Teachers Guide for Learning and Teaching Arduino

Workbook

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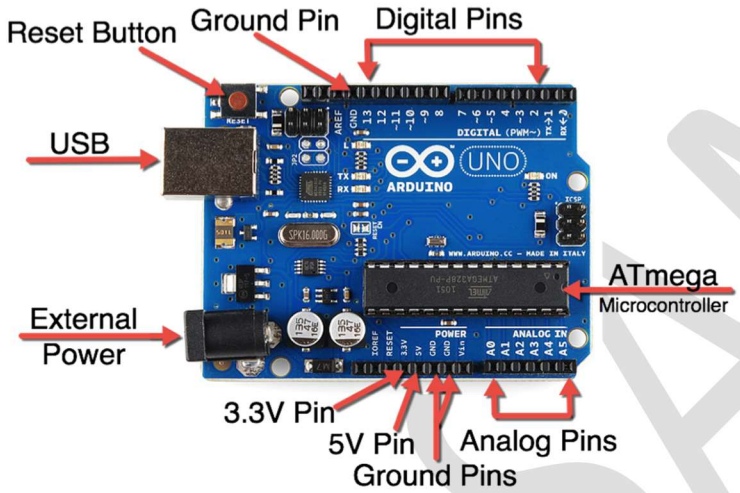
Part IV: Additional Arduino Exercises

1. What is Arduino?

Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards can read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. You can tell your board what to do by sending a set of instructions to the microcontroller on the board. To do so you use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing.

Arduino Uno



The UNO is the best board to get started with electronics and coding. If this is your first experience tinkering with the platform, the UNO is the most robust board you can start playing with. The UNO is the most used and documented board of the whole Arduino family. Working with Arduino gives students an opportunity to be creative while learning a useful programming language.

Arduino components are very inexpensive. Kits cost can be purchase for under $100 per student. In a school setting 3 students may share a kit.

2. Using Tinkercad.com

Tinkercad has a Circuits feature that allows you to create electronic circuits. It has a built in Arduino simulator in which you can write and run code for such circuits. You can add components including LEDs, Resistors, motors, and a variety of sensors to your Arduino. We will use Tinkercad prior to setting up any circuit in real life to make our electrical devices will work properly, and to prevent them from being damaged. ***Tinkercad has an option to create a class. Teachers can add students and monitor student progress.***

Sample code works on Arduino IDE software and Tinkercad

Text 1 (Arduino Uno R

```
1
2  void setup()
3  {
4      pinMode(13, OUTPUT);
5   }
6
7  void loop()
8  {
9
10   digitalWrite(13, HIGH);    // Turn on the LED
11   delay(1000);               // Wait for one second
12   digitalWrite(13, LOW);     // Turn off the LED
13   delay(1000);               // Wait for one second
14
15
16 }
```

LIST OF COMPONENTS

(OMITTED- WILL BE PROVIDED WITH THE FULL VERSION OF THE WORKBOOK)

4. HOW TO APPROACH THESE TUTORIALS?

Most Arduino books are written from the perspective of a computer programmer. This workbook is designed to be used in a school setting. Each tutorial includes research questions which encourages students to learn properties of electronic materials and devices, computer programming questions which provides the students an opportunity to learn coding in depth.

Project Based Learning:
The workbook also aims to remove any barriers from the teacher. A *Base Code* is provided with each tutorial and a suggested *Discovery Challenge***.** The challenges get progressively more challenging; however, the teacher and students gain enough experience with each tutorial to complete the challenges and create innovative circuits. Throughout the entire experience students are encourage to do research and challenge themself.

(READ MORE IN THE FULL VERSION)

