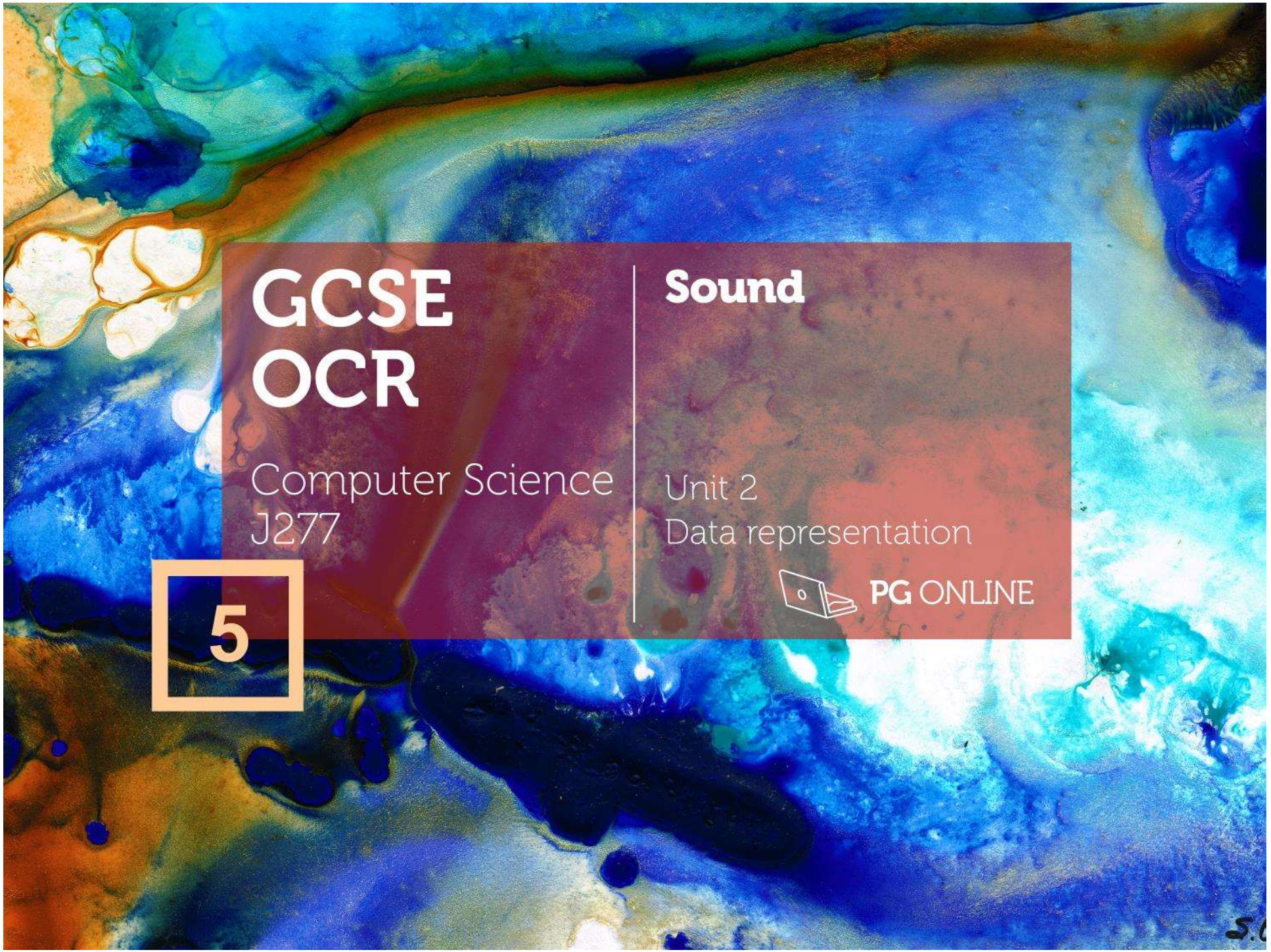

GCSE
OCR
Computer Science
J277
Sound
Unit 2
Data representation
PG ONLINE
5

Objectives

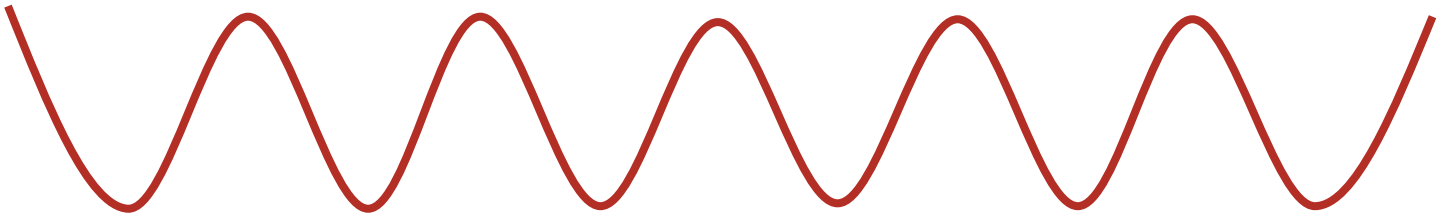
- Understand how sound is sampled and stored in digital form
- Be able to represent a short sound file in binary
