DATANAMICS Pty. Ltd.,

How to use the Compucorp Micro Scientist

MODEL 320/322

COMPUTER DESIGN CORPORATION

CONTENTS

INTRODUCTION

The Micro Scientist is an extraordinarily powerful and versatile machine, yet it's ridiculously simple to operate.

You just think your problem through, then enter it the way you would write it out, pressing a single key whenever you come to a common mathematical or trigonometric function. At the end, you press = to see your answer.

If you have a programmable model you can run through a long calculation once, and the machine will repeat all the steps automatically whenever you enter new variables. You can program a calculation with up to 80 steps in it.

The Micro Scientist is somewhat larger than a slide rule, but it's far more powerful and accurate than anything else its size.

To get the most out of the Micro Scientist you should go through this manual carefully and follow all the instructions. It won't take long, and when you're through you'll appreciate what this new tool can do for you.

BEFORE YOU START

You'll find the On/Off switch on the back.

When you switch the Micro Scientist on, all registers are cleared and the decimal point is set to two places. Press the RESET key on the front. You'll see 0.00 on the display.

The Micro Scientist will run about 3½ hours on its batteries. You can also run it indefinitely on house current by plugging the AC adapter into the socket on the back. Be sure to set the adapter for the right line voltage.

About 15 minutes before the batteries give out, the Micro Scientist will warn you by flashing the display. To recharge the batteries, turn off the machine, plug in the AC adapter and leave it overnight. You can also operate the machine while charging the batteries.

If you have a programmable model of the Micro Scientist you'll see a RUN/LOAD switch and a START/STOP button. The switch should be up for now. Ignore the button.

If you have a G model, set the GRAD/DEG switch to DEG unless you work with grads. When you're doing circular trigonometry the Micro Scientist will assume either 360-degree circles or 400-grad circles depending on the custom of your country and the setting of the switch.

$$\boxed{\text{RESET}} \quad \boxed{\begin{matrix}\text{CLEAR}\\\text{ENTRY}\end{matrix}}$$

Whenever you find you've made a mistake in a calculation and want to start over, RESET will send you back to the beginning.

CLEAR ENTRY will merely erase what you just entered so you can correct a mistake without wiping out your previous steps.

It's a good idea to press RESET before starting a calculation, just to be sure no leftovers are cluttering up the operating registers.

If you see E---- on the display (it stands for ERROR) that means you've tried to do something mathematically illegal or have produced a number larger than the Micro Scientist will hold (its capacity is 10^{+98} to 10^{-98}). To get going again you'll have to press either RESET or CLEAR ENTRY.

The following misdemeanors will cause E----:

• Dividing by zero

• 1/x of zero

• $\sqrt{}$ of a negative number

• Log of zero or negative number

• Arcsine of a number greater than 1 or less than −1

• Entry of more than 13 digits (or a decimal point followed by more than 12 digits)

• Taking the tangent of 90° or 90±n(180°)

• Calculating 0^{-r} with the a^r key

• Calculations that produce numbers beyond 10^{+98} to 10^{-98}

• Pressing two or more keys simultaneously

• Pressing more than two keys in succession while the machine is busy calculating (it can remember two keystrokes)

LET'S CALCULATE

First, practice entering numbers. Press 12345 and see the digits pop on at the left of the decimal point, with a comma after the first two. Keep going till you have 123456789. See how the decimal point moved right to accommodate all the digits. Now enter some more digits. Notice that when you entered the eleventh digit the display switched to scientific notation. Try entering a 14th digit. E----. Press RESET or CLEAR ENTRY.

Now press the decimal point key and see 0. 0. Enter 123456789. That's all the fractional digits you'll see. Keep going with 1234. On 4 you'll see E---- again because you can only enter 12 digits after the decimal point. RESET OR CLEAR ENTRY.

Now let's do an equation: $\dfrac{2 \times 3 - 4}{5} + 6 = ?$ Enter it as

| 2 | × | 3 | − | 4 |

| ÷ | 5 | + | 6 | = | 6 40 |

↑
Dec
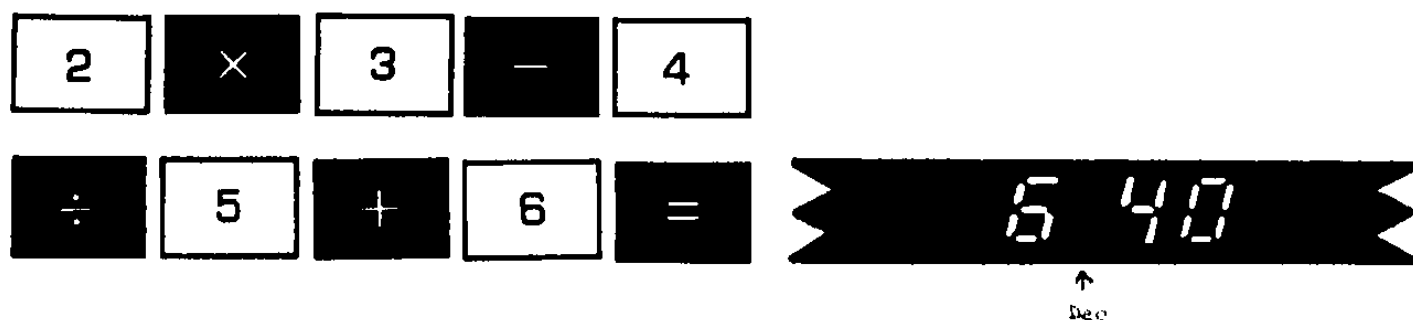
Notice that whenever you pressed one of the arithmetic keys the answer to the previous calculation appeared on the screen, so that these keys act as intermediate = keys.

(	)

You'll see two parenthesis keys – (and). You can nest these two deep. The) key acts as = for the calculation inside the parentheses. Keep track of your parentheses. If you close without opening you'll get E---- and you'll have to start over. Same if you open a third set without closing the second.

Solve this variation on the previous equation: $\dfrac{2 \times 3 - 4}{(5 + 6)} = ?$ Enter it as

2	×	3	–	4
÷	(	5	+	6

)	=	*0.18*

You get a different answer, of course.

SET DP

Now change the decimal setting. Poke SET D.P. and 8, then SET D.P. and 9.

