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

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USE OF THE HEWLETT-PACKARD 9810

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CALCULATOR SYSTEM IN WATER QUALITY ANALYSIS

BY

JERALD S. FIFIELD

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USE OF THE HEWLETT-PACKARD 9810 CALCULATOR SYSTEM IN WATER QUALITY ANALYSIS

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JERALD S. FIFIELD

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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.



- 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

0

1 2 <u>Program</u>

ALKALINITY CALCIUM TOTAL HARDNESS

÷

- 1. Follow initialization procedure (if not done already).
- 2. <u>NOTE</u>: If an incorrect entry occurs, and CONTINUE has <u>not</u> been executed, push CLEAR X and enter correct value. If CONTINUE was executed and a mistake discovered, start anew by pushing END, then CONTINUE.

TOTAL HARDNESS	} Title of program.
PUSH "SET FLAG" IF STANDARD HAS BEEN CALIBRATED STANDARD CALIBRATION	For an initial run, push CONTINUE. If the stan- dard has been calibrated, push SET FLAG, then CONTINUE and go to Step 3.
ENTER NORMALITY Ø.Ø25ØØ* VOLUME OF STANDARD USED (IN MLS) 1Ø.ØØØØØ*	Information required to calibrate normality of the standard. Enter what is requested, then push CONTINUE. The numbers indicate what was entered.
ENTER FOL (MLS) OF TITRANT USED ENTRY 1.00000 10.20000 ENTRY 2.00000 10.25000	Amount of titrant used per sample in calibrating the standard. 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 indicates what was entered.
3.ØØØØØ 11.ØØØØØ ENTRY 4.ØØØØØ	When all data has been entered, push SET FLAG, then CONTINUE.
NORMALITY MEAN Ø.Ø2385	
S.D. Ø.ØØ1Ø2	Statistics on the actual normality of your standard.
C.V.(%) 4.27483)

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

MLS OF SAMPLE=? 5Ø.ØØØØØ* ENTER VOL (MLS) OF TITBANT USED	Enter the volume of your sample, then push CONTINUE. The number indicates what was entered.
ENTRY 1.00000 5.30000 ENTRY 2.00000 5.60000	Amount of titrant used per sample. Enter a value, then push 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.
ENTRY 3.ØØØØØ 5.5ØØØØ ENTRY 4.ØØØØØ TOTAL HARDNESS (MG/L AS CACO3) MEAN	When all data has been entered, push SET FLAG, then CONTINUE.
26Ø.73132 S.D. 7.28549 C.V.(%) 2.79425	Statistics for your desired program. Push PAPER to remove your copy.

- 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

NUMBERPROGRAM3C.O.D.

.

.

- 1. Follow initialization procedure (if not done already).
- 2. <u>NOTE</u>: If an incorrect entry occurs, and CONTINUE has <u>not</u> 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.	} Title of program
PUSH "SET FLAG" IF STANDARD HAS BEEN CALIBRATED	For an initial run, push CONTINUE. If the standard has been calibrated, push SET FLAG, then CONTINUE and go to step 3.
NORMALITY=? Ø.25ØØØ* VOLUME OF STANDARD USED (IN MLS) 1Ø.ØØØØØ* ENTER VOL (MLS)	Information required to calibrate normality of the standard. Enter what is requested, then push CONTINUE. The numbers indicate what was entered.
OF TITRANT USED ENTRY 1.00000 10.10000 ENTRY 2.00000 10.00000 ENTRY	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.
3.ØØØØØ 10.2ØØØØ ENTRY 4.ØØØØØ	When all data has been entered, push SET FLAG, then CONTINUE.
NORMALITY MEAN Ø.24752	Statistics on the actual normality of your
S.D. Ø.ØØ245	standard.
C.V.(%) Ø.99Ø1Ø	

