## The TI-Innovator Piano

## Mini Project 2: Playing the Piano

In this second mini project, you will import the piano image. You will learn how to draw a circle to represent a piano key press. Once you have this module coded, you will have a functioning piano that plays music.

**Objectives:**

- import PIANO to draw your keyboard
- use getKey to retrieve key press values
- use IF statements to make decisions
- use LISTS to store information
- use a WHILE statement to repeat code

**The Piano Project Overview:**

After completing a series of 5 mini projects, you will have a few different ways to play a piano. You will be able to play the piano using the keys on your handheld, using the brightness sensor on the TI-Innovator Hub, using a separate ultrasonic sensor or using the ultrasonic sensor on the TI-Rover. If you are unfamiliar with using the getKey command, you should do mini-project 1 "Detect which keys are pressed" in the Maze project before this activity.

Mini-project order:

1. Piano setup
2. **<u>Play the piano using the keypress event</u>**.
3. Play the piano using the brightness sensor on the TI-Innovator Hub
4. Play the piano using an ultrasonic sensor an the TI-Innovator Hub
5. Play the piano using the ultrasonic sensor on the TI-Innovator Rover

1. Create a program named: PIANOKEY

   Use recall to import the keyboard code from the first project.

   rcl ( 2nd sto→ )
   prgm
   EXEC
   Select PIANO
   Press the enter key

2.

Musical notes are determined by the frequency of a vibrating object such as a speaker, drum head, or as in a guitar or a piano. The notes of the musical scale have a special mathematical relationship. If a note has a frequency F, then the very next note has a frequency $F * 2^{1/12}$.

Multiplying a note's frequency by $2^{1/12}$ gives the next note in the scale.

** *Refer to [TI Codes with TI-Innovator](#) Unit 2-SB3 for additional information on this topic.*

3. We will turn the calculator sideways and use the lowest two rows to represent the keys on the piano keyboard.

4. Middle C, represented by the [2nd] key, key 21, has a frequency of 261.64 Hz.

The next note C# has a frequency of $261.64*2^{1/12} \approx 277.20$ Hz.

D has a frequency of $261.64*2^{2/12} \approx 293.68$ Hz.

D# has a frequency of $261.64*2^{3/12} \approx 311.14$ Hz.

What is the frequency for E?
What is the frequency for B?
What is the frequency for the C above middle C (key 91)?

5. Middle C, our first key, has a frequency of 261.64 Hz. Using that as our base,

   $C = 261.64*2^{0/12}$

   $C\# = 261.64*2^{1/12}$

   $D = 261.64*2^{2/12}$

   $D\# = 261.64*2^{3/12}$

   Now to match the key number to the exponent numerator. Complete the table below.

| Key Number | Exponent Numerator |
|---|---|
| 21 | 0 |
| 22 | 1 |
| 31 | 2 |
| 32 | 3 |
| | 4 |
| | 5 |
| .. | 6 |
| | 7 |
| | 8 |
| | …… |

Can you find a mathematical pattern to relate the key number to the exponent's numerator?

6. There are several patterns in your table, but not one consistent formula that matches the key number to the exponent. Therefore, we'll store the relationship in a list then use the list and an If statement to make a selection.

   Here's our code

   :{21,22,31,32,41,51,52,61,62,71,72,81,91,92}→ $L_1$

   Now write a loop to continuously get a key press value until the user presses the clear button.

7. Does your code look like

```
:{21,22,31,32,41,51,52,61,62,71,72,81,91,92}→L1
:0→K
:While K≠45
:getKey →K
```

Now to set the frequency based on the key press. The items in the list are $L_1(1) = 21$, $L_1(2) = 22$….. $L_1(14) = 92$. We will write the following If statement to determine the frequency.

```
:{21,22,31,32,41,51,52,61,
62,71,72,81,91,92}→L1
:For(A,1,14)
:If L1(A)=K
:Then
:261.24*(2^((A-1)/12))→F
:End
:End
:End
```

```
For(A,1,14)
If L1(A)=K
Then
261.24*(2^((A-1)/12)) →F
End
End
```

8. Now to play a given frequency when a key is pressed. The generic code is Send("SET SOUND frequency TIME time)

```
:For(A,1,14)
:If L1(A)=K
:Then
:261.24*(2^((A-1)/12))→F
:Send("SET SOUND eval(F) T
IME 0.5)
:End
:End
:End
```

Insert the line

Send("SET SOUND eval(f) TIME 0.5”)
Into your loop right after you find the frequency.

Connect your calculator to the TI-Innovator Hub.

Run your program. Try several different keys.

9. Recall in project 1 you wrote the code to highlight all the nature keys using points.

```
:For(A,0,7)
:Pt-On(25+30*A, 30, 2, MAGENTA)
:End
```

In this project, you’ll write similar code. Notice all the natural keys end in a 1 because they are in column 1 on your calculator. All the sharp keys end in a 2 because they are in row 2.

How can you determine in code the last value of a number? If the remainder of the key number divided 10 equals 1, the key is a natural key.

remainder(K,10) will give you the remainder

In project one, you used A = 0 to 7 in your loop. Notice if we remove the 1s off the keys, they are numbered 2, 3, 4….9. These are in order now starting at 2.

iPart(K,10) gives you the integer part of K/10

Can you use these two pieces of information to write the For loop to draw the points based on the key pressed? This for loop should go right before the last End statement so it is inside your While statement.

10. Did you write an IF statement similar to the one below? You need a ClrDraw to clear any old drawn points. Adding the comment "NATURAL KEYS is not required, but it makes it easier to debug your code.

```
:"NATURAL KEYS
:If remainder(K,10)=1
:Then
:ClrDraw
:iPart(K/10) - 2 →R
:Pt-On(25+ 30*R, 30, 2, MAGENTA)
:End
:End
```

Ends the While K≠45 Loop

Execute your code. Make sure it works before you go to the next step.

11. Write a similar IF statement to draw a point on a sharp key if it is pressed.

You should INSERT the IF before the last End statement.

Remember the code to draw points on ALL sharp keys was:

```
:For(A,0,7)
:If A≠2 and A ≠6
:Pt-On(41+30*A, 90, 2, MAGENTA)
:End
```

12. Did your code look similar to the one below?

```
:"SHARP KEYS
:If remainder(K,10)=2
:Then
:ClrDraw
:iPart(K/10) - 2 →R
:If R≠2 and R ≠6
:Then
:Pt-On(41+ 30*R, 90, 2, MAGENTA)
:End
:End
:End
```

Ends the While K≠45 Loop

Execute your full program. You know have a functioning digital piano.