PLEASE NOTE: Many of the pages in this manual are of poor quality.
I hope to replace it soon with a better version.

Science Fair®

DIGITAL COMPUTER KIT

100 SAFE EXCITING EXPERIMENTS

THE EXCITEMENT OF YOUR OWN COMPUTER!

LIST OF EXPERIMENTS

"Ten . . . nine . . . eight . . . seven . . ."

At space centers lights flash, buttons are pushed, levers moved.
"Six . . . five . . . four . . ."
At home or at school, in front of television sets, people throughout the world wait, hope and wonder.

"Three . . . two . . . one . . Lift off!"
The rocket spouts fire, roars and inches slowly off its pad. It speeds upward, straight at first, then tips ever so slightly. Soon it is racing toward space and we hear the voices of the astronauts and their land-based fellow workers. They speak calmly. But if one computer failed, perhaps one so small it could fit into a baseball glove, their voices might grow very excited indeed. For the success of a space flight depends on the computer. . . computers as large as an office building or as small as a grapefruit. And many of their parts that contain important flight information could fit into the dot at the end of this exclamation point!

Surrounded by computers, astronauts trained here at the Manned Spacecraft Center in Houston, Texas, for the Apollo moon projects.

But these electronic "brains" do much more than help human brains hurl men into space. They are an important part of your everyday life. A computer "learning machine" probably helps your teachers. Or you may have played a game such as "electronic tennis" that uses a computer connected to a television set. And when you dial a telephone number, the computer routes it to Grandma or Fred. A computer makes your reservation on an airliner. It keeps the weather satellites in the porper orbit so that you get the information that tells you whether to wear a sweater or a raincoat to the ballgame.

Computers have become an everyday part of our lives.

A computer can do so many complex things so fast that some people are afraid of them. The very thought of plunging into building something that seems so complicated is enough to bring out beads of sweat on the forehead of an honor-roll student. So before you even begin the games, quizzes and experiments in this kit, there is something you should know. The computer doesn't think. It doesn't feel. It can't be sad or joyful, mad or on-top-of-the-world. It can't love someone.

And it isn't a genius. A youngster in kindergarten knows more numbers that it does and can count higher. It's true!. The computer knows only two numbers—0 and 1. Zero is "off" and one is "on". This is as simple to understand as you light switch if you were to put a number one at "on" and a zero at "off".

And keep in mind that you have your own marvelous computer sitting above your neck. If one were built to even attempt to be equal to yours, it would fill a building as high as a skyscraper and require all the power of Niagara Falls to run it!

THE COMPUTER . . . AN EXTENSION OF YOU!

Have you ever thought of an automobile as being an extension of a person's legs? After all, it enables you to cover the ground faster than you could on your own.

We might also consider television as an extension of our eyes and ears, for it permits us to see and hear far more than we could if we spent our entire lifetime traveling.

In this way, we might look at the computer as an extension of our brains. It helps us to figure out problems in a matter of minutes that might take a mathematician hundreds of years to work out with paper and pencil.

Although a computer seems to have a mind of its own, everything that comes out of it must first be put into it by a human being. If the human being makes a mistake, the computer makes a mistake. During one attempt to launch a rocket toward Venus, the rocket went out of control after only five minutes and had to be destroyed. The multi-million dollar loss was the result of a hyphen (–) being left out of the instructions that were entered into the on-board computer.

THE COMPUTER'S GIFT TO MANKIND

For centuries mankind has dreamed of the day when people would be free of work that was boring or painful drudgery. We want to create things, build, have time to imagine, dream, play. The invention and use of machines in the 1800's did away with much back-breaking work. But the machines of the "industrial revolution" also gave us work that is often repetitive and monotonous. For example, machines made shoes much faster than they could be made by hand, therefore more people could afford to buy shoes. But the warm, satisfying feeling that came with making shoes by hand disappeared.

Now we have entered what is sometimes called the "second industrial revolution"—the computer age. It is still in its infancy. Where computers can lead us (or more correctly, we lead them) is limited only by our imagination.

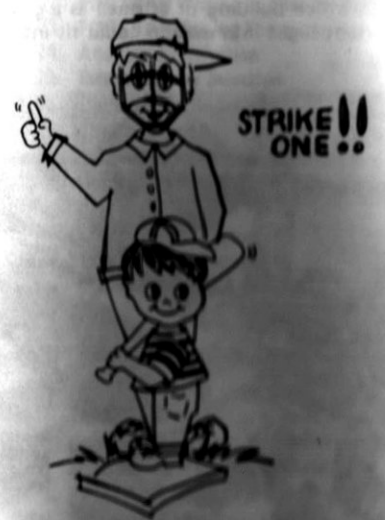
Electronic computers release man from countless hours of figuring, leaving him free to create.

Computers are so much a part of our lives that living as we know it would come to a screeching halt if all computers were suddenly swept away. Half of the people of the United States would have to work as telephone operators. The other half would have to work in banks clearing checks. The post offices would disappear under a mountain of mail for there would not be enough hands to care for the letters and packages computer-controlled machines now send on their way.

All airline flights would be cancelled; for without computers, flight safety would be almost non-existent. We would also have to forget about things like space and underseas exploration.

And worst of all, some of your examination papers might never get graded!

IT BEGAN WITH OUR FINGERS



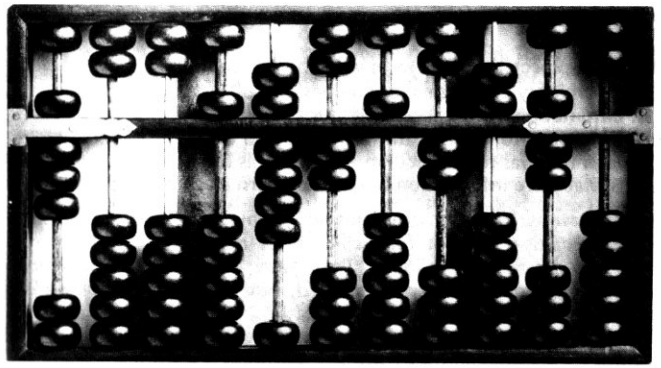
"Strike one!" The baseball umpire shouts as he holds up one finger.

The umpire is using man's oldest computer . . . his fingers.

When our early ancestors became aware of the difference between one and more than one, they bagan to count. They used fingers to represent numbers. Even today we call numbers "digits" from the Latin word for fingers, *digiti*. When early man needed to count higher than the number he could count on his fingers and toes, he developed new counting aids. For instance, a shephard might cut one notch in his staff for each sheep in his flock.

As civilization grew, caravans and ships moved from city to city. Merchants needed a clearer and more accurate method of computing business transactions. So they invented a kind of "calculator sandbox". By placing pebbles on grooves marked in sand and moving them about, they could count and make a record of the count.

You have probably used a small electronic calculator. Did you know it got its name from the Latin word *calculus* meaning small stone or pebble?



A Chinese abacus. Each bead in the top compartment has a value of five. Each bead in the lower section has a value of one. Counting is done by moving the beads toward the board that divides the two sections.

As trading and shopkeeping became more complicated, the need grew for something more efficient than pebbles in the sand. And so it was that 3,000 to 5,000 years ago, man took his first step in the development of processing information by mechanical means—the invention of the abacus.

People, including students, in many parts of the world, especially Asia, the near Eastern countries, and parts of Russia, still use the abacus. But in Europe and the Western world, the abacus fell from popular use about 600 years ago. This was due to two reasons. One was that paper, a very scarce and expensive item in ancient times, became more available and less expensive. It therefore became a convenient material on which to work out mathematical problems. The other reason was the appearance of the Arabic-numeral system of counting which is still used in almost every part of the world.

Until Arabic numerals appeared on the scene, Roman numerals were used throughout Europe. But imagine being a student in Roman times and trying to work out these problems:

```
  XX          XIII
  XII       x  VI
+ IV
```

Okay? Now you've discovered for yourself why we use Roman numerals on clocks and chapter headings and not much more.

The Arabic numbers used by most of the world originated with the Hindus in India about 2000 years ago. Arabic numbers were easier to work with but there was still a big problem because as yet there was no zero. Man had simply not thought about "nothing" in terms of a symbol, or number. But without the zero it was easy to lose one's place doing simple arithmetic. Just try multiplying 2,003 by 801 while leaving out the zeros and you'll see what we mean.

When the Hindus "discovered" the zero about 1200 years ago, it was adopted by the Arabs and its use spread gradually throughout the rest of Europe and much of the world.

Who would have thought that a zero, which seems so simple, such a "nothing", would be one of the great mathematical discoveries of all time!

COMPUTER NUMBERS

Considering the immense numbers of calculations necessary for today's science and industry, you would think that computers would require a more complex system of counting than a base-ten system that goes back to finger counting. But no, just the opposite is the case. Computers use a base-two system that we call "binary".

The system was devised in the early 1800's by a young woman, a mathematical genius with the unlikely name of Lady Lovelace. Using just two digits, the 1 and the 0, the binary system is used by computers to form all decimal numbers in the ten-base system you are used to working with!

But more about binary numbers later.

THE STORY OF MODERN COMPUTERS

Like aviation, atomic energy and television, computer technology is the result of the total efforts of many people who lived in many different centuries and in many different countries. A few of these inventive people stand out for their very special contributions.

Blaise Pascal

A 19-year-old Frenchman grew very tired of the slow, boring, and error-prone job of working out problems on paper for his tax-collector father. So at about the same time that the Pilgrims were stuffing their first Thanksgiving turkey, Blaise Pascal invented the first mechanical machine that could add and subtract.

Although it was a very simple device, it could carry tens from one column to the next. You can see an updated example in an automobile's odometer, the dashboard instrument that shows the number of miles traveled.

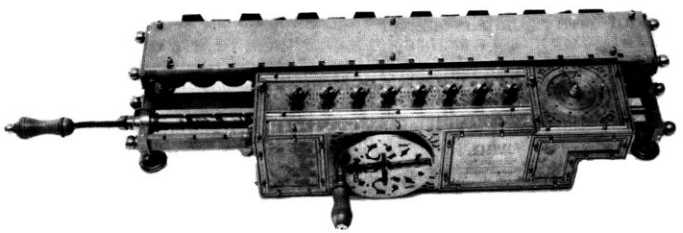
Pascal's calculator invented about 1640. Its gears carry the "tens" over to the next column.

Gottfried Wilhelm von Leibnitz

About thirty years later, in 1672, a German Baron named Gottfried Wilhelm von Leibnitz improved upon Pascal's device. He added some more gears and wheels so that it could multiply and divide as well as add and subtract.

Few people rushed forward to order the fine machine since there was not much need at that time for mathematical speed.

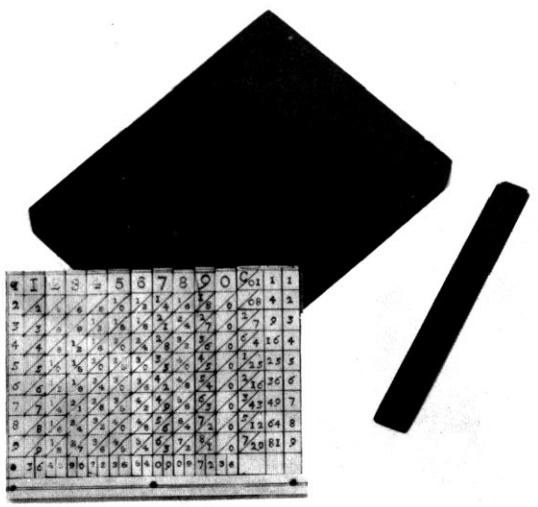
Today almost every business office uses some improved version of Pascal's adding machine and Leibnitz's calculator.



This machine designed by Gottfried Leibnitz was designed to perform multiplication by rapidly repeated additions.

John Napier

During that same seventeenth century, a Scotsman, John Napier, developed a simple, inexpensive device for multiplying. "Napier's bones" became what we now call "slide rules" and grew quite popular throughout Europe.



John Napier's "bones". Napier was also one of the first persons to use the decimal point.

Joseph Jacquard

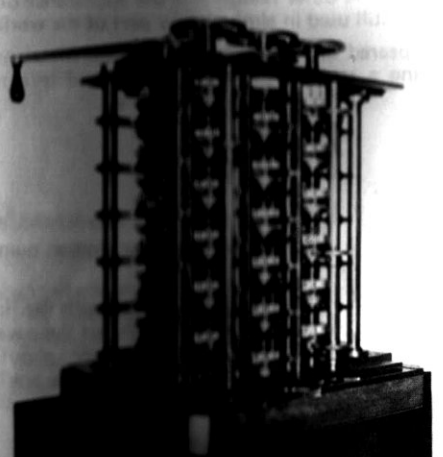
One would hardly expect that a loom to weave cloth would appear in the historical background of today's mighty computers, but it does. In 1801, Joseph Jacquard, a Frenchman, developed an automatic weaving loom. He punched into cards on paper tape the operating instructions needed to control the beautiful and complex patterns to be woven by the loom. Though this was not a calculating device, his brainchild resulted in the punched computer cards that store information fed into modern electronic computers.

Jacquard should have written the same message on his loom that is printed on many of today's computer cards—"Do not fold, spindle, or mutilate"—for angry weavers burst into his home and destroyed the loom. They were afraid that the machine would put them out of work. Jacquard was nearly killed, but later, when his invention brought prosperity to the town, he was hailed as a hero.

Charles Babbage

The first real computers were never built—except in the mind of a grumpy mathematics professor named Charles Babbage. Like computer people today, he loved problems and puzzles. Among other things, he invented the speedometer and a machine for playing tick-tack-toe.

Babbage worked for nearly 35 years on the "engines", as he called them, that would solve complex mathematical problems. But Babbage was born 130 years too soon. The craftsmen of that time could not produce the precise parts he needed to make his calculator work. He died a failure, but is still generally accepted as "the father of the computer".



Man's first digital computer, the "Difference Engine" built by Charles Babbage in 1823.

Herman Hollerith

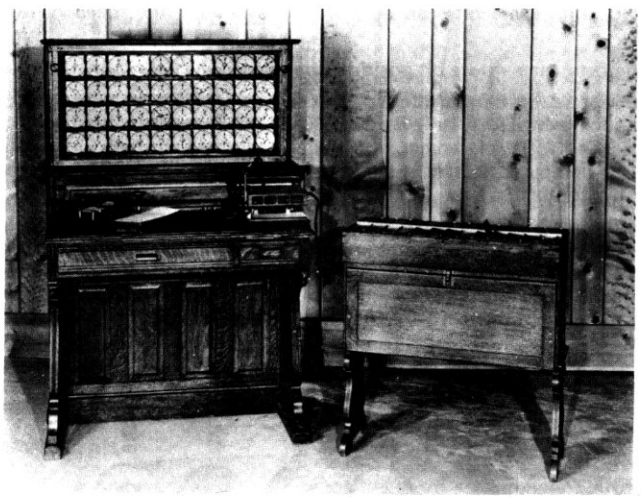
It is said that necessity is the mother of invention. And in 1880, "necessity" was the counting of the people of the United States by the Census Bureau.

The time it was taking to sort, count and tabulate the information by pencil and paper alarmed a 19-year-old employee of the department named Herman Hollerith. It took seven-and-one-half years to complete the 1880 census. Hollerith reasoned that with the nation rapidly approaching fifty million people, the 1890 census would not be tabulated before the next one would come due ten years later, as the Constitution demands.

Hollerith got busy and developed a machine which was used for the census of 1890. It reduced the time required to process the information by five years!

Hollerith's Electric Tabulating System used punched cards similar to the ones used on Jacquard's loom. Each card had 240 separate squares, and each square had a special meaning, such as a person's age, his occupation or education. After the holes were punched into the card by hand, they were fed into the machine. Fine sensing wires found the location of the holes, then "read", tabulated and sorted the information very quickly.

This was the first practical use of a digital computer. The basic principle of Hollerith's punchcard calculating machine is used in today's complex computers.



Herman Hollerith's 1890 Census Machine. It contained many operating prinicples used in present-day data processing systems.

THE RECENT PAST

Great changes took place in the world and especially the United States after 1890. Cars, airplanes, radio and television were about to enter the scene. If we were to grow and develop, we needed calculating machines to help us.

An actual mechanical computer was built in 1915 which helped out in a military way in World War I. It was difficult to manufacture and maintain so it never came into popular use.

Dr. Vannevar Bush

In the early 1930's, Dr. Vannevar Bush constructed the first general-purpose computer. This model was hand-operated and had no electrical parts.

In 1935 Dr. Bush began constructing a much faster and more accurate computer that used electrical connections. During World War II it was used to help soldiers figure the distance that large artillery weapons and anti-aircraft guns had to be raised in order for a shell to hit its target.

Professor Howard Aiken

A major advance in electronic computers was made by Professor Howard Aiken of Harvard University. His machine consisted of 78 adding machines and desk calculators. It was controlled by a large roll of punched paper similar to that used by a player-piano.

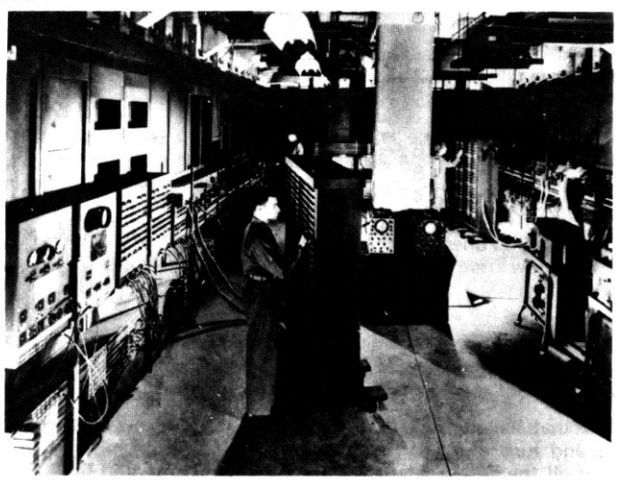
J. Presper Eckert and Dr. John Mauchly

Plans for the first all-electronic computer were completed in 1943 by J. Presper Eckert and Dr. John Mauchly. It took them two years just to solder together the 500,000 connections for the 18,000 vacuum tubes in the computer.

Called ENIAC, its first working assignment was to solve a problem in nuclear physics. In two weeks ENIAC had the answer, and of that time only two hours were spent in actual problem solving. It would have taken one man 100 years to solve the problem without ENIAC's help!

ENIAC labored for the government from 1947 to 1955 solving problems of weather predictions, ballistics and nuclear explosions.

Since that time, the ability, speed and reliability of automatic, electronic computers has increased millions of times over. And yet, comparing the computer of today, to what is in store for tomorrow, is much like comparing the Red Baron's tri-wing Fokker with a modern jetliner.



ENIAC, the first all-electronic digital computer. It was built in 1946 and could perform 5,000 additions per second.

THE ARITHMETIC OF ELECTRONIC COMPUTERS

Remember we mentioned how the computer understands only two numbers, one and zero? In computer language it's called the "binary code".

The system is simple, but before we explain it, let's briefly review the decimal system. As you know, the column that a number is in gives it a special value. Located in the right hand column, it has what we might call "face value"—a 3 has a value of three. But when we move it to the left one column, and add a zero to the right (to make sure we know that column is empty) it increases in value ten times. Each time it is moved one column to the left, it increases ten times.

1000's	100's	10's	1's	
			3	= 3 ones
		3	0	= 3 tens
	3	0	0	= 3 hundreds
3	0	0	0	= 3 thousands

In the binary system, each time a number is moved one place to the left, its value is multiplied by two, or in other words, doubled.

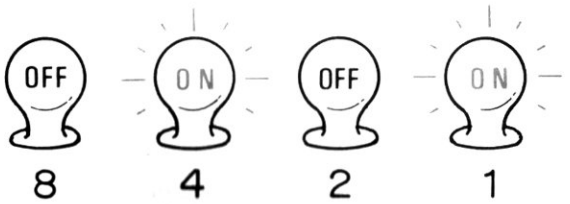
16's	8's	4's	2's	1's	
0	0	0	1	1	= 3
1	1	1	1	0	= 30

In the first line we have taken one 2 and one 1 = 3.

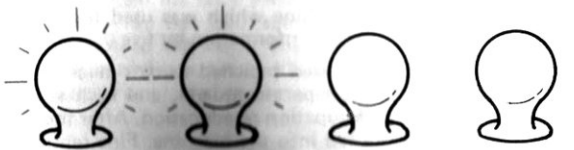
In the second line, we have one 16
one 8
one 4
one 2
(and no ones) 0
30

You know the computer understands only two possible conditions. When there is an electrical pulse, it is "on" or "1". When there is no electrical pulse it is "off" or "0".

Now let's assume that there are four electric light bulbs in a row that will receive these electrical pulses and turn on or off. In this way any decimal number from 0 to 15 can be represented. If all the bulbs were off, the binary number would be 0000 (or decimal number 0). If all of the bulbs were on, the binary number would be 1111 or decimal number 15.



The binary number here is 0101, or decimal number 5.



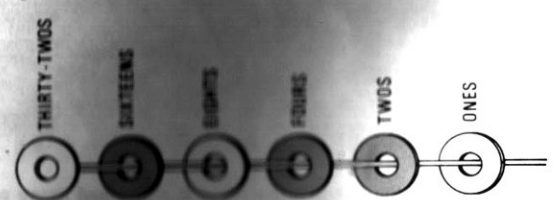
What binary number do these light bulbs represent?

In the computer system, these bits of information (represented by "lighted lamps") are called **bits**, for binary digits. When a component or circuit is "on" it is a "**1**" bit; "off" it is "0" bit. These bits can be activated at almost the speed of light—trillions per second.

For larger numbers, many more bit positions are needed than are shown here.

Bits can also represent letters of the alphabet just as numbers do when you use them to write a code such as where A is 1, B is 2, C is 3, etc. Binary numbers can also represent signs such as $ or %. The placement of the bits, as in the light bulb illustration, makes it possible for the computer to handle almost any type and amount of information. Computers may hold trillions of bits.

Circuits where these bits are stored, are not the size of light bulbs. Some are microscopic spots. Some "circuits" are called cores (magnetic cores) and are about the size of a period. Millions of these are threaded on thin criss-crossed wires similar to a tennis racket. When electricity runs through the wire, the cores can be magnetized to represent zeros or ones. Look at this string of cores.



Each shaded core represents a magnetized core, a "one". What number does this string of cores represent?

The electronic brain doesn't multiply and divide as we do. What it does is add and subtract—but with lightning speed. For example, the computer works the problem 4 x 4 by adding 4 + 4 + 4 + 4 and comes up with 16. (The binary number is 10000.)

Subtraction is addition in reverse, and division is subtracting over and over again.

Even the most difficult mathematical problems can be broken down into adding, subtracting, multiplying and dividing. The computer breaks it down to either addition or subtraction.

HE LANGUAGE OF COMPUTERS

In our day-to-day lives, we use a series of short-cuts. We say "OK" for "that is all right". We write "Blvd." for Boulevard, and so on and on.

The computer, too, uses a system of symbols and abbreviations to shorten the binary numbers that must be used.

More recently "macro-instructions" have been added. That sets off a whole series of instructions. In other words, instead of a list of perhaps 23 separate orders for processing and preparing bills to be sent out to customers, the macro-instructions would include all of them in one "word".

There are several different computer languages. COBOL (Common Business Oriented Language) was inspired by the Department of Defense as a language that would link all computers. These languages have helped simplify communications between man and the machine.

INSIDE THE ELECTRONIC BRAIN

The computer works very much the same as you do when you solve a problem.

Let's say that there's a ball game on September 14th that you'd like very much to go to. If it's a school day, you won't be able to go. You check a calendar and find out that you have the day free. Next you might wonder if you have enough money for a ticket. If not, you can't go. But then, maybe you could get it by mowing the neighbor's lawn.

Now if you get the money, will you be able to get a ride there with Uncle Harry? He passes the ballpark on his way to work. If not, you figure that you could take the bus. But you know your mother will insist you get a ride back other than on the bus.

Well, you figure, you could meet Uncle Harry at his office after work if he would stay late and drive you home.

Now if all of these things work out, on the afternoon of September 14th, you'll be in the stands eating hot dogs and cheering for the home team.

The steps the computer uses to solve a problem is called a **program**. This is where you bring together all the separate facts and figures called **data** that you need to use for that problem. That is the computer's **input**.

The Processing Unit

This is where the actual work is done. Most of the work is arithmetic, but this unit also assembles, classifies, compares and summarizes information. "Logical" circuits substitute binary 1 and 0 for "yes" and "no".

Inside the computer thousands of wires connect its different parts like train tracks criss-crossing the country. And like railroad switches, electronic computer switches clear the way and set up direct lines of travel from one location to another so that the "train" (electronic pulses) can find whatever it needs.

Output

When the computer has finished its problem-solving, it must translate the answer back into a form that human beings can understand.

Output devices can be, to name a few, typewriters of special design or other types of printers; television-type screens; or pre-recorded voices such as you hear when a telephone operator says "that number has been changed to 869-9507." In this case, telephone people recorded long lists of numbers and words. The computer instructed the audio device to put out each word and number in that specific order when the old number was dialed.

This design model of a modern computer shows magnetic memory disks on the left, output printers in front, and several output display screens that look like television sets.

PUTTING IT ALL TOGETHER

Now let's have a look at how all of these separate computer parts work.

Input

Information (data) is received in the computer in different ways. Sometimes it's punched cards or paper. Sometimes it's magnetic tape, disks or drums.

Some computers can read special magnetized "inks" like those on bank checks. Others can "read" by sensing light and dark patterns. Still others can "hear", that is, respond to sound waves.

But however information is received, it all must be converted into "current on"—yes, or binary number 1; or "current off"—no, or binary number 0.

This person is using a light pen and a typewriter-type device for input. Output appears on the screen.

Internal Storage or Memory

Most computer systems have two memory sections. One holds permanent instructions which are often needed. The second memory section holds data and instructions that are required for the one particular program.

You might compare it to the way you have stored your home telephone number in your permanent memory bank. But when you get a theater number from information, you store it in a temporary bank.

Next you organize the data so that you can go through each step of the program. This is handled by the **control unit** of the computer.

The main part of the computer, the **central processor,** handles the actual calculations. Sometimes you need to store something in your memory for later use in figuring out your problem. The computer has its **memory,** too.

At the end you come up with a solution, or **output.**

Briefly, then, this is the way it works.

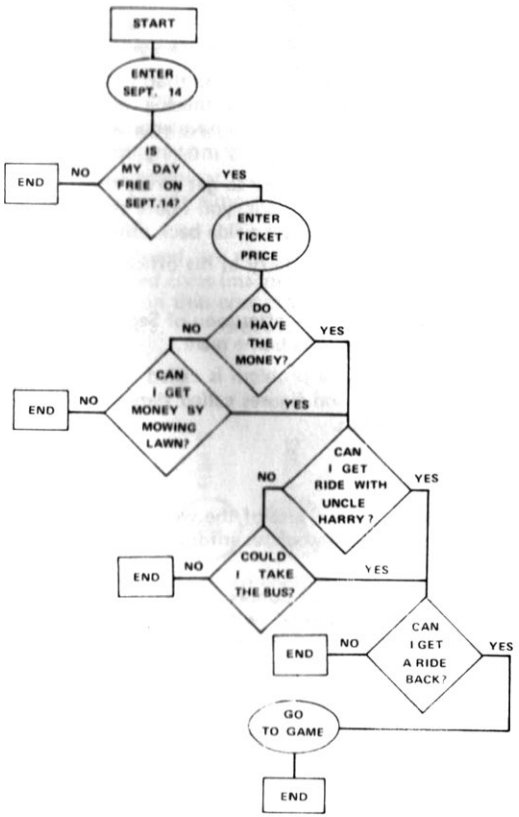
The programmer analyzes the problem. He or she reduces it to a series of small steps which the computer can use in solving the problem. The steps are coded into a language that the computer can understand.

This input (data) is put into **input.** The processor works out the problem, stores information it has been ordered to store in **memory,** and puts out the solution in a way humans can understand in **output.**

The flow chart

Computer programmers work with flow charts that show the steps the computer must take in working out the problems. The designs they use have different meanings. The rectangle, for instance, indicates processing or directions; the diamond shape means decision.

The following flow chart shows how a programmer might set up your problem for a computer to solve.



Actually, flow charts are not usually this simple. Consider what must be done when designing a new airplane. The shape of the wings and tail section, the jet engines, the electrical circuits, the safety devices, the fuel lines—all of these and more present complicated problems that the computer will help solve. The flow chart in this case might run into dozens of pages for each problem.

CAREERS IN COMPUTERS

Remember how the people smashed Jacquard's weaving loom because they felt it would put so many of them out of work? Well, that's the way many people felt about computers. And it's true that the electronic brain has taken over many jobs that were once handled by people. But the computer has brought about many times more job and career opportunities.

It takes many, many people to make and operate computers. They must work very carefully because if they make a mistake in these jobs, the computers' answers will be wrong.

People in the computer field must work very carefully. If they make a mistake in their jobs, the computer's answers will be wrong.

Following is a brief description of some of the jobs that center on computers.

Design Engineer

The outside of a computer may look as simple as a locker, but inside are many parts that must all work together. Each part is planned by a design engineer. For example, one engineer plans the electrical parts showing where each and every wire and bolt should go. Then he builds a test model that must work perfectly before the company will begin making the electrical part of the computer.

Mechanical Engineer and Production Engineer

The production engineer uses the design engineer's plan to figure out a way to assemble the computer parts. He works closely with a mechanical engineer, the person who knows all about machines and how they work. Together they work out and write out careful instructions for putting all the parts together.

Production Foreman

This person explains to the workers the written instructions for putting the computer together. The foreman checks to see that it is assembled correctly and that each part is put together in the amount of time that was planned for the job.

Systems Analyst

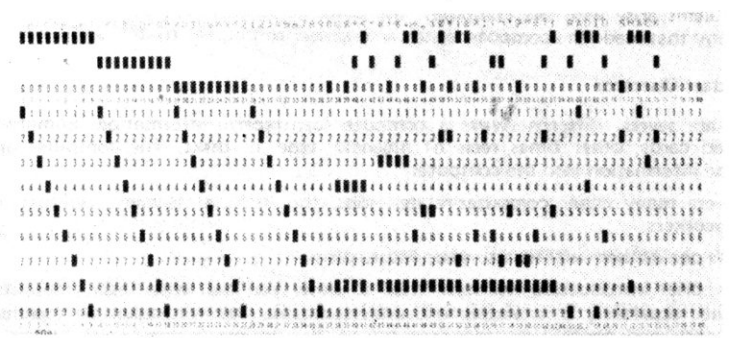
This analyst talks to people in a company to find out how they handle certain jobs. He then works out ways that the jobs could be done better and faster and cheaper with the help of a computer. This helps the sales people.

Programmer

The programmer is the brain behind the computer. He or she writes out a set of instructions called a program for each job. The programmer is also able to put these instructions in the special computer language (we call it "machine language").

Keypunch Operator

The keypunch operator uses a machine that is like a typewriter. But instead of typing words, the machine punches holes in small cards. These cards then contain the code that gives the computer the information it needs to do its job.



Computer punch card with alphabet, numbers and special symbols (read across vertically, from left to right). Combinations of holes represent letters and symbols to the computer.

The Assembler

The worker puts the computer pieces together. Some of the parts are so small that the assembler must work while looking at them through a microscope.

Electrical Technician

This skilled worker tests all the electrical parts of a computer to see that they work. If something goes wrong, he or she must be able to check the computer against a blueprint —the drawing that shows everything inside a computer and all its parts. This specially-trained technician must also be able to take the machine apart and put it back together again if need be.

Quality Assurance Technicians

This employee tests, with special instruments, the material—wires, metals and plastics—that the computer is made of. If something is wrong, this person reports that different materials will have to be used.

Quality Assurance Engineer

This person tests every part of a computer to make sure it will work when it is put together. Only when he or she says it is all right will the company go ahead and build it.

Packaging Engineer

This engineer designs a different package for every kind of computer. Before beginning, he or she must find out if the computer is going to be sent by truck or train, airplane or boat.The package is designed to guarantee that the computer will reach the customer undamaged.

Technical Writer and Technical Illustrator

These people use pictures and words for the instruction book that tells the customers how the computers work. The words and drawings must be clear. The book is similar to the one you're reading now.

Customer Engineer

If problems arise with the computer, the customer sends out a call for help. Then the company that made the computer sends an engineer to find the trouble and fix it.

Computer Operator

There are several different ways a computer can receive information. Sometimes it's punched cards; other times reels of magnetic tape, or disks. The computer operator puts the information into the computer.

There are many other computer-related jobs, too, such as teachers, salespeople, and office workers.

Perhaps one of them will fit into your future plans.

In this brief introduction, we have tried to show you that when each computer unit is studied separately, it is simple and understandable. And yet, taken all together with all its parts and possibilities, it is so complex that no one person could understand all there is to know about these great, exciting electronic brains.

We hope the projects in this kit will fire your enthusiasm, for you and the computer are already rushing headlong, hand in hand, into the future.

Your Digital Computer Kit is not a complex piece of equipment that can handle extremely difficult problems—it really only works with "on" and "off"—"yes" and "no". And it's all done with simple switching.

You do **the programming** (as you wire up the experiment).

The **input** is provided by moving the Switches (S1 through S10).

The **processor** is all the wiring and switching.

The **output** is the lighted panel with questions and answers printed on the slide-in sheets.

And that's what a computer is.

So now get into building the Kit and then try a few programs.

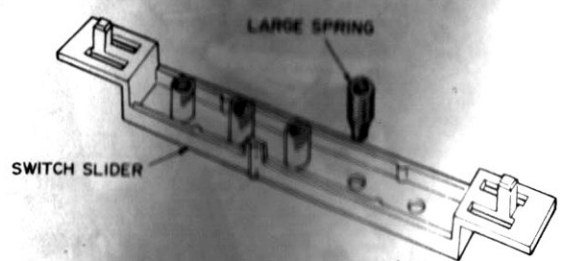
By now you must be anxious to start building your **Digital Computer Kit,** so let's get going. The best way to become familiar with all the parts is to lay them out on a clean surface and learn their names. The Parts List will give you the correct names and how many of each is required. Check your parts carefully against the Parts List — make sure you've got everything.

You'll also need 2 size "C" Batteries. We recommend Radio Shack's Alkaline Enercell, Catalog Number 23-551 for extra long life.

Got everything? Ready to go?

ASSEMBLING THE SWITCHES

Figure 1

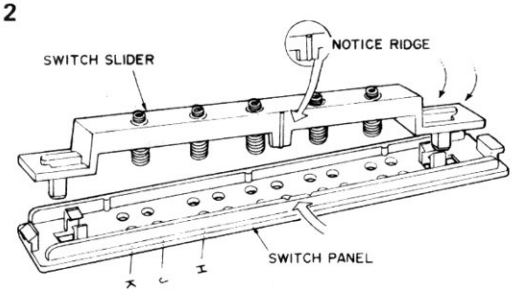


Position one of the Switch Sliders as shown. Insert 5 Large Springs into the holes. Start the springs in by hand, then press them all the way in using a #1 Phillips screw driver.
Be sure to press the springs all the way down — they must fit tight.

This Switch Slider is a part of a Slide Switch Assembly.
There are 10 Slide Switch Assemblies but you'll only have to assemble 9 — one has been pre-assembled and mounted in the Case as an example. (See Figure 4.)

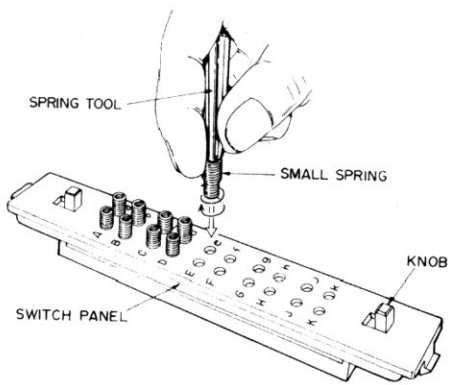
Press Springs into the other 8 Switch Sliders.

Figure 2



Notice on one side of the Switch Slider, you'll see a ridge. Hold the Switch Slider with the ridge toward you and place one of the Switch Panels under it as shown. The holes on the under side of the Switch Panel will be labeled K,J,H ... as illustrated. Snap the Switch Slider into the Switch Panel, starting with the end on your right (see arrows on drawing). Then press the other end into place, check that the Switch Slider can be moved back and forth smoothly. Assemble the other 8.

Figure 3



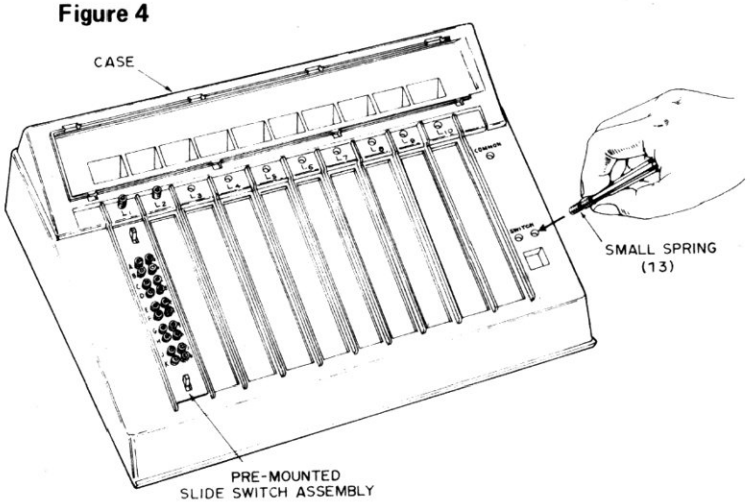
To complete the Slide Switch Assembly, hold it upright in front of you as shown. Pull the Slide Switch toward the right when you are looking at it as shown in Figure 3. You will notice that every other set of holes in the Switch Panel will be partially blocked by one of the Springs inside the Assembly. Install Small Springs in the holes in the Switch Panel, beginning with the first set of holes (A—a). Use the Spring Tool to push and twist the springs fully into the holes. Be sure the springs are firmly seated. Proceed with C—c, E—e . ..... every other pair of holes.

Move the Slide Switch in the other direction and install Small Springs in the remaining holes. When you've completed the assembly, move the Switch Slider back and forth. Look through the space between the Switch Slider and the Switch Panel. Check to make sure that the large springs slide smoothly and make contact between a pair of Small Springs in each position of the Switch.

Repeat this assembly procedure for each of the remaining 8 Slide Switch Assemblies. When all nine are completed, lay them aside for a while — you'll install them later.

INSTALLING SPRINGS IN THE CASE

Figure 4

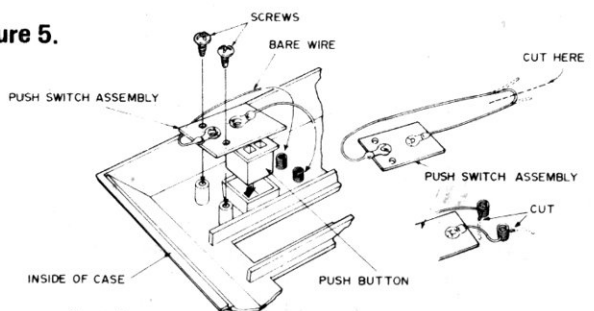


Position the Case as shown.

Use the Spring Tool to push and twist 13 Small Springs into the Case. Install 10 springs across the top of the Case into the holes marked L1—L10, then put one spring into the hole below the word COMMON and finally two springs into the holes below the word SWITCH.

INSTALLING THE PUSH SWITCH ASSEMBLY

Figure 5.



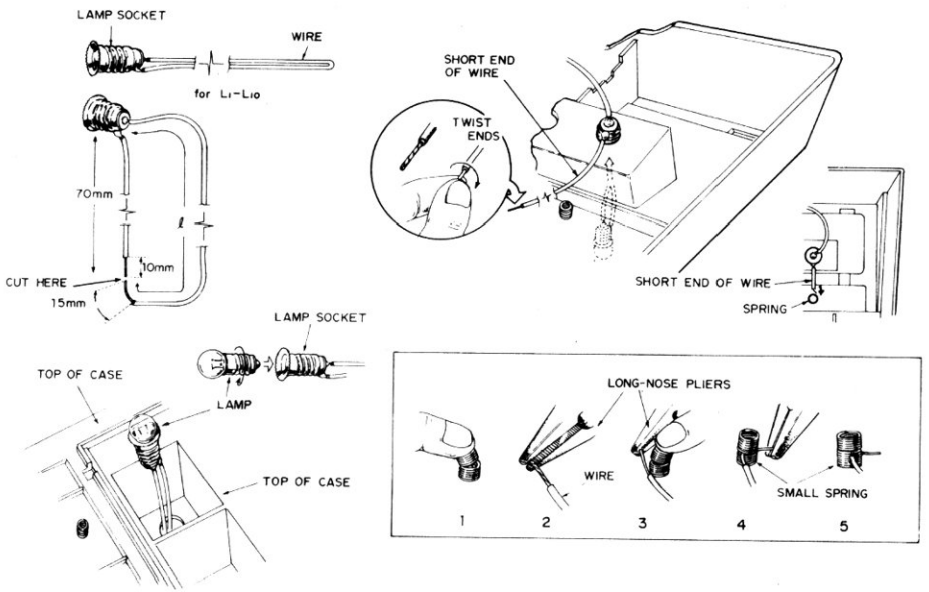
Turn the Case over—face down.