0.   18 18 18 18

1.8 18 18 18 18 – 01

Notice that the display is now in scientific notation. You can change the decimal point setting at any time, depending on the accuracy you want to see in your answer (the Micro Scientist is always calculating with 13 digits, of which it will display up to 10). Regardless of where you set the decimal point, the machine will move it left or right to protect your most significant digits.

$$\boxed{\text{EXP}}$$

If you wish, you can enter your numbers in scientific notation with the EXP key, regardless of the decimal setting. $2345 \times 10^9 + (32 \times 10^8) \times (45 \times 10^{12}) \div (23 \times 10^{-9})$ is entered as follows:

$$\boxed{\substack{\text{SET} \\ \text{DP}}} \quad \boxed{2}$$

$$\boxed{2} \quad \boxed{3} \quad \boxed{4} \quad \boxed{5} \quad \boxed{\text{EXP}} \quad \boxed{9} \quad \boxed{+} \quad \boxed{3} \quad \boxed{2}$$

$$\boxed{\text{EXP}} \quad \boxed{8} \quad \boxed{\times} \quad \boxed{4} \quad \boxed{5} \quad \boxed{\text{EXP}} \quad \boxed{1} \quad \boxed{2} \quad \boxed{\div}$$

$$\boxed{2} \quad \boxed{3} \quad \boxed{\text{EXP}} \quad \boxed{9} \quad \boxed{\substack{\text{CHG} \\ \text{SIGN}}} \quad \boxed{=}$$

```
 4. 5943043 47    33
```
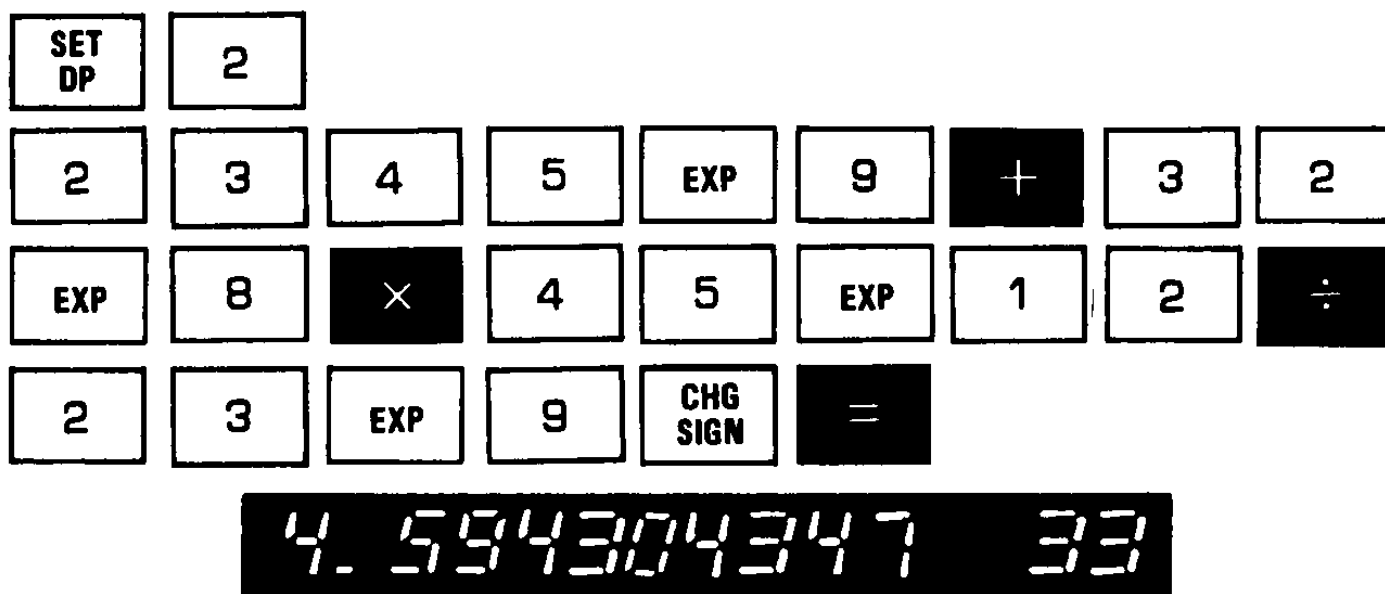
$$\boxed{\substack{\text{CHG} \\ \text{SIGN}}}$$

Notice that you used the CHG SIGN key to make the last exponent negative. You can press this key before, during or after entering either mantissa or exponent to change its sign. If a number is already negative, CHG SIGN will make it positive.
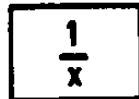
$$\boxed{\pi}$$

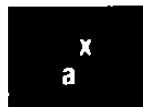This key puts a 12-digit π in the machine. SET D.P. 9 will show you 10 digits of it.

```
 3. 141592653
```

```
 ┌─────┐
 │  √  │
 └─────┘
```

As you might expect, this gives you the square root of the number on the display.

```
┌───────────────────────┐
│  1.7724538 50         │
└───────────────────────┘
```

```
 ┌─────┐
 │  1  │
 │  ─  │
 │  x  │
 └─────┘
```

This gives you the reciprocal of your number.

```
┌───────────────────────┐
│  5.64 1895835 - 01    │
└───────────────────────┘
```

```
 ┌─────┐
 │  x  │
 │ a   │
 └─────┘
```

