Computers

Worksheet 14

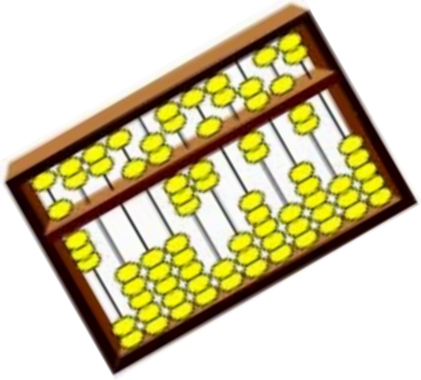
A worksheet produced by the Native Access to Engineering Programme

What is a computer?

Computers. They're everywhere. We use them everyday … at home, at work, at school. But do you really know what a computer is and do you have any idea how a computer works?

According to the on line version of the Merriam Webster dictionary, a computer is

: a programmable electronic device that can store, retrieve, and process data



The ancient Babylonians used a computing device called an abacus around 3000 BCE.

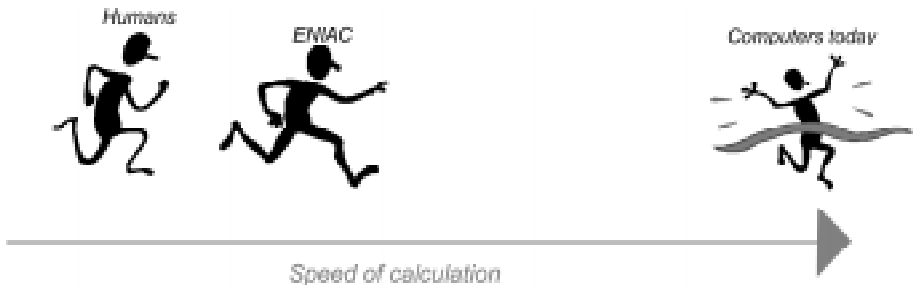
A little computer history

You probably use a computer in school. Your parents might have, but probably didn't, and the chances that your grandparents used a computer when they were your age are very, very small.

Do you know when computers were first used in your community?

Although some of the knowledge which contributed to the development of computers can be traced back almost 5000 years, the first general purpose computer, called ENIAC, was turned on in 1943. It was huge, and, compared to today's computers, really, really slow.

Why would anyone want a really slow computer?



What ENIAC and other early computers were really good at was processing and performing calculations on huge amounts of data. Despite being slow – for computers – they could still get through long and tedious calculations much faster than any human.

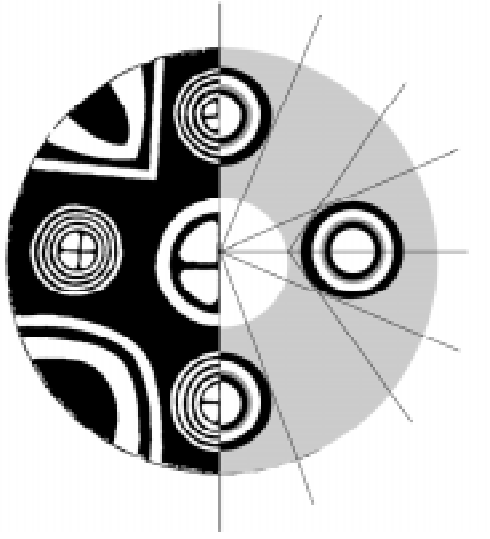
A tool which walks in two worlds

The computer you use in school can probably do just about anything you can imagine: it can help you draw pictures, research a paper and take you just about anywhere in the world. You probably don't use it to manipulate numbers and equations, but computers are still used to crunch numbers by scientists, architects and engineers all over the world.

Douglas Cardinal, the internationally renowned Aboriginal architect, saw how computers could be used almost as soon as they were small enough to fit on a desk. One night in the early 1980s, he replaced the drafting tables, rulers and pencils in his firm with computers equipped with computer aided drafting and design (CADD) software. Although his employees were shocked at the suddenness of the change, the company became one of the first completely electronic architectural firms in North America, and a showcase for the testing and advancement of computer and CADD use in Canada. Mr. Cardinal uses the computer as a tool which helps him walk in two worlds: he grounds his designs in tradition and the needs of his clients, but uses computers to help bring his visions to reality.