Figure 5 shows the inside lower left corner of the Case. Drop the Push Button into the square hole—be sure it goes in like the drawing.

Arrange the Push Switch Assembly as illustrated, then cut the wire in two. Position the Push Switch Assembly over the Push Button and secure it with 2 screws as shown. Fasten the Bare Wire ends into the SWITCH Springs. (To fasten a wire into a spring, see the detail in Figure 6.) Put the Push Switch Assembly's top wire into the spring on the right and the bottom wire into the spring on the left. Clip off excess wire ends as illustrated.

PREPARING AND INSTALLING THE LAMP SOCKETS

Figure 6.



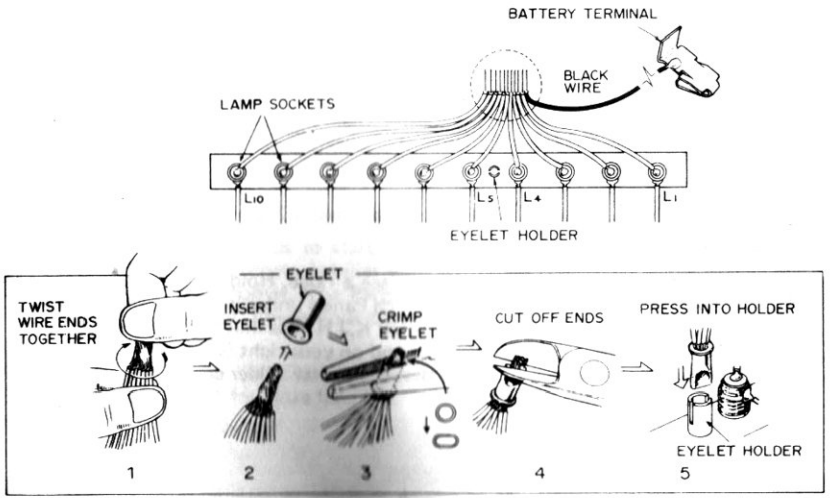
Pick up a Lamp Socket. Look at the upper left of Figure 6. Cut the wire 70 mm from the Sockets. Carefully remove about 10 mm of insulation from the short end and about 15mm of insulation from the long end. Repeat this procedure for each of the Lamp Sockets. Now screw a Lamp into each of the Lamp Sockets as illustrated.

Position Case right-side up. Refer to the lower left of Figure 6. Install one of the Lamp Sockets in the top of the Case as shown. Start the Lamp Socket into the hole, then grasp its Base on the underside of the Case. Pull and move the Socket while carefully pressing the Lamp from the top. Mount all the Lamp Sockets this way.

CAUTION: Be careful not to break the Lamp.

Turn the Case over, face down. Prepare one (any one) of the **short** Lamp Socket wires by twisting the end as shown at the upper right of Figure 6. Attach this short wires end into the nearest small spring inside the Case as illustrated. To attach a wire to a spring, follow the simple steps shown in Figure 6. Repeat this procedure untill you've hooked up all 10 of the Lamp Socket **short** wires.

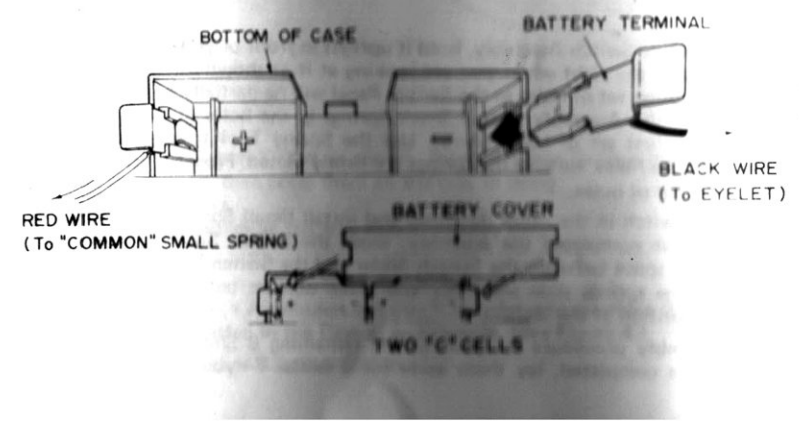
Figure 7.



Gather up all 10 of the Lamp Socket **long** wire bare ends along with the bare end of the Battery Terminal Black wire. Twist all these bare wire ends together and press into the Eyelet. When all wires are neatly inside the Eyelet, use a pair of pliers to squeeze the Eyelet together. Cut off excess wire ends. Push the crimped Eyelet (with wire ends) into the black plastic Eyelet Holder inside back of the Case.

INSTALLING BATTERY TERMINALS

Figure 8.



Slide the Battery Terminal **with the Black wire** into the slot on the right (near the "–" mark). Slide the Battery Terminal **with the red wire** into the slot on the left (near the "+" mark). Press the Terminals down as far as they will go. Connect the bare end of the Red wire into the Small Spring under COMMON (above Push Switch Assembly).

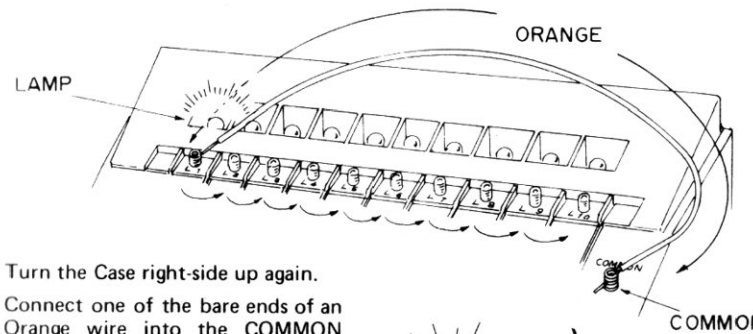
Install two size "C" Batteries into the Battery Compartment. Be sure you install them correctly as shown (the flat end is the "–" end). We recommend that you use long life Batteries, such as Radio Shack's Alkaline Enercell, Catalog Number 23-551. Snap the Battery Cover on top of the Battery Compartment.

O.K., let's take a Construction Break and test the electrical circuits.

TESTING THE LAMPS

Figure 9.

TESTING LAMPS

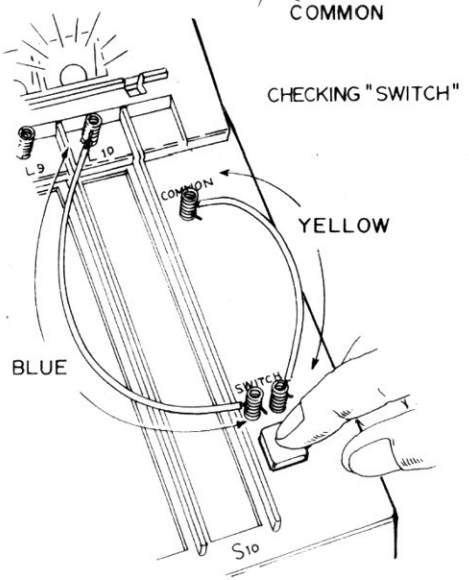


Turn the Case right-side up again.

Connect one of the bare ends of an Orange wire into the COMMON Spring. Extend the other end to touch L1 Spring. The Lamp above L1 should light up. If it doesn't, check that the Lamp is screwed all the way in and that wiring connections are tight. Repeat this test for each of the Lamps (L2–L10). Disconnect the wire.

TESTING THE PUSH-BUTTON SWITCH

Figure 10.



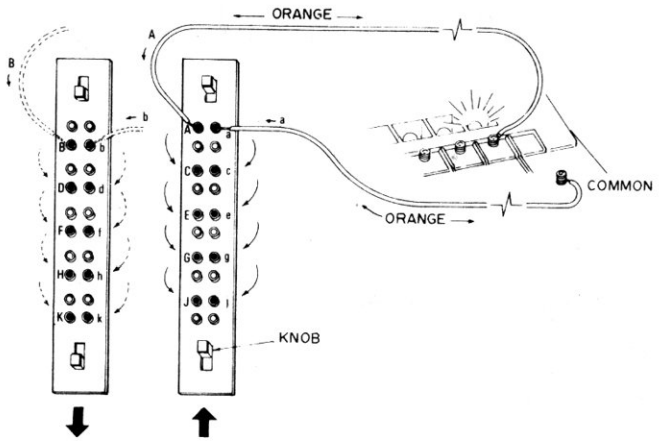
Now check the SWITCH.

Connect a Yellow wire between COMMON and one side of the SWITCH. Connect a Blue wire between the other side of the SWITCH and one of the Lamp Springs. L10 will be handy. Press the SWITCH – L10 Lamp should light. This means the SWITCH is working properly. Disconnect the wires.

TESTING THE SLIDE SWITCHES

Figure 11.

S1-S10 CHECKING EACH SLIDE SWITCH ASSEMBLY



You'll need to test each of the Slide Switch Assemblies. This will take a bit of time but you'll benefit two ways—first, it will build your confidence in wiring programs and second, you'll learn how the Switches operate.

Connect one end of an Orange wire to the COMMON Spring. Leave the other end free to use for this test. Connect one end of another Orange wire to L10 Lamp Spring.

Take one of the Slide Switch Assemblies and lay it on your work surface. Push the Knob up as shown on the right in Figure 11. Pick up the two free wire ends. Touch the bare end of one wire to Spring "A" and the bare end of the other wire to Spring "a". The Lamp should light. (Make sure the Slide Switch Assembly's Knob is pushed all the way up.) Now check "C" and "c" — continue and check every **second** pair of Springs E–e; G–g; J–j.

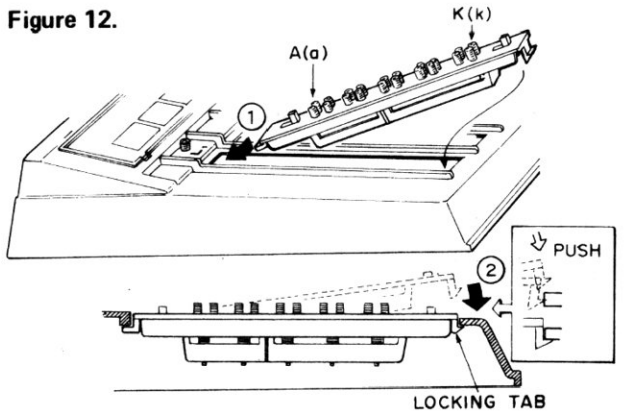
On the same Slide Switch Assembly, pull the Knob down as shown on the left in Figure 11. This time, touch the bare end of one wire to "B" and the other to "b". The Lamp should light. (Make sure the Slide Switch Assembly's Knob is pulled all the way down.) Now check "D" and "d"—continue and check every **second** pair of Springs F–f; H–h; K–k.

Repeat this procedure to test each of the Slide Switch Assemblies, including the one already mounted in the Case. If any of the Slide Switch Assemblies fail these tests, check that the Large Springs inside the Switch Slider move freely and make contact between the Small Springs in the Switch Panel when the Knob is moved up or down. Also, see that all the Small Springs in the Switch Panel are straight and pushed down snugly.

O.K., now that we know everything is working right, we can get ready to install the Assemblies into the Case.

FINAL ASSEMBLY

Figure 12.

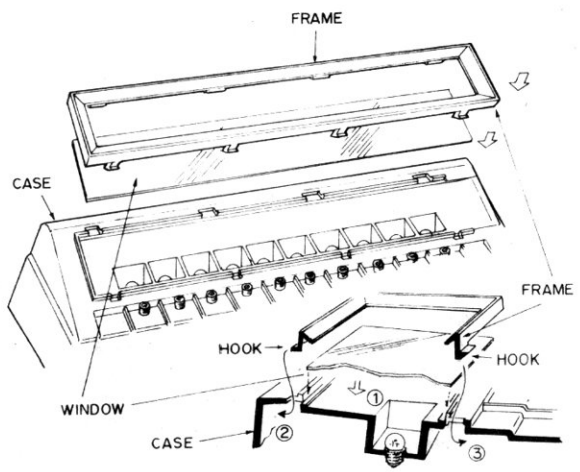


We'll show you how we installed Slide Switch Assembly S1 and you can do the remaining Switch Assemblies. Position the Case, face up, in front of you. As you install the Slide Switch Assemblies, arrange them so that every other one is Blue. Take a Slide Switch Assembly and start it into the Case with "A"–"a" Springs at the top as shown. (1) Slide it all the way up then push the bottom down (2) to snap the plastic locking tab into the Case.

Note: if for any reason you need to remove a Slide Switch Assembly, simply press the plastic locking tab (from beneath the Case) toward the top of the Case and push the Assembly out from the bottom.

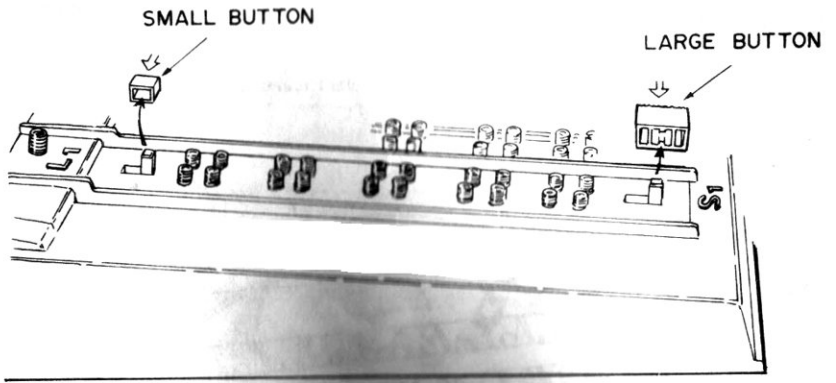
It's beginning to look pretty good, isn't it? Just a few more things and you'll be finished.

Figure 13.



Lay the Window over the Lamps as illustrated. Place the Frame over the Window and snap the Hooks into the Case as shown.

Figure 14.



Press a Small Button onto the top Knob and a Large Button onto the bottom Knob on each of the 10 Slide Switch Assemblies, S1–S10.

This completes construction and testing of your **Digital Computer Kit.** Now you are ready to have some real fun and learn more about computers as you work the programs we've given you in the remainder of this Manual.

At the end of some of the experiment, we have given you the Solution - when you see Solution in red, stop and try the experiment - figure out the answer for yourself. No fair peeking!

NOTES:

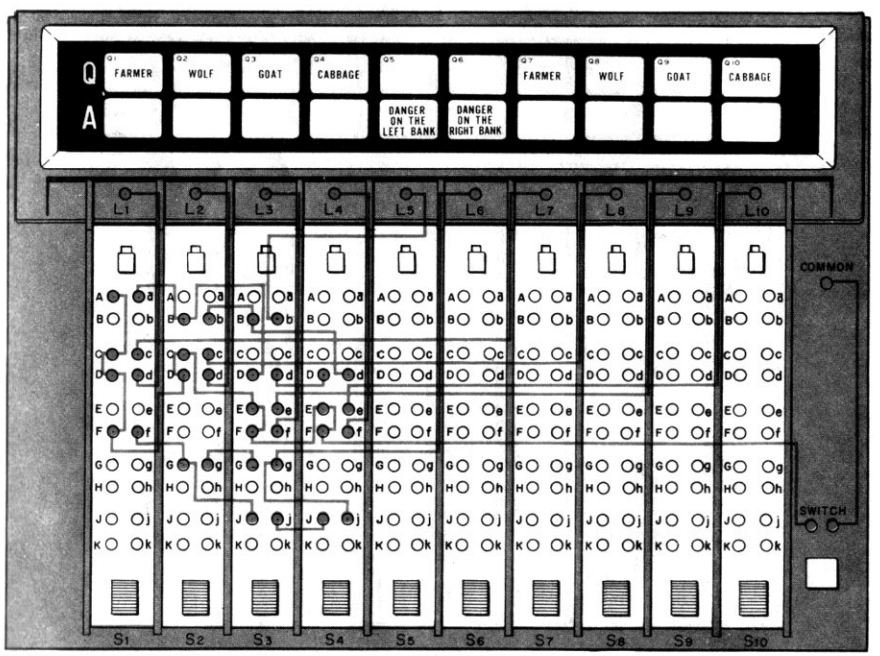
PROGRAM 1: CROSSING THE RIVER

Connect wires as shown. Here's a brain-teaser about a Farmer, a Wolf, a Sheep and a Cabbage which have to cross a river in a boat which can carry only the Farmer plus one item (or animal). If the wrong combination is left unguarded, you know what happens—the Wolf would love to eat the Sheep. . . or this Sheep has a craving for Cabbage! See if you can figure out the combination which avoids danger, using a minimum number of boat trips.

Operation: Switches S1 through S4 represent the Farmer, Wolf, Goat and Cabbage. Switch down equals that one on left bank; switch up equals the right bank. Press SWITCH Button to check program action. Now, remember, only 2 in the boat! Try it. If you make a mistake, "DANGER ON THE LEFT or RIGHT BANK" will light up. No fair peeking!

Solution: 1st trip: Farmer & Goat. 2nd: Farmer returns. 3rd: Farmer & Wolf. 4th: Farmer & Goat return. 5th: Farmer & Cabbage. 6th: Farmer returns. 7th: Farmer & Goat.

NOTES:



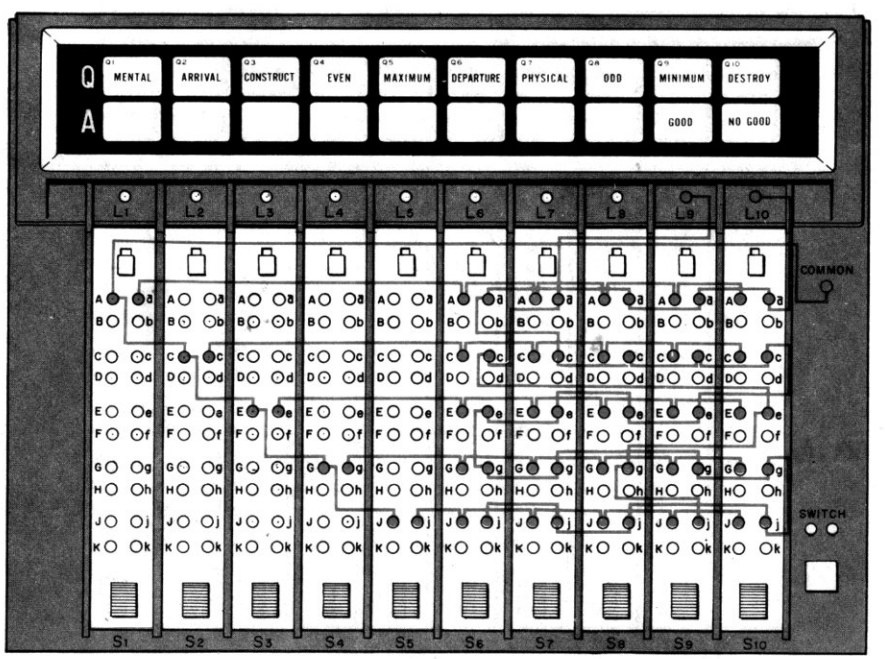
PROGRAM 2: SYMMETRICAL WORDS (1)

Connect the wires as shown. Now you can test your knowledge of some words by putting your Computer to work. It can tell you if two words you select relate to one another. This can be very interesting and it provides you and your friends a fun-way to increase your vocabulary. Simply select any one of the first 5 words (Q1-Q5) by pushing up on the corresponding Slide Switches (S1-S5), then you decide which word in the last 5 (Q6-Q10) relates to it. Push up on the corresponding Slide Switch (S6-S10). If your decision was correct, "GOOD" will light up, but if you're wrong, "NO GOOD" will illuminate.

Caution: Always select one of the first 5 words and then one of the last 5—never two of the same group.

Solution: Q1 relates to Q7, Q2 to Q6, Q3 to Q10, Q4 to Q8 and Q5 to Q9.

NOTES:



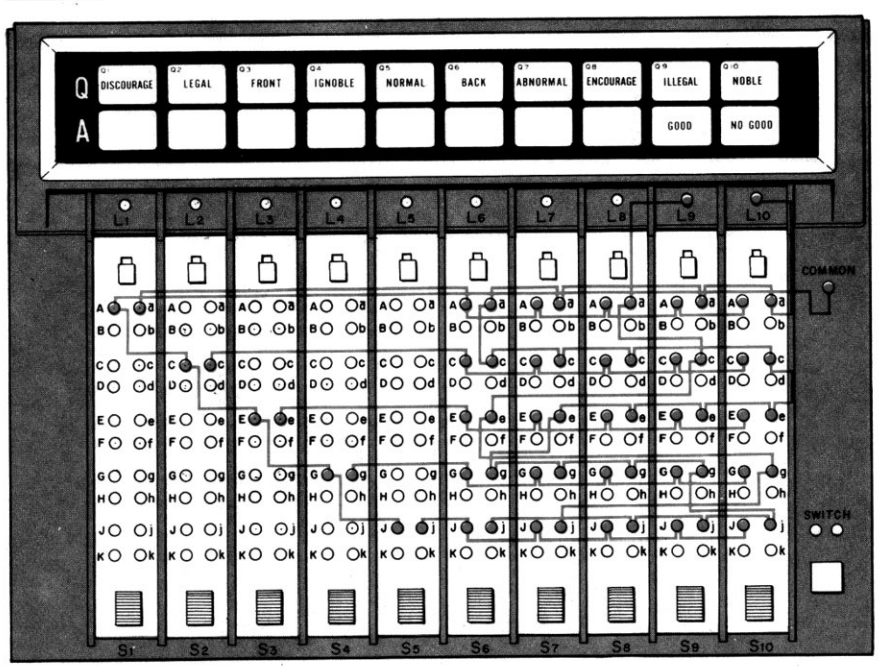
PROGRAM 3: SYMMETRICAL WORDS (2)

Connect wires as shown. Here's another mental exercise you can enjoy with the assistance of your Computer. You might want to ask a friend to join in and have some fun with you. Pretend this is a quiz show and you are the Master of Ceremonies. Select one of the first 5 words by pushing up any one of the Slide Switches (S1-S5), then have your friend make his selection. He can select a word he thinks has the opposite meaning by pushing up the corresponding Slide Switch (S6-S10). The Computer will evaluate his decision and indicate "GOOD" if he is correct. But, if he is wrong, it will show "NO GOOD".

Caution: As in the previous program, select one of the first 5 words and then one of the last 5—never two from the same group.

Solution: Q1 is an antonym of Q8, Q2 of Q9, Q3 of Q6, Q4 of Q10 and Q5 of Q7.

NOTES:

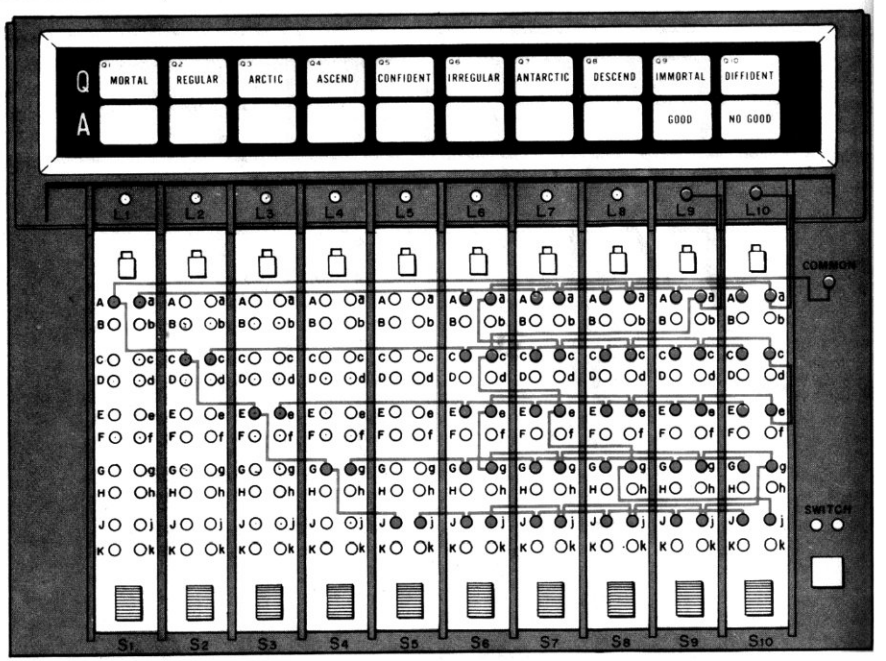


PROGRAM 4: SYMMETRICAL WORDS (3)

Connect wires as shown. You may want to continue your quiz show by including this new program. Since this program includes some slightly more difficult words, it might be fun to call in an older brother or sister and maybe even Mom or Dad or some other adult. You can run the show with your Computer! (Be careful that they don't see your solutions below.) Get the whole family involved! Everyone can applaud for a correct answer and boo at a wrong one. Once again, the Computer will check their answers and indicate "GOOD" when it's correct and "NO GOOD" when it's wrong. Remember, select one word from the first 5 and one from the last 5—never two words from the same group.

Solution: Q1 is an antonym of Q9, Q2 of Q6, Q3 of Q7, Q4 of Q8 and Q5 of Q10.

NOTES:

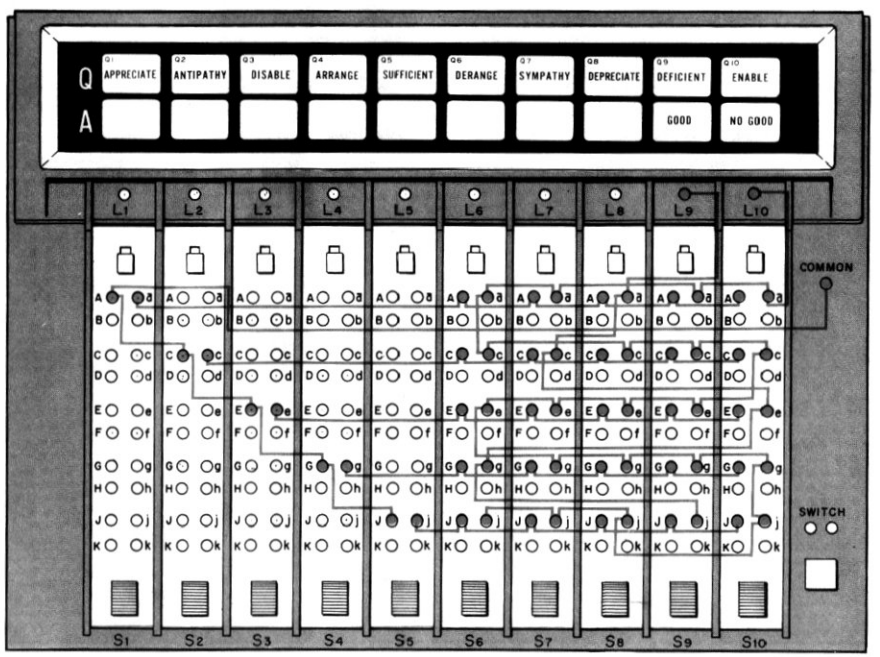


PROGRAM 5: SYMMETRICAL WORDS (4)

Connect wires as shown. Again, this program deals with words that are opposite in meaning. This time let's ask the Computer what the correct word is. First, select any one of the first 5 words as you've done in the past several programs, then without looking at the words in the second group (you might want to temporarily cover up the words), ask the Computer—is it Q6, Q7, Q8, Q9 or Q10? You do this by pushing up and down, one at a time S6 through S10. The Computer will indicate "GOOD" for the correct one and "NO GOOD" for all others. Get your dictionary handy and check the answers—see if your Computer is as smart as it's supposed to be. Always select a word from the 1st 5 words to compare with a word from the last 5 words.

Solution: Q1 is an antonym of Q8, Q2 of Q7, Q3 of Q10, Q4 of Q6 and Q5 of Q9.

NOTES:



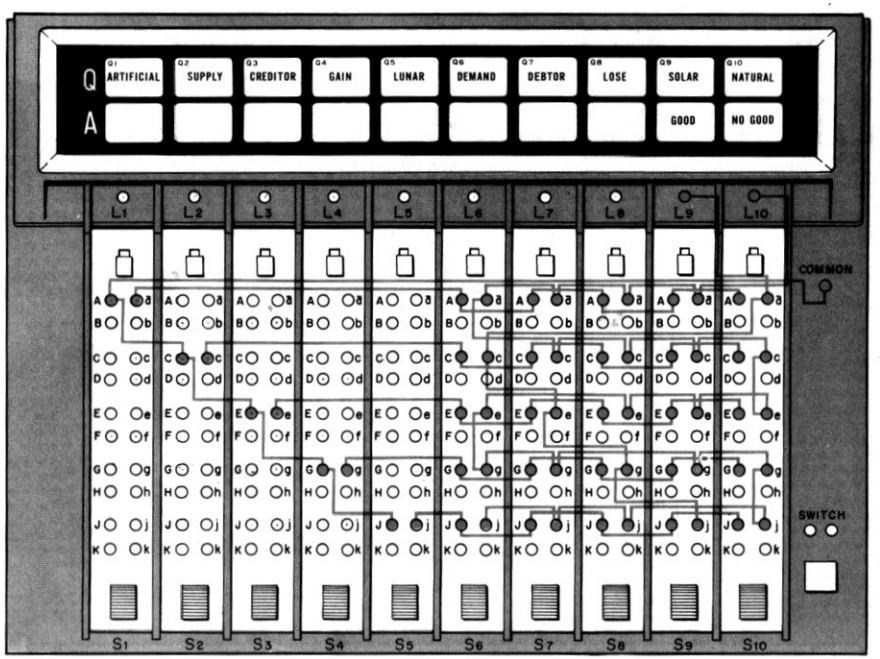
PROGRAM 6: SYMMETRICAL WORDS (5)

Connect wires as shown. This and the preceding four programs are what is called in Computer Language, **Combinational Logic.** In other words, you must select the correct combination to get a "GOOD" answer from the Computer. The next seven programs in this Manual use **Sequential Logic**—but we'll discuss that later.

Choose any one word from the 1st group (Q1 through Q5) and push up the corresponding Slide Switch (S1 through S5). Now, notice how Combinational Logic is employed when you (or your friends) select a word with an opposite meaning from the 2nd group (Q6 through Q10). If you enter the right combination, you'll get a correct answer and the Computer will indicate "GOOD".

Solution: Q1 is an antonym of Q10, Q2 of Q6, Q3 of Q7, Q4 of Q8 and Q5 of Q9.

NOTES:



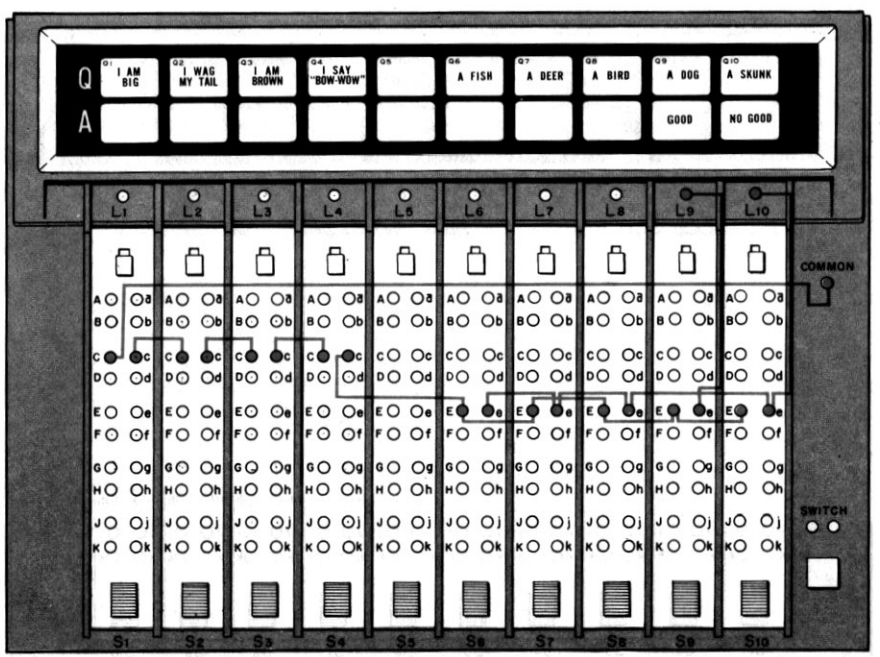
PROGRAM 7: WHO AM I ? (1)

Connect wires as shown. This program is a little different from the ones you have done before. Here, the question is asked, "Who am I?" You are given four hints (I AM BIG, I WAG MY TAIL, I AM BROWN, I SAY "BOW-WOW"). Read each hint, one at a time, and push up the Slide Switch under it (S1 through S4)—leave them pushed up. When you have the first four Slide Switches pushed up, look over the answers (A FISH, A DEER, A BIRD, A DOG, A SKUNK) then push up the Slide Switch under the one you think it is (S6 through S10). If your decision was correct, "GOOD" will light up, but if you're wrong, "NO GOOD" will illuminate.

Caution: Be sure to pull each **answer** Slide Switch (S6 through S10) back down before pushing up another. If you fail to do this, you will only confuse the Computer and it'll give you an inaccurate answer.

Solution: Q9—A DOG.

NOTES:

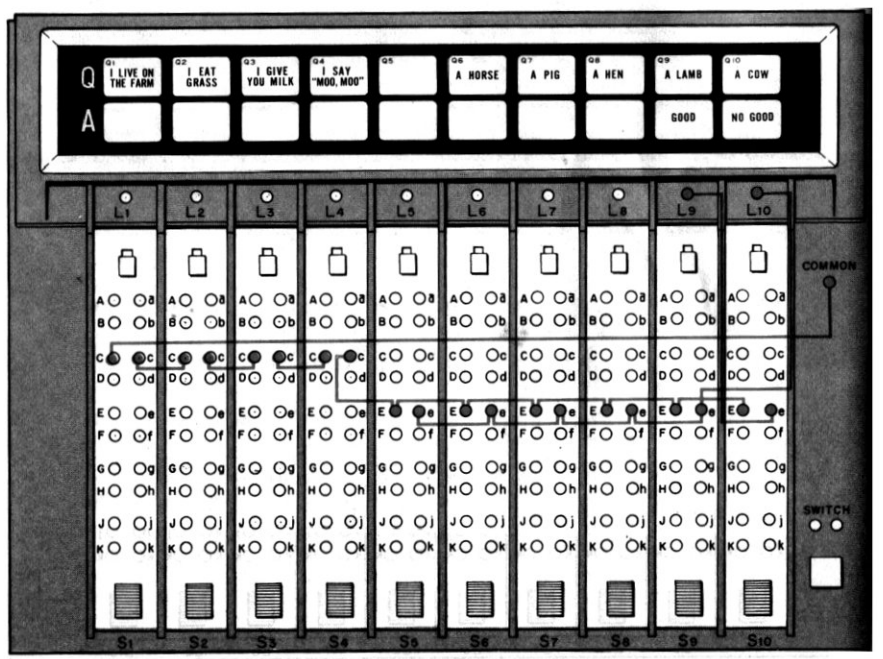


PROGRAM 8: WHO AM I ? (2)

Connect wires as shown. Anyone familiar with farm life would have very little trouble guessing the correct answer from the hints given but whether you know anything about farms or not, you can still get a correct answer with your Computer. Just enter the hints (I LIVE ON THE FARM, I EAT GRASS, I GIVE YOU MILK, I SAY "MOO-MOO") by pushing up the Slide Switch (S1 through S4) under each one—leave them pushed up. OK, what's your choice—A HORSE, A PIG, A HEN, A LAMB or A COW? Push up the Slide Switch under your choice (S6 through S10). If you guessed right, "GOOD" will light up but if you were wrong, "NO GOOD" will illuminate. Remember, you must choose only one at a time—push each **answer** Slide Switch (S6 through S10) back down before you enter (push up) another.

Solution: Q10—A COW.

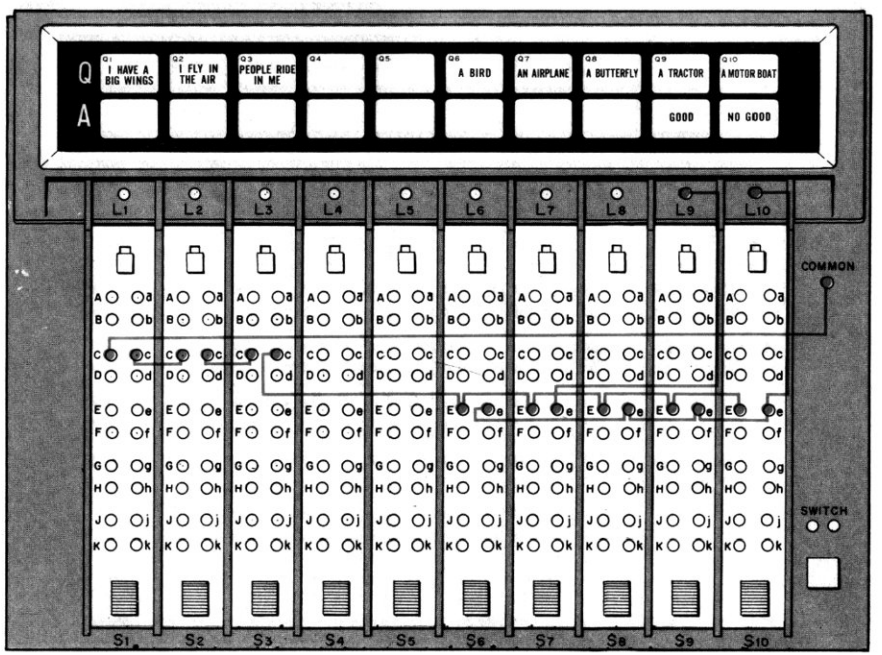
NOTES:



PROGRAM 9: WHAT AM I ? (1)

Connect wires as shown. Now here's an item that everyone, now-a-days, could guess very quickly with the hints given but pretend you lived a hundred years or so ago. . .(and, let's assume you had your Computer with you). With the first two hints (S1 & S2 pushed up), you might have considered the answer to be A BIRD or maybe A BUTTERFLY but when you got that third hint—PEOPLE RIDE IN ME, you'd probably think "this is impossible!" But, you entered the hint anyway (pushed up S3). Then you entered one answer at a time by pushing up Slide Switches S6 through S10, one at a time (remembering to pull each one back down before entering another). You noted that when you entered A BIRD, A BUTTERFLY, A TRACTOR or A MOTORBOAT, you got a "NO GOOD" light, but when you entered AN AIRPLANE, you saw the "GOOD" light illuminate. So, long before its invention, you knew about the Airplane. It's amazing, what you can do with a Computer! As you continue to work with Computers, you'll discover some really neat ways to find out the unknown by entering certain hints into a Computer (this is called **Programming a Computer**).

NOTES:



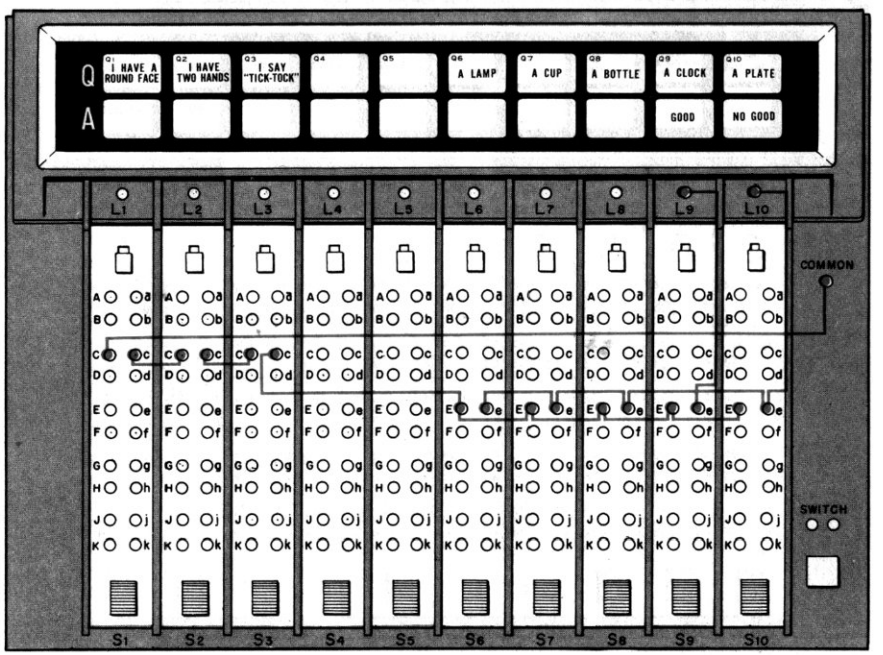
PROGRAM 10: WHAT AM I ? (2)

Connect wires as shown. With this program, we continue to talk about familiar items. We do this so you can concentrate on learning the principles of Computer Programming and thus learn more about what a Computer can do. Enter the Hints (I HAVE A ROUND FACE, I HAVE TWO HANDS and I SAY "TICK-TOCK") by pushing Slide Switches S1 through S3 up—leave them up.

