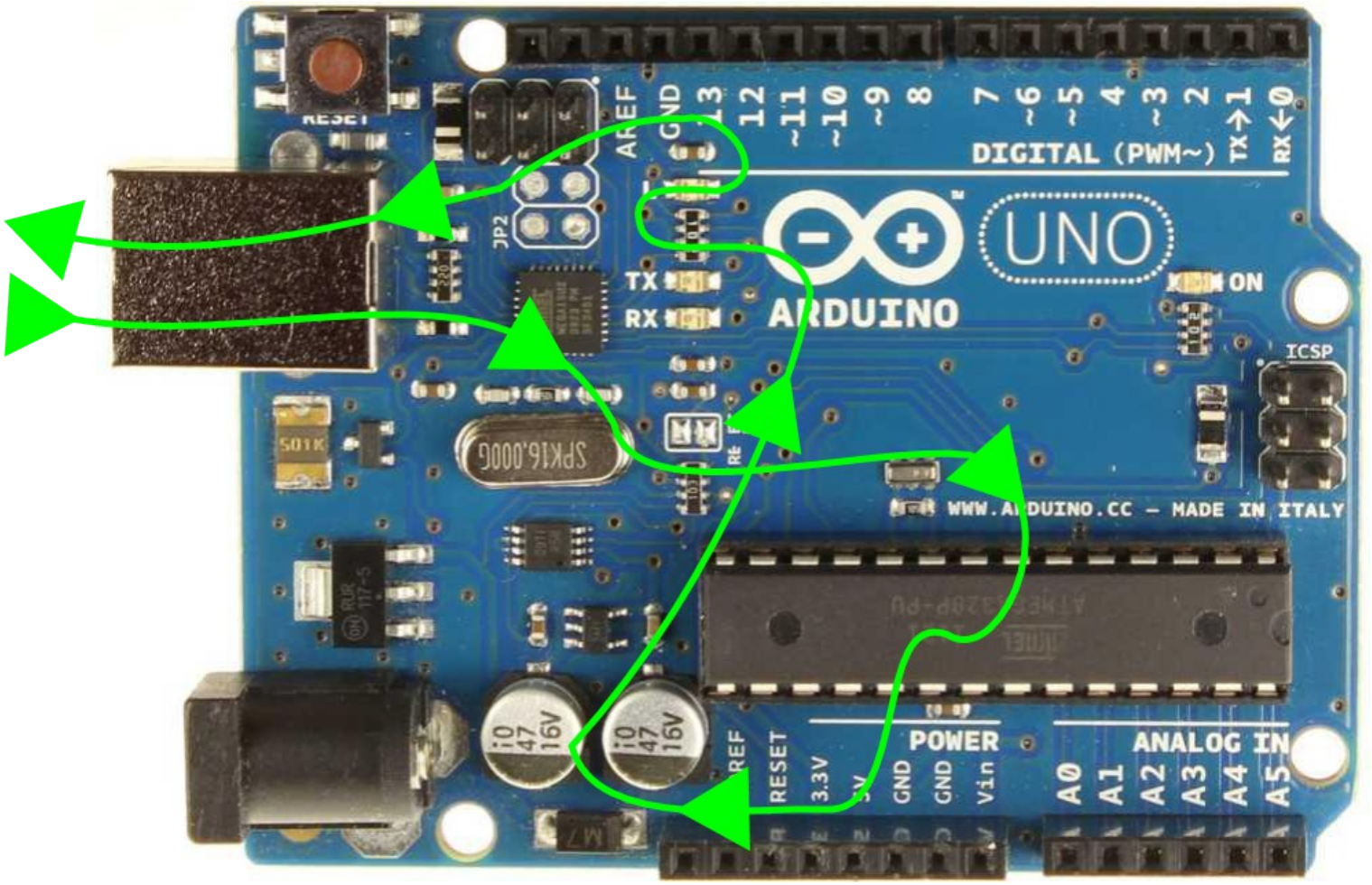


Voltage, Current, Resistance





Arduino LED Circuit



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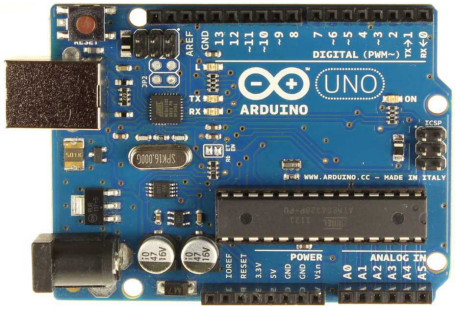
Voltage, Current, Power



5V
0.5mA
2.5mW

360V
250A
90kW

5V
0.5A
2.5W

160V
1000A
160kW

240V
4A
960W

400kV
5000A
2000MW

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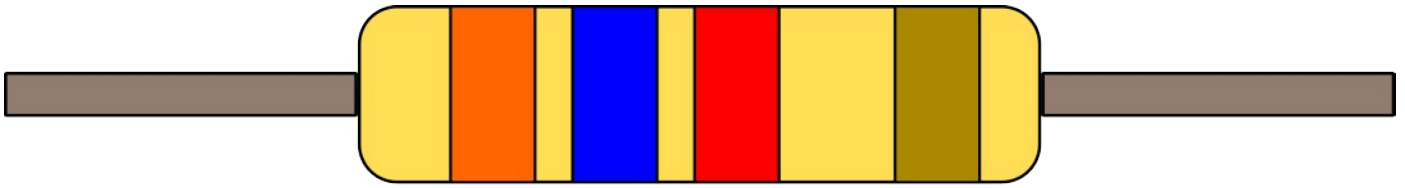
Resistor Colour Codes