This is one of the most powerful keys on the machine. It raises a number (a) to a power (x). Enter the number, touch a^x, enter the power and then touch =.

```
┌───────┐ ┌───────┐
│ SET   │ │   3   │
│ DP    │ │       │
└───────┘ └───────┘

┌───┐ ┌───┐ ┌───┐ ┌───┐ ┌───┐
│ 1 │ │ 2 │ │ · │ │ 3 │ │ aˣ│
└───┘ └───┘ └───┘ └───┘ └───┘

┌───┐ ┌───┐ ┌───┐ ┌───┐ ┌───┐
│ 1 │ │ · │ │ 2 │ │ 3 │ │ = │   21.907
└───┘ └───┘ └───┘ └───┘ └───┘
```
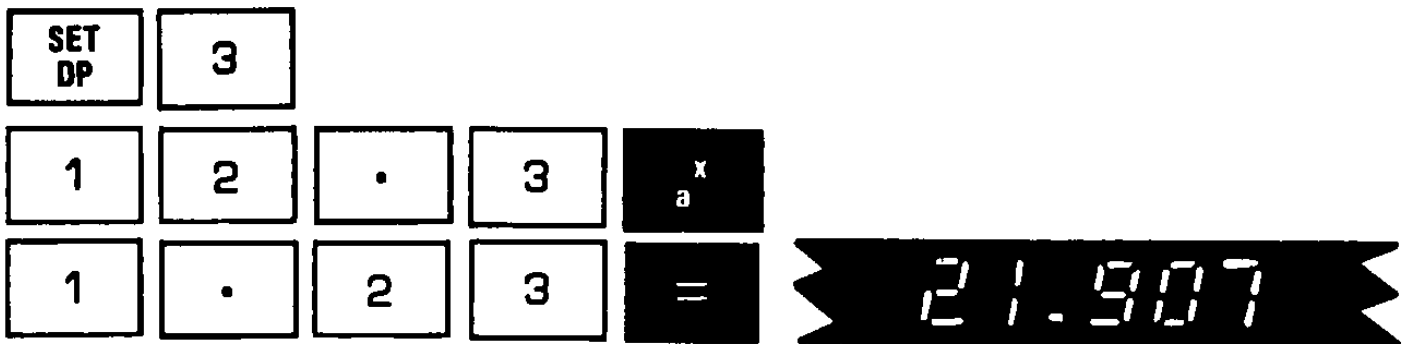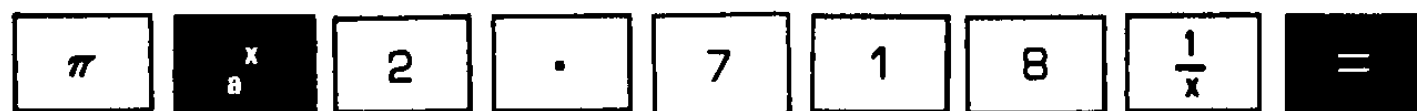
By using the parentheses you can raise to complicated powers — for instance $a^{(b + c \sin \theta)}$ where $a = 3$, $b = .5$, $c = .2$ and $\theta = 30°$:
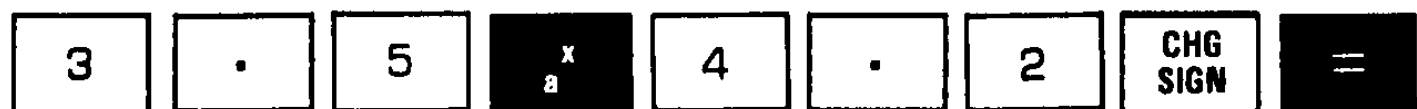
SET DP	5

3	a^x	(	.	5	+	(	.	2

×	3	0	SIN COS	)	)	=
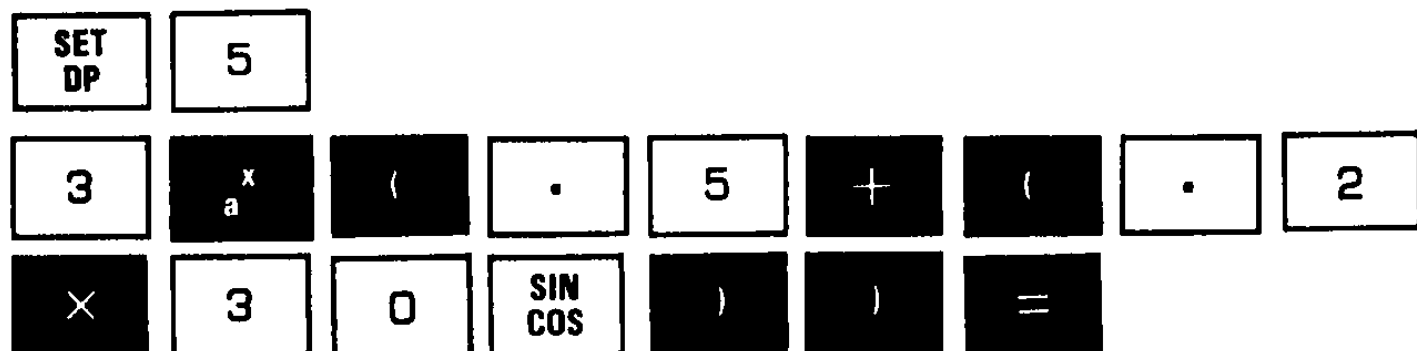
```
1.93318
```

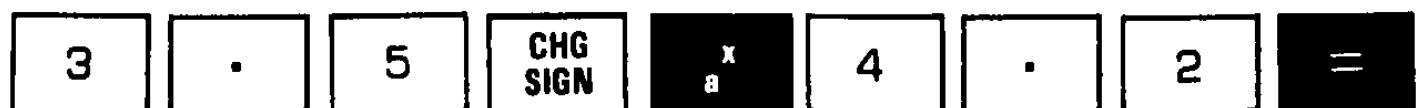You can extract funny roots with a^x and the $\frac{1}{x}$ key. Suppose you want the 2.718th root of 3.14159:

π	a^x	2	.	7	1	8	$\frac{1}{x}$	=

```
1.52373
```

You can raise a number to a negative power — say, $3.5^{-4.2}$.

3	.	5	a^x	4	.	2	CHG SIGN	=

```
0.00518
```

But you can't raise a negative number to a non-integer power:

3	.	5	CHG SIGN	a^x	4	.	2	=

```
E----
```

RESET

$$\boxed{\begin{array}{c} \text{Ln} \\ \text{LOG} \end{array}}$$

This key puts the natural logarithm of your number on the screen and puts the log base 10 in Second Function.

1	8	Ln LOG

$$2.89037$$

2ND FUNC

$$1.25527$$

Press 2ND FUNC again and see the natural log back. The 2ND FUNC key simply exchanges the number on the screen with the one in the Second Function register whenever you press it.

$$\boxed{\begin{array}{c} e^X \\ 10^X \end{array}}$$

This gives you the two antilogs.

.	6	9	3	2	e^X 10^X

$$2.00010$$

2ND FUNC

$$4.93400$$

If you need e for anything you can always get it with | 1 | | e^X 10^X |

$$2.71828$$

Following are some more double-function keys:

```
┌─────┐
│ SIN │
│ COS │
└─────┘
```