Now, you or one of your friends guess the answer. Is it A LAMP, A CUP, A BOTTLE, A CLOCK or A PLATE? Then, push up on the Slide Switch (S6 through S10) under the answer chosen.

Solution: Of course you know it; Q9—A CLOCK.

NOTES:

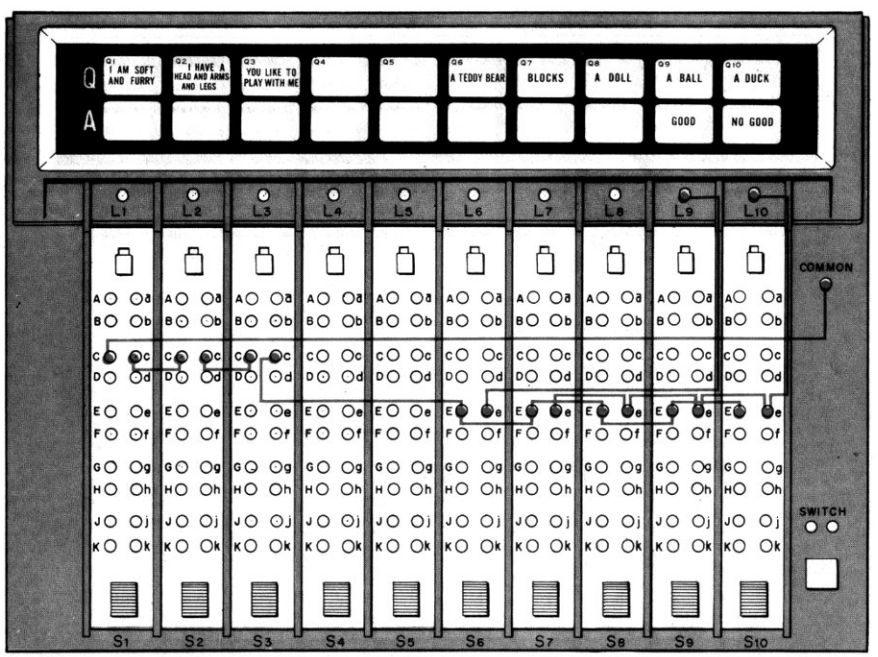


PROGRAM 11: WHAT AM I ? (3)

Connect wires as shown. This is another fun program but while you have fun, you are learning some important principles. For example, look closely at the wiring arrangement for the three hints across S1, S2 and S3. You remember, during construction, when you pushed a Slide Switch up, a Large Spring (inside) would complete the circuit between two Small Springs (one on each side)? When you push up S1, "C" and "c" are connected. The same is true for S2 and S3. Notice how power is brought from COMMON to S1? Push up S1 and power is connected to S2. Push up S2 and the power connection goes to S3. Each switch is pushed up in sequence (one after the other). This is called "Sequential Logic". Now, give the three hints by pushing up on S1 through S3, then guess "WHAT AM I?" by pushing up one of the Slide Switches (S6 through S10) for the answer you think is correct. "GOOD" will indicate a correct answer. "NO GOOD" will illuminate for a wrong answer.

Solution: Q6—A TEDDY BEAR.

NOTES:

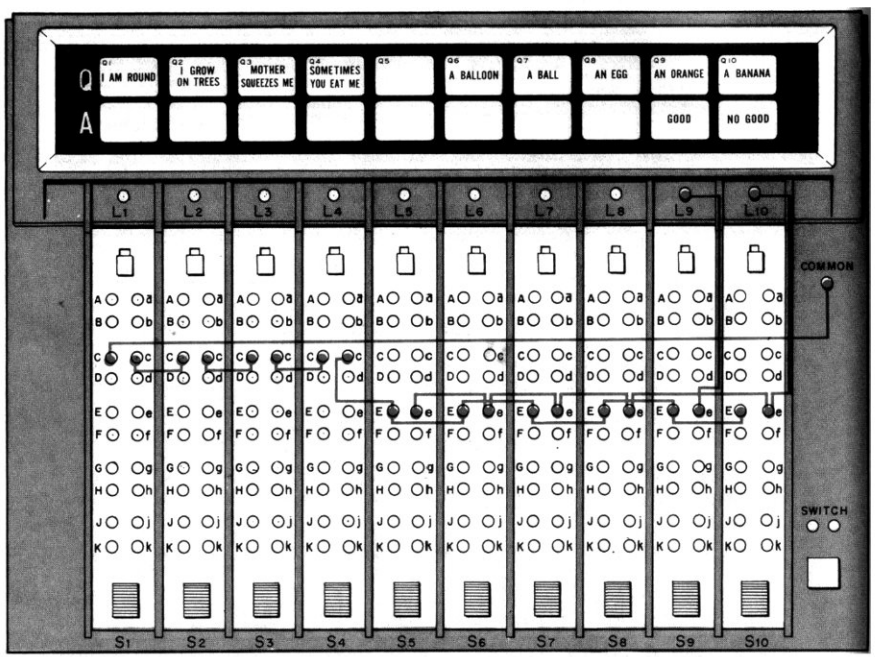


PROGRAM 12: WHAT AM I ? (4)

Connect wires as shown. Again, this program uses "Sequential Logic" when entering the hints into the Computer. From the Wiring Chart you can see that S1, S2, S3 and S4 must all be pushed up to complete the circuit from COMMON over to the answer group of Slide Switches (S6 through S10). The Computer must have all the facts—you can't get any answers until all four hints have been given (that is, S1 through S4 must be pushed up).
Call out the hints, one at a time, and push up the Slide Switch under it. Now, the Computer is ready to give the correct answer. You or one of your friends consider the hints carefully, then select which item you think answers the question "WHAT AM I?" If you are correct, the Computer will show "GOOD" but if you are wrong, you'll see "NO GOOD" light up.

Solution: Q9—AN ORANGE.

NOTES:

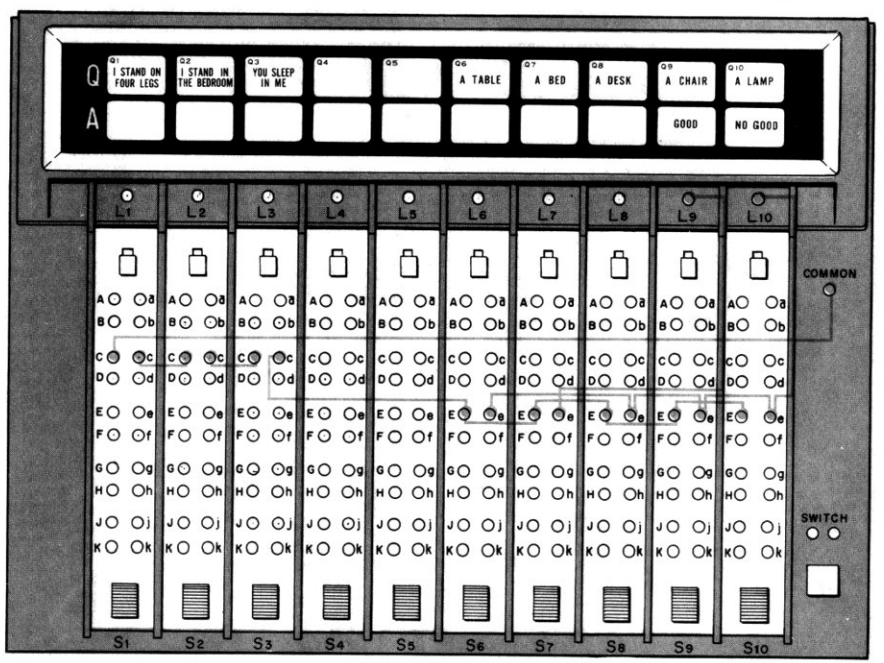


PROGRAM 13: WHAT AM I ? (5)

Connect wires as shown. Hey! This is great, isn't it? You are not only finding out some things a Computer can do but you're also learning **how it works.** You've probably already noticed, this is another "Sequential Logic" program—but let's look at something else. Follow the wire from the "GOOD" Lamp (L9) down to "e" on Slide Switch S7. Oops! We've already given away the secret. Guessing is over now—you already know what the correct answer will be. But just to be sure, let's go ahead and enter the hints by pushing up S1, S2 and S3 then you might read the hints to a friend and let him select one of the answers by pushing up one of the Slide Switches (S6 through S10). As before, "GOOD" will indicate a correct answer and "NO GOOD" a wrong one.

Solution: Q7—A BED.

NOTES:

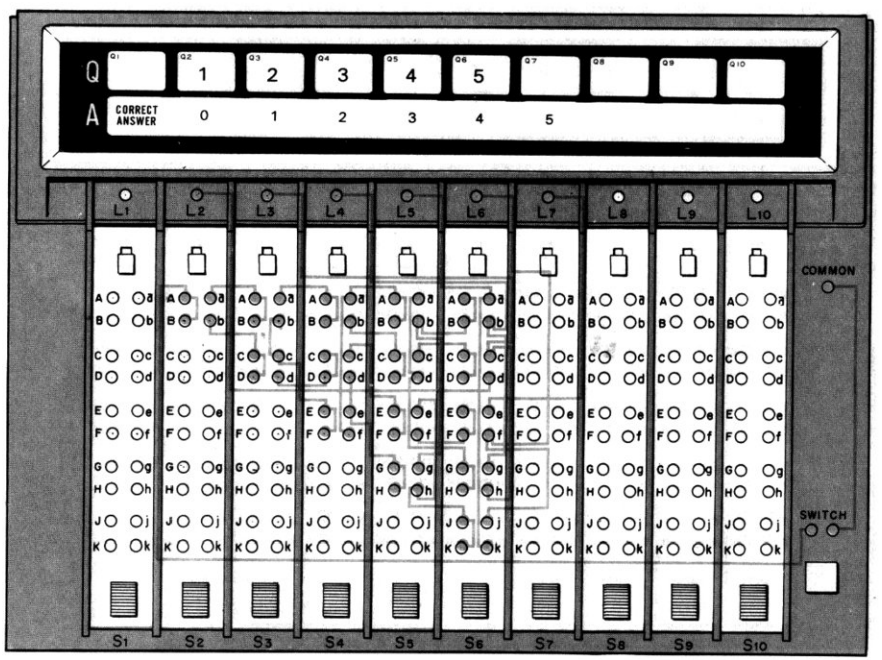


PROGRAM 14: QUESTION (1)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. What is the capital of Greece?
   A. Athens B. Bagdad
2. In order of state-hood, what number would Alaska be?
   A. No. 49 B. No. 45
3. What is the formal distance of a Marathon race?
   A. 4500 m B. 42195 m
4. What is the only opera composed by Beethoven?
   A. Fidelio B. Carmen
5. What do you call the president's residence in Washington D.C.?
   A. Diet B. White House

Solution: 1—A, 2—A, 3—B, 4—A, 5—B

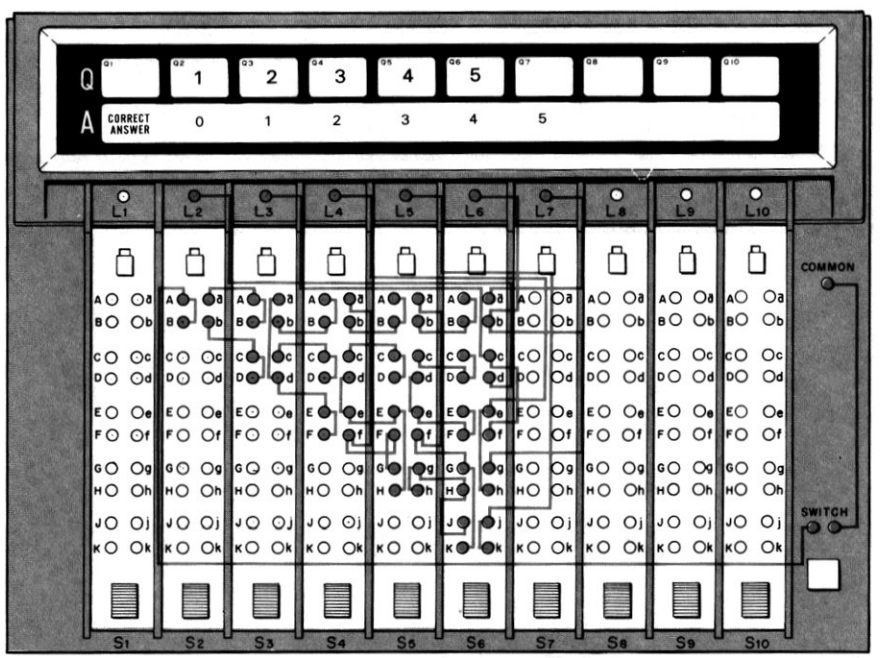


PROGRAM 15: QUESTION (2)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. How many pencils are in a gross?
   A. 256 B. 144
2. How many clubs are there in a half-a-set of golf clubs?
   A. 7 B. 12
3. What is the tenth letter of the alphabet?
   A. J B. K
4. What is the name of a salt lake about 400 meters below sea level?
   A. The Dead Sea B. Salt Lake
5. What is the number code used in most electronic computers?
   A. Decimal B. Binary

Solution: 1–B, 2–A, 3–A, 4–A, 5–B

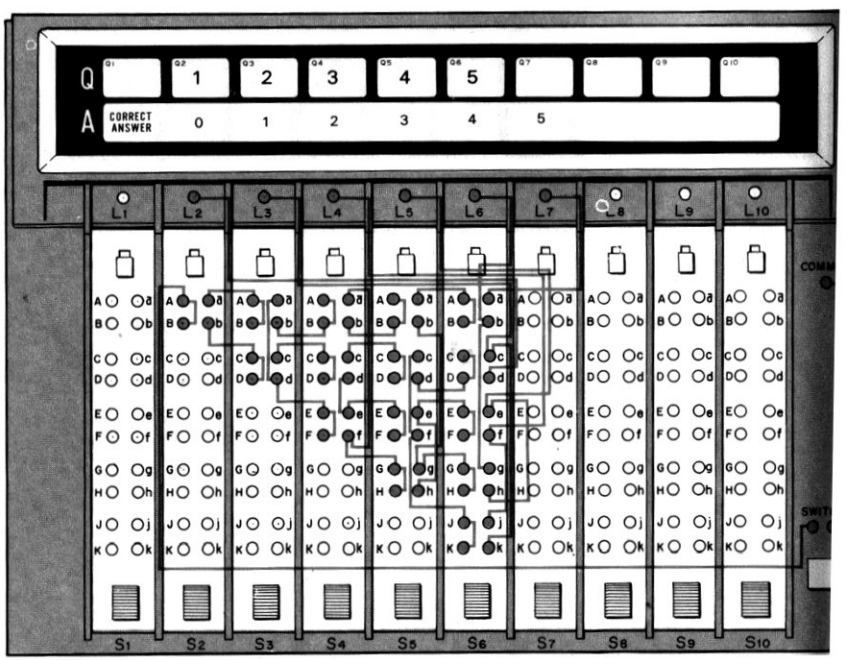


PROGRAM 16: QUESTION (3)

Connect wires as shown. You'll find the question's number in the "Q" line on the Compute Program Panel. Use the Slide Switch (S2 through S6) under the question's number to en answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B Answer all five questions (by positioning S2 through S6) then press the SWITCH Butt A number will light up in the "ANSWER" line on the Computer's Program Panel showi you how many correct answers you have.

1. The East River is on one side of Manhattan. What is on the other side?
   A. Tennessee River B. Hudson River
2. In order of sequence, what number was President Abraham Lincoln?
   A. Sixteenth B. Second
3. What is the capital of Switzerland?
   A. Berne B. Zurich
4. When did Columbus discover America?
   A. 1066 B. 1492
5. What game is similar to football?
   A. Baseball B. Soccer

Solution: 1–B, 2–A, 3–A, 4–B, 5–B

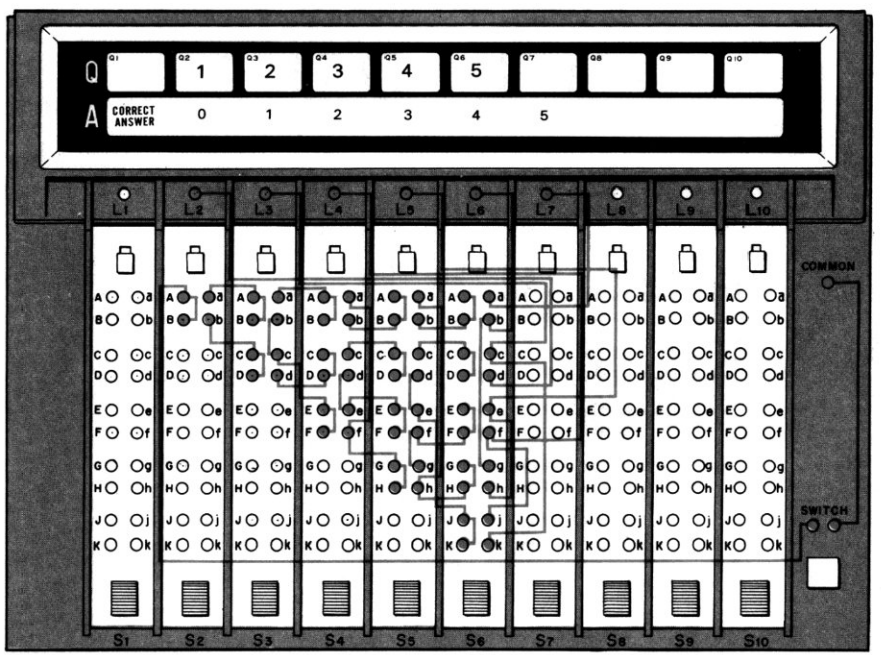


PROGRAM 17: QUESTION (4)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. Who was the famous painter connected with Tahiti Island?
   A. Van Gogh B. Gauguin
2. How far is the moon from the earth?
   A. 800,000 miles B. 240,000 miles
3. If we use the abbreviation EE when describing a camera, what do we mean?
   A. Electric eye B. Easy eye
4. How high is Mount Everest?
   A. 8,848 meters B. 6,820 meters
5. What is the approximate alcohol content of whiskey?
   A. 20% B. 40%

Solution: 1–B, 2–B, 3–A, 4–A, 5–B

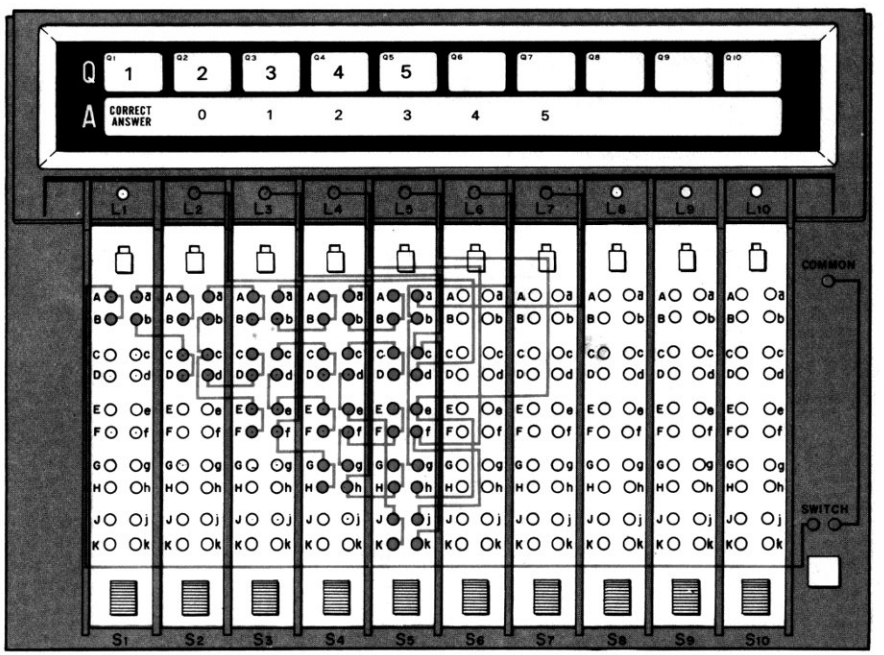


PROGRAM 18: QUESTION (5)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. The specific gravity of water reaches maximum at 4°C. What is its value?
   A. 0.1 B. 1.0
2. From what country did Christianity orginate?
   A. Egypt B. Israel
3. What is the approximate population of the United States?
   A. 220,000,000 B. 450,000,000
4. Who was the man whose life was saved from a flood in the Old Testament?
   A. Noah B. Adam
5. How many states were in the United States at the time of the Bicentennial?
   A. 51 B. 50

Solution: 1–B, 2–B, 3–A, 4–A, 5–B

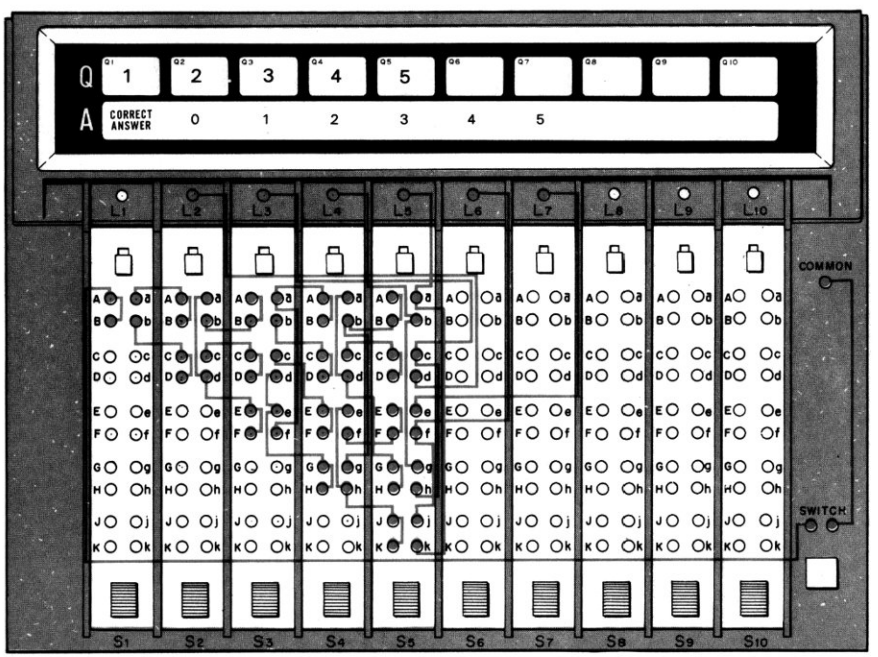


PROGRAM 19: QUESTION (6)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. Who was the author of "Uncle Tom's Cabin"?
   A. Mrs. Stowe B. Mrs. King
2. Who was the son of David that built a temple in Israel?
   A. Napoleon B. Solomon
3. What is the name of the national park with large canyons in the United States?
   A. Yellowstone B. Grand Canyon
4. How many days are in a week?
   A. 7 B. 5
5. Who has received credit for inventing the telephone?
   A. Morse B. Bell

Solution: 1–A, 2–B, 3–B, 4–A, 5–B

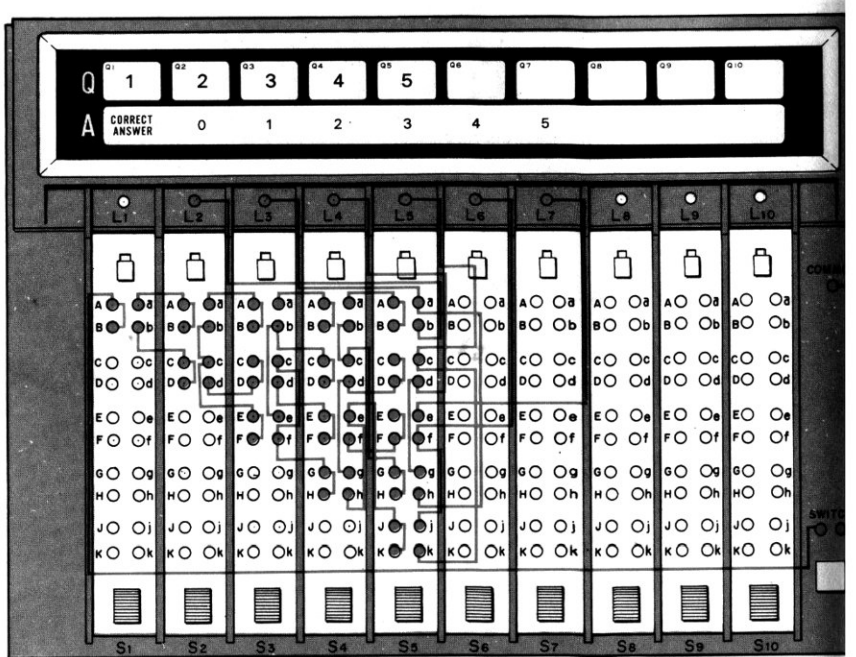


PROGRAM 20: QUESTION (7)

Connect wires as shown. You'll find the question's number in the "Q" line on the Compute Program Panel. Use the Slide Switch (S1 through S5) under the question's number to en answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B Answer all five questions (by positioning S1 through S5) then press the SWITCH Butt A number will light up in the "ANSWER" line on the Computer's Program Panel show you how many correct answers you have.

1. What is a protractor used for?
   A. To measure angles B. To measure time.
2. What is the name given to an electrical insulator such as air or glass?
   A. Non-conductor B. Gas
3. Upon incidence in a convex lens, where does light parallel to the axis go?
   A. Focal point B. Infinity
4. What is the symbol ♂ in biology?
   A. Male B. Female
5. What is the capital of Argentina?
   A. La Paz B. Buenos Aires

Solution: 1–A, 2–A, 3–A, 4–A, 5–B

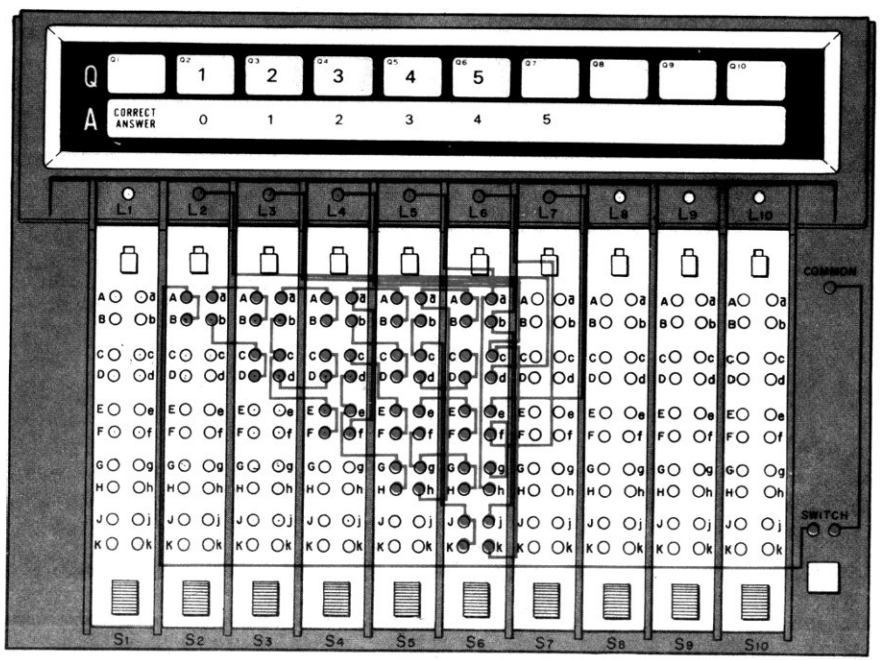


PROGRAM 21: QUESTION (8)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. How many hairs are on the head of an average human adult?
   A. One hundred thousand B. One million
2. What is the metro in Paris?
   A. Subway B. Tea house
3. What is mica used for?
   A. Electrical conductor B. Electrical insulator
4. What is the name of a port city north of the Suez Canal?
   A. Capetown B. Port Said
5. With what country do you associate the symbol of an olive branch?
   A. France B. Greece

Solution: 1–A, 2–A, 3–B, 4–B, 5–B

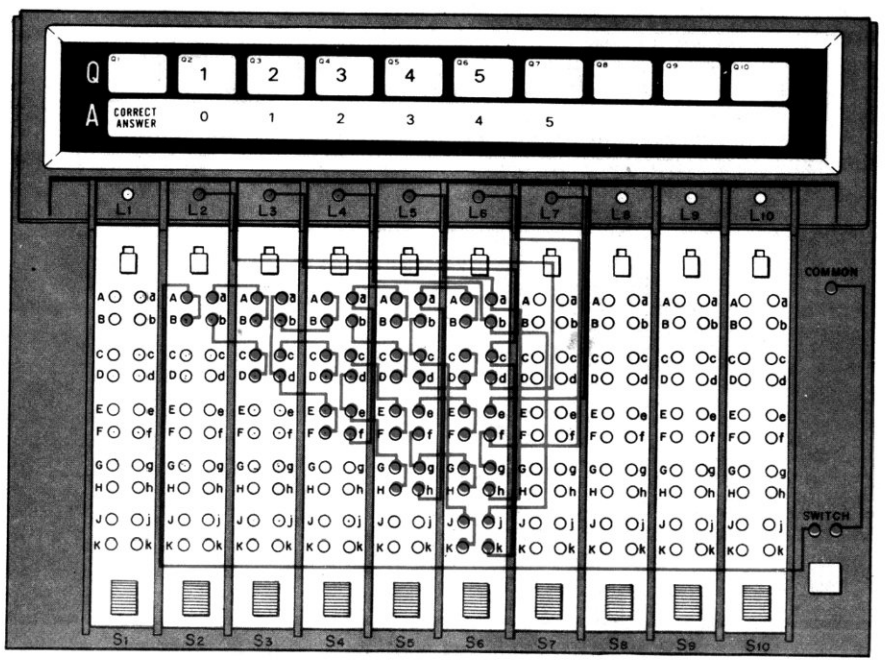


PROGRAM 22: QUESTION (9)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER " line on the Computer's Program Panel showing you how many correct answers you have.

1. An orchestra has three kinds of musical instruments: percussion, wind and what else?
   A. String B. Wood wind
2. Electrical solder is an alloy of what two metals?
   A. Silver and Copper B. Lead and Tin
3. How many players are on a basketball team?
   A. 9 B. 5
4. How many oxygen atoms are in ozone?
   A. 2 B. 3
5. What is the main religion in Pakistan?
   A. Buddism B. Islam

Solution: 1–A, 2–B, 3–B, 4–B, 5–B

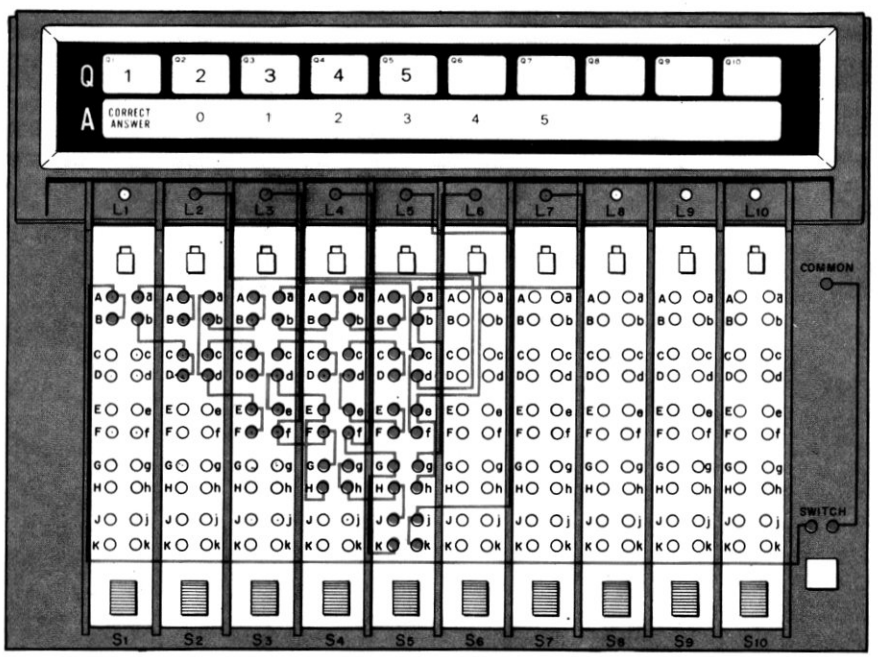


PROGRAM 23: QUESTION (10)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. What is a famous desert in Northern China?
   A. Sahara B. Gobi
2. The legislative branch of government in Great Britain is called?
   A. Parliament B. Congress
3. In what sport does "18 holes" mean "one-round"?
   A. Golf B. Bowling
4. What animal can run 110 km/h and is the fastest in the world?
   A. Cheetah B. Ostrich
5. What did some Greek soldiers hide in during the Trojan War?
   A. Tank B. Wooden horse

Solution: 1–B, 2–A, 3–A, 4–A, 5–B

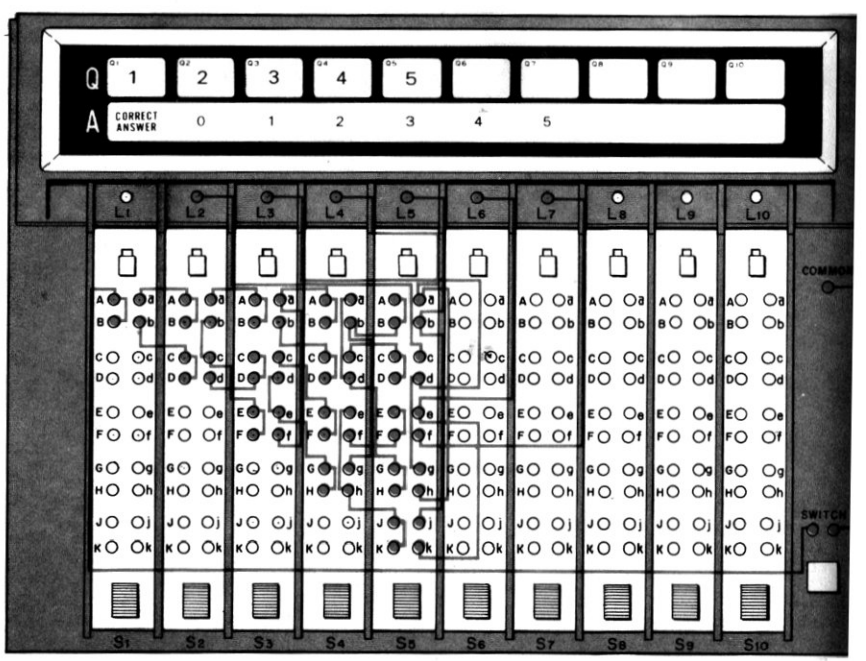


PROGRAM 24: QUESTION (11)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer Program Panel. Use the Slide Switch (S1 through S5) under the question's number to ent answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B Answer all five questions (by positioning S1 through S5) then press the SWITCH Butto A number will light up in the "ANSWER" line on the Computer's Program Panel showi you how many correct answers you have.