3600

= 3K6 +/- 5%

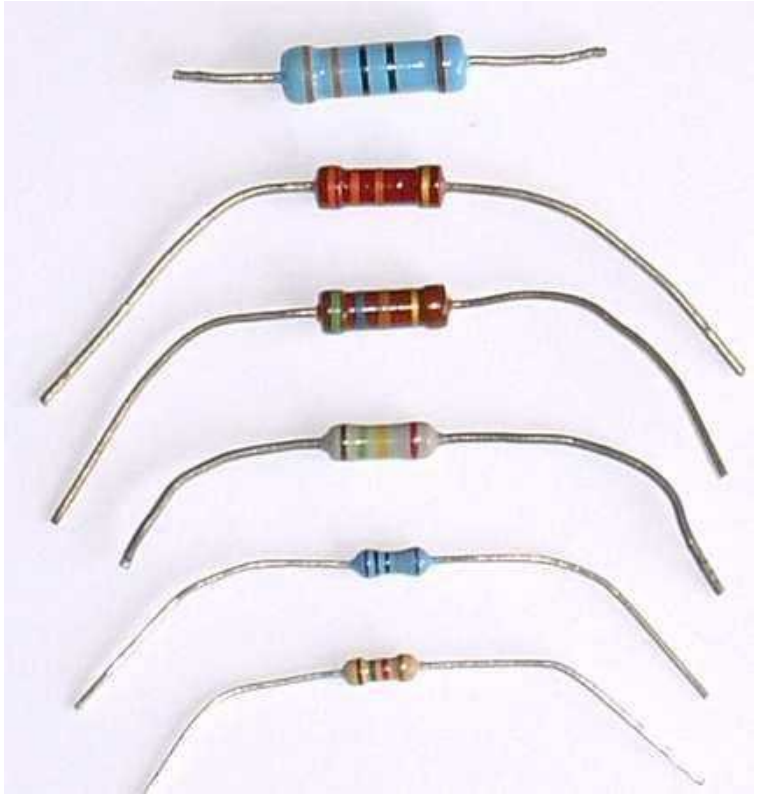
+/- %

Multipliers:
R or Ω = 1
K = 1,000
M = 1,000,000

For example:
1K = 1,000
220R = 220Ω = 220
6M8 = 6,800,000

Components

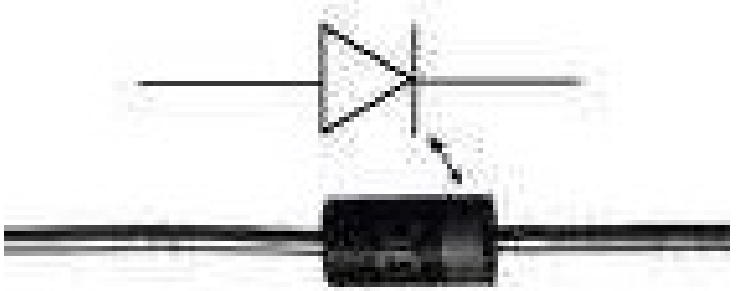
Resistor



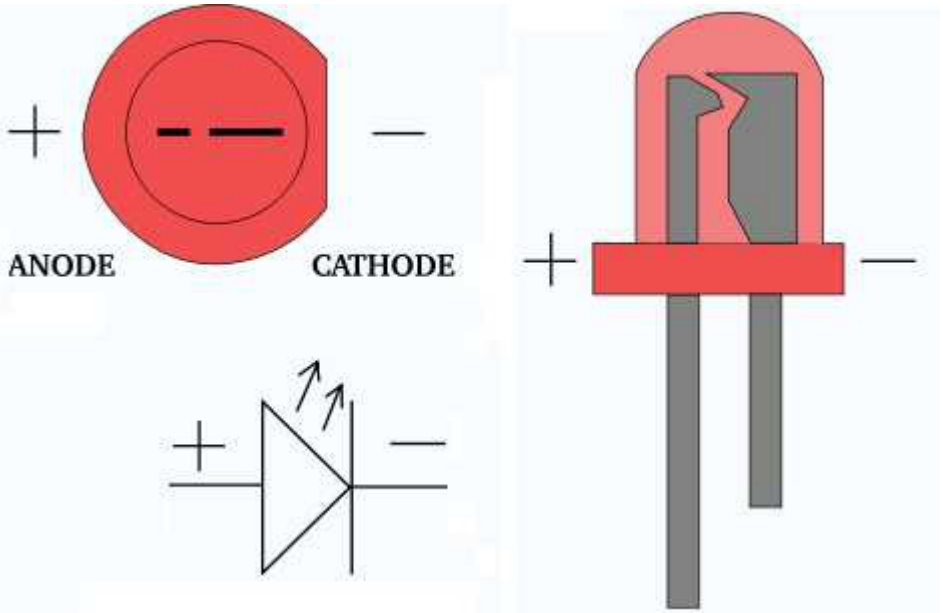
Capacitor

Components

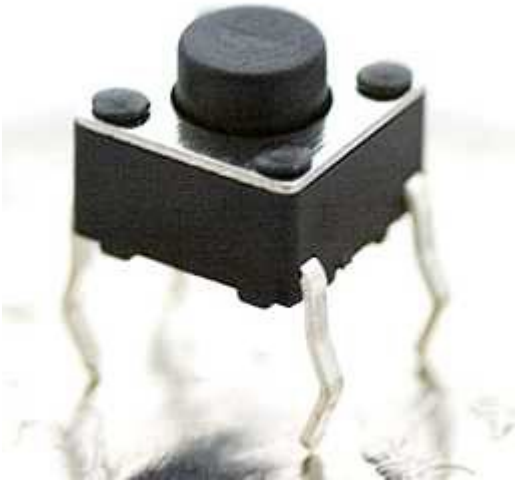
