HEWLETT-PACKARD

HP-67/HP-97

Clinical Lab and Nuclear Medicine Pac

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HEWLETT hp PACKARD

WE NEED YOUR HELP

To provide better calculator support for people like you, we need your help. Your timely inputs will enable us to provide high quality software in the future and improve the existing application pacs for your calculator. Your early reply will be extremely helpful in this effort.

1. Pac name ______________________________

2. How important was the availability of this pac in making your decision to buy a Hewlett-Packard calculator? ☐ Would not buy without it. ☐ Important ☐ Not important

3. Did you buy this pac and your calculator at the same time? ☐ Yes ☐ No

4. In deciding to buy this application pac, which three programs seemed most useful to you? Program numbers 1.________ 2.________ 3.________

5. Which three programs in this application pac seemed least useful to you? Program numbers 1.________ 2.________ 3.________

6. What program(s) would you add to this pac?

____

____

____

7. In the list below, select up to three application areas for which you purchased this pac. Please indicate the order of importance by 1, 2, 3, (1 represents the most important area).

Engineering
___ 01 Chemical
___ 02 Civil/Structural
___ 03 Electrical/Electronic
___ 04 Industrial
___ 05 Mechanical
___ 06 Surveying
___ 10 Other (Specify) ________

Science
___ 31 Biology
___ 32 Chemistry
___ 33 Earth Sciences
___ 34 Mathematics
___ 35 Medical Sciences
___ 36 Physics
___ 37 Statistics
___ 39 Other (Specify) ________

Business
___ 51 Accounting
___ 52 Banking
___ 53 Insurance
___ 54 Investment Analysis
___ 55 Real Estate
___ 56 Securities
___ 57 Sales
___ 58 Marketing
___ 59 Other (Specify) ________

Other
___ 71 Architecture
___ 72 Aviation
___ 73 Computer Science
___ 74 Education
___ 75 Navigation
___ 79 Other (Specify) ________

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ATTENTION: APPLICATIONS

Introduction

The 19 programs of Clinical Lab and Nuclear Medicine Pac have been drawn from the fields of clinical chemistry, nuclear medicine, radioimmunoassay, and statistics.

Each program in the pac is represented by a magnetic program card and a section in this manual. The manual provides a description of the program with relevant equations, a set of instructions for using the program, and one or more example problems, each of which includes a list of the actual keystrokes required for its solution. Program listings for all the programs in the pac appear at the back of this manual. Explanatory comments have been incorporated in the listings to assist you should you want to study the actual workings of the program.

No knowledge of programming is required to use the programs in this pac. However, some familiarity with keyboard operations, as described in Sections 1 through 5 of the Owner's Handbook, is assumed. If you have already run a number of programs from Standard Pac or another applications pac, you will be able to use these programs with very little additional instruction. We recommend that you read only ''A Word about these Programs'' on pages iv and v of this manual. If, on the other hand,this is your first exposure to running prerecorded programs, be sure to read the entire introductory section on pages iv to xii.

We hope that Clinical Lab and Nuclear Medicine Pac will assist you in the solution of numerous problems around the laboratory. We have tried to provide you with the most commonly used statistics programs as well, but should you find the need for more, there is another pac, Stat Pac I, exclusively for statistics.

We would very much appreciate knowing your reactions to the programs in this pac, and to this end we have provided a questionnaire inside the front cover of this manual. Would you please take a few minutes to give us your comments on these programs? It is in the comments we receive from you that we learn how best to increase the usefulness of programs like these.

CONTENTS

Statistics

A WORD ABOUT THESE PROGRAMS

This application pac has been designed for both the HP-97 Programmable Printing Calculator and the HP-67 Programmable Pocket Calculator. The most significant difference between the HP-67 and the HP-97 calculators is the printing capability of the HP-97. Most of the computed results in this pac are output by the command PRINTx. On the HP-97 these results will be output on the printer. On the HP-67 each PRINTx command will be interpreted as a PAUSE: the program will halt, display the result for about five seconds, then continue execution.

If you use an HP-67, you may want more time to copy down the number displayed by a PRINTx command. All you need to do is press any key on the keyboard during the pause interval in which the result is displayed. This action will cause the program to halt; execution of the halted program may be re-initiated by pressing R/S. Values that are output by a PRINTx command are marked by three asterisks (***) in the keystroke solutions to example problems. The keystroke solutions reflect another slight difference between the HP-67 and the HP-97. It is sometimes necessary in these solutions to include operations that involve prefix keys, namely, f on the HP-97 and f, g, and h on the HP-67. For example, the operation [10^x] is performed on the HP-97 as f [10^x] and on the HP-67 as g [10^x]. In such cases, the keystroke solution omits the prefix key and indicates only the operation (as here, [10^x]). As you work through the example problems, take care to press the appropriate prefix keys (if any) for your calculator.

Programs 1 through 13 of this pac are alike in that many of the same operations are available in each of these programs. A look at the magnetic cards for these programs will show three instructions repeated in gold on every card of these thirteen: PTNT #, P OFF?, and REPRINT. These three operations are intended primarily for use on the HP-97. In addition, either CLEAR or START appears on all of the first thirteen cards. Some discussion of these common operations may be helpful.

The instruction PTNT # allows you to key in a patient number which will be immediately printed in order to identify the data and results of the following calculations. The patient number used should be a whole number; the program will append two digits after the decimal point to identify the program being used, 01 to 13. For example, if the patient number 1234 is used in program 7, the program would print the identification 1234.07, which serves to identify the entire context of the calculations which are to follow. The use of the patient number for identification purposes is entirely optional and may be omitted.

The interrogative P OFF? asks the question: do you want to turn the print function off? When the program is loaded, a flag is set that causes all inputs and outputs of the program to be printed. If this information is not all desired, you may eliminate some or all of it, depending on the program,by turning the print function off. It may later be turned back on at any time without affecting the operation of the program.

The instruction REPRINT allows for an additional printout of all data and results after a calculation has been completed. Frequently in the clinical lab, the results of a test must be reported to several different departments. The REPRINT feature allows you to obtain additional copies of the data and results directly from the program.

The instructions CLEAR and START are similar in that both have to do with initialization of the program and should be executed before any other operation in the program. They differ in that CLEAR is an optional instruction and START is mandatory. Basically, CLEAR simply sets certain registers to zero to insure that meaningless information is not output during a REPRINT. On the other hand, START loads registers with necessary initial values without which the program would fail to function properly.

RUNNING A PROGRAM

Loading a Program

Select the *Protein Electrophoresis* card, CL1-02A, from the card case supplied with this application pac.

Set the PRGM-RUN switch to RUN.

If you are using the HP-97, set the printer switch to MAN. All the programs in this pac are designed for manual printer setting.

Gently insert either end of the card (printed side up) in the reader slot of your calculator as shown in figure 1a or 1b.

Figure 1a. HP-97

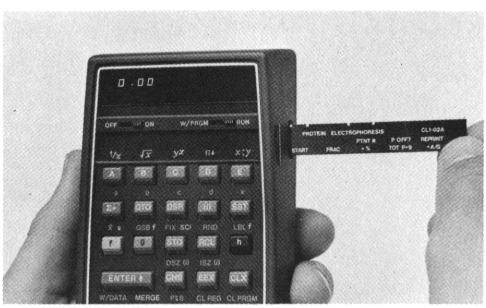


Figure 1b. HP-67

When the card is part way in, a motor engages and passes it out the other side of the calculator. Sometimes the motor engages but does not pull the card in. If this happens, push the card a little farther into the machine. Do not impede or force the card; let it move freely.

The display will show "Error" if the card reads improperly. In this case, press CLX and reinsert the card.

Since *Protein Electrophoresis* is longer than 112 steps (the capacity of one side of a magnetic card), the display now shows "Crd" indicating that a second card pass is necessary to load the remaining steps. With the writing still visible to you, insert the *opposite* end of the card (figures 2a and 2b) and pass the card through the card reader again.

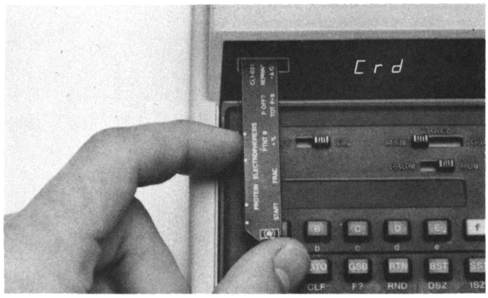


Figure 2a. HP-97

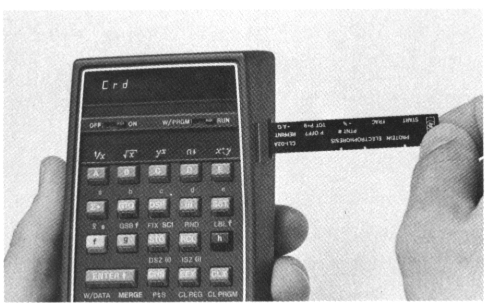


Figure 2b. HP-67

When the motor stops, remove the card from the other side of the calculator and insert it in the ''window slot'' of the calculator (figures 3a and 3b).

Figure 3a. HP-97

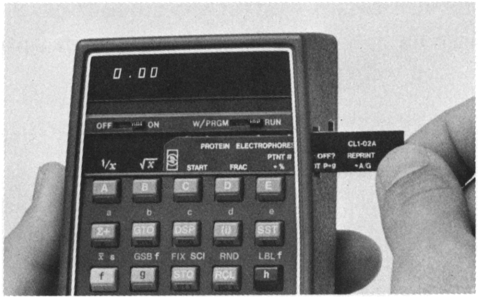


Figure 3b. HP-67

The program has now been stored in the calculator. It will remain stored until another program is loaded or the calculator is turned off.

The Magnetic Card

Complete instructions for running the program are found in the User Instructions form for that program. The first few times you run the program, you should refer to these instructions at each step of the operation. Thereafter, mnemonic symbols on the magnetic card itself will provide shorthand instructions to the program's operation.

Take a look at the card that you have inserted in the window slot of the calculator. Notice that the mnemonic symbols on the card are grouped above the user-definable keys A through E. For example, the symbols ''→%'' and ''PTNT #'' are associated with key C. Symbols in gold are associated with the shifted keys f A through f E.
Below is a table of the important symbols and conventions you will find on magnetic cards.

SYMBOL OR CONVENTION	INDICATED MEANING
White mnemonic: x A	White mnemonics are associated with the user-definable key they are above when the card is inserted in the calculator's window slot. In this case the value of x could be input by keying it in and pressing A.
Gold mnemonic: y x f E	Gold mnemonics are similar to white mnemonics except that the gold f key must be pressed before the user-definable key. In this case y could be input by pressing f E.
x↑y A	↑ is the symbol for ENTER↑. In this case ENTER↑ is used to separate the input variables x and y. To input both x and y you would key in x, press ENTER↑, key in y and press A.

SYMBOLS AND CONVENTIONS (Continued)

SYMBOL OR CONVENTION	INDICATED MEANING
[x] A	The box around the variable x indicates input by pressing STO A.
(x) A	Parentheses indicate an option. In this case, x is not a required input but could be input in special cases.
➔ x A	➔ is the symbol for calculate. This indicates that you may calculate x by pressing key A.
➔ x, y, z A	This indicates that x, y, and z are calculated by pressing A once. The values would be printed in x, y, z order.
➔ x; y; z A	The semi-colons indicate that after x has been calculated using A, y and z may be calculated by pressing R/S.
➔ ''x,'' y A	The quote marks indicate that the x value will be ''paused'' or held in the display for one second. The pause will be followed by the display of y.
◁▷ x A	The two-way arrow ◁▷ indicates that x may be either output or input when the associated user-definable key is pressed. If numeric keys have been pressed between user-definable keys, x is stored. If numeric keys have not been pressed, the program will calculate x.
P? A	The question mark indicates that this is a mode setting, while the mnemonic indicates the type of mode being set. In this case a print mode is controlled. Mode settings typically have a 1.00 or 0.00 indicator displayed after they are executed. If 1.00 is displayed, the mode is on. If 0.00 is displayed, it is off.
START A	The word START is an example of a command. The start function should be performed to begin or start a program. It is included when initialization is necessary.
DEL A	This special command indicates that the last value or set of values input may be deleted by pressing A.

FORMAT OF USER INSTRUCTIONS

The completed User Instructions Form—which accompanies each program—is your guide to operating the programs in this Pac.

The form is composed of five labeled columns. Reading from left to right, the first column, labeled STEP, gives the instruction step number.

The INSTRUCTIONS column gives instructions and comments concerning the operations to be performed.

The INPUT DATA/UNITS column specifies the input data, and the units of data if applicable. Data input keys consist of [0] to [9] and decimal point (the numeric keys), [EEX] (enter exponent), and [CHS] (change sign).

The KEYS column specifies the keys to be pressed after keying in the corresponding input data.

The OUTPUT DATA/UNITS column specifies intermediate and final outputs and their units, where applicable.

