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Use of the Hewlett-Packard 9810 Calculator System in Water Quality Analysis

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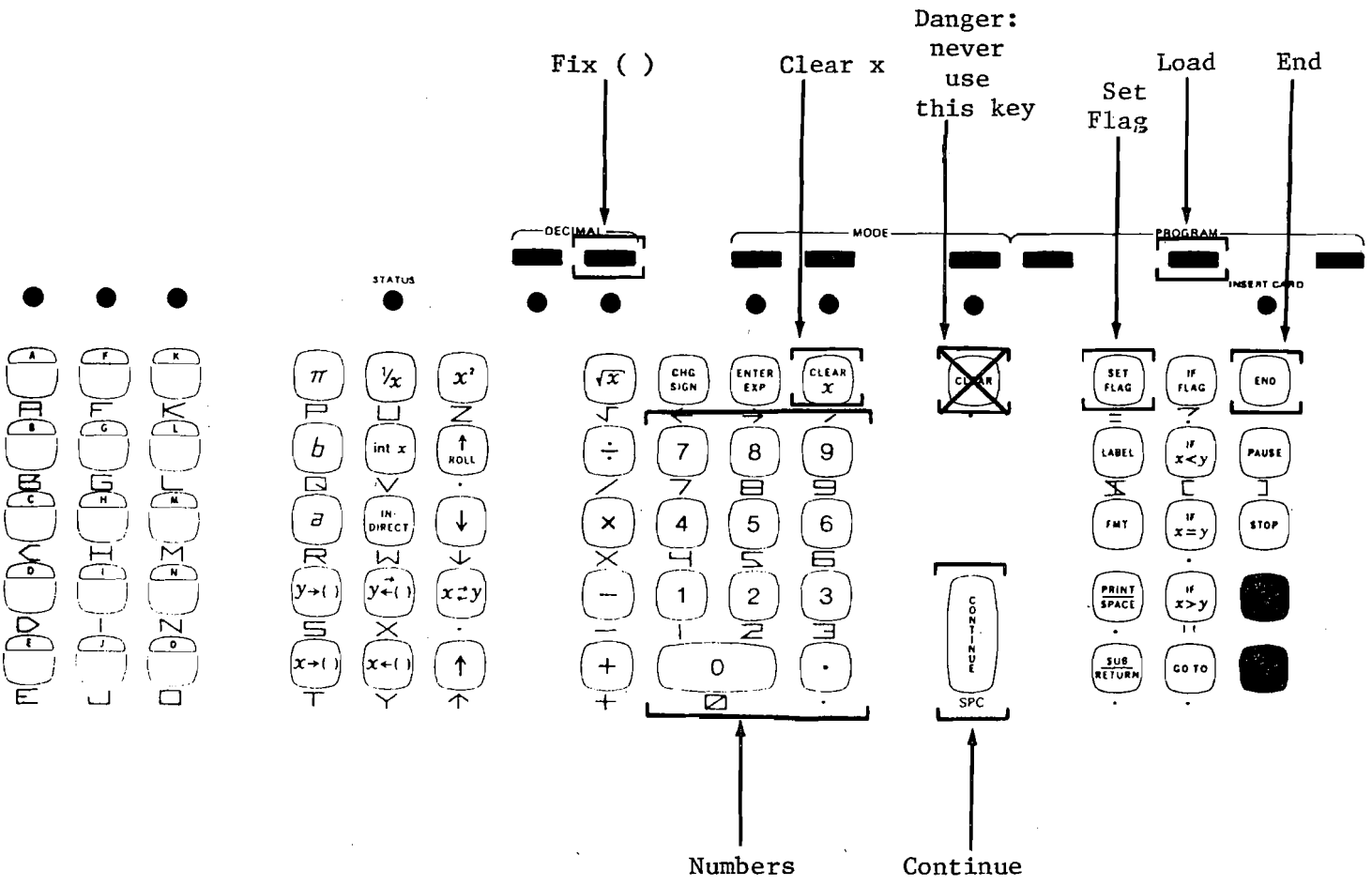
Introduction

It is the purpose of this manual to illustrate the utilization of the Hewlett-Packard, Model 9810A calculator for analyzing water quality data. Familiarization of each program's capabilities is essential for successful application, thus the user should read over the section used before beginning. Each section is complete with instructions and illustrative examples.

INITIALIZATION PROCEDURE INSTRUCTIONS

INITIALIZATION PROCEDURE

Listed below are the keys which may be used for this section.



INITIALIZATION

1. Turn on computer.
2. Turn on cassette memory and insert tape.
3. Push END.
4. Insert magnetic card in the Reader, push LOAD and remove magnetic card.
5. Push END.
6. Push CONTINUE.
7. Enter one of the following numbers, then CONTINUE.

Number	Program
0	alkalinity
1	calcium
2	total hardness
3	C.O.D.
4	iron standard curve
6	ammonia standard curve
8	orthophosphate standard curve
10	nitrite standard curve
12	mean, S.D., and C.V. for NH_3, Fe, N, or P
14	D.O. and/or B.O.D.
16	graphs (includes linear regression)