Diode

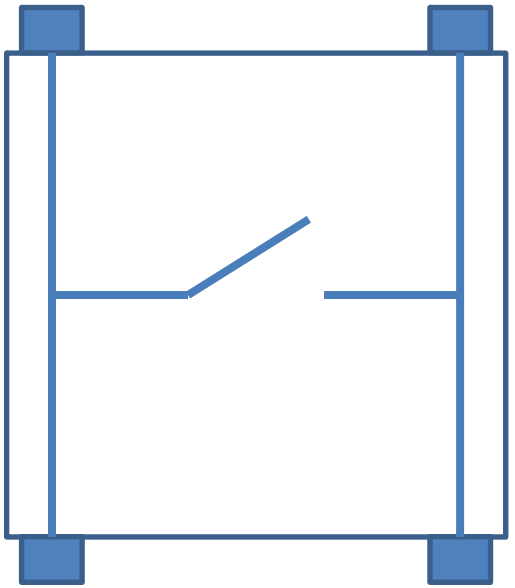


LED



Tactile Switch





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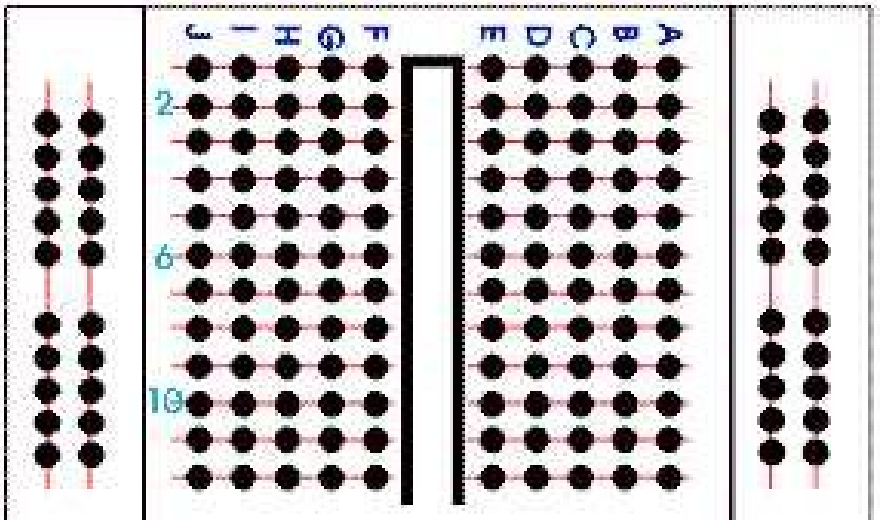
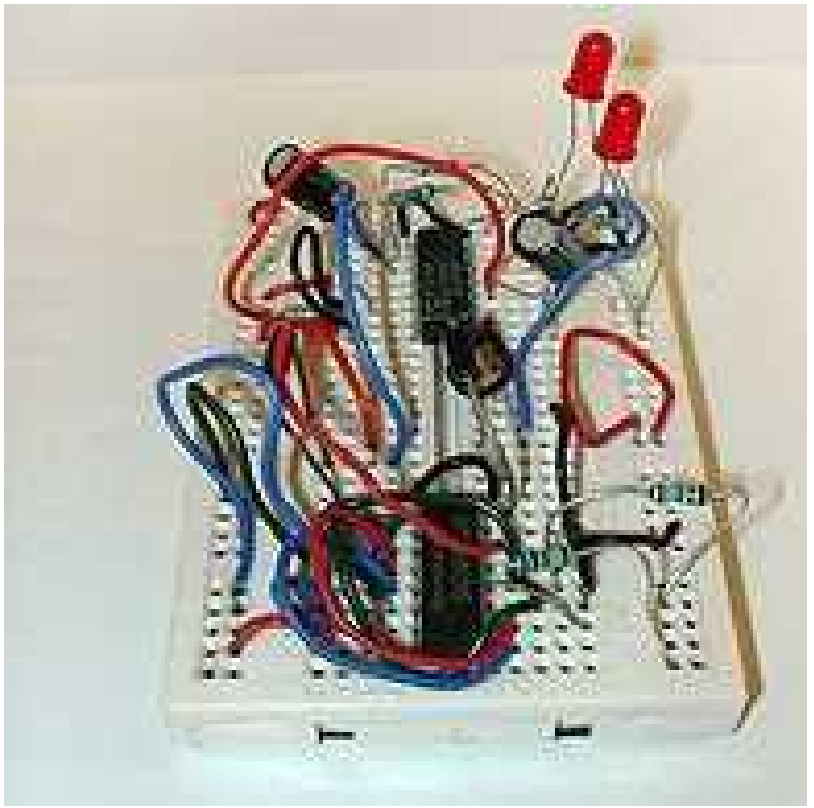
Breadboard





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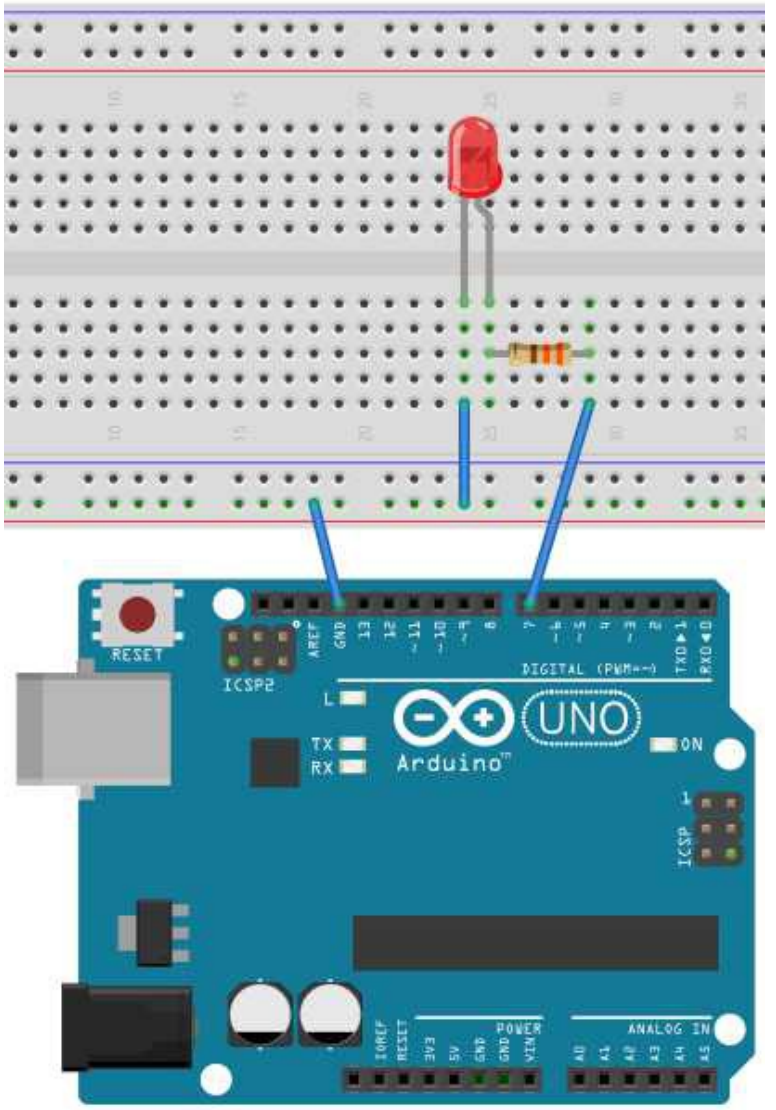
Another blinking LED