The following illustrates the User Instruction Form for *Protein Electrophoresis,* CL1-02A.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	Initialize.		[A]	0.00
3	(optional) Key in patient number.	Ptnt #	[f] [C]	Ptnt # .02
4	To suppress output of data, turn			
	print function off.		[f] [D]	0.00
5	To turn print back on later.		[f] [D]	1.00
6	Key in the counts of the first			
	protein fraction.	$Fract_1$	[B]	1.00
7	Repeat this step for the rest of			
	the fractions.	$Fract_i$	[B]	i
8	Calculate the percentage each			
	fraction is of the whole.		[C]	%
9	(optional) Key in the total grams			
	of protein and find the grams in			
	each fraction.	Total Protein	[D]	grams
10	(optional) Find the albumin/			
	globulin ratio.		[E]	A/G
11	(optional) Obtain a reprint of all			

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
	data and results (Total Protein			
	and grams omitted if Total			
	Protein not input).		f E	Ptnt # .02
				$Fract_1$...
				$Fract_n$
				$(\%)_1$...
				$(\%)_n$
				Total Protein
				$grams_1$...
				$grams_n$
				A/G
12	For a new case, go to step 2.			

Since you loaded this program in "Loading a Program" on page vi, step 1 is already done and we can move to step 2. (If you turned your calculator off, you must reload the program.) Leave the magnetic card in the window slot above keys A through E.

Step 2 is an initialization procedure, marked START on the magnetic card. Press A now to perform the initialization, as shown in the KEYS column. You should see a display of 0.00.

Step 3 is optional and allows for input of the patient number if identification of the output is desired. The number output at this step is the patient number followed by ".02", which marks the second program of the pac, CL1-02A. Key in the patient number 1234 and see an output of 1234.02.

Steps 4 and 5 have to do with the optional print mode, which may be turned off or on through the keystrokes f D. When the program is loaded, the print function is on; pressing f D will turn it off and display 0.00. Try it. Successive presses of f D will turn the print function on, then off, alternately displaying 1.00 (on) and 0.00 (off). Try this, but leave 1.00 displayed (print function on) when you are finished. This will allow the input data to be output through PRINTx commands.

Step 6 begins the actual input of the fractionation data. You are to key in the counts for the first protein fraction ($Fract_1$ under INPUT DATA/UNITS) and press B. This value will be output and a 1.00 will be displayed to mark the input of the first fraction. Step 7 instructs you to input the remaining protein fractionation counts in a like manner, keying in each value and pressing B.

The number displayed after each value is input indicates the number of functions input so far. Try this sequence with the values from the table below.

Fraction	Substance	Counts
1	Albumin	67
2	α_1-globulin	4
3	α_2-globulin	10
4	β-globulin	14
5	γ-globulin	13

Use the keystrokes 67 B 4 B 10 B 14 B 13 B. At the end of this sequence the display should show 5.00.

Now that all fractions have been input, step 8 instructs you to find the percentages for the fractions input by pressing C. Each percentage is output by a PRINTx command, and the percentages will be output in the order the fractions were input. Press C now. The outputs you should see are, in this order, 62.04, 3.70, 9.26, 12.96, and 12.04.

Step 9 is optional. Here you may key in the total grams of protein and press D to find the number of grams in each fraction. Key in 7, press D, and you should see these outputs: 4.34, 0.26, 0.65, 0.91, and 0.84.

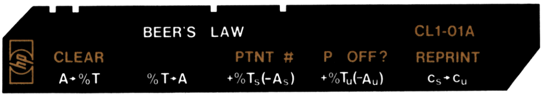
Step 10 is optional. You may press E to compute the albumin/globulin ratio. Press E now and find an A/G value of 1.63.

Step 11 is also optional. This is the REPRINT feature described on page v. If f E is pressed, the entire set of data and results will be output through PRINTx commands in the order shown in the OUTPUT DATA/UNITS column. You may do this now and check that the values returned by the REPRINT function are the same as those you keyed in or calculated earlier.

If your answers agree with ours, you are ready to try other programs in this pac. Otherwise, go back to the start of this section and try the procedure again.

Notes

BEER'S LAW



This program combines two independent routines in the area of spectrophotometry. The first routine, on keys **A** and **B**, solves Beer's law interchangeably to find either absorbance (optical density) or percent transmittance (%T). To find %T, key in absorbance and press key **A**. The output will be %T. To find absorbance, key in %T and press key **B**. Absorbance will be output.

The second routine, on keys **C**, **D**, and **E**, allows calculation of the concentration of an unknown given the concentration of a standard and the absorbance of %T of the standard and unknown. If the percent transmittance of the standard ($\%T_s$) is known, it may be keyed in to key **C**. If the absorbance of the standard (A_s) is known instead, it may be keyed in *as a negative number* to key **C**. Similarly, for the unknown, percent transmittance ($\%T_u$) may be keyed in as a positive number or absorbance (A_u) as a negative number to key **D**. Then the concentration of the standard (c_s) should be keyed in to key **E**. This will allow output of the concentration of the unknown (c_u).

Equations:

$$A = 2 - \log \%T$$

$$\%T = 10^{2-A}$$

$$c_u = c_s \times \frac{A_u}{A_s}$$

Reference:

Clinical Chemistry, ed. Henry, Cannon, and Winkelman, Harper and Row, 1974.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	(optional) Initialize for reprint.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .01
4	To suppress printing of data			
	and results, turn print			
	function off.		f D	0.00
5	To turn print function back on.		f D	1.00
6	To solve interchangeably for			
	A and %T, go to step 7; to find			
	an unknown concentration,			
	go to step 9.			
	A⇄%T			
7	To find percent transmittance,			
	key in absorbance.	A	A	%T
8	To find absorbance, key in			
	percent transmittance.	%T	B	A
	Unknown concentration			
9	Key in A or %T for the			
	standard and the unknown			
	(follow A by CHS):			
	• Standard	$+\%T_s(-A_s)$	C	$+\%T_s(-A_s)$
	• Unknown	$+\%T_u(-A_u)$	D	$+\%T_u(-A_u)$
10	Key in concentration of			
	standard and compute			
	concentration of unknown.	c_s	E	c_u

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
	Reprint			
11	Reprint all data and results.		f E	Ptnt # .01
				A
				%T
				$+\%T_s(-A_s)$
				$+\%T_u(-A_u)$
				c_s
				c_u

Example:

A standard solution with a solute concentration of 2 mg/ml is found to have an absorbance of 0.41 at 550 nm. An unknown from patient number 10183 is found to show 46% transmittance at the same wavelength. Convert this %T to absorbance. Also find the solute concentration in the unknown. After all calculations obtain a reprint.

Keystrokes:	**Outputs:**
f A →	0.00 (Clear)
10183 f C →	10183.01 *** (Ptnt ID)
46 B →	46.00 *** (%T)
	0.34 *** (A)
.41 CHS C →	−0.41 *** ($-A_s$)
46 D →	46.00 *** ($\%T_u$)
2 E →	2.00 *** (c_s)
	1.65 *** (c_u)
f E →	10183.01 *** (Ptnt ID)
	0.34 *** (A)
	46.00 *** (%T)
	-0.41 *** ($-A_s$)
	46.00 *** ($\%T_u$)
	2.00 *** (c_s)
	1.65 *** (c_u)

Notes

PROTEIN ELECTROPHORESIS

This program is designed to aid in the calculations of protein fractionation. The required data for the program are the integration counts for each protein fraction and, optionally, the total protein. The results calculated by the program are the percentage of the total for each fraction and, if total protein has been input, the number of grams of each protein fraction. An optional output is the albumin/globulin ratio.

To operate the program, press key **A** to intialize. Then for each fraction, key in its integration counts and press key **B**. After the counts have been keyed in for every fraction, you may press key **C** to find the percentage that each fraction is of the total. A single press of **C** will cause all the percentages to be output in the same order as the counts were input. You may then, if you wish, key in the total protein in grams, press key **D**, and output the grams of protein for each fraction.

The albumin/globulin ratio (A/G) may be calculated by pressing key **E**. If A/G is to be found, albumin should be the first fraction input, followed by the four globulin counts.

Equations:

Let Fract_i be the counts for the i^{th} fraction, and $(\%)_i$ the percentage of the total for the i^{th} fraction.

$$(\%)_i = \frac{\text{Fract}_i}{\sum_{j=1}^{n} \text{Fract}_j} \times 100$$

Let TPr be the total protein in grams and g_i be the number of grams of the i^{th} fraction.

$$g_i = \frac{\text{Fract}_i}{\sum_{j=1}^{n} \text{Fract}_j} \times \text{TPr}$$

$$\text{A/G} = \frac{\text{Fract}_1}{\sum_{j=2}^{5} \text{Fract}_j}$$

Remarks:

1. If the print function is turned off, input data will not be printed. Calculated results will still be printed regardless of the status of the print function.
2. If a reprint is called for by pressing f E, all possible inputs and outputs will be printed except that if no value was keyed in for total protein, neither it nor the grams of each fraction will be output.
3. The use of this program need not be restricted to protein fractionation. It may be used as a general-purpose total and percent-of-total program. The only restriction is that the number of inputs (fractions) is limited to 21.

Reference:

Clinical Chemistry, ed. Henry *et. al.*, Harper and Row, 1974.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	Initialize.		A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .02
4	To suppress output of data,			
	turn print function off.		f D	0.00
5	To turn print back on later.		f D	1.00
6	Key in the counts of the first			
	protein fraction.	$Fract_1$	B	1.00
7	Repeat this step for the rest			
	of the fractions.	$Fract_i$	B	i
8	Calculate the percentage			
	each fraction is of the whole.		C	%
9	(optional) Key in the total			
	grams of protein and find the			
	grams in each fraction.	Total Protein	D	grams
10	(optional) Find the albumin/			
	globulin ratio.		E	A/G

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
11	(optional) Obtain a reprint of			
	all data and results (Total			
	Protein and grams omitted if			
	Total Protein not input).		f E	Ptnt # .02
				$Fract_1$...
				$Fract_n$
				$(\%)_1$...
				$(\%)_n$
				Total Protein
				$grams_1$...
				$grams_n$
				A/G
12	For a new case, go to step 2.			

Example:

The following integration counts are determined electrophoretically for serum proteins:

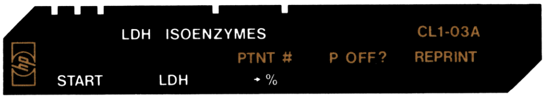
Albumin	67
α_1-globulin	4
α_2-globulin	10
β-globulin	14
γ-globulin	13

If the total amount of protein is 7.0 grams, find the percentage of the total and the number of grams for each protein fraction. Also find the albumin/globulin ratio. The patient number is 10183.

Keystrokes:	Outputs:
A →	0.00
10183 f C →	10183.02 *** (Ptnt ID)
67 B →	1.00
4 B →	2.00
10 B →	3.00
14 B →	4.00
13 B →	5.00

C ⟶	62.04 ***	(% albumin)
	3.70 ***	(% α_1)
	9.26 ***	(% α_2)
	12.96 ***	(% β)
	12.04 ***	(% γ)
7 D ⟶	7.00 ***	(Total Protein)
	4.34 ***	(g albumin)
	0.26 ***	(g α_1)
	0.65 ***	(g α_2)
	0.91 ***	(g β)
	0.84 ***	(g γ)
E ⟶	1.63 ***	(A/G)

LDH ISOENZYMES



This program analyzes the results of the fractionation of lactic dehydrogenase isoenzymes and computes for each isoenzyme (LDH_1 through LDH_5) the percentage it represents of the whole. After key **A** is pressed to initialize the program, each enzyme value is input by keying in the value and pressing **B**. After all five LDH fractions have been input, key **C** may be pressed to find the percentage each enzyme is of the whole.

An additional feature of the program is the checking of the computed percentage of each enzyme against its accepted normal value. All five percentages are computed and output; if one or more of these values lie outside the accepted normal range, the word ''Error'' will be displayed at the end of all calculations. (This indicates only that a value is abnormal; the answers calculated are accurate.)

The abnormal value or values should then be determined by inspection. The normal values used by the program are shown below.

Enzyme	Normal Range
LDH_1	18%—33%
LDH_2	28%—40%
LDH_3	18%—30%
LDH_4	6%—16%
LDH_5	2%—13%

These values for normal ranges may be changed easily within the program if you so desire. Simply look at the program listing and find the value you want to change by referring to the program comments. Delete the number as it now exists in the program and key in your own value. Do not forget to record the modified program on a blank magnetic card if you want to preserve it.

Equations:

Let LDH_i be the value of the i^{th} LDH isoenzyme ($i = 1,\ldots,5$) and $LDH_i\%$ be that enzyme's percentage of the whole.

$$LDH_i\% = \frac{LDH_i}{\sum_{j=1}^{5} LDH_j}$$

Remarks:

If the print function is turned off, input data will not be printed. Calculated results will still be printed regardless of the status of the print function.

