

### Project 3: Music with Piezo and Arduino

#### Description:

The Piezo speaker is a small metal plate enclosed in a round case that flexes and 'clicks' when current is passed through the plate. By quickly switching the current on and off the plate 'clicks' rapidly we hear this as a pitch. This project will have us use the 'Tone' block to create musical patterns using the Arduino and the Piezo.

#### Building and Wiring:

You need the following:

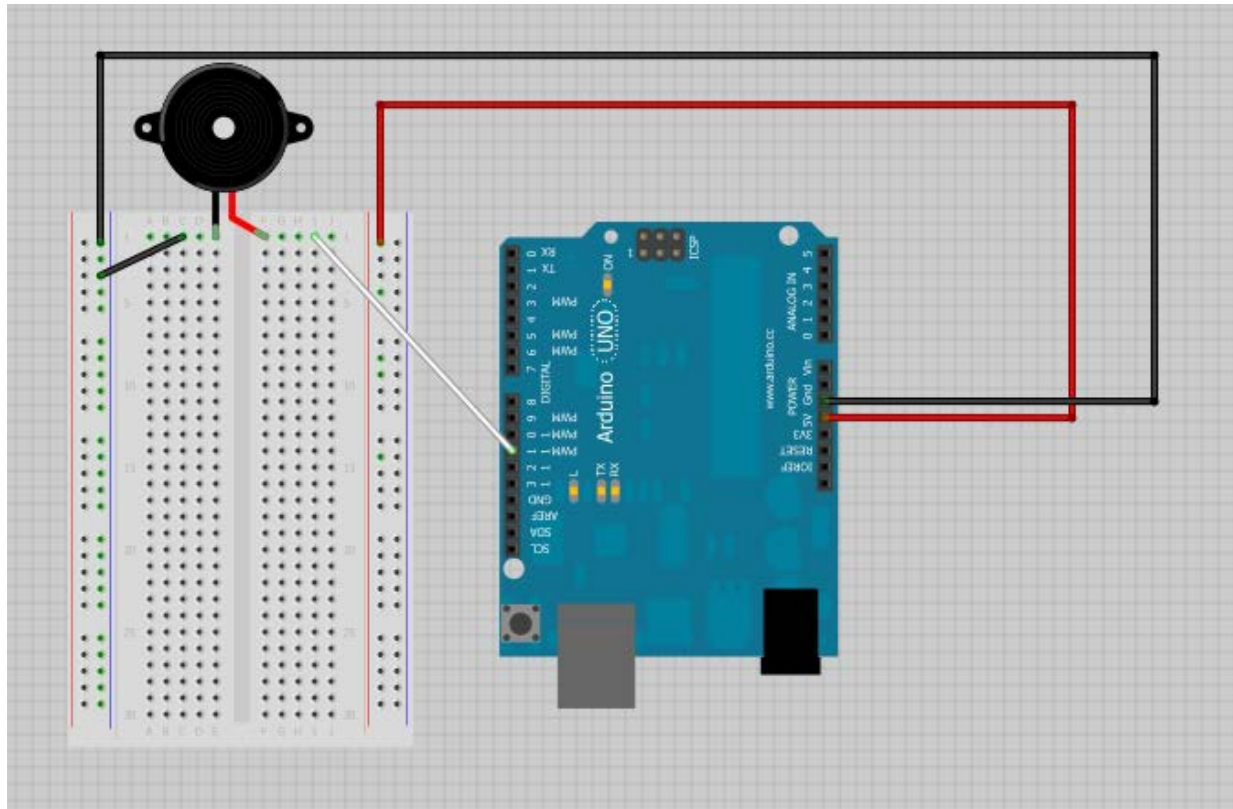
1. Arduino Board and Breadboard set up from Project 2 (8 LED lights)
2. Piezo Speaker



3. White or light colored wire for signal
4. Dark colored wire for ground. (Black)

**Process:**

You may keep the same design from the LED Row of lights project. The diagram below shows the wiring without the LED lights.