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

MLS OF SAMPLE=? 20.00000

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

BLANK	
ENTER VOL. (MLS)	
OF TITRANT USED	Amount of titrant used for the blanks. Enter
ENTRY	a value, then CONTINUE. Repeat until all data
1.00000	\rightarrow has been entered (minimum entry = 2). The first
25.30000	number is a counter and the second is the entry.
ENTRY	
2.00000	
24.70000	
ENTRY	When all data has been entered, push SET FLAG,
3.00000	then CONTINUE.
MEAN	$\left \mathbf{\lambda} \right ^{-1}$
25.0000	
	1
S.D.	Statistics for your blank.
Ø.42426	
(
C.V.(%)))
1.697Ø6	
SAMPLE	
ENTER VOL (MLS)	
OF TITRANT USED	
ENTRY	Amount of titrant used for the samples. Enter a
1.00000	value, then CONTINUE. Repeat until all data has
22.00000	been entered (minimum entry = 2). The first
ENTRY	number is a counter and the second is the entry.
2.00000	
20 80000	
ENTRY	
4.00000	
21.30000	
ENTRY	
5.0000	
21.40000	
ENTRY	When all data has been entered, push SET FLAG,
6.0000	f then CONTINUE.
MEAN	
21.52000	
S.D.	
0.53572	Statistics for your sample.
0 11 (")	
U.V.(%)	j j
2.48942	
	COD of your comple Buch DADED to remove the
	copy
344.55440	, copy.
L	

- 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.

e.

INSTRUCTIONS

NUMBER

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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. <u>Note:</u> If an incorrect entry occurs, and CONTINUE has <u>not</u> 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	Title of program.
MAX ABSORPTION=?	Enter the largest value you want for the absor-
Ø.6ØØ*	<pre>> bance axis, then CONTINUE. The number indicates > what was entered.</pre>
WAVELENGTH=?)
543.000	
CELL LENGTH=?	
L.000	General information for your graph. Enter what
(1 = IN, 2 CM)	is requested, then continue.
X=?	\langle
35.ØØØ*	
Y = ?	
Ø.118*	
X=?	Coordinates to be entered for platting your points.
Y=?	X=Concentration
Ø.26Ø*	Y=Absorbance
X=?	At least 3 points are needed. Enter X, then
105.000	CONTINUE. Enter Y, then CONTINUE. Arrange your
Y = ?	data such that X is in <u>ascending</u> order.
Ø.355*	
1/0 000	
Y=?	
Ø.51Ø*	/
X = ?	When all points have been plotted puch SET FIAG
	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.

EQUATION Y = ? Ø.152ØØ* X= 43.78442 Y = ?Ø.3ØØØØ* in mg/l. X= 84.53973 Y = ?Ø.523ØØ* X= 145.94807 Y = ?

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

- 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.



INSTRUCTIONS

NUMBER

12

Program

Mean, S.D., and C.V. for NH_3 , Fe, N, or P

- 1. Follow initialization procedure (if not already done).
- 2. <u>NOTE</u>: 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. C.V. FOR IRON, NI ORTHOPHO	D., AND AMMONIA TRITE OR SPHATE	Title of program
ENTER AB ENTRY	SORBANCE 1.ØØØØØ	
ENTRY	Ø.14ØØØ 2.ØØØØØ 0.14500	
ENTRY	3.ØØØØØ Ø.145ØØ	Absorbance readings of your sample. Enter a value then CONTINUE. Repeat until all data has
ENTRY	4.ØØØØØ Ø.143ØØ	been entered (minimum entries is 2). The first number is a counter and the second indicates what was entered.
ENTRY	5.00000 0.14900	
ENTRY	6.00000 0.13300 7.00000	When all data has been entered, push SET FLAG,
MEAN	Ø.1425Ø	
S.D.	Ø.ØØ55Ø	Statistics on the absorbance of your samples.
ENTER VA	3.86284	
IF GRAPH $STANDARD$ $4 = FE$ $6 = NH3$ $8 = P$ $10 = N$	ING CURVE	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. <u>NOTE</u>: If an incorrect entry occurs, and CONTINUE has <u>not</u> been executed, push CLEAR X and enter correct value. If CONTINUE was executed and a mistake discovered, start anew by pushing END, then CONTINUE.

