



2022 Sec 4 Advanced Physics
Introduction to Arduino Microcontroller

Name: _____ () Class: _____ Date: _____

Online resources at <https://bit.ly/3hW0VQe>

Objectives: At the end of this lesson, you should be able to

1. Understand what is an Arduino microcontroller and its uses
2. Use LEDs and buzzer with the Arduino microcontroller
3. Write a sketch using the Arduino software



Apparatus:

- 01 Maker UNO microcontroller
- 01 mini breadboard
- 01 micro USB cable
- 02 resistors (1 kΩ)
- 02 LEDs (red, green, yellow or blue)
- Jumper wires

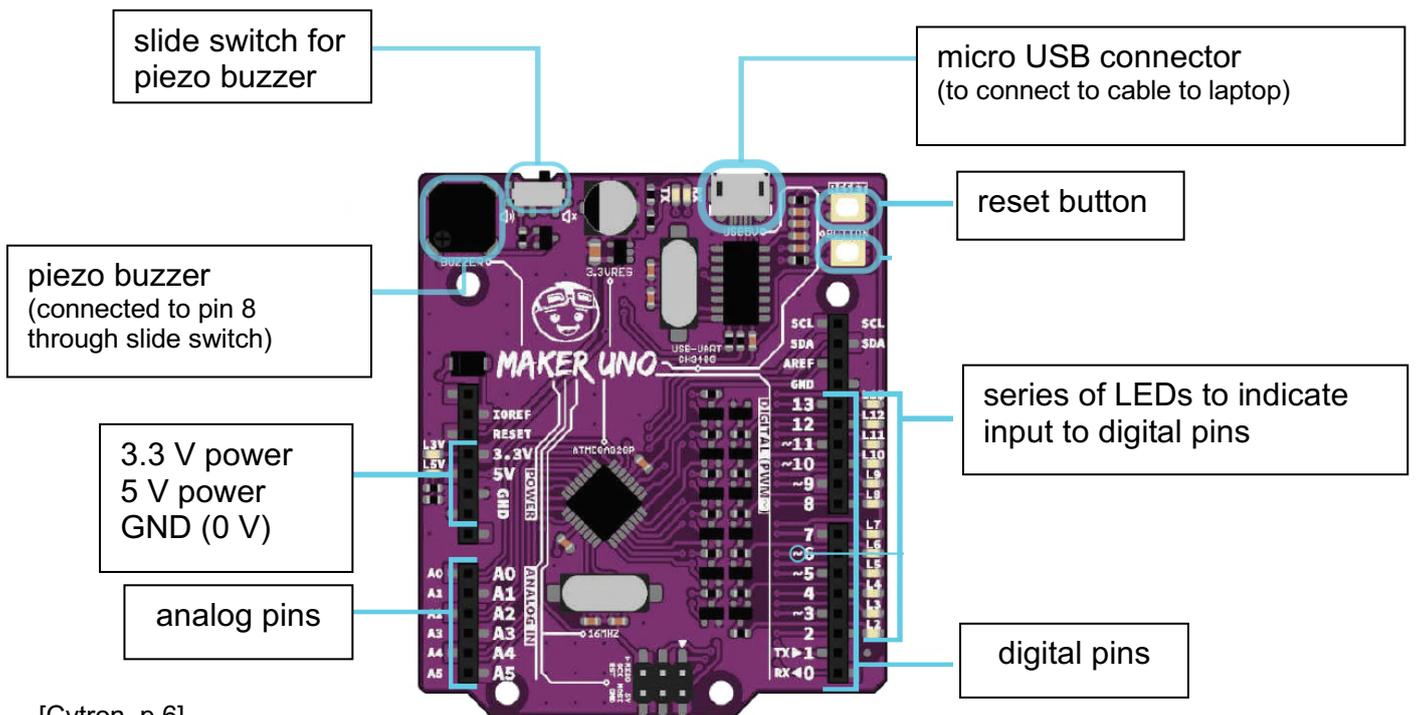


1. About Arduino

- Main Arduino website: <https://www.arduino.cc/>
- History: 2005 in Italy
- Hardware: **Arduino microcontroller** is a circuit board that can “receive information” (input) usually from sensors and “do something” (output) via other sensors or devices.
- Software: **sketch** (or Arduino program) to tell the hardware what to do (via C++ programming)