8. Follow instructions printed by the computer and/or those stated in the manual.

PLOTTER BOARD INSTRUCTIONS

PLOTTER BOARD INSTRUCTIONS

INITIALIZATION

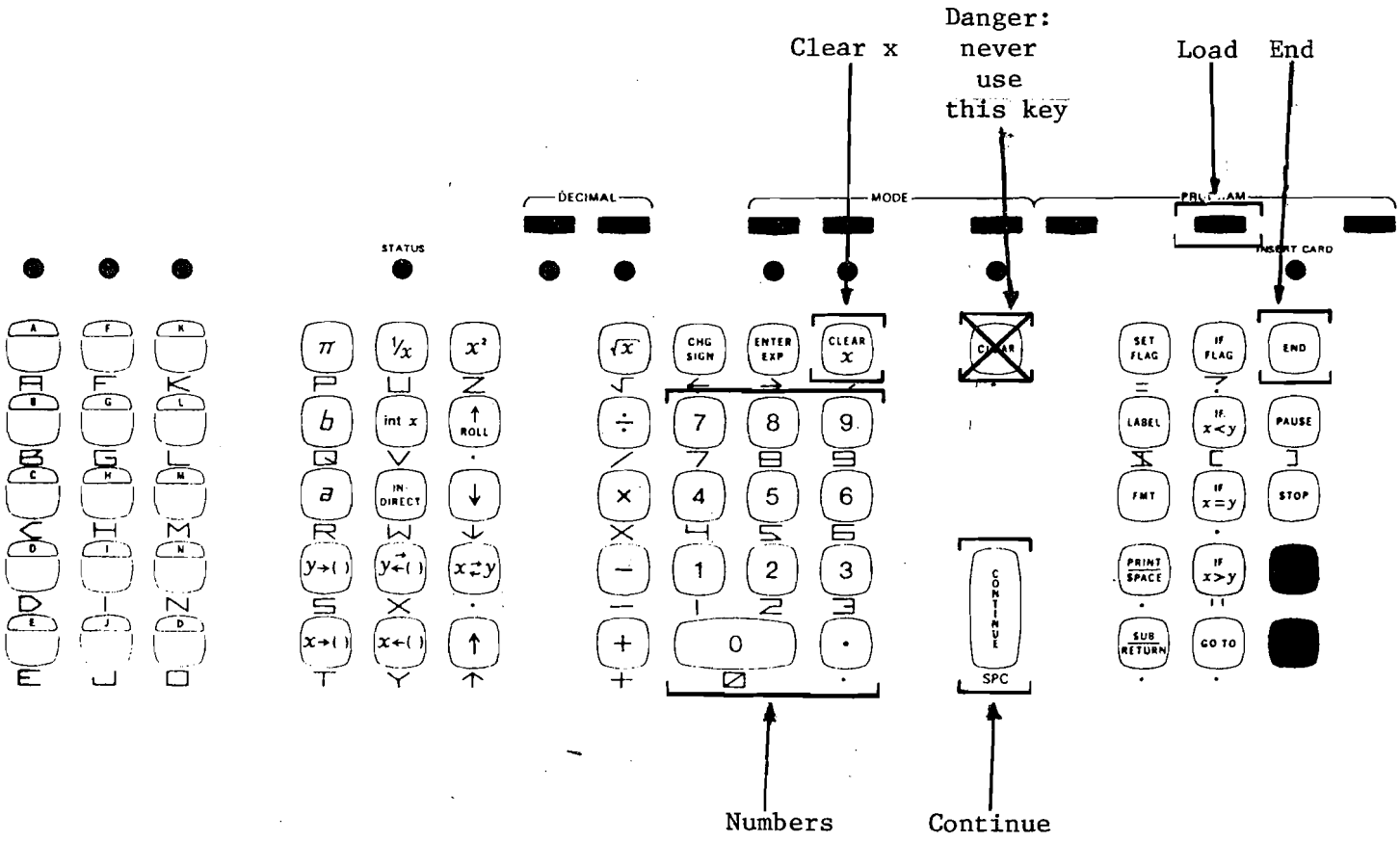
1. Push LINE ON. The button should stay down.
2. Push CHART HOLD. The button should stay down.
3. Push UPPER RIGHT.
4. Push CHART HOLD. The button should stay up.
5. Place your paper on the board. Remove the plastic tip from the pen and put it in the plotting position (i.e., the tip facing the paper).
6. Push CHART HOLD. The button should stay down.
7. Push LOWER LEFT. Adjust the pen to the desired position on the lower left section of your paper by manipulating the two knobs located at the immediate left of the LOWER LEFT button.
8. Push UPPER RIGHT. Adjust the pen to the desired position on the upper right section of your paper by manipulating the two knobs located at the immediate right of the UPPER RIGHT button.
9. Push LOWER LEFT to check the position of the pen. Repeat steps 7 and 8 until you are satisfied with the position of the pen.
10. Continue with the desired program.

TERMINATION

1. Push UPPER RIGHT.
2. Replace the plastic cap on the pen. Remove the pen from the plotting position (i.e., the tip nob facing the paper).
3. Push CHART HOLD. The button should stay up.
4. Remove your graph.
5. If another graph is to be developed, proceed to step 5 of the initialization procedure above.
6. If no more graphs are to be drawn, push LINE ON. The button should stay up.

Number	Program
0	alkalinity
1	calcium
2	total hardness
3	C.O.D.
4	iron standardization curve
6	ammonia standardization curve
8	orthophosphate standardization curve
10	nitrite standardization curve
12	mean, S.D. and C.V. for NH_3, Fe, N, or P
14	D.O. and/or B.O.D.

Listed below are the keys which may be used for the above programs.