- Explain how sampling intervals and resolution affect the size of a sound file using the terms:
    - Sample rate
    - Bit depth
- Explain the trade-off between file size and the quality of playback

Starter

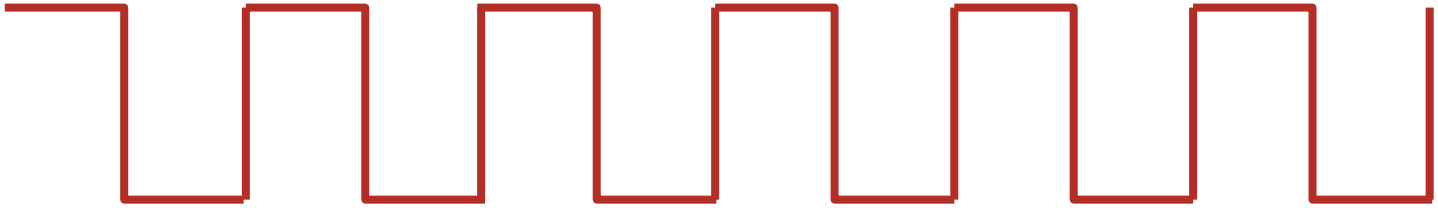
- A computer uses binary 1s and 0s
  - How do you think this is able to store sound?