1. What is a unit of volume of liquid measure?
   A. Liter B. Centimeter
2. What protects electrical circuits from current overload and is usually made out of le and tin alloy?
   A. Fuse B. Solder
3. What is the name of the swimming race in which one swims in four different styles?
   A. 400-meter relay B. Individual medley
4. What is the name of the music about the American Flag composed by Sousa?
   A. Stars and Stripes B. Double-Headed Eagle
5. What do you call the 4th string on a violin?
   A. G string B. H string

Solution: 1–A, 2–A, 3–B, 4–A, 5–A

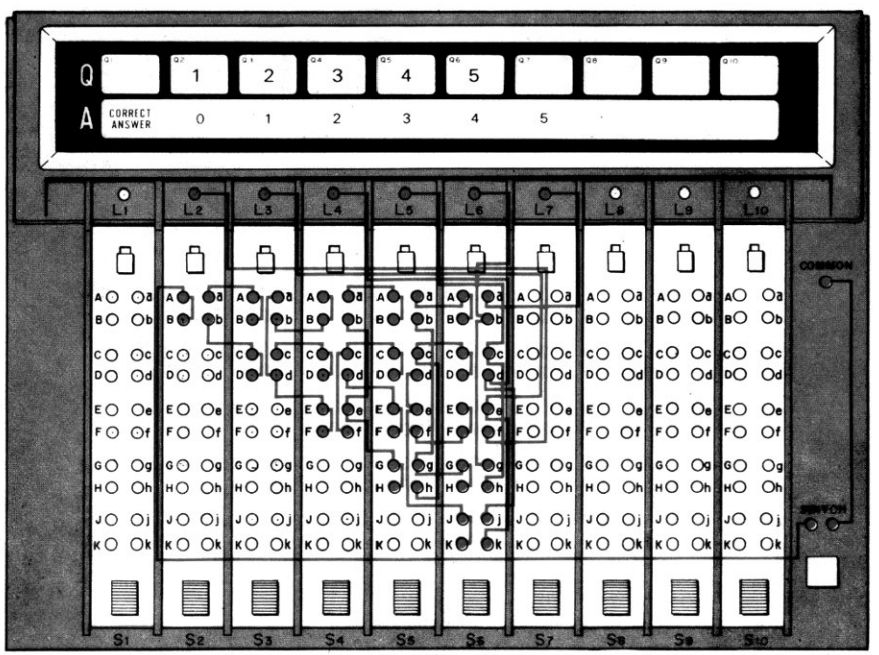


PROGRAM 25: QUESTION (12)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. Who was the leader of the Reformation?
   A. Fransisco Xavier B. Martin Luther
2. What was the name of a famous 13th and 14th century traveler/explorer?
   A. Marco Polo B. Gandhi
3. In which country did the Industrial Revolution begin?
   A. France B. England
4. When did the American Colonies become independent of England?
   A. 1667 B. 1776
5. In which country was the Magna Charta written?
   A. Germany B. England

Solution: 1–B, 2–A, 3–B, 4–B, 5–B

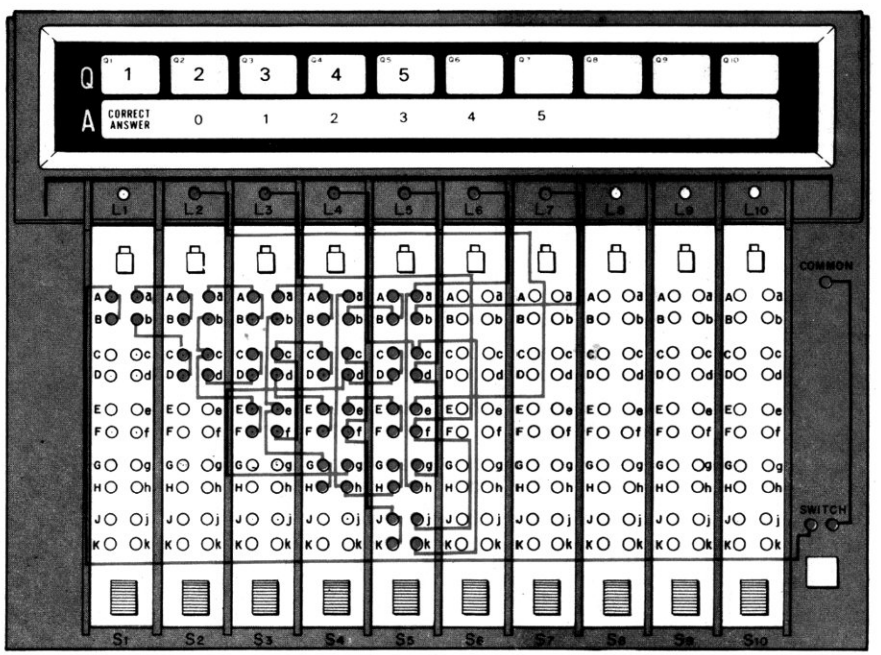


PROGRAM 26: QUESTION (13)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. What do we call the horizontal lines which make up the picture on a TV screen?
   A. Video B. Raster
2. How many seams are there on a baseball?
   A. 2 B. 1
3. Who was the first woman to appear in the Old Testament?
   A. Cleopatra B. Eve
4. What is the opposite of a Radical politician?
   A. Conservative B. Clique
5. Where is the Pampas?
   A. Argentina B. Korea

Solution: 1–B, 2–B, 3–B, 4–A, 5–A

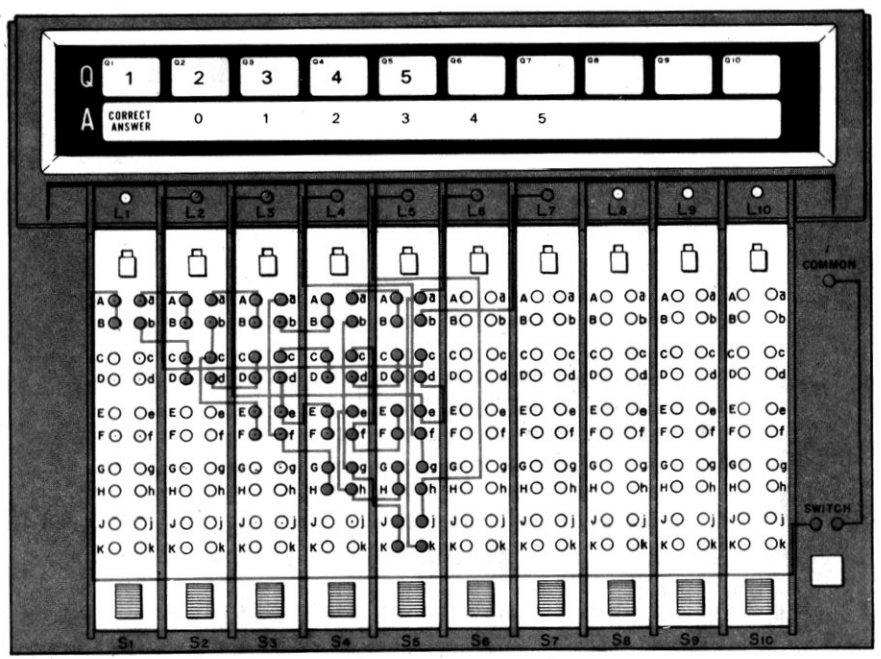


PROGRAM 27: QUESTION (14)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. What is the opposite of East?
   A. North B. West
2. Washington is located near the Potomac River. What river is London located near?
   A. The Rhine B. The Thames
3. What is the unit of weight for precious stones?
   A. Carat B. Gram
4. In a medley relay, the first swimmer uses the back stroke; what is the second style?
   A. Breast Stroke B. Butterfly Stroke
5. What is the largest country in the world?
   A. Soviet Union B. China

Solution: 1–B, 2–B, 3–A, 4–B, 5–A

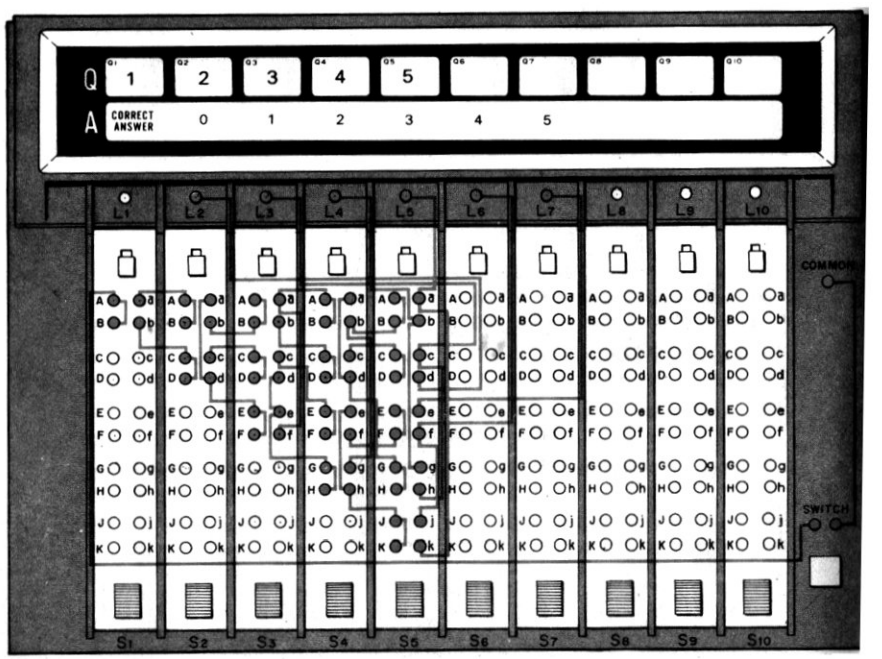


PROGRAM 28: QUESTION (15)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. What do you call the class of tools made out of stone before men found metal?
   A. Stone Implements B. Earthenware
2. What would you call the opposite of Up-town?
   A. Low-town B. Down-town
3. What is the opposite of "positive"?
   A. Passive B. Negative
4. A human heart has two parts—the Atria and?
   A. Ventricles B. Myocardium
5. What is the unit of atmospheric pressure?
   A. Millimeter B. Millibar

Solution: 1–A, 2–B, 3–B, 4–A, 5–B

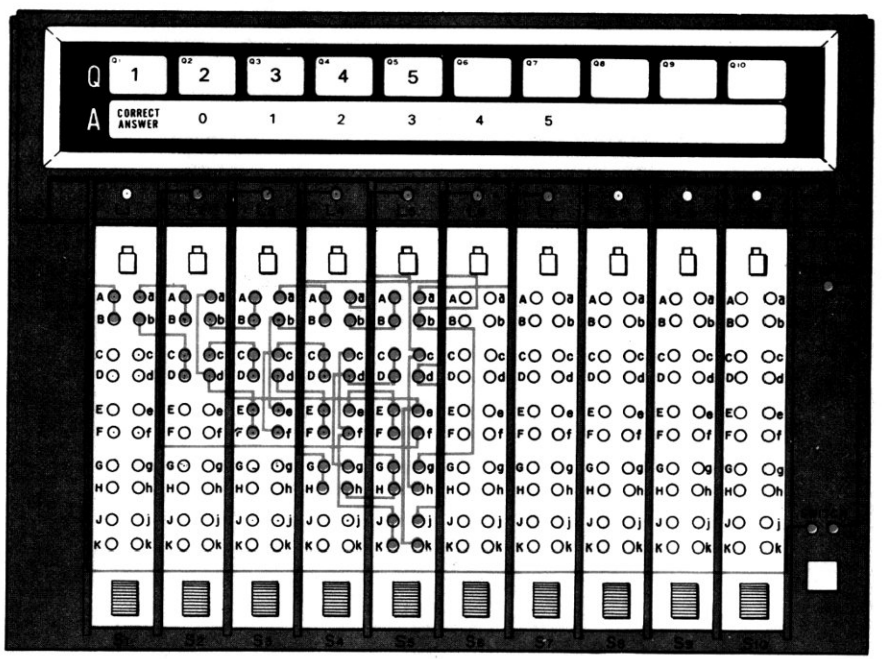


PROGRAM 29: QUESTION (16)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. How much does a liter of pure water weigh?
   A. 1 gram B. 1000 grams
2. What do weather people call an area created between high pressure areas on a weather chart?
   A. Low pressure area B. Typhoon
3. What is used to turn an electric circuit On and Off?
   A. Flash B. Switch
4. Alphabetical symbols are used for elements; for example, elements, "A" is for Argon. What is "C" for?
   A. Carbon B. Hydrogen
5. The square root of 81 is 9. What is the fourth root of 81?
   A. $\sqrt{3}$ B. 3

Solution: 1–B, 2–A, 3–B, 4–A, 5–B

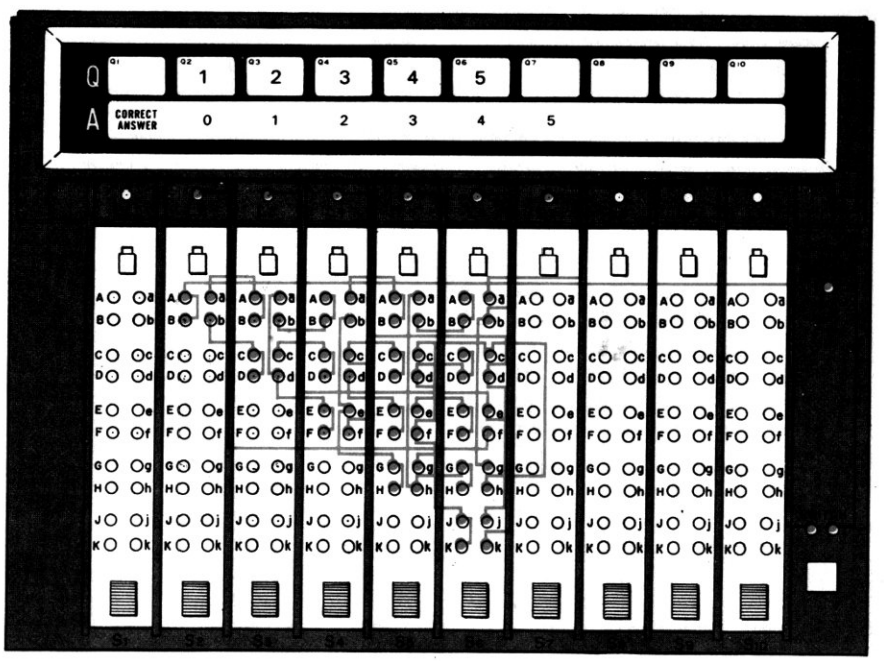


PROGRAM 30: QUESTION (17)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. What temperature Fahrenheit is equal to 100° Centigrade?
   A. 220°F B. 212°F
2. A radio loud speaker operates on what principle?
   A. Magnetism B. Electrostatics
3. What is another name for Pingpong?
   A. Home Tennis B. Table Tennis
4. Who was the discoverer of Dysentery Bacillus?
   A. Shiga B. Jenner
5. What number is on the side opposite 3 on dice?
   A. 6 B. 4

Solution: 1–B, 2–A, 3–B, 4–A, 5–B

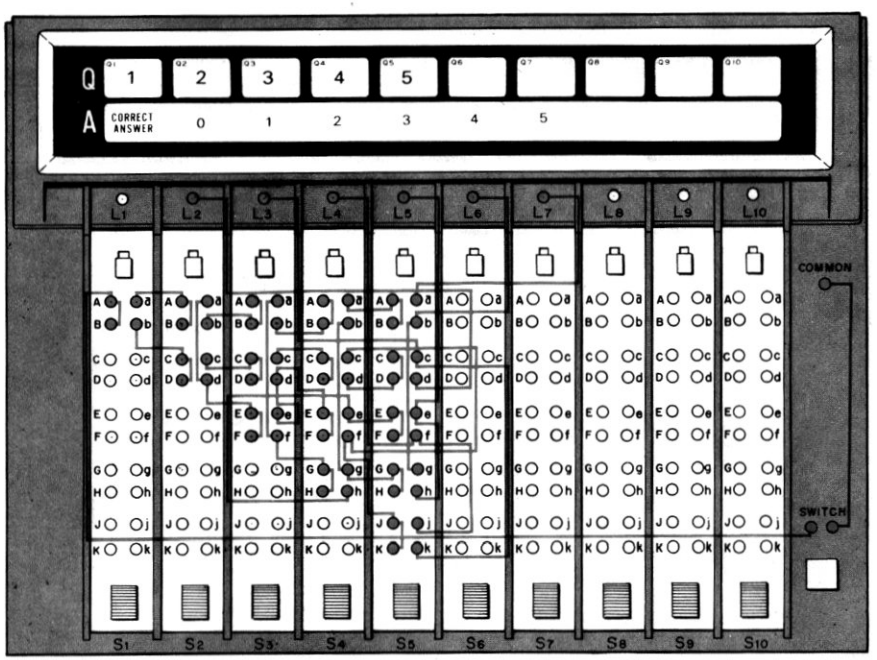


PROGRAM 31: QUESTION (18)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. What is the name of the method of hardening iron by heating and then suddenly cooling?
   A. Carbon B. Temper
2. Nylon is made from four substances—Hydrogen, Oxygen, Nitrogen and what else?
   A. Carbon B. Iodine
3. How long does one round in professional boxing take?
   A. 3 minutes B. 1 minute
4. What is the meaning of the five rings in the Olympic mark?
   A. 5 Promises B. 5 Continents
5. What is the highest mountain in the world?
   A. Himalayas B. Everest

Solution: 1–B, 2–A, 3–A, 4–B, 5–B

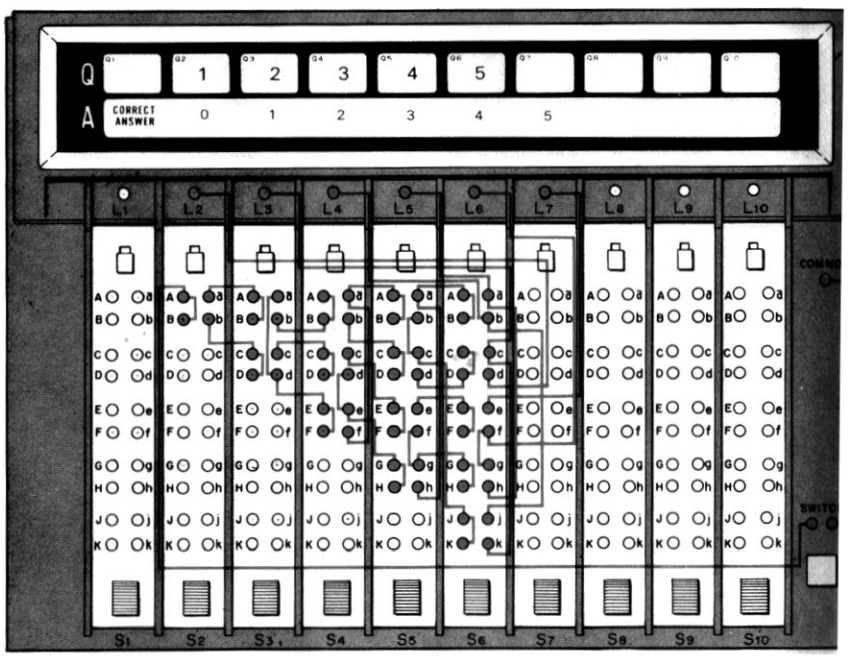


PROGRAM 32: QUESTION (19)

Connect wires as shown. You'll find the question's number in the "Q" line on the Compute Program Panel. Use the Slide Switch (S2 through S6) under the question's number to en answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B Answer all five questions (by positioning S2 through S6) then press the SWITCH Butt A number will light up in the "ANSWER" line on the Computer's Program Panel showi you how many correct answers you have.

1. Where does a player go who violates the rules in an Ice Hockey game?
   A. Penalty Box B. Circle
2. Who composed "Raindrop"?
   A. Liszt B. Chopin
3. The King is a King in a Card Game—who is the Jack?
   A. A Prince B. A Soldier
4. What is the center of a bow-and-arrow target called?
   A. Center B. Mark
5. What is the name of the small bread pieces served with soup?
   A. Toast B. Crouton

Solution: 1–A, 2–B, 3–B, 4–B, 5–B

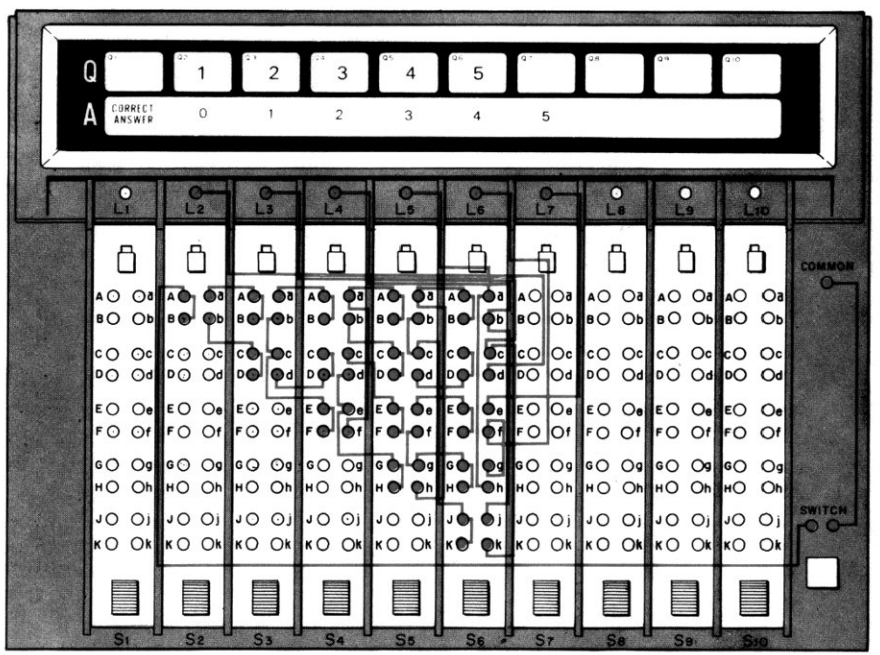


PROGRAM 33: QUESTION (20)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. How many people are on each team in a game of Rugby?
   A. 15 B. 11
2. What is the capital of Australia?
   A. Canberra B. Sydney
3. Where is the Sahara Desert?
   A. South America B. Africa
4. What is the acid in a lemon?
   A. Acetic B. Citric
5. "Turkish March" was composed by Beethoven and who else?
   A. Schubert B. Mozart

Solution: 1–A, 2–A, 3–B, 4–B, 5–B

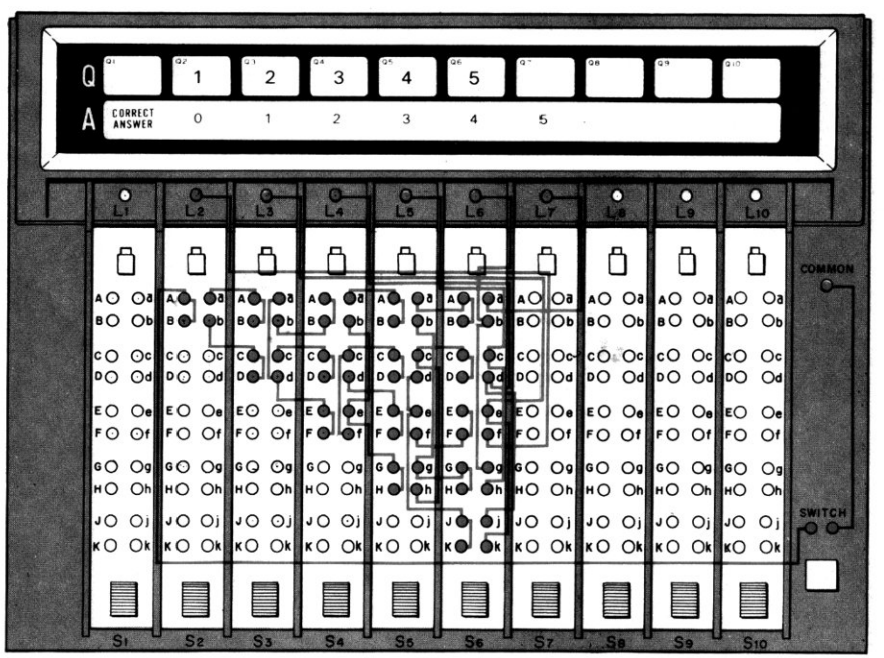


PROGRAM 34: QUESTION (21)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. How high does a referee count before ruling a knock-out in Boxing?
   A. 15 B. 10
2. Who was the philosopher who killed himself with poison in Old Greece?
   A. Socrates B. Aristotle
3. What is the number of the pin nearest the bowler in 10-pin Bowling?
   A. 10 B. 1
4. What is the Disney movie made after the symphony of Beethoven?
   A. Dumbo B. Fantasia
5. In which city in the United States is the most famous automobile race held?
   A. New York B. Indianapolis

Solution: 1–B, 2–A, 3–B, 4–B, 5–B

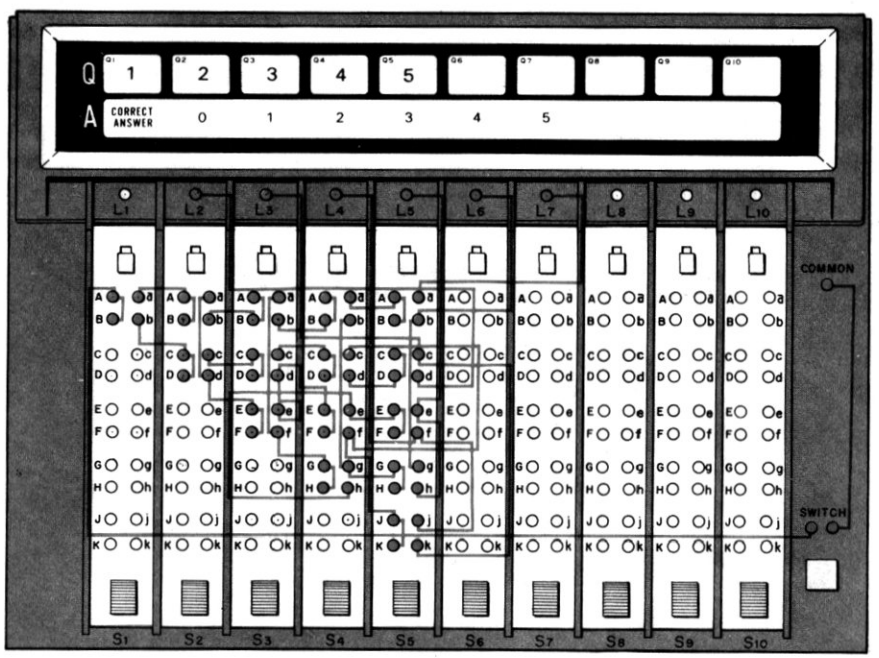


PROGRAM 35: QUESTION (22)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. Who was the author of the "007 series"?
   A. B. Rasseln B. Ian Fleming
2. A lady might carry a parasol to protect her from what?
   A. The sun B. A mugger
3. Who said "Brutus, you also. . . ."?
   A. Caesar B. Solomon
4. In which city is the Louvre Museum located?
   A. London B. Paris
5. What is the name of the world-famous prize given at special ceremonies in Stockholm?
   A. Oscar B. Nobel Prize

Solution: 1–B, 2–A, 3–A, 4–B, 5–B

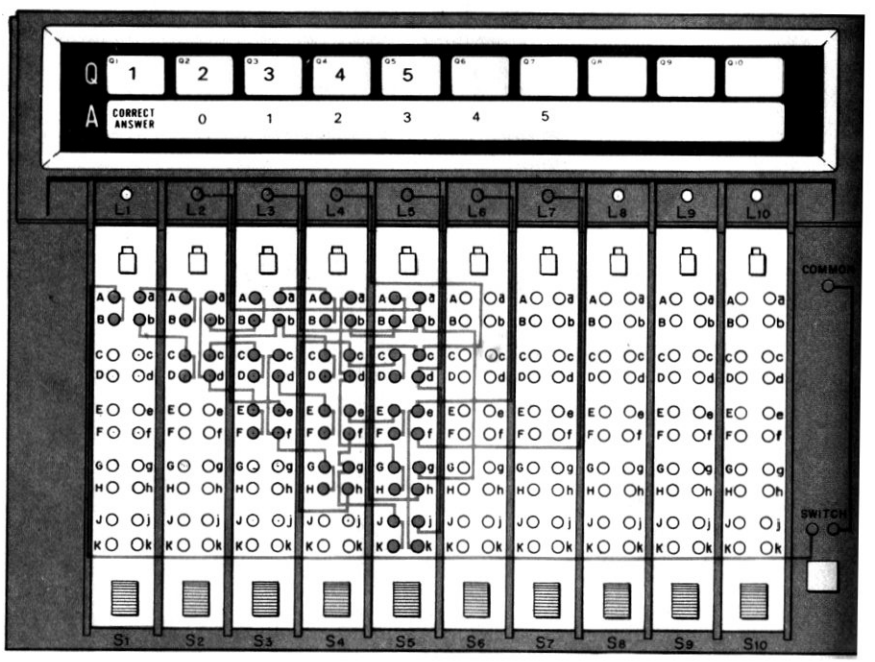


PROGRAM 36: QUESTION (23)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S1 through S5) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S1 through S5) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. "$" stands for "dollars"; what does "£" stand for?
   A. Pounds B. Marks
2. What is the country of origin of the Olympic Games?
   A. Egypt B. Greece
3. Which country does Flamenco Music belong to?
   A. Spain B. Mexico
4. Which is the biggest country in South America?
   A. Argentina B. Brazil
5. Along which river did Egyptian Civilization appear?
   A. The Nile River B. The Ganges River

Solution: 1–A, 2–B, 3–A, 4–B, 5–A

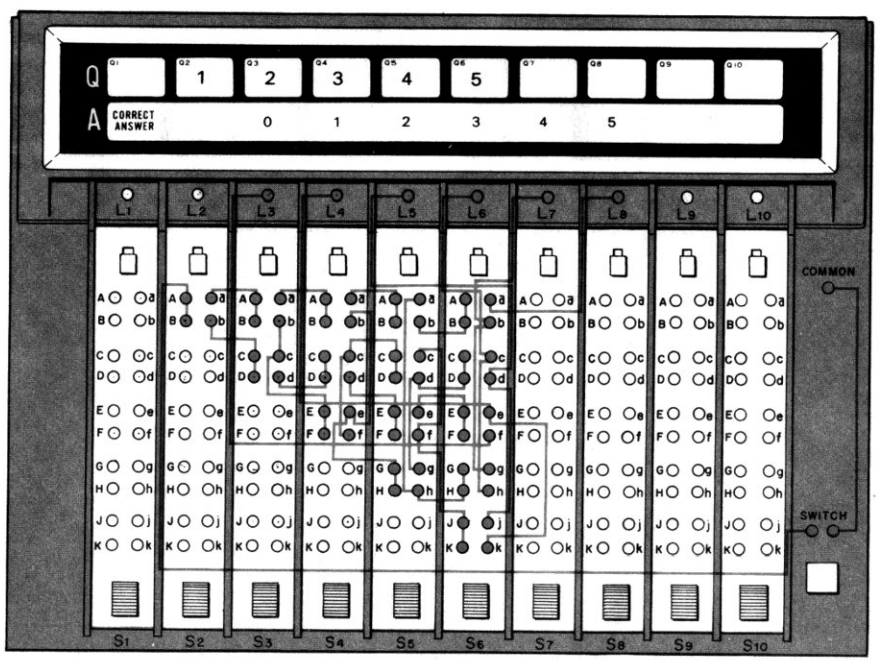


PROGRAM 37: QUESTION (24)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1. What is a general name for the following group of countries: India, Pakistan and Thailand?
   A. West Asia B. South-East Asia
2. Which is the organization of commerce in Western Europe?
   A. NATO B. EEC
3. What is the name of a canal in Central America?
   A. Suez B. Panama
4. In which country was ice cream first made?
   A. Italy B. Spain
5. What is the reciprocal of 10?
   A. 1.0 B. 0.1

Solution: 1–B, 2–B, 3–B, 4–A, 5–B

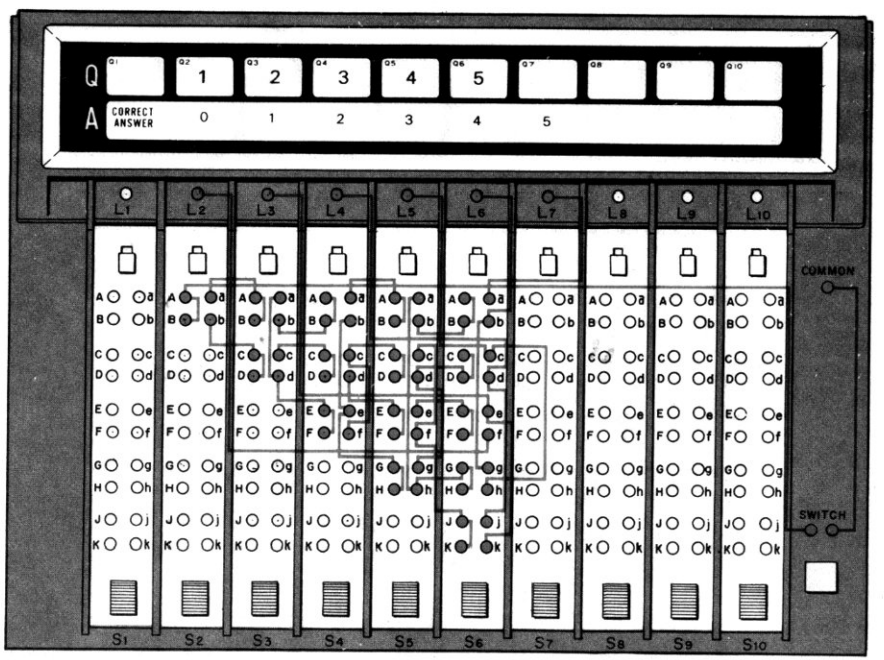


PROGRAM 38: QUESTION (25)

Connect wires as shown. You'll find the question's number in the "Q" line on the Computer's Program Panel. Use the Slide Switch (S2 through S6) under the question's number to enter answer "A" or "B". Pull the switch toward you (down) for "A" or push it up for "B". Answer all five questions (by positioning S2 through S6) then press the SWITCH Button. A number will light up in the "ANSWER" line on the Computer's Program Panel showing you how many correct answers you have.

1 Which newspaper has the largest circulation?
   A. New York Times B. New York Daily News
2. In a baseball game, the dugout for the home team is on which side?
   A. First base side B. Third base side
3. Which island is called the "Paradise of the South Pacific"?
   A. Hawaii B. Tahiti
4. How many states did the U.S.A. have at the time of Independence?
   A. 13 B. 23
5. Which song was composed by Foster?
   A. Home on the Hill B. Old Black Joe

Solution: 1–B, 2–A, 3–B, 4–A, 5–B

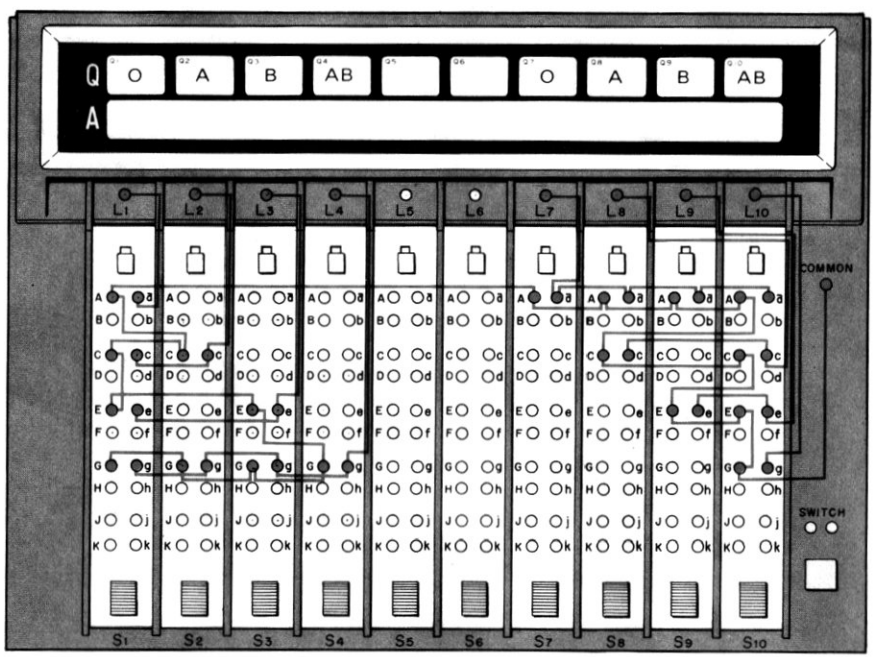


PROGRAM 39: A TYPE OF BLOOD

Connect wires as shown. Human beings' blood can be divided into four large groups according to the type of agglutinogen contained in their red cells. Some contain agglutinogen A, others agglutinogen B, others both A and B and still others neither A nor B. The latter type is called type O. Individuals with the same blood type may receive blood from each other without danger. On the other hand, an individual who has type A cannot receive type B blood without a violent reaction. Some blood groups may receive blood from other groups without developing reactions which could be fatal. This program shows both the types of the recipients' blood and the types of the donors' blood.

Operation: Push up one of the Slide Switches (S1 through S4) under your blood type from the Recipient's group. On the Computer Program Panel—the Recipient's blood types will light up. Now, push up one of the Slide Switches (S7 through S10) under your blood type from the Donor's group. On the Computer Program Panel—the blood types that could be given to you (without danger) will light up.

Recipient **Donor**



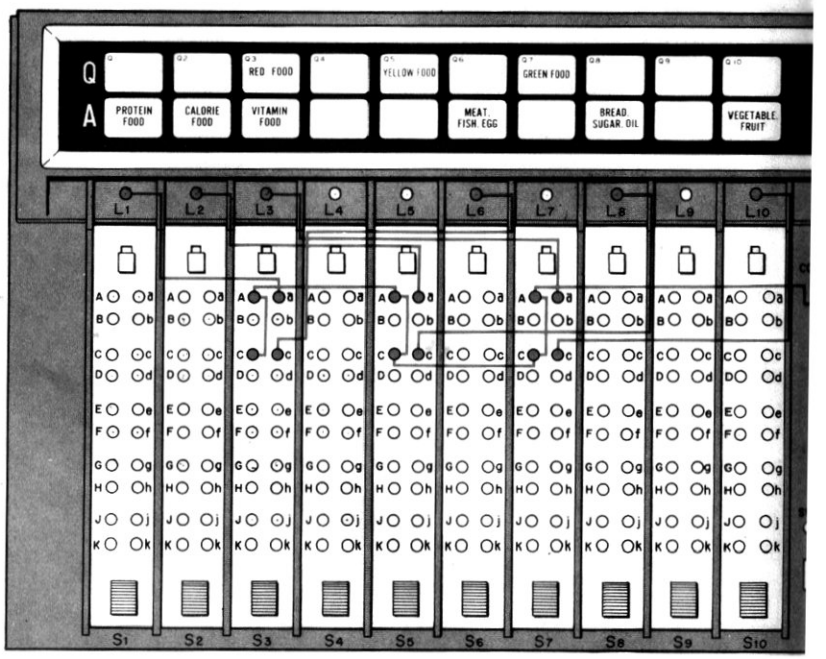
PROGRAM 40: FOODS

Connect wires as shown. In today's world, we are all aware of how important it is physically fit. Also, you, no doubt, recognize how necessary it is for us to have p nutrition. You can use this program to check what kind of nutrition is contained in a of foods depending upon their color. Also, you can determine what items belong to the nutrition category.

Operation: Push up one of the Slide Switches under a color of food (Q3, Q5 or Q7). (Computer Program Panel, the kind of nutrition will light up on the left side and belonging to that category will light up on the right side.

Caution: Do not select more than one food color at a time. To do so, will only c the Computer and it will give you an incorrect answer.

NOTES:



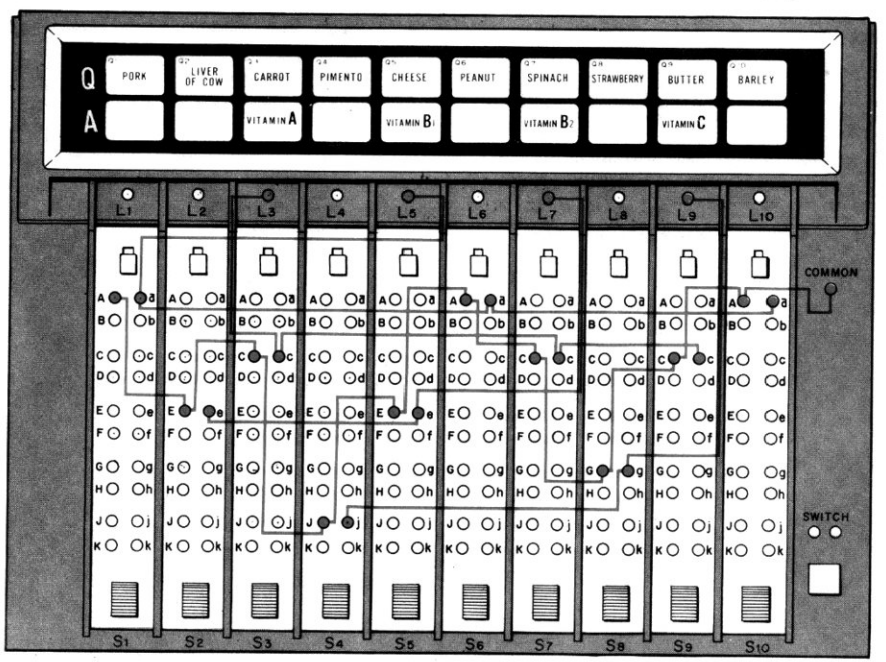
PROGRAM 41: VITAMINS

Connect wires as shown. In the previous program, we mentioned the importance of proper food. As you know, our bodies require certain essential vitamins to maintain good health. Of course, our primary vitamin source is the food we eat, but we need to know what foods contain those necessary vitamins. With this program, you can use your Computer to analyze what main vitamin is supplied by each of the foods given.

Operation: Select which food (Q1 through Q10) you wish to analyze. Push up the Slide Switch (S1 through S10) under the food you selected. On the Computer Program Panel, the main vitamin contained in that food will light up.

Caution: Do not push up more than one Slide Switch at a time. To do so, will only confuse the Computer and cause it to give you an incorrect answer.

NOTES:

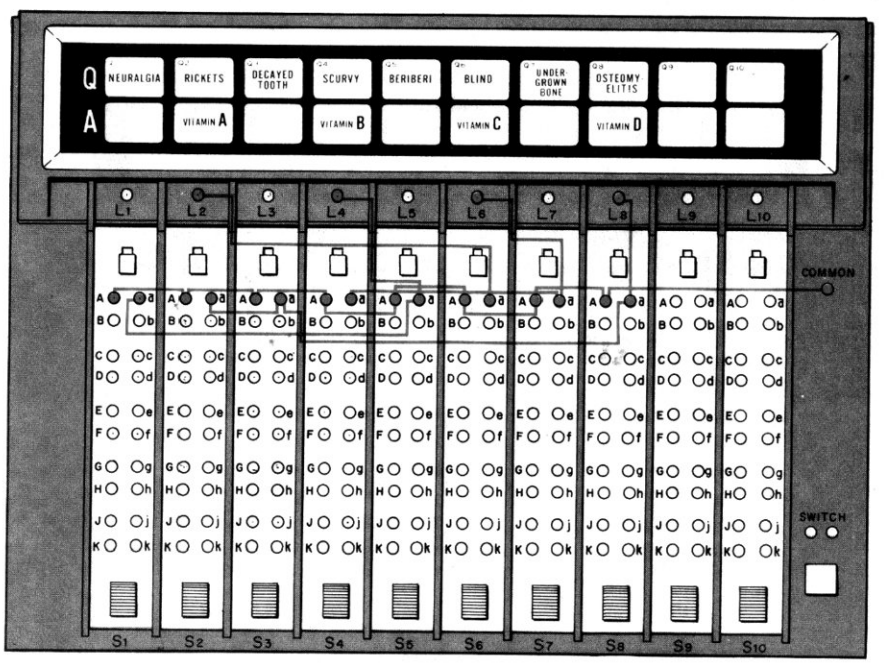


PROGRAM 42: VITAMIN DEFICIENCY DISEASES

Connect wires as shown. In the previous program, we mentioned the necessity of essential vitamins for good health. Now, we will see that without certain vitamins, or with a severe lack of them, our bodies are susceptible to one or more diseases. The only cure for these diseases comes through supplying to the body sufficient quantities of the required vitamins. In cases such as these, supplementary vitamins, prescribed by a doctor, may be in order. With this program, you can use your Computer to reveal which vitamin is deficient for each of the diseases listed.

Operation: Select which disease (Q1 through Q8) you want to check out. Push the Slide Switch up (S1 through S8) under your selection. The vitamin deficiency causing that disease will light up on the Computer's Program Panel. Remember, don't push up more than one Slide Switch at a time or you'll get an incorrect answer.