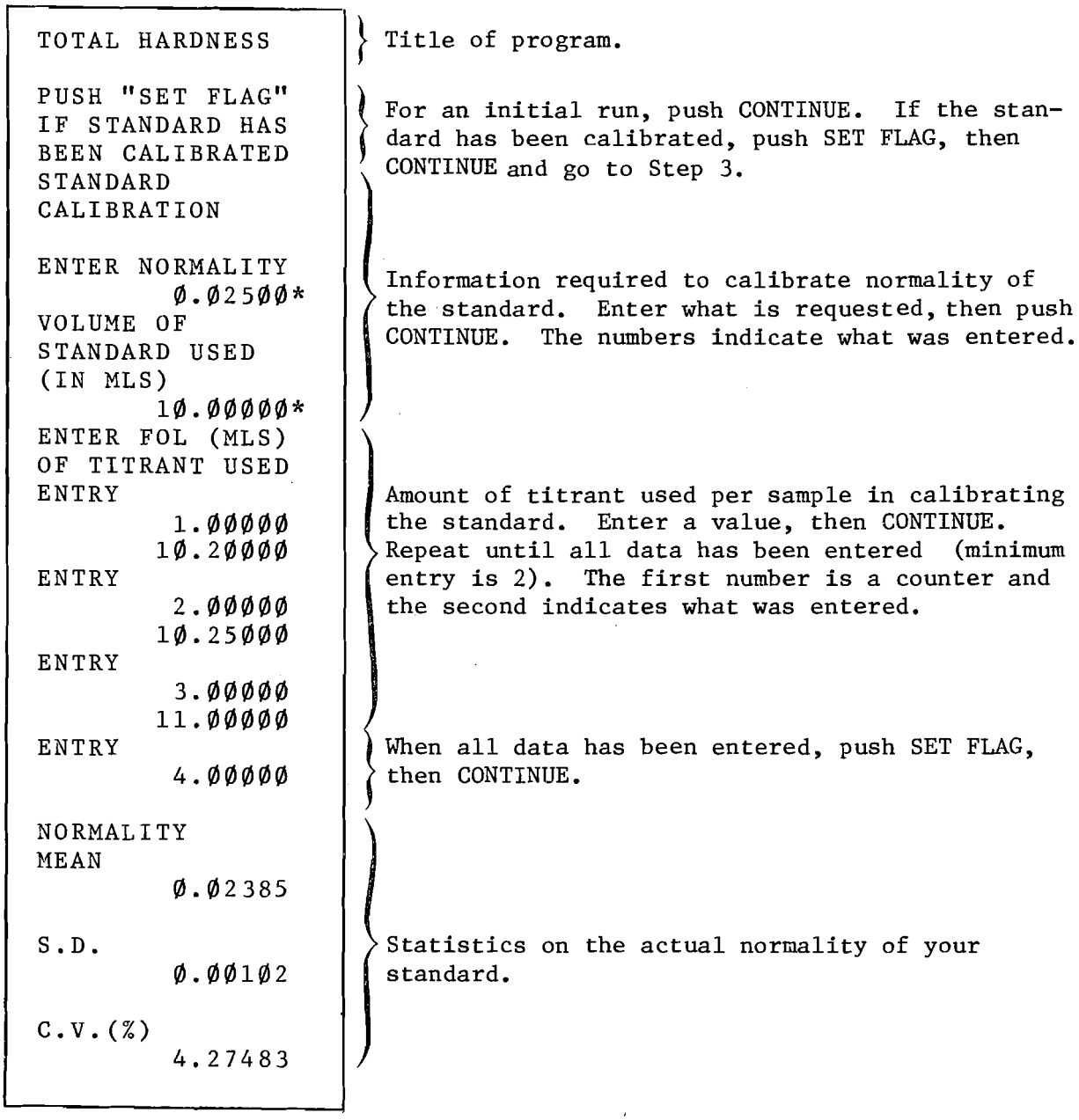


INSTRUCTIONS

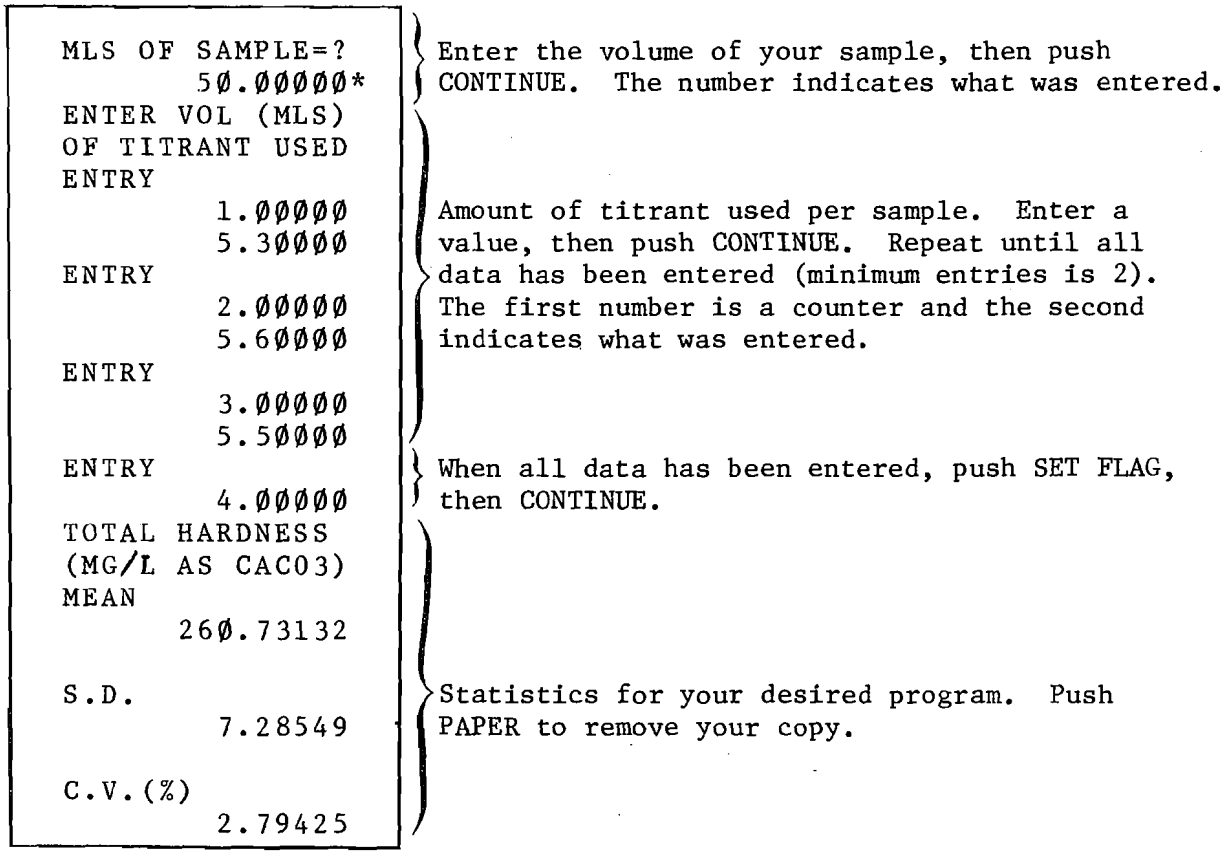
NUMBER	PROGRAM
0	ALKALINITY
1	CALCIUM
2	TOTAL HARDNESS

1. Follow initialization procedure (if not done already).

2. NOTE: If an incorrect entry occurs, and CONTINUE has not been executed, push CLEAR X and enter correct value. If CONTINUE was executed and a mistake discovered, start anew by pushing END, then CONTINUE.



3. Once the standard has been calibrated, the following will be executed:



4. If the same program is to be run again, push END, then CONTINUE.

5. If another program is desired, follow the procedure outlined in that section.

6. If no other program is to be run, turn off the computer and cassette memory.

INSTRUCTION

NUMBER	PROGRAM
3	C.O.D.

1. Follow initialization procedure (if not done already).

2. NOTE: If an incorrect entry occurs, and CONTINUE has not been executed, push CLEAR X and enter correct value. If CONTINUE was executed and a mistake discovered, start anew by pushing END, then CONTINUE.

```
C.O.D.

PUSH "SET FLAG"
IF STANDARD HAS
BEEN CALIBRATED

NORMALITY=?
        Ø.25ØØØ*
VOLUME OF
STANDARD USED
(IN MLS)
       1Ø.ØØØØØ*
ENTER VOL (MLS)
OF TITRANT USED
ENTRY
         1.ØØØØØ
        1Ø.1ØØØØ
ENTRY
         2.ØØØØØ
        1Ø.ØØØØØ
ENTRY
         3.ØØØØØ
        1Ø.2ØØØØ
ENTRY
         4.ØØØØØ

NORMALITY
MEAN
        Ø.24752

S.D.
        Ø.ØØ245

C.V.(%)
        Ø.99Ø1Ø
```

Title of program

For an initial run, push CONTINUE. If the standard has been calibrated, push SET FLAG, then CONTINUE and go to step 3.

Information required to calibrate normality of the standard. Enter what is requested, then push CONTINUE. The numbers indicate what was entered.

Amount of titrant used per sample in calibrating the standard. Enter a value, then CONTINUE. Repeat until all data has been entered (minimum entries is 2). The first number is a counter and the second indicates what was entered.

When all data has been entered, push SET FLAG, then CONTINUE.

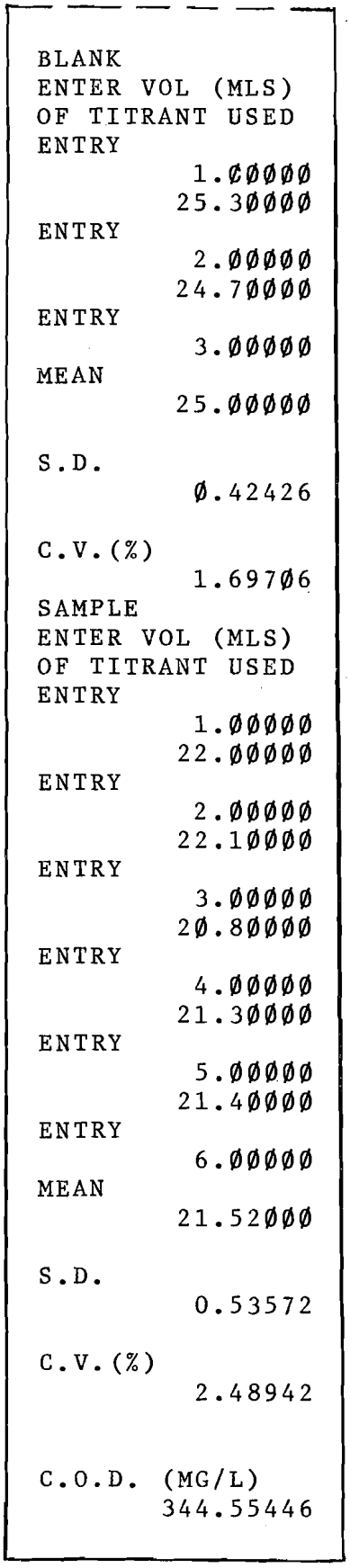
Statistics on the actual normality of your standard.