2. Maker Uno Board (a Arduino-compatible microcontroller)

- Refer details at <https://sg.cytron.io/p-maker-uno-simplifying-arduino-for-education>



[Cytron, p.6]

3. Arduino software

- The Arduino software has been downloaded & installed in the laptop from <https://www.arduino.cc/en/Main/Software>. A software driver CH341SER has also been downloaded & installed from <https://cdn.cytron.io/makeruno/CH341SER.EXE>

3.1 Powering up the Arduino board

- Connect the Maker Uno board to the USB port on the laptop using the micro USB cable.
- A few LEDs (for 3.3 V, 5 V pins) may light up. There may be a beeping sound.
- Click the Reset button. The LED at pin 13 should flicker momentarily.

3.2 Launching Arduino software

- Double click on the Arduino icon on the laptop desktop to start the software. The “sketch” will open in a separate window. This shows



```
sketch_jul06a | Arduino 1.8.12
File Edit Sketch Tools Help

sketch_jul06a

void setup() {
  // put your setup code here, to run once:
}

void loop() {
  // put your main code here, to run repeatedly:
}
```

- From **Tools** menu > **Board** > choose Arduino Uno (may be selected automatically)
- From **Tools** menu > **Port** > choose COM# (where # is any number)

Task 1: Light up a digital pin LED	[Cytron, 2018, p.11]
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- Type these two additional lines of code:

➤ **pinMode (7, OUTPUT);**

➤ **digitalWrite (7, HIGH);**

```
void setup() {
  // put your setup code here, to run once:
  pinMode (7, OUTPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite (7, HIGH);
}
```

setup routine

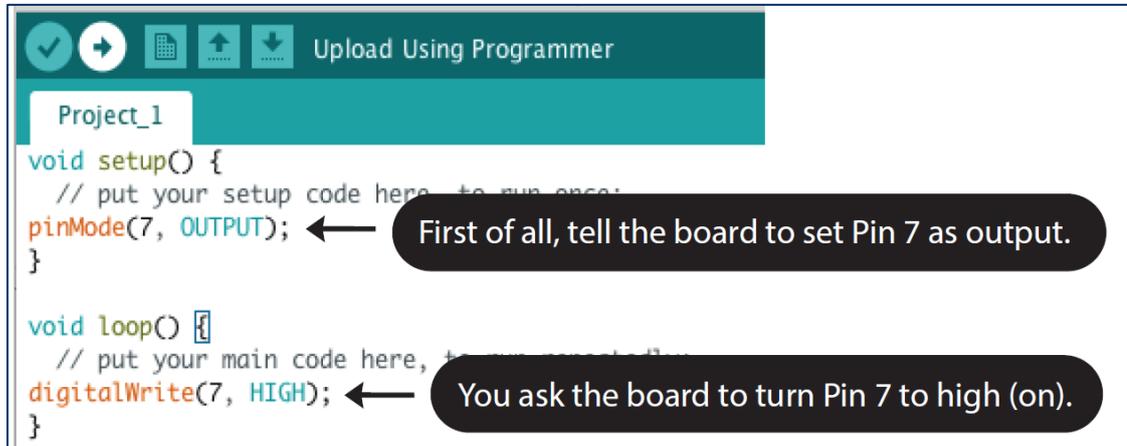
loop routine

3.3 Upload sketch onto Maker Uno board

- Click the “tick” icon to verify the sketch. Wait a few seconds till you see “Done compiling” at the bottom of the sketch. If prompted, just save the file.
- Click the “right arrow” icon to upload the sketch into the Maker Uno board. Wait a few seconds till you see “Done uploading” at the bottom of the sketch.

What do you observe?