You've already used this key, remember? It gives you the sine and cosine of the angle on the display — any size angle, positive or negative, expressed in decimal form.

```
┌─────┐ ┌─────┐ ┌─────┐
│  3  │ │  0  │ │ SIN │
└─────┘ └─────┘ │ COS │
┌─────┐         └─────┘
│ 2ND │
│FUNC │
└─────┘
```

$$0.50000$$

$$0.86502$$

```
┌───────┐
│ SIN⁻¹ │
│ COS⁻¹ │
└───────┘
```
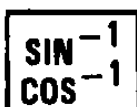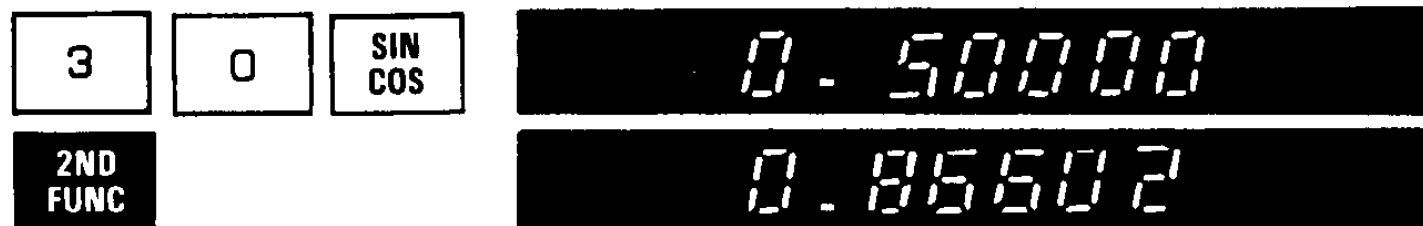
This one gives you the arcsine and arccosine. Arcsine is limited to the range of −90 to +90, arccosine to the range of 0 to 180. If you try to find the arcsine or arccosine of a number outside the range of −1 to +1 you'll get E - - - - -

```
┌─────┐
│ O→R │
│ R→O │
└─────┘
```
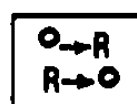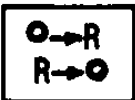
This key converts decimal degrees to radians, and vice versa.

```
┌─────┐ ┌─────┐
│ SET │ │  8  │
│ DP  │ └─────┘
└─────┘
┌─────┐ ┌─────┐ ┌─────┐
│  3  │ │  0  │ │ O→R │
└─────┘ └─────┘ │ R→O │
                └─────┘
```

$$0.52359877$$
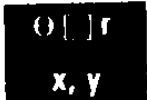
That gives you 30° in radians. Now get your 30° back:

```
┌─────┐ ┌─────┐
│ 2ND │ │ O→R │
│FUNC │ │ R→O │
└─────┘ └─────┘
```

$$30.00000000$$

(You see, the Second Function register assumed the 30 was radians and converted it to degrees, so the [O→R / R→O] key came up with 30 the second time around.)

[O[ ]r / x, y]   [x[ ]y / O, r]

With these two keys you can convert polar coordinates (θ, r) to rectangular (x, y) and vice versa. [O[ ]r / x, y] is called To Rectangular, [x □ y / O, r] To Polar.
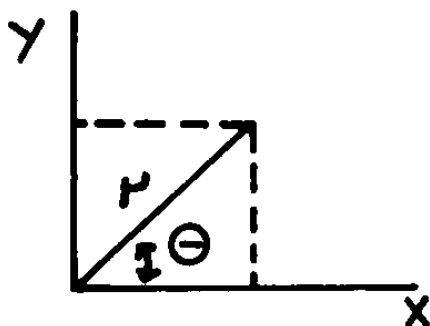

The legends on the keys tell you how to do it. Enter x, poke the To Polar key, enter y and poke =. The first value (θ) will be on the display, 2ND FUNC will give you r.

To go the other way, enter the angle, poke the To Rectangular key, enter r and poke =

If one side is −3 and the other is 4, find the angle and the hypotenuse:

[SET OP]   [3]

[CHG SIGN]   [3]   [x □ y / O, r]   [4]   [=] 126.869

[2ND FUNC] 5.000
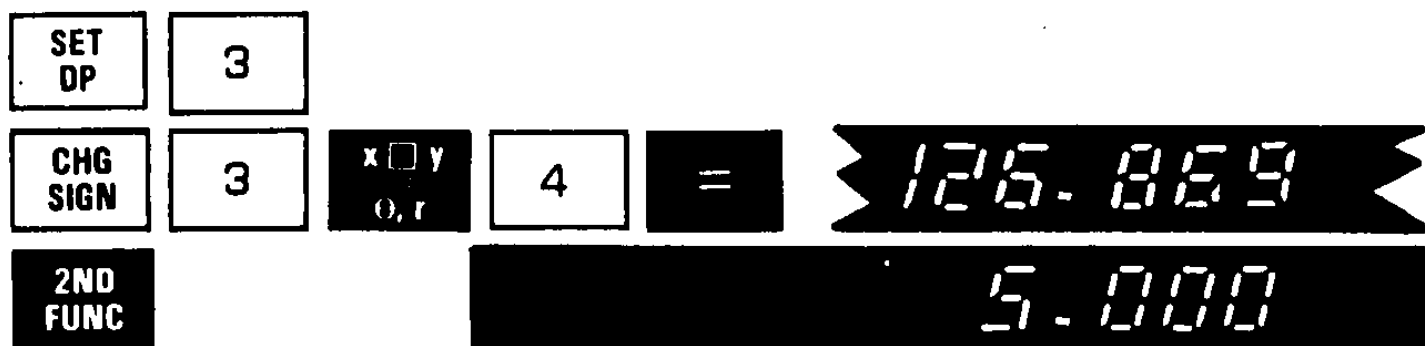
If the angle is 335° and the radius is 7, what are the rectangular coordinates?

| 3 | 3 | 5 | O→r x,y | 7 | = | *6.344* |

2ND FUNC

-2.958

| TAN | TAN⁻¹ |
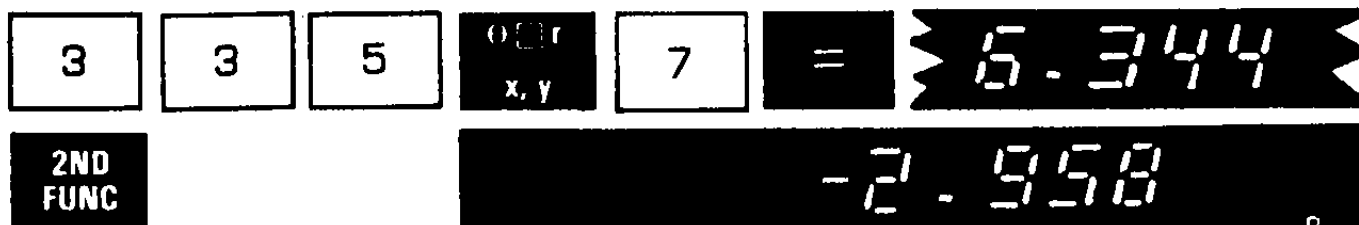
These two keys give you tangents and arctangents. The sign of the tangent is correct, and the angle may be positive or negative, of any magnitude. Arctangent is limited to the range of -9.99×10^{99} to $+9.99 \times 10^{99}$, and the resulting angle will lie between -90 and $+90$ degrees (-100 to $+100$ grads).