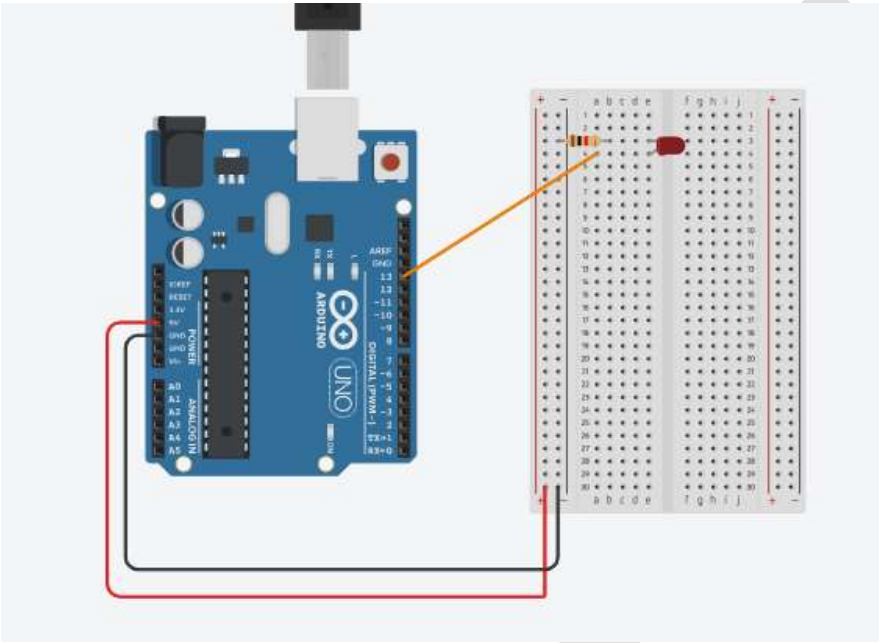
PART I: WORKING WITH SIMPLE DEVICES

Circuit 1: LED

Turn an LED on for one second, off for one second, and repeat forever.

Electrical Engineering Questions

1) What is the function of a resistor?
2) What does the acronym LED stand for?
3) How is an LED different from an incandescent light bulb?
4) Why is it more efficient than an incandescent light bulb?



Equipment:

Arduino (1), Breadboard (1), LED (1) , 200 to 1000 Ohm resistor (1), wires.

Base Code Please type this code in the Arduino IDE software or online simulator (i.e.: thinkercad)

```
void setup()
{
  pinMode(13, OUTPUT);
}
void loop()
{
  digitalWrite(13, HIGH);
  delay(1000); // Wait for 1000 millisecond(s)
  digitalWrite(13, LOW);
  delay(1000); // Wait for 1000 millisecond(s)
}
```

Programming Questions

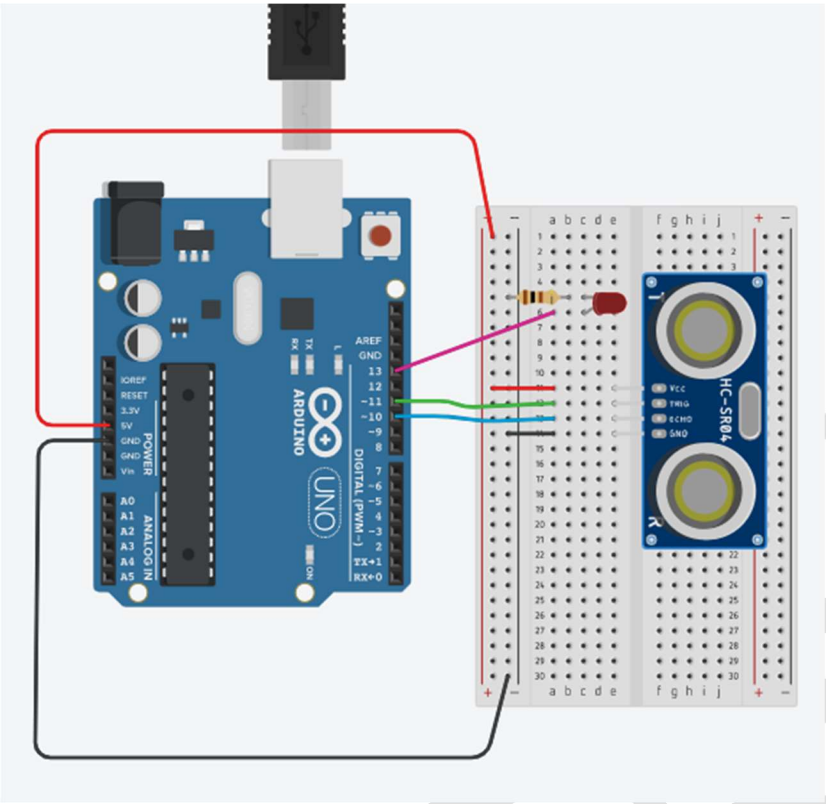
1) Explain what `void setup()` means and why it is necessary for an arduino sketch.
2) How can you assign a high/low value to a digital pin?
3) What is the purpose of the `delay()` function and what are its parameters measured in? *(Hint: Parameters are inside the parentheses.)*