	ŕ٦	
DO AND/OR BOD		Title of program
DO ONLY?	Ń	· · · · · · · · · · · · · · · · · · ·
(1 = YES 2 = NO)		Choose between D.O. or B.O.D. The number indicates
		what choice was made.
1.00000*	1	
PUSH "SET FLAG"	ÌÌ	For an initial run, push CONTINUE. If the
IF STANDARD HAS		standard has been calibrated, push SET FLAG, then
BEEN CALIBRATED	IJ	CONTINUE and go to D.O. or B.O.D. instructions.
STANDARD	$\left \right\rangle$	
CALIBRATION		Information required to calibrate normality of
	۱ (the standard. Enter what is required, then push
ENTER NORMALITY		CONTINUE. The numbers indicate what was entered.
Ø.Ø25ØØ*		
MLS OF STANDARD		
20.00000*	K	· · · · · ·
ENTER VOL (MLS)		
OF TITRANT USED		
ENTRY		Amounts of titrant used per sample in calibrating
1.0000		the standard. Enter a value then CONTINUE. Repeat
20.2000		until all data has been entered (minimum entry is
ENTRY		2). The first number is a counter and the second
2.00000		indicates what was entered.
20.20000		
ENTRY	1	
3.00000	1	
20.20000	K	
ENIRI / ddddd		when all data has been entered, push SET FLAG,
4.00000	ľ	then CONTINUE.
NORMAL TTY	<u>ן</u>	
MFAN		
MLAN Ø Ø2475	ľ	
Ø: Ø2475		Statistics on the actual normality of your
S D		(startistics on the actual normality of your
0. 00000	Ł	Standard.
0.00000	1	
C.V.(%)	ł	
0.00000	1	/
	÷.	

D.Q.	Instructions
------	--------------

1 ML OF .Ø25 N NA2S203 EQUALS Equivalance of $Na_2S_2O_3$ to milligrams/liter of Ø.99Ø1Ø °2. MG OF 02/L AS DO D.O. SAMPLE Identifies what sample is being analyzed for D.O. 1.00000 ENTER VOL (MLS) OF TITRANT USED ENTRY Amount of titrant used. Enter a value, then 1.00000 CONTINUE. Repeat until all data has been entered 3.00000 (minimum entry is 2). The first number is a ENTRY counter and the second is the entry. 2.00000 2.90000 ENTRY 3.00000 3.10000 When all data has been entered, push SET FLAG, ENTRY 4.00000 then CONTINUE. MEAN 2.97Ø3Ø Statistics of D.O. for your sample. The mean and S.D. S.D. are final D.O. values (in mg/ ℓ of 0₂). Ø.Ø99Ø1 C.V.(%) 3.33333 SAMPLE Identifies the next sample being analyzed. 2.00000 ENTER VOL (MLS) OF TITRANT USED ENTRY 1.00000 Amount of titrant used. Enter a value, then CONTINUE. Repeat until all data has been entered 0.7ØØØØ ENTRY (minimum entry is 2). The first number is a 2.00000 counter and the second is the entry. 8.50000 ENTRY 3.00000 8.40000 When all data has been entered, push SET FLAG, ENTRY 4.00000 then CONTINUE. MEAN 8.44884 S.D. Statistics of D.O. for your sample. The mean and Ø.15124 S.D. are final D.O. values (in mg/ ℓ of 0₂). C.V. (%) 1.79007

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

• •

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B.O.D. Instructions

Title of program

SET FLAG WHEN SAMPLE CALCULA-TIONS ARE COM-PLETED

B.O.D.