| 3 | 0 | TAN |

0.577

TAN⁻¹

30.000

| D.MS→DEC | DEC→D.MS |

These convert degrees/minutes/seconds (or grads) to decimal degrees, and vice versa. Convert 65°21'46" to decimal degrees:

| SET DP | 5 |

| 6 | 5 | . | 2 | 1 | 4 | 6 | D.MS→DEC |

65.36277

DEC→D.MS

65.21460
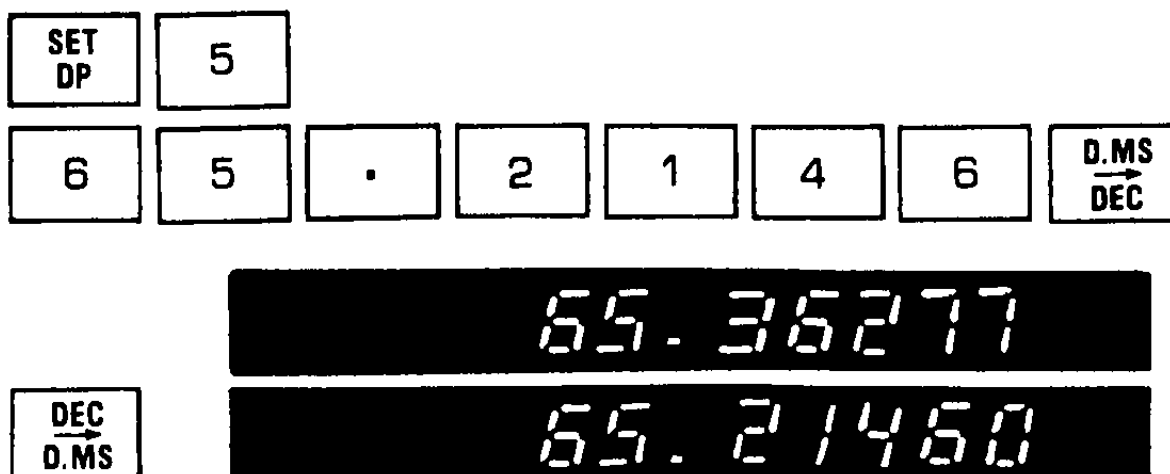
(The DEC/D.MS key rounds degrees/minutes/seconds to the nearest second.)

Remember that the Micro Scientist calculates in decimal degrees, so if your problem is in degrees/minutes/seconds or radians, or if you want them in an answer, don't forget to convert.
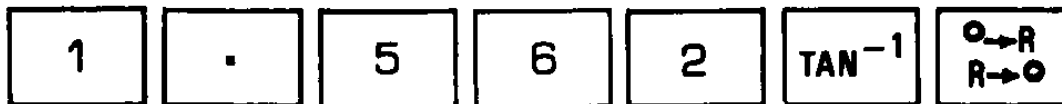
CIRCULAR TRIG EXAMPLES

Find the arccosine of .635 in degrees/minutes/seconds:

.	6	3	5	SIN⁻¹ COS⁻¹	2ND FUNC	DEC → D.MS

$$50.34480$$

Find the arctangent of 1.562 in radians:

1	.	5	6	2	TAN⁻¹	O→R R→O

$$1.00133$$

Find the arccosine of .70710 in radians:

.	7	0	7	1	SIN⁻¹ COS⁻¹	2ND FUNC	O→R R→O

$$0.78540$$

Now try the sine of .683 radians

.	6	8	3	O→R R→O	2ND FUNC	SIN COS

$$0.63112$$

Now let's do SIN[2π(31.52) + .524]

2	×	π	×	3	1	.	5	2

+	.	5	2	4	=	O→R R→O	2ND FUNC	SIN COS

$$-0.60491$$

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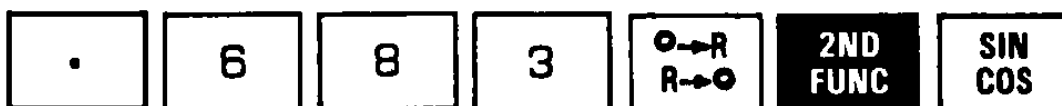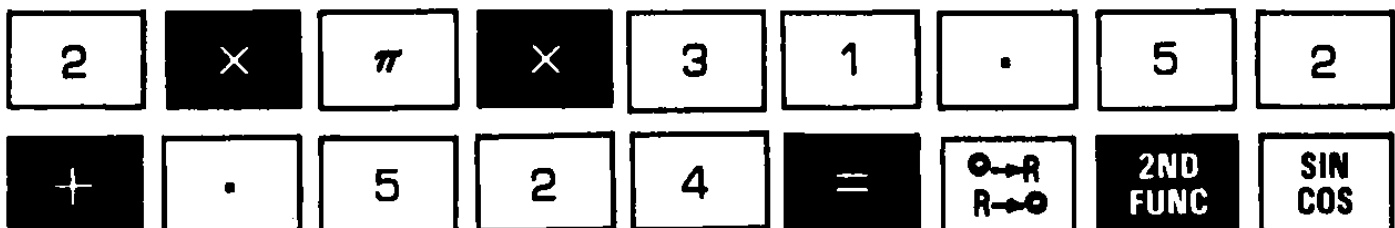
If you weren't watching the display you missed seeing a remarkable number just before you pressed SIN/COS: 11,377.22298 degrees, buried in the middle of an innocent calculation. You're probably not accustomed to accuracy like that, but you'll learn to love it.

STROKESAVERS

SET DP	0

| 3 | × |

=	9.
=	27.
=	81.

| 3 | × |

×	9.
×	81.
=	6.561.

| 3 | + |

| = | 6. |
| = | 9. |
| = | 12. |

| 3 | + |

+	6.
+	12.
=	24.

16

See if you can figure out what is happening. (Don't bother to play around with ÷ or —. It won't get you anywhere.)

STORING NUMBERS

| EXCH$_n$	ST$_n$	RCL$_n$

The three black keys in the leftmost row get you into and out of ten storage registers.

To store a number in a register, just press ST$_n$ and a single digit for the address of the register (0 through 9). To get the number back, press RCL$_n$ and the register digit.