NOTES:



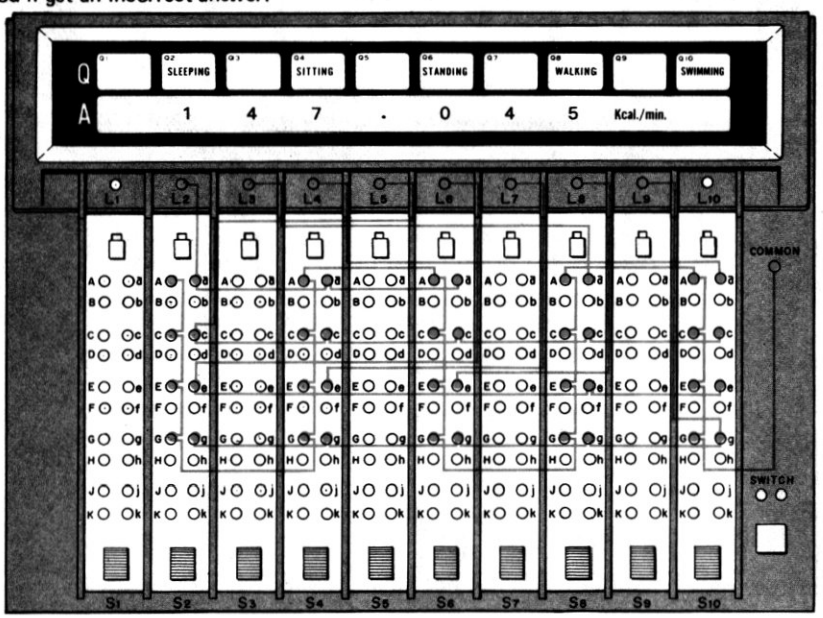
PROGRAM 43: CALORIE CONSUMPTION OF HUMAN MOTION

Connect wires as shown. You may want to know how many calories (units of heat that come from the foods we eat) are consumed during different activities (over a period of about one minute of this activity). This could be important to you if you are overweight or underweight. By taking in (eating) more calories than you expend, you'll probably gain weight but if you burn-up calories faster than you replace them, you'll probably lose weight. When you ask the Computer how many calories are consumed while participating in each of the activities listed (Q2, Q4, Q6, Q8 or Q10), it will light up a number and "K cal/min.". "K cal/min." means "1,000 calories per minute" of that activity. Thus, when your computer tells you 1.0 K cal/min. for sleeping, it means that your body uses up 1,000 calories during each minute of sleep.

Note: The calories we are dealing with are the physical units of heat measurement. When we talk about calories and foods and the human body, that calorie is equal to 1,000 of the basic physics unit. You can call "food calories" a "kilocalorie". Thus, in the example above during one minute of sleep, your body is using up 1 calorie.

Operation: Push up a Slide Switch (S2, S4, S6, S8 or S10) one at a time under each of the questions (SLEEPING, SITTING, STANDING, WALKING or SWIMMING). A set of numbers will light up with "K cal/min.". Remember, "K cal/min." means "1,000 calories/min.", so multiply the number on the Computer's Program Panel times 1,000 and you've got the number of calories.

Caution: Push up a Slide Switch one at a time and always pull it back down before pushing up another one. To push up more than one at a time will only confuse the Computer and you'll get an incorrect answer.



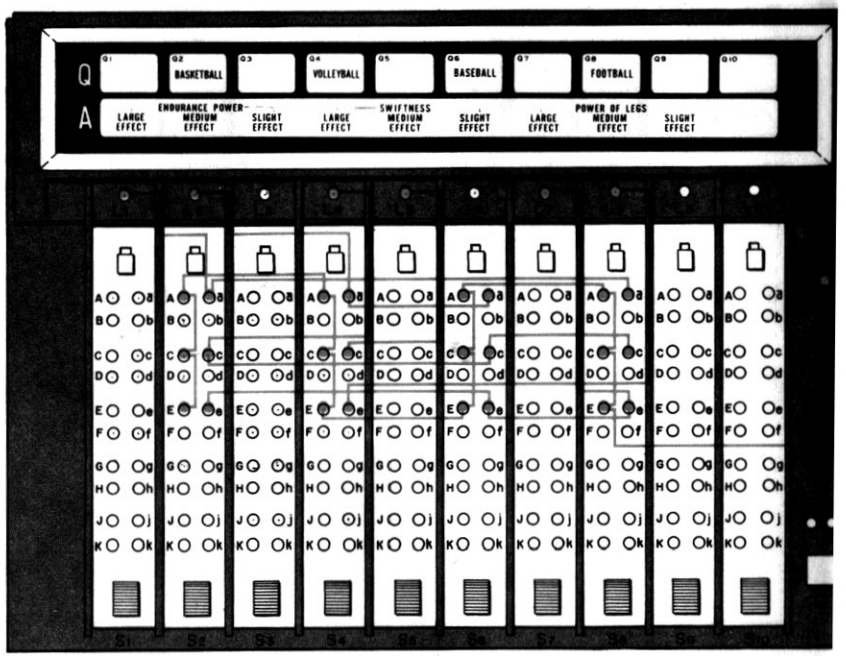
PROGRAM 44:
EFFECT OF VARIOUS SPORTS ON THE HUMAN BODY (1)

Connect wires as shown. This program enables your Computer to tell you certain effects t sports such as BASKETBALL, VOLLEYBALL, BASEBALL or FOOTBALL have on human body. One of the effects (LARGE, MEDIUM or SLIGHT) will light up under each the three headings: ENDURANCE POWER, SWIFTNESS and POWER OF LEGS. You m want to know these effects if you desire to achieve a particular physical stamina or if y must consider a disability or a handicap when selecting a sport to play.

Operation: Push up the Slide Switch under any one of the questions (Q2, Q4, Q6 or Q The effect of that sport on the human body will light up under each of the three heading the ANSWER line.

Caution: Push up a Slide Switch one at a time and always pull it back down before push up another one. To push up more than one at a time will only confuse the Computer you'll get an incorrect answer.

NOTES:



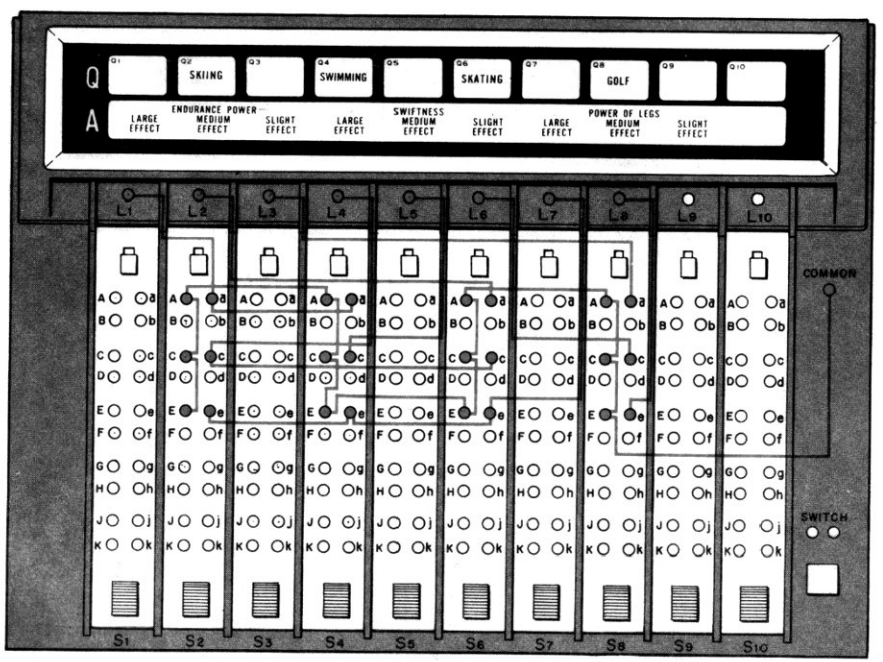
PROGRAM 45:
EFFECT OF VARIOUS SPORTS ON THE HUMAN BODY (2)

Connect wires as shown. This program enables your Computer to tell you certain effects that sports such as SKIING, SWIMMING, SKATING or GOLF have on the human body. One of the effects (LARGE, MEDIUM or SLIGHT) will light up under each of three headings: ENDURANCE POWER, SWIFTNESS and POWER OF LEGS. You may want to know these effects if you desire to achieve a particular physical stamina or if you must consider a disability or a handicap when selecting a sport to play.

Operation: Push up the Slide Switch under any one of the questions (Q2, Q4, Q6 or Q8). The effect of that sport on the human body will light up under each of the three headings in the ANSWER line.

Caution: Push up a Slide Switch one at a time and always pull it back down before pushing up another one. To push up more than one at a time will only confuse the Computer and you'll get an incorrect answer.

NOTES:



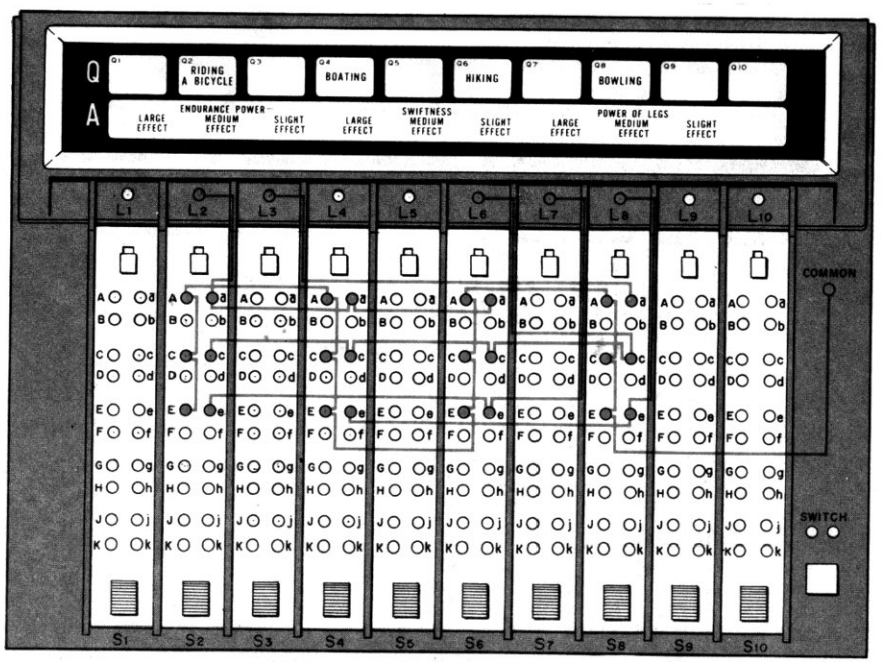
PROGRAM 46:
EFFECT OF VARIOUS SPORTS ON THE HUMAN BODY (3)

Connect wires as shown. This program enables your Computer to tell you certain effects that sports such as RIDING A BICYCLE, BOATING, HIKING or BOWLING have on the human body. One of the effects (LARGE, MEDIUM or SLIGHT) will light up under each of three headings: ENDURANCE POWER, SWIFTNESS and POWER OF LEGS. You may want to know these effects if you desire to achieve a particular physical stamina or if you must consider a disability or a handicap when selecting a sport to play.

Operation: Push up the Slide Switch under any one of the questions (Q2, Q4, Q6 or Q8). The effect of that sport on the human body will light up under each of the three headings in the ANSWER line.

Caution: Push up a Slide Switch one at a time and always pull it back down before pushing up another one. To push up more than one at a time will only confuse the Computer and you'll get an incorrect answer.

NOTES:



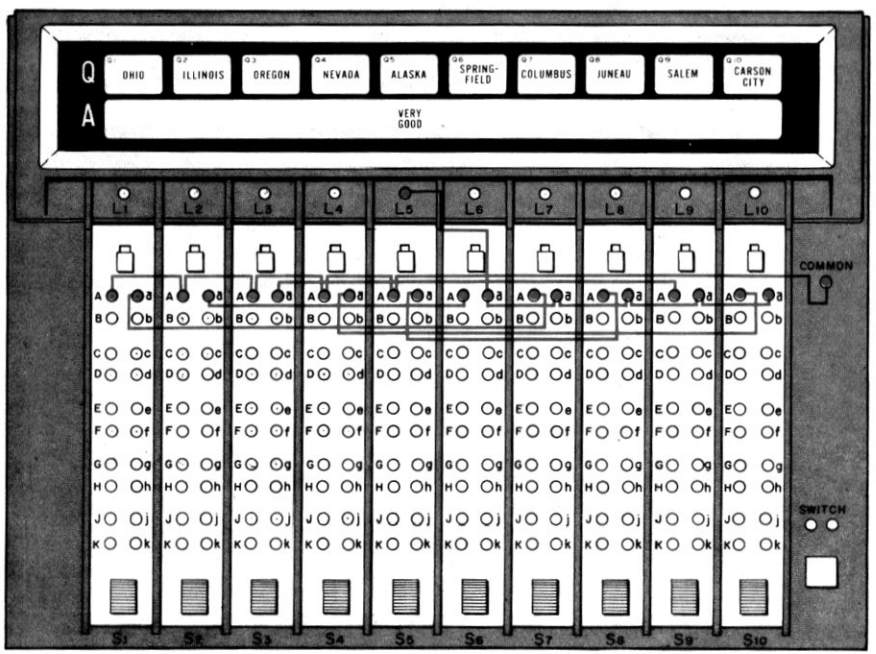
PROGRAM 47: STATE AND CAPITAL

Connect wires as shown. With this program your Computer can tell you what the capital is of a state in the United States. You are given the names of five states and five capitals—of course, as you become more familiar with your Computer and how it works, you can make-up other Program Panel Sheets to expand your Computer's capability. With ten sheets you could cover all fifty states.

Operation: Select a name of a state from the first five questions (Q1 through Q5) and push up the Slide Switch under it—make sure all the other Slide Switches are pulled down. Now choose from the last five questions (Q6 through Q10) which name you think is the capital of that state and push up the Slide Switch under it. If you are correct, VERY GOOD will light up in the ANSWER line but if you are wrong, the ANSWER line will remain dark.

Caution: Do not push up more than one Slide Switch at a time. To do so, will only confuse the Computer and cause it to give you an incorrect answer.

NOTES:

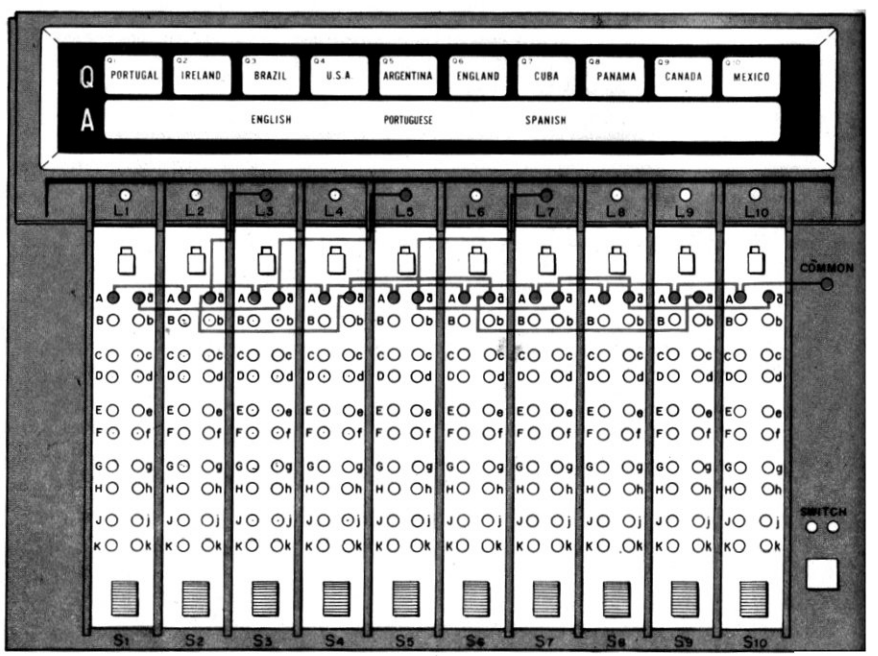


PROGRAM 48: NATION AND LANGUAGE

Connect wires as shown. If you or someone you know has the opportunity to travel to another country, one of the most important things (other than your passport) is to learn what language is spoken there. Your Computer, programed as it is, can answer that question for the nations listed on the Program Panel Sheet. With a bit of study, you can add other information on another sheet to expand your Computer's Capability.

Operation: Push up the Slide Switches under any one of the nation's names in the "Q" line (Q1 through Q10). The language spoken in that nation will light up in the ANSWER line. Be sure to pull each Slide Switch back down before pushing up another. To push up more than one Slide Switch at a time will only confuse the Computer and cause it to give you an incorrect answer.

NOTES:



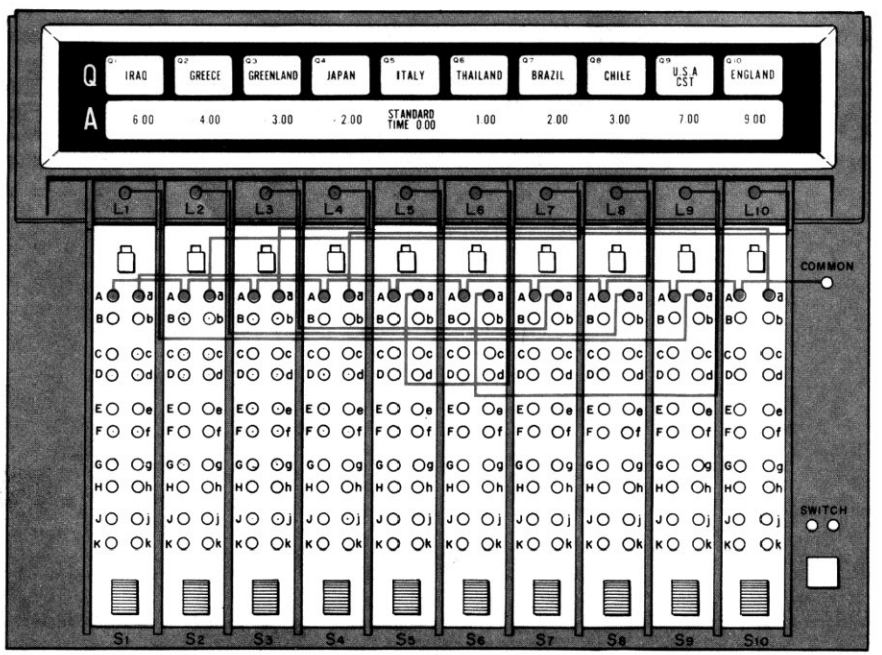
PROGRAM 49:
STANDARD TIME IN VARIOUS COUNTRIES OF THE WORLD

Connect wires as shown. Throughout the world, a time standard known as "Greenwich Mean Time", G.M.T. (or, more properly—Coordinated Universal Time, UTC) is used as a basis for calculating time. This time is reckoned from the "mean solar time for the meridian at Greenwich, England". Greenwich Mean Time is used primarily by communicators and navigators. If you want to know the G.M.T. for a country whose name is listed on the Computer's Program Panel, you can find out with this program.

Operation: Push up the Slide Switch under the name of one of the countries listed in the "Q" line (Q1 through Q10). A time difference will light up in the ANSWER line. Take any given time of the country you selected and add or subtract (as indicated) the time difference (shown to you by your Computer) to find the Greenwich Mean Time.

Caution: Do not push up more than one Slide Switch at a time. To do so, will only confuse the Computer and cause it to give you an incorrect answer.

NOTES:



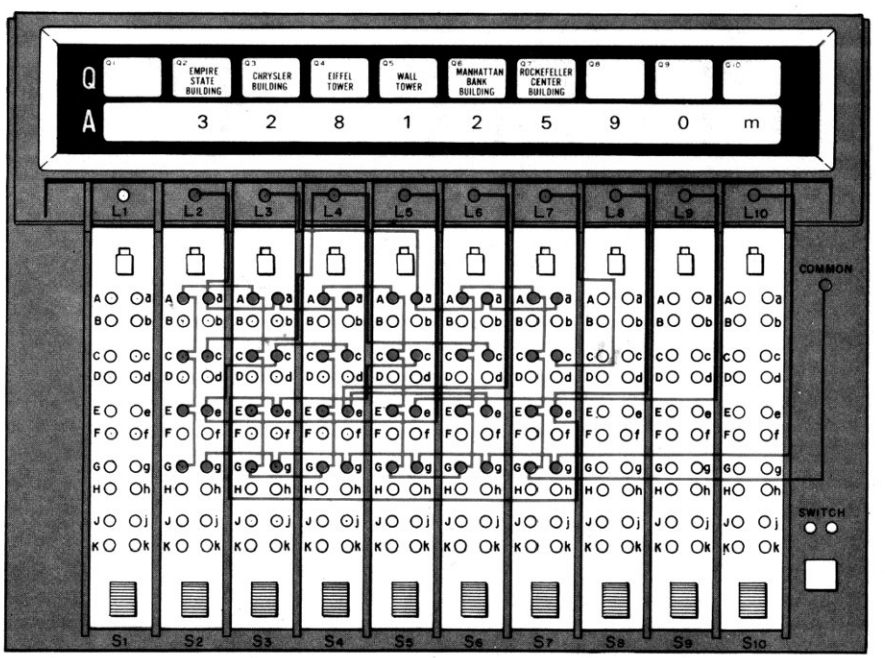
PROGRAM 50: TALL BUILDINGS OF THE WORLD

Connect wires as shown. You can use this program to learn the height of the EMPIRE STATE BUILDING, CHRYSLER BUILDING, EIFFEL TOWER, WALL TOWER, MANHATTAN BANK BUILDING or ROCKEFELLER CENTER BUILDING. When you select one of the buildings, the number of meters (represented by "m" on the Program Panel Sheet) will light up.

Of course there are many other tall buildings (new ones are always being constructed). Check a new encyclopedia and find out what the tallest ones are. Then see if you can make up your own programs.

Operation: Push up the Slide Switch under the name of the building for which you want to know the height. A set of numbers plus "m" will light up. Group the illuminated numbers together with "m" (for meters) to get your answer. For example, when you push up the Slide Switch under the name of the EMPIRE STATE BUILDING, the numbers 3, 8 and 1 along with "m" will light up. This is then read "381 meters high".

Caution: Do not push up more than one Slide Switch at a time. To do so, will only confuse the Computer and cause it to give you an incorrect answer.



PROGRAM 51: WORLD'S LARGEST ISLANDS

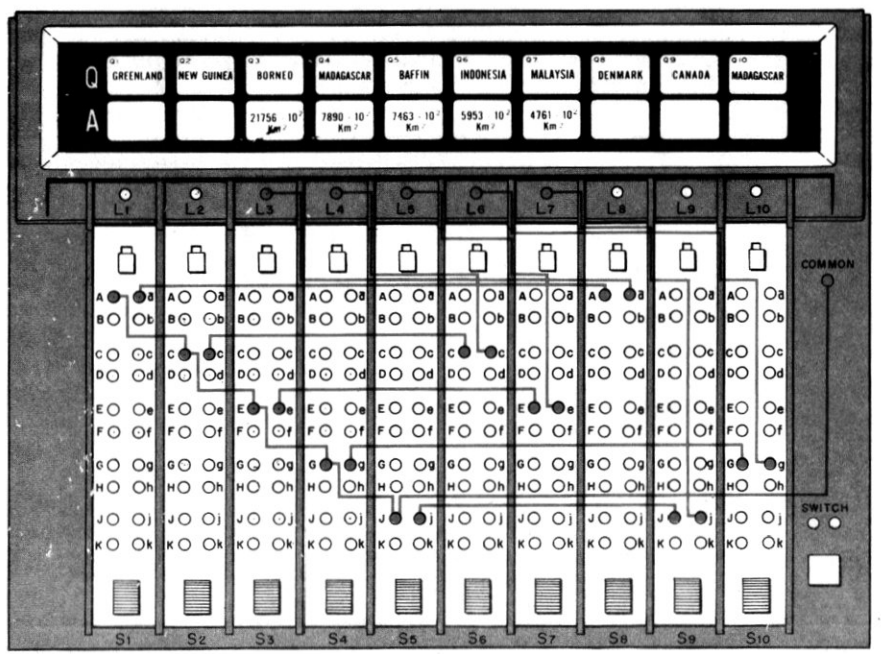
Connect wires as shown. There are several large islands in the world, some of which are so large that you may not have thought of them as islands. With this program, you can learn the names of some of the main large islands of the world, their location and their dimensions.

Operation: Select one of the five main islands from the first five questions (Q1 through Q5) and push up the Slide Switch under your choice. Then select a geographical location where you think this Island is, or the country it belongs to (S6-S10). If your selection is correct, the island's dimensions will light up. If you're wrong, you'll see no light.

Caution: Push up only one of the first five and one of the last five Slide Switches at one time. Remember to pull both switches back down before asking the Computer about another island.

Solution: Q1–Q8, Q2–Q6, Q3–Q7, Q4–Q10, Q5–Q9

NOTES:



PROGRAM 52: WORLD'S LONGEST RIVERS

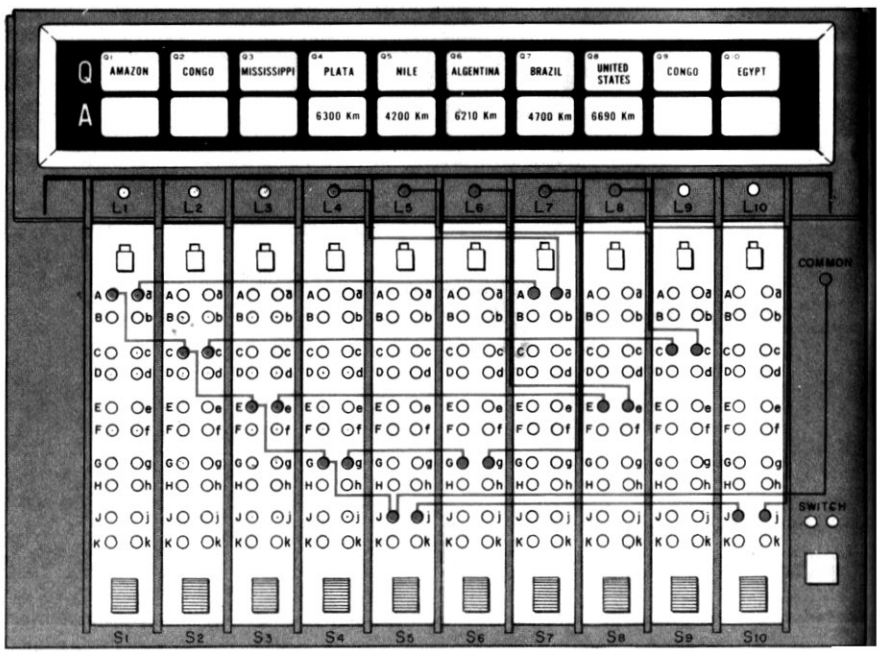
Connect wires as shown. Here's a good way for you to learn about some of the main rivers in the world. This program will help you learn their names, what country they are in and their lengths. You may be suprised when you find out how long these rivers are.

Operation: Select one of the five rivers from the first five questions (Q1 through Q5) and push up the Slide Switch under your choice. Then select the country where you think that river is (S6-S10). If your selection is correct, the river's length will light up. If you're wrong, you'll see no light.

Caution: Push up only one of the first five and one of the last five Slide Switches at one time. Remember to pull both switches back down before asking the Computer about another river.

Solution: Q1–Q7, Q2–Q9, Q3–Q8, Q4–Q6, Q5–Q10

NOTES:



PROGRAM 53: ASIA'S TALLEST MOUNTAINS

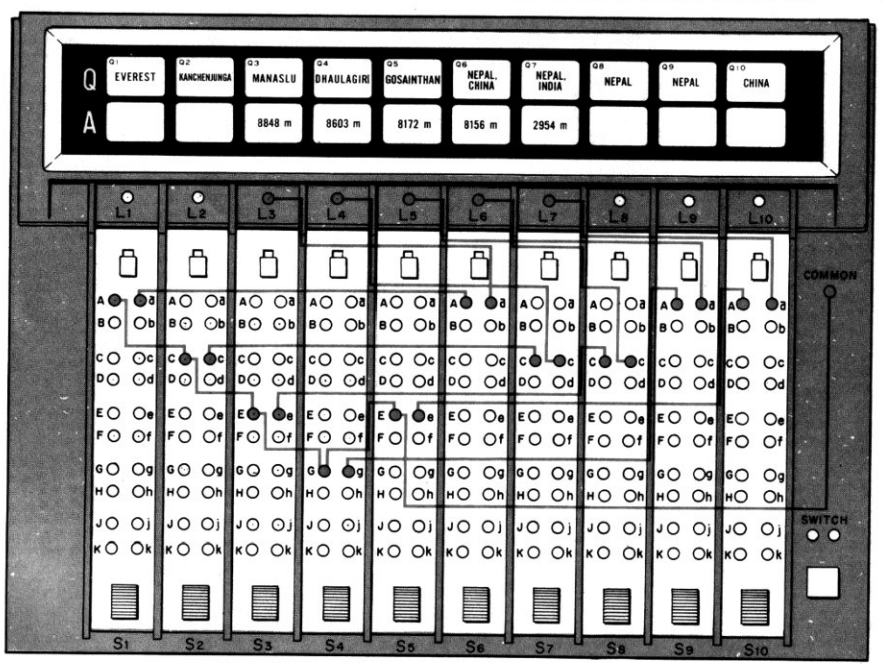
Connect wires as shown. Now you can learn the names of some of the tallest mountains in the world. This program will help you to learn their names, the countries they are in and their heights. Some of these mountain's names will probably sound very strange to you—that's because they are all in Asia.

Operation: Select one of the five mountains from the first five questions (Q1 through Q5) and push up the Slide Switch under your choice. Then select the country where you think the mountain is (S6-S10). If your selection is correct, the mountain's height will light up. If you're wrong, you'll see no light.

Caution: Push up only one of the first five and one of the last five Slide Switches at one time. Remember to pull both switches back down before asking the Computer about another mountain.

Solution: Q1—Q6, Q2—Q7, Q3—Q8, Q4—Q9, Q5—Q10

NOTES:



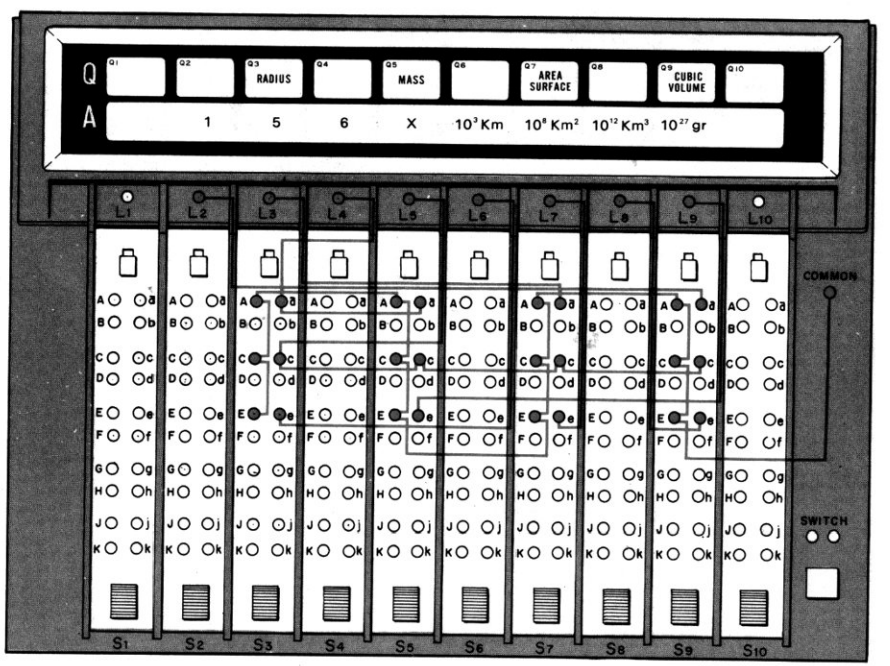
PROGRAM 54: THE EARTH

Connect wires as shown. You can learn some very interesting facts about the planet on which we live as you work with this program. Your Computer can tell you the Earth's RADIUS, MASS, SURFACE AREA and CUBIC VOLUME. It will give you a number, an X (this means "times") and a scientific notation (using a base 10). You combine this information to get the answer.

Operation: Push up on the Slide Switch under any one of the questions (Q3, Q5, Q7 or Q9) listed in the "Q" line. A number, an X and a scientific notation will light up in the ANSWER line. For example, for the Earth's RADIUS, the Computer will give you 6×10^3 km (6000 kilometers).

Caution: Push up only one Slide Switch at a time. To push up more than one at a time will only cause the Computer to give you an incorrect answer. Make sure all of the Slide Switches are down (pulled back) before entering a question, that is, pushing up one of the Slide Switches.

Solution: RADIUS — 6×10^3 Km
MASS — 6×10^{27} gr
AREA SURFACE — 5×10^8 Km^2
CUBIC VOLUME — 1×10^{12} Km^3



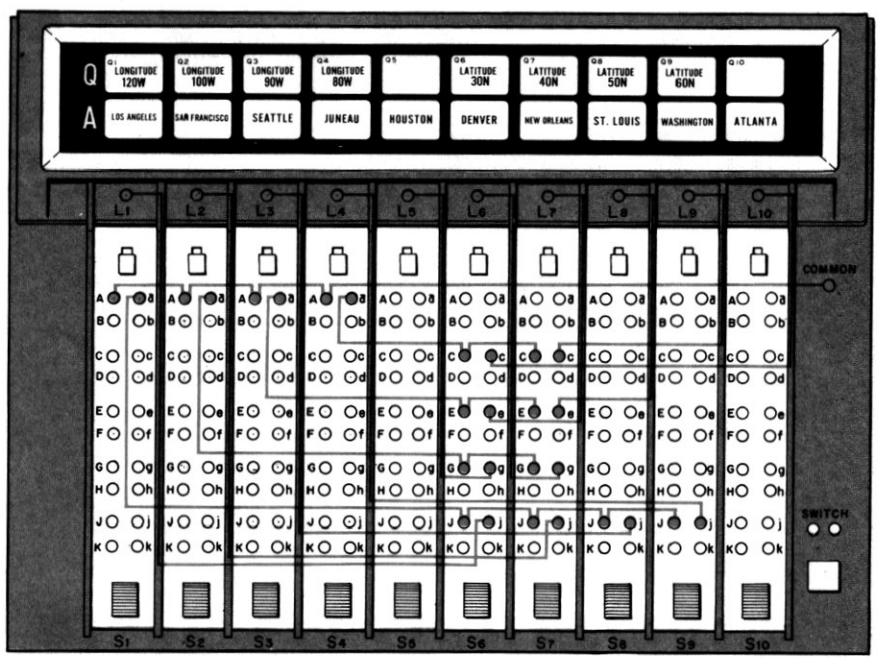
PROGRAM 55: LATITUDE AND LONGITUDE

Connect wires as shown. You can use the co-ordinates, LATITUDE and LONGITUDE, to locate any place on the surface of the earth. These co-ordinates are used by navigators to direct the courses of ships and aircraft. You'll find this program to be fascinating as you enter co-ordinates of your choice, then watch the Computer as it instantly shows you in the ANSWER line the city located there.

Operation: Push up the Slide Switch under any one of the four LONGITUDES (Q1, Q2, Q3 or Q4)—leave it up, then select any one of four LATITUDES (Q6, Q7, Q8 or Q9) and push up the Slide Switch under it. These co-ordinates will describe the location of a city in the United States. The name of that city will light up on the Program Panel.

Caution: Enter only one LONGITUDE and one LATITUDE at a time. Be sure to pull all switches down (towards you) before entering another set of co-ordinates.

NOTES:



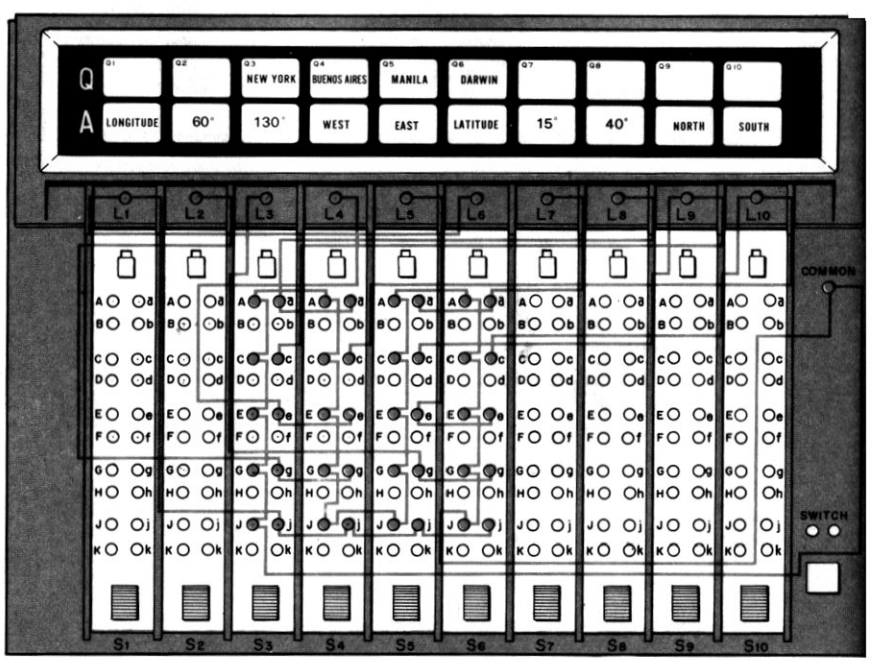
PROGRAM 56: LATITUDE AND LONGITUDE OF VARIOUS CITIES

Connect wires as shown. Wasn't that fun, working with co-ordinates (LATITUDES and LONGITUDES) in the previous program? In it, you selected co-ordinates to locate a city. In this program, you can select the name of a city and your Computer will tell you what its co-ordinates are. It will light up LONGITUDE, a number and either EAST or WEST; also, LATITUDE, a number and either NORTH or SOUTH.

Operaton: Select the name of one of the cities from the "Q" line (Q3, Q4, Q5 or Q6) and push up the Slide Switch under it. LONGITUDE, a number and either EAST or WEST will light up along with LATITUDE, a number and either NORTH or SOUTH. For example, for NEW YORK, you'll see: LONGITUDE 60° WEST and LATITUDE 40° NORTH.

Caution: Push up only one Slide Switch at a time. Be sure to pull it back down before pushing up another one. To do so will only confuse the Computer and cause it to give you an incorrect answer.

NOTES:



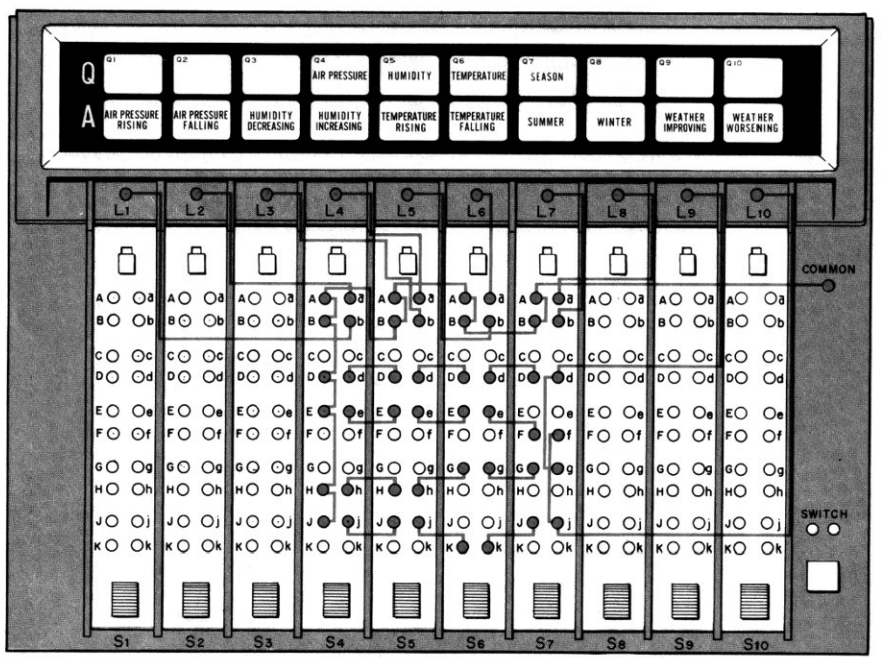
PROGRAM 57: WHAT WILL THE WEATHER BE LIKE?

Connect wires as shown. When you enter a set of conditions into your Computer for AIR PRESSURE, HUMIDITY, TEMPERATURE and SEASON, it will light up either WEATHER IMPROVING or WEATHER WORSENING. You can become your own weatherman by taking a few measurements and entering the information into your Computer.

