

# Codes in a song – *Modems*

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## Summary

All data on computers is stored and transmitted using the binary number system. When the binary digits need to be sent over phone lines (which often happens in home internet connections), the digits are converted to sound, and decoded at the other end, using a *modem*. This activity uses an audio coding similar to that used by a modem, but the sounds are recorded as songs, which students can decode.

## Curriculum Links

- ✓ Computing: data storage
- ✓ Maths: Binary numbers

## Skills

- ✓ Recognising high and low pitches.
- ✓ Elementary arithmetic

## Ages

- ✓ 7 years and up

## Materials

You will need:

- ✓ The mp3 files of the songs (downloadable from [csunplugged.org/modem](http://csunplugged.org/modem); files encoding both English and Chinese messages are available).
- ✓ The video “Reaching out” from [youtube.com/csunplugged](http://youtube.com/csunplugged) (available in October 2010)

## What to do

This activity follows on from the introduction to binary numbers (<http://csunplugged.org/binary-numbers>) and is an extension of the worksheet on Email and Modems.

- Discuss how computers could send zeroes and ones over a phone line – the students should conclude that you need to convert them to sound, and they are likely to come up with the use of high and low tones.
- Discuss how 5-bit numbers can be used to code the alphabet (1=A, 2=B, etc.) as shown in the table below, and try sending 5-bit numbers using 5 high/low pitches. For example, “low-low-high-low-high” is the number 00101, which is the 5<sup>th</sup> letter, “e”. Use 00000 for space. (The Chinese version of the mp3 files uses Pinyin, with the numbers 1 to 4 giving the 4 tones, and 5=A, 6=B etc.).

1	2	3	4	5	6	7	8	9	10	11	12	13
a	b	c	d	e	f	g	h	i	j	k	l	m
14	15	16	17	18	19	20	21	22	23	24	25	26
n	o	p	q	r	s	t	u	v	w	x	y	z

Letter codes (English)

1	2	3	4	5	6	7	8	9	10
—	/	∨	\	a	b	c	d	e	f
11	12	13	14	15	16	17	18	19	20
g	h	i	j	k	l	m	n	o	p
21	22	23	24	25	26	27	28	29	30
q	r	s	t	u	ü	w	x	y	z

Letter codes (Chinese)

- Now play the song files with the high/low pitches (E01.mp3 to E06.mp3), and challenge the students to decode them. For example, the first file decodes to 01000 00101 01100 01100 01111 00000 10111 01111 10010 01100 00100, which is “HELLO WORLD”.
- The final challenge is to try to decode the binary messages in the video “Reaching out” (from youtube.com/csunplugged). The tune has high and low notes in groups of five that can be decoded as in the above activity. But the challenge is a lot deeper: the main message gives further instructions on finding another message, which in turn provides a URL and password for students to follow to claim a reward. (The lyrics of the video explain how to decode it!)



The “Reaching out” video

#### Follow up

- The “reaching out” video actually contains many hidden messages – there are over 20 messages coded in different parts of the video, including the instrumental parts and the dancing.

- Students could write and record their own songs (this could tie in with media lessons, or music lessons!)
- For senior students, discuss how long an audible pulse would have to be to make sure its pitch can be decided (to keep the pitches at audible frequencies, this limits the number of bits that can be transmitted in a second).
- Investigate the idea of steganography – hiding a message in a file that seems to be used for another purpose. The “Reaching out” video is a form of steganography, although not a particular secure way of hiding a message!

## What’s it all about?

It is common for a home connection to the internet to be via a modem, which is short for “modulator-demodulator”. Older modems use audible tones, which is the harsh screeching sound that many internet users are familiar with – fax machines also use the same kind of modem to transmit images. The more recent DSL modems use frequencies above human hearing, so that data can be transmitted on the phone line while it is still being used for speech.

For more information about defragging, see the Wikipedia article at:  
<http://en.wikipedia.org/wiki/Modem>