1	2	3	4	5	ST$_n$	0	CLEAR ENTRY

$$\square.$$

RCL$_n$	0

$$12.345.$$
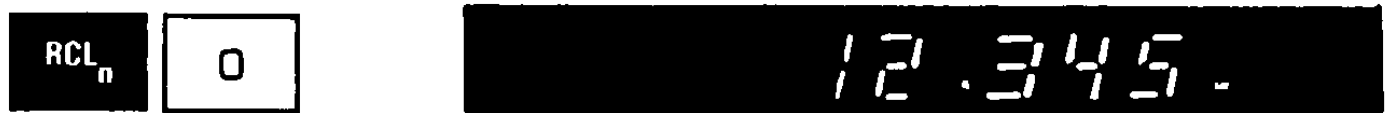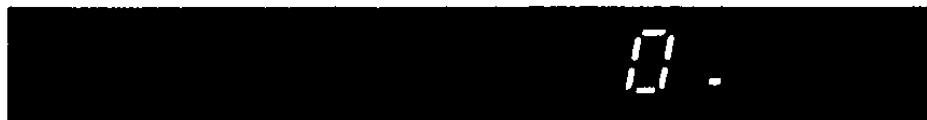
You can exchange a number in the entry register with one that's stored in a register by poking EXCH$_n$ and the register digit. That's handy if you've filled all ten registers and want to use one of the stored numbers without losing the number on the display It'll be in the register you exchanged it to whenever you want it back.
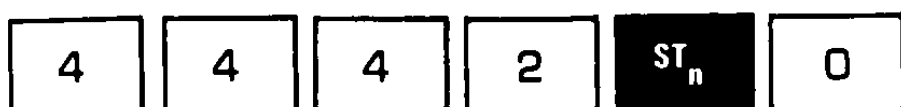
4	5	6	7	8	EXCH$_n$	0

$$12.345.$$

RCL$_n$	0

$$45.678.$$
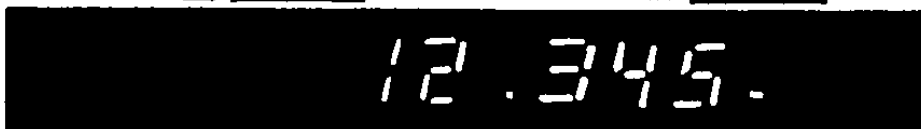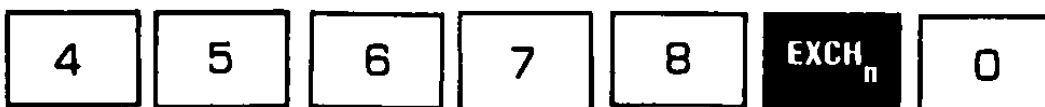
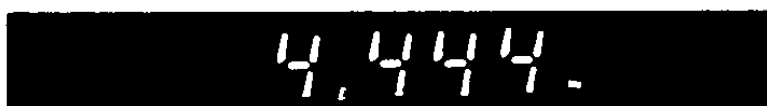Remember, when you put a number into a register with ST$_n$ it will replace whatever was in that register before.

RCL_n, however, does not empty a register. It simply copies the number onto the display, leaving it still in its register.

You can add a number to what's in a register, subtract from it, multiply it or divide it — do anything to it that you would do to a number in the entry register.

Put 4442 in Register 0:

| 4 | 4 | 4 | 2 | ST_n | 0 |

```
  4,442.
```

Add 2 to it:

| 2 | ST_n | + | 0 |

```
      2.
```

| RCL_n | 0 |

```
  4,444.
```

Divide it in half:

| 2 | ST_n | ÷ | 0 |

```
      2.
```

| RCL_n | 0 |

```
  2,222.
```

Multiply it by 4:

| 4 | ST_n | × | 0 |

```
      4.
```

| RCL_n | 0 |

```
  8,888.
```

Easy? Just remember to push ST_n *before* the arithmetic key, the register number *after.*

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Just as you can add, subtract, multiply or divide directly *into* a register, you can do the same *out of* a register:

| 1 | 2 | ST_n | 3 | 2 | 4 | RCL_n | ÷ | 3 |

$$2.$$

| 6 | RCL_n | × | 3 |

$$72.$$

| 1 | 6 | RCL_n | − | 3 |

$$4.$$

| 6 | RCL_n | + | 3 |

$$18.$$

| RCL_n | 3 |

$$12.$$

You'll also see how you can add one scratchpad register to another, subtract one from another, multiply or divide one by another, raise one to the power of another, etc.:

| 2 | 4 | ST_n | 0 | 1 | 2 | ST_n | 1 | 6 |

| ST_n | 2 | 5 | ST_n | 3 | RCL_n | 0 | ÷ | RCL_n |

| 1 | × | RCL_n | 2 | y^x | RCL_n | 3 | = |

$$248.832.$$

EXAM

The Chezy-Manning equation determines the flow of water in a circular pipe. This is it:

$$Q = \frac{\left(\dfrac{1.485\pi/4}{4^{2/3}}\right)D^{8/3}S^{1/2}}{n}$$

Let's let D (diameter in feet) be 1.5, S (slope in feet per foot) be .001, and n (roughness coefficient) be .015.

If you're going to solve the equation more than once, you should store the expression $\dfrac{1.485\pi/4}{4^{2/3}}$ because it's a constant. Compute it as follows and stick it in Register 0.

SET DP	4

1	.	4	8	5	×	π	÷	4

÷	(	4	a^x	(	2	÷	3	)

)	=	ST_n	0

```
0.4628
```

Now do the equation:

RCL_n	0	×	(	1	.	5	a^x	(

8	÷	3	)	)	×	.	0	0

1	√	÷	.	0	1	5	=

```
2.8769
```

If you get 2.8769 cubic feet, you pass. Of course, if you're going to solve a lot of Chezy-Manning equations you'd better program the whole sequence so you won't have to keep repeating all those steps. Next chapter.

SCRATCHPAD PROGRAMMING

Now you're going to program the Chezy-Manning equation. First press RESET, then flip the RUN/LOAD switch down, and you're ready to enter your program. Notice that the display has changed.

```
0. 000000 00 01
```
MANTISSA   EXP   STEP

While you're loading a program the Micro Scientist displays everything in scientific notation. The two digits on the right tell you what program step you're about to execute. This one has 23 steps in it.

You enter the program by simply repeating the equation, except that before you enter each variable you press the START/STOP button. (With the switch on LOAD the START/STOP button tells the program to stop at that point so you can enter a variable. With the switch on RUN it tells the program to start running again after you've entered the variable.) Press START/STOP when you're through entering to tell the machine the program is complete.