Operation: Push up or pull down the Slide Switches (S4 through S7) under AIR PRESSURE, HUMIDITY, TEMPERATURE and SEASON to light up the appropriate condition in the ANSWER line. When you have entered a condition for each of the four questions (Q4 through Q7), WEATHER IMPROVING or WEATHER WORSENING will light up.

Note: Remember, we discussed "Sequential Logic" earlier in this manual? Well, this is another "Sequential Logic" program—you must enter information into the Computer by positioning the Slide Switches either up or down under each of the four questions (Q4 through Q7) and leave them in that position to represent a set of conditions.

NOTES:



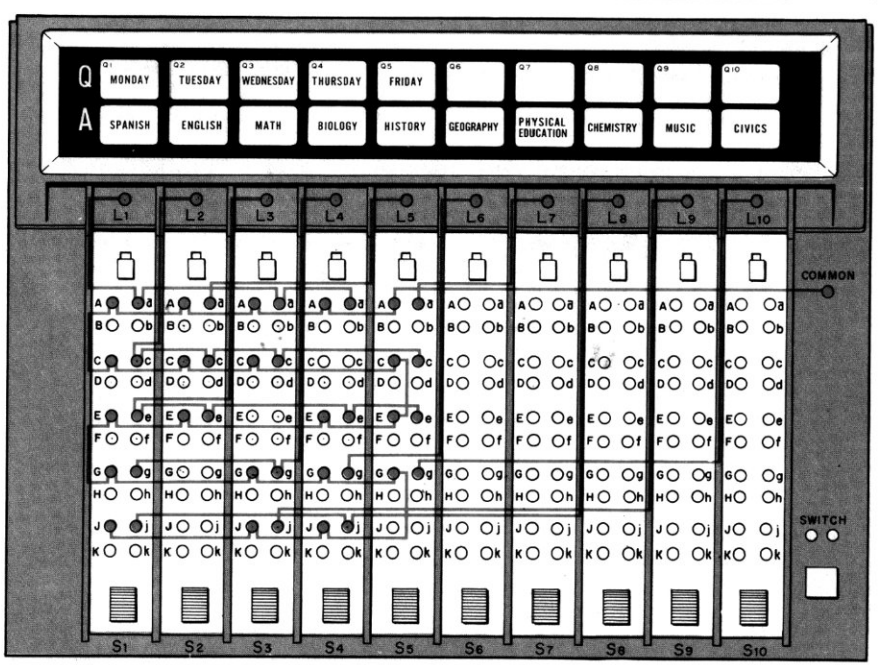
PROGRAM 58: STUDENT TIME-TABLE

Connect wires as shown. As you work with this program, you'll get the feeling this student's schedule is plenty full. He will have to seriously apply himself to make good grades. You can find out what subjects he'll be studying each day of the week, MONDAY through FRIDAY. As you get to be more familiar with programming your Computer, you may become able to make up a program and draw a Program Panel Sheet that will represent your own TIME-TABLE (or schedule).

Operation: Push up one of the Slide Switches under any one of the five days listed in the "Q" line (Q1 through Q5). The names of the subjects being studied that day will light up. Pull that switch back down before pushing up another one.

Caution: Do not push up more than one Slide Switch at one time. To do so will only confuse the Computer and cause it to give you an incorrect answer.

NOTES:



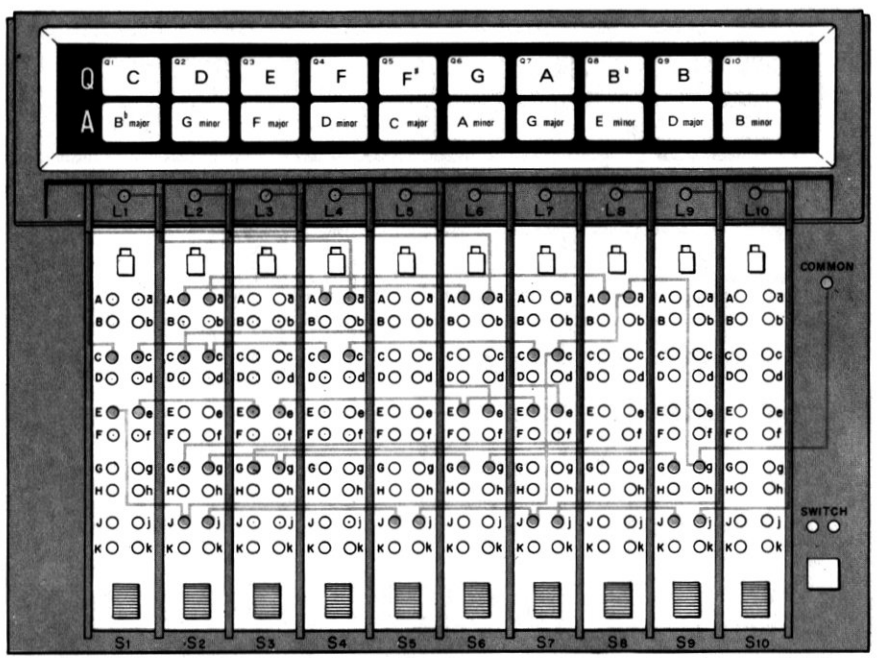
PROGRAM 59: MUSICAL CHORDS

Connect wires as shown. In some of the earlier programs in this manual, we discussed "Combinational Logic". Here is another program that uses "Combinational Logic". As you may already know, it takes three specific notes to make up a musical chord. Your Computer, with this program, can tell you what musical chords are made as a result of your selecting a combination of three notes.

Operation: Select a combination of three notes from the "Q" line (Q1 through Q9) and push up the Slide Switch under each note you select. If the combination of notes you've selected makes up a musical chord, the name of that chord will light up in the ANSWER line. For example, when you push up the Slide Switches under the combination C, E and G, the musical chord "C major" will light up.

Solution: C major (C,E,G)–D major (D,F$^{\#}$,A)–D minor (D,F,A)–
E minor (E,G,B)–F major (F,A,C)–G major (G,B,D)–
A minor (A,C,E)–B$^{\flat}$ major (B$^{\flat}$,D,F)–B minor (B,D,F$^{\#}$)

NOTES:



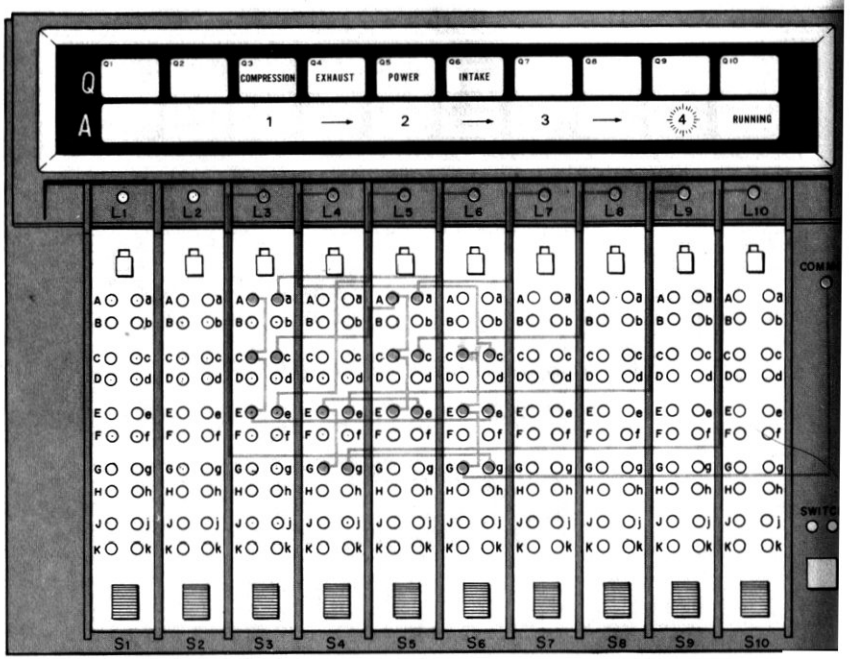
PROGRAM 60: FOUR STROKE ENGINE

Connect wires as shown. The functions of a FOUR STROKE ENGINE must occur in prop sequence for it to operate. For this program, the four functions: COMPRESSION, EXHAUS POWER and INTAKE are listed on the Program Panel Sheet in the "Q" line (Q3 throu Q6). With this program, your Computer can help you place these four functions in th proper sequence. Here we are using "Sequential Logic".

Operation: Select which of the four functions (Q3 through Q6) you think is first, then pu up the Slide Switch (either of S3 through S6) under it. Select the second, third and four the same way. To be correct, you must light up 1→ first, then 2→ , then 3→ and last ..... RUNNING.

Solution: Push up Slide Switches in the following sequence: S6 first, then S3, then S5 a last S4.

NOTES:



PROGRAM 61: SPEED OF SOUND

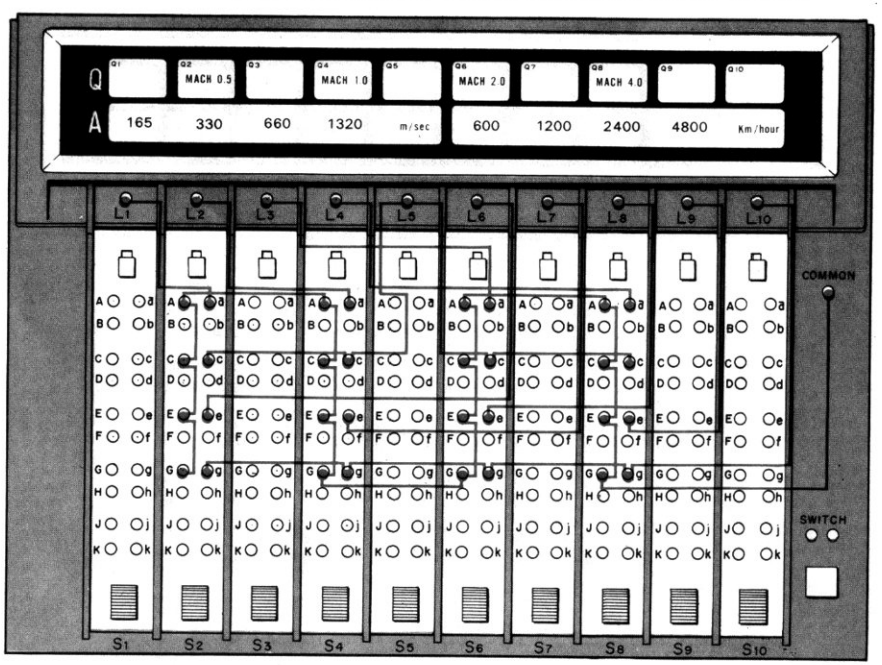
Connect wires as shown. As aircraft began to fly faster than the speed of sound, we began to hear the term "MACH" refered to. MACH is the speed of sound at sea level (1194 km/hour at 0°C). Many mathematical factors are required to calculate MACH at different altitudes and various temperatures but we will not go into all that now. This program will enable your Computer to give you the approximate speed of sound in m/sec (meters per second) and Km/hour (Kilometers per hour).

Operation: Select either MACH 0.5, MACH 1.0, MACH 2.0 or MACH 4.0 from the "Q" line (Q2, Q4, Q6 or Q8) and push up the Slide Switch under it. A number plus m/sec will light up on the left and a number plus Km/hour will light up on the right side.

Caution: Push up only one switch at a time. Be sure to pull it back down before pushing up another one. To fail to do so will only confuse the Computer and cause it to give you an incorrect answer.

Note: To convert Km/hour into mph (miles per hour) divide Km/hour by 1.609.

NOTES:



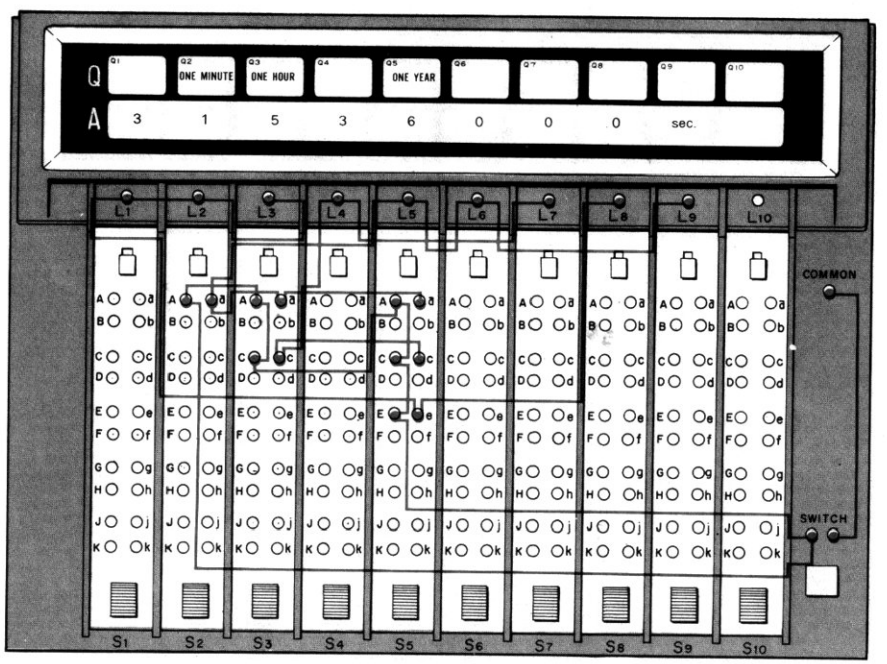
PROGRAM 62: MINUTE, HOUR AND YEAR

Connect wires as shown. We should all be aware of where and on what we spend our time. There's an old song entitled "Time waits for no one, it passes you by". We don't mind wasting a second or two but when we think of how seconds add up to minutes and hours and years, we should be extra careful with our seconds. With this program, your Computer can tell you how many seconds are in a minute, in an hour or in a year.

Operation: Push up one of the Slide Switches under either ONE MINUTE, ONE HOUR or ONE YEAR. When you press the SWITCH button, a number plus SEC. (for seconds) will light up.

Caution: Push up only one switch at a time and be sure to pull it back down before pushing up another one. To push up more than one switch at a time will only confuse the Computer and cause it to give you an incorrect answer.

NOTES:



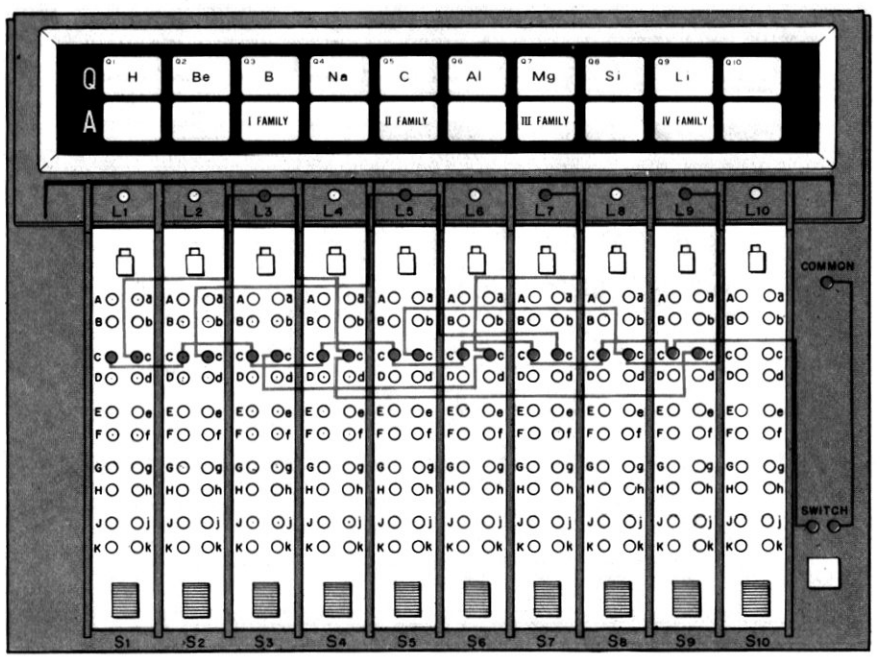
PROGRAM 63: PERIODIC TABLE OF ELEMENTS (1)

Connect wires as shown. In chemistry, we find that elements fall into particular categories, families or groupings. On the Program Panel Sheet for this program, you are given certain chemical symbols in the "Q" line and the titles of some of the families in the ANSWER line. With this program, your Computer can relate each symbol to a family.

Operation: Push up a Slide Switch under any one of the chemical symbols—press the SWITCH button and that element's family or group will light up. Families contain more than one element—for example, H (Hydrogen), Li(Lithium) and Na (Sodium) fall into "I FAMILY" (they all have the same valence).

Caution: Do not push up more than one Slide Switch at a time. To do so will only confuse the Computer and cause it to give you an incorrect answer. Always make sure all the Slide Switches are pulled back (down) before pushing up another one.

NOTES:



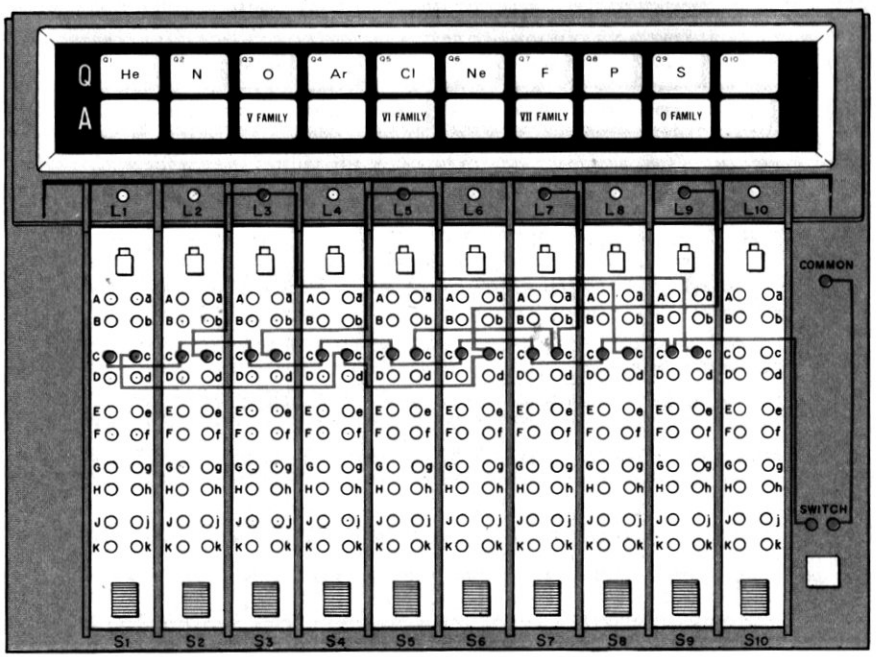
PROGRAM 64: PERIODIC TABLE OF ELEMENTS (2)

Connect wires as shown. As in the previous program, we find that some elements fall into groups categories or families. On this Program Panel Sheet you are given another list of elements in the "Q" line and the titles of some more families in the ANSWER line. With this program, your Computer can relate each symbol to a family.

Operation: Push up a Slide Switch under any one of the chemical symbols—press the SWITCH button and that element's family or group will light up. Families contain more than one element—for example, N (Nitrogen) and P (Phosphorus) fall into "V FAMILY" (they both have the same valence).

Caution: Do not push up more than one Slide Switch at a time. To do so will only confuse the Computer and cause it to give you an incorrect answer. Always make sure all the Slide Switches are pulled back (down) before pushing up another one.

NOTES:

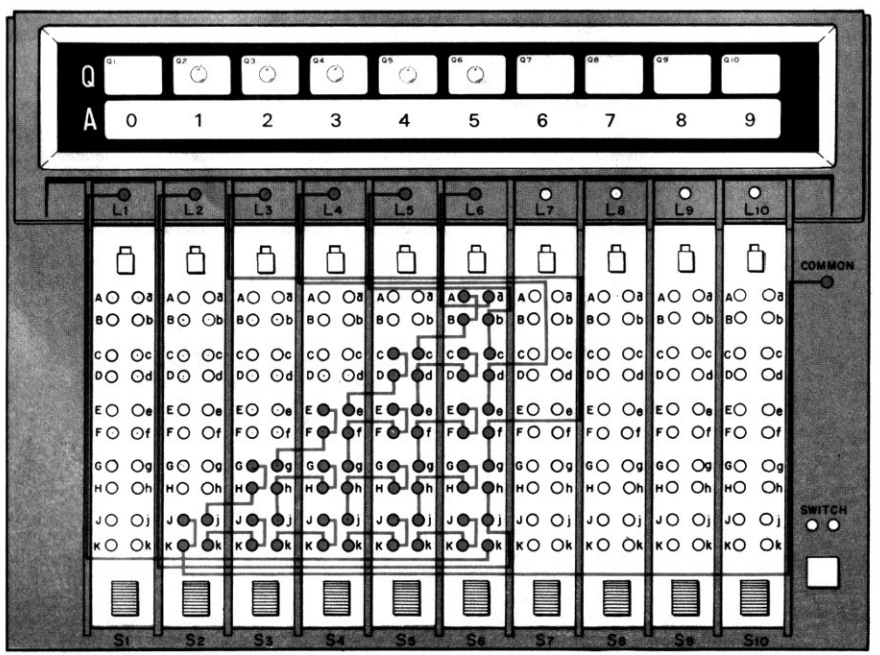


PROGRAM 65: COUNTING

Connect wires as shown. In this program, your Computer appears to think for itself. You can select any number of apples from one to five. (Q2 through Q6) by pushing up the Slide Switch under each one you select. Quicker'n you can bat your eye, your Computer adds them up and lights up their sum in the ANSWER line. They don't have to be in sequence—you can select any one (Q2 through Q6) and the number "1" will light up or select two to get the number "2" and so on. Notice that with all the Slide Switches down (pulled back), the "0" will light.

Now, as you can see, with this program your Computer can be used for counting. Try skipping numbers or entering your selection in reverse (Q6 through Q2)—you'll find you can't fool this witty Computer.

NOTES:



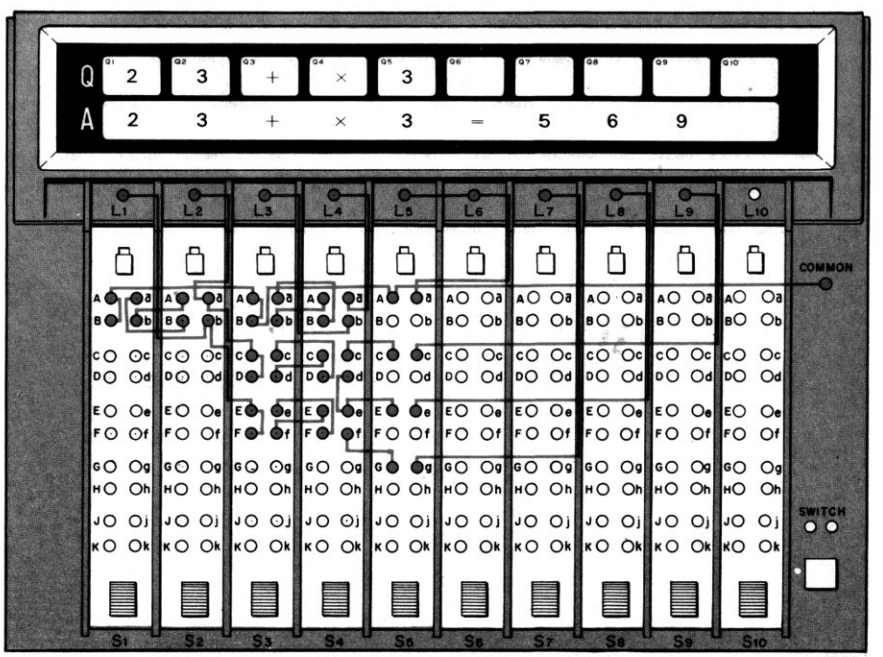
PROGRAM 66: CALCULATOR (1)

Connect wires as shown. With this program, you can use your Computer as a calculator for either addition or multiplication. Of course, we are limited here by the information given on the Program Panel Sheet but you will probably catch on to the program principle and be able to make up more programs and add Program Panel Sheets on your own.

Operation: Select either the number 2 (Q1) or the number 3 (Q2) and push up the Slide Switch under either it, then push up the Slide Switch under either "+" for addition or "x" for multiplication and finally, push up the the Slide Switch under the number 3 (Q3). The numbers and signs you've selected, plus the answer, will light up in the ANSWER line.

Solution: (a) 2+3 = 5, (b) 3+3 = 6, (c) 2x3 = 6, (d) 3x3 = 9

NOTES:



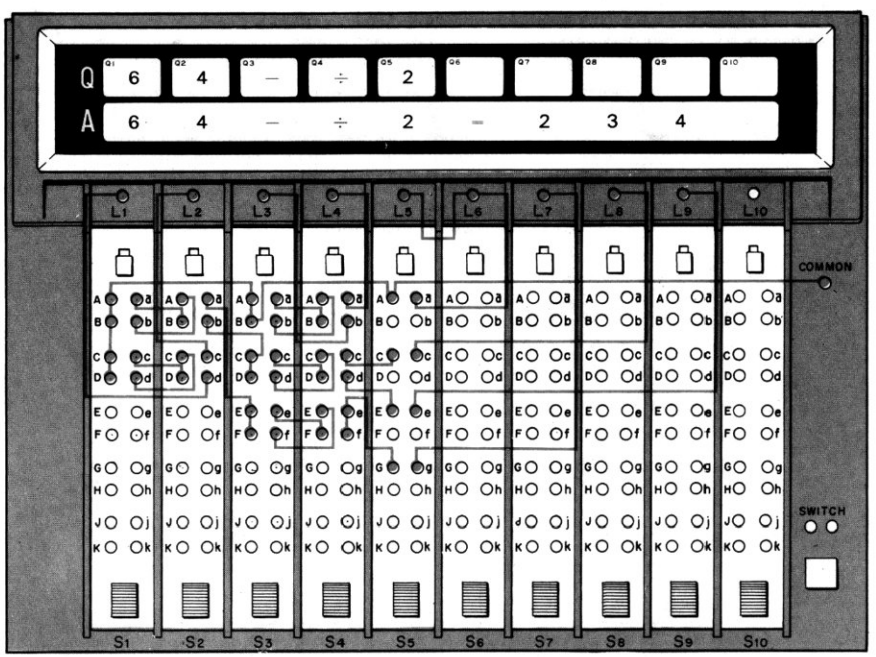
PROGRAM 67: CALCULATOR (2)

Connect wires as shown. Here's another program where you can use your Computer as a calculator but this time the program calls for subtraction or division. Here again, we are limited to the numbers on the Program Panel Sheet but by now you've more than likely caught on the the programming principle and you can expand the program on your own.

Operation: Select either the number 6 (Q1) or the number 4 (Q2) and push up the Slide Switch under it, then push up the Slide Switch under either "–" for subtraction or "÷" for division and finally, push up the Slide Switch under the number 2. The numbers and signs you've selected, plus the answer, will light up in the ANSWER line.

Solution: (a) $4-2=2$, (b) $6-2=4$, (c) $4\div2=2$, (d) $6\div2=3$

NOTES:

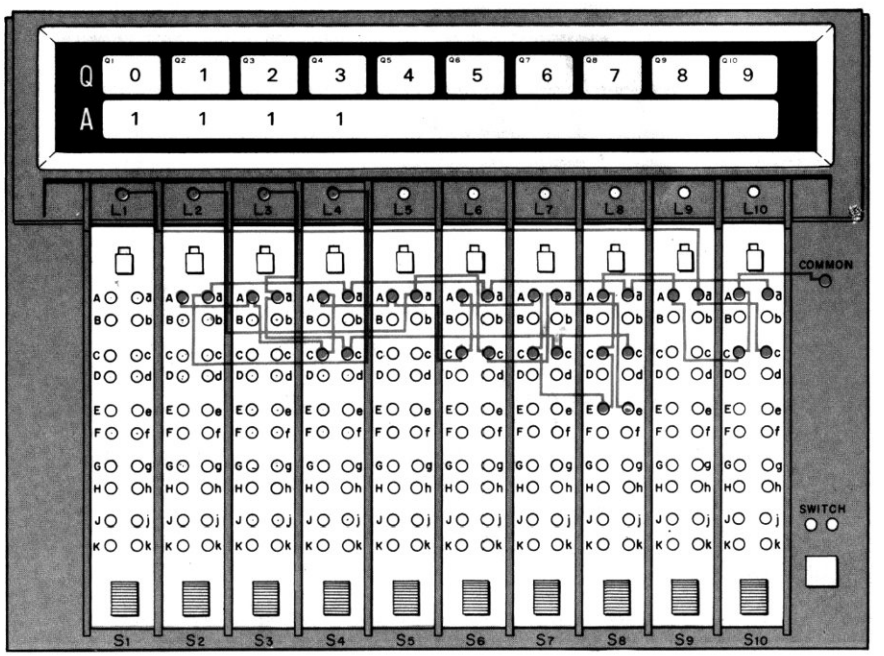


PROGRAM 68: DECIMAL TO BINARY CONVERTER

Connect wires as shown. With this program, your Computer can help you convert Decimal Numbers (0 to 9, used in mathematics) to Binary Numbers (either 0 or 1, used in computers). Binary Numbers are read "0" for "off" and "1" for "on", left to right. For example, if the first three spaces are "off" (no light) and the fourth space is "on" (lit up), you read it 0001. (This is equal to the Decimal Number "1".)

Operation: Push up a Slide Switch under any one of the numbers (0 to 9) in the "Q" line (Q1 through Q10)—the Binary Number will light up in the ANSWER line. Do not push up more than one Slide Switch at a time.

Decimal Numbers	Binary Numbers
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001



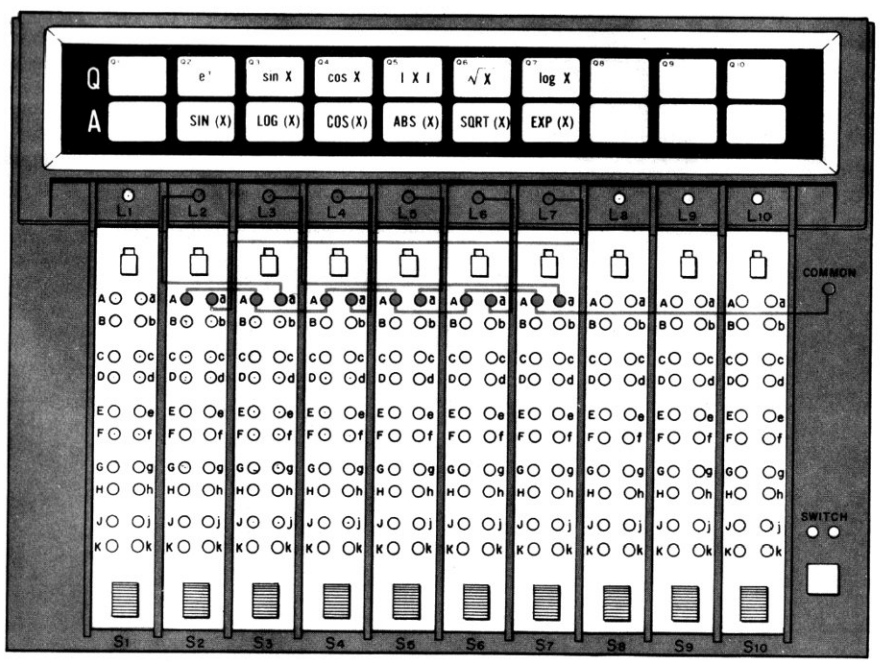
PROGRAM 69: SUBROUTINES IN FORTRAN

Connect wires as shown. In this program, we will introduce you to FORTRAN (FORmula TRANslation). This is a procedure-oriented computer language designed to be used with problems that can be written as a formula. To put it more simply, your Computer can help you translate algebraic symbols into a language used by some computers.

Operation: Push up the Slide Switch under any one of the algebraic notations in the "Q" line (Q2 through Q7). The FORTRAN equivalent of your selection will light up in the ANSWER line. Do not push up more than one Slide Switch at a time.

Algebraic Notation	FORTRAN
e^x	EXP (x)
sin X	SIN (x)
cos X	COS (x)
$\|x\|$	ABS (x)
$\sqrt{x}$	SQRT (x)
log X	LOG (x)

NOTES:

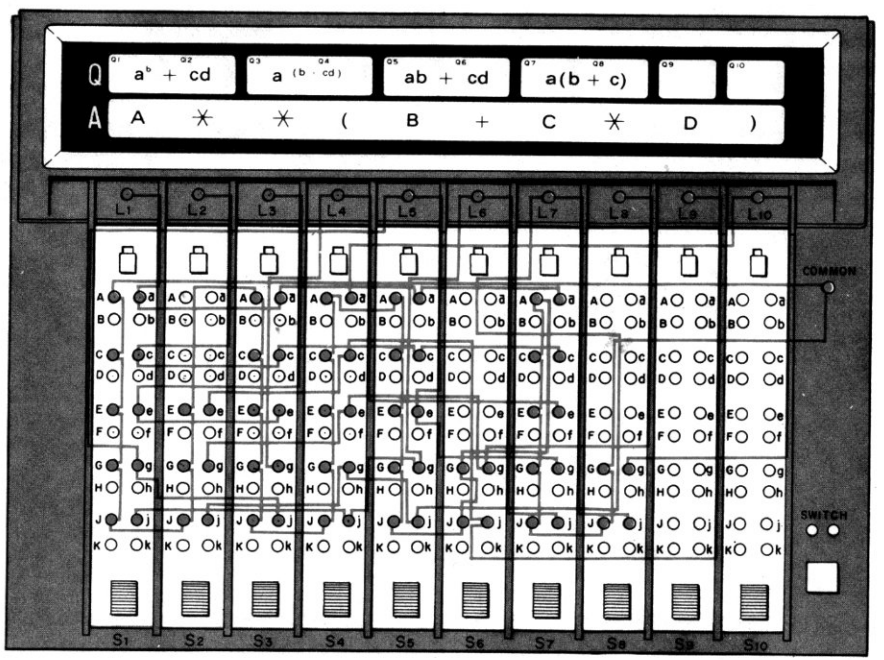


PROGRAM 70:
FORTRAN WRITING FORMAT FOR ARITHMETIC OPERATIONS (1)

Connect wires as shown. In the program previous to this one, we introduced you to FORTRAN. Now we will give you some further exposure to this computer language. With this program, your Computer can help you translate some algebraic notations into FORTRAN.

Operaton: On the Program Panel Sheet, the algebraic notations are written across a pair of question blocks. Select one of the pairs (Q1 & Q2, Q3 & Q4, Q5 & Q6 or Q7 & Q8) and push up the two Slide Switches under that pair. Your Computer will translate the algebraic notation and light up its FORTRAN equivalent in the ANSWER line. Do not push up more than one pair of Slide Switches at a time.

Algebraic Notation	FORTRAN
$a^b + cd$	A**B + C*D
$a^{(b+cd)}$	A**(B + C*D)
ab + cd	A*B + C*D
a(b + c)	A*(B + C)



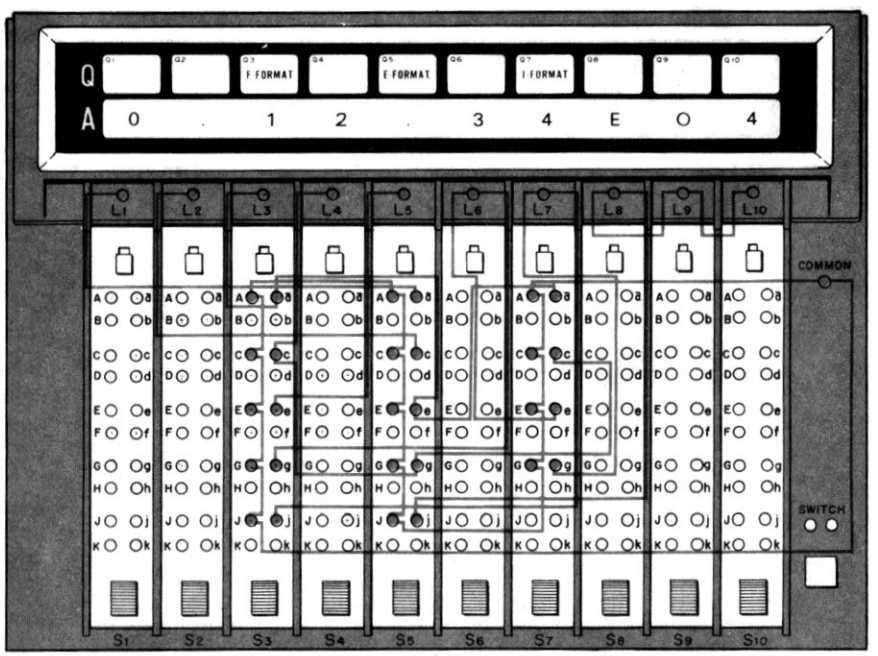
PROGRAM 71:
FORTRAN WRITING FORMAT FOR ARITHMETIC OPERATIONS (2)

Connect wires as shown. As you learn more about FORTRAN, you will find some computer programs that use formats. These formats contain certain pre-entered data which help to lessen the task for the programmer and make the computer's work easier. Your Computer, programed as it is now, can tell you the FORTRAN for the formats (F,E and I) listed on the Program Panel Sheet.

Operation: Select either F-FORMAT (Q3), E-FORMAT (Q5) or I-FORMAT (Q7)– push up the Slide Switch under the one you select and its FORTRAN equivalent will light up in the ANSWER line. Do not push up more than one Slide Switch at a time.

Format	FORTRAN
F-FORMAT	12.34
E-FORMAT	0.12E04
I- FORMAT	1234

NOTES:

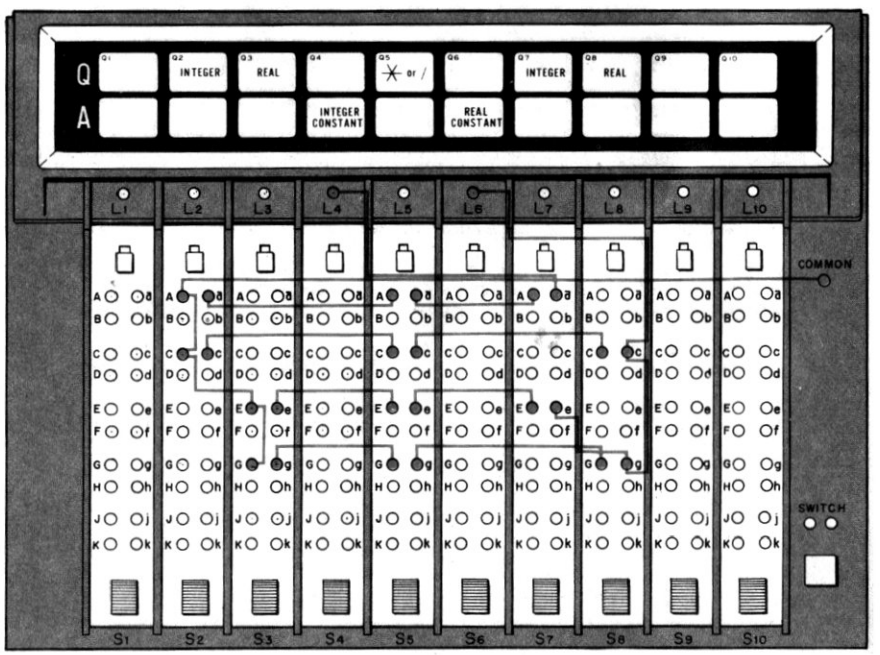


PROGRAM 72:
FORTRAN WRITING FORMAT FOR ARITHMETIC OPERATIONS (3)

Connect wires as shown. Certain terms, such as, INTEGER and REAL are used in computer FORTRAN. This program will enable your Computer to tell you if a given sequence is an INTEGER CONSTANT or a REAL CONSTANT. You may have already noticed, but this program uses "Sequential Logic" which we discussed earlier in this manual.

Operaton: Select either INTEGER or REAL (Q2 or Q3) on the left side of the Program Panel and push up one of the Slide Switches under your choice. Push up S5 (under Q5) to enter * or / into the sequence. Now select either INTEGER or REAL (Q7 or Q8) on the right side and push up the Slide Switch under your choice. Your Computer will respond by lighting up either INTEGER CONSTANT or REAL CONSTANT.