Reference:

Clinical Chemistry, ed. Henry *et. al.*, Harper and Row, 1974.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	Initialize.		A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .03
4	To suppress printing of			
	input data, turn the print			
	function off.		f D	0.00
5	To turn the print function			
	back on.		f D	1.00
6	Key in the first LDH enzyme			
	value.	LDH_1	B	1.00
7	Repeat step 6 for LDH			
	values 2 through 5.	LDH_i	B	i
8	Calculate the percentage			
	each enzyme is of the total.*		C	LDH_1 %
				...
				LDH_5 %

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
9	(optional) Obtain a reprint of			
	all data and results.*		f E	Ptnt # .03
				LDH_1
				...
				LDH_5
				LDH_1 %
				...
				LDH_5 %
	*A display of "Error" following			
	execution of this step			
	indicates a percentage			
	value that lies outside the			
	normal range for that			
	enzyme.			

Example:

Electrophoretic separation of the LDH isoenzymes results in the following counts:

Enzymes	Counts
LDH_1	95
LDH_2	120
LDH_3	85
LDH_4	15
LDH_5	22

Find the percentage of the whole for each isoenzyme. The patient number is 10183. Obtain a reprint of the data and results.

Keystrokes:	Outputs:
A →	0.00
10183 f C →	10183.03 *** (Ptnt ID)
95 B →	1.00
120 B →	2.00
85 B →	3.00
15 B →	4.00
22 B →	5.00

C ——→	28.19 *** (% LDH_1)
	35.61 *** (% LDH_2)
	25.22 *** (% LDH_3)
	4.45 *** (% LDH_4)
	6.53 *** (% LDH_5)
	''Error''
CLX (clears ''Error'') ——→	0.00
f E ——→	10183.03 ***
	95.00 ***
	120.00 ***
	85.00 ***
	15.00 ***
	22.00 ***
	28.19 ***
	35.61 ***
	25.22 ***
	4.45 ***
	6.53 ***
	''Error''

A visual scan of the results indicates that the message ''Error'' resulted from the percentage value of LDH_4 (4.45%) being below the normal range (6%—16%).

BODY SURFACE AREA

This program calculates body surface area by either the method of Dubois or the method of Boyd. In both cases, the required inputs are height and weight, which may be input either in metric (cm, kg) or English (in., lb.) units. Quantities in English units should be input as negative numbers; that is, [CHS] should be pressed after keying the number in.

To operate the program, the height in either cm or inches should be keyed in to [A], and the weight in either kg or pounds keyed in to [B]. Then pressing [C] will allow the calculation of body surface area in m^2 by the method of Dubois; pressing [D] computes BSA in m^2 by the Boyd formula. Even if you have already found BSA by one method, you may also find it by the other method simply by pressing the appropriate key; the values of height and weight need not be re-input.

Equations:

Let Ht be height, Wt be weight, and BSA be the body surface area in m^2.

$$\text{Ht (cm)} = 2.54 \text{ Ht (in.)}$$

$$\text{Wt (kg)} = 0.45359237 \text{ Wt (lb.)}$$

Dubois:

$$\text{BSA } (m^2) = \text{Ht (cm)}^{0.725} \cdot \text{Wt (kg)}^{0.425} \cdot 7.184 \times 10^{-3}$$

Boyd:

$$\text{BSA } (m^2) = \text{Wt (g)}^{(0.7285 - 0.0188 \log \text{Wt})} \cdot \text{Ht (cm)}^{0.3} \cdot 3.207 \times 10^{-4} .$$

Remarks:

1. The Dubois formula for BSA is undefined for children with a BSA less than 0.6 m^2. In such cases BSA should be calculated by the Boyd formula.
2. Turning off the print function will suppress printing of both data and results.

References:

D. Du Bois and E.F. Du Bois, Clin. Cal. 10, Arch. Int. Med., **17,** 863, 1916.

Edith Boyd, *Growth of the Surface Area of the Human Body,* U. of Minnesota Press, 1935, p. 132.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	(optional) Initialize if reprint			
	desired.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .04
4	To suppress printing of data			
	and results.		f D	0.00
5	To turn print function back on.		f D	1.00
6	Key in height (+ cm, − in.)	Ht	A	Ht (cm)
7	Key in weight (+ kg, − lb.)	Wt	B	Wt (kg)
8	Compute BSA by method of			
	either			
	• Dubois		C	BSA (m^2)
	• Boyd		D	BSA (m^2)
9	(optional) Reprint all data			
	and results.		f E	Ptnt # .04
				Ht input
				Wt input
				BSA (m^2)

Example 1:

Patient number 10183 is a male, height 176 cm, weight 63.5 kg. What is his BSA by the Dubois formula? Compare by also finding the Boyd BSA.

Keystrokes:	Outputs:
10183 f C →	10183.04 *** (Ptnt ID)
176 A →	176.00 (Ht (cm))
63.5 B →	63.50 (Wt (cm))
C →	1.78 *** (Dubois)
D →	1.76 *** (Boyd)

Example 2:

Patient number 10070 is a female, height 64 inches, weight 112 pounds. Find her BSA by the Boyd formula. Obtain a reprint. Remember to input height and weight as negative numbers.

Keystrokes:		Outputs:		
f A	→	0.00		
10070 f C	→	10070.04	***	(Ptnt ID)
64 CHS A	→	162.56		(Ht (cm))
112 CHS B	→	50.80		(Wt (kg))
D	→	1.52	***	(Boyd)
f E	→	10070.04	***	(Ptnt ID)
		-64.00	***	(Ht)
		-112.00	***	(Wt)
		1.52	***	(BSA)

Notes

UREA CLEARANCE

This program calculates urea clearance given the urine flow rate and the concentration of urea in urine and blood. The urine flow rate may be corrected for the patient's body surface area, if desired. The program will calculate standard or maximum clearance depending on whether the corrected urine flow rate is above or below 2 ml/min. The percent of mean normal may also be found.

If the urine flow rate is to be corrected for body surface area, key **f** **B** should be pressed to indicate that. No action is necessary if the correction is not desired. If correction is to be made, the program will need to find the patient's body surface area (BSA) in register R_A. If the program *Body Surface Area* (CL1-04A) has been run immediately before this program, BSA will already have been stored in R_A. Otherwise you will need to key in the patient's BSA and store it in R_A.

When inputting the urine flow rate, you may either key in the flow rate ($\dot{V}$, in ml/min.) directly to key **B**, or key in both the urine volume V in ml and the time t in min. to key **A**. If the print function is on and inputs are being printed, in both cases the printout will be of $\dot{V}$, the flow rate in ml/min. The number in the display at the end of routine **A** or **B** is $\dot{V}_{corr}$, the flow rate after correction for BSA. It is the size of this number that determines whether the standard or the maximum clearance will be calculated. This number will also be printed if the print function is on.

Equations:

$$\dot{V}(\text{ml/min}) = \frac{V\ (\text{ml})}{t\ (\text{min})}$$

$$\dot{V}_{corr} = \begin{cases} \dfrac{1.73}{BSA}\,\dot{V} & \text{if corrected for BSA} \\ \dot{V} & \text{if no correction for BSA} \end{cases}$$

Maximum clearance ($\dot{V}_{corr} > 2$):

$$C_m(\text{ml/min}) = \frac{U_{urea}\ \dot{V}_{corr}}{B_{urea}}$$

Standard clearance ($\dot{V}_{corr} \leqslant 2$):

$$C_s(\text{ml/min}) = \frac{U_{urea}\sqrt{\dot{V}_{corr}}}{B_{urea}}$$

where

U_{urea} = concentration of urea in urine

B_{urea} = concentration of urea in blood

$$\% \text{ mean normal } C_m = 1.33\ C_m$$

$$\% \text{ mean normal } C_s = 1.85\ C_s$$

Remarks:

1. Any units may be used for U_{urea} and B_{urea} as long as they are consistent.
2. Some users may prefer to ignore the distinction between standard and maximum clearance and use the maximum formula for all cases. This can be accomplished by using the program *Creatinine Clearance* (CL1-06A) and inputting U_{urea} and B_{urea} in place of U_{creat} and P_{creat}, respectively.
3. If the print function is turned off, neither inputs nor outputs will be printed.

Reference:

Clinical Chemistry, ed. Henry *et al.*, Harper and Row, 1974.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	(optional) Initialize if reprint			
	desired.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .05
4	To suppress printing of data			
	and results, turn the print			
	function off.		f D	0.00
5	To turn the print function			
	back on.		f D	1.00

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
6	If BSA is required and *Body*			
	Surface Area has not been			
	run, key in BSA.	BSA (m^2)	STO A	
7	If $\dot{V}$ is to be corrected for BSA		f B	BSA (m^2)
8	Perform either one of the			
	steps below:			
	• Key in urine volume and			
	time	V (ml)	ENTER↑	
		t (min)	A	$\dot{V}_{corr}$
	• Key in urine flow rate	$\dot{V}$(ml/min)	B	$\dot{V}_{corr}$
9	Key in the concentration of			
	urea in urine.	U_{urea}	C	U_{urea}
10	Key in the concentration of			
	urea in blood and find the			
	urea clearance.	B_{urea}	D	C_{urea}(ml/min)
11	Find the percent of mean			
	normal.		E	% m.n.
12	(optional) Reprint data and			
	results.		f E	Ptnt # .05
				$\dot{V}$
				$\dot{V}_{corr}$
				U_{urea}
				B_{urea}
				C_s or C_m
				% m.n.
13	For a new case go to step 2.			

Example 1:

A patient, number 10183, is to be tested for urea clearance. A volume of 204 ml of urine is collected over a period of 120 min. The concentration of urea in this urine is found to be 903 mg/100 ml. A blood sample is taken halfway through the urine collection and found to have a urea concentration of 26 mg/100 ml. Determine the urea clearance. Do not correct for body surface area.

Keystrokes:	**Outputs:**
10183 f C →	10183.05 *** (Ptnt ID)
204 ENTER↑ 120 A →	1.70 *** ($\dot{V}$)
	1.70 *** ($\dot{V}_{corr}$)
903 C →	903.00 *** (U_{urea})
26 D →	26.00 *** (B_{urea})
	45.28 *** (C_s, ml/min)
E →	83.77 *** (% m.n.)

Example 2:

Patient number 10142 is a male, height 188 cm, weight 88.5 kg. A urine flow rate of 2.7 ml/min. is recorded. The concentration of urea is 798 mg/100 ml in urine and 21 mg/100 ml in blood. Determine the urea clearance corrected for body surface area using the Dubois formula for BSA.

Keystrokes: **Outputs:**

Load side 1 and side 2 of *Body Surface Area* (CL1-04A).

f D →	0.00 (Print off)
188 A →	188.00 (Ht, cm)
88.5 B →	88.50 (Wt, kg)
C →	2.15 (Dubois BSA)

Load side 1 and side 2 of *Urea Clearance* (CL1-05A).

10142 f C →	10142.05 *** (Ptnt ID)
f B →	2.15 (BSA)
2.7 B →	2.70 *** ($\dot{V}$)
	2.17 *** ($\dot{V}_{corr}$)
798 C →	798.00 *** (U_{urea})
21 D →	21.00 *** (B_{urea})
	82.53 *** (C_m, ml/min)
E →	109.76 *** (% m.n.)

CREATININE CLEARANCE

This program allows the calculation of creatinine clearance given the urine flow rate and the concentration of creatinine in urine and plasma. The urine flow rate may be corrected for the patient's body surface area if desired.

To indicate that a correction should be made for the body surface area, press **f** **B**. No action is necessary if the correction is not desired. If correction is to be made, the program will need to find the patient's body surface area (BSA, in m²) in register R_A. The program *Body Surface Area* (CL1-04A) automatically leaves BSA stored in R_A. If *Body Surface Area* has not been run immediately befroe this program, you will need to key in the BSA and press **STO** **A**.

When inputting the urine flow rate, you may either key in the flow rate ($\dot{V}$, in ml/min.) directly to key **B**, or key in both the urine volume (V, in ml) and the time (t, in minutes) to key **A**. If the print function is on and inputs are being printed, in both cases the printout will be of $\dot{V}$, the flow rate in ml/min. The number in the display at the end of routine **A** or **B** is $\dot{V}_{corr}$, the flow rate after correction for BSA. (If no correction is desired, $\dot{V}_{corr}$ will be the same as $\dot{V}$.) This number will also be printed if the print function is on.

Equations:

$$\dot{V}(\text{ml/min}) = \frac{V\ (\text{ml})}{t\ (\text{min})}$$

$$\dot{V}_{corr} = \begin{cases} \dfrac{1.73}{BSA}\,\dot{V} & \text{if corrected for BSA} \\ \dot{V} & \text{if not corrected for BSA} \end{cases}$$

$$C_{creat(ml/min)} = \frac{U_{creat}\ \dot{V}_{corr}}{P_{creat}}$$

where

C_{creat} = creatinine clearance

U_{creat} = concentration of creatinine in urine

P_{creat} = concentration of creatinine in plasma

Remarks:

1. Any units may be used for U_{creat} and P_{creat} as long as they are consistent.
2. If the print function is turned off, neither inputs nor outputs will be printed.