Remember, you've got the constant $\dfrac{1.485\pi/4}{4^{2/3}}$ stored in Register 0, so you don't have to go through that routine unless you turned the machine off, in which case you'll have to compute it again (see page 21) and stick it in Register 0.
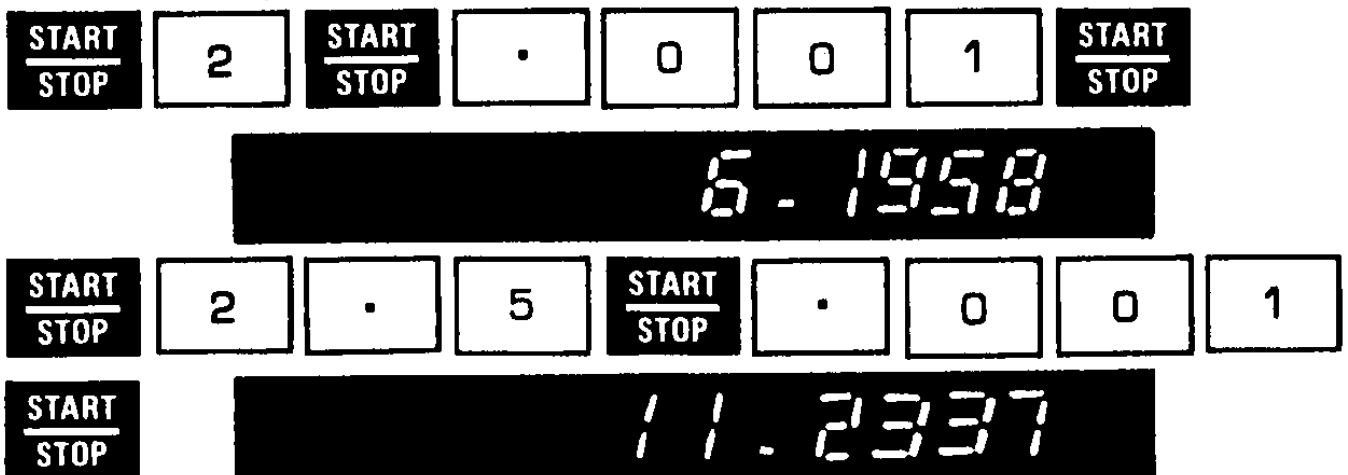
You also won't need to treat the roughness coefficient (.015) as a variable because you're merely going to see what happens to the flow with different sizes of pipe and different slopes. So you'll only have two variables — diameter and slope.

Enter the program like this:

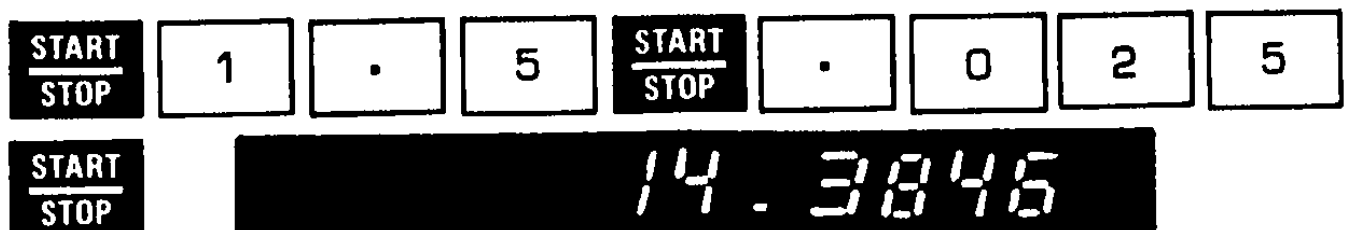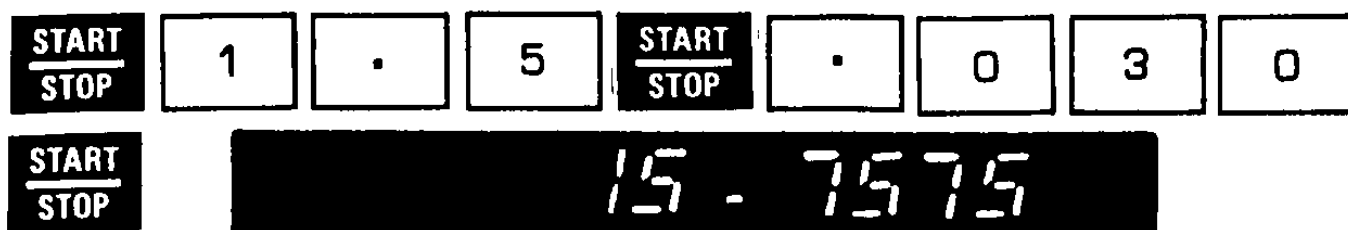| RCL n | 0 | × | (| START/STOP | 1 | . | 5 | a^x |
(	8	÷	3	)	)	×	START/STOP	.
0	0	1	√	÷	.	0	1	5
=	START/STOP
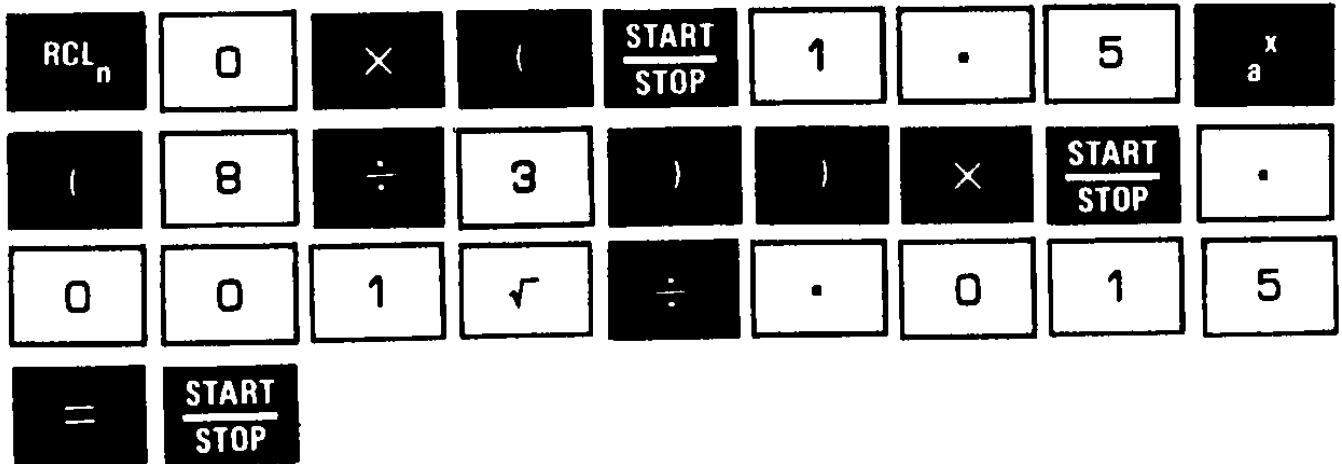
When you're through you should see the answer: 2.876924. Now flip the RUN/LOAD switch up and see it to the original four decimal places. Now let's run the program with the same variables. First press START/STOP. You'll see the constant recalled from Register 0 (0.4628) and the machine will wait for you to put in the first variable. Enter 1.5 and press START/STOP. When the machine waits again, enter .001 and press START/STOP. You should see good old 2.8769 again.