Alter the previous sketch:

```
int ledPin = 13;
```

to

```
int ledPin = 7;
```

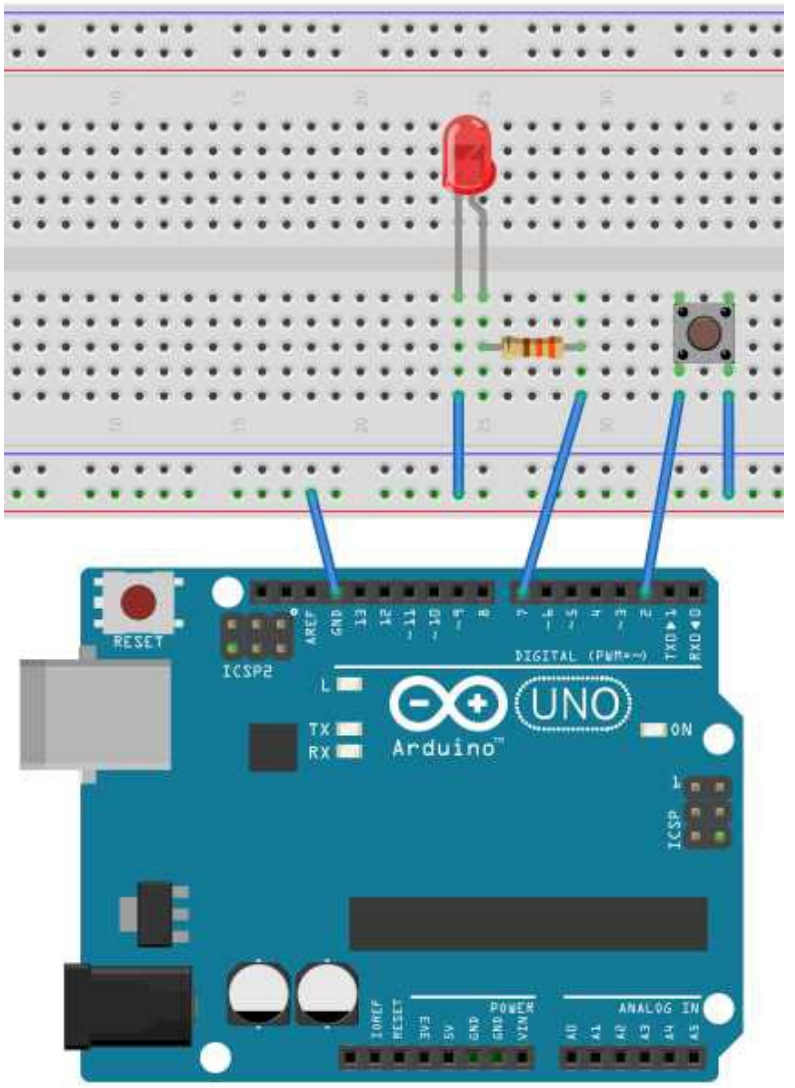


Exercises:

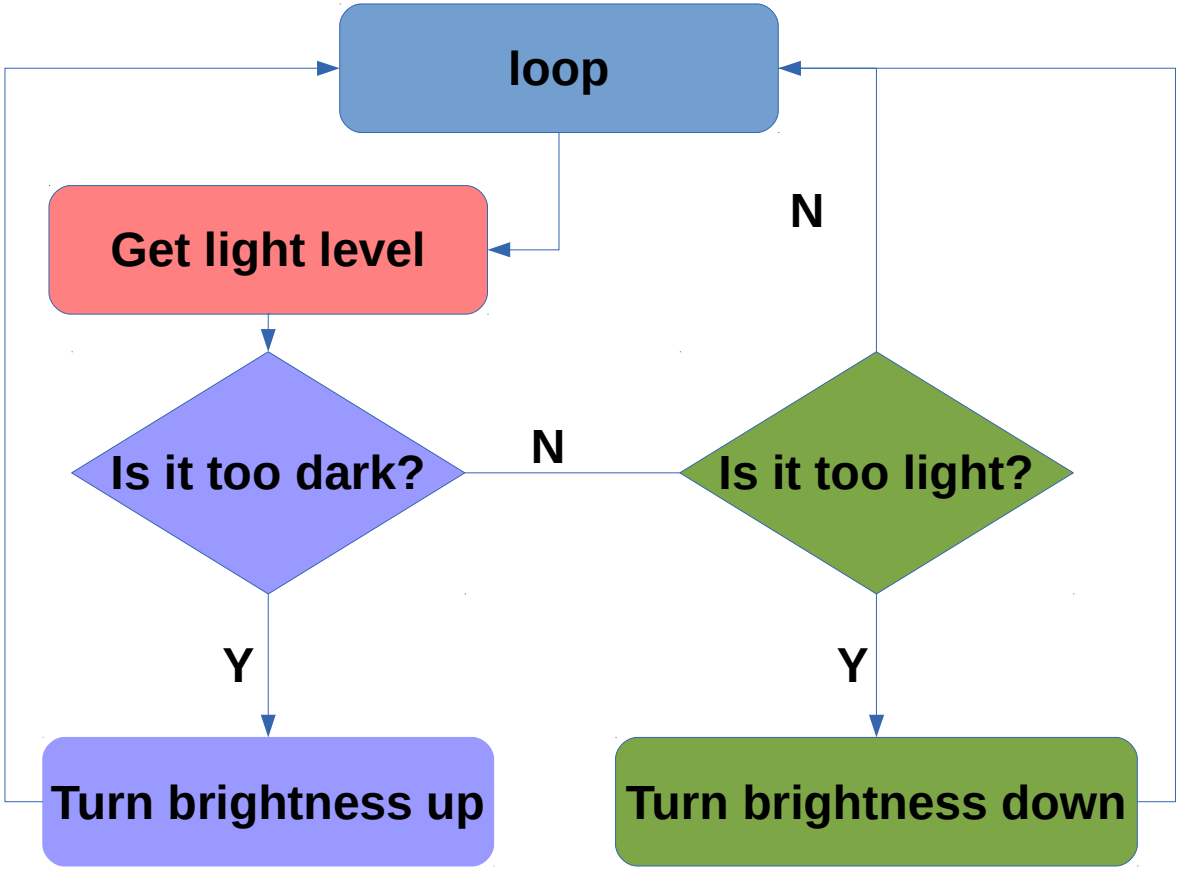
- Alter the blink frequency
- Two short blinks and one long blink
- Blink both LEDs alternately

Switch controlling LED

```
int ledPin = 13;
int switchPin = 2;

// store the switch value
int switchvalue;

void setup ()
{
  pinMode(ledPin, OUTPUT);
  // Set the switch pin
  // as input with pull-up
  pinMode(switchPin, INPUT_PULLUP);
}

void loop ()
{
  // read the switch value
  switchvalue = digitalRead(switchPin);
  // and write it to the LED
  digitalWrite(ledPin, !switchvalue);
}
```