Reference:

Clinical Chemistry, ed. Henry *et al.*, Harper and Row, 1974.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 of program.			
2	(optional) Initialize if reprint			
	desired.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .06
4	To suppress printing of data			
	and results, turn print			
	function off.		f D	0.00
5	To turn print function back			
	on later		f D	1.00
6	If BSA is required and *Body*			
	Surface Area has not been			
	run, key in BSA.	BSA (m^2)	STO A	
7	If $\dot{V}$ is to be corrected for BSA.		f B	BSA (m^2)
8	Perform either one of the			
	steps below:			
	• Key in urine volume and			
	time	V (ml)	ENTER↑	
		t (min)	A	$\dot{V}_{corr}$
	• Key in urine flow rate.	$\dot{V}$(ml/min)	B	$\dot{V}_{corr}$
9	Key in the concentration of			
	creatinine in urine.	U_{creat}	C	U_{creat}
10	Key in the concentration of			
	creatinine in plasma and find			
	the creatinine clearance.	P_{creat}	D	C_{creat}(ml/min)

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
11	(optional) Reprint data and			
	results.		f E	Ptnt # .06
				$\dot{V}$
				$\dot{V}_{corr}$
				U_{creat}
				P_{creat}
				C_{creat}
12	For a new case go to step 2.			

Example 1:

A male, patient number 10095, is tested for creatinine clearance. A urine volume of 506 ml is collected over a 4-hour (240-min.) period. The concentration of creatinine is found to be 43.4 mg/dl in urine and 0.91 mg/dl in plasma. Find the creatinine clearance. Do not correct for body surface area.

Keystrokes:	Outputs:
10095 f C →	10095.06 *** (Ptnt ID)
506 ENTER↑ 240 A →	2.11 *** ($\dot{V}$)
	2.11 *** ($\dot{V}_{corr}$)
43.4 C →	43.40 *** (U_{creat})
0.91 D →	0.91 *** (P_{creat})
	100.55 *** (C_{creat}, ml/min)

Example 2:

Patient number 10124 is a female with a body surface area of 1.56 m². Given a urine flow rate of 1.81 ml/min., a creatinine concentration of 46.5 mg/dl in urine and 1.03 mg/dl in plasma, find the creatinine clearance.

Keystrokes:	Outputs:
10124 f C →	10124.06 *** (Ptnt ID)
1.56 STO A →	1.56 (BSA)
f B →	1.56
1.81 B →	1.81 *** ($\dot{V}$)
	2.01 *** ($\dot{V}_{corr}$)
46.5 C →	46.50 *** (U_{creat})
1.03 D →	1.03 *** (P_{creat})
	90.62 *** (C_{creat}, ml/min)

Notes

AMNIOTIC FLUID ASSAY

This program performs calculations for the spectrophotometric estimation of bile pigments in amniotic fluid. Measurement of absorbance changes in the fluid has been shown to be useful in determining the management of Rh-sensitized pregnancies. The absorbance of the fluid is measured at two wavelengths (typically, 365 nm and 550 nm) to form a baseline, and then at a third wavelength between these two (typically, 450 nm) to allow calculation of the difference (Δ) between the actual and the interpolated absorbances at the intermediate wavelength. Then, given the weeks of gestation, the "b" factor and, optionally, the Liley zone number may be found.

The inputs to the program, then, are the absorbances of the amniotic fluid at three wavelengths (A_{365}, A_{550}, and A_{450}). From these may be found ΔA_{450}, the difference in absorbance at the intermediate wavelength. The final input is the week of gestation (Wk), from which may be found the "b" factor and zone. The last two outputs are the most meaningful for the obstetrician; for interpretation, see references 1 and 2 below.

Equations:

$$\Delta A_{450} = A_{450} - e^{[.541\,(\ln A_{365} - \ln A_{550}) + \ln A_{550}]}$$

$$b = \Delta A_{450}/a^{Wk}$$

where

$a = 0.91509$

Wk = week of gestation

Liley zones:

Zone I: $b < 0.7$

Zone II: $0.7 \leq b \leq 3$

Zone III: $b > 3$

Remarks:

1. Some users may prefer to take absorbance readings at wavelengths other than those indicated here. Burnett[3], for instance, advocates readings at 350 nm, 550 nm, and 455 nm. It is quite easy to modify the program to handle such a case. The only change required is the alteration of

one constant occupying four steps of program memory, 024–027. At present in these locations the program holds the constant .541. For Burnett's values (350, 550, 455) this constant would have to be changed to .475. In general, if the three wavelengths used are x, y, and z, with $x < z < y$, the constant to be used is

$$\frac{y - z}{y - x}.$$

The absorbances at wavelengths x, y, and z should be input to keys **A**, **B**, and **C** respectively.

2. If the print function is turned off, neither inputs nor outputs will be printed.

References:

1. R.C. Brown and W.J. Beckfield, "Computer-assisted spectrophotometric analysis of amniotic fluid in erythroblastosis fetalis," *Amer. J. Clin. Path.,* **57:** 659-663, 1972.
2. A.W. Liley, "Liquor amnii analysis in the management of the pregnancy complicated by rhesus sensitization," *Amer. J. Obstet. Gynecol.,* **82:** 1359-1370, 1961.
3. R. Burnett, "Instrumental and procedural sources of error in determination of bile pigments in amniotic fluid," *Clin. Chem.,* **18:** 150-154, 1972.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	(optional) Initialize if reprint			
	desired.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .07
4	To suppress printing of data			
	and results, turn print			
	function off.		f D	0.00
5	To turn print function back			
	on later.		f D	1.00
6	Key in absorbance at 365 nm.	A_{365}	A	A_{365}
7	Key in absorbance at 550 nm.	A_{550}	B	A_{550}

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
8	Key in absorbance at 450 nm			
	and find ΔA_{450}.	A_{450}	C	ΔA_{450}
9	Key in week of gestation and			
	find b factor.	Wk	D	b
10	(optional) Find Liley zone			
	number (1, 2, or 3).		E	Zone
11	(optional) To obtain a reprint			
	of data and results.		f E	Ptnt # .07
				A_{365}
				A_{550}
				A_{450}
				ΔA_{450}
				Week
				b
				Zone

Example:

A sample of amniotic fluid from patient number 10070 is found to have absorbances of 0.43, 0.25, and 0.39 at wavelengths 365 nm, 550 nm, and 450 nm respectively. Find ΔA_{450}, the b factor, and the Liley zone number given that it is the 35th week of gestation.

Keystrokes:	**Outputs:**
10070 f C →	10070.07 *** (Ptnt ID)
.43 A →	0.43 *** (A_{365})
.25 B →	0.25 *** (A_{550})
.39 C →	0.39 *** (A_{450})
	0.05 *** (ΔA_{450})
35 D →	35. *** (Wk)
	1.22 *** (b)
E →	2. *** (Zone)

Notes

BLOOD ACID-BASE STATUS

This program computes total plasma CO_2 (TCO_2) and base excess (BE) from the partial pressure of CO_2 (PCO_2), pH, and hemoglobin concentration (Hgb). The PCO_2 and pH values used should be found at 37°C; if they are found at a body temperature (BT) other than 37°C, the program will correct them to 37°C values if BT is also input. An additional, optional output of the program is the concentration of plasma bicarbonate ($[HCO_3^-]$).

To operate the program, if the body temperature is different from 37°C, then key in BT in °C and press key **A**. If BT = 37°C, it need not be input; if it is, however, no harm will be done. Next key in PCO_2 in mm Hg and press **B**; the number displayed at the completion of this step is the value of PCO_2 corrected to 37°C. Then key in pH and press **C**; the result in the display at the end of this step is the pH value corrected to 37°C. Finally, press **D** to calculate TCO_2 in mmol/*l*. As an optional step, hemoglobin may now be input in units of g/100 ml. Pressing **E** will allow the calculation of base excess in mEq/*l* using an equation suggested by Siggaard-Andersen. The last value output is $[HCO_3^-]$, which may be found by pressing **R/S** after the calculation of base excess.

Equations:

$$PCO_2\ (37°C) = PCO_2\ (BT) \cdot 10^{0.019\ (37-BT)}$$

$$pH\ (37°C) = pH\ (BT) - 0.0146\ (37 - BT)$$

$$TCO_2 = s \cdot PCO_2 \left[1 + 10^{pH-pK}\right]$$

where

s = solubility of CO_2 in plasma, mmol/*l* (taken to be 0.0307)

pK = 6.11

$$[BE]_b = (1 - 0.0143\ Hgb)\ ([HCO_3^-] - (9.5 + 1.63\ Hgb)\ (7.4 - pH) - 24)$$

where

$[BE]_b$ = base excess in mEq/*l* of blood

Hgb = hemoglobin concentration in g/100 ml

$$[HCO_3^-] = s \cdot PCO_2 \cdot 10^{pH-pK}$$

where

$[HCO_3^-]$ = concentration of plasma bicarbonate in mmol/*l*.

Remarks:

1. This program can also be used to correct PCO_2 and pH values from 37°C to body temperature. To do this, let x = (74 − BT) °C. Key in x to key **A**. Then input PCO_2 and pH to keys **B** and **C**, respectively. The number displayed after each of these steps is the value of the parameter corrected to body temperature. For example, if it is desired to correct a 37°C PCO_2 value of 45 mm Hg to a body temperature value with BT = 40°C, let x = 34. Key in 34, press **A**, key in 45, and press **B**. The corrected PCO_2 is found to be 51.31 mm Hg.
2. The equation to correct pH to 37°C values is a simplication of a formula from Severinghaus. It ignores the pH and BE dependent terms. This introduces a very small error except at extreme conditions of acid-base status and large temperature shifts. For example, at a pH of 7.2 or 7.6, the error is 0.0013 units per ℃.
3. If the print function is turned off, neither inputs nor outputs will be printed.

References:

John W. Severinghaus, ''Blood gas calculator,'' *J. Appl. Physiol.*, **21:** 1108 – 1116, 1966.

Siggaard-Andersen, ''Titrable acid or base of body fluids,'' *Annals New York Academy of Science*, **133:** 41-48, 1966.

L.J. Thomas, Jr., ''Algorithms for selected blood acid-base and blood gas calculation,'' *J. Appl. Physiol.*, **33:** 154-158, 1972.

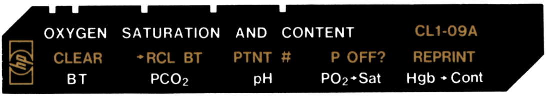
STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2 of			
	program.			
2	(optional) Initialize if reprint			
	desired.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .08
4	To suppress printing of data			
	and results, turn print			
	function off.		f D	0.00
5	To turn print function back			
	on later.		f D	1.00
6	If PCO_2 and pH are to be cor-			
	rected to 37°C, key in body			
	temperature in °C.	BT (°C)	A	37 – BT
7	Key in partial pressure of CO_2 in			
	mm Hg.	PCO_2(mm Hg)	B	PCO_2 (37°)
8	Key in pH.	pH	C	pH (37°)
9	Find total plasma CO_2 in mmol/l.		D	TCO_2(mmol/l)
10	(optional) Key in hemoglobin			
	concentration and compute			
	base excess and $[HCO_3^-]$	Hgb(g/100ml)	E	BE (mEq/l)
			R/S	$[HCO_3^-]$(mmol/l)
11	To obtain a reprint.		f E	Ptnt # .08
				BT
				PCO_2
				pH
				TCO_2
				Hgb
				BE
				$[HCO_3^-]$

Example :

Patient number 10183 has a body temperature of 40°C. His PCO_2 at 40°C is found to be 51 mm Hg, his pH at the same temperature 7.31. His hemoglobin concentration is 16 g/100 ml. Find TCO_2, BE, and $[HCO_3^-]$.

Keystrokes:	Outputs:.	
f A →	0.00	
10183 f C →	10183.08 ***	(Ptnt ID)
40 A →	40.00 ***	(BT)
	-3.00	(37 − BT)
51 B →	51.00 ***	(PCO_2(40))
	44.73	(PCO_2(37))
7.31 C →	7.31 ***	(pH(40))
	7.35	(pH(37))
D →	25.44 ***	(TCO_2)
16 E →	16.00 ***	(Hgb)
	-1.21 ***	(BE)
R/S →	24.07 ***	($[HCO_3^-]$)

OXYGEN SATURATION AND CONTENT



This program estimates oxygen saturation of blood from various body parameters and computes oxygen content. If the actual oxygen saturation is known, oxygen content may be computed directly.