3. Once the computer has calibrated the standard, the following steps are executed:

```
MLS OF SAMPLE=?

       2Ø.ØØØØØ
```

Enter the volume of your sample, then push CONTINUE. The number indicates the entry.



Amount of titrant used for the blanks. Enter a value, then CONTINUE. Repeat until all data has been entered (minimum entry = 2). The first number is a counter and the second is the entry.

When all data has been entered, push SET FLAG, then CONTINUE.

Statistics for your blank.

Amount of titrant used for the samples. Enter a value, then CONTINUE. Repeat until all data has been entered (minimum entry = 2). The first number is a counter and the second is the entry.

When all data has been entered, push SET FLAG, then CONTINUE.

Statistics for your sample.

C.O.D. of your sample. Push PAPER to remove your copy.

4. If the program is to be run again, push END, then CONTINUE.

5. If another program is desired, follow the procedure outlined in that section.

6. If no other program is to be run, turn off the computer and cassette memory.

INSTRUCTIONS

NUMBER	PROGRAM
4	IRON STANDARDIZATION CURVE
6	AMMONIA STANDARDIZATION CURVE
8	ORTHOPHOSPATE STANDARDIZATION CURVE
10	NITRITE STANDARDIZATION CURVE

1. Follow the procedure for setting up your graph on the plotter.

2. Follow initialization procedure (if not already done).

3. Note: If an incorrect entry occurs, and CONTINUE has not been executed, push CLEAR X and enter correct value. If CONTINUE was executed and a mistake discovered, start anew by pushing END, then CONTINUE.

```
NITRITE
MAX ABSORPTION=?
              Ø.6ØØ*
WAVELENGTH=?
           543.ØØØ
CELL LENGTH=?
             1.ØØØ
CELL UNITS
(1 = IN.   2    CM)
X=?
            35.ØØØ*
Y=?
             Ø.118*
X=?
            7Ø.ØØØ
Y=?
             Ø.26Ø*
X=?
           1Ø5.ØØØ
Y=?
             Ø.355*
X=?
           14Ø.ØØØ
Y=?
             Ø.51Ø*
X=?
```

Title of program.

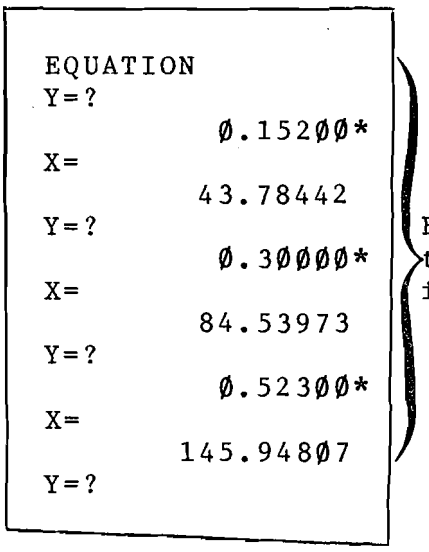
Enter the largest value you want for the absorbance axis, then CONTINUE. The number indicates what was entered.

General information for your graph. Enter what is requested, then CONTINUE.

Coordinates to be entered for plotting your points:
X=Concentration
Y=Absorbance
At least 3 points are needed. Enter X, then CONTINUE. Enter Y, then CONTINUE. Arrange your data such that X is in ascending order.

When all points have been plotted, push SET FLAG, then CONTINUE. The best straight line will be drawn and an equation, with R^2, written on your graph. (See page 17.)

4. The following will illustrate how concentrations can be found if you know absorbance.

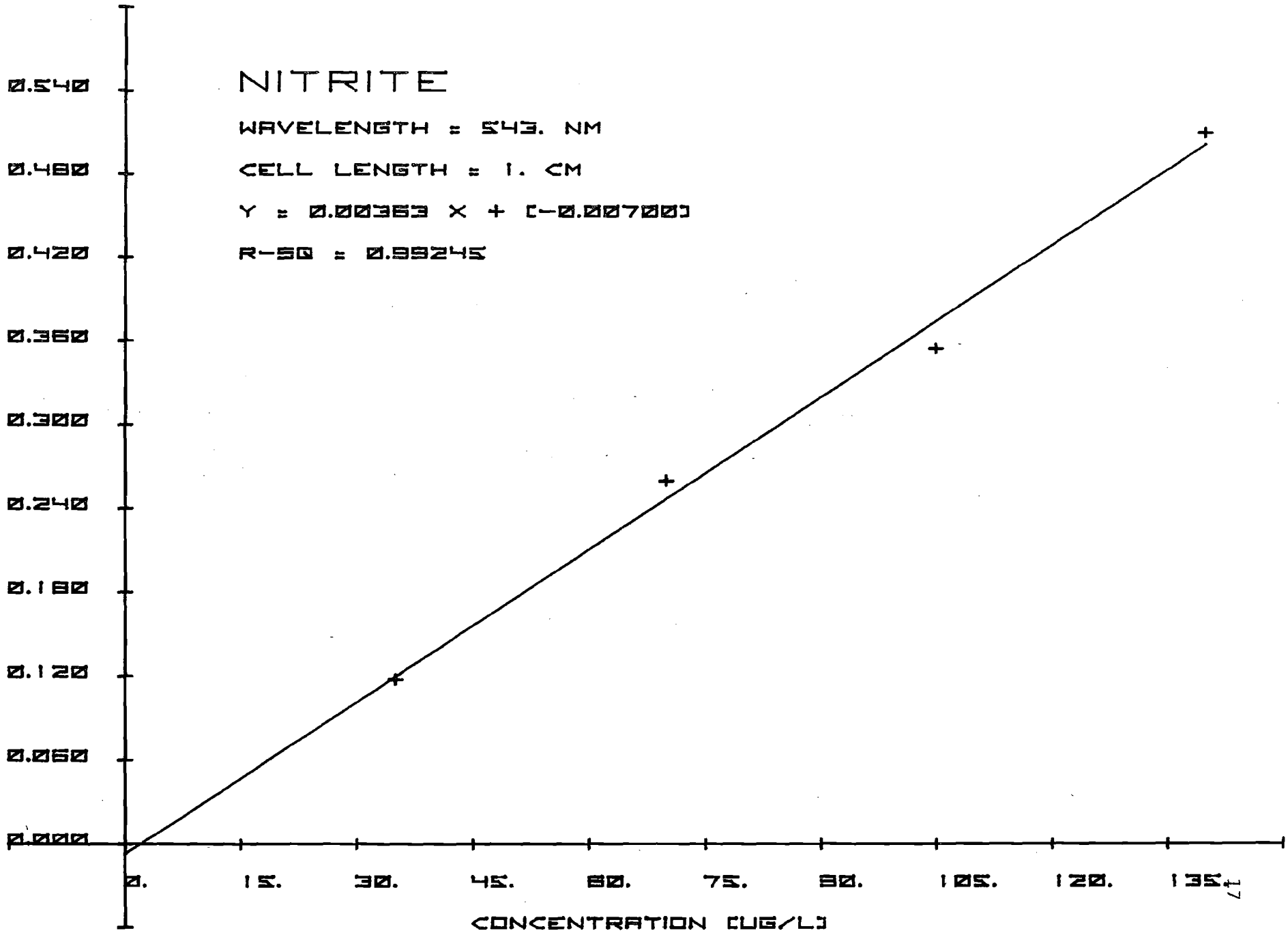


Enter the absorbance (i.e., Y) of your sample, then CONTINUE. The X represents concentrations in mg/ℓ.