The Canadian Museum of Civilzation in Hull, QC. Designed by Douglas Cardinal.

Can you think of ways in which computers might be used to bridge the traditional and the modern?



Other Native people, band councils and businesses have found ways to use computers that contribute to economic development and to the preservation or rekindling of traditions. Computers are being used to preserve and teach Native languages, sell soap stone carvings and other art on line, and to map traditional trap lines, hunting and fishing grounds through the use of GPS and GIS databases.

How are computers used in your community?

Hardware and Software

Every computer brings together two elements which help it to perform useful functions: hardware and software.

What is the difference between hardware and software?

All of the physical components found inside a computer's casing are its hardware: the motherboard, central processing unit, hard drive, graphics card etc.

Software are computer programs; sets of instructions written in a computer programming language.

Can you name any programming languages?

Hardware is your brain; software are all the things we learn through life. Humans even have an OS: we're born with basic instructions like breathing, eating, sleeping and waste elimination already installed.

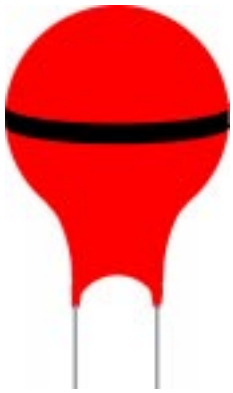
The most basic piece of software on any computer is the operating system or OS. The OS gives the machine its basic instructions, it also acts as an interface between you and the computer, letting both of you know where and how to store, find and retrieve files. Depending on what else you do with your computer, you will use other software to write papers, manipulate images or surf the Web.

Software, once installed on your computer, is stored in hardware, specifically in the computer's memory.

Electronic devices

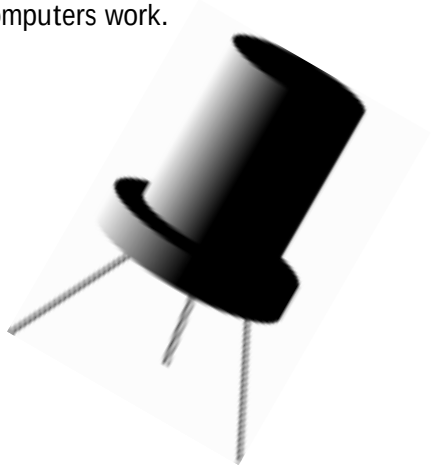
Computers are electronic machines which depend on the flow of electrons to work. Electronic machines are built from electronic components, like resistors, capacitors and transistors, which control the way electric current flows around a circuit. Because different types of electronic components perform different functions, the way they are put together in a circuit determines how the circuit functions and what tasks it can accomplish.

Capacitors store up electricity and release it as needed.



Resistors actually resist the flow of electricity, reducing the amount of current that flows through a circuit. When something resists the flow of electrical current, it generally converts some of the electrical energy into light or heat.

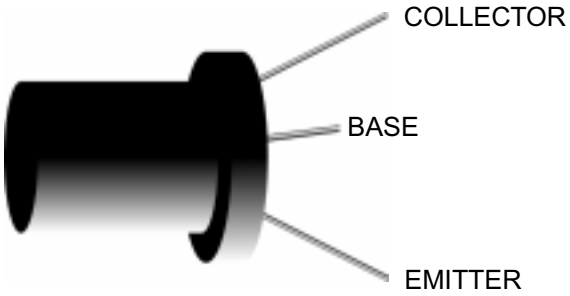
Transistors are electronic switches which can start or stop current flow through parts of a circuit. Transistors are a key component in the way computers work.



Can you think of any electric devices that use resistors to convert electricity into heat or light?

Transistors, switching and binary code

A transistor has three legs, called the base, collector and emitter.



If current flows into the base leg, the transistor is on and current is allowed to flow from the collector to the emitter.

If no current flows into the base leg, the transistor is off and no current flows from the collector to the emitter.

The switching between on and off of transistors causes pulses of electricity through a circuit. To a computer these pulses are actually digital information. If electrons flow it reads the pulse as on or 1. If the electrons don't flow, it reads the pulse as off or 0. Off or on, 0 or 1, this is the only way computers read information. It is called binary code.