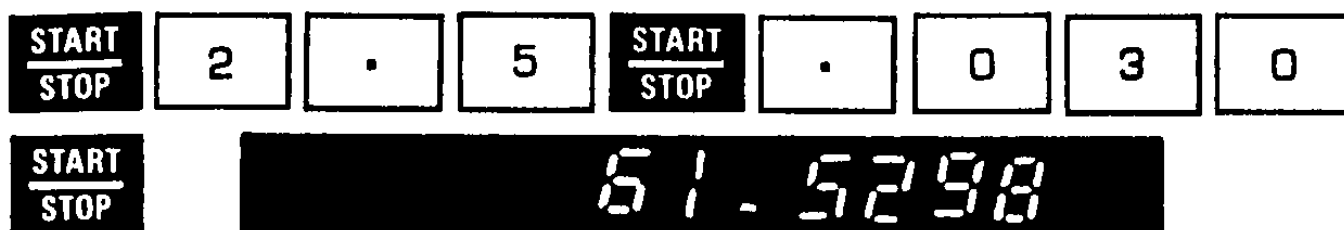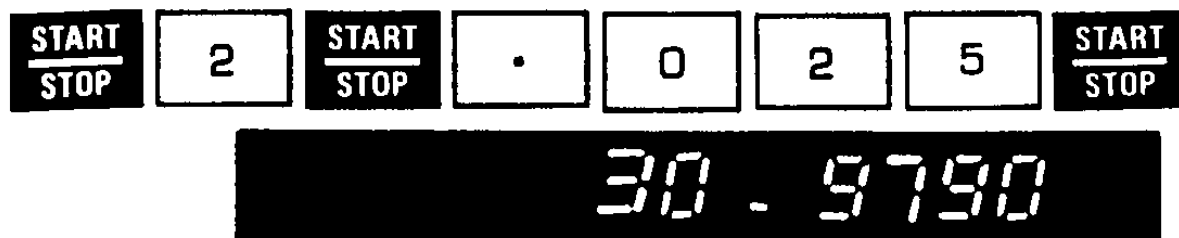Now let's try some other values for pipe size, keeping slope the same.

| START/STOP | 2 | START/STOP | . | 0 | 0 | 1 | START/STOP |

| | 6.1958 |

| START/STOP | 2 | . | 5 | START/STOP | . | 0 | 0 | 1 |
| START/STOP | 11.2337 |

Now let's change the slope and keep the original diameter.

| START/STOP | 1 | . | 5 | START/STOP | . | 0 | 2 | 5 |
| START/STOP | 14.3846 |

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[START/STOP] [1] [.] [5] [START/STOP] [.] [0] [3] [0]

[START/STOP] `15.7575`

Let's change both.

[START/STOP] [2] [START/STOP] [.] [0] [2] [5] [START/STOP]

`30.9750`

[START/STOP] [2] [.] [5] [START/STOP] [.] [0] [3] [0]

[START/STOP] `61.5298`

You can put up to 80 program steps into the Micro Scientist. If you try to put in more than that, it will go back to the beginning and start over, erasing the original steps as it goes.

NOTE: You can't press RESET or CLEAR ENTRY while you're loading a program. If you make a mistake you'll have to flip the switch to RUN and back to LOAD and start over.

We call this a scratchpad programmer because it can save you an enormous amount of jotting and scribbling. If you've got a variety of big problems that you do over and over, you'd better look at our desktop computers. They're just as easy to operate, but they have more than 4,000 program steps, over 500 memory registers, and you can store programs and data forever on magnetic cards, punched cards, tapes and cassettes. You can get printed output in just about any format you want.

We'll be happy to demonstrate one to you. In the meantime, have fun with your new little partner.

BATTERY OPERATION AND RECHARGING

Your Micro Scientist may be operated with the batteries it is shipped with or on normal AC with the accessory adapter/charger provided (set the adapter/charger to your line voltage).

The nickel-cadmium batteries supplied are rechargeable. Useful life is approximately 1,000 charge/discharge cycles — nearly four years of average daily operation. When fully discharged, the batteries will require about 15 hours to become fully charged, with the charger plugged in and the Micro Scientist turned off. With the machine turned on and operating, recharging will take somewhat longer.

In an emergency, any standard "D" cell may be used. Carbon-zinc batteries have a life of approximately two hours. Alkaline batteries will last approximately two and one-half hours.

To remove the batteries, turn the Micro Scientist over. Squeeze the two round plungers at the top of the case together and pull outward on the handle. The battery compartment will swing open. Remove the batteries and replace with fresh ones. Nickel-cadmium batteries, Compucorp Part No. 3400017, are recommended.
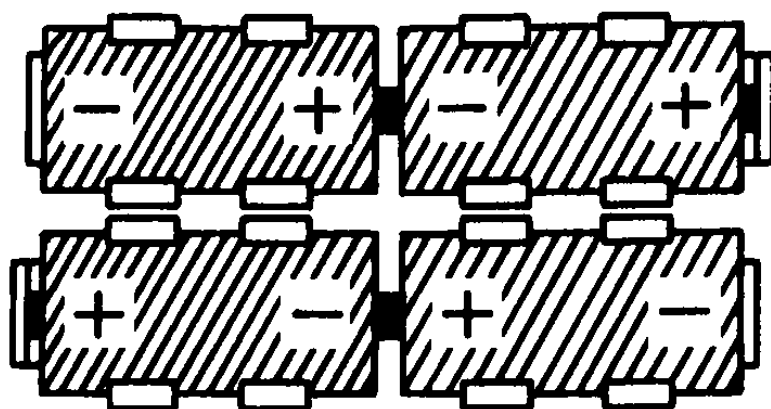
NOTE: Observe polarity of batteries when installing. Improper battery installation may severely damage the calculator. Follow this diagram when installing batteries.

WARNING

Standard "D" cell carbon zinc flashlight batteries may not be used while the adapter is connected and operating on AC power. It could be dangerous or cause severe damage to the calculator.