Analogue to digital conversion

- Analogue sound signals are continuous



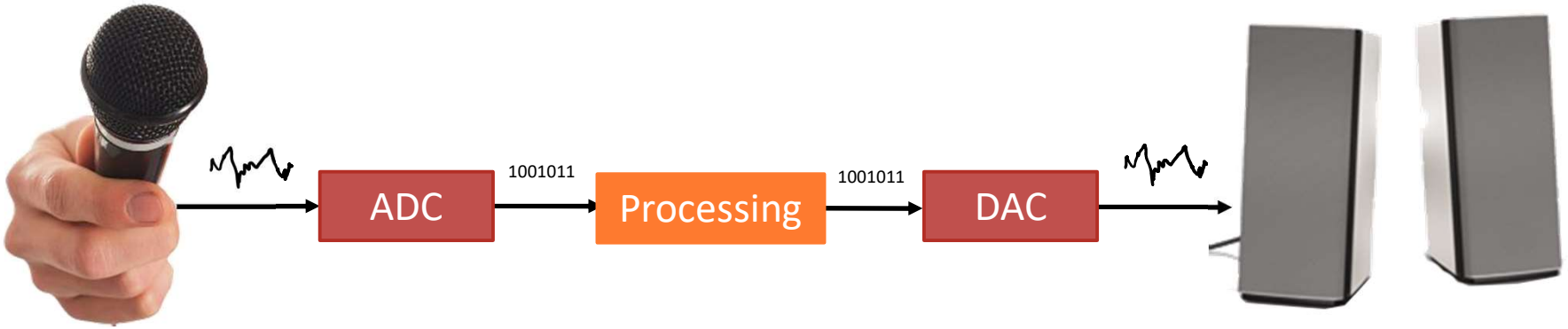
- Digital signals are discrete



- Sound is digitized by repeatedly measuring and recording the sound wave

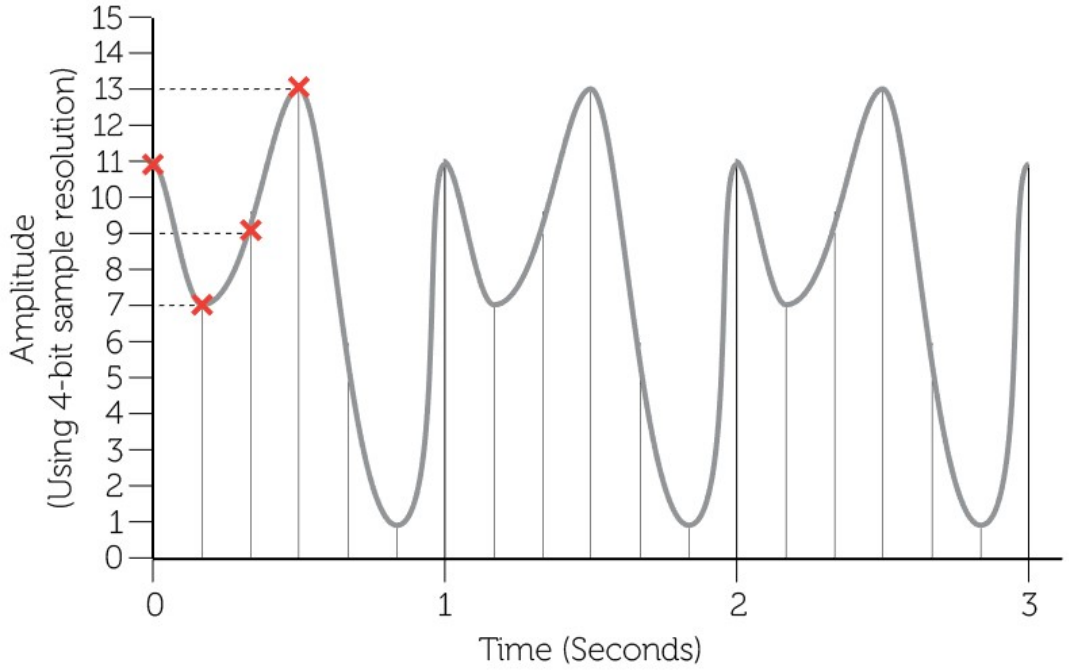
Analogue to digital convertors

- Sounds must be converted into a digital form in order to be stored and processed by a computer
  - An Analogue to Digital Convertor (ADC) is used to convert inputs to digital signals
  - A Digital to Audio Convertor (DAC) is used to convert digital signals to outputs



