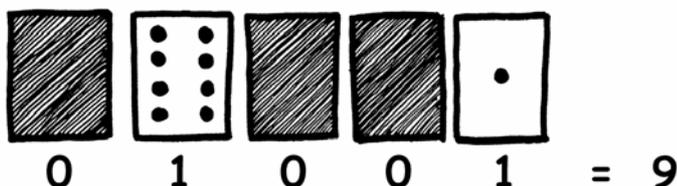# Worksheet Activity: Working With Binary

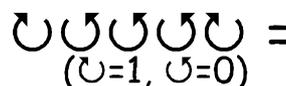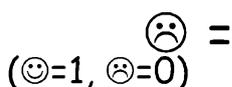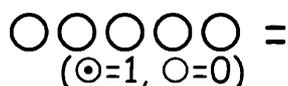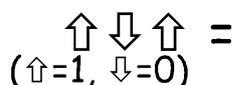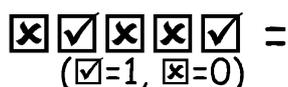The binary system uses **zero** and **one** to represent whether a card is face up or not. **0** shows that a card is hidden, and **1** means that you can see the dots. For example:

0   1   0   0   1   = 9

Can you work out what **10101** is? What about **11111**?

What day of the month were you born? Write it in binary. Find out what your friend's birthdays are in binary.

Try to work out these coded numbers:

⊠ ☑ ⊠ ⊠ ☑ =
(☑=1, ⊠=0)

👍 👎 👍 👎 =
(👍=1, 👎=0)

⇧ ⇩ ⇧ =
(⇧=1, ⇩=0)

+ + ✕ + =
(**+**=1, ✕=0)

○ ○ ○ ○ ○ =
(⊙=1, ○=0)

↻ ↻ ↻ ↻ ↻ =
(↻=1, ↺=0)

📬 📭 =
(📬=1, 📪=0)

▲ ▼ ▲ ▼ ▼ =
(▲=1, ▼=0)

☹ =
(☺=1, ☹=0)

♠ ♠ ♠ ♠ ♠ =
(♠=1, ♣=0)

Extra for Experts: Using a set of rods of length 1, 2, 4, 8 and 16 units show how you can make any length up to 31 units. Or you could surprise an adult and show them how they only need a balance scale and a few weights to be able to weigh those heavy things like suitcases or boxes!
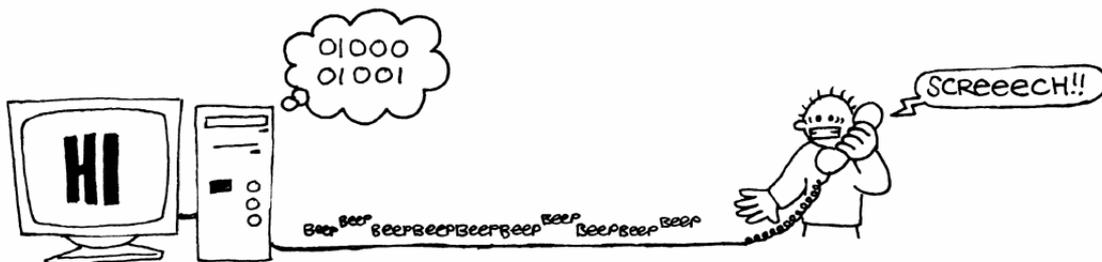

Worksheet Activity: Sending Secret Messages

Tom is trapped on the top floor of a department store. It's just before Christmas and he wants to get home with his presents. What can he do? He has tried calling, even yelling, but there is no one around. Across the street he can see some computer person still working away late into the night. How could he attract her attention? Tom looks around to see what he could use. Then he has a brilliant idea—he can use the Christmas tree lights to send her a message! He finds all the lights and plugs them in so he can turn them on and off. He uses a simple binary code, which he knows the woman across the street is sure to understand. Can you work it out?
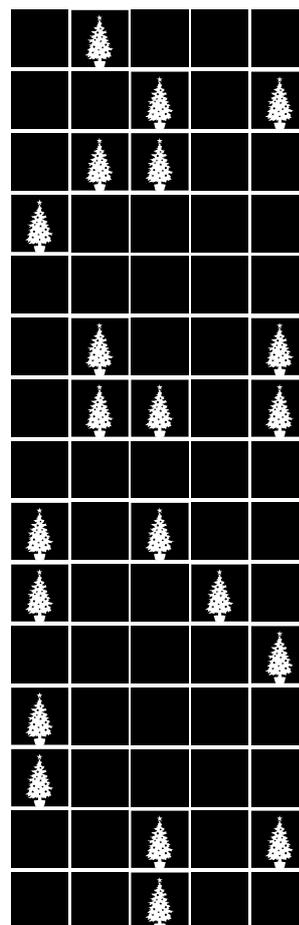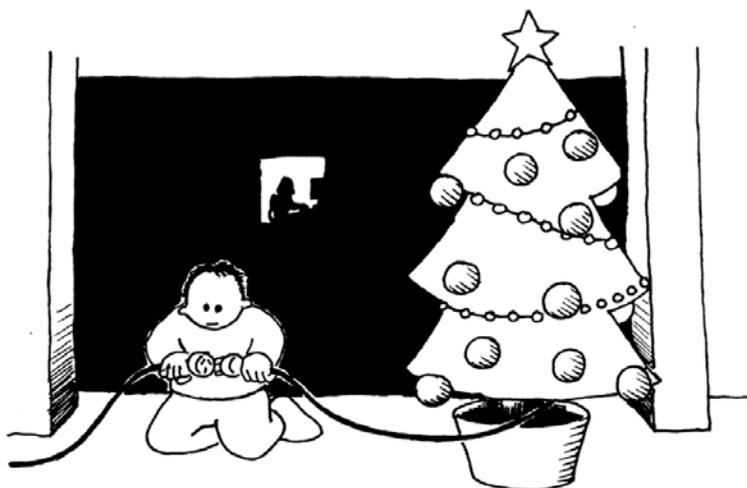
1	2	3	4	5	6	7	8	9	10	11	12	13
a	b	c	d	e	f	g	h	i	j	k	l	m