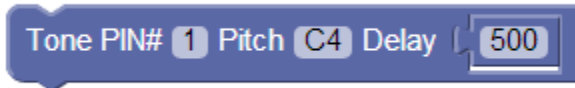


- A. White wire from Arduino Pin 11 to I1 on Breadboard
- B. Piezo + on F1
- C. Piezo – on E1
- D. Black wire from C1 to Blue Rail (Ground)

## Encoding Music:

Description of Blocks:

The Tone block takes three parameters; PIN#, Pitch, and Delay (Duration of the Pitch).



PIN#: Pin on Arduino board for signal

Pitch: The note you want the Piezo to Play






Delay: How many milliseconds to play the pitch.

## Music notation:

Music notation conveys two parameters: Which Pitch to play and how long to play the pitch. The following chart shows how pitches are related to the vertical location of the notes:



The shape of the notes shows the rhythm (duration).

Note	Name	Beats
	Whole note	4 beats
	Half note	2 beats
	Quarter note	1 beat
	Eighth note	1/2 beat
	Sixteenth note	1/4 beat

For this lesson we will program the melody for 'Twinkle Twinkle Little Star. Here is the notation below:

ACOUSTIC GUITAR

# TWINKLE, TWINKLE LITTLE STAR (TRADITIONAL)

FRENCH MELODY

ACOUSTIC GUITAR

Musical notation for 'Twinkle, Twinkle Little Star' on acoustic guitar. It consists of three staves in G major, 4/4 time. The first staff has a treble clef and a key signature of one sharp (F#). The melody is written with quarter notes and rests. The second and third staves are identical to the first, but the second staff has a bass clef and the third staff has a treble clef. Fingering numbers (1-4) are written below the notes in the first staff.

First, label the pitches beneath each note. The first line is done here as an example:

ACOUSTIC GUITAR

# TWINKLE, TWINKLE LITTLE STAR (TRADITIONAL)

FRENCH MELODY

ACOUSTIC GUITAR

Musical notation for 'Twinkle, Twinkle Little Star' on acoustic guitar with pitch labels. It consists of three staves in G major, 4/4 time. The first staff has a treble clef and a key signature of one sharp (F#). The melody is written with quarter notes and rests. The second and third staves are identical to the first, but the second staff has a bass clef and the third staff has a treble clef. Fingering numbers (1-4) are written below the notes in the first staff. Below the first staff, the pitches C, C, G, G, A, A, G, F, F, E, E, D, D, C are written under each note.

Now, label the rhythm values for each note above the line:

q = Quarter note

h = Half note

ACOUSTIC GUITAR

## TWINKLE, TWINKLE LITTLE STAR (TRADITIONAL)

FRENCH MELODY

ACOUSTIC GUITAR

The musical score consists of three staves. The top staff is in treble clef with a key signature of one sharp (F#) and a 3/4 time signature. It contains the melody with red rhythm labels above each note: q, q, q, q, q, q, h, q, q, q, q, q, q, h. Below the first staff are guitar chord diagrams: C, C, G, G, A, A, G, F, F, E, E, D, D, C. The second and third staves show the bass line with fret numbers 1, 2, 3, 4, 5, 7, 9, 10, 12, 14, 15, 17, 19, 20, 22, 24, 25, 27, 29, 30, 32, 34, 35, 37, 39, 40, 42, 44, 45, 47, 49, 51, 52, 54, 55, 57, 59, 60, 62, 64, 65, 67, 69, 70, 72, 74, 75, 77, 79, 80, 82, 84, 85, 87, 89, 90, 92, 94, 95, 97, 99, 100.

Here is a blank copy of Twinkle Twinkle to label:

ACOUSTIC GUITAR

## TWINKLE, TWINKLE LITTLE STAR (TRADITIONAL)

FRENCH MELODY

ACOUSTIC GUITAR

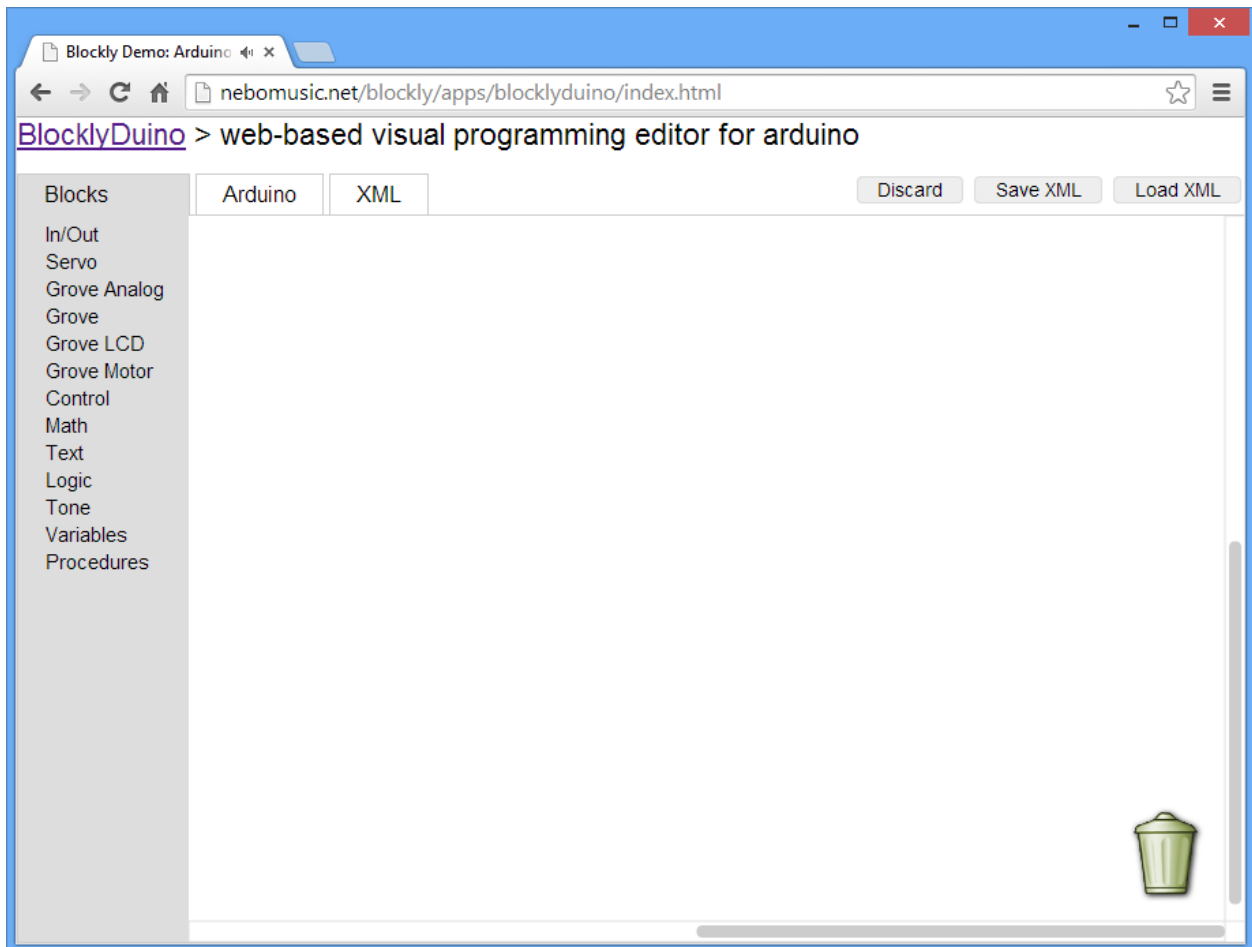
The musical score consists of three staves in treble clef with a key signature of one sharp (F#) and a 3/4 time signature. The notes are present but the rhythm labels are missing, leaving blank space for the student to label them. The fret numbers 1, 2, 3, 4, 5, 7, 9, 10, 12, 14, 15, 17, 19, 20, 22, 24, 25, 27, 29, 30, 32, 34, 35, 37, 39, 40, 42, 44, 45, 47, 49, 51, 52, 54, 55, 57, 59, 60, 62, 64, 65, 67, 69, 70, 72, 74, 75, 77, 79, 80, 82, 84, 85, 87, 89, 90, 92, 94, 95, 97, 99, 100 are indicated below the notes.

## Blockly Programming

For this program we will define variables for rhythm notation and tempo. These will help us control the speed and rhythm of the music.