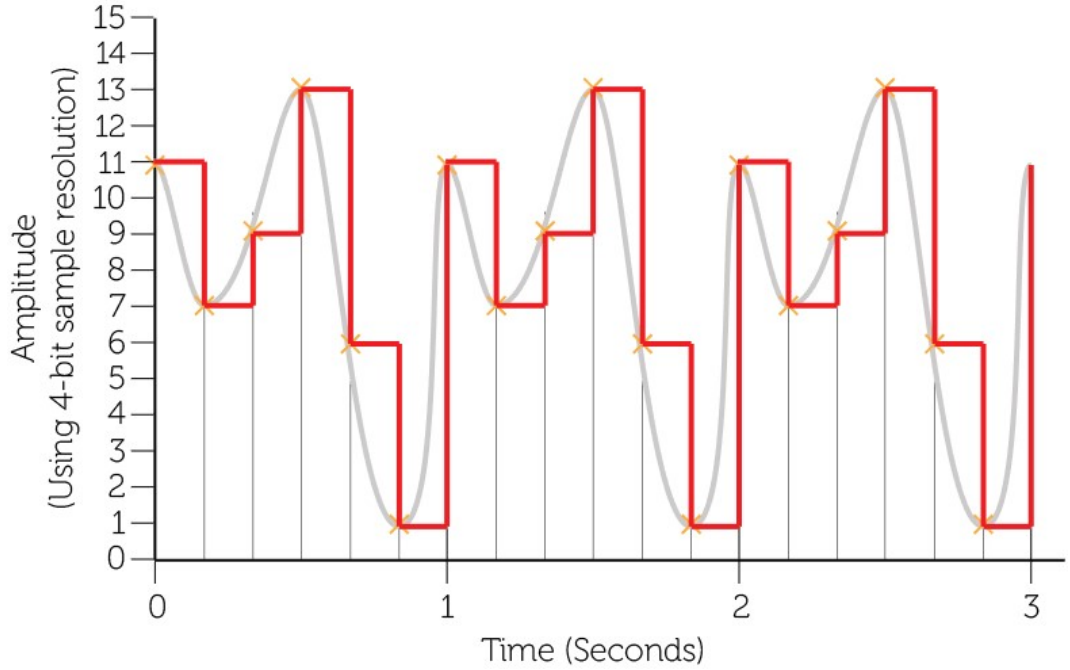
Sound sampling

- Sound is sampled using a bit depth and sample rate
  - The **bit depth** determines how closely the wave is sampled on the y-axis



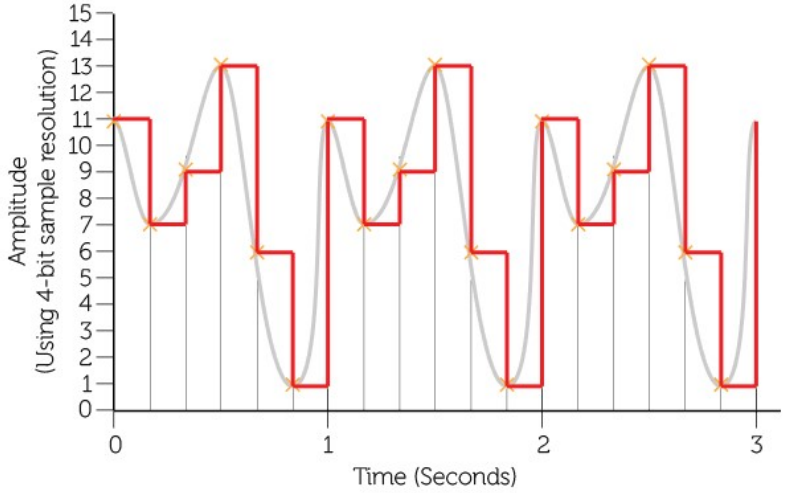
Sound sampling

- The sample rate is the number of samples taken per second
  - It is measured in hertz (Hz)

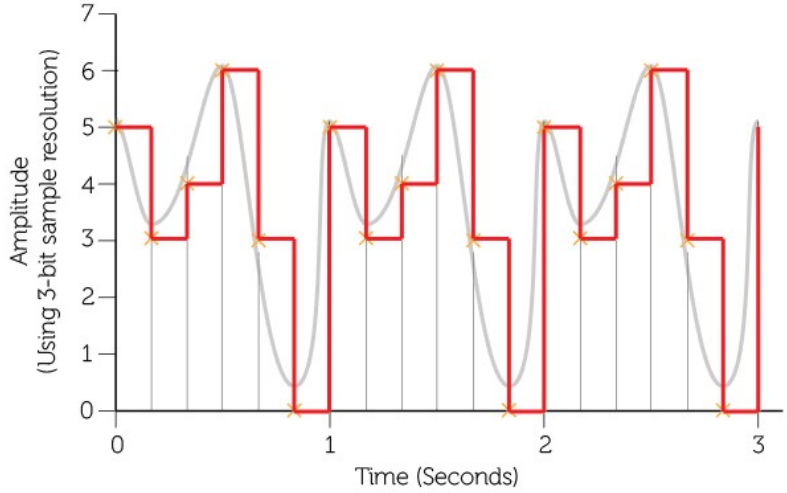


Sample resolution

- The number of bits (audio bit depth) used to record each measurement is known as the resolution
  - More bits used per sample enables the height of the wave to be more accurately measured but increases file size