What's happening?



```
Project_1
void setup() {
  // put your setup code here, to run once:
  pinMode(7, OUTPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite(7, HIGH);
}
```

First of all, tell the board to set Pin 7 as output.

You ask the board to turn Pin 7 to high (on).

Note:

- You must type exactly the code shown, including the uppercase letters & punctuations such as semi-colons!
- Single line comments start with // (to explain a line of code)
- There is only **one** curly close bracket “}” at the end of the **loop** section, otherwise an error will be shown.

Task 2: Blink an LED

[Cytron, 2018, p.15]

- Modify the previous code by adding these three additional lines of code under the **loop routine** section:

- **delay (100);**
- **digitalWrite (7, LOW);**
- **delay (100);**

```
void loop() {
  // put your main code here, to run repeatedly:
  digitalWrite (7, HIGH);
  delay (100);
  digitalWrite (7, LOW);
  delay (100);
}
```



- Click this to verify & upload the sketch. Wait a few seconds till you see “Done uploading” at the bottom of the sketch.

What do you observe?

Note:

- “delay (100)” instructs the board to pause for 100 milliseconds (do nothing).
- 1 second = 1000 milliseconds (or 1000 ms)
- Try different values of the delay, e.g. 500 or 1000 or 2000.

Task 3: Compose basic tones (using piezo buzzer)

[Cytron, 2018, p.44]

- From **File** menu > **New** > to start a new sketch
- Type the following sketch and upload it to the Maker Uno board.

```
void setup() {  
  // put your setup code here, to run once:  
  pinMode(8, OUTPUT);  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
  tone (8, 262, 250);  
  delay (325);  
  tone (8, 294, 250);  
  delay (325);  
  tone (8, 330, 250);  
  delay (325);  
  tone (8, 349, 250);  
  delay (325);  
  tone (8, 392, 250);  
  delay (325);  
  tone (8, 440, 250);  
  delay (325);  
  tone (8, 494, 250);  
  delay (1000);  
}
```

Note:

- The piezo buzzer on the Maker Uno board is connected to pin 8.
- Use the slide switch to turn it to the  sign if you want to use the piezo buzzer.
- Also use the switch to turn off the buzzer (or to use pin 8).

What do you observe?

Note	C ₄	D ₄	E ₄	F ₄	G ₄	A ₄	B ₄	C ₅	D ₅	E ₅	F ₅	G ₅
Frequency	262	294	330	349	392	440	494	523	587	659	698	784
	Do	Re	Mi	Fa	So	La	Ti					

What's happening?

1. To play a tone from the piezo buzzer.

- **tone (pin, frequency, duration);**

- pin: The pin that is connected with a piezo buzzer
- frequency: the frequency of the tone in Hertz
- duration: the duration of the tone in milliseconds (whether it is 1 beat, 2 beats or etc.)

2. There is always a delay after a tone.

- The delay has to drag 30% longer than the tone duration to ensure the tone is completed.
- e.g.: The tone duration for 1 beat is 250ms, thus we need to allow a 325ms delay.

Questions

1. Suggest how such a microcontroller may be used to control a specific device in your house, in terms of inputs (e.g. from sensors) and outputs (action).

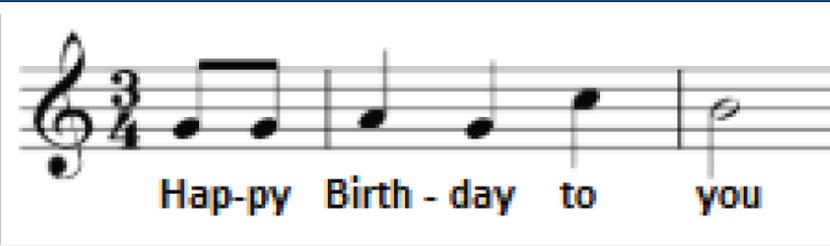
2. Suggest a simple application of what you have learned in this lesson, e.g. to build an interesting or useful device or gadget.