### Process:

1. Go to <http://nebomusic.net/blockly/apps/blocklyduino/index.html> and remove any blocks so you have a blank programming area:

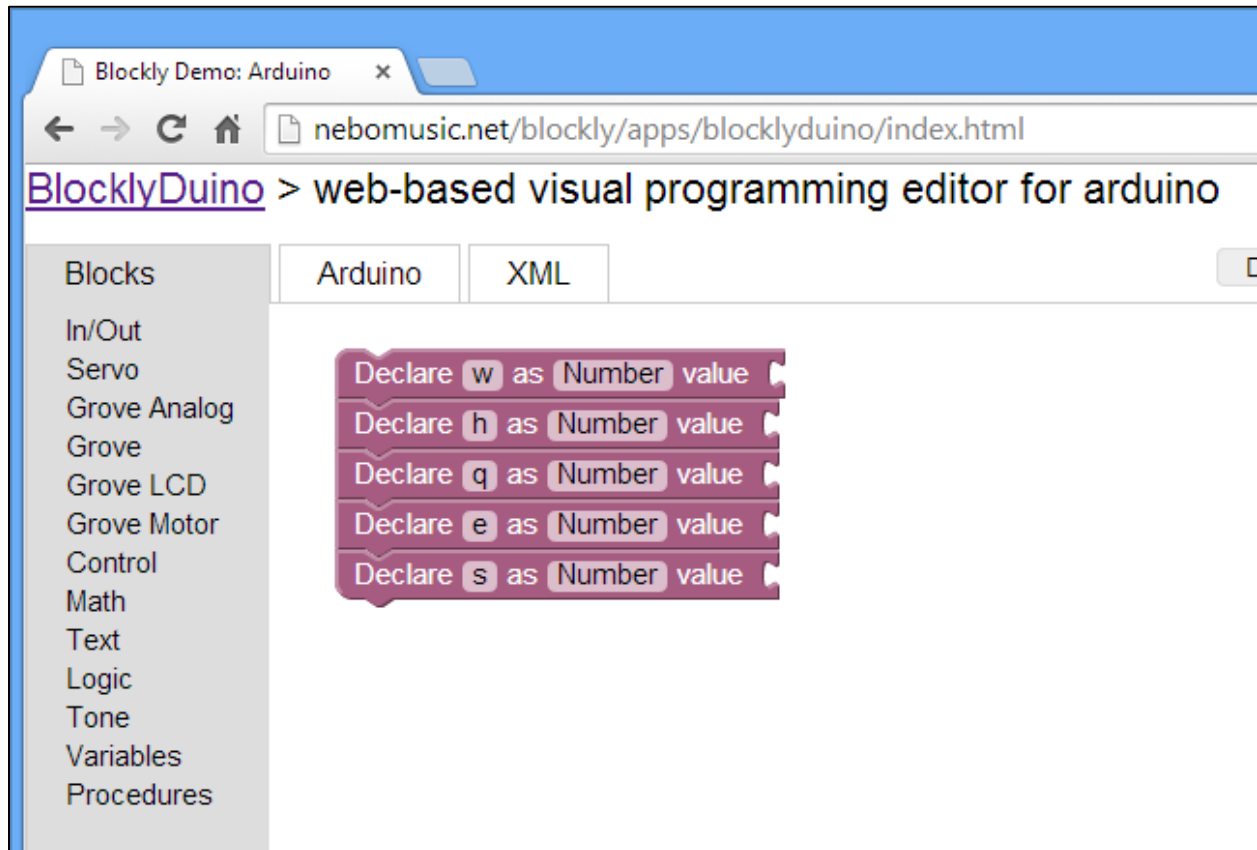


2. We need to declare variables. Drag 5 variable declare blocks to the programming area:

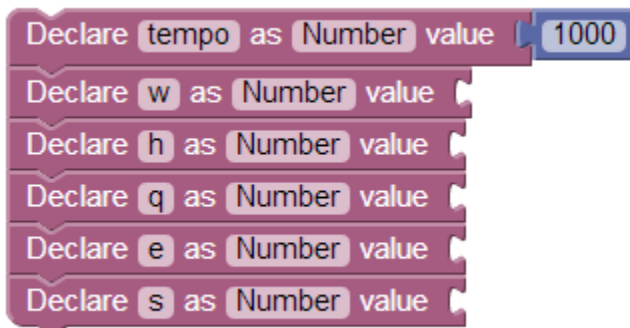
The screenshot shows a web browser window with the title "Blockly Demo: Arduino" and the URL "nebomusic.net/blockly/apps/blocklyduino/index.html". The page header reads "BlocklyDuino > web-based visual programming editor for arduino". Below the header, there are two tabs: "Arduino" (selected) and "XML". On the left side, there is a vertical menu titled "Blocks" with the following categories: In/Out, Servo, Grove Analog, Grove, Grove LCD, Grove Motor, Control, Math, Text, Logic, Tone, Variables, and Procedures. In the main programming area, five purple "Declare" blocks are stacked vertically. Each block contains the text "Declare item as Number value".