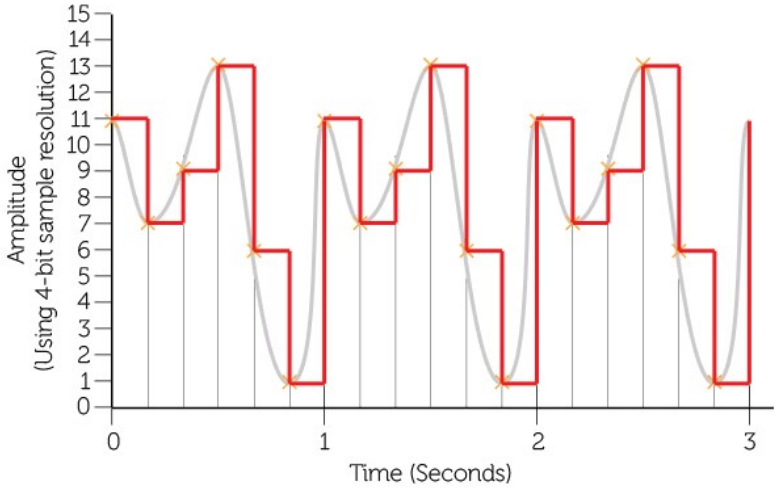
Higher (4-bit) resolution



Lower (3-bit) resolution

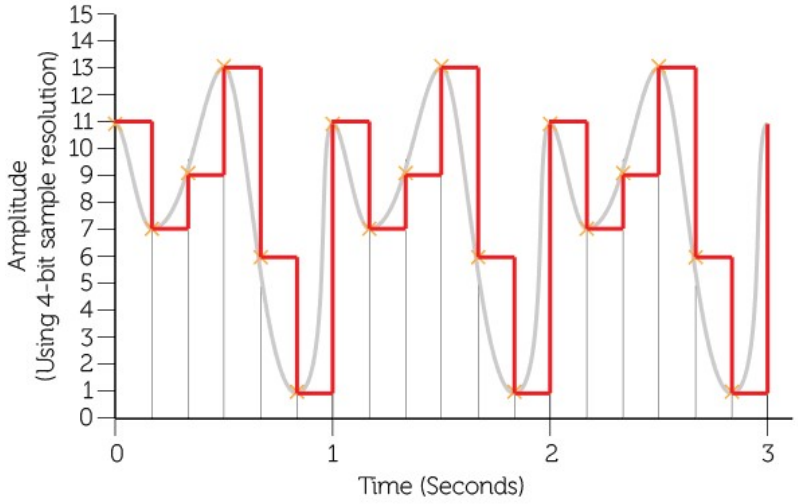
Hertz

- Sample rate is usually measured in hertz (Hz)
- 1Hz = 1 sample per second
- CDs are usually sampled at 44,100Hz (44.1kHz)
  - What is the sample rate in Hertz of the following sample?

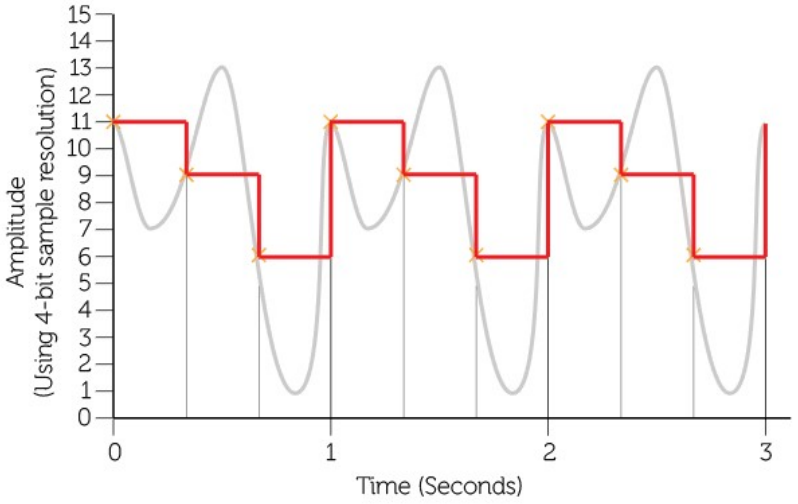


Sampling rate

- The frequency or sample rate per second affects the level of detail in the digital representation
- The greater the frequency, the greater the accuracy, and file size