DO SAMPLE 1.00000 ENTER VOL (MLS) OF TITRANT USED ENTRY 1.00000 7.51000 ENTRY 2.00000 7.61ØØØ ENTRY 3.00000 7.51000 ENTRY 4.00000 MEAN 7.46865 S.D. Ø.Ø5716 C.V. (%) Ø,76538 DO SAMPLE 2.00000

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=? d d5ddd	Enter the CONTINUE.
BLANK 1=?	Enter the
BLANK 2=?	\int Enter the
D.O. 1=? 7 47000*	Enter the
D.O. 2=? 6.49000*) Enter the
MG BOD/L EQUALS 6.60000	$\}$ The BOD fo
DECIMAL FRACTION OF SAMPLE=?	brace Repeat the

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

<u>Number</u> 16 Program Graphing (includes linear regressions)





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

INITIALIZATION	
ENTER PROGRAM NUMBER	Enter 16, then CONTINUE.
PUSH FIX(), THEN ENTER THE NUMBER OF DIGITS YOU WANT AFTER THE DECIMAL POINT FOR THE AXIS	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.
FINALLY, PUSH CONTINUE	
16.	Program number chosen.

- 2. <u>NOTE</u>: If an incorrect entry occurs, and CONTINUE has <u>not</u> 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	Title of program.
X - MAX = ?	
X-MIN = ?	Maximum and minimum cordinates of your graph.
Y-MAX =?	to be plotted adequately.
150. Y-MIN =?	
ARE YOU PLOTTING ON GRAPH PAPER? (Ø=NO 1=YES)	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

Enter 1, then CONTINUE.

LINEAR REG	?
$(\emptyset = NO 1$	= YES)
A- (10.000
Y=?	25.000*
X=?	1.5 01010h
Y = ?	49.99
X = ?	45.000*
·	90.000
1 = : 1	25.000*
<u>X = ?</u>	

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.)

	LIN EXE	E A C U	R TE	R E D	G.	W	AS		
	GEN IS	E R Y	AL =	E MX	QU +	AT B	ION		
	DO ENT SOL (Ø=	YO ER VE NO	U X F	WA A OR 1=	NT ND Y YE	T ? (S)	0		
	Y=? X=		9	ø.	ØØ	ØØ	Ø*		
•	Y = ? X =		6 3	7. 3.	94 5Ø	72 ØØ	3 Ø*		
	Y = ?		2	3.	61	99	5	-	

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=? 150.00000* Y ≈ 194.58528 X=? 72.60000* Y = 95.93047 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.



GRAPHING Title of program. X - MAX = ?200. X-MIN = ?Ø. Maximum and minimum coordinates of your graph. See, the linear regression instructions. Y-MAX = ?15Ø. Y-MIN = ?Ø. ARE YOU PLOTTING ON GRAPH PAPER? See the linear regression instructions $(\emptyset = NO$ 1 = YES) Enter 0, then CONTINUE. LINEAR REG? $(\emptyset = NO$ 1 = YES)

Non Linear Regression Instructions

- 8. <u>NOTE</u>: 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 <u>before</u> a decision on connection points is made. This allows more than one curve to be put on a single graph.

		-	
$\begin{array}{c} \text{CONNEC} \\ (\emptyset = \text{NO}, \\ X = ? \end{array}$	T POINTS? 1=YES)	}.	This allows the option of connection each point with a straight line. Enter your choice, then CONTINUE
Y = ?	2Ø.ØØØ 1Ø.ØØØ*		
X=? Y=?	30.000		
X=?	32.500* 60.000		
x=?	65.ØØØ*		Enter your value for X, then CONTINUE. Enter your value for Y, then CONTINUE. Repeat the above until all data has been plotted.
Y = ? X = ?	98.000*		
Y = ?	15Ø.ØØØ 12Ø.ØØØ*		
X = ? Y = ?	180.000		
X=?	130.000*]/	

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.



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