NOTES:

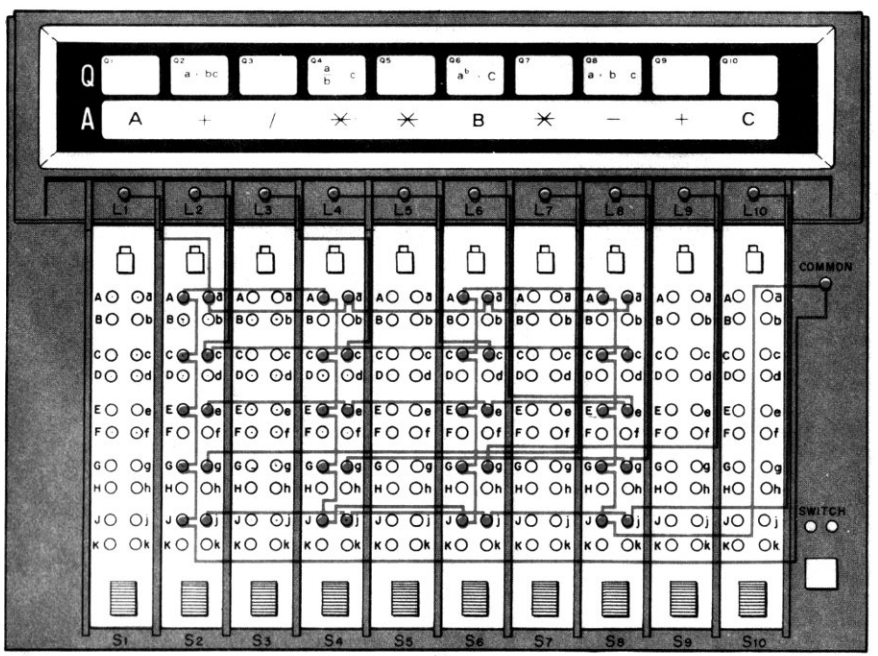


PROGRAM 73:
FOTRAN WRITING FORMAT FOR ARITHMETIC OPERATIONS (4)

Connect wires as shown. A computer can't solve an algebraic problem in the same form we use. You have to translate your problem into a computer language, such as FORTRAN. Then the computer can take even an extremly complex problem and in just a few millionths of a second—there's the answer. With this program, your Computer can help you convert some more algebraic problems into FORTRAN. As you become more familiar with the FORTRAN symbols shown on this Program Panel Sheet, you may be able to write additional programs to convert other problems to FORTRAN.

Operation: Select any one of the problems from the "Q" line (Q2, Q4, Q6 or Q8) and push up the Slide Switch under your choice. The FORTRAN equivalent for that problem will light up in the ANSWER line. Read the lit symbols from left to right. Do not push up more than one Slide Switch at a time.

Algebraic Problem	FORTRAN Problem
$a + bc$	A + B*C
$\frac{a}{b} - c$	A/B − C
$a^b + c$	A**B + C
$a + b - c$	A + B − C



PROGRAM 74: ADDITION BY SELECTION

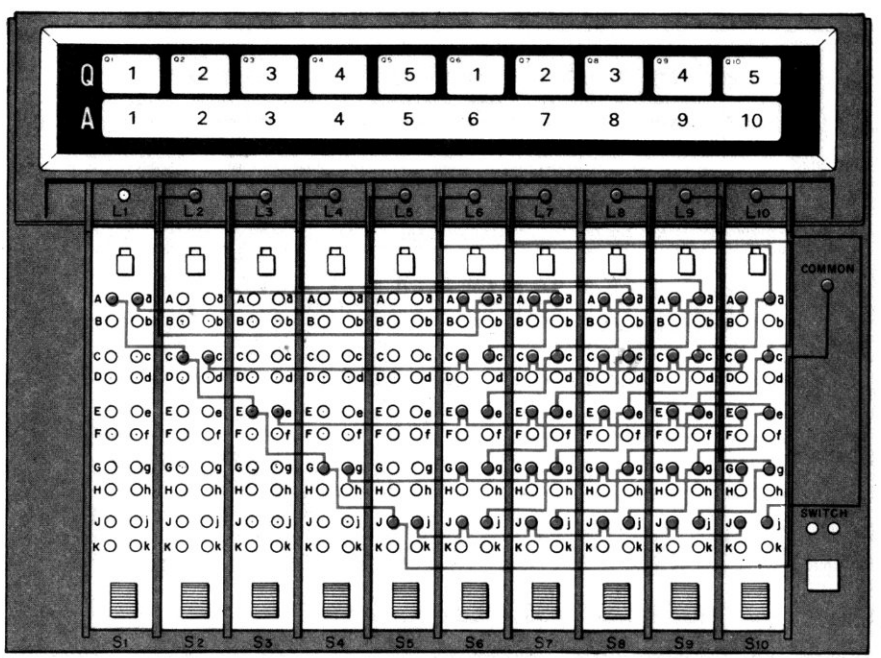
Connect wires as shown. Your Computer can use this "Sequential Logic" program to help you add numbers by selection. This is a very simple program, so if you've been a bit reluctant before this to try your hand at writing your own program, this could be a good one to try.

Operation: There are two sets of numbers in the "Q" line. The first set is the numbers 1 through 5 (Q1 through Q5) and the second set repeats the numbers 1 through 5 (Q6 through Q10). Select one of the numbers from the first set and push up the Slide Switch under your choice, then select one of the numbers from the second set and push up the Slide Switch under your choice. The sum of the two numbers you selected will light up in the ANSWER line.

	1 (Q6)	2 (Q7)	3 (Q8)	4 (Q9)	5 (Q10)
1 (Q1)	2	3	4	5	6
2 (Q2)	3	4	5	6	7
3 (Q3)	4	5	6	7	8
4 (Q4)	5	6	7	8	9
5 (Q5)	6	7	8	9	10

The chart at the left represents **a matrix** or you can even think of it as a **number-chart memory**. In Computers, numbers (or data or information) are stored in locations which can be identified by the two co-ordinates.

Example: Location Q4, Q9 = 8.

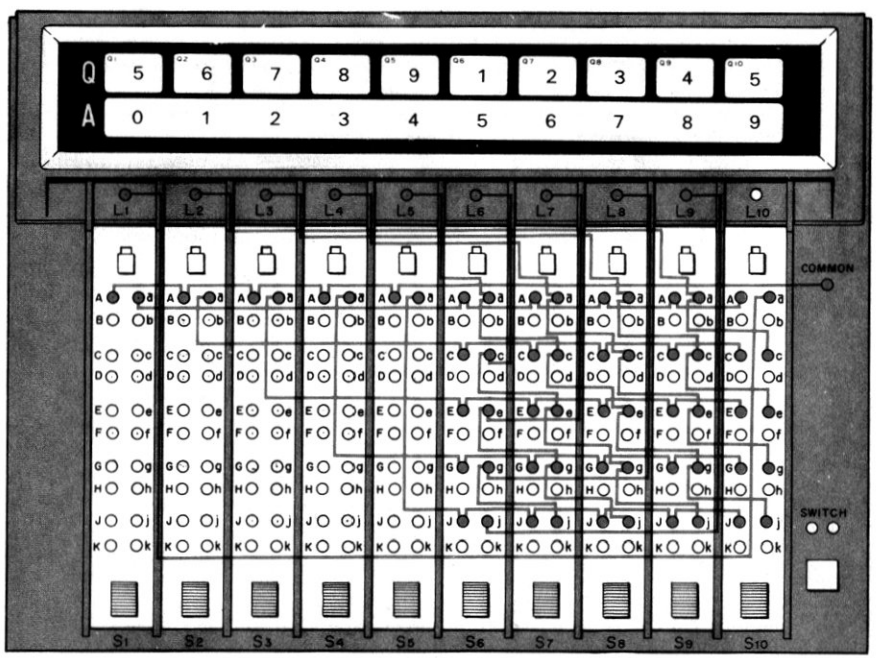


PROGRAM 75: SUBTRACTION BY SELECTION

Connect wires as shown. This is another "Sequential Logic" program—with it, your Computer can help you perform subtraction by selection. As you can see, we are limited to the numbers listed on the Program Panel Sheet, but if you wish to expand this list, you should not have much difficulty doing so.

Operation: There are two sets of numbers in the "Q" line. The first set is the numbers 5 through 9 (Q1 through Q5) and the second set repeats the numbers 1 through 5 (Q6 through Q10). Select one of the numbers from the first set and push up the Slide Switch under your choice, then select one of the numbers from the second set and push up the Slide Switch under your choice. The difference of the two numbers you selected will ight up in the ANSWER line.

	1 (Q6)	2 (Q7)	3 (Q8)	4 (Q9)	5 (Q10)
5 (Q1)	4	3	2	1	0
6 (Q2)	5	4	3	2	1
7 (Q3)	6	5	4	3	2
8 (Q4)	7	6	5	4	3
9 (Q5)	8	7	6	5	4



PROGRAM 76: MATHEMATICAL SQUARES

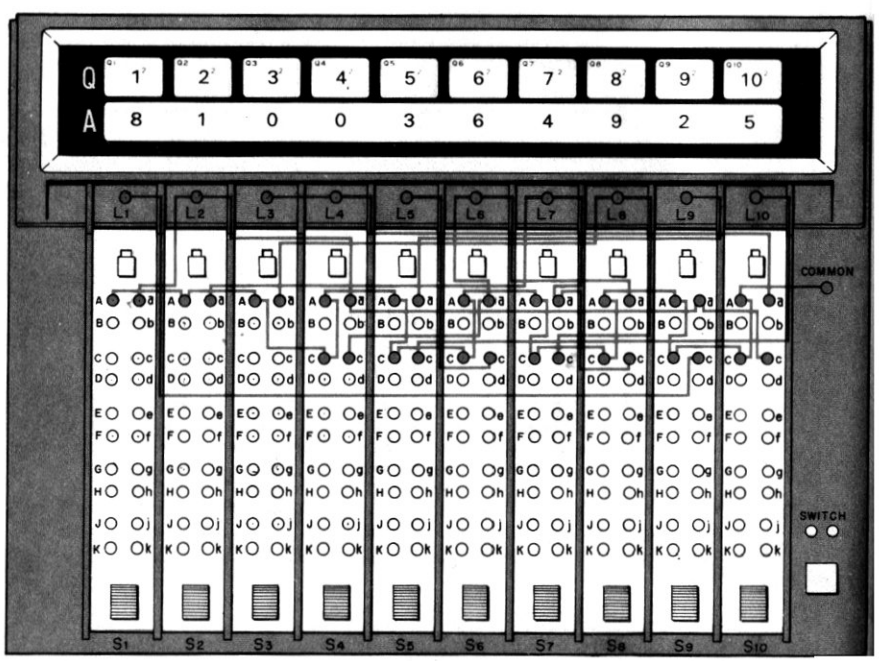
Connect wires as shown. Here's an easy way for you to find out the value of the square of a number from 1 to 10. With this program your Computer will be able to give you the square of a number in the blink of an eye.

Operation: Select any one of the numbers 1 through 10 (Q1 through Q10) and push up the Slide Switch under your choice. The square of that number will light up in the ANSWER line. Push up only one Slide Switch at a time—be sure all Slide Switches are pulled back down before pushing up another one.

Solution:

$1^2 = 1$	$6^2 = 36$
$2^2 = 4$	$7^2 = 49$
$3^2 = 9$	$8^2 = 64$
$4^2 = 16$	$9^2 = 81$
$5^2 = 25$	$10^2 = 100$

NOTES:



PROGRAM 77: THE POWERS OF 2

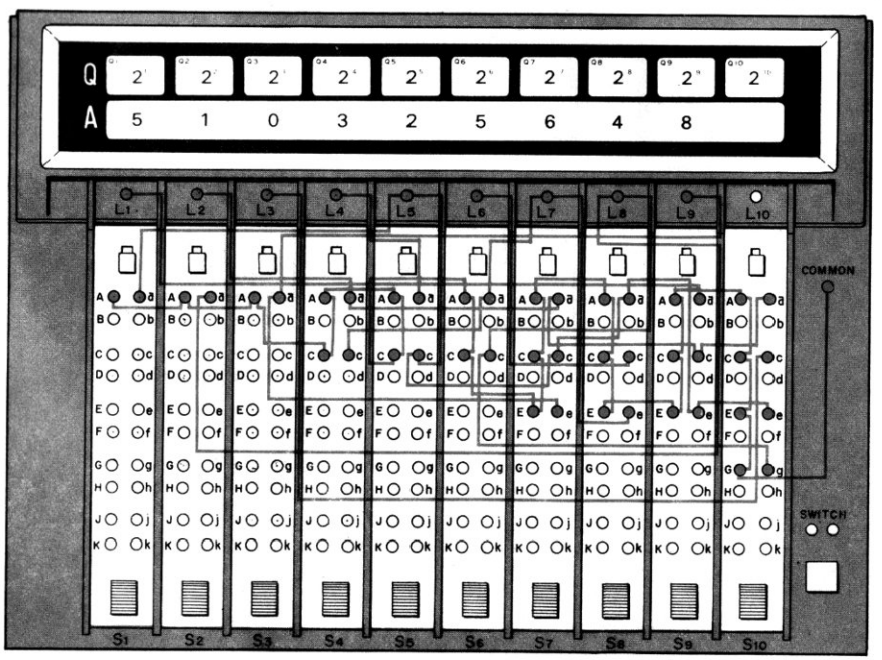
Connect wires as shown. With this program, your Computer can give you the numerical value for 2 raised to a power from 1 to 10. It's with problems like these that your Computer can really save your time. For example, you can have the answer with your Computer before you could write the problem down on paper in long-hand.

Operation: Select a 2 with any power from 1 to 10 (Q1 through Q10) and push up the Slide Switch under your choice. The solution to the problem will light up in the ANSWER line. Read lit numbers from left to right. Do not push up more than one switch at a time.

Solution:

$2^1 = 2$	$2^6 = 64$
$2^2 = 4$	$2^7 = 128$
$2^3 = 8$	$2^8 = 256$
$2^4 = 16$	$2^9 = 512$
$2^5 = 32$	$2^{10} = 1024$

NOTES:

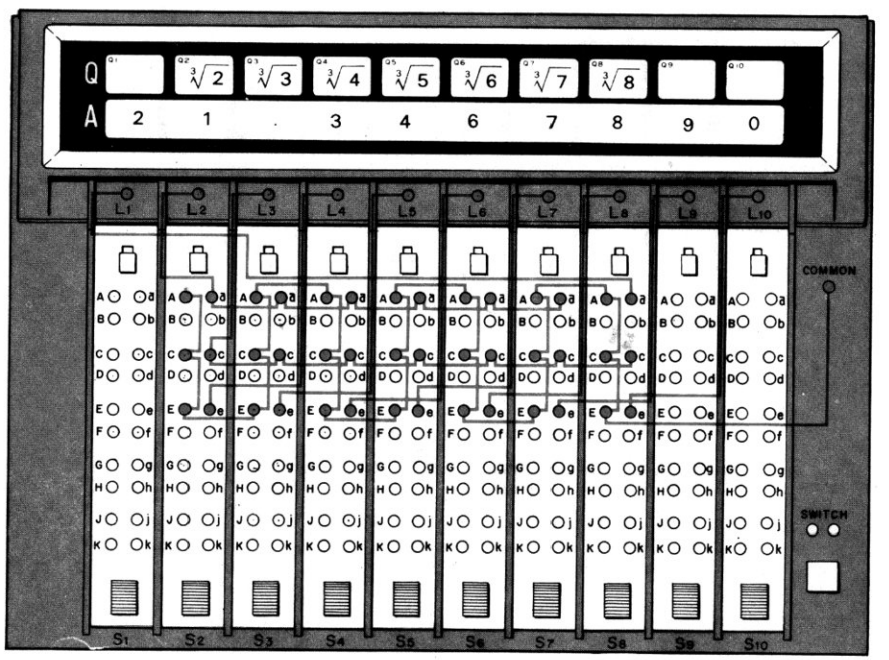


PROGRAM 78: CALCULATING A CUBE ROOT

Connect wires as shown. Your Computer functions with this program to give you the cube root of numbers. It does not give you a complete number but rather rounds the number off to the next highest "tenth" digit. Larger and more sophisticated computers can carry the numbers out for several digits but you'll get the idea how it works.

Operaton: Select any one of the cube root problems from the "Q" line (Q2 through Q8) and push up the Slide Switch under your choice. The solution to the problem will light up in the ANSWER line. Read lit numbers from left to right. Do not push up more than one switch at a time.

Solution: $\sqrt[3]{2} = 1.3$
$\sqrt[3]{3} = 1.4$
$\sqrt[3]{4} = 1.6$
$\sqrt[3]{5} = 1.7$
$\sqrt[3]{6} = 1.8$
$\sqrt[3]{7} = 1.9$
$\sqrt[3]{8} = 2.0$

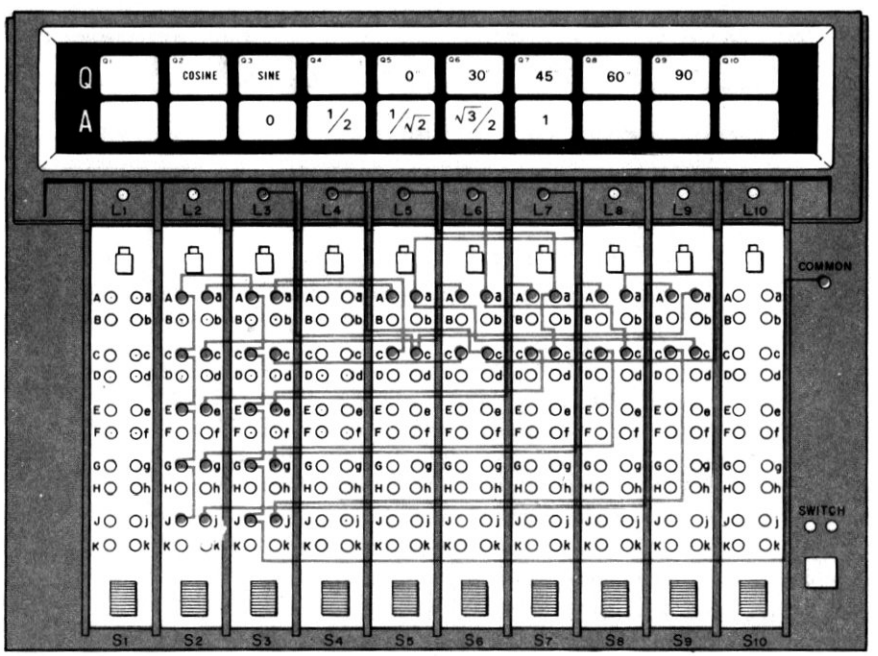


PROGRAM 79: SINE AND COSINE FUNCTIONS

Connect wires as shown. With this program, your Computer can give you the SINE and COSINE values for 0°, 30°, 45°, 60° and 90°

Operation: Select either COSINE (Q2) or SINE (Q3) and push up the Slide Switch under your choice—leave it up, then select one of the given angular degrees (Q5 through Q9) and push up the Slide Switch under your choice. The solution for the problem will light up in the ANSWER line.

Solution:
(a) Q2, Q5 ..... $\cos 0^\circ = 1$
(b) Q2, Q6 ..... $\cos 30^\circ = \sqrt{3}/2$
(c) Q2, Q7 ..... $\cos 45^\circ = 1/\sqrt{2}$
(d) Q2, Q8 ..... $\cos 60^\circ = 1/2$
(e) Q2, Q9 ..... $\cos 90^\circ = 0$
(f) Q3, Q5 ..... $\sin 0^\circ = 0$
(g) Q3, Q6 ..... $\sin 30^\circ = 1/2$
(h) Q3, Q7 ..... $\sin 45^\circ = 1/\sqrt{2}$
(i) Q3, Q8..... $\sin 60^\circ = \sqrt{3}/2$
(j) Q3, Q9 ..... $\sin 90^\circ = 1$

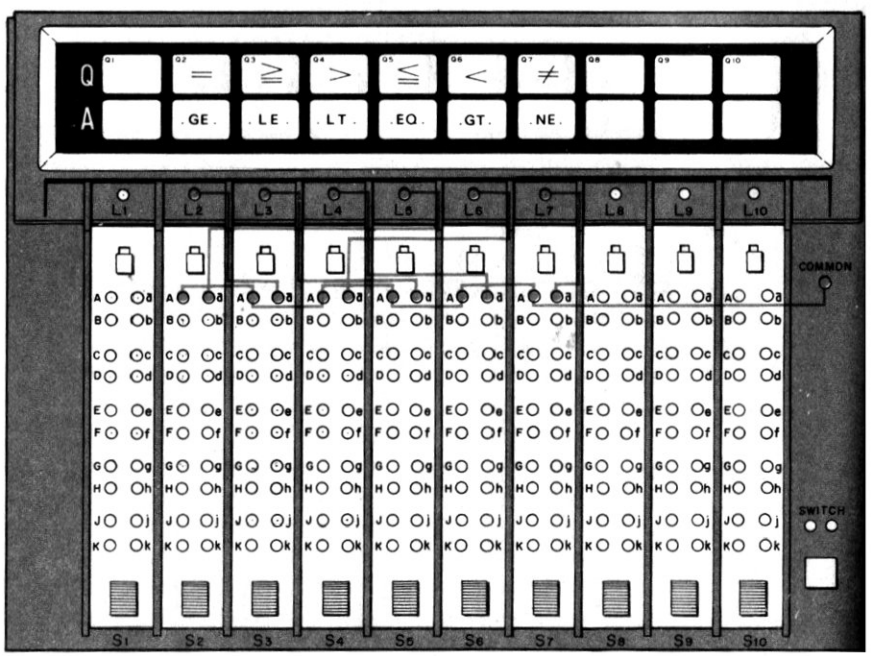


PROGRAM 80: OPERATORS INTO FORTRAN

Connect wires as shown. Remember a few programs back, we talked a little about FORTRAN? Here's a program that will enable your Computer to convert certain mathematical symbols into the FORTRAN equivalent.

Operation: Select one of the mathematical symbols in the "Q" line (Q2 through Q7) and push up the Slide Switch under your choice. The FORTRAN equivalent of that symbol will light up in the ANSWER line. Push up only one Slide Switch at a time, then pull it back down (towards you) before pushing up another one.

Solution:
= ..... .EQ. (equal to)
≧ ..... .GE. (equal or greater than)
> ..... .GT. (greater than)
≦ ..... .LE. (equal or less than)
< ..... .LT. (less than)
≠ ..... .NE. (not equal to)



PROGRAM 81: RESOLVING INTO FACTORS (1)

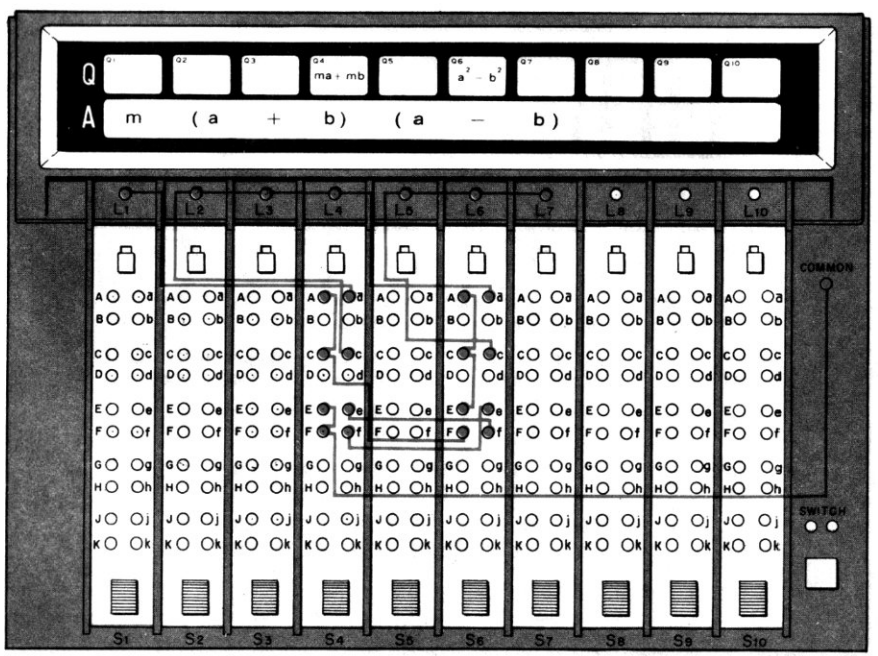
Connect wires as shown. This program will enable your Computer to take two algebraic expressions (ma + mb and $a^2 - b^2$) and resolve them into factors.

Operation: Select one of the algebraic expressions (Q4 or Q6) and push up the Slide Switch under your choice. Your Computer will work the problem instantly and cause the factors to light up in the ANSWER line.

Caution: Push up only one Slide Switch at a time and be sure to pull it back down before pushing up another one.

Solution: $ma + mb = m(a + b)$
$a^2 - b^2 = (a + b)(a - b)$

NOTES:



PROGRAM 82: RESOLVING INTO FACTORS (2)

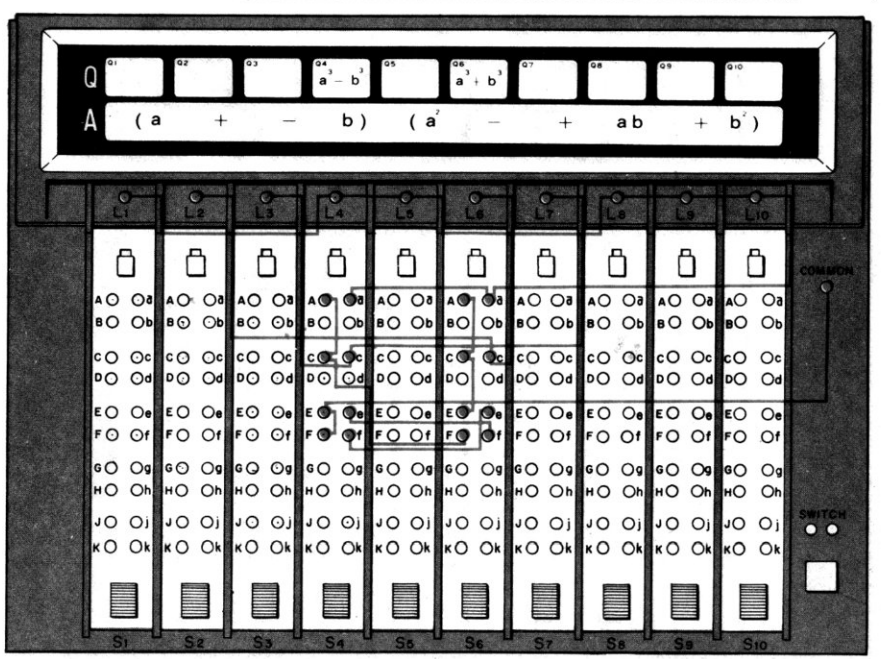
Connect wires as shown. Here's another program with which your Computer can take algebraic expressions ($a^3 + b^3$ and $a^3 - b^3$) and resolve them into factors.

Operation: Select one of the algebraic expressions (Q4 or Q6) and push up the Slide Switch under your choice. Your Computer will work the problem instantly and cause the factors to light up in the ANSWER line.

Caution: Push up only one Slide Switch at a time and be sure to pull it back down before pushing up another one.

Solution: $a^3 + b^3 = (a + b)(a^2 - ab + b^2)$
$a^3 - b^3 = (a - b)(a^2 + ab + b^2)$

NOTES:



PROGRAM 83: AREA OF SHAPES

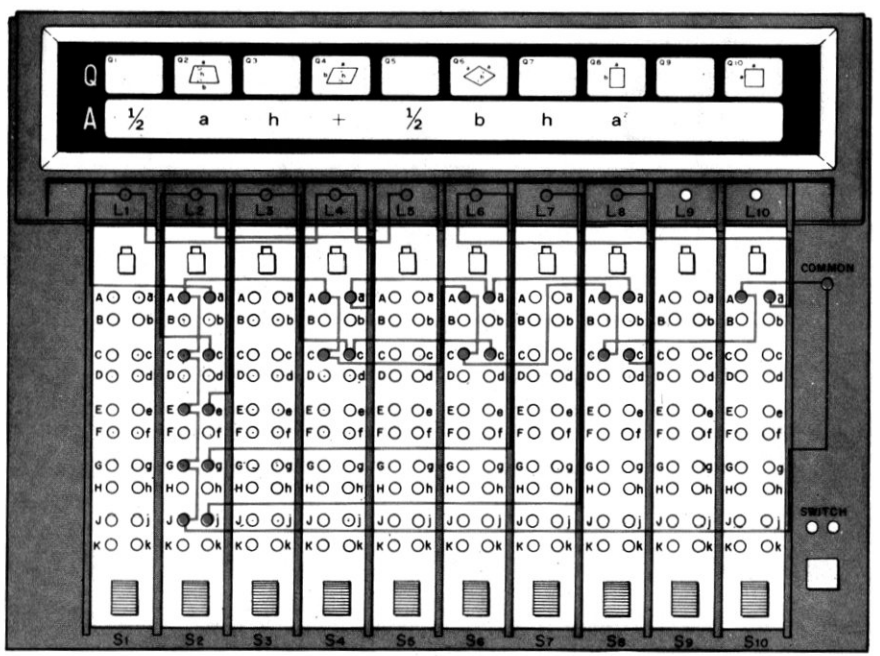
Connect wires as shown. Ever have trouble remembering the formula for the area of certain shapes? Most of us do from time to time. Here's a program for your Computer that serves as a neat reminder. It will give you the formula for finding the area of a TRAPEZOID, PARALLELOGRAM, RHOMBUS, RECTANGLE or SQUARE.

Operation: Select one of the shapes (Q2, Q4, Q6, Q8 or Q10) and push up the Slide Switch under your choice. The formula you need will light up in the ANSWER line. You read the lighted symbols from left to right. Do not push up more than one Slide Switch at a time.

Solution:

TRAPEZOID	1/2 ah + 1/2 bh = 1/2 h(a + b)
PARALLELOGRAM	ah
RHOMBUS	ah
RECTANGLE	ab
SQUARE	a^2

NOTES:



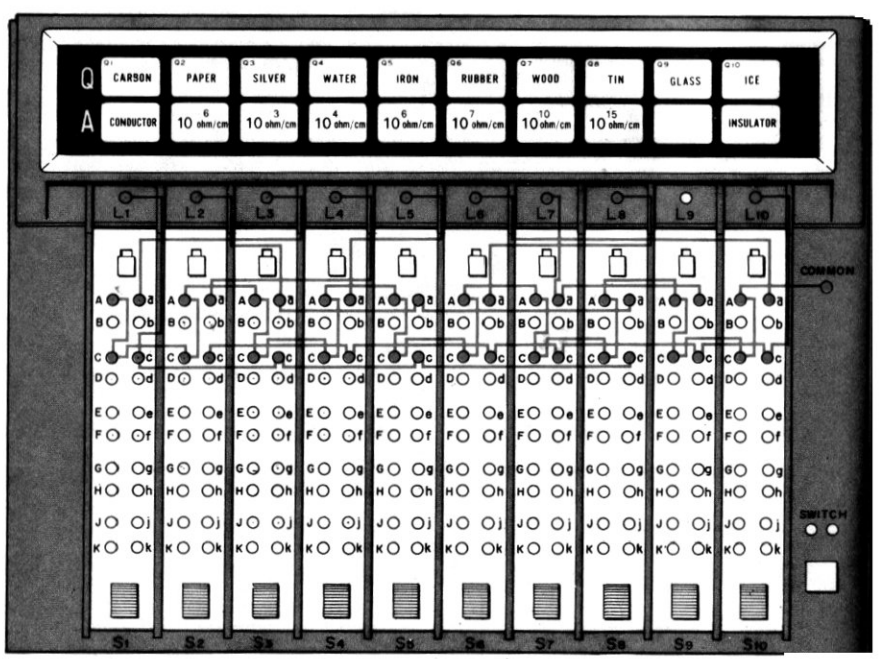
PROGRAM 84: CONDUCTORS AND INSULATORS

Connect wires as shown. The next several programs deal with some factors concerning electronics. This program will help you select good insulators and good conductors—this is important when studying electricity. With this program, your Computer will be able to give you information about certain materials—whether they are CONDUCTORS or INSULATORS of electrical current and the value of their electrical resistance.

Operation: Select one of the materials from the "Q" line (Q1 through Q10). Push up the Slide Switch under your choice. In the ANSWER line, your Computer will light up either CONDUCTOR or INSULATOR along with a value of electrical resistance for the material you selected.

Caution: Push up only one Slide Switch at a time and make sure it is pulled back down before pushing up another one.

NOTES:

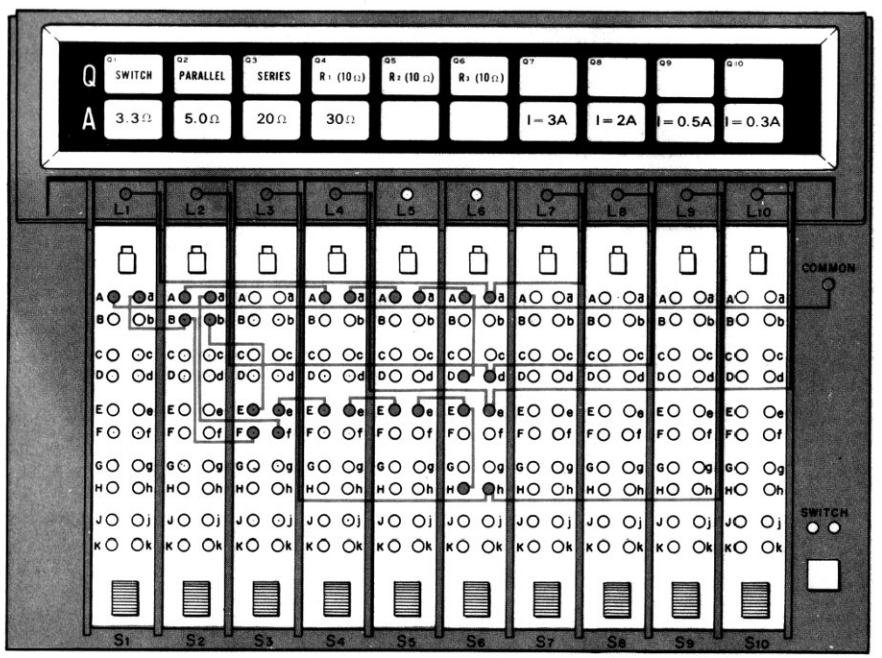


PROGRAM 85: OHM'S LAW

Connect wires as shown. If you are going to work with electricity or electronics you'll have to know Ohm's Law. You'll find that current increases or decreases in proportion to voltage; also, that it increases or decreases inversely proportional to resistance. The formula for OHM's LAW is: I (current) equals E (voltage) divided by R (resistance). With this program, your Computer can help you find the Resistance and the Current for either Parallel or Series circuits assuming Voltage is set at 10 volts.

Operation: Select either PARALLEL (Q2) or SERIES (Q3) and push up the Slide Switch under your choice. Then select a combination of either R1 and R2 (Q4 and Q5) or R1, R2 and R3 (Q4, Q5 and Q6) and push up the Slide Switches under the combination you chose. Push up Slide Switch S1 and the circuit's resistance and current values will light up in the ANSWER line (Resistance will be at the left in [Ω] and Current at the right in Amperes [A]).

NOTES:



PROGRAM 86: RESISTORS IN PARALLEL AND SERIES

Connect wires as shown. For you to find the total resistance of a circuit, you must first determine if it is in Series or Parallel. If the circuit is in Series, the following formula would apply:

$$R_{total} = R1 + R2 + R3 + \cdots\cdots\cdots + Rn$$

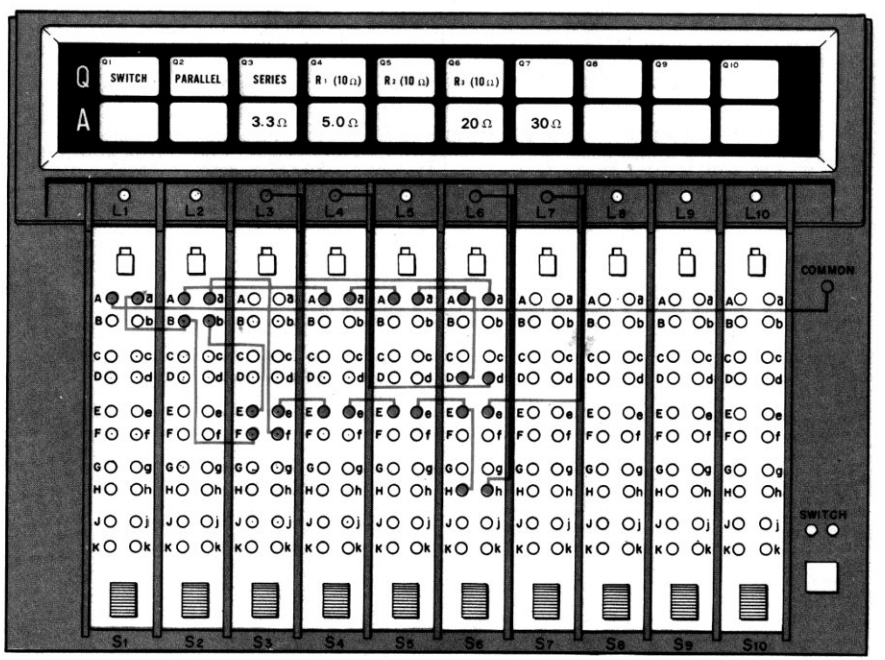
If the circuit is in Parallel, a different formula is used:

$$R_{total} = \frac{1}{\frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \cdots + \frac{1}{Rn}}$$

With this program, your Computer can make these computations easily and give you the correct answer at lightning speed.

Operation: For these calculations, we assign a value of 10 ohms to each Resistor. Select either PARALLEL or SERIES (Q2 or Q3) and push up the Slide Switch under your choice. Now, select a combination of either R1 and R2 (Q4 and Q5) or R1, R2 and R3 (Q4, Q5 and Q6) and push up the Slide Switches under the combination you selected. OK now, push up Slide Switch S1 under SWITCH (Q1) and your Computer will light up either 3.3Ω, 5.0Ω, 20Ω, or 30Ω in the ANSWER line.

Solution: Series . . . . . (a) R1, R2 : 20 Ohms, (b) R1, R2, R3 : 30 Ohms
Parallel . . . . . (b) R1, R2 : 5.0 Ohms, (b) R1, R2, R3 : 3.3 Ohms



PROGRAM 87: CALCULATION OF COMBINED SERIES AND PARALLEL RESISTANCES

Connect wires as shown. In the previous program we showed you how to calculate either a Series or Parallel resistance circuit. In this program we will see how your Computer can calculate the total resistance of a combination of Series and Parallel resistance circuits.

Operation: For these calculations we assign a value of 10 Ohms to all resisters (R1 through R6). Select a combination of either R1 and R2 (Q2 and Q3) or R1, R2 and R3 (Q2, Q3 and Q4) and push up the Slide Switches under your selections. Then, select either R4 (Q6) or a combination of R4 and R5 (Q6 and Q7) or all three, R4, R5 and R6 (Q6, Q7 and Q8) and push up the Slide Switches under the combination you chose. All set? OK now, push up Slide Switch S1 under SWITCH (Q1) and your Computer will light up the result in the ANSWER line.