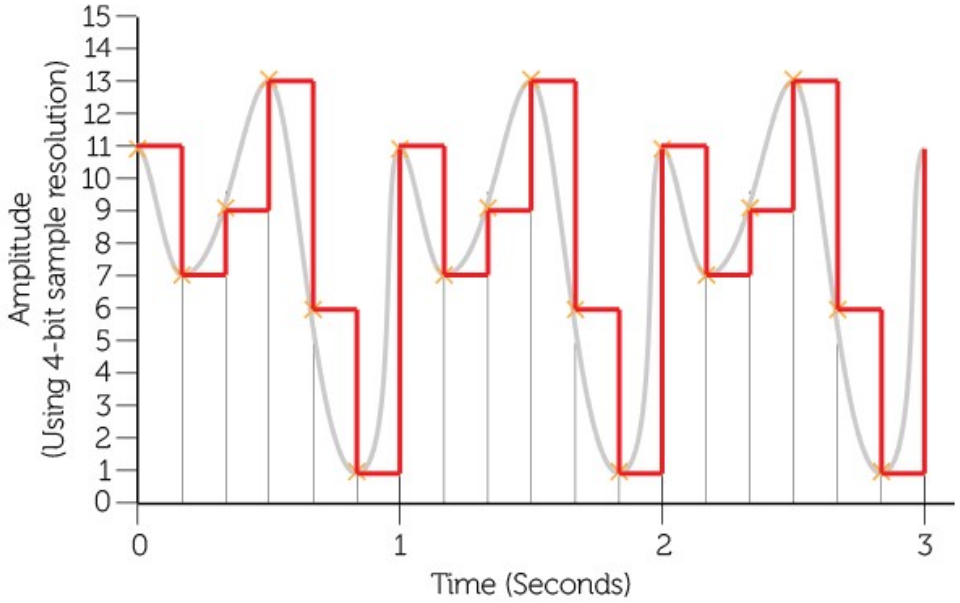


Higher frequency



Lower frequency

Calculating sound file sizes



- File size (bits) = sample rate x bit depth x duration
  - 6 samples per second x 4-bit resolution x 3 seconds =
  - 72 bits / 8 = 9 bytes

Worksheet 5

- Complete **Task 1** on **Worksheet 5**

Digitised sound quality

- Recording quality improves:
  - the more frequently we sample the sound
  - the more accurately we record the wave height
- Increasing the **sampling rate** (frequency) means recording more data points
  - Increasing the **bit-rate** improves the accuracy of each data point
- What happens to the size of the sound file if the frequency and bit-rate are increased?