References:

1. Cytron Technologies Sdn Bhd (2018). Arduino Learning Guide For Beginner using Maker Uno. From https://cdn.cytron.io/makeruno/Arduino_Learning_Guide_for_Beginner_Using_Maker_UNO.pdf
2. Cytron Technologies Sdn Bhd (n.d.). Maker UNO Starter Kit Module. From https://cdn.cytron.io/makeruno/Maker_UNO_Starter_Kit_Module.pdf
3. Official website <https://www.arduino.cc>
4. More resources at <http://johnlittle.pbworks.com/w/page/114023272/arduino>

CHALLENGE A – Music

Play the first line of “Happy Birthday”



Note	G4	G4	A4	G4	C5	B4
Frequency	392	392	440	392	523	494
Duration	125ms	125ms	250ms	250ms	250ms	500ms

```
void setup() {
  // put your setup code here, to run once:
  pinMode (8,OUTPUT);
}

void loop() {
  // put your main code here, to run repeatedly:
  //1st line
  tone (8, 392, 125);
  delay (163);
  tone (8, 392, 125);
  delay (163);
  tone (8, 440, 250);
  delay (325);
  tone (8, 392, 250);
  delay (325);
  tone (8, 523, 250);
  delay (325);
  tone (8, 494, 500);
  delay (1000);
}
```

Done uploading.

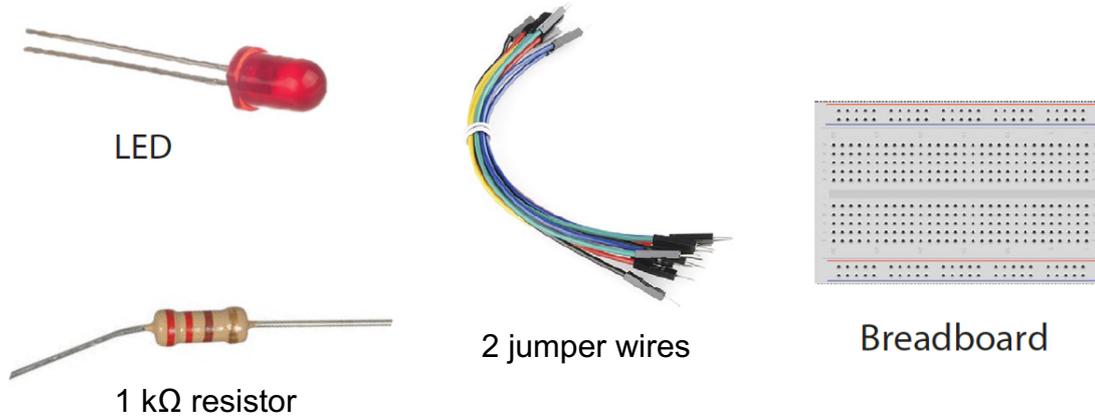
Note: Use the slide switch to turn on/ off buzzer!

Adapted from [Cytron, 2018, p.46-49]