Do you know why it is called binary code?

In a computer one piece of information, a 0 or a 1, is called a bit. Computers process and store information in chunks of 8 bits, each called a byte.

If you have a computer with a 1 gigabyte of hard disk space, how many bits can it store?

Binary Counting

Counting in binary is relatively easy once you know how.

Say you have one byte of memory. You can draw a picture of a byte which looks like this.

Bit	Bit	Bit	Bit	Bit	Bit	Bit	Bit

1 Byte

Each box represents a bit and will contain a 0 or a 1.

1	0	1	1	0	1	0	1

The key is that each box also represents a power of 2, starting from the right with 2^0.

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	0	1	1	0	1	0	1

If a bit contains a 1, it actually holds a value of 1 times whatever power of two the box represents. You figure out the value of the byte by:

1. Multiplying the bit value by the power of two which it represents;
2. Adding the resulting numbers together.

So, in our example you get...

2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
1	0	1	1	0	1	0	1

$$(1 \times 2^7) + (0 \times 2^6) + (1 \times 2^5) + (1 \times 2^4) + (0 \times 2^3) + (1 \times 2^2) + (0 \times 2^1) + (1 \times 2^0)$$
$$= (1 \times 128) + (0 \times 64) + (1 \times 32) + (1 \times 16) + (0 \times 8) + (1 \times 4) + (0 \times 2) + (1 \times 1)$$
$$= 128 + 0 + 32 + 16 + 0 + 4 + 0 + 1$$
$$= 181$$

So the binary number 10110101, is actually the number 181.

What's the biggest number one byte can hold?

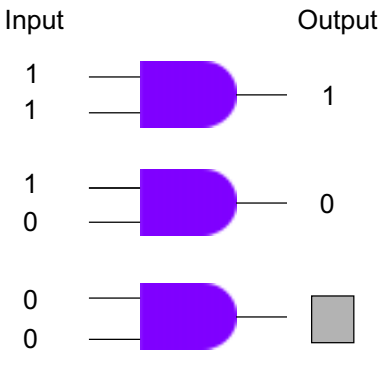
Logic Gates

In digital electronic circuits, like the ones in a computer, groups of transistors can be arranged into logic gates. Logic gates are grouped together to perform the complex calculations and functions which make a computer work.

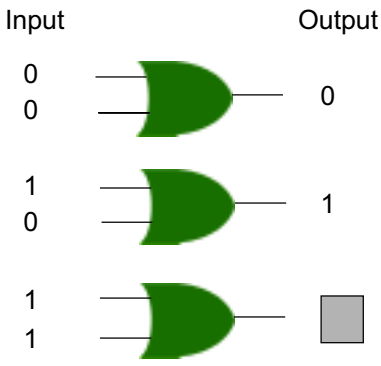
One type of logic gate grouping is called a flip-flop. Flip-flops essentially send the same piece or pieces of information back and forward between each other. Large groupings of flip-flops are contained in every computer: they are joined together to form the computer's memory.

Each logic gate manipulates the value of the bits that pass through it. There are three main kinds of logic gates: AND, NOT and OR.

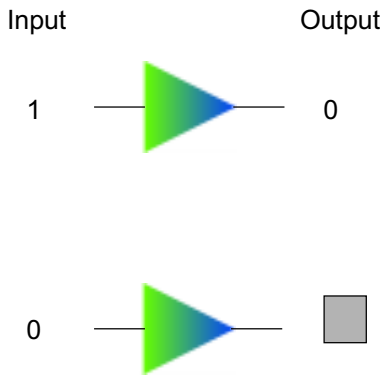
An AND gate has two inputs and one output. If both input values are 1, it outputs a 1, otherwise it outputs 0.



An OR gate also has two inputs and one output. If both input values are 0, it outputs a 0, otherwise it outputs 1.



A NOT gate has one input and one output. It changes the value of the input. So if the input value is 1, it outputs a 0.