5. Push the HOLD button (it should stay up). Remove your graph.

6. If this, or any other program is to be run again, follow the procedure for that section.

7. If no other program is to be run, turn off the computer, cassette memory, and plotter board. Be sure the plastic lid is on the tip of the pen.


NITRITE
WAVELENGTH = 543. NM
CELL LENGTH = 1. CM
Y = 0.00363 X + [-0.00700]
R-SQ = 0.99245
0.540
0.480
0.420
0.360
0.300
0.240
0.180
0.120
0.060
0.000
0.
15.
30.
45.
60.
75.
90.
105.
120.
135.
CONCENTRATION [UG/L]

INSTRUCTIONS

NUMBER	PROGRAM
12	MEAN, S.D., AND C.V. FOR NH_3, FE, N, OR P

1. Follow initialization procedure (if not already done).

2. NOTE: If an incorrect entry occurs, and CONTINUE has not been executed, push CLEAR X and enter correct value. If CONTINUE was executed and a mistake discovered, start anew by pushing END, then CONTINUE.

```
MEAN, S.D., AND
C.V. FOR AMMONIA
IRON, NITRITE OR
ORTHOPHOSPHATE

ENTER ABSORBANCE
ENTRY
          1.ØØØØØ
          Ø.14ØØØ
ENTRY
          2.ØØØØØ
          Ø.145ØØ
ENTRY
          3.ØØØØØ
          Ø.145ØØ
ENTRY
          4.ØØØØØ
          Ø.143ØØ
ENTRY
          5.ØØØØØ
          Ø.149ØØ
ENTRY
          6.ØØØØØ
          Ø.133ØØ
ENTRY
          7.ØØØØØ
MEAN
          Ø.1425Ø

S.D.
          Ø.ØØ55Ø

C.V.(%)
          3.86284

ENTER VALUE
IF GRAPHING
STANDARD CURVE
 4 = FE
 6 = NH3
 8 = P
1Ø = N
```

Title of program

Absorbance readings of your sample. Enter a value then CONTINUE. Repeat until all data has been entered (minimum entries is 2). The first number is a counter and the second indicates what was entered.

When all data has been entered, push SET FLAG, then CONTINUE.

Statistics on the absorbance of your samples.

Option to allow the user to go to a standard curve without having to go to the initialization procedure.

3. If the program is to be run again, push END, then CONTINUE.

4. If another program is desired, follow the procedure outlined in that section.

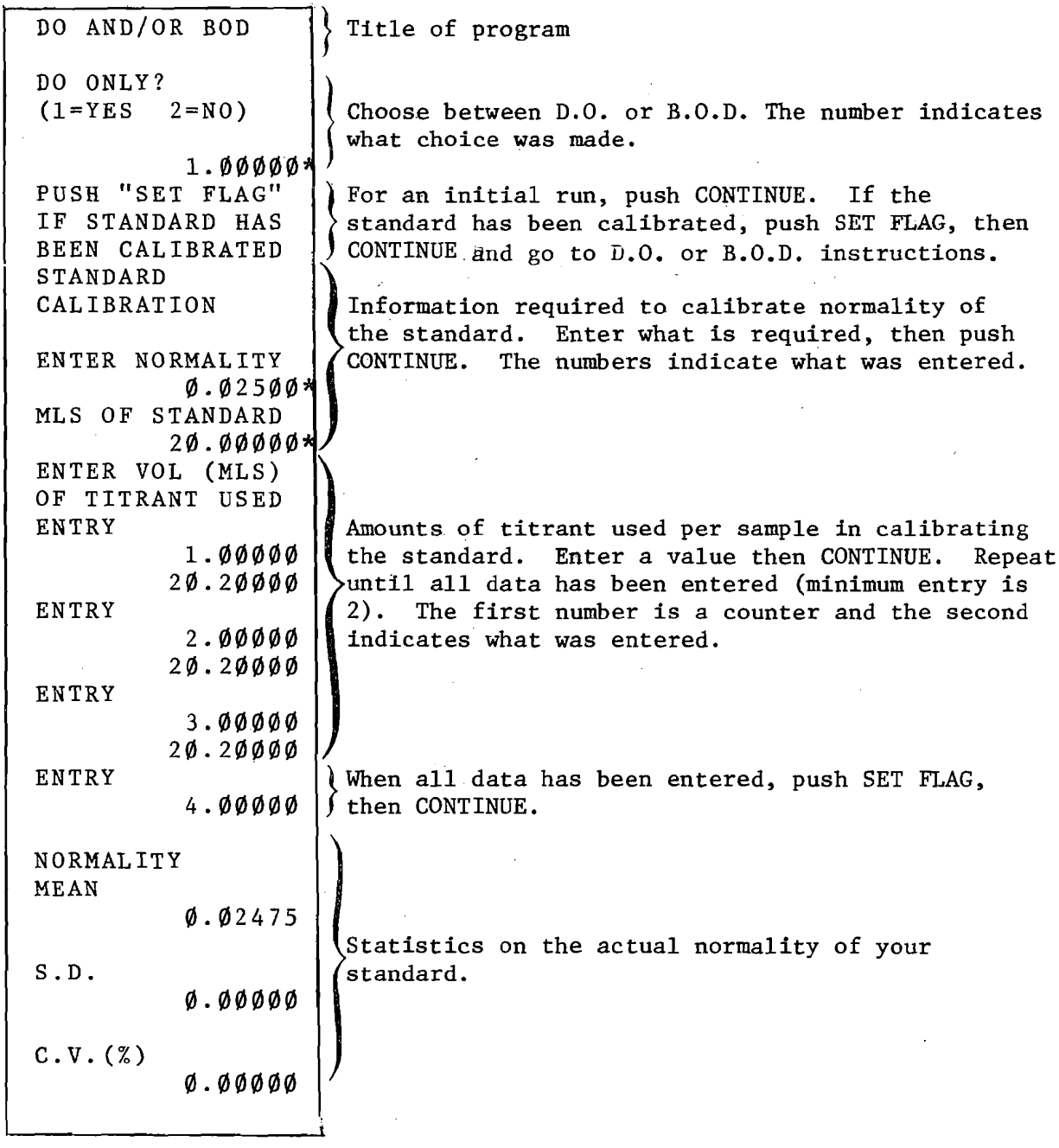
5. If no other program is to be run, turn off the computer and cassette memory.

INSTRUCTIONS

NUMBER	PROGRAM
14	D.O. AND/OR B.O.D.

1. Follow initialization procedure (if not already done.)

2. NOTE: If an incorrect entry occurs, and CONTINUE has not been executed, push CLEAR X and enter correct value. If CONTINUE was executed and a mistake discovered, start anew by pushing END, then CONTINUE.



