

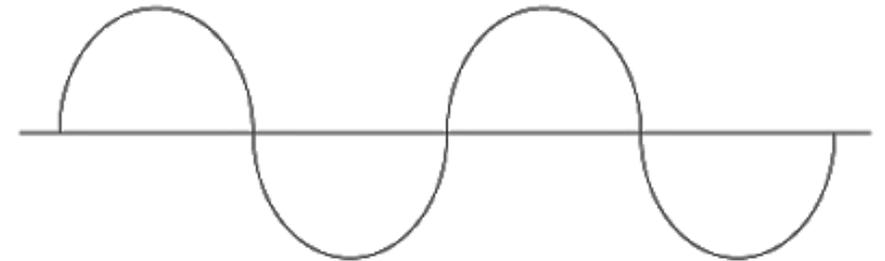
SAMPLING THEORY



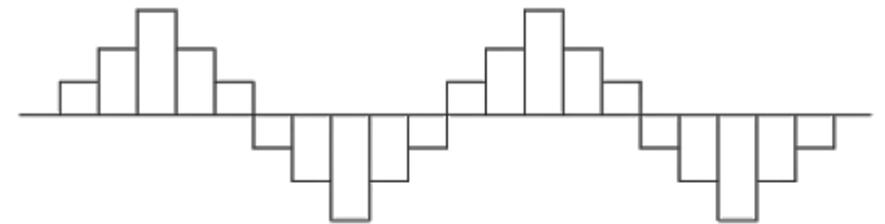
Analogue and Digital Recording

- An **analogue waveform** can be described as a representation of the changes in air pressure that result from vibrations created by sound
- The **amplitude** of an analogue waveform can have any value between the maximum and minimum
- A **digital** signal uses binary values to store amplitude data and therefore has a finite number of values it can use