CHALLENGE B – Traffic Lights

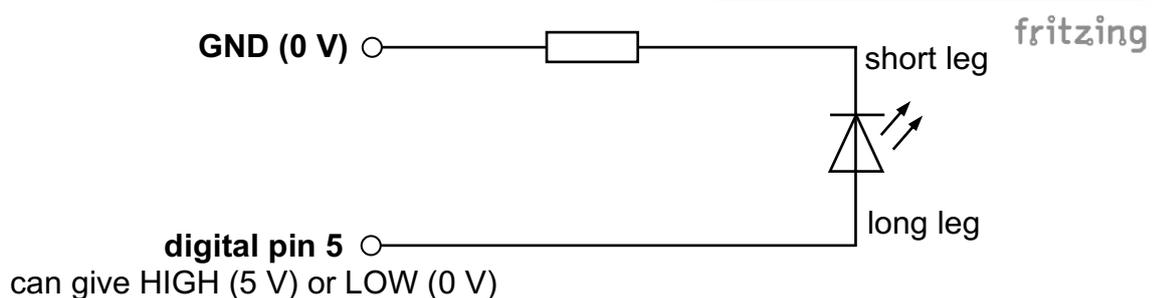
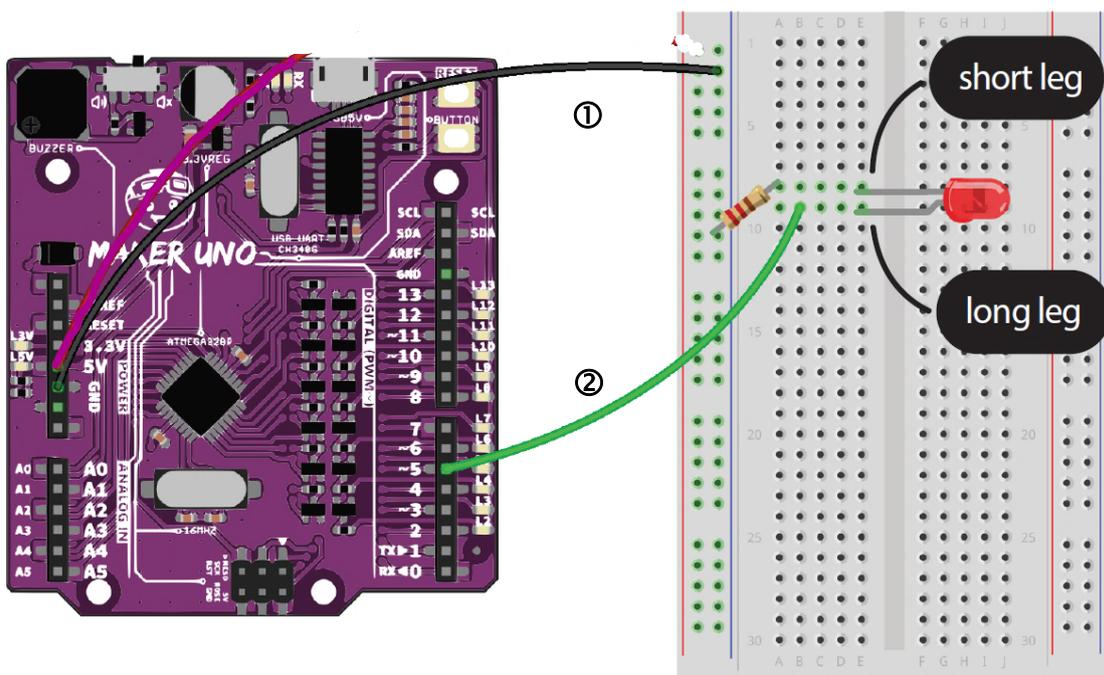
Construct an LED circuit & blink the LED

1. Apparatus



2. Construct this circuit:

- jumper wire ① from board GND (0V) → resistor → short leg of LED
- jumper wire ② from board digital pin 5 → long leg of LED



3. Create the sketch:

- Open a new sketch file.
- Type the codes below into the new sketch.
- Upload the sketch onto the Maker Uno board.
- Observe the LED at digital pin 5 showing a short and a long blink – pin 5 controls the blinking of the LED

```
sketch_jul09a §  
  
void setup() {  
  // put your setup code here, to run once:  
  pinMode (5, OUTPUT);  
}  
  
void loop() {  
  // put your main code here, to run repeatedly:  
  digitalWrite (5, HIGH);  
  delay (200);  
  digitalWrite (5, LOW);  
  delay (200);  
  digitalWrite (5, HIGH);  
  delay (1000);  
  digitalWrite (5, LOW);  
  delay (1000);  
}
```

Adapted from [Cytron, 2018, p.33-34]

4. Further Challenge B2: **Blink a 2nd LED**

- Add another pair of resistor & LED
- from same row on breadboard → 2nd resistor → short leg of 2nd LED
- jumper wire ③ from board digital pin 6 → long leg of 2nd LED
- add similar codes for pin 6 - turn on and off each LED for different timings

5. Further Challenge B3: **Blink a 3rd LED [Build a Traffic Lights]**

- Repeat steps with 3rd pair of resistor & LED, using pin 7
- Turn on and off each LED for different timings to build a traffic lights system!