D.O. Instructions

```
1 ML OF .Ø25 N
NA2S2Ø3 EQUALS
       Ø.99Ø1Ø
MG OF Ø2/L AS DO
D.O.

SAMPLE
       1.ØØØØØ
ENTER VOL (MLS)
OF TITRANT USED
ENTRY
       1.ØØØØØ
       3.ØØØØØ
ENTRY
       2.ØØØØØ
       2.9ØØØØ
ENTRY
       3.ØØØØØ
       3.1ØØØØ
ENTRY
       4.ØØØØØ
MEAN
       2.97Ø3Ø

S.D.
       Ø.Ø99Ø1

C.V.(%)
       3.33333
SAMPLE
       2.ØØØØØ
ENTER VOL (MLS)
OF TITRANT USED
ENTRY
       1.ØØØØØ
       Ø.7ØØØØ
ENTRY
       2.ØØØØØ
       8.5ØØØØ
ENTRY
       3.ØØØØØ
       8.4ØØØØ
ENTRY
       4.ØØØØØ
MEAN
       8.44884

S.D.
       Ø.15124

C.V. (%)
       1.79ØØ7
```

Equivalance of $Na_2S_2O_3$ to milligrams/liter of O_2.

Identifies what sample is being analyzed for D.O.

Amount of titrant used. Enter a value, then CONTINUE. Repeat until all data has been entered (minimum entry is 2). The first number is a counter and the second is the entry.

When all data has been entered, push SET FLAG, then CONTINUE.

Statistics of D.O. for your sample. The mean and S.D. are final D.O. values (in mg/ℓ of O_2).

Identifies the next sample being analyzed.

Amount of titrant used. Enter a value, then CONTINUE. Repeat until all data has been entered (minimum entry is 2). The first number is a counter and the second is the entry.

When all data has been entered, push SET FLAG, then CONTINUE.

Statistics of D.O. for your sample. The mean and S.D. are final D.O. values (in mg/ℓ of O_2).

3. Continue in a similar manner until all your samples have been analyzed for D.O.

B.O.D. Instructions

```
B.O.D.

SET FLAG WHEN
SAMPLE CALCULA-
TIONS ARE COM-
PLETED

DO SAMPLE
     1.ØØØØØ
ENTER VOL (MLS)
OF TITRANT USED
ENTRY
     1.ØØØØØ
     7.51ØØØ
ENTRY
     2.ØØØØØ
     7.61ØØØ
ENTRY
     3.ØØØØØ
     7.51ØØØ
ENTRY
     4.ØØØØØ
MEAN
     7.46865

S.D.
     Ø.Ø5716

C.V. (%)
     Ø.76538
DO SAMPLE
     2.ØØØØØ
```

Title of program

If D.O. samples are to be calculated push CONTINUE

Titrant entries to calculate the D.O. of your sample. Enter value, then CONTINUE (a minimum of 2 entries is required). The first number is a counter and the second represents what was entered

When all data has been entered, push SET FLAG, then CONTINUE

Statistics of D.O. for your sample. The mean and S.D. are final D.O. values (in mg/ℓ of O_2).

If all samples have been calculated for D.O. then push SET FLAG, and CONTINUE. Otherwise, push CONTINUE.

```
DECIMAL FRACTION
OF SAMPLE=?
     Ø.Ø5ØØØ
BLANK 1=?
     7.75ØØØ*
BLANK 2=?
     7.1ØØØØ*
D.O. 1=?
     7.47ØØØ*
D.O. 2=?
     6.49ØØØ*
MG BOD/L EQUALS
     6.6ØØØØ
DECIMAL FRACTION
OF SAMPLE=?
```

Enter the fraction of your sample used, then CONTINUE. The number represents what was entered.

Enter the initial blank D.O. value, then CONTINUE.

Enter the second blank D.O. value, then CONTINUE.

Enter the initial sample D.O. value, then CONTINUE.

Enter the second D.O. value, then CONTINUE.

The BOD for that particular day being analyzed.

Repeat the above until all days have been completed.

4. Push PAPER to remove your copy.

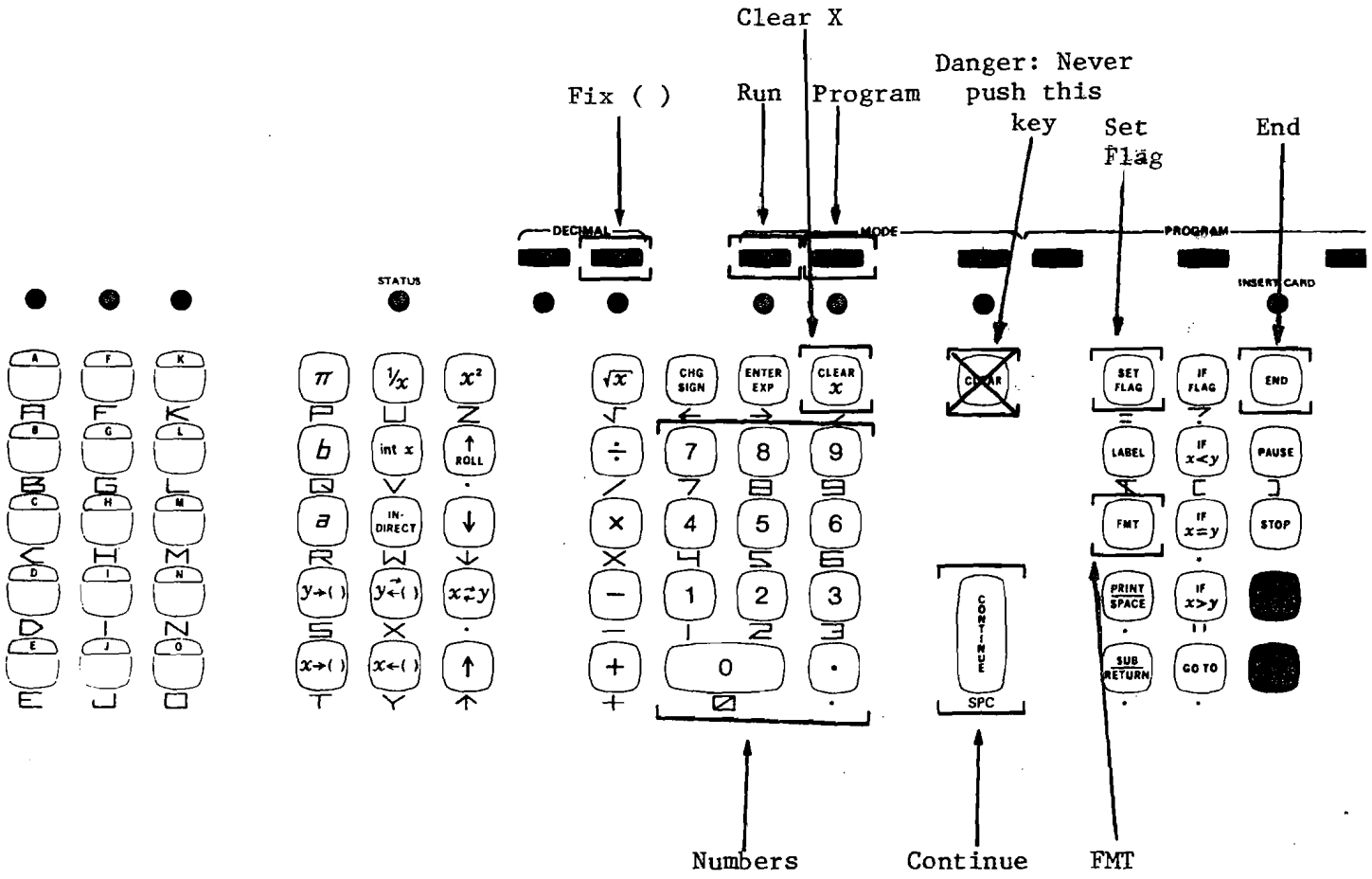
5. If this, or another, program is to be run again, follow the procedure outlined in that section.