Estimated saturation

Typically, the input parameters to the program are PCO_2, pH, and PO_2 *measured at 37*°C, and the body temperature in °C. If the parameters PCO_2 and pH are known only at body temperature, they may be corrected to 37°C through use of the program *Blood Acid-Base Status,* CL1-08A. If CL1-08A is run before this program, the values of BT, PCO_2, and pH may be recalled by this program for input to the appropriate keys. For example, pressing **f** **B** will recall the value of BT. Pressing **A** will then input the recalled value to this program *and* recall the value of PCO_2. Pressing **B** will input the recalled PCO_2 value and recall the value of pH. If CL1-08A has not been run previously, the recalled values will be meaningless numbers or zero.

After the input of PO_2 to **D**, an intermediate value of virtual PO_2 (VPO_2) will be calculated prior to the calculation of estimated saturation. The value found for VPO_2 will not be output but may be displayed after the calculation of saturation by pressing **RCL** **C**. VPO_2 is not a real physiologic PO_2. Its only use is in estimating O_2 saturation.

Suppose as an alternate case that BT,PCO_2, and pH are not known, but virtual PO_2, or alveolar PO_2 (P_AO_2) is known. In this case, only the known VPO_2 or P_AO_2 need be input in order to compute estimated saturation. Input VPO_2 or P_AO_2 to key **D** as *negative* numbers, i.e., key in the value followed by **CHS**, then press **D**. The output, as before, will be estimated oxygen saturation.

After computing saturation, the hemoglobin concentration in g/100 ml should be keyed into **E**. Output from this sequence will be the oxygen content as a volume percent.

Known saturation

If the actual O_2 saturation is known, the oxygen content may be computed directly. Simply key in the O_2 saturation, press **ENTER↑**, key in hemoglobin concentration and press **E**. Oxygen content will be output.

Equations:

$$VPO_2 = PO_2 \cdot 10^{[0.024(37-BT) + 0.48(pH-7.4) + 0.06\log(40/PCO_2)]}$$

$$O_2\ Sat = \frac{(VPO_2)^4 - 15(VPO_2)^3 + 2045(VPO_2)^2 + 2000(VPO_2)}{(VPO_2)^4 - 15(VPO_2)^3 + 2400(VPO_2)^2 - 31{,}100(VPO_2) + 2{,}400{,}000}$$

$$O_2\ content = 1.34 \cdot \frac{Sat\ (\%)}{100} \cdot Hgb + 0.0031\ VPO_2$$

Remarks:

1. In the computation of VPO_2, it is important to input the values for pH and BT exactly, as these have a great influence on the value of VPO_2. PCO_2 has relatively little influence.
2. The equation for VPO_2 is a hybrid of the equation used by Thomas and that used by Kelman. There is some disagreement regarding the best value of the pH multiplier, 0.48 being used by most workers, but see, for example, Kelman.
3. The calculation of saturation from PO_2 will give inaccurate results for fetal hemoglobin, present in babies less than six months old, and for some abnormal adult hemoglobins and certain other blood conditions. The results of the estimation and any subsequent calculations based on it, should be viewed with caution unless the dissociation curve has been previously established to be normal. If both PO_2 and O_2 saturation are measured, the program may be used as a convenient means to check for the normality of the dissociation curve.
4. If the print function is turned off, neither inputs nor outputs will be printed.
5. After a keystroke sequence in which **D** is pressed to find saturation, **E** should also be pressed to complete the sequence even if Hgb is not input and the calculated oxygen content is meaningless.

References:

L.J. Thomas, Jr., "Algorithms for selected blood acid-base and blood gas calculation," *J. Appl. Physiol.*, **33:** 154-158, 1972.

G. Richard Kelman, "Digital computer subroutine for the conversion of oxygen tension into saturation." *J. Appl. Physiol.*, **21:** 1375-1376, 1966.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	(optional) Initialize if reprint			
	desired.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .09
4	To suppress printing of data			
	and results, turn print			
	function off.		f D	0.00
5	To turn print function back			
	on later.		f D	1.00
6	If oxygen saturation is to be			
	estimated, go to step 7; if it			
	is known already, go to step 14.			
	Estimated saturation			
7	If BT was stored from *Blood*			
	Acid-Base Status (CL1-08A),			
	it may be recalled.		f B	BT (°C)
8	Input body temperature in °C.	BT (°C)	A	PCO_2(if stored)
9	Input PCO_2 in mm Hg.	PCO_2 (mm Hg)	B	pH(if stored)
10	Input pH.	pH	C	pH
11	Input PO_2 in mm Hg (CHS for			
	VPO_2 or P_AO_2) and find			
	oxygen saturation.	PO_2 (mm Hg)	D	Sat (%)
12	Key in hemoglobin and find			
	oxygen content as a volume			
	percent.	Hgb (g/100ml)	E	O_2 content

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
13	To obtain a reprint.		f E	Ptnt # .09
				BT
				PCO_2
				pH
				PO_2
				Sat (%)
				Hgb
				O_2 content
	Known saturation			
14	Key in saturation and			
	hemoglobin concentration and			
	find oxygen content as a			
	volume percent.	Sat (%)	ENTER↑	
		Hgb (g/100ml)	E	O_2 content

Example 1:

Patient number 10183 has a body temperature of 40°C. The following parameters are measured at 37°C: PCO_2 = 45 mm Hg, pH = 7.35, and PO_2 = 75 mm Hg. Find the estimated O_2 saturation. Given a hemoglobin concentration of 16 g/100 ml, find oxygen content.

Keystrokes:	Outputs:
10183 f C →	10183.09 *** (Ptnt ID)
40 A →	40.00 *** (BT)
45 B →	45.00 *** (PCO_2)
7.35 C →	7.35 *** (pH)
75 D →	75.00 *** (PO_2)
	90.92 *** (Sat %)
16 E →	16.00 *** (Hgb)
	19.68 *** (O_2 cont.)

Example 2:

Alveolar PO_2 (P_A O_2) is known to be 103 mm Hg in patient number 10184. Find the estimated O_2 saturation. Given a hemoglobin concentration of 14.5 g/100 ml, find the oxygen content.

Keystrokes:	Outputs:
10184 f C →	10184.09 *** (Ptnt ID.)
103 CHS D →	-103.00 *** (P_AO_2)
	97.72 *** (Sat %)
14.5 E →	14.50 *** (Hgb)
	19.31 *** (O_2 cont.)

Example 3:

Oxygen saturation is measured at 92%. Hemoglobin concentration is 16 g/100 ml. What is the oxygen content?

92 ENTER↑ 16 E →	92.00 *** (Sat %)
	16.00 *** (Hgb)
	20.04 *** (O_2 cont.)

Notes

RED CELL INDICES

This program computes red cell indices based on three measured values: red cell count, hematocrit, and hemoglobin. The indices computed are mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), and mean corpuscular hemoglobin concentration (MCHC).

The red cell count in millions per mm^3 should be input to key **A** and hematocrit as a percent to key **B**. Then hemoglobin in g/dl (g/100 ml) is keyed in, and **C** is pressed to allow calculation of MCV in cubic microns (μ^3). Pressing **D** will cause the output of MCH in picograms, pg (or micromicrograms, $\mu\mu$g). Finally, key **E** is pressed to compute MCHC in g/dl (g/100 ml).

Equations:

$$\text{MCV } (\mu^3) = \frac{\text{Hct (\%)} \times 10}{\text{Count } (10^6/\text{mm}^3)}$$

$$\text{MCH (pg)} = \frac{\text{Hgb (g/dl)} \times 10}{\text{Count } (10^6/\text{mm}^3)}$$

$$\text{MCHC (g/dl)} = \frac{\text{Hgb (g/dl)} \times 100}{\text{Hct (\%)}}$$

Remarks:

If the print function is turned off, neither inputs nor outputs will be printed.

Reference:

Davidson and Henry, *Todd-Sanford Clinical Diagnosis by Laboratory Methods,* W.B. Saunders Co., 1969.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1.			
2	(optional) Initialize if reprint			
	desired.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .10
4	To suppress printing of data			
	and results, turn print			
	function off.		f D	0.00
5	To turn print function back			
	on later.		f D	1.00
6	Key in red cell count in			
	millions per mm^3.	Count ($10^6/mm^3$)	A	Count
7	Key in hematocrit.	Hct (%)	B	Hct (%)
8	Key in hemoglobin in g/100ml			
	and find mean corpuscular			
	volume in μ^3.	Hgb (g/dl)	C	MCV (μ^3)
9	Compute mean corpuscular			
	hemoglobin in pg ($\mu\mu$g).		D	MCH (pg)
10	Compute mean corpuscular			
	hemoglobin concentration			
	in g/dl (g/100ml).		E	MCHC (g/dl)
11	To obtain a reprint of data			
	and results.		f E	Ptnt # .10
				Count
				Hct (%)
				Hgb
				MCV
				MCH
				MCHC

Example:

A sample of venous blood from patient 10183 reveals a red cell count of 2.25 x $10^6/mm^3$, a hematocrit of 21%, and hemoglobin of 7.2 g/dl (g/100 ml). Find the indices MCV, MCH, and MCHC.

Keystrokes:	Outputs:
10183 f C →	10183.10 *** (Ptnt ID)
2.25 A →	2.25 *** (Count)
21 B →	21.00 *** (Hct %)
7.2 C →	7.20 *** (Hgb)
	93.33 *** (MCV)
D →	32.00 *** (MCH)
E →	34.29 *** (MCHC)

Notes

TOTAL BLOOD VOLUME

This program computes total blood volume by the radioisotope dilution technique. The inputs to the program are the background counts per minute (Bck), the volume of radioactive solution injected (V Inj), the dilution of the standard solution (Std Dil), the counts per minute of the standard (Std CPM), and the counts per minute of the sample of whole blood (WB CPM). From these values the program will compute total blood volume (TBV).

Equations:

$$\text{TBV} = \text{Dil} \times \text{V Inj} \times \frac{\text{Std CPM} - \text{Bck}}{\text{WB CPM} - \text{Bck}}$$

Remarks:

1. Total blood volume will be computed in the same units as volume injected. Typically the units used will be milliliters (ml).
2. Equal volumes of whole blood, diluted standard solution, and distilled water should be used for the measurement of whole blood counts, standard counts, and background counts. These three counts need not be counts *per minute;* they may be counts recorded over any length of time, so long as the same time interval is used for all three counts.
3. This same program may be used to find total plasma volume provided that a sample of plasma rather than whole blood is counted for the final input. Total blood volume may be determined from total plasma volume from the equation

$$\text{Total blood volume} = \frac{\text{Total plasma volume}}{(1 - \text{Hct} \times 0.9)}$$

4. If the patient has had prior radioactivity administered, a patient background correction may be necessary. To do this, a count must be made of a blood sample before the current dose is administered. These pre-dose counts should be subtracted from the post-dose whole blood counts to give the corrected counts to be input at the final step.
5. If the print function is turned off, neither inputs nor outputs will be printed.

Reference:

Beierwaltes, Keyes, and Carey, *Manual of Nuclear Medicine Procedure,* Chemical Rubber Co., 1971.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1.			
2	(optional) Initialize for reprint.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .11
4	To suppress printing of data			
	and results, turn print			
	function off.		f D	0.00
5	To turn print function back			
	on later.		f D	1.00
6	Key in background counts.	Bck	A	Bck
7	Key in volume of fluid			
	injected.	Vol. inj.	B	Vol. inj.
8	Key in dilution of standard.	Std. dil.	C	Std. dil.
9	Key in standard counts.	Std. CPM	D	Std. CPM
10	Key in whole blood counts			
	and find total blood volume.	Blood CPM	E	TBV
11	To obtain a reprint.		f E	Ptnt # .11
				Bck
				Vol. inj.
				Std. dil.
				Std. CPM
				Blood CPM
				TBV

Example:

5 ml of radioiodinated serum albumin (RISA) are injected into patient 10183. The stock RISA is diluted by a factor of 250 and a 1 ml aliquot of this standard is found to have an activity of 2518 counts over a five-minute period. A 1 ml sample of the patient's whole blood, collected 10 minutes after injection, is found to have an activity of 837 counts over a five-minute period. A five-minute count of 1 ml distilled water yields 152 counts. What is the patient's total blood volume?

Keystrokes:	Outputs:
10183 f C →	10183.11 *** (Ptnt ID)
152 A →	152.00 *** (Bck)
5 B →	5.00 *** (V Inj)
250 C →	250.00 *** (Dil)
2518 D →	2518.00 *** (Std CPM)
837 E →	837.00 *** (WB CPM)
	4317.52 *** (TBV, ml)

Notes

SCHILLING TEST

This program performs the calculations involved with the Schilling test for the determination of vitamin B_{12} absorption. The inputs to the program are the background counts per minute, the dilution and counts per minute of the standard, the volume of urine excreted, and the counts per minute of the urine. The output is the % of dose excreted.

The program is set up to handle urine volume (U Vol) in liters (l). It is assumed that if the urine volume collected was less than 1 l, the volume was brought up to 1 l by the addition of water. If the volume was a liter or more, no dilution should be made.