Making sense of your code



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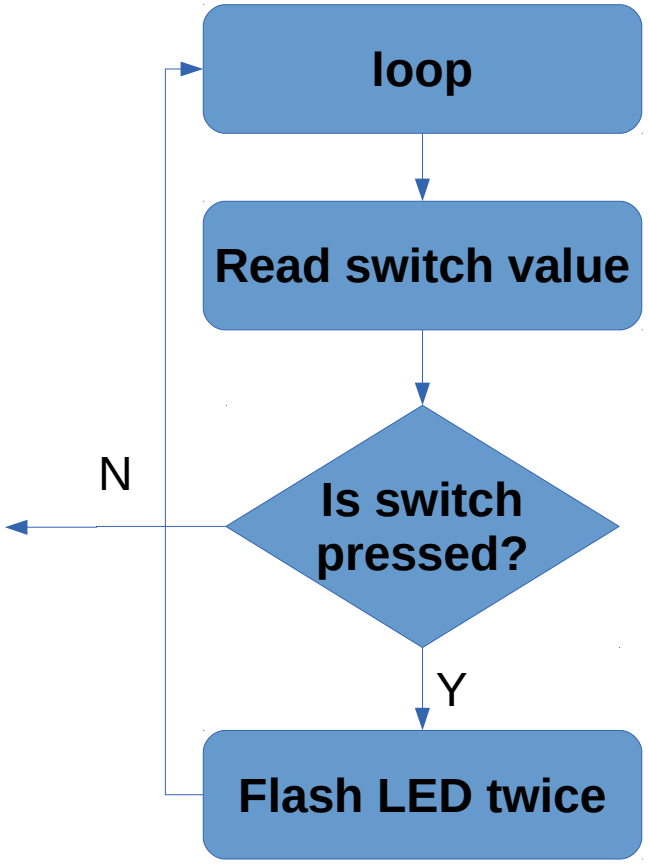
From Flowchart to Code

```
int lightLevel = 0;
int tooDarkLevel = 100;
int tooLightLevel = 125;

int brightness = 0;

void setup()
{
  setBrightness( brightness );
}
```

```
void loop()
{
  lightLevel = getLightValue();

  if (lightLevel < tooDarkLevel)
  {
    brightness = brightness + 1;
    setBrightness( brightness );
  }
  else if (lightLevel > tooLightLevel)
  {
    brightness = brightness - 1;
    setBrightness( brightness );
  }
}
```

Exercise using “if”

Blink the LED twice each time the switch is pressed.



“Comparison Operators”	
if(A == B)	Does A equal B?
if(A != B)	Does A NOT equal B?
if(A > B)	Is A greater than B?
if(A >= B)	Is A greater or equal to B?
if(A < B)	Is A less than B?
if(A <= B)	Is A less than or equal to B?

Try using: `if(switchValue == LOW)`

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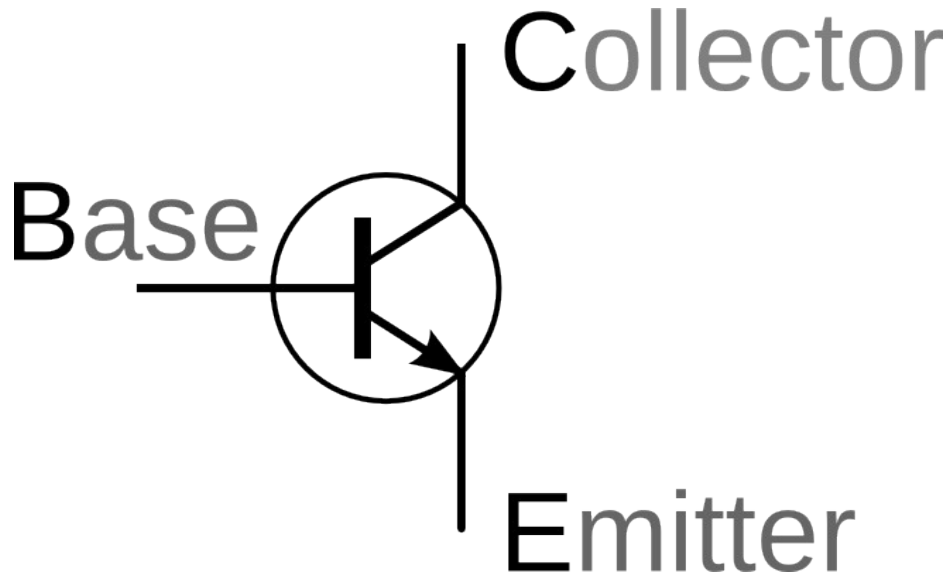
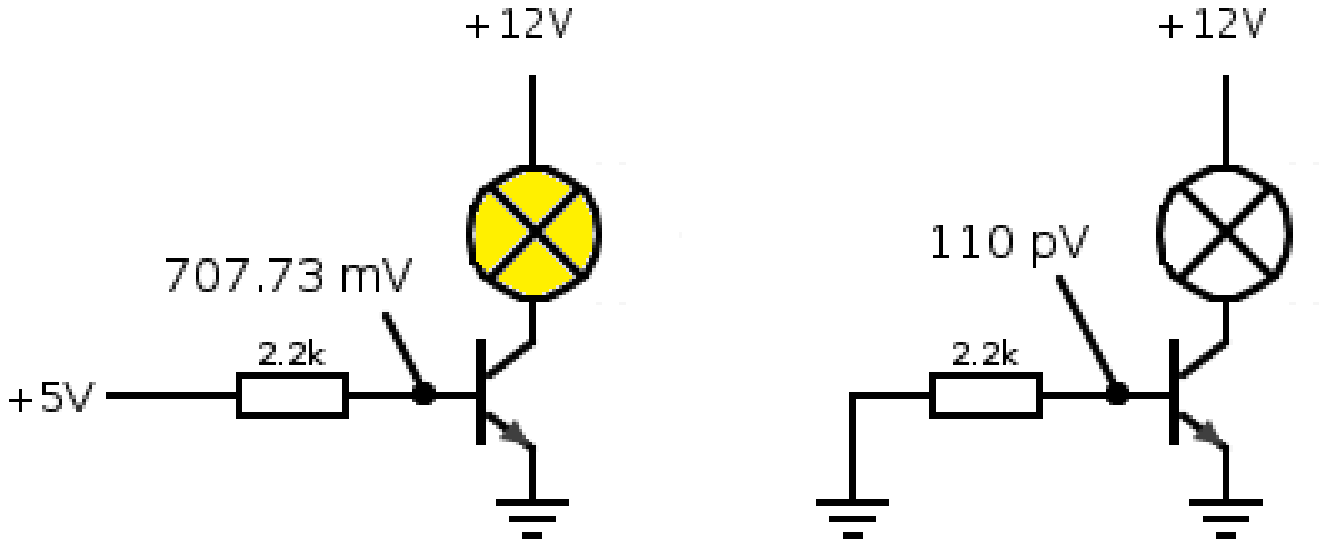
High Power Loads

- These devices need more current than the Arduino can supply.
- We use a transistor to increase the current available.
- Transistor acts as a Arduino controlled switch.
- Need protection from inductive loads (usually wound coils such as motors and relays).
- NPN Bipolar and N-channel MOSFET are commonly used with the Arduino.
- Voltage of the load (motors, etc.) can be higher than Arduino voltage.

