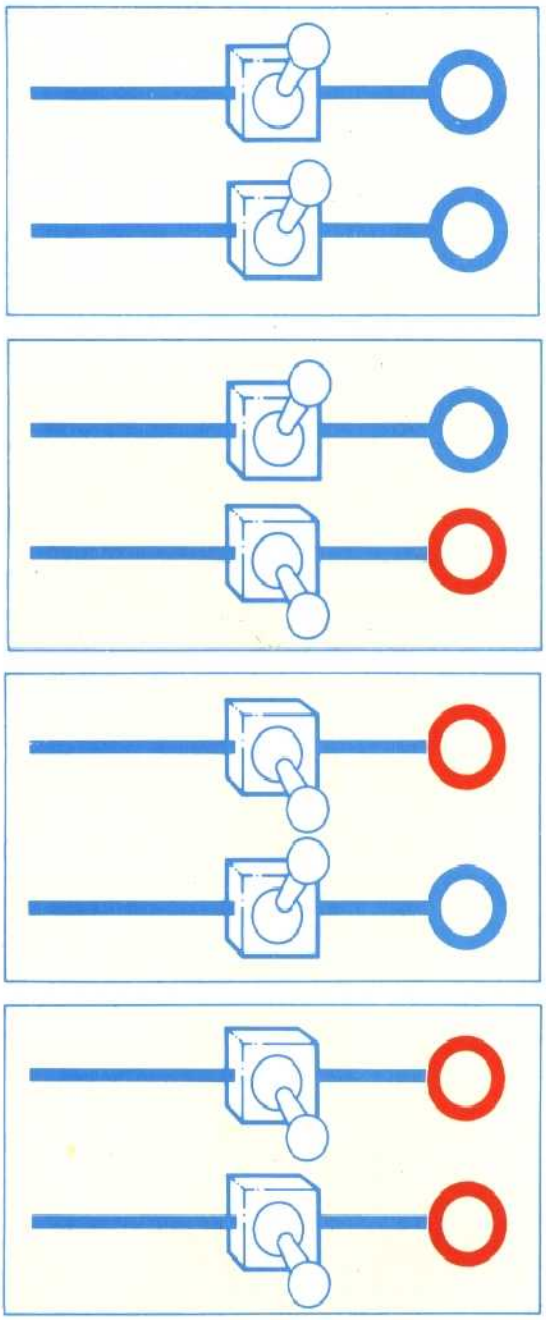

Switching Into Numbers
Computers use electrical circuits to represent numbers. The circuits consist largely of switches. A switch may be in either of two states; on or off. Two switches together can make four combinations of on and off. Computers use a system like this to represent numbers. Off/off is zero, off/on is one, on/off is two and on/on is three. Using groups of more than two allows larger numbers to be represented. Computers can process large numbers and complicated mathematical operations very quickly using thousands of microscopic switches

quick look at some of the principles involved.

On one level, a computer is nothing but a box full of tiny electric switches that can be connected together in different ways. This, however, is not the best place to start if you want to understand what computers can *do*; only the men and women who design and build them really need to understand this level, but the rest of us don't. For one thing a modern computer is an exceedingly complex machine; thanks to the astonishing developments in microelectronics (the famous silicon chip) it is possible for even a small home computer to contain some 250,000 of these little switches. All of these switches can be either 'on' or 'off'. Any pools punter will tell you that the number of combinations of 'on' or 'off' is staggeringly large. For another thing the computer you buy will have a program permanently built into it that disguises this mind-boggling complexity, and allows you to 'talk' to the machine using a few shortened but easily recognisable English words.

Many people are surprised when they first use a computer because when they switch it on, they discover that it knows nothing useful at all. Oddly enough, the notion is not yet dead that the computer is an 'electronic brain' that is supposed to know everything. Surely it must know what the capital of Afghanistan is called? Or the height of Mt Kilimanjaro? In fact, far from knowing all these things, the silicon chip that forms the 'brain' of a microcomputer doesn't even know the alphabet or any arithmetic. All it understands are several hundred number combinations, and everything else that it can be taught has eventually to be translated into these numbers. The little switches already mentioned can remember numbers; a pattern of ON and OFF switches represents a number (in the binary number system which only uses '0's and '1's). The fact that the computer can remember, in other words, *store*, information, is vital to the way it works; the electronic memory in a Sinclair Spectrum holds information equivalent to six pages of words in this course (it could store much, much more again on tape, but that is all it can hold on its own).

As well as storing numbers in its memory, a computer can do things *to* these numbers: it can add and subtract them, compare them with each other and move them about inside its memory. Everything that the machine can do is built up from these simple acts. Suppose we want to store text in the computer. Let's invent a code, so that each letter of the alphabet is given a number: then the computer can store words as numbers and shuffle them around. We want to play Frogger? Let's take a picture of a frog and draw it in the squares of a grid so that each little square can be given a number . . . It isn't, of course, necessary to invent these codes yourself because all this work has already been done by the manufacturers and designers and put together in the shape of computer programs.

What is a program? It's a list of instructions to the computer to perform those simple actions (add, compare, etc.) in a particular order, just as a knitting pattern tells the knitter how to perform a sequence of simple stitches in a certain order to produce a garment. But what are these instructions, and how do they get to the computer? Actually they are just more numbers and they are also stored in the computer's memory! This seems to present us with a chicken-and-egg paradox. The computer can do nothing without a program to tell it what to do; every time you press the letter 'A' on the keyboard a program inside the computer must scan the keyboard, find out what key you pressed and then tell the computer the number code for that letter. But at some point, when the computer was first designed, this keyboard-scanning program did not exist. Painstakingly, someone had to put the right numbers directly into the keyboard's memory, using special instruments, just to enable it to understand letters typed on its keyboard and to let it show those letters on a television screen.