Records. The diamond needle (stylus) rides up and down on bumps, which contain the sound information. This causes the little magnets to wiggle. Electrical signals are induced in the coil (Faraday’s Law). Note that this is a stereo record since it has a left and right signal.

Long-playing (LP) record rotates at about \( \frac{30}{78} \) rpm (rotations per minute). Light My Fire by the Doors (1967) takes up a band of \( \frac{7}{1} \) inch on the LP. The song is 7 minutes long. The record turns

\[ \text{30 rotations per minute} \times 7 \text{ minutes} = \frac{210}{	ext{(rounded off)}} \text{ times. This gives the number of grooves.} \]

This means

\[ \text{200 grooves per inch, which is very approximately } \frac{100}{100} \text{ per centimeter.} \]

Tape Decks. As the tape is pulled near the soft iron tape head, the soft iron senses the “baby magnets” on the tape. This induces changing magnetic fields in the iron, which are picked up in coil via Faraday’s Law (see left). Reverse the steps for recording.

Actually 198 → 2

In a cassette player tape moves at about \( \frac{7}{12} \) inches per second. How much feet of tape do you need in a cassette in order to tape Light My Fire?

Do the calculation here.

\[ \text{I-ARC Model} \]

\[ \text{I} \rightarrow \text{ft needed on cassette} \]

\[ \text{A} \rightarrow \frac{2 \text{ in.}}{\text{7 min}} (60 \text{ sec}) (\frac{1 \text{ ft}}{12 \text{ in.}}) = \frac{2 \cdot 7}{12} \cdot 60 = \frac{70}{6} = 70 \text{ ft} \]

\[ \text{C} \rightarrow \text{pull out tape measure} \]

To extract the signal in the above two inventions you have \( \text{motion 1}^{\text{st}} \) and \( \text{current 2}^{\text{nd}} \). What about making (cutting) a record or making (recording) a tape?

CD Players. An infrared laser (beyond the red region of the spectrum) scans little pits which contain the sound information.

A bit is a “0” or “1”

A nibble = 4 bits such as 1010 or 1110

A byte = 8 bits such as 1100, 1001

Can leave a space for each nibble →
Sampling rate—-to get the hardest case of 20,000 Hz, you need to throw a block down for the crest and one for the trough ⇒ 40 kHz

Decimal: 1724 means 1 thousand plus 7 hundred plus 2 tens + 4.

8 + 0 + 2 + 1 ⇒ 11

Binary: 1011 means 1 eight + 0 four + 1 two + 1 one = 11 in decimal. We write this as 1011₂ = 11₁₀. The subscript 2 means binary; the subscript 10 means decimal (i.e., regular numbers).

Here is how you count in binary: 0000, 0001, 0010, 0011, 0100, 0101, 0110, 0111, 1000. These are binary numbers for 0 to 8.

Convert $45 to binary. Think in terms of $1, $2, $4, $8, $16, $32.

You have bills of these values. You must always give only one type of any given denomination at most. Give a $32. Then, you owe your friend only $45 − $32 = $13. Continue in this way and fill in the table to arrive at your answer. Remember to enter 0 if you do not need that bill.

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Good match since

Digitize both amplitude and time. Digitization is like using small boxes to match the wave.

1. Time (The Horizontal Dimension of the Graph). Look at the cute little wave labeled "smallest wave" at the left. If this wave is a 20,000-Hz sine wave, then we can get by with a square wave here. Why?

A cup @ 20,000 Hz; sine

H1 H3 H5

No H2, No H4 ⇒ 20 kHz sine

Values go from 0 to the max. So add 1 to each above to get number of available values.

Max A (Amplitude) is half this since you use half the blocks for the crest and half for the trough.

For one channel, need 2 for stereo.

Max 4-bit value: 1111₂ = 15

Max 8-bit value: 1111 1111₂ = 255

Max 16-bits: 1111 1111 1111 1111₂ = 65,535

Decibel Range for Sound

10 x Number zeros after the 1

10.2 = 20 dB

10.4 = 40 dB

100,000,000 (approximately)

90 dB → CD quality

Half are stacked above equilibrium to get max crest and half are stacked below equilibrium to get trough → 16-bit Sound

Do this 40,000 / 15 for each channel