



A7.8 Sound and MIDI

Data representation · A level · AQA 7517 4.5.6.7, Eduqas A500QS 2.3 ·
about 30 min

Name _____

Class _____

Date _____

What this lesson is about

Sample rate, sample resolution, the Nyquist theorem and aliasing, and MIDI events played on the robot's piezo.

- Sampled sound
- The Nyquist theorem
- MIDI

Questions

6 marks in all

1. How many bytes does a 30 second mono recording take at a sampling rate of 8,000 Hz and a sample resolution of 8 bits? [1 mark]

-
2. A recording must keep frequencies up to 5,000 Hz. What is the lowest sampling rate, in Hz, the Nyquist theorem allows? [1 mark]

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3. A 440 Hz tone is sampled at 600 Hz. What happens? [1 mark]

- ☐ A It is recorded as a lower, wrong frequency: aliasing
- ☐ B It is recorded correctly
- ☐ C It is recorded as silence
- ☐ D It is recorded at twice the frequency

4. Which of these are MIDI event messages or data carried in them? [1 mark]

Tick every answer that is true.

- ☐ A Note on
- ☐ B Note off
- ☐ C Velocity
- ☐ D The sampled sound wave

5. Which is a disadvantage of MIDI compared with sampled sound? [1 mark]

- ☐ A It cannot store speech or singing
- ☐ B Its files are larger
- ☐ C It is hard to change the tempo
- ☐ D It cannot change instrument

6. What does this program print?

[1 mark]

```
for note in [57, 69, 81]:  
    print(note, round(440 * 2 ** ((note - 69) / 12)))
```

The task: play the MIDI events

`events` is a list of (`note`, `seconds`) pairs: `note` is a MIDI note number (0 to 127) and `seconds` is how long to play it. 1. Write `frequency(note)`, which returns $440 \times 2^{((note - 69) / 12)}$ rounded to the nearest whole number with `round`, as an `int`. 2. For each event in order, print `note <note> = <frequency> Hz` and play it on the piezo with `tone(frequency, seconds)`. 3. After the last note, print `minimum sample rate: <n> Hz`, where `n` is twice the highest frequency you played: the Nyquist rate for recording those notes' fundamental frequencies. Calculate every frequency; do not type them in.

```
# the two lines every program starts with: the commands, then the robot  
from bugbot import *  
connect()  
  
events = [(60, 0.25), (64, 0.25), (67, 0.25), (72, 0.5)]  
  
def frequency(note):  
    return 440
```

Plan your program here, then type it in and press Run.



Do it on the robot

www.bugbotlab.com/learn/a7-8-sound-and-midi/

The simulator checks it and tells you when it passes. Nothing to install, no account.

Challenges

1. Add a velocity to each event and print it next to the note. Why can the piezo not show it?
2. How many bytes would the four notes take as 8-bit mono samples at 8,000 Hz? Compare that with a few bytes per MIDI event.
3. At what sampling rate would note 108, the top of a piano, alias?