3. For each block, change the item names to:

- w (Whole note)
- h (Half note)
- q (Quarter note)
- e (Eighth note)
- s (Sixteenth note)

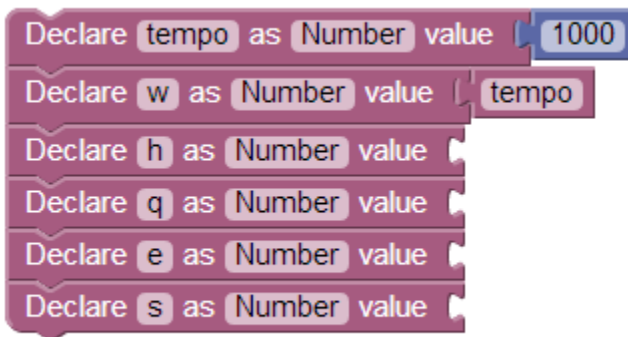


4. Drag an additional Declare variable block and name it "tempo". Set tempo's value to 1000.



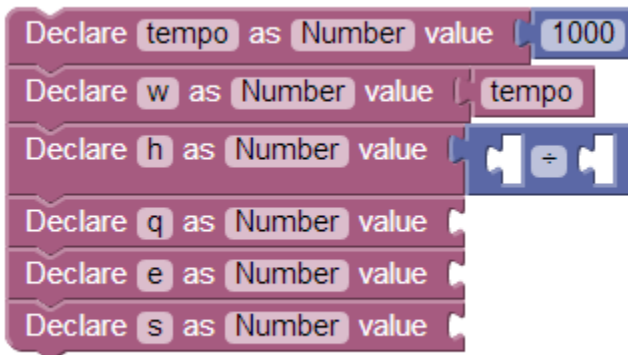


5. Set 'w' value to 'tempo'



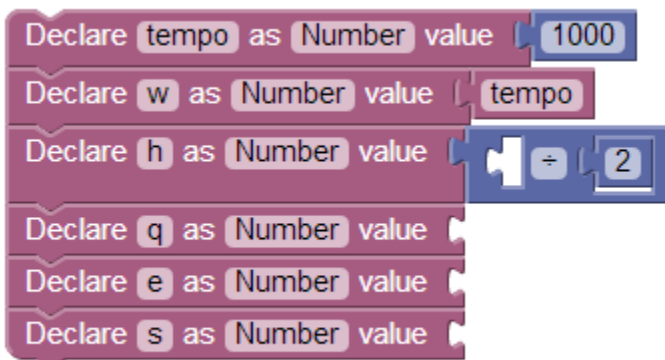
```
Declare tempo as Number value 1000
Declare w as Number value tempo
Declare h as Number value
Declare q as Number value
Declare e as Number value
Declare s as Number value
```

6. Since a half note is one half the value of a whole note, we will set the variable 'h' equal to w divided by 2. Click on Math and place a 'divide' block into the h value socket.