NPN Transistor





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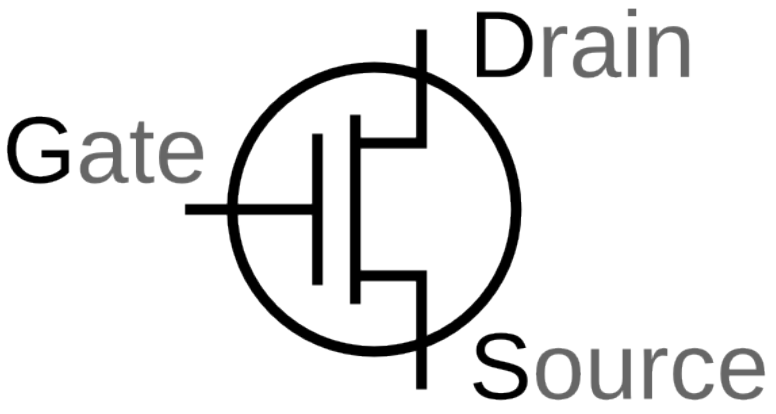
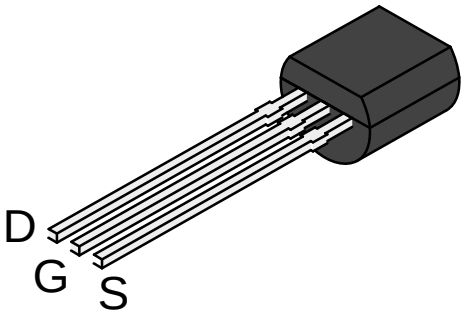
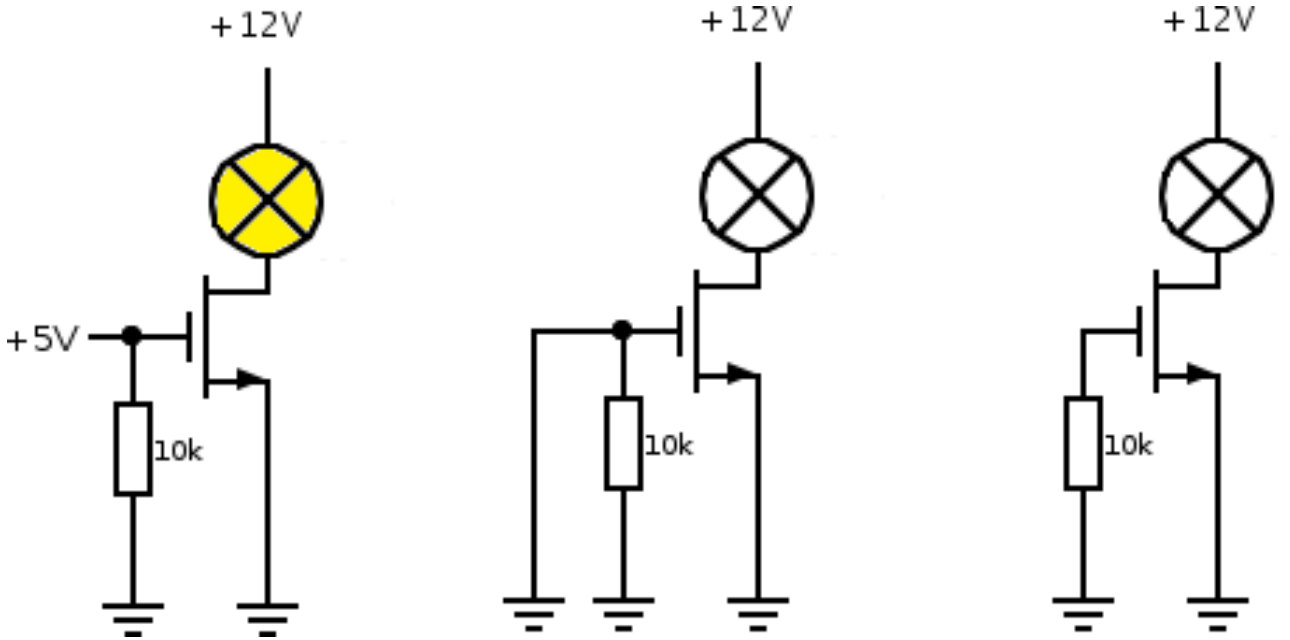
N-Channel MOSFET