Equations:

$$\%\ \text{excretion} = \frac{V}{\text{Dil}}\left[\frac{\text{Urine CPM} - \text{Background CPM}}{\text{Standard CPM} - \text{Background CPM}}\right] \times 100$$

$$\text{where } V = \begin{cases} 1 \text{ if U Vol} \leq 1\,l \\ \text{U Vol if U Vol} > 1\,l \end{cases}$$

$$\text{Dil} = \text{Dilution of the standard}$$

Remarks:

1. The background, standard, and urine counts should be of equal volumes counted over equal time intervals (which need not be one minute).
2. The patient should not have had recent prior radioactivity.
3. If the print function is turned off, neither data nor results will be printed.

Reference:

Beierwaltes, Keyes, and Carey, *Manual of Nuclear Medicine Procedures*, Chemical Rubber Co., 1971.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1.			
2	(optional) Initialize if reprint is			
	desired.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .12
4	To suppress printing of data			
	and results, turn print			
	function off.		f D	0.00
5	To turn print function back			
	on later.		f D	1.00
6	Key in background counts.	Bck	A	Bck
7	Key in dilution of the standard.	Std Dil	B	Std Dil
8	Key in standard counts.	Std CPM	C	Std CPM
9	Key in volume of urine			
	collected.	U Vol (*l*)	D	U Vol
10	Key in the urine counts and			
	calculate percentage of dose			
	excreted.	U CPM	E	%
11	To obtain a reprint of data			
	and results.		f E	Ptnt # .12
				Bck
				Std Dil
				Std CPM
				U Vol
				U CPM
				%

Example:

A capsule of radioactive B_{12} is administered orally to patient 10183. Over the following 24 hours, a volume of 2.54 *l* of urine is collected. A 20 ml aliquot of the urine is counted for 10 minutes to give 1923 counts. A 1 ml sample of the standard is diluted to 20 ml and counted for 10 minutes, giving 1757 counts. 20 ml of tap water is used for a background count; over a ten-minute interval, 127 counts are recorded. Find the percent of dose excreted.

Keystrokes:	Outputs:
10183 f C →	10183.12 *** (Ptnt ID)
127 A →	127.00 *** (Bck)
20 B →	20.00 *** (Std Dil)
1757 C →	1757.00 *** (Std CPM)
2.54 D →	2.54 *** (U Vol)
1923 E →	1923.00 *** (U CPM)
	13.99 *** (% excreted)

Notes

THYROID UPTAKE

This program computes thyroid uptake as a percentage of an administered dose of radioiodine. The inputs to the program are the counts per minute for the standard, the standard background, the patient counts (after ingestion of the dose), and the patient background. After these variables have been input, pressing **E** will allow computation of the percent uptake.

After calculation of the uptake, two corrections may be made to the computed value. The first correction involves recent prior radioactivity in the patient. The second correction involves a significant difference in activity between the standard and the dose. These are discussed in more detail below.

If the patient has had recent prior radioactivity, the computed uptake must be corrected to account for this. In such a case the patient counts and the background counts *before* ingestion of the present dose must be known. In addition, it will be necessary to correct these predose counts for radioactive decay over the elapsed time between the measurements of the predose counts and of the counts after ingestion of the dose. The program *Radioactive Decay Corrections* (CL1-14A) may be used to account for this decay. *Radioactive Decay Corrections* will compute and store a decay factor D that will be used by this program, *Thyroid Uptake,* to adjust the predose counts to the present time.

To correct for prior radioactivity, then, you should first load side 1 and side 2 of *Radioactive Decay Corrections* (CL1-14A). Select the radioisotope of the *prior* radioactivity. Key in 1, press **A**, then key in the time interval over which the decay has occurred, in the format DD.HH (days.hours), remembering always to allow 2 places for hours. (For example, a period of 1 day 6 hours should be keyed in as 1.06.) After keying in the elapsed time, press **B**, then press **C**. The decay factor D will be displayed and automatically stored. Now load side 1 and side 2 of *Thyroid Uptake* and follow the basic procedure to find the uncorrected percentage uptake. After computing % uptake from key **E**, key in the predose patient counts, press **ENTER↑**, key in the predose background counts and press **f** **A**. The corrected percentage uptake will be computed.

The second possible correction to be made is to account for a significant difference in the activities of the standard and the dose. These activities should be measured before the dose is administered. The counts at this point are referred to as precounts. If the standard and dose precounts agree within ±3%, no correction is necessary. If the precounts differ by more than 3%, however, then the computed thyroid uptake should be corrected. To make the correction, after pressing **E** to find the uptake, key in the standard precount, press ENTER↑, key in the dose precount, and press f B. The program will compute the corrected thyroid uptake.

The two corrections to computed uptake operate independently of each other. Either, both, or neither correction may be made. If both are to be made, they may be made in either order. If a reprint is called for after a correction is made, the reprint will show the corrected value of uptake but will not show the inputs that went into the correction (i.e., the patient and background predose counts or the standard and dose precounts).

Equations:

$$\%\text{ uptake} = K \times \frac{\text{NPC}}{\text{Std CPM} - \text{Std Bck}} \times 100$$

where

$$\begin{aligned}\text{NPC} &= \text{Net Ptnt Cts}\\ &= \text{Ptnt CPM} - \text{Ptnt Bck}\end{aligned}$$

and K is a correction factor.

$$K = \begin{cases} 1 \text{ if no correction} \\ \dfrac{\text{NPC} - D \times (\text{Ptnt Predose Ct} - \text{Bck Predose Ct})}{\text{NPC}} \text{ if prior radioactivity} \\ \dfrac{\text{Std. Precount}}{\text{Dose Precount}} \quad \text{if different activities} \end{cases}$$

where

D is the radioactive decay factor.

Remarks:

1. The counts need not be input as counts *per minute;* however, all counts should be measured over the same time interval.
2. If the print function is turned off, neither inputs nor outputs will be printed.

Reference:

Beierwaltes, Keyes, and Carey, *Manual of Nuclear Medicine Procedures,* Chemical Rubber Co., 1971.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	If correction is to be made			
	for prior patient radio-			
	activity, go to step 2.			
	Otherwise go to step 6.			
2	Load side 1 and side 2 of			
	Radioactive Decay Cor-			
	rections (CL1-14A) and select			
	the radioisotope of the prior			
	radioactivity.			
3	Key in a 1 for the initial			
	activity.	1	A	1.00
4	Key in time elapsed in format			
	Days.Hours (e.g., 1 day			
	6 hours is keyed in as 1.06).	t(dd.hh)	B	t(dd.hh)
5	Compute the decay factor			
	(will be stored automatically).		C	D
	Basic Procedure			
6	Load side 1 and side 2 of			
	Thyroid Uptake (CL1-13A).			
7	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .13
8	To suppress printing of			
	data and results, turn print			
	function off.		f D	0.00
9	To turn print function back			
	on later.		f D	1.00
10	Key in counts for the standard.	Std. CPM	A	Std. CPM
11	Key in background counts			
	for the standard.	Std Bck.	B	Net Std. Cts.
12	Key in counts for the patient.	Ptnt. CPM	C	Ptnt. CPM

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
13	Key in background counts for			
	the patient.	Ptnt. Bck.	D	Net Ptnt. Cts.
14	Compute thyroid uptake as			
	a percent.		E	% Uptake
	Corrections			
15	For prior radioactivity, go to			
	step 16, for differences in			
	standard and dose, go to			
	step 19. For no correction,			
	go to step 20.			
	Prior Radioactivity			
16	For prior radioactivity, CL1-14A			
	should have been run at			
	step 2.			
17	Now key in patient predose			
	counts and predose			
	background and compute the			
	corrected percent uptake.	Predose Cts.	ENTER↑	
		Predose Bck.	f A	% Uptake
18	For differences in dose and			
	standard, go to step 19.			
	Otherwise go to step 20.			
	Differences in dose and			
	standard			
19	Key in standard and dose			
	precounts and find the cor-			
	rected percent uptake.	Std. Prect.	ENTER↑	
		Dose Prect.	f B	% Uptake

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
	Reprint			
20	To obtain a reprint of data			
	and results.		f E	Ptnt # .13
				Std. CPM
				Std. Bck.
				Ptnt. CPM
				Ptnt. Bck.
				% Uptake

Example 1:

Before a dose of radioiodine (^{131}I) is administered to patient 10183, a count is made of the patient's current level of radioactivity from a prior ingestion of ^{131}I. The patient's predose activity is found to be 75 counts per minute (CPM) and the background predose activity 25 CPM. Twenty-four hours after ingestion of the dose, the patient's activity is measured as 350 CPM with a background of 100 CPM. The activity of a standard of ^{131}I is measured at 1500 CPM with a background of 200 CPM. Find the percentage uptake corrected for prior radioactivity.

Keystrokes: **Outputs:**

Load side 1 and side 2 of *Radioactive Decay Corrections* (CL1-14A).

Select ^{131}I as prior radioisotope.

Keystrokes	Outputs	
f E →	193.20	(^{131}I half-life)
1 A →	1.00	
0.24 B →	0.24	(24 hours)
C →	0.92	(Decay factor)

Load side 1 and side 2 of *Thyroid Uptake* (CL1-13A).

Keystrokes	Outputs	
10183 f C →	10183.13 ***	(Ptnt ID)
1500 A →	1500.00 ***	(Std CPM)
200 B →	200.00 ***	(Std Bck)
	1300.00	(Net Std CPM)
350 C →	350.00 ***	(Ptnt CPM)
100 D →	100.00 ***	(Ptnt Bck)
	250.00	(Net Ptnt CPM)
E →	19.23 ***	(% uptake)
75 ENTER↑ 25 f A →	75.00 ***	(Ptnt Predose)
	25.00 ***	(Bck Predose)
	15.70 ***	(Corrected uptake)

Example 2:

A standard and a dose are measured (before ingestion of the dose) at activities of 14,500 and 12,500 counts. Since the activities differ by more than 3%, a correction will have to be made to the computed percentage uptake. After ingestion of the dose, the standard activity is found to be 11,500 counts with a background count of 1000. The patient's activity is found as 2650 counts with a background of 500 counts. Find the corrected uptake.

Keystrokes:	Outputs:
11500 **A** →	11500.00 *** (Std Cts)
1000 **B** →	1000.00 *** (Std Bck)
	10500.00 (Net Std Cts)
2650 **C** →	2650.00 *** (Ptnt CPM)
500 **D** →	500.00 *** (Ptnt Bck)
	2150.00 (Net Ptnt Cts)
E →	20.48 *** (% Uptake)
14500 **ENTER↑** 12500 **f** **B** →	14500.00 *** (Std Prects)
	12500.00 *** (Dose Prects)
	23.75 *** (Corrected uptake)

RADIOACTIVE DECAY CORRECTIONS

This program is designed to allow calculation of the decay in radioactivity of an isotope over a specified time interval. The half-lives of 15 different radioisotopes are stored by the program and may be used in calculating the decay. Generally, to use the program you will select an isotope, key in the activity A_0 at the initial time, then key in the elapsed time t and calculate the present activity A. There are thus three variables needed to define the problem entirely: A_0, t, and A.

An additional feature of the program is its ability to calculate *any* one of these variables given the other two. Thus you are not restricted to finding the present activity given the initial activity and time; you may also solve for initial activity given time and present activity, or for time given initial activity and present activity.

The radioisotope to be selected must be specified in one of two ways. Six isotopes are available directly by pressing user-definable keys [E] and [f] [A] through [f] [E]. Nine additional isotopes are available by keying in a digit, 1 through 9, and pressing [D]. For instance, to specify use of the radioisotope ^{57}Co, simply press [f] [B]. To specify the isotope ^{14}C, key in the number 2 and press [D]. A table of the correspondence between the isotopes and the numbers 1-9 may be found in the User Instructions. A list of available isotopes and their assumed half-lives is shown below.

You may use any units for the initial and present radioactivity, so long as they are consistent. The elapsed time must be input in the units Days. Hours (DD.HH), where two full decimal places must be allotted to the hours. For instance, an elapsed time of 5 days 18 hours would be keyed in and displayed as 5.18; a time of 1 day 6 hours as 1.06; and a time of 12 hours as 0.12.