Discovery Challenge

Create a model of a traffic light, make the appropriate changes to the hardware and software necessary

Part III: Making Things Interact

Circuit 13: Ultrasonic Motion Sensor



Equipment:

Arduino (1), Ultrasonic Distance Sensor (1), LED (1), 330 Ohm Resistor (1)

Electrical Engineering Questions

1) Explain the function of the Trigger pin and the Echo pin.
2) Use your knowledge of physical science to explain how the motion sensor measures distance using the speed of sound.

Base Code Please type this code in the Arduino IDE software or online simulator (i.e.: Tinkercad)

```
#define trigPin 13
#define echoPin 12
#define led 11
void setup()
{ Serial.begin (9600);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
pinMode(led, OUTPUT);
}
void loop()
{ long duration, distance;
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = (duration/2) / 29.1;
if (distance < 10)
{ digitalWrite(led,HIGH);
}
else {
digitalWrite(led,LOW);
}
Serial.print(distance);
Serial.println(" cm");
delay(500);
}
```

Programming Questions

1) What does `pulseIn()` do?
2) What are the `trigPin & echoPin` responsible for?
3) Explain why this formula is used to calculate the distance of an object from the sensor. HINT:

```
distance = .034/2 * duration;
```

Discovery Challenge

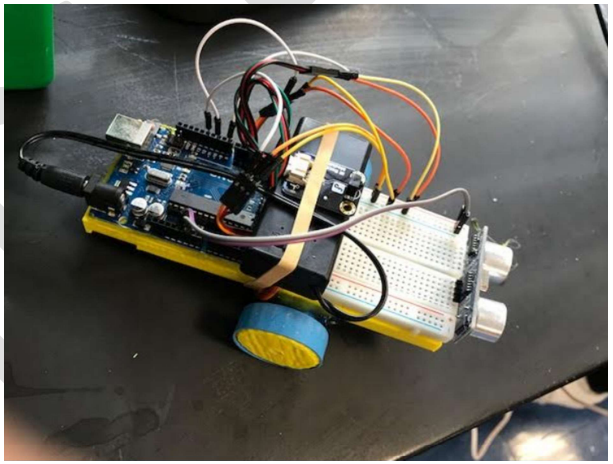
CHALLENGE: Add a speaker and have it play a note if there is an object 25 cm from the motion sensor.

Project Based Learning

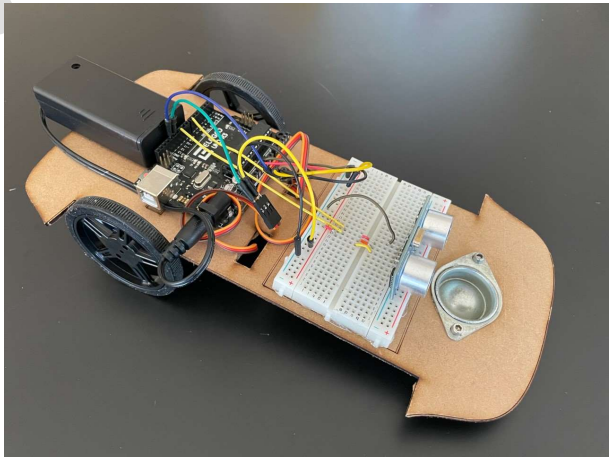
Presentations: After completing these tutorials students can design creative circuits. This provides an opportunity for students to practice your presentation skills. Please scan the following QR code to see some sample student work

Arduino Rover

In addition students are now ready to create their own Arduino Rover from scratch. This provides a great opportunity for students to explore engineering practices consistent with the Next Generation Science Standards. These rovers could be programed to avoid obstacle using the Ultrasonic motion sensor, to be controlled with an app using a Bluetooth capable mobile device or to operate with an IR remote control.



Rover with 3D printed parts



Rover with Laser cut cardboard base