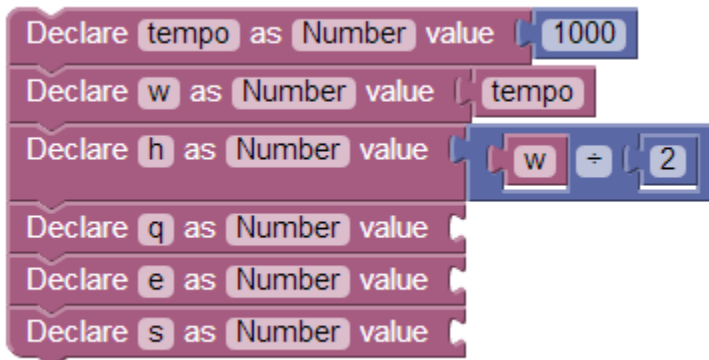
```
Declare tempo as Number value 1000
Declare w as Number value tempo
Declare h as Number value [÷]
Declare q as Number value
Declare e as Number value
Declare s as Number value
```

7. Place the number 2 in the second slot of the divide block



```
Declare tempo as Number value 1000
Declare w as Number value tempo
Declare h as Number value [÷] [2]
Declare q as Number value
Declare e as Number value
Declare s as Number value
```

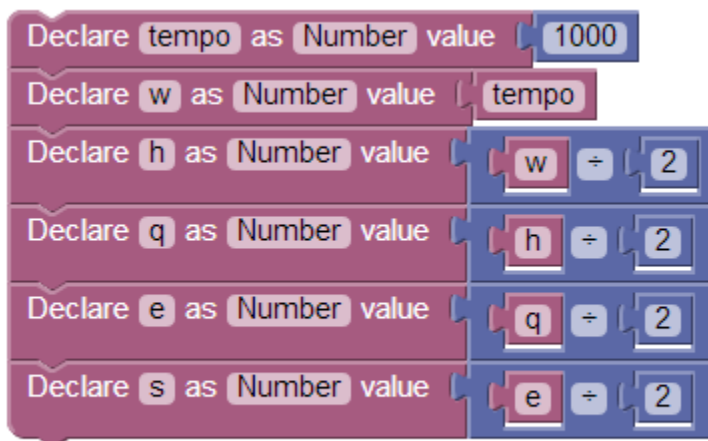
8. Place the variable value 'w' in the first slot.



Scratch code blocks for step 8:

- Declare tempo as Number value 1000
- Declare w as Number value tempo
- Declare h as Number value  $w \div 2$
- Declare q as Number value
- Declare e as Number value
- Declare s as Number value

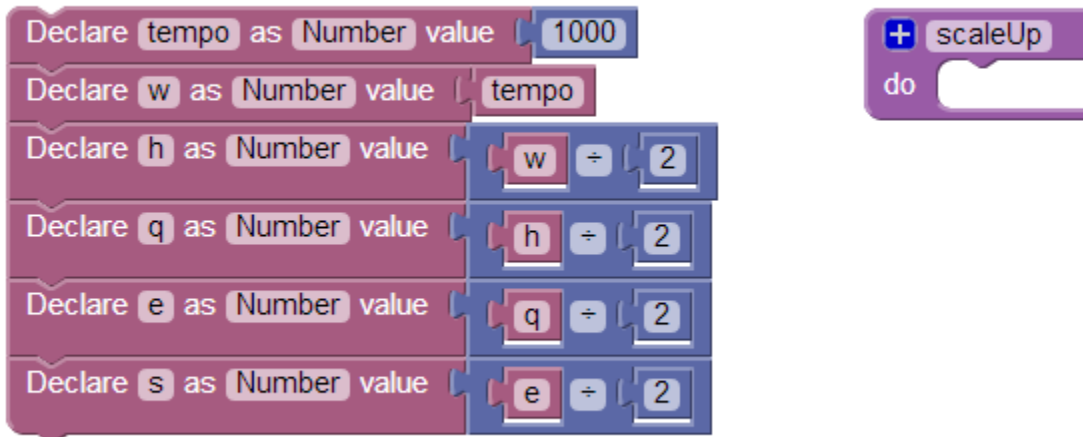
9. We will repeat the process for q, e, and s.



Scratch code blocks for step 9:

- Declare tempo as Number value 1000
- Declare w as Number value tempo
- Declare h as Number value  $w \div 2$
- Declare q as Number value  $h \div 2$
- Declare e as Number value  $q \div 2$
- Declare s as Number value  $e \div 2$

10. Now that we have the rhythm values set, let us practice with a scale. Drag a procedure block to the programming area and change the name to 'scale'.