6. If no other program is to be run, turn off the computer and cassette tape drive.

INSTRUCTIONS

NUMBER	PROGRAM
16	GRAPHING (INCLUDES LINEAR REGRESSIONS)

Listed below are the keys which may be used for this section.



1. Follow initialization procedure (if not already done).

```
INITIALIZATION

ENTER PROGRAM
NUMBER

PUSH FIX(), THEN
ENTER THE NUMBER
OF DIGITS YOU
WANT AFTER THE
DECIMAL POINT
FOR THE AXIS

FINALLY, PUSH
CONTINUE

              16.
```

Enter 16, then CONTINUE.

This allows you to select the number of digits after the decimal point desired if it is decided to allow the computer to draw and label each axis.

Program number chosen.

2. NOTE: If an incorrect entry occurs, and CONTINUE has not been executed, push CLEAR X and enter correct value. If CONTINUE was executed and a mistake discovered, start anew by pushing END then CONTINUE.

3. Follow Plotter Instructions

```
GRAPHING

X-MAX =?
            15Ø.
X-MIN =?
              Ø.

Y-MAX =?
            15Ø.
Y-MIN =?
              Ø.

ARE YOU PLOTTING
ON GRAPH PAPER?
(Ø=NO 1=YES)
```

Title of program.

Maximum and minimum cordinates of your graph. Choose numbers which will include your values to be plotted adequately.

If 0 is entered, a graph will be drawn with the ordinates and abscissa each divided into ten equal parts. After the graph is developed, follow the linear regression or non-linear regression instructions.

Linear Regression Instructions

```
LINEAR REG?
(Ø = NO  1 = YES)
X=?
          1Ø.ØØØ
Y=?
          25.ØØØ*
X=?
          45.ØØØ
Y=?
          45.ØØØ*
X=?
          9Ø.ØØØ
Y=?
         125.ØØØ*
X=?
```

Enter 1, then CONTINUE.

Once the linear regression option has been selected, enter the coordinates as requested, then CONTINUE. These points will be plotted on your graph.

When all data has been entered, push SET FLAG, then CONTINUE. On your graph, the best straight line will be drawn along with the equation and R^2 value written. (See the graph on page 32.)

```
LINEAR REG. WAS
EXECUTED

GENERAL EQUATION
IS Y = MX + B

DO YOU WANT TO
ENTER X AND
SOLVE FOR Y?
(Ø=NO, 1=YES)


Y=?
      9Ø.ØØØØØ*
X=
      67.94723
Y=?
      33.5ØØØØ*
X=
      23.61995
Y=?
```

This allows you to use the linear regression equation developed to solve for the dependent variable (i.e. Y) or independent variable (i.e. X). Enter 0 or 1, then CONTINUE.

Example of solving for the independent variable (i.e. X) when Y is known. Enter value of Y, then CONTINUE (Repeat as often as desired).

```
X=?
      15Ø.ØØØØØ*
Y=
      194.58528
X=?
       72.6ØØØØ*
Y=
       95.93Ø47
X=?
```

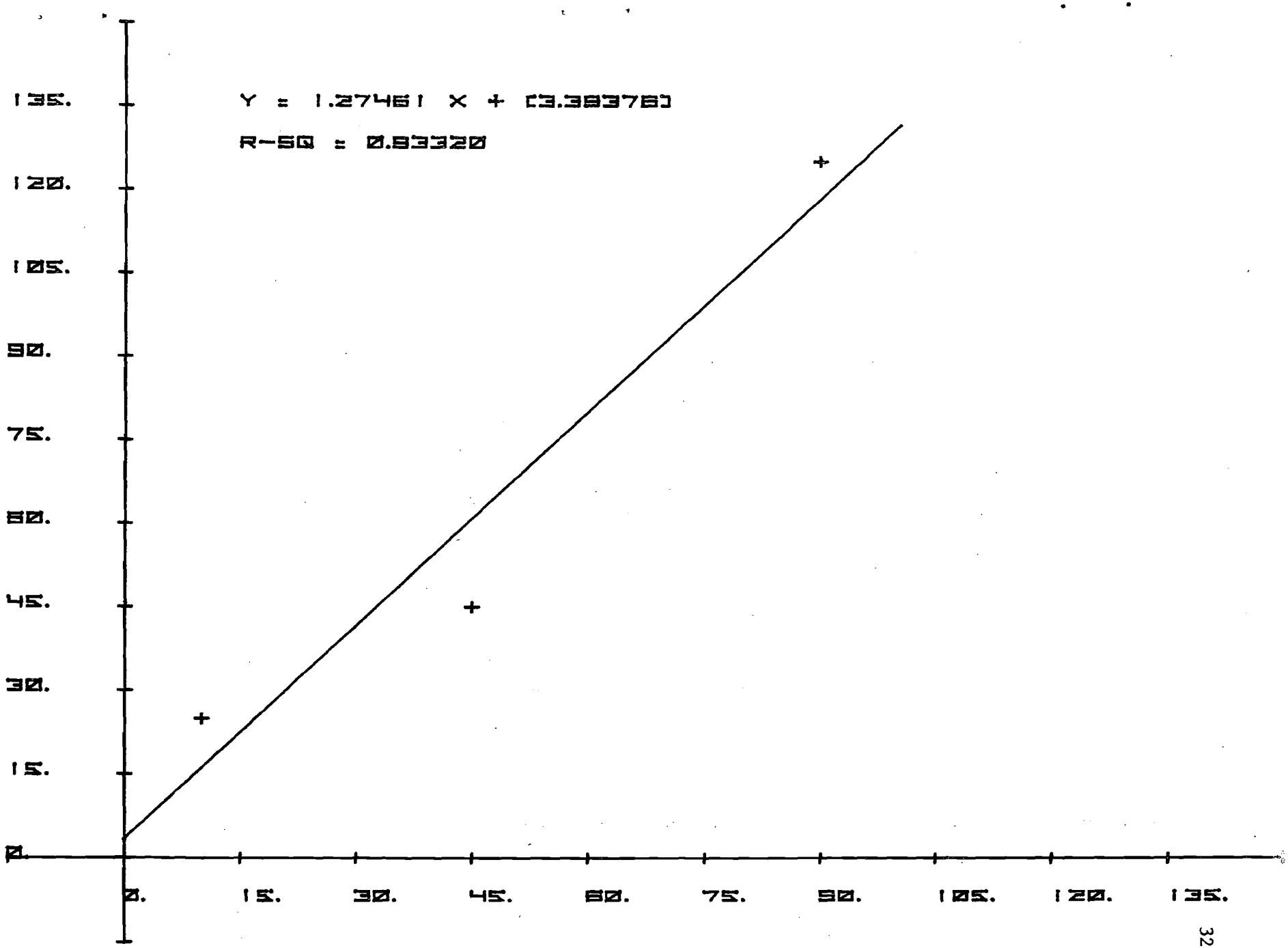
Example of solving for the dependent variable (i.e. Y) when X is known. Enter value of X, then CONTINUE (Repeat as often as desired).

4. Remove graph from plotter.

5. To run this or any other program, follow the procedure of that section.

6. If no other program is to be run, turn off the computer, cassette memory and plotter board (the ON button should be up).