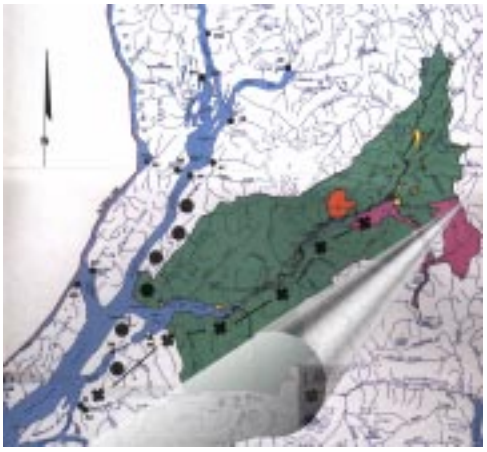
Can you identify the values which belong in each box?

Integrated circuits and the importance of silicon

How many transistors are in a computer?

Getting a computer to superimpose a map of traditional trap lines over an existing map of land takes a lot of computer power. What you see on the monitor is one map on top of another, showing you where your grandfather and his grandfather used to trap food and fur. To the computer the two maps and the act of superimposing them represent megabytes of memory and millions of calculations.

As you can imagine, it takes many, many transistors for a computer to do the work we consider useful.



Memories of Elders can be used to develop maps of traditional trap lines. By superimposing the new maps over existing ones, traditional knowledge can help in land claims and treaty negotiations.

So why aren't computers still huge like ENIAC was?

Advances in technology have allowed us to miniaturize the electronic components in computers to the point where they are literally microscopic. Entire circuits containing millions of transistors are etched onto silicon wafers through a complex process which exposes the wafer to chemicals and ultraviolet light.

What's the difference between ultraviolet light and regular light?

Because the electronic components on a computer chip are so small, the tiniest speck of dust could ruin the manufacturing of a chip, so they are made in ultraclean rooms. Even the people who make them have to cover up so they don't release any dust or dirt into the room.

The completed circuits are called integrated circuits or silicon chips. Each completed wafer contains several hundred chips. There are a number of these chips in your computer. The central processing unit is the most important one, it tells all the other chips what to do.

A CPU chip is about this big,

and getting smaller all the time.

Do you have any idea where silicon can be found?

Silicon, the key ingredient in computer chips, is found in sand. It is a semi-conductor. Semi-conductors are materials which can act as both electrical conductors and electrical insulators. Depending on the other elements it is mixed with, silicon will allow electrical current to flow through a circuit (act as a conductor) or stop a current from flowing through a circuit (act as an insulator).

Computers and community

For a tool which began as a number crunching device, computers have proven themselves to be very versatile. They have evolved from being the tools of science and big business, to being the tools of education, economic development and communication. With a computer and Internet connection, a person in Rankin Inlet can talk to people just about anywhere in the world.

What does this mean for people in rural and remote communities?

For rural and remote communities, computers and the Internet can provide access to services which aren't available near home, services such as banks, libraries and medical care. Diabetics can be monitored by doctors at a distance, people can stay at home with their families while pursuing college and university courses, students with old text books can get up-to-date information via on-line books and newspapers. They can even visit the Louvre Museum in Paris.

The Louvre actually played a pivotal role in getting Rankin Inlet on line. Community teacher, Bill Belsey, and students used the museum's web site to demonstrate the power of the Internet to the local council. After showing them an image of Van Gogh's self-portrait one of the Elders understood the potential of the technology right away. In Inuktitut, he told the people in the room, "We must have this for our grandchildren."

What will your children and grandchildren use computers to do?

One of Van Gogh's many self-portraits.

Source:
www.vangoghgallery.compainting/p_0501.htm

References

Online

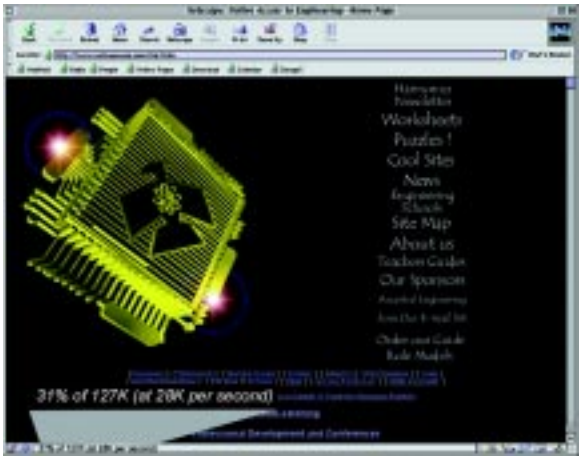
1. Britannica On-Line
   www.britannica.com
2. Douglas J. Cardinal Architect Ltd.
   www.djcarchitect.com/
3. How chips are made
   intel.com/educatiobn/chips/fabrication.htm
4. Net of the North
   www.zdnet.com/zdnn/stories/news/0,4586,2163397,00.html
5. Will Future Computers be made of DNA?
   library.thinkquest.org/3037/dna.htm