Analog

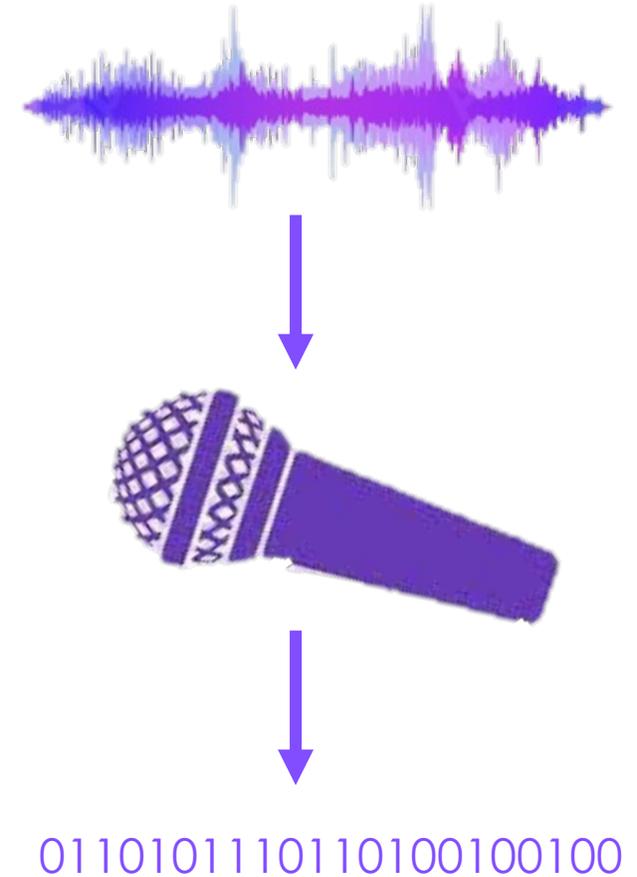


Digital



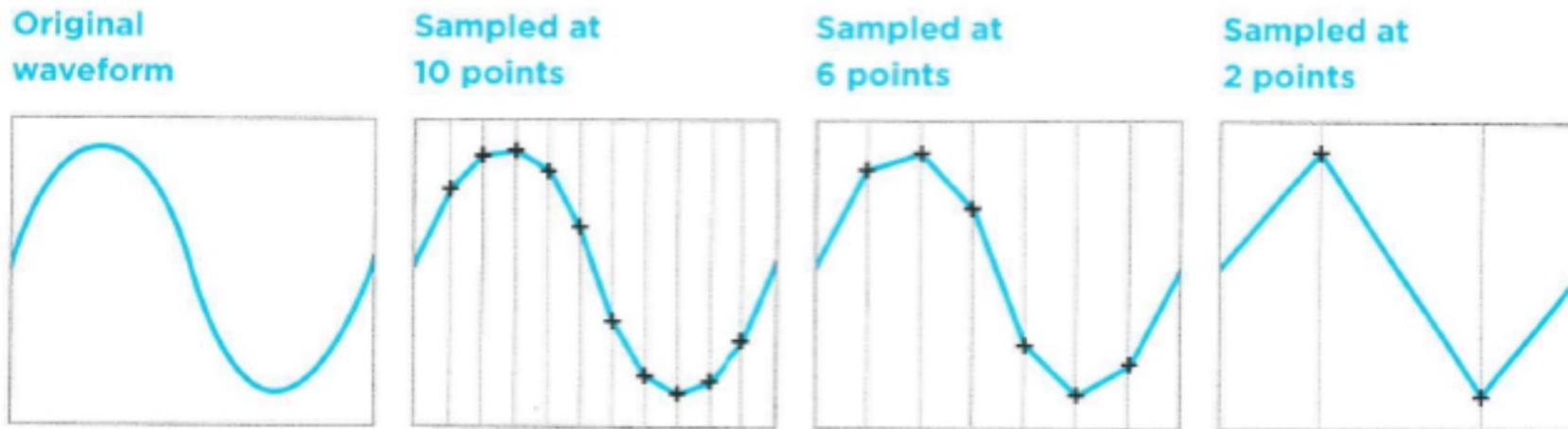
Analogue to Digital Conversion

- When an analogue signal is converted into a digital one, samples of the **momentary amplitude** of the waveform are taken and converted into **binary code**
 - The continuous signal is converted into a discrete series of binary numbers
- The overall quality of this digital signal is dependent on the **sample rate** and **bit depth** of the encoding



Sample Rate

- The number of times the **amplitude** of an analogue signal is measured during the conversion process (measured in Hz)
- A sample rate of 1Hz would mean 1 sample of the wave's amplitude is being taken every second



Sample Rate

- The most common sample rates used for audio are **44.1kHz (CD quality)** and **48kHz (DVD quality)**
- Higher sample rates exist but are less common
 - Any audio recorded with a sample rate/bit depth higher than 44.1kHz/16-bit is considered **high definition** audio
- The **higher** the sample rate, the **greater** the highest frequency captured will be

