Name:
Date:

Circuit #11 Piezo Element

1.

How is this circuit, or a circuit like it, used in everyday life? Provide at least three examples.

Got your incredibly annoying song blaring out of your tiny speaker? Great.

2.

The piezo speaker uses digital pulsing (on or off) to create an analog sound value which can rise or fall in an analog fashion even though it is technically digital. What other digitally simulated analog signal is this similar to?

3.

Although the action of the piezo speaker is similar to the simulated analog signal, what word or command in the code shows us that it is different? What command would you use if you wanted to use the simulated analog signal instead of the purely digital one?

4.

Is it possible to make the piezo speaker play a note so low that the human ear cannot hear it?

5.

Piezo elements are used for many things other than playing music. In fact you might have a piezo element in your pocket right now. List at least three usages of a piezo element other than a piezoelectric speaker.

6.

Find and correct the three errors in the code below.

```
void loop() {
for (int i = 0; i < length; i++) {
      if  notes[i] == ' ' {
        delay(beats[i] * tempo); // rest
      } else {
playNote(notes[i], beats[i] *  tempo);
      }
         pause between notes
      Delay(tempo / 2);
    }
  }
```

7.

Underline all instances of matrices in the code above.

Fun Fact:

There are now digital turntables which manipulate digital sound samples similar to this piezo element. When the sample is slowed down the sample's frequency drops as well due to the increase in gap size between the digital values. When the sample is sped up the pitch rises because the gaps decrease.

8.

There are many different outputs you can couple with this circuit. For example: add a servo with a backdrop to indicate which note is being played, or couple it with an RGB LED that shines a different color depending on where in the scale the note is positioned. Write, in plain English, how you would control a chosen output as well as the piezo component.

9.

How is this circuit, or a circuit like it, used in everyday life? Provide at least three examples.

Got your incredibly annoying song blaring out of your tiny speaker? Great.

10.

Now you are going to add volume control to your piezo speaker. First place a 330Ω resistor on the circuit. Draw the two possible schematics of this new circuit to the right. What changes when you add the 330Ω resistor?

11.

Next replace the 330Ω resistor with a 10KΩ resistor. What changes this time? What does this lead you to believe about resistors and the piezo speaker? Explain.

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12.

How is this circuit, or a circuit like it, used in everyday life? Provide at least three examples.

13.

Got your incredibly annoying song blaring out of your tiny speaker? Great.

Now you are going to add volume control to your piezo speaker. First place a 330Ω resistor on the circuit. Draw the two possible schematics of this new circuit to the right. What changes when you add the 330Ω resistor?

14.

Next replace the 330Ω resistor with a 10KΩ resistor. What changes this time? What does this lead you to believe about resistors and the piezo speaker? Explain.

Now replace the resistor with the potentiometer. Measure the resistance of the potentiometer and write below the lowest resistance value it can be set to and the highest resistance value it can be set to.

Lowest resistance: _____ Ω

Highest resistance: _____ Ω

But wait! Can't we just turn down the volume using a lower PWM value in the code? Why are we changing resistors when it's so much easier to just rewrite the code a little? Find the line of code you will need to change to try using PWM to control the volume instead of a resistor and write it below.

15.

Now actually change the code and listen to the results. Can't hear any difference? Try using a lower PWM value. You should definitely notice a difference now. That's different from changing the volume right? Now use your potentiometer to change the PWM value of the piezo speaker circuit. You will need to change the code to do this. Write the three essential lines of code you used to make this happen below, don't forget semicolons. (Hint, one of them is a variable declaration before the setup() method.)

16.

Does your piezo speaker turn off when you turn your potentiometer all the way one way? This is because the analog values go up to 1023 but the PWM only go to 255. You can use the map() method to fix this. Write the line of code which will fix the problem below. (If it still turns off with map, make sure your PWM value never goes all the way down to zero.)

The effect that changing the PWM has on "Twinkle, Twinkle Little Star" is kind of like an effect that many musicians use in on their instruments in modern music. What is that effect?

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