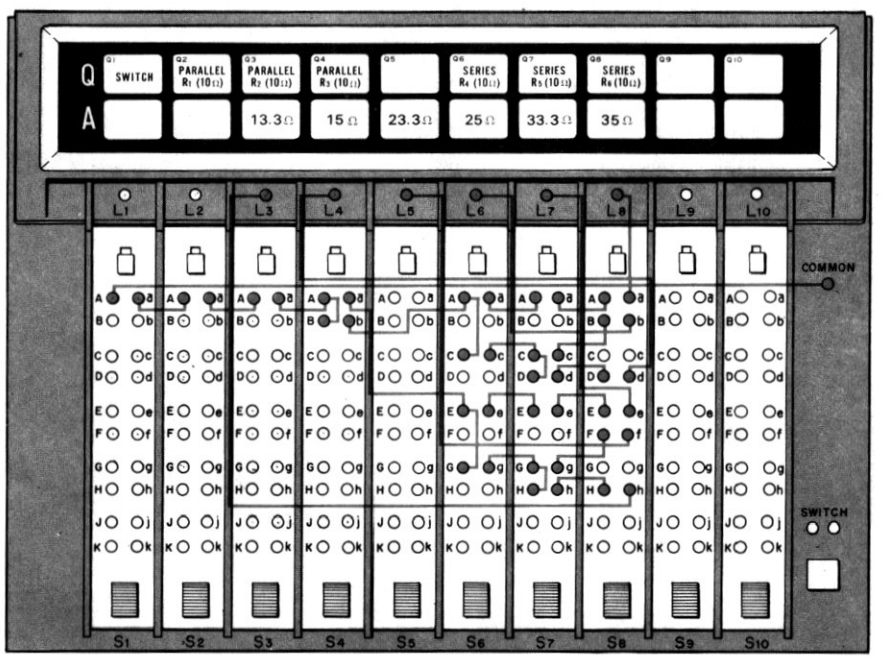
Solution:

(a) R1, R2, R4: 15Ω, (b) R1, R2, R4, R5 : 25Ω

(c) R1, R2, R4, R5, R6 : 35Ω, (d) R1, R2, R3, R4 : 13.3Ω

(e) R1, R2, R3, R4, R5 : 23.3Ω, (f) R1, R2, R3, R4, R5, R6 : 33.3Ω

NOTES:



PROGRAM 88: CAPACITORS IN PARALLEL AND SERIES

Connect wires as shown. In this program you can learn how to calculate either Series or Parallel Capacitance circuits. First, you must determine if a circuit is in Series or Parallel. If it is in Series, you would have to use the following formula:

$$C\ total = \frac{1}{\frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \cdots + \frac{1}{Cn}}$$

If the circuit is in Parallel, another formula would be used:

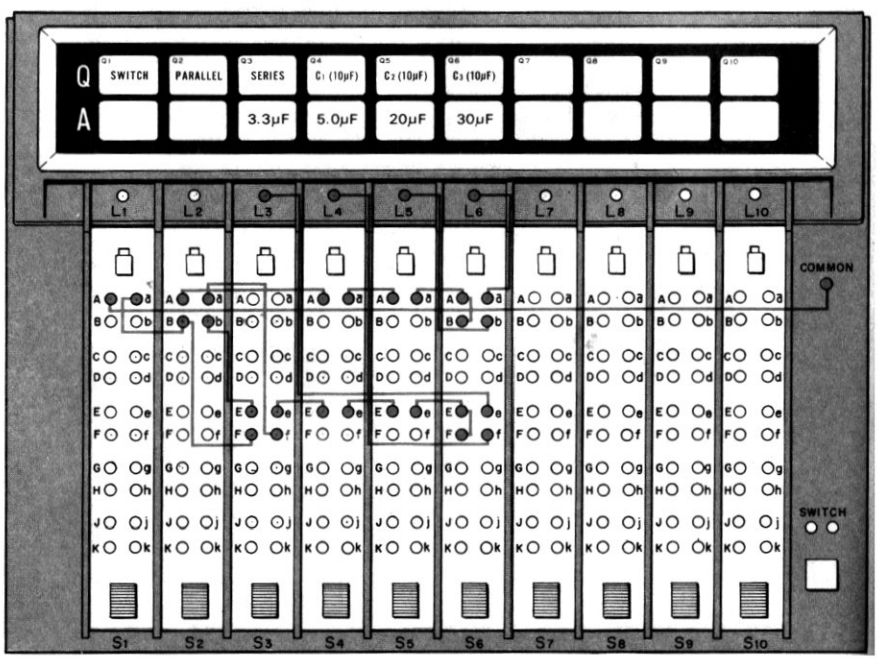
$$C\ total = C1 + C2 + C3 + \ldots\ldots\ldots + Cn$$

With this program, your Computer can make these computations for you; thus saving you from toiling with lengthy calculations.

Operation: For these calculations we assign a value of 10 μF for each Capacitor. Select either PARALLEL or SERIES (Q2 or Q3) and push up the Slide Switch under your choice. Then, select a combination of either C1 and C2 (Q4 and Q5) or C1, C2 and C3 (Q4, Q5 and Q6). OK now, push up Slide Switch S1 under SWITCH (Q1) and your Computer will light up the results in the ANSWER line.

Solution: Series . . . . . (a) C1, C2 : 5.0 μF, (b) C1, C2, C3 : 3.3 μF

Parallel . . . . (c) C1, C2 : 20 μF, (d) C1, C2, C3 : 30 μF



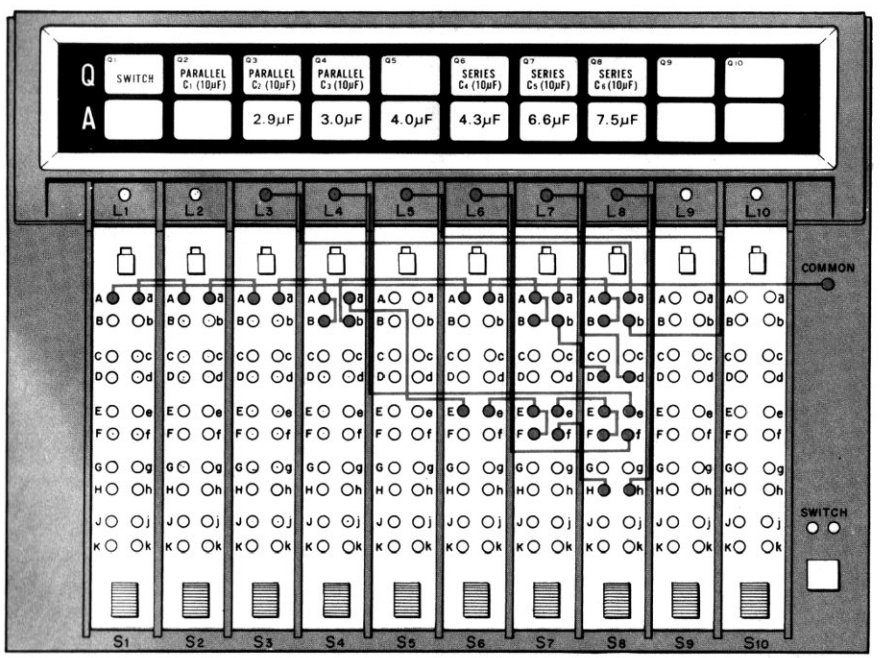
PROGRAM 89: CALCULATION OF COMBINED SERIES AND PARALLEL CAPACITORS

Connect wires as shown. In the previous program we showed you how to calculate either a Series or Parallel Capacitance circuit. In this program we will see how your Computer can calculate the total circuit capacitance of a combination of Series and Parallel Capacitance circuits.

Operation: For these calculations we assign a value of 10 μF to all Capacitors (C1 through C6). Select a combination of either C1 and C2 (Q2 and Q3) or C1, C2 and C3 (Q2, Q3 and Q4) and push up the Slide Switches under your selections. Then, select either C4 (Q6) or a combination of C4 and C5 (Q6 and Q7) or all three, C4, C5 and C6 (Q6, Q7 and Q8) and push up the Slide Switches under the ones you chose. All set? OK now, push up Slide Switch S1 under SWITCH (Q1) and your Computer will light up the result in the ANSWER line.

Solution:

(a) C1, C2, C4 : 6.6 μF
(b) C1, C2, C4, C5 : 4.0 μF
(c) C1, C2, C4, C5, C6 : 2.9 μF
(d) C1, C2, C3, C4 : 7.5 μF
(e) C1, C2, C3, C4, C5 : 4.3 μF
(f) C1, C2, C3, C4, C5, C6 : 3 μF



PROGRAM 90: REACTANCE CALCULATION: L AND f

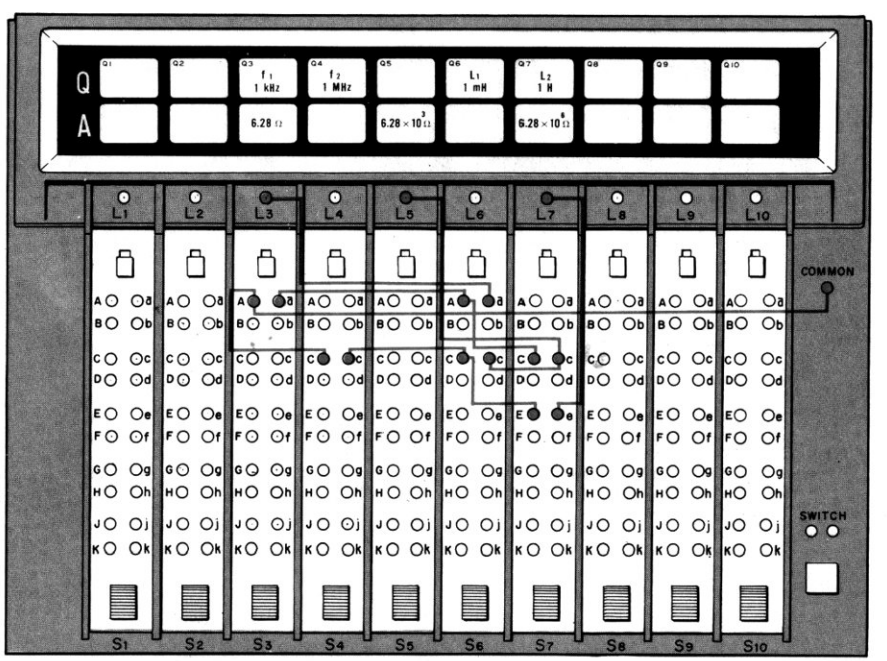
Connect wires as shown. All the electricity programs up to this point have dealt with DC (direct current) only, but this program concerns AC (alternating current). You'll learn how to calculate Inductive Reactance (X_L) when AC is applied thru an Inductor (L) at a given Frequency (f). You would use the following formula: X_L (in Ohms) = $2\pi fL$.

Operation: Select a given Frequency (from the "Q" line) of either f_1 = 1 kHz (Q3) or f_2 = 1 MHz (Q4) and push up the Slide Switch under your choice. Then, select an Inductor—either L_1 = 1 mH (Q6) or L_2 = 1 H (Q7) and push up the Slide Switch under the one you've selected. Your Computer will light up either 6.28Ω, 6.28 x $10^3\Omega$ or 6.28 x $10^6\Omega$ in the ANSWER line.

Solution:

(a) f_1, L_1 : 6.28 Ohms
(b) f_1, L_2 : 6.28 x 10^3 Ohms
(c) f_2, L_1 : 6.28 x 10^3 Ohms
(d) f_2, L_2 : 6.28 x 10^6 Ohms

NOTES:



PROGRAM 91: REACTANCE CALCULATION: C AND f

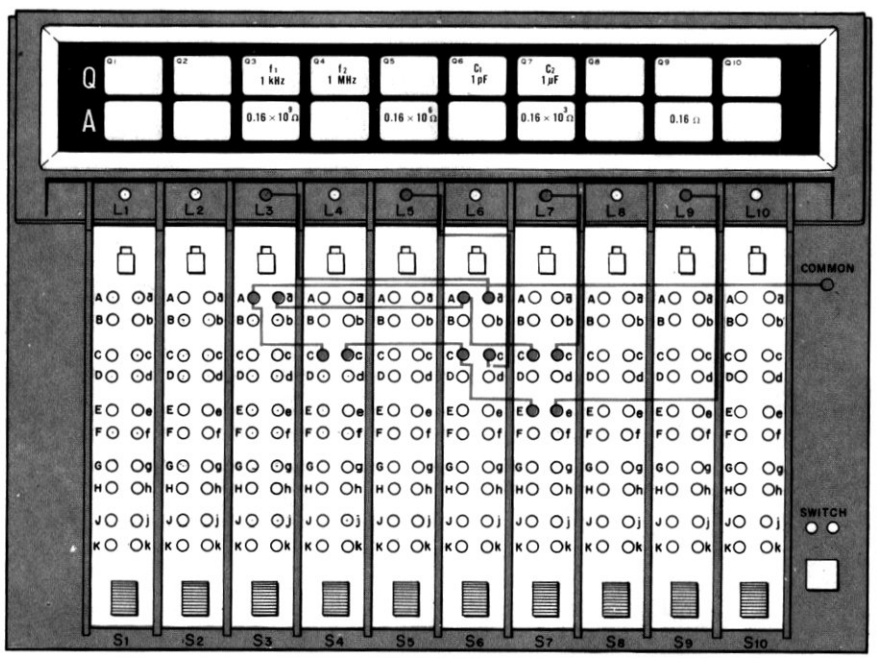
Connect wires as shown. We talked about Inductive Reactance (X_L) in the previous program but what if you need to know the Capacitive Reactance (X_C) of a circuit? With this program, you'll learn how to calculate Capacitive Reactance (X_C) When AC is applied thru a Capacitor (C) at a given frequency (f). You would use the formula:

$$X_C \text{ (in Ohms)} = \frac{1}{2\pi fC}$$

Operation: Select a given Frequency (from the "Q" line) of either f_1 = 1 kHz (Q3) or f_2 1 MHz (Q4) and push up the Slide Switch under your choice. Then, select the value of a Capacitor of either 1 pF (Q6) or 1 μF (Q7) and push up the Slide Switch under the one you've selected. Your Computer will light up either $0.16 \times 10^9 \Omega$, $0.16 \times 10^6 \Omega$, $0.16 \times 10^3 \Omega$ or 0.16Ω in the ANSWER line.

Solution:

(a) f_1, C_1 : 0.16×10^9 Ohms
(b) f_1, C_2 : 0.16×10^3 Ohms
(c) f_2, C_1 : 0.16×10^6 Ohms
(d) f_2, C_2 : 0.16 Ohms



PROGRAM 92: RESONANT FREQUENCY OF AN L/C CIRCUIT

Connect wires as shown. When Inductive Reactance (X_L) and Capacitive Reactance (X_C) are balanced in an AC circuit, we have what is called a Resonant Frequency (f). To determine the Resonant Frequency (f) of a circuit, you would have to apply the following formula:

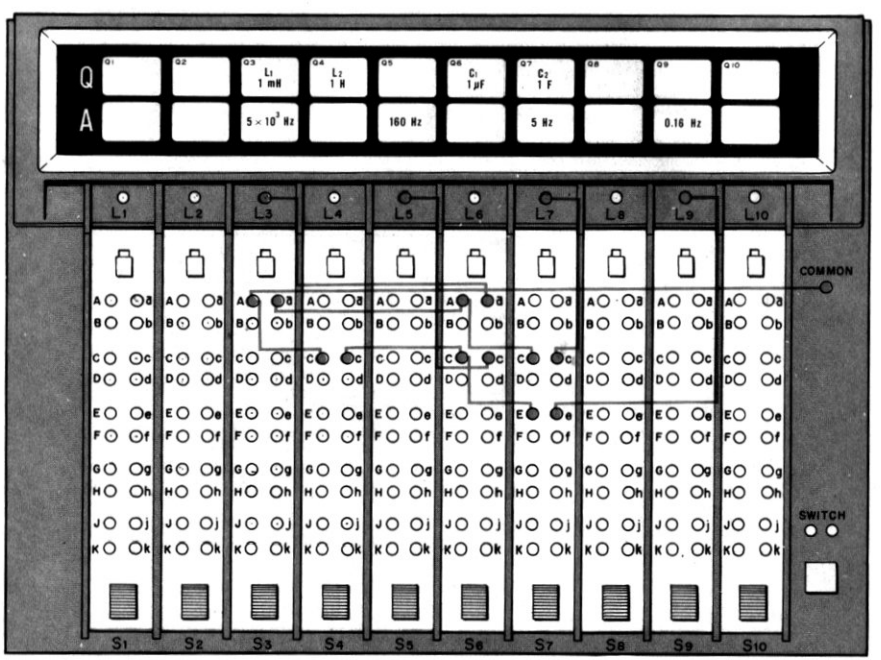
$$f \text{ (in Hertz)} = \frac{1}{2\pi\sqrt{LC}}$$

With this program, your Computer can give you the Resonant Frequency (f) for a given value of Inductive Reactance (X_L) and Capacitive Reactance (X_C).

Operation: Select an Inductor—either L_1 = 1 mH (Q3) or L_2 = 1 H (Q4) and push up the Slide Switch under your choice. Then, select a Capacitor—either C_1 = 1μF (Q6) or C_2 = 1F (Q7) and push up the Slide Switch under the one you've selected. Your Computer will light up either 5×10^3 Hz, 160 Hz,5 Hz or 0.16 Hz in the ANSWER line.

Solution:

(a) L_1, C_1 : 5×10^3 Hz
(b) L_1, C_2 : 5 Hz
(c) L_2, C_1 : 160 Hz
(d) L_2, C_2 : 0.16 Hz

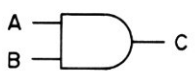


PROGRAM 93: "AND" GATE

Connect wires as shown. In this and the next three programs, we will introduce you to some simple forms of Computer Logic. In Computer Logic Circuits, inputs and an output will be either a "1" or a "0". The "AND" Gate is one of the more basic elements—it has two inputs and one output. If both inputs are "1"s, the output will be a "1", but if either or both inputs are "0", the output will be "0". With this program, your Computer can help you to predict the output of an "AND" Gate.

Operation: Push up the Slide Switches under A (Q3) and B (Q4) and C will light up in the ANSWER line. Now pull down (back towards you) the Slide Switch under either A or B—try one and then the other. Pull both Slide Switches down then push both back up. Notice in the ANSWER line, C lights up only when both A **and** B Slide Switches are pushed up.

"AND" Gate Symbol

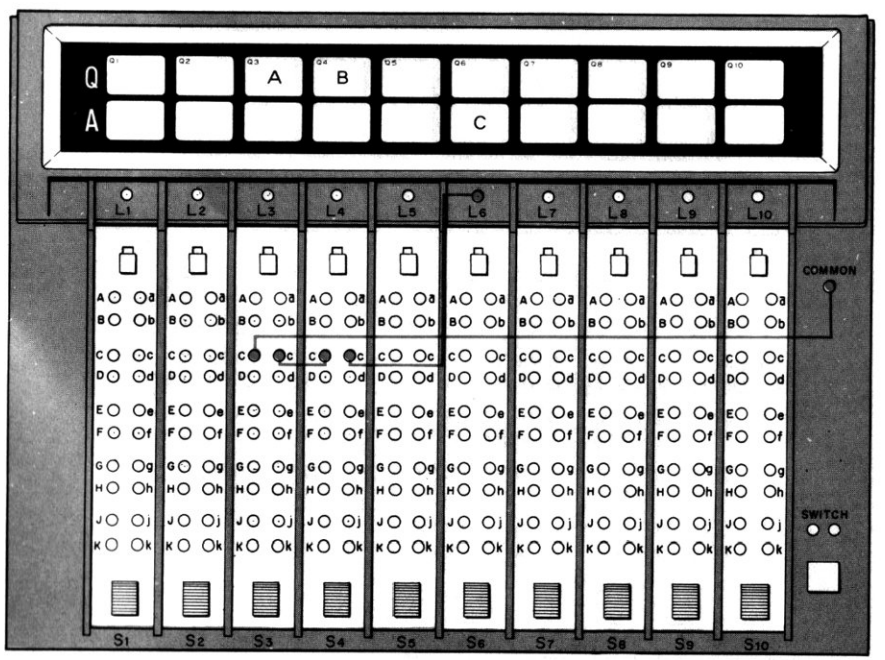


C = A·B

Truth Table

Input A	0	0	1	1
Input B	0	1	0	1
Output C	0	0	0	1

0 = off = down
1 = on = up



PROGRAM 94: "OR" GATE

Connect wires as shown. In this program you'll learn about another of the basic elements in Computer Logic Circuitry. The "OR" Gate has two inputs and one output. If both inputs are "0", the output will be "0" but if either input (A or B) is a "1" or if both input are "1"s, the output will be a "1". With this program, your Computer can help you predict the output of an "OR" Gate.

Operation: Push up one of the Slide Switches under either A (Q3) or B (Q4) and C will light up in the ANSWER line. Try one and then the other—you'll notice C is lit when either **or** both Slide Switches are up but C will be "off" when both inputs are "off".

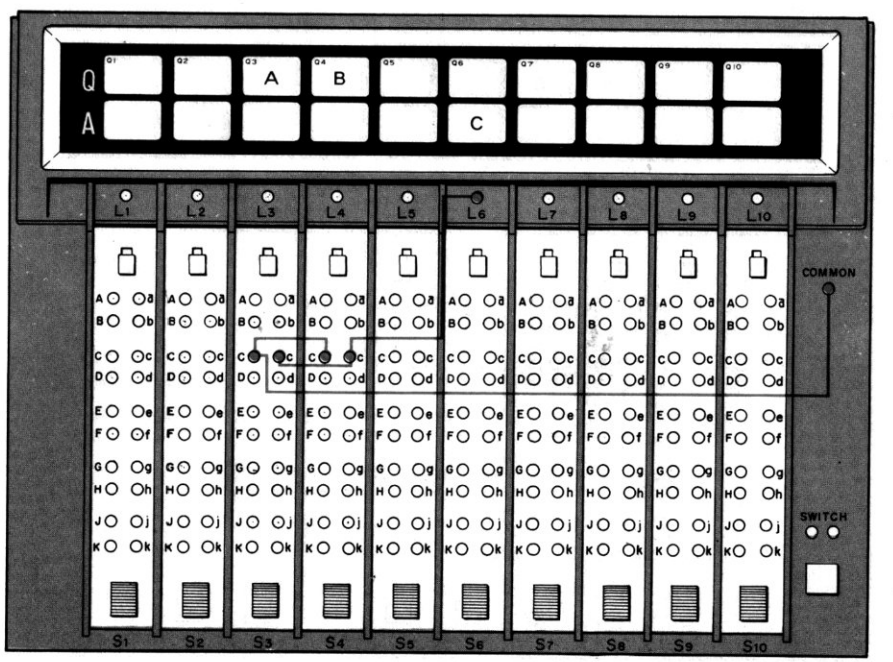
"OR" Gate Symbol

C = A + B

Truth Table

Input A	0	0	1	1
Input B	0	1	0	1
Output C	0	0	0	1

0 = off = down
1 = on = up

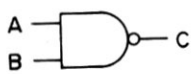


PROGRAM 95: "NAND" GATE

Connect wires as shown. Remember the "AND" Gate? This program will demonstrate how a "NAND" Gates Logic works. You should notice that it is exactly opposite to an "AND" Gate—in fact, "NAND" means "NOT AND". If either of the inputs (A or B) are "1", the output will be "1" but if both inputs are "1", the output will be "0". If both inputs are "0", the output will be a "1". With this program, your Computer can help you predict the output of a "NAND" Gate.

Operation: Push up one of the Slide Switches under either A (Q3) or B (Q4) and C will light up in the ANSWER line. Try one and then the other—you'll notice C is lit with either one pushed up. Now, Push up both Slide Switches under A and B—notice C does not light up but if you pull both Slide Switches back down (towards you), C lights up again.

"NAND" Gate Symbol

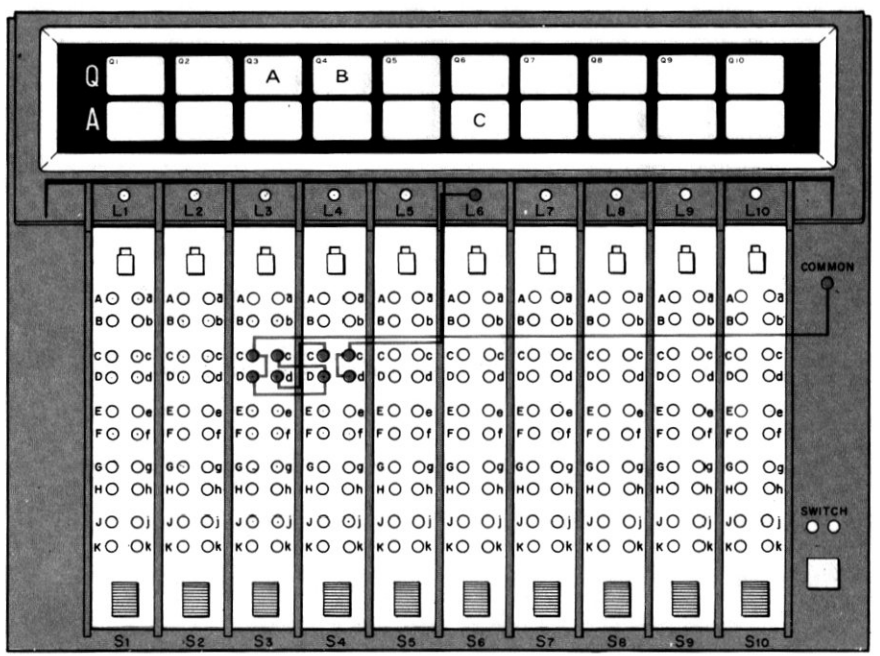


$C = \overline{A \cdot B}$

Truth Table

Input A	0	0	1	1
Input B	0	1	0	1
Output C	1	1	1	0

0 = off = down
1 = on = up



PROGRAM 96: EXCLUSIVE "OR"

Connect wires as shown. Remember the "OR" Gate? This program will demonstrate how an Exclusive "OR" gate functions. It is identical to an "OR" except that when both inputs (A and B) are "1"s, the output will be a "0". With this program, your Computer can help you predict the output of an Exclusive "OR".

Operation: Push up one of the Slide Switches under either A (Q3) or B (Q4) and C will light up in the ANSWER line. Try one and then the other—you'll notice C is lit with either one pushed up. Now, push up both Slide Switches under A and B—notice C does not light up: also, if you pull both Slide Switches back down (towards you), C again, does not light up.

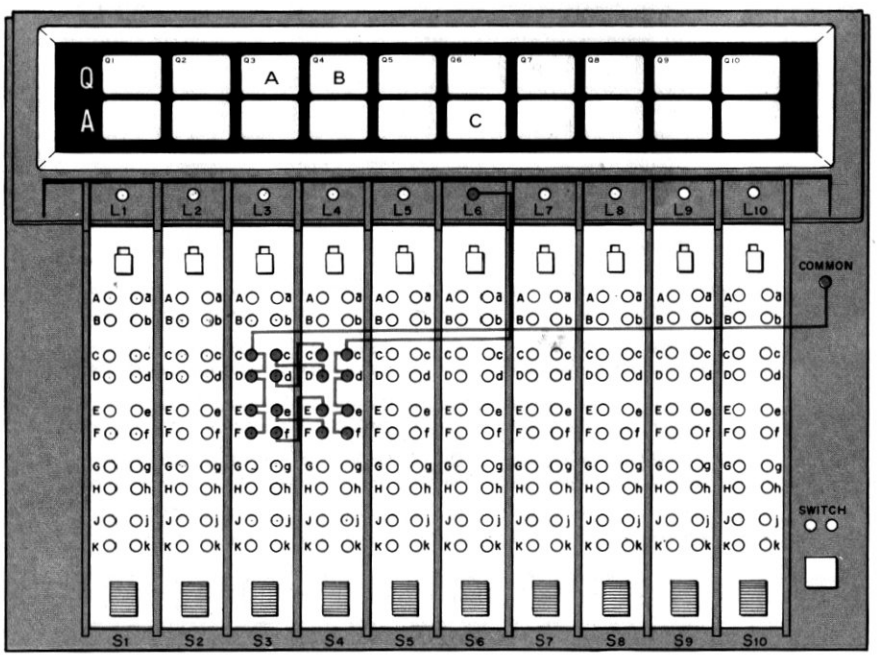
Exclusive "OR"

$C = \overline{A}.B + A.\overline{B}$
$= A \oplus B$

Truth Table

Input A	0	0	1	1
Input B	0	1	0	1
Output C	0	1	1	0

0 = off = down
1 = on = up

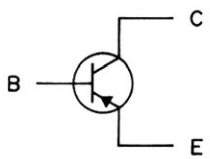


PROGRAM 97: PNP OR NPN TRANSISTOR

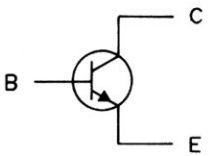
Connect wires as shown. This program will help you recognize the two basic types of Transistors. First you must realize there are two types of Transistors: PNP and NPN. With this program, your Computer can draw (by lighting up images in the ANSWER line) the type of Transistor you are asking about and point out its terminals.

Operation: Select either of the Transistor types—NPN (Q1) or PNP (Q2) and push up the Slide Switch under your choice. The schematic symbol for the one you selected will light up in the ANSWER line. Now, as you push up the Slide Switches one at a time under EMITTER (Q5), COLLECTOR (Q7) and BASE (Q9), their terminal connections will light up in the ANSWER line. Do not select more than one Transistor type at one time.

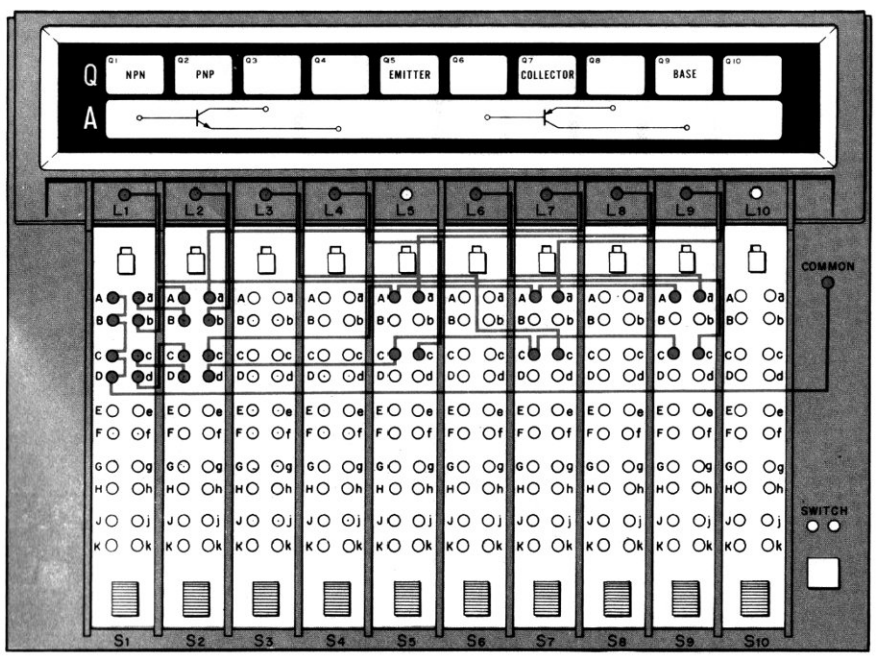
Solution:



PNP Type

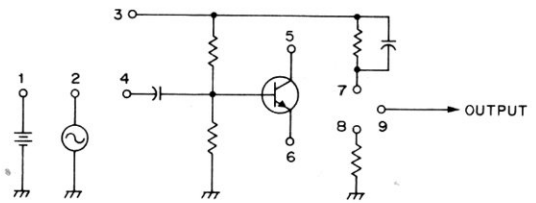


NPN Type



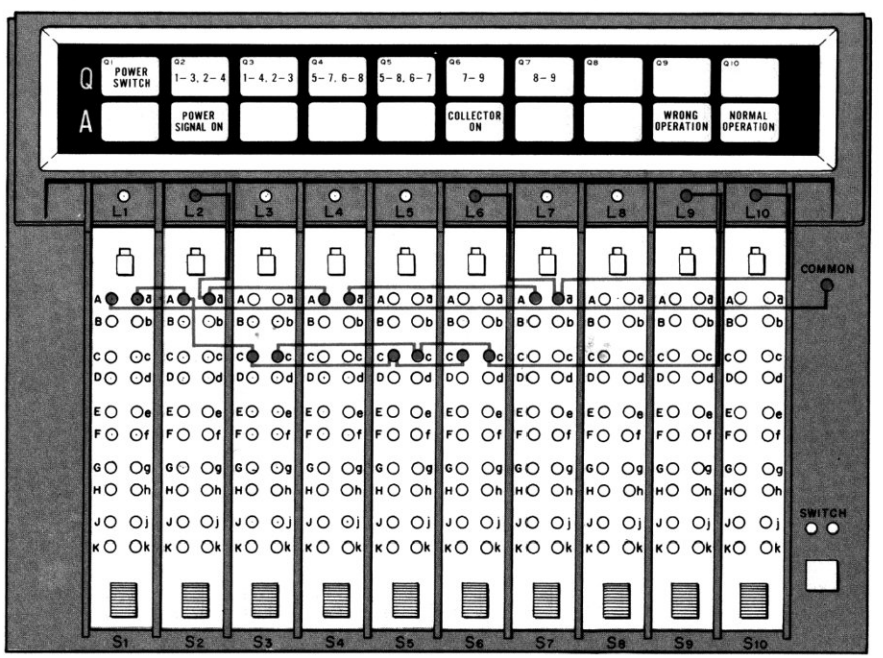
PROGRAM 98: COMMON COLLECTOR CIRCUIT

Connect wires as shown. With this program, your Computer can help you select the correct connection points for a COMMON COLLECTOR Transistor Circuit—refer to the schematic drawing below.



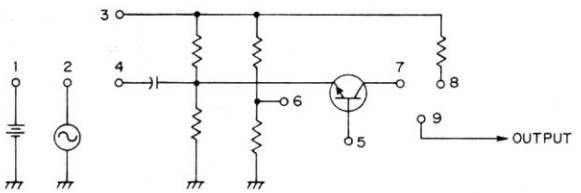
Operation: Refer to the schematic drawing and make connections between the numbered points that you think are correct by pushing up Slide Switches under the connection points listed in the "Q" line. Select one of the following combinations: either Q2 or Q3, Q4 or Q5, Q6 or Q7 and push up the Slide Switch under the ones you select. Now, push up the Slide Switch under POWER SWITCH (Q1) to light up the ANSWER line. If you get them all right, POWER/SIGNAL ON, COLLECTOR ON and NORMAL OPERATION will light up in the ANSWER line but if you make a mistake, WRONG OPERATION will light up.

Solution: Q2 (1–3, 2–4), Q4 (5–7, 6–8), Q7 (8–9)



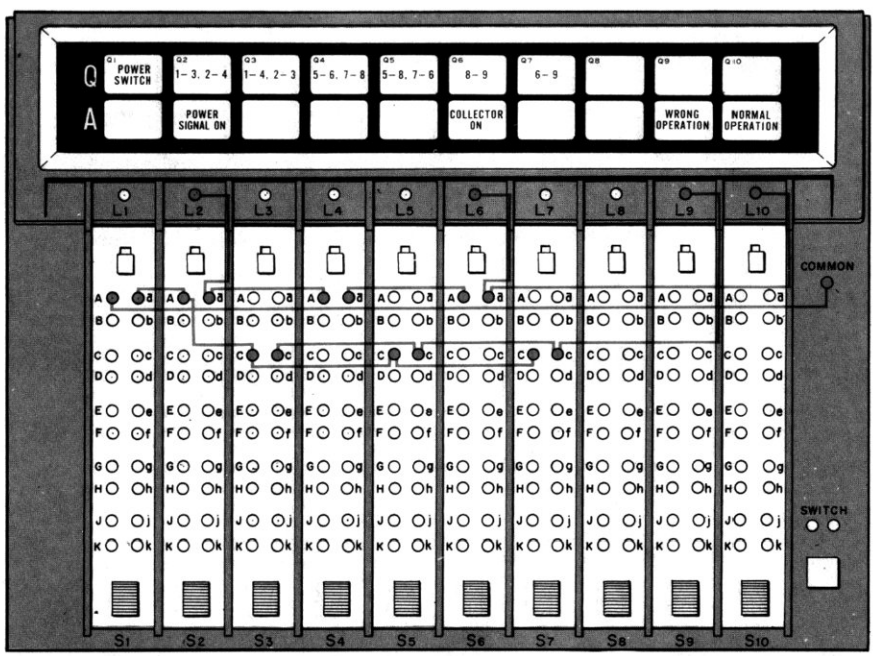
PROGRAM 99: GROUNDED BASE CIRCUIT

Connect wires as shown. With this program, your Computer can help you select the correct connection points for a GROUNDED BASE Transistor Circuit–refer to the schematic drawing below.



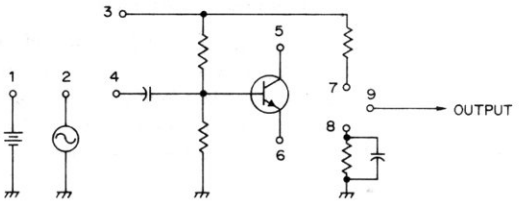
Operation: Refer to the schematic drawing and make connections between the numbered points that you think are correct by pushing up Slide Switches under the connection points listed in the "Q" line. Select one of the following combinations: either Q2 or Q3, Q4 or Q5, Q6 or Q7 and push up the Slide Switch under the ones you select. Now, push up the Slide Switch under POWER SWITCH (Q1) to light up the ANSWER line. If you get them all right, POWER/SIGNAL ON, COLLECTOR ON and NORMAL OPERATION will light up in the ANSWER line but if you make a mistake, WRONG OPERATION will light up.

Solution: Q2 (1–3, 2–4), Q4 (5-6, 7–8), Q6 (8–9)



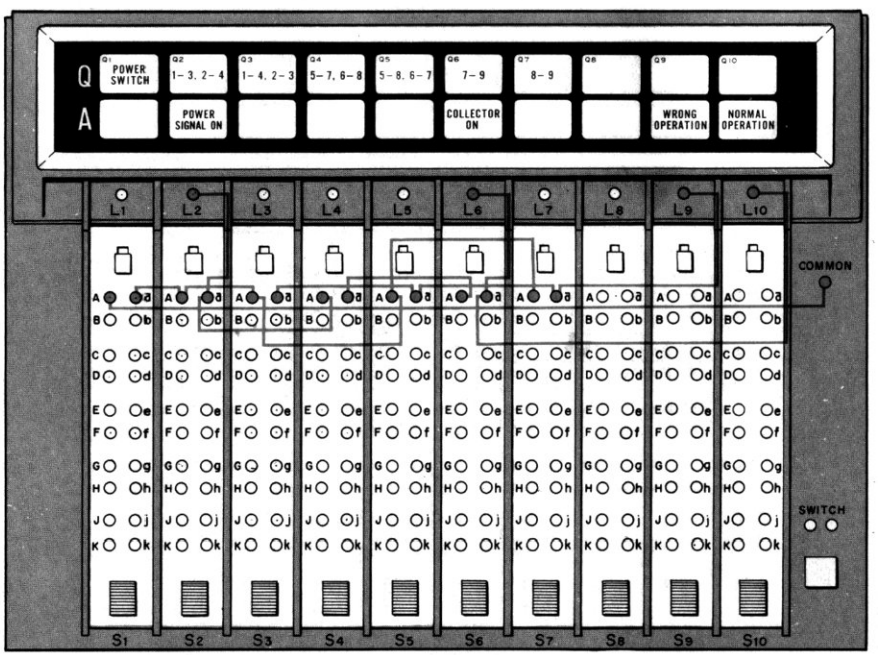
PROGRAM 100: AMPLIFIER CIRCUIT (Grounded Emitter)

Connect wires as shown. With this program, your Computer can help you select the correct connection points for an AMPLIFIER (Grounded Emitter) Transistor Circuit–refer to the schematic drawing below.



Operation: Refer to the schematic drawing and make connections between the numbered points that you think are correct by pushing up Slide Switches under the connection points listed in the "Q" line. Select one of the following combinations: either Q2 or Q3, Q4 or Q5, Q6 or Q7 and push up the Slide Switch under the ones you select. Now, push up the Slide Switch under POWER SWITCH (Q1) to light up the ANSWER line. If you get them all right, POWER/SIGNAL ON, COLLECTOR ON and NORMAL OPERATION will light up in the ANSWER line but if you make a mistake, WRONG OPERATION will light up.

Solution: Q2 (1–3, 2–4), Q4 (5–7, 6–8), Q6 (7–9)



PARTS LIST

Description	Part No.
Battery Cover	DB-0217
Battery Terminal, Minus	B-0300
Battery Terminal, Plus	B-0299
Button, Large (10)	K-2742
Button, Small (10)	K-2741
Case	Z-3775
Eyelet, 3 x 10 mm	
Frame	Z-3776
Hook-up wire	
Red 75 mm (44)	
Yellow 150 mm (15)	
Blue 250 mm (5)	
Orange 350mm (2)	
Lamp. 2.5 V, 0.15 A (10)	L-0836
Lamp Socket (10)	HB-6940
Program Panel Sheet (100)	
Push Button	K-2740

Description	Part No.
Push Switch Assembly	S-7333
Eyelet, 2.5 x 4 mm (2)	
Leaf Spring Contact	HB-6943
Lug (2)	HB-6941
Push Button Board	HB-6942
Screw, 3 x 8 mm Tapping-type (2)	HD-3028
Slide Switch Assembly	S-7334
Spring, Large (5)	
Spring, Small (20)	
Switch Panel	
Switch Slider	
Spring Large (45 plus 3 spares)	RB-5983
Spring Small (193 plus 6 spares)	RB-5984
Spring Tool (2)	HB-6939
Switch Panel (9)	HB-6937
Switch Slider (9)	HB-6938
Window	G-0317

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