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Pulse Width Modulation

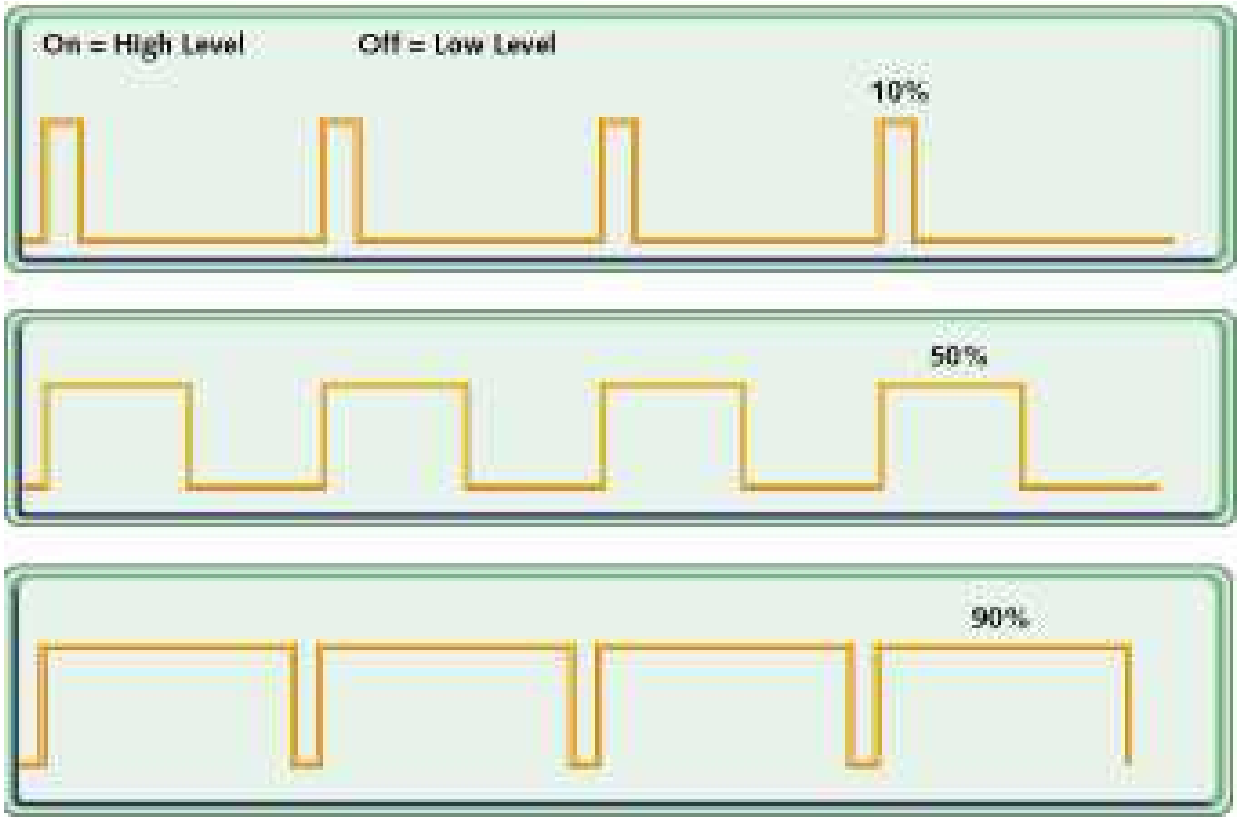
Drives motor at full voltage.

This gives high torque even at low speeds.

Used on Arduino pins 3, 5, 6, 9, 10, 11

Code:
analogWrite(pin,value);

Value 0 - 255



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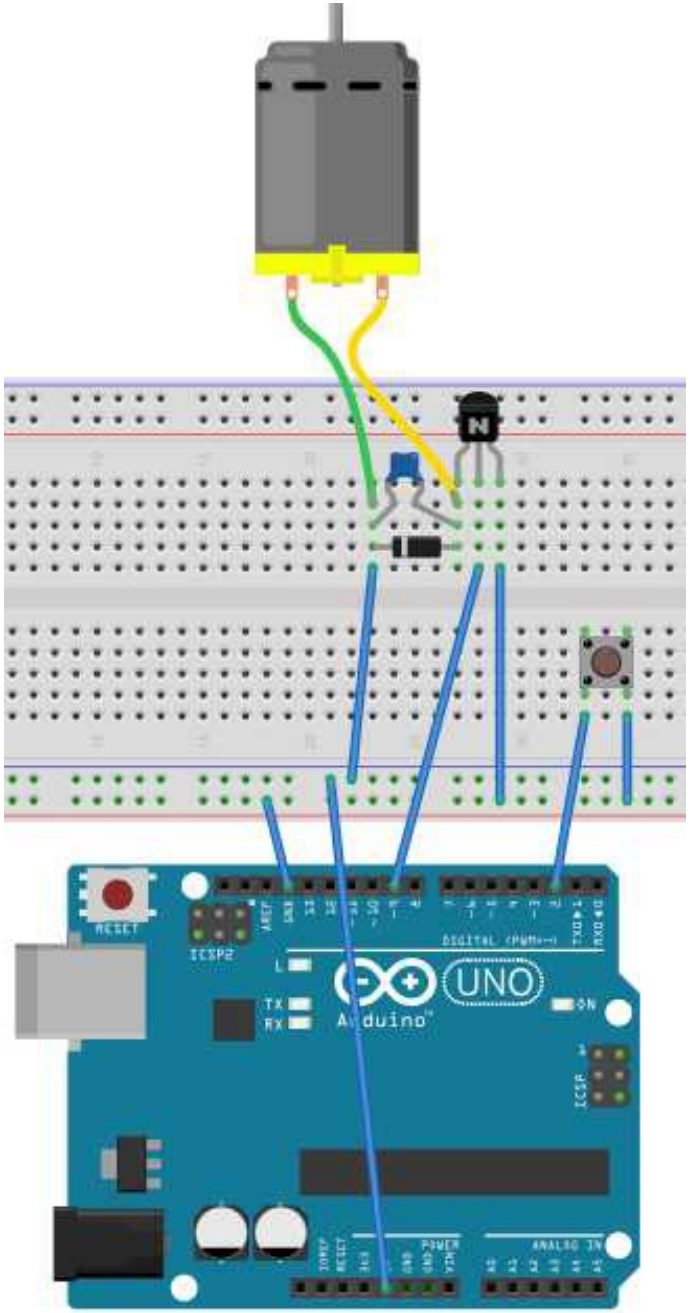
Motor Control

Motor on/off control with switch

```
void setup()
{
    pinMode(9, OUTPUT);
    pinMode(2, INPUT_PULLUP);
}

void loop()
{
    if (digitalRead(2) == 0)
    {
        analogWrite(9,100);
    }
    else
    {
        analogWrite(9,0);
    }
}
```



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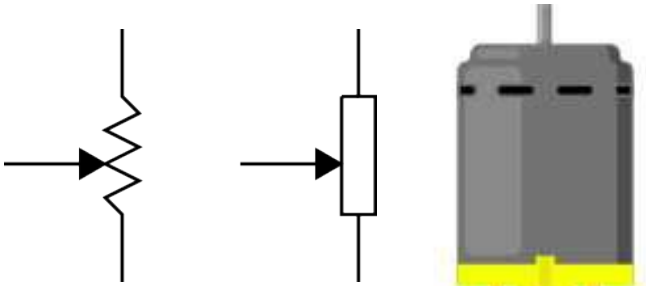
Reading real-world signals

- Arduino has 6 analog inputs
- Read with:
  - int value = analogRead(pin);
  - Pin is 0-5 or A0-A5
  - Value from 0 to 1023 representing voltage of 0-5V