The Nyquist Theorem

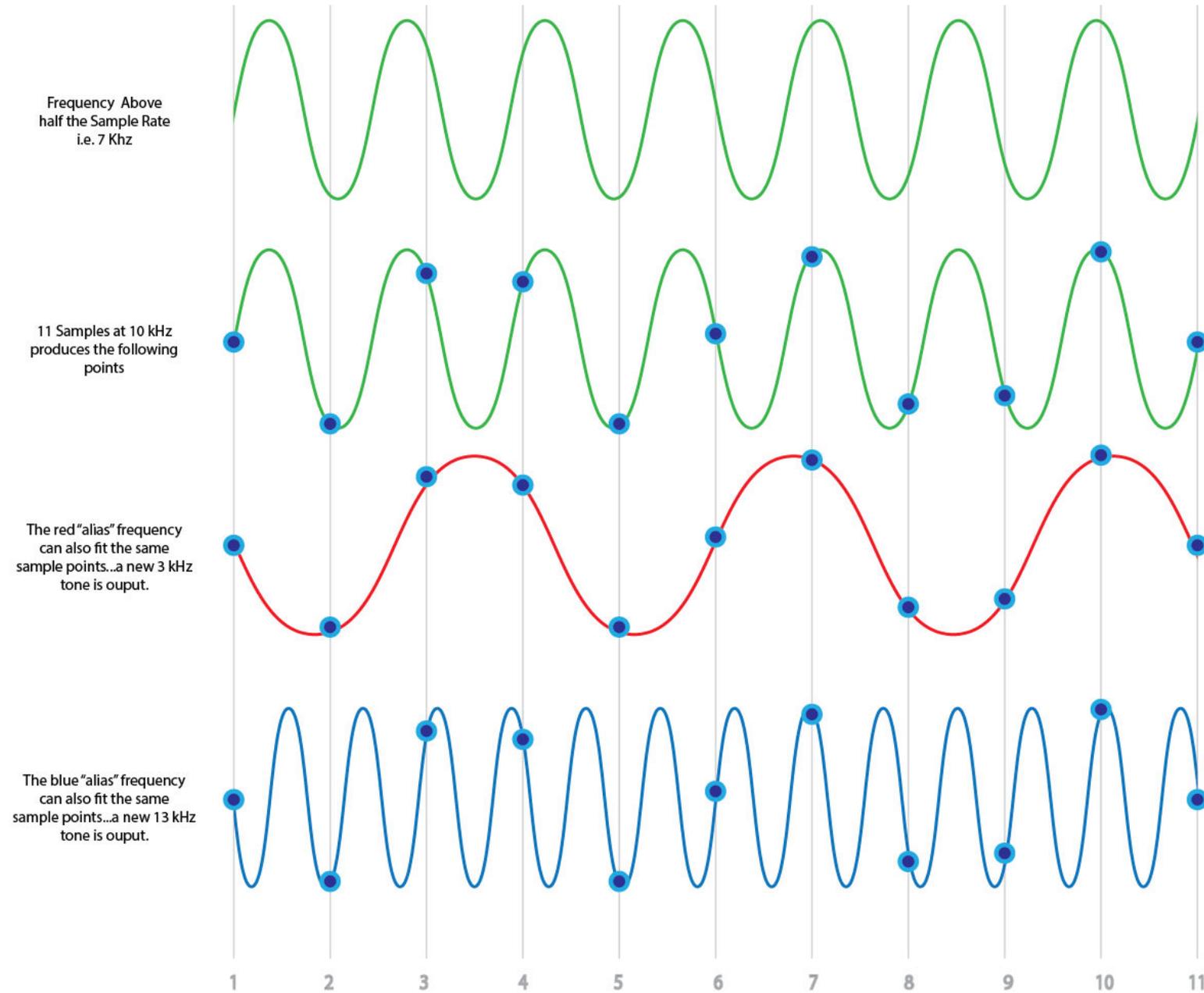
- The Nyquist Theorem states that, in order to accurately recreate an analogue signal with a computer, the sample rate during ADC must be at least twice the highest frequency of the signal.

$$f_{\text{Nyquist}} = f_{\text{Sample}} / 2$$

Aliasing

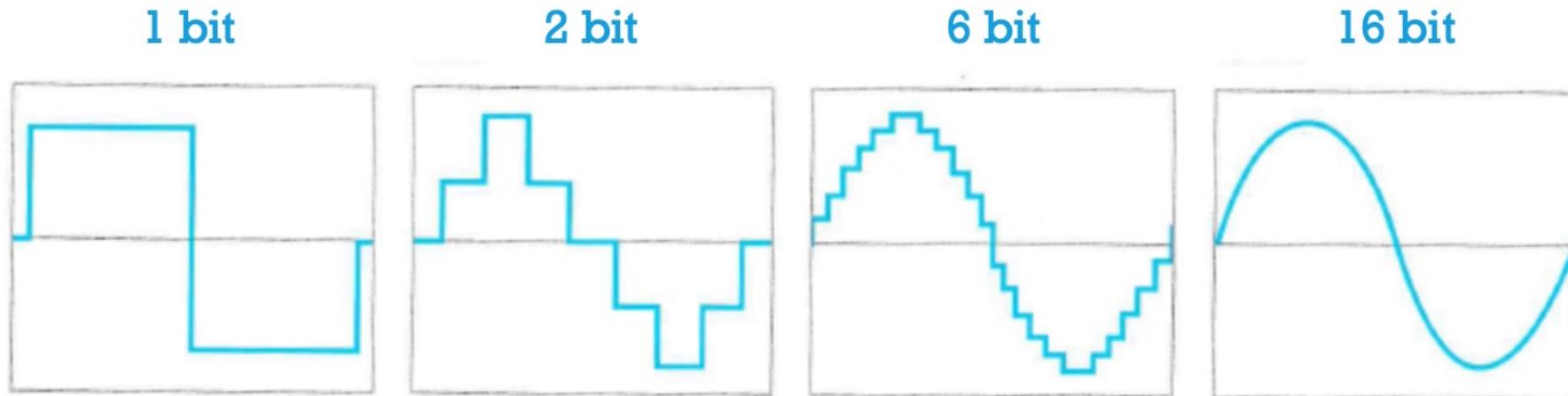
- Aliasing is a type of artefact found in digital audio
- It occurs in the form of a sampling error when audio is recorded at too low of a sample rate
- The frequency of the original audio is misidentified
- Can introduce unwanted artefacts to a recording