11. Click the Tone section and place a Tone block into the 'scaleUp' function.



12. Place the 'q' variable value into the Delay socket.



13. Change the PIN# to 11 (The pin we wired with the Arduino)



14. This will play one pitch. Complete the scale with seven additional Tone blocks as follows:



15. Place a 'do scaleUp' block under the variable stack:

The image shows two Scratch code blocks. The first block is a stack of six 'Declare' blocks. The first block is 'Declare tempo as Number value' with a value of 1000. The second block is 'Declare w as Number value' with a value of tempo. The third block is 'Declare h as Number value' with a value of w + 2. The fourth block is 'Declare q as Number value' with a value of h + 2. The fifth block is 'Declare e as Number value' with a value of q + 2. The sixth block is 'Declare s as Number value' with a value of e + 2. Below this stack is a 'do scaleUp' block. The second block is a 'do scaleUp' block. It contains a 'do' loop with eight 'Tone' blocks. Each 'Tone' block has 'PIN# 11', 'Pitch' (C4, D4, E4, F4, G4, A4, B4, C5), and 'Delay q'. The 'do' loop is connected to the 'do scaleUp' block.

16. Copy the Arduino tab code to Sketch and run on your Arduino board. You should hear a scale (over and over and over . . .)

17. Now that we have a experimented with scaleUp, lets create procedures to play Twinkle Twinkle. Declare a new Procedure named 'twinkle1'



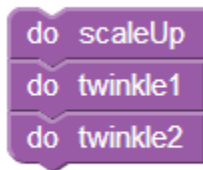
18. Reading from the notation, place the Tone blocks for the first line part of line 1 in 'twinkle'



19. Create a Procedure twinkle2 to play the rest of line 1.



20. In the 'do Procedure' section. Add blocks for 'do twink1' and 'do twink2'.



21. Complete procedures for the rest of Twinkle, Twinkle. Note that Line 3 is exactly line Line 1. Also, Line 2 has a repeated section. Use these hints to write an additional procedure to play the whole song.



Additional Songs:

### JINGLE BELLS

varganist.ru

Musical score for "Jingle Bells" in 4/4 time. The melody is written on a treble clef staff with a key signature of one sharp (F#). The bass line is written on a bass clef staff with a key signature of one sharp (F#). The melody line includes a 5-finger position marker and a 9-finger position marker. The bass line includes a 13-finger position marker. The notes in the melody line are: E, E, E, E, E, E, E, G, C, D, E. The notes in the bass line are: F, F, F, F, F, E, E, E, E, G, G, F, D, C.

### ODE TO JOY

Musical score for "Ode to Joy" in 4/4 time. The melody is written on a treble clef staff with a key signature of one sharp (F#). The notes in the melody line are: C, G, C, G, C, G, C, G, C, G, C, G, C, G, C. The notes in the bass line are: C, F, C, G, C, G, C, F, C, G, C.

E E F G | G F E D | C C D E | E D D  
E E F G | G F E D | C C D E | D C C  
D D E C | D F E C | D F E D | C D G  
E E F G | G F E D | C C D E | D C C

## Frere Jacques

The image shows the musical notation for the song 'Frere Jacques' in 4/4 time. It consists of two staves. The first staff contains the melody, and the second staff contains the bass line. Below the notes are letter-based chord notations: C D E C, C D E C, E F G, E F G for the first staff; and G A G F E C, G A G F E C, C G C, C G C for the second staff. The website address www.abcnotation.com/tunes is printed at the bottom.

### Vocabulary:

**Piezo:** Electric device with a thin plate of metal that quickly changes position when current is changed. By quickly changing the current to on and off the Piezo can emit a single tone. Piezo's are used for the 'beeping' sounds in smoke alarms, alarms, greeting cards, and other simple electronic devices.

**Pulse Width Modulation (PWM):** Rapidly changing the 'on and off' signal thousands of times a second. This allows for the Arduino to produce pitches on a Piezo or drive servos.