Books

1. Benson, Harris. *University Physics*. John Wiley and Sons Inc. New York: 1991.
2. Rogers, Kirsteen etal. *The Usborne Internet-Linked Science Encyclopedia*. Usborne Publishing. London: 2000.

Math Problems

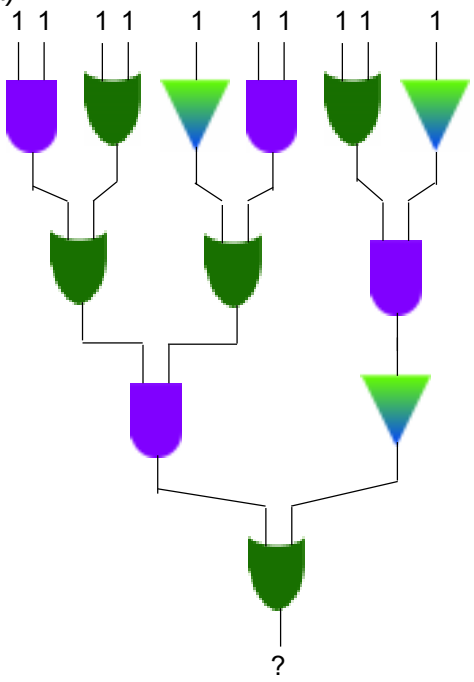
1. You live in a northern community which is connected to the Internet. During a session in your school's computer lab you're downloading information from the Web. In the bottom left hand corner of your navigation screen it says, 31% of 127K (at 28K per second).



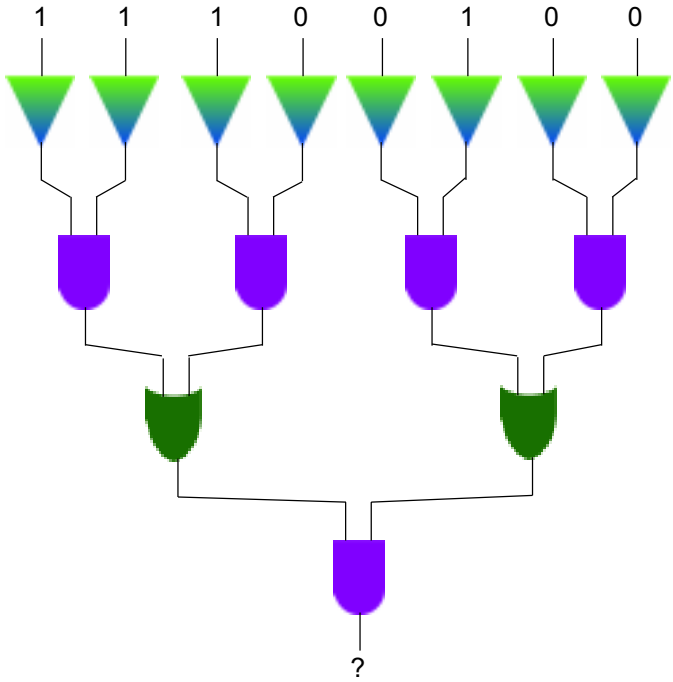
a) How much of the web page have you already downloaded?
b) How long has it taken you to download this amount?
c) How much longer will you have to wait before the entire page is downloaded?

2. Your computer teacher has opened up one of the computers and explained what each piece of hardware does. You can't see the individual logic gates but she explains how they work. From the given inputs, can you figure out the output of each series of logic gates?

a)



b)



3. She also explains how you figure out the value of binary numbers. What is the value of each of the following binary numbers?

a) 1001011
b) 1111111
c) 110011001100