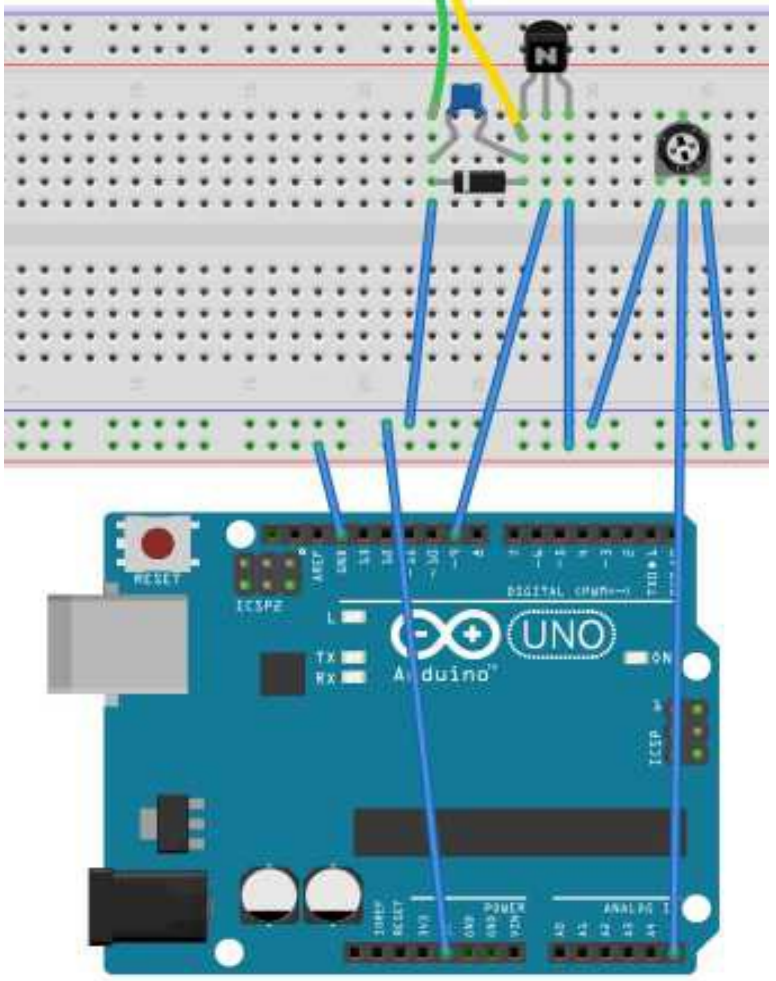
Potentiometer (Variable Resistor)



Speed control using potentiometer

```
void setup()
{
    pinMode(9, OUTPUT);
}

void loop()
{
    int light = analogRead(5);
    analogWrite(9, light/4);
}
```

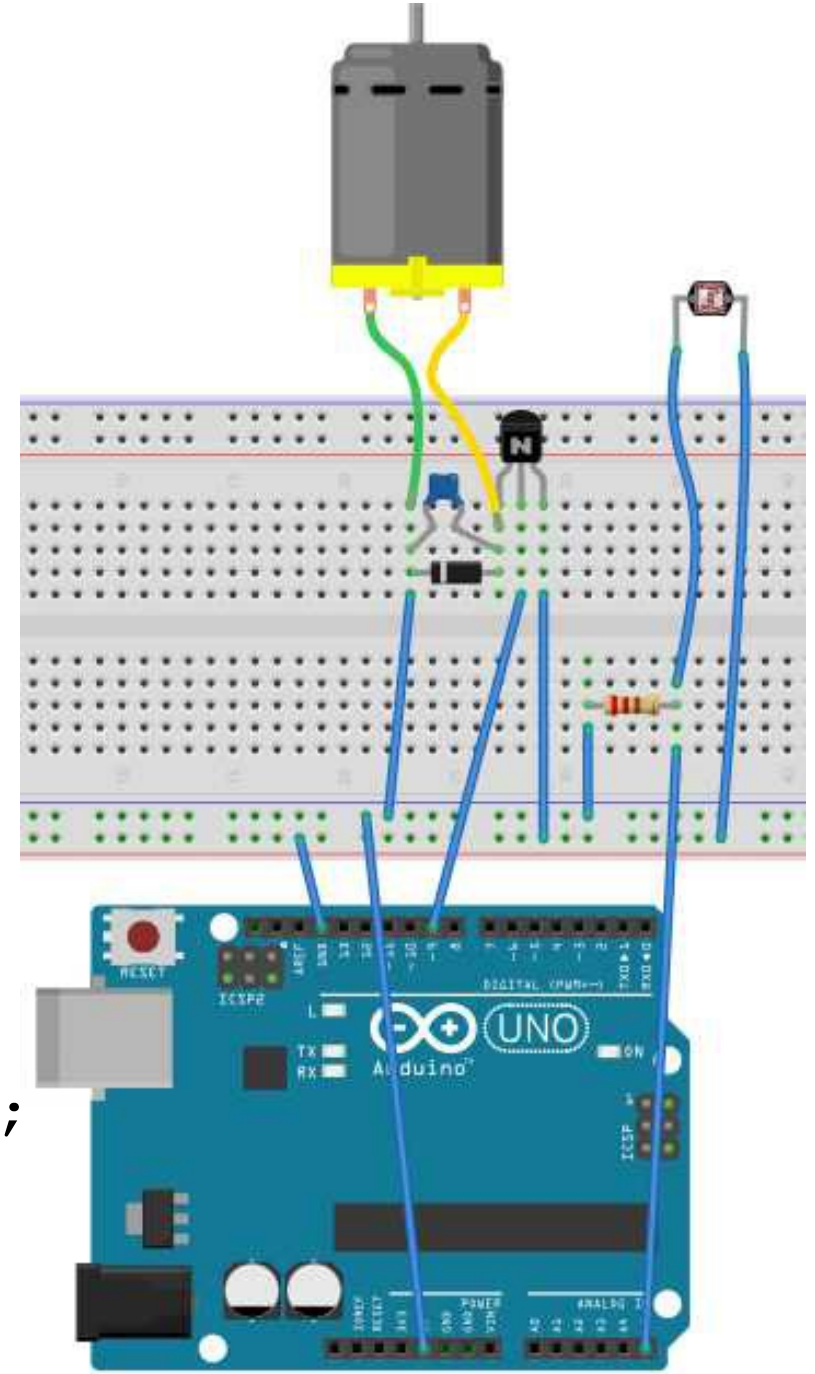


Light Dependant Resistor

Speed control according to light level

```
void setup()
{
    pinMode(9, OUTPUT);
}

void loop()
{
    int light = analogRead(5);
    analogWrite(9, light/4);
}
```



Challenges

- “Knightrider” LEDs
- Colour Changing RGB LED
- Traffic lights
- Make some noise!

Hint: use LDR and tone() function

- Line following robot
- Your own project?