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

Worksheet Activity: E-mail and Modems

Computers connected to the internet through a modem also use the binary system to send messages. The only difference is that they use beeps. A high-pitched beep is used for a one and a low-pitched beep is used for a zero. These tones go very fast—so fast, in fact, that all we can hear is a horrible continuous screeching sound. If you have never heard it, listen to a modem connecting to the Internet, or try calling a fax machine—fax machines also use modems to send information.

Using the same code that Tom used in the department store, try sending an e-mail message to your friend. Make it easy for yourself and your friend though—you don't have to be as fast as a real modem!

Worksheet Activity: Counting higher than 31

Look at the binary cards again. If you were going to make the next card in the sequence, how many dots would it have? What about the next card after that? What is the rule that you are following to make your new cards? As you can see, only a few cards are needed to count up to very big numbers.

If you look at the sequence carefully, you can find a very interesting relationship:

1, 2, 4, 8, 16…

Try adding: 1 + 2 + 4 = ?   What does it come to?

Now try 1 + 2 + 4 + 8 = ?

What happens if you add all the numbers up from the beginning?

Have you ever heard of "let your fingers do the walking"? Well now you can let your fingers do the counting, but you can get much higher than ten—no, you don't have to be an alien! If you use the binary system and let each finger on one hand represent one of the cards with dots you can count from 0–31. That's 32 numbers. (Don't forget that zero is a number too!)

Try counting in order using your fingers. If a finger is up it is a one, and if it is down it is a zero.

You can actually get from 0–1023 if you use both hands! That's 1024 numbers!

If you had really bendy toes (now you would have to be an alien) you could get even higher. If one hand can be used to count 32 numbers, and two hands can count to 32 × 32 = 1024 numbers, what is the biggest number Miss Flexi-Toes can reach?
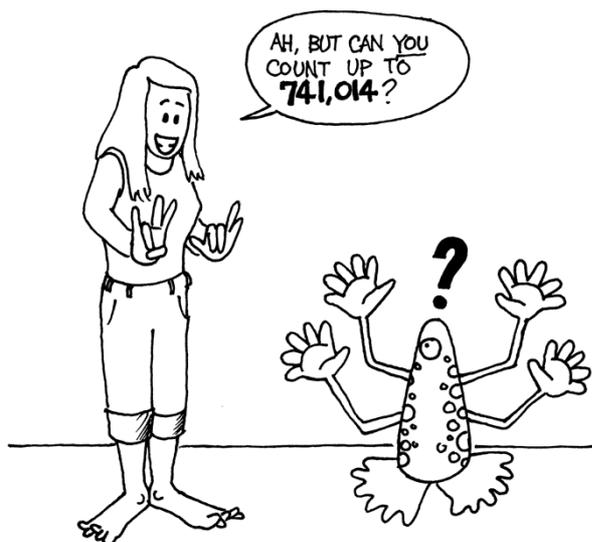
Worksheet Activity: More on Binary Numbers

1. Another interesting property of binary numbers is what happens when a zero is put on the right hand side of the number. If we are working in base 10 (decimal), when you put a zero on the right hand side of the number, it is multiplied by 10. For example, 9 becomes 90, 30 becomes 300.

   But what happens when you put a 0 on the right of a binary number? Try this:

   # 1001 → 10010
   ### (9)   (?)

   Make up some others to test your hypothesis. What is the rule? Why do you think this happens?

2. Each of the cards we have used so far represents a 'bit' on the computer ('bit' is short for '**b**inary dig**it**'). So our alphabet code we have used so far can be represented using just five cards, or 'bits'. However a computer has to know whether letters are capitals or not, and also recognise digits, punctuation and special symbols such as **$** or **~** .

   Go and look at a keyboard and work out how many characters a computer has to represent. So how many bits does a computer need to store all the characters?

   Most computers today use a representation called ASCII (**A**merican **S**tandard **C**ode for **I**nformation **I**nterchange), which is based on using this number of bits per character, but some non-English speaking countries have to use longer codes.