7. Be sure the plastic lid is on the tip of the ink pen.


Y = 1.27461 X + [3.38376]
R-SQ = 0.93320
135.
120.
105.
90.
75.
60.
45.
30.
15.
0.
0.
15.
30.
45.
60.
75.
90.
105.
120.
135.

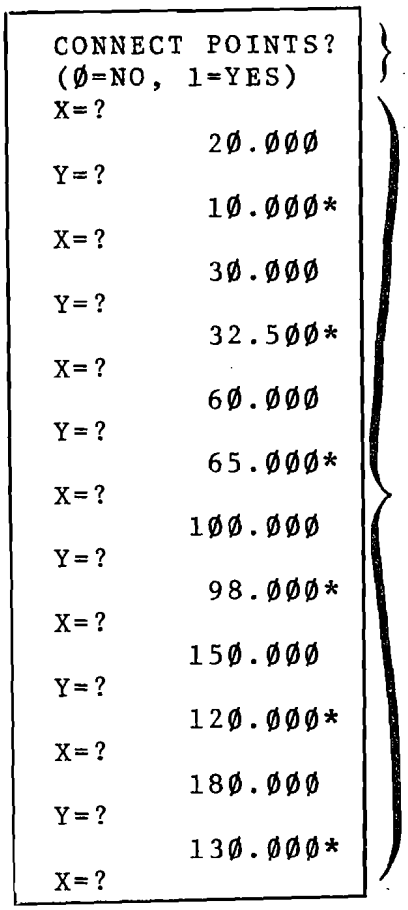
Non Linear Regression Instructions

GRAPHING	Title of program.
X-MAX =? 2ØØ. X-MIN =? Ø. Y-MAX =? 15Ø. Y-MIN =? Ø.	Maximum and minimum coordinates of your graph. See, the linear regression instructions.
ARE YOU PLOTTING ON GRAPH PAPER? (Ø = NO 1 = YES)	See the linear regression instructions
LINEAR REG? (Ø = NO 1 = YES)	Enter 0, then CONTINUE.

8. NOTE: As the program is written, each point will be marked with a "+" This may be altered by the following steps:

   1) push GO TO 0462
   2) push PRGM
   3) push:
      a) FMT
      b) 1
      c) FMT
      d) any number or symbol desired
      e) FMT
   4) push RUN
   5) push 0.1, then FMT 11
   6) push END, then CONTINUE

   This must be executed before a decision on connection points is made. This allows more than one curve to be put on a single graph.



This allows the option of connection each point with a straight line. Enter your choice, then CONTINUE

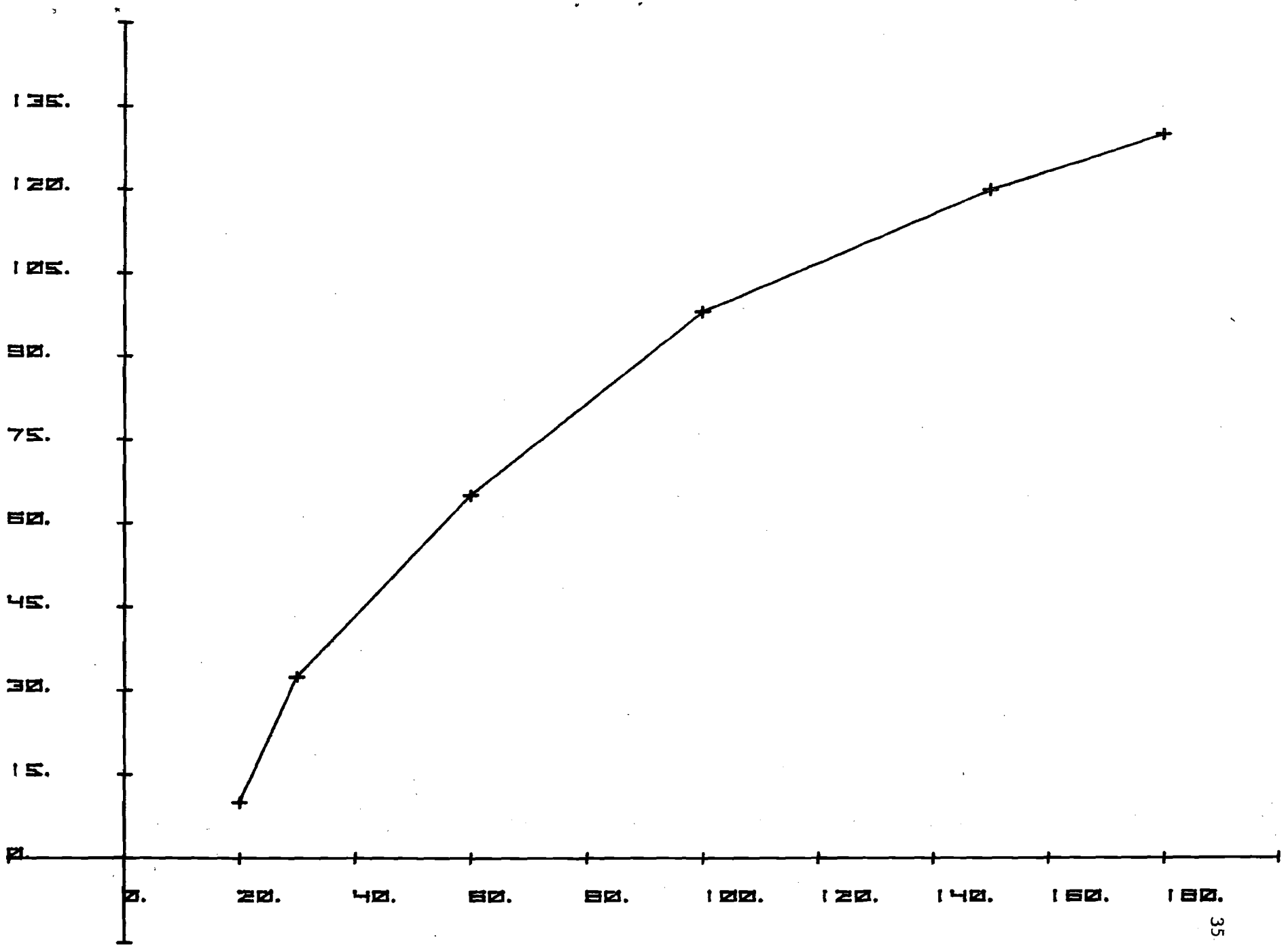
Enter your value for X, then CONTINUE. Enter your value for Y, then CONTINUE. Repeat the above until all data has been plotted.

9. If another curve is to be plotted on the same graph, go to step 8.

10. Remove your graph (see plotting instructions).

11. If no other program is to be run, turn off the computer, cassette memory and plotter board (the ON button should be up).

12. If this, or any other program is to be run, the initialization procedure for that section must be followed.


135.
120.
105.
90.
75.
60.
45.
30.
15.
0.
0.
20.
40.
60.
80.
100.
120.
140.
160.
180.

BIBLIOGRAPHY

Cowan, Pete and Don Porcella (eds.) 1975. Water Quality Analysis Laboratory Procedures Syllabus. 94 pages.

Hewlett-Packard Company. 1971. Hewlett-Packard 9810A Calculator Operating and Programming Manual. 151 pages.