Equations:

$$A = A_0 \left(\frac{1}{2}\right)^{t/\tau_{1/2}}$$

$$t = \frac{\tau_{1/2} \ln (A/A_0)}{\ln (1/2)}$$

where:

A_0 = initial radioactivity
A = present radioactivity
t = time elapsed, in hours
$\tau_{1/2}$ = half-life of radioisotope, in hours

Isotope	$\tau_{1/2}$ (hrs)
^{51}Cr	667.2
^{57}Co	6480
^{99m}Tc	6
^{125}I	1440
^{131}I	193.2
^{137}Cs	262980
^{3}H	107470
^{14}C	5.058×10^7
^{18}F	1.87
^{32}P	343.2
^{75}Se	2880
^{85}Sr	1536
^{113m}In	1.73
^{133}Xe	126.5
^{197}Hg	65

Remarks:

1. It is also possible to use this program for isotopes other than those provided by the program. In such a case, instead of selecting a radioisotope by the usual means, simply key in half-life in hours of the new isotope and press **STO** **B**. Then execute the rest of the program in the same fashion as usual.
2. Hours are not always rounded nicely to days for output. For example, a time of 6 days 23.8 hours would be computed in days. hours format as 6.238. In display mode FIX DSP 2, this would appear as 6.24, even though 7.00 might be the preferred rounded format.
3. Neither inputs nor outputs will be printed by the program.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	Select one of the fifteen radio-			
	isotopes and display half-life			
	in hours:			
	• Chromium—51 (^{51}Cr)		f A	667.20
	• Cobalt—57 (^{57}Co)		f B	6480.00
	• Technetium—99m (^{99m}Tc)		f C	6.00
	• Iodine—125 (^{125}I)		f D	1440.00
	• Iodine—131 (^{131}I)		f E	193.20
	• Cesium—137 (^{137}Cs)		E	262980.00
	• Hydrogen—3 (^{3}H)	1	D	107470.00
	• Carbon—14 (^{14}C)	2	D	50580000.00
	• Flourine—18 (^{18}F)	3	D	1.87
	• Phosphorus—32 (^{32}P)	4	D	343.20
	• Selenium—75 (^{75}Se)	5	D	2880.00
	• Strontium—85 (^{85}Sr)	6	D	1536.00
	• Indium—113m (^{113m}In)	7	D	1.73
	• Xenon—133 (^{133}Xe)	8	D	126.50
	• Mercury—197 (^{197}Hg)	9	D	65.00
3	Key in two of the following			
	three quantities:			
	• Activity at time zero	A_0	A	A_0
	• Time elapsed in days.hours			
	format*	t (dd.hh)	B	t (dd.hh)
	• Present activity	A	C	A
4	Compute remaining variable:			
	• Activity at time zero		A	A_0
	• Time elapsed in days.hours			
	format		B	t (dd.hh)
	• Present activity		C	A

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
5	For a new isotope, go to step 2;			
	to change one or both input			
	parameters, go to step 3.			
	*Recall that two digits must			
	always be allocated for hours.			
	For example, 1 day 6 hours is			
	keyed in as 1.06.			

Example:

An activity of 200 μCi is measured for a standard of ^{51}Cr. What is the activity after a week?

Keystrokes:	Outputs:	
f A →	667.20	($\tau_{1/2}$ for ^{51}Cr)
200 A →	200.00	(A_0)
7 B →	7.00	(t = 7 days)
C →	167.97	(A, μCi)

RADIOIMMUNOASSAY

This program performs the calculations for a logit/log plot of radioimmunoassay data. The program allows for any number of replicates in the counts input and for any number of standards. Outputs include correlation coefficient r, slope m, and intercept b of the least-squares regression line computed. Then, given counts for an unknown, the program will compute the corresponding concentration.

To run this program, first press **A** to initialize. Then key in the non-specific binding (or blank) counts, NSB, and press **B**; repeat for as many replicates as desired. After all replicates have been keyed in, press **R/S** to compute the average non-specific binding count. (This step is *not* optional; do not omit it.) The same procedure is repeated for the counts at zero concentration, B_0, which are input to key **C**. After input of all replicates **R/S** is pressed to compute the average B_0.

The next step in the operation of the program is the input of the data for the standards. The counts for the first standard are input to key **D**; as many replicates as desired may be keyed in. After all replicates for the first standard have been keyed in, the concentration of the standard is input to key **E**. This procedure (replicates to key **D**, concentration to key **E**) is repeated for as many standards as desired. Pressing key **f** **A** will then cause the output of the correlation coefficient r, the slope m, and the intercept b of the least-squares logit/log regression line computed from the standards. (The values of r, m, and b must be found before going to the next step, which is the calculation of the concentration of an unknown.) The regression performed is an unweighted regression.

At this point, the counts of an unknown may be keyed into **f** **B**; repeat for any number of replicates. After all replicates have been keyed in, **f** **C** may be pressed to find the concentration of that unknown. Repeat for as many unknowns as desired.

Two output options are available in this program. If neither option is selected, the only values output will be r, m, b, and the concentration of each unknown. Selection of the PRINT mode on key **f** **D** allows output of the following values as well: all input values (counts and standard concentrations) and the average of each set of counts input (assuming replicates). The second option, on key **f** **E**, is called PLOT. If this option is selected, the net B/B_0 and the log and logit (x and y) values for standards and unknowns will also be output. This information is intended to assist those who wish to make a plot by hand of the logit-log relationship.

Equations:

Let

NSB = average of replicate counts for non-specific binding
B_0 = average of replicate counts for zero concentration
B_i = average of replicate counts for i^{th} standard ($i = 1, 2, \ldots, n$)
C_i = concentration of i^{th} standard

Let

$$x_i = \log C_i$$

$$y_i = \text{logit}\left(\frac{B_i - NSB}{B_0 - NSB}\right)$$

$$= \ln\left[\frac{(B_i - NSB)/(B_0 - NSB)}{1 - (B_i - NSB)/(B_0 - NSB)}\right]$$

$$= \ln\left(\frac{B_i - NSB}{B_0 - B_i}\right)$$

$$\text{net } B_i/B_0 = \frac{B_i - NSB}{B_0 - NSB}$$

The program fits a line of the form $y = mx + b$ to the (x_i, y_i) pairs. All sums below are from 1 to n.

$$m = \frac{\Sigma xy - \frac{\Sigma x \, \Sigma y}{n}}{\Sigma x^2 - \frac{(\Sigma x)^2}{n}}$$

$$b = \bar{y} - m\,\bar{x}$$

where:

$$\bar{y} = \frac{\Sigma y}{n}$$

$$\bar{x} = \frac{\Sigma x}{n}$$

$$r = \frac{\Sigma xy - \frac{\Sigma x \, \Sigma y}{n}}{\left[\Sigma x^2 - \frac{(\Sigma x)^2}{n}\right]^{1/2}\left[\Sigma y^2 - \frac{(\Sigma y)^2}{n}\right]^{1/2}}$$

Let

B = average of replicate counts for an unknown
C_u = concentration of unknown

$$C_u = 10^x$$

$$\text{where } x = \frac{1}{m}\left[\ln\left(\frac{B - NSB}{B_0 - B}\right) - b\right]$$

Remarks:

1. The term "intercept" is used in this program to refer to the point on the logit axis (the y-axis) where it is intersected by the regression line. It does not mean, as it is sometimes used in RIA documents, the concentration for which the value of the logit function is zero.
2. After computation of r, m, and b, these values may be found in the following registers: r in R_C and Z, m in R_B and Y, and b in R_A and X.

References:

Rodbard, Bridson, and Rayford, "Rapid calculation of radioimmunoassay results", *J. Lab. Clin. Med.*, 74:770 (1969).

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	To allow output of input data			
	and intermediate results, turn			
	print function on.		f D	1.00
3	To turn print function off later.		f D	0.00
4	To allow output of (log conc.,			
	logit) values, turn plot			
	function on.		f E	1.00
5	To suppress further output of			
	plot data.		f E	0.00
	Setup			
6	Initialize.		A	
7	Key in non-specific binding			
	counts; repeat for as many			
	replicates as desired.	NSB	B	i
8	After all replicates, find			
	average NSB.		R/S	$\overline{NSB}$

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
9	Key in counts for zero dose;			
	repeat for as many replicates			
	as desired.	B_0	C	i
10	After all replicates, find			
	average B_0.		R/S	$\bar{B}_0$
	Standards			
11	Key in counts for first standard;			
	repeat for as many replicates			
	as desired.	B	D	i
12	Key in concentration of first			
	standard; optional outputs			
	are shown in parentheses;			
	1.00 indicates first standard.	Conc.	E	($\bar{B}$)
				(net B/B_0)
				(Conc.)
				(Logit)
				(Log conc.)
				1.00
13	Repeat steps 11 and 12 for			
	all standards.			
	Results			
14	Calculate correlation coef-			
	ficient (r), slope (m), and			
	intercept (b) of regression line.		f A	r
				m
				b
	Unknowns			
15	Key in counts for an unknown;			
	repeat for as many replicates			
	as desired.	B	f B	i

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
16	Find concentration of			
	unknown; optional outputs			
	are shown in parentheses.		f C	($\bar{B}$)
				(net B/B_0)
				Conc.
				(Logit)
				(Log)
17	Repeat steps 15 and 16 for			
	any number of unknowns.			
	New Case			
18	For a new assay, go to step 6.			

Example:

Below are the data for non-specific binding (NSB), zero concentration (B_0), and various standards for a radioimmunoassay.

Description	Counts per minute	Concentration (pg)
NSB	425, 339, 342, 369	-
B_0	10670, 10570, 10925	-
Standard 1	9176, 9850	25
Standard 2	8453, 7967	50
Standard 3	6323, 6057	100
Standard 4	3866, 4088	200
Standard 5	2027, 2221	400
Standard 6	1251, 1462	800

Find r, m, and b for the regression line. Find the concentrations corresponding to the unknown counts below.

Unknown	Counts per minute
1	10230, 10170
2	3270, 3400

Use the PRINT and PLOT options for complete outputs.

Keystrokes:	Outputs:
A f D	1.00 (Print on)
f E	1.00 (Plot on)
425 B	425.00 *** (1^{st} NSB)
	1.00
339 B	339.00 ***
	2.00
342 B	342.00 ***
	3.00
369 B	369.00 ***
	4.00
R/S	368.75 *** (Avg. NSB)
10670 C	10670.00 *** (1^{st} B_0)
	1.00
10570 C	10570.00 ***
	2.00
10925 C	10925.00 ***
	3.00
R/S	10721.67 *** (Avg. B_0)
9176 D	9176.00 *** (1^{st} of std. 1)
	1.00
9850 D	9850.00 ***
	2.00
25 E	9513.00 *** (Avg. for std. 1)
	0.88 *** (net B_1/B_0)
	25.00 *** (Conc. of std. 1)
	2.02 *** (Logit = y_1)
	1.40 *** (Log = x_1)
	1.00 (Std. 1)
8453 D	8453.00 *** (1^{st} of std. 2)
	1.00

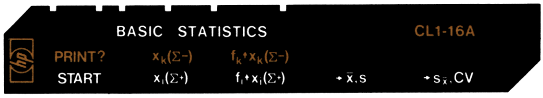
Keystrokes	Output		Remarks
7967 [D] →	7967.00	***	
	2.00		
50 [E] →	8210.00	***	(Avg. for std. 2)
	0.76	***	(net B_2/B_0)
	50.00	***	(Conc. of std. 2)
	1.14	***	(y_2)
	1.70	***	(x_2)
	2.00		(Std. 2)
6323 [D] →	6323.00	***	(1^{st} of std. 3)
	1.00		
6057 [D] →	6057.00	***	
	2.00		
100 [E] →	6190.00	***	(Avg. for std. 3)
	0.56	***	(net B_3/B_0)
	100.00	***	(Conc. of std. 3)
	0.25	***	(y_3)
	2.00	***	(x_3)
	3.00		(Std. 3)
3866 [D] →	3866.00	***	(1^{st} of std. 4)
	1.00		
4088 [D] →	4088.00	***	
	2.00		
200 [E] →	3977.00	***	(Avg. for std. 4)
	0.35	***	(net B_4/B_0)
	200.00	***	(Conc. of std. 4)
	−0.63	***	(y_4)
	2.30	***	(x_4)
	4.00		(Std. 4)
2027 [D] →	2027.00	***	(1^{st} of std. 5)
	1.00		
2221 [D] →	2221.00	***	
	2.00		

Keystrokes		Output	
400 [E]	→	2124.00 ***	(Avg. for std. 5)
		0.17 ***	(net B_5/B_0)
		400.00 ***	(Conc. of std. 5)
		-1.59 ***	(y_5)
		2.60 ***	(x_5)
		5.00	(Std. 5)
1251 [D]	→	1251.00 ***	(1^{st} of std. 6)
		1.00	
1462 [D]	→	1462.00 ***	
		2.00	
800 [E]	→	1356.50 ***	(Avg. for std. 6)
		0.10 ***	(net B_6/B_0)
		800.00 ***	(Conc. of std. 6)
		-2.25 ***	(y_6)
		2.90 ***	(x_6)
		6.00	(Std. 6)
[f] [A]	→	-1.00 ***	(r)
		-2.89 ***	(Slope m)
		6.03 ***	(Intercept b)
10230 [f] [B]	→	10230.00 ***	(1^{st} of unkn. 1)
		1.00	
10170 [f] [B]	→	10170.00 ***	
		2.00	
[f] [C]	→	10200.00 ***	(Avg. of unkn. 1)
		0.95 ***	(net B/B_0)
		11.83 ***	(Conc. of unkn. 1)
		2.94 ***	(Unkn. y)
		1.07 ***	(Unkn. x)
		11.83	
3270 [f] [B]	→	3270.00 ***	(1^{st} of unkn. 2)
		1.00	

3400 f B →	3400.00 ***
	2.00
f C →	3335.00 *** (Avg. of unkn. 2)
	0.29 *** (net B/B_0)
	254.57 *** (Conc. of unkn. 2)
	-0.91 *** (Unkn. y)
	2.41 *** (Unkn. x)
	254.57

Notes

BASIC STATISTICS



This program computes the basic statistics of one variable: mean ($\bar{x}$), standard deviation (s), standard error ($s_{\bar{x}}$), and coefficient of variation (C.V. %).