Worksheet 5

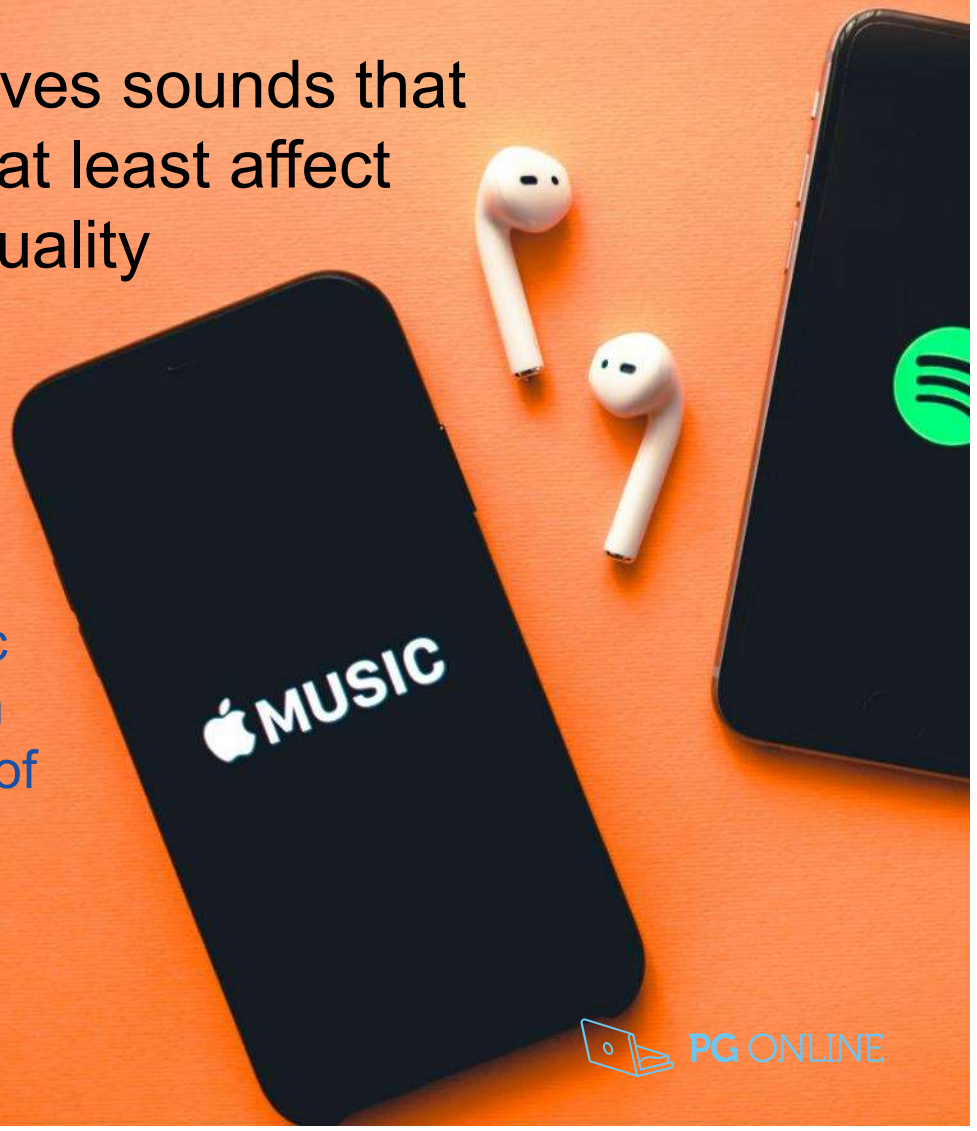
- Complete **Task 2** on **Worksheet 5**

Our hearing range

- We can hear sounds between 20-20,000 Hz
  - Younger people can hear sounds at a higher frequency
- Try the test sound and see how high you and your class can hear

Lossy compression – MP3

- Lossy compression removes sounds that we can't easily hear or that least affect the perceived playback quality
  - Lossy compression leaves out some data from the original so can negatively affect the sound quality
  - However, a minute of music can be stored in 1 MB of an MP3 file, but needs 10 MB of an uncompressed WAV file
  - This is useful for storing, downloading or streaming



Lossless compression

- Lossless compression formats are able to reduce the file size when compressed but do not lose any information
- The following music file formats are lossless:
  - FLAC (Free Lossless Audio Codec)
  - ALAC (Apple Lossless Audio Codec)
  - WMA Lossless (Windows Media Audio)

Other file formats

- **WAV** and **AIFF** files are uncompressed audio files
- Lossy file formats are still very popular as they reduce the file size well
  - **MP3** (MPEG-1 Audio Layer III)
  - **AAC** (Advanced Audio Coding) – typically higher quality than MP3

Plenary

- In pairs take turns to test each other on the following questions
  - The sample rate is measured in what unit?
  - The number of bits available to store each sample is known as what?
  - What is the formula for calculating the size of an uncompressed music file?
  - Track1.wav uses a sample rate of 20 kHz, Track2.wav uses a sample rate of 10 kHz. Which file is the higher quality? Which is the larger file size?

Plenary

Answers

- In pairs take turns to test each other on the following questions
  - The sample rate is measured in what unit? **Hertz (Hz)**
  - The number of bits available to store each sample is known as what? **Bit depth**
  - What is the formula for calculating the size of an uncompressed music file?
    Sample rate x bit depth x duration
  - Track1.wav uses a sample rate of 20 kHz, Track2.wav uses a sample rate of 10 kHz. Which file is the higher quality? Which is the larger file size?
    Track1 is higher quality and a larger file size

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