Aliasing

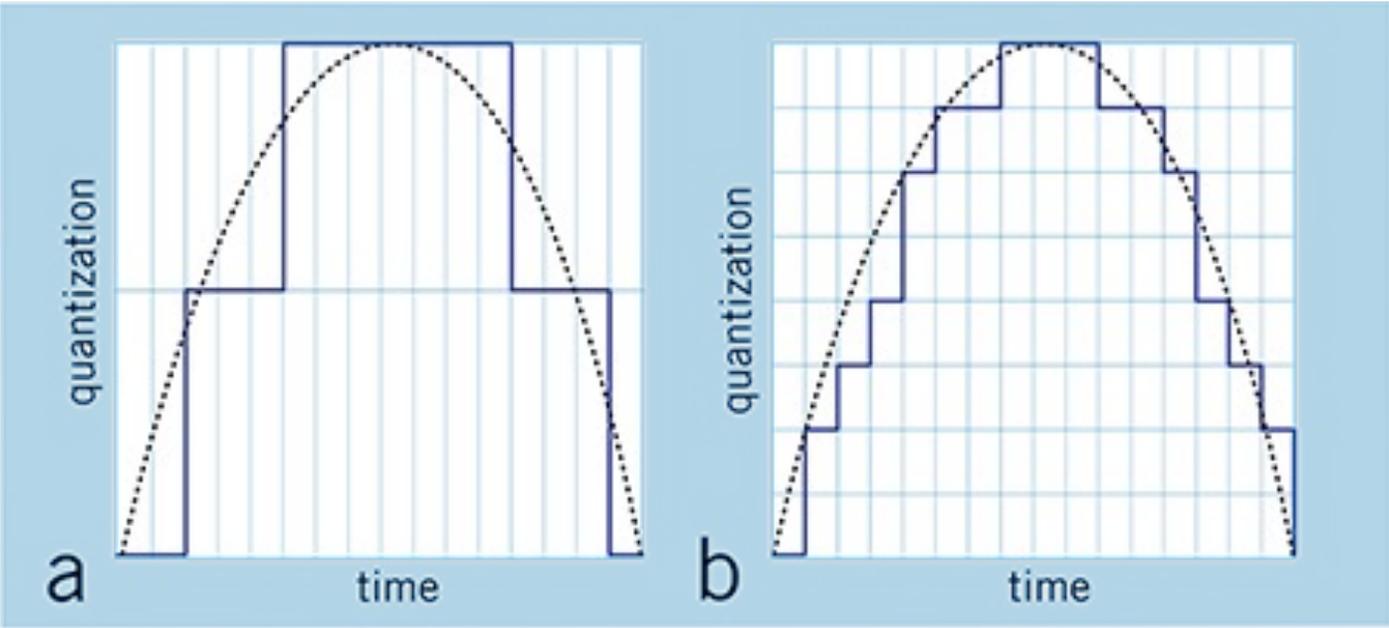


Bit Depth

- Determines the detail that the amplitude of the signal is encoded in
- By increasing the bit depth you sample the amplitude of the audio in finer increments leading to a more accurate representation of the signal
- CD quality uses a bit depth of 16 bit but 24 bits are also commonly used when working with audio

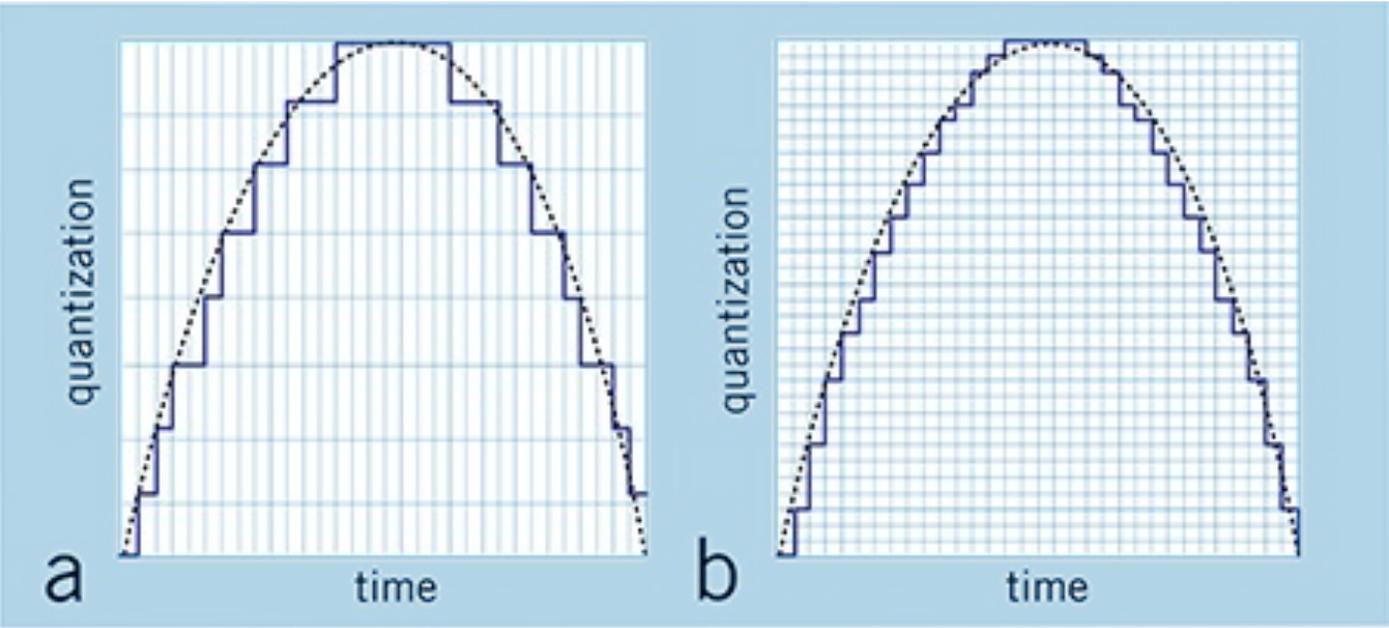


Lower Sample Rate
Lower Bit Depth



Higher Sample Rate
Higher Bit Depth

High Sample Rate
Lower Bit Depth



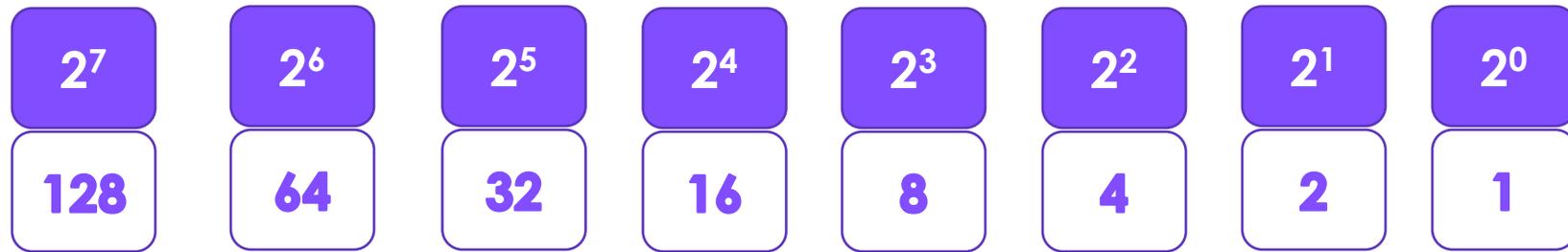
High Sample Rate
Higher Bit Depth

Bits and Bytes

- A string of binary digits is made up of bits
- A group of 8 bits is called a byte
- One or more bytes create a digital word
- The number of bits in a word determines the resolution of the sample

Binary Conversion

- Method 1



Binary Conversion

- Method 2