The input data to the program may be either grouped or ungrouped. Ungrouped data should be input to key **B** and grouped data to key **C**; keys **f** **B** and **f** **C** provide error correction for the ungrouped and grouped cases, respectively. If an incorrect entry is made, it may be corrected by keying in that entry a second time and pressing the appropriate error correction key. Suppose, for example, that 7.31 is one data point in a set of ungrouped data, but that a mistake is made in entering it. Instead of 7.31, the value 4.31 is input to key **B**. To correct this mistake, you would simply key in 4.31 and press **f** **B**. At this point the error has been eliminated. Now enter the correct data, 7.31, and press **B**.

Equations:

Ungrouped data:

Let $\{x_1, x_2, \ldots, x_n\}$ be the set of data points.

$$\text{Mean } \bar{x} = \frac{1}{n}\sum_{i=1}^{n} x_i$$

$$s = \sqrt{\frac{\Sigma x_i^2 - \dfrac{(\Sigma x_i)^2}{n}}{n-1}}$$

$$\text{Standard error } s_{\bar{x}} = \frac{s}{\sqrt{n}}$$

$$\text{Coefficient of variation C.V. \%} = \frac{s}{\bar{x}} \times 100$$

Grouped data:

Let $\{x_1, x_2, \ldots, x_n\}$ be a set of data points occurring with the respective frequencies $f_1, f_2, \ldots, f_n$.

$$\text{Mean } \bar{x} = \frac{\Sigma f_i x_i}{\Sigma f_i}$$

$$\text{Standard deviation } s = \sqrt{\frac{\Sigma f_i\, x_i^2 - \frac{(\Sigma f_i\, x_i)^2}{\Sigma f_i}}{\Sigma f_i - 1}}$$

$$\text{Standard error } s_{\bar{x}} = \frac{s}{\sqrt{\Sigma f_i}}$$

$$\text{Coefficient of variation C.V. \%} = \frac{s}{\bar{x}} \times 100$$

Remarks:

1. Grouped and ungrouped data may be mixed in the same set of data.
2. The preprogrammed Σ+ and Σ- keys may be used to input and correct ungrouped data in place of keys B and f B. Calculation of mean and standard deviation may also be done by the preprogrammed keys $\bar{x}$ and s for both grouped and ungrouped data.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1.			
2	Initialize.		A	0.00
3	To allow printing of input data,			
	turn print function on.		f A	1.00
4	To turn print function off later.		f A	0.00
5	For ungrouped data, go to			
	step 6; for grouped data, go			
	to step 9.			
	Ungrouped data			
6	Perform this step for i = 1,			
	2, ..., n:			
	Input data point.	x_i	B	i
7	To correct an erroneous entry.	x_k	f B	i
8	Go to step 11.			
	Grouped data			
9	Perform this step for i = 1,			
	2, ..., n:			
	Input frequency and data.	f_i	ENTER↑	
		x_i	C	i

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
10	To correct an erroneous entry.	f_k	ENTER↑	
		x_k	f C	i
	Results			
11	Compute mean and standard			
	deviation.		D	$\bar{x}$
				s
12	Compute standard error and			
	coefficient of variation.		E	$s_{\bar{x}}$
				C.V.%
13	For a new set of data, go			
	to step 2.			

Example 1:

Hemoglobin concentration was measured for nine male patients. Compute the basic statistics for these data.

Hemoglobin concentration (g/dl)

13.8	17.4
16.9	13.4
16.5	17.9
17.7	15.2
16.0	

Keystrokes:	Outputs:		
A →	0.00		
f A →	1.00		(Print on)
13.8 B →	13.80	***	(x_i)
	1.00		(i)
16.9 B →	16.90	***	
	2.00		
16.5 B →	16.50	***	
	3.00		
17.7 B →	17.70	***	
	4.00		

Keystrokes		Outputs	
16 B	→	16.00 ***	
		5.00	
17.4 B	→	17.40 ***	
		6.00	
3.4 B	→	3.40 ***	(Error!)
		7.00	(k = 7)
3.4 f B	→	3.40 ***	(Correction)
		6.00	
13.4 B	→	13.40 ***	(x_7)
		7.00	
17.9 B	→	17.90 ***	
		8.00	
15.2 B	→	15.20 ***	
		9.00	
D	→	16.09 ***	(Mean)
		1.65 ***	(Std. dev.)
E	→	0.55 ***	($s_{\bar{x}}$)
		10.23 ***	(C.V. %)

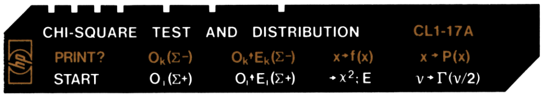
Example 2:

A certain test was performed on college students ranging in age from 18 to 22 years. The number of subjects of each age is shown in the table. Compute the mean age of the students in the test.

Age	18	19	20	21	22
# Subjects	5	9	13	7	1

Keystrokes:		**Outputs:**	
A	→	0.00	
If Example 1 has just been run, turn print off:			
f A	→	0.00	(Print off)
5 ENTER↑ 18 C	→	1.00	
9 ENTER↑ 19 C	→	2.00	
13 ENTER↑ 20 C	→	3.00	
7 ENTER↑ 21 C	→	4.00	
1 ENTER↑ 22 C	→	5.00	
D	→	19.71 ***	(Mean)
		1.05 ***	(Std. dev.)

CHI-SQUARE EVALUATION AND DISTRIBUTION



This program allows you to perform two important calculations concerning the chi-square statistic. The first of these calculates the value of the χ^2 statistic for the goodness of fit test. The second evaluates the chi-square density f(x) and the cumulative distribution P(x) given x and the degrees of freedom ν.

The χ^2 statistic may be computed for the case where the expected frequencies are equal as well as for the case where they are different. If they are equal, only the observed frequencies O_i need be input to key **B**; error correction is available on key **f** **B**. After calculation of χ^2 from key **D**, the expected frequency E may be calculated. If the expected frequencies are different, both the observed and expected frequencies should be input to key **C**. Error correction is provided on key **f** **C**.

To make calculations involving the chi-square distribution, first input the degrees of freedom ν to key **E**. Then key in the value of x and press **f** **D** to find the density f(x) or **f** **E** to find the cumulative distribution P(x).

Equations:

Chi-square evaluation:

$$\chi^2 = \sum_{i=1}^{n} \frac{(O_i - E_i)^2}{E_i}$$

where:

O_i = observed frequency
E_i = expected frequency

If the expected values are equal

$$\left(E = E_i = \frac{\Sigma O_i}{n} \text{ for all } i\right)$$

then

$$\chi^2 = \frac{n\Sigma O_i^2}{\Sigma O_i} - \Sigma O_i$$

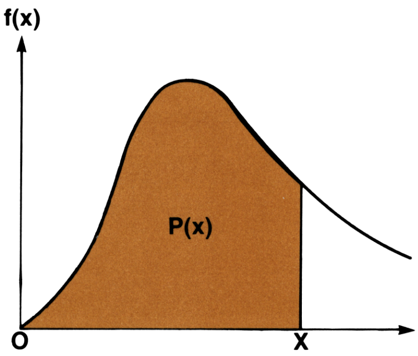
Chi-square distribution:

Chi-square density:

$$f(x) = \frac{1}{2^{\frac{\nu}{2}}\Gamma\left(\frac{\nu}{2}\right)} x^{\frac{\nu}{2}-1} e^{-\frac{x}{2}}$$

where:

$x \geqslant 0$
ν is the degrees of freedom.



Series approximation is used to evaluate the cumulative distribution

$$P(x) = \int_0^x f(t)\,dt$$

$$= \left(\frac{x}{2}\right)^{\frac{\nu}{2}} \frac{e^{-\frac{x}{2}}}{\Gamma\left(\frac{\nu+2}{2}\right)} \left[1 + \sum_{k=1}^{\infty} \frac{x^k}{(\nu+2)(\nu+4)\ldots(\nu+2k)}\right]$$

where:

$$\Gamma\left(\frac{\nu}{2}\right) = \begin{cases} \left(\frac{\nu}{2} - 1\right)!, \ \nu \text{ even} \\ \left(\frac{\nu}{2} - 1\right)\left(\frac{\nu}{2} - 2\right) \cdots \left(\frac{1}{2}\right) \Gamma\left(\frac{1}{2}\right), \ \nu \text{ odd} \end{cases}$$

$$\Gamma\left(\frac{1}{2}\right) = \sqrt{\pi}$$

The program computes successive partial sums of the above series. When two consecutive partial sums are equal, the value is used as the sum of the series.

Remarks:

1. In order to apply the goodness of fit test to a set of given data, it may be necessary to combine some classes to ensure that each expected frequency is not too small (not less than, say, 5).
2. The program for distribution requires that $\nu \leqslant 141$. If $\nu > 141$, erroneous overflow will result.
3. If both x and ν are large, the calculation of f(x) may cause overflow.

References:

(Evaluation) J.E. Freund, *Mathematical Statistics,* Prentice Hall, 1962.

(Distribution) Abramowitz and Stegun, *Handbook of Mathematical Functions,* National Bureau of Standards, 1968.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	Initialize.		A	20.00
3	To allow printing of data and			
	results, turn the print function			
	on.		f A	1.00
4	To turn the print function off			
	later.		f A	0.00
5	For χ^2 evaluation, go to			
	step 6; for χ^2 distribution,			
	go to step 15.			
	χ^2 evaluation			
6	If the expected frequencies			
	are equal, go to step 7;			
	if they are not equal, go to			
	step 11.			
	Expected frequencies equal			
7	Perform this step for i = 1,			
	2, ..., n:			
	Key in observed value.	O_i	B	i

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
8	To correct an erroneous entry.	O_k	f B	i
9	Calculate the χ^2 statistic and			
	(optionally) the average			
	expected frequency.		D	χ^2
			R/S	E
10	For a new case, go to step 2.			
	Expected frequencies			
	unequal			
11	Perform this step for i = 1,			
	2, ..., n:			
	Key in observed and	O_i	ENTER↑	
	expected frequency.	E_i	C	i
12	To correct an erroneous	O_k	ENTER↑	
	entry.	E_k	f C	i
13	Calculate the χ^2 statistic.		D	χ^2
14	For a new case, go to step 2.			
	χ^2 distribution			
15	Key in degrees of freedom.	ν	E	$\Gamma(\nu/2)$
16	Key in x and compute either			
	• Density	x	f D	f(x)
	or			
	• Cumulative distribution	x	f E	P(x)
17	For a new case, go to step 2.			

Example:

Ten one-minute counts of a Cesium-137 check source yielded the following results. Use this program to evaluate the counting instrument. (Note that with 10 data points, the degrees of freedom $\nu = 9$.)

25601	25553
25546	25841
25592	25560
25820	25633
25569	25464

Keystrokes:	Outputs:	
A f A →	1.00	(Print on)
25601 B →	25601.00 ***	
	1.00	
25546 B →	25546.00 ***	
	2.00	
25592 B →	25592.00 ***	
	3.00	
25820 B →	25820.00 ***	
	4.00	
25569 B →	25569.00 ***	
	5.00	
25553 B →	25553.00 ***	
	6.00	
25841 B →	25841.00 ***	
	7.00	
25560 B →	25560.00 ***	
	8.00	
25633 B →	25633.00 ***	
	9.00	
25464 B →	25464.00 ***	
	10.00	
D →	5.10 ***	(χ^2)
R/S →	25617.90 ***	(E)
9 E →	9.00 ***	(ν)
	11.63 ***	(Γ (ν/2))
5.10 f E →	5.10 ***	
	0.17 ***	(P (χ^2))

Since P (χ^2) is between 0.1 and 0.9, the counting instrument is assumed to be operating properly.

Notes

t STATISTICS

This program will compute either of two test statistics which are used to compare population means: the paired t statistic or the t statistic for two means.

The paired t statistic applies to a set of *paired* observations drawn from two normal populations with unknown means μ_1, μ_2:

x_i	x_1	x_2	...	x_n
y_i	y_1	y_2	...	y_n

The paired t statistic can be used to test the validity of the hypothesis that the means are equal. If the computed value of t is significant (as determined by *t Distribution,* CL1-19A), then we reject the hypothesis that the population means are equal.

The x- and y-values are input to key [B]. Error correction is provided by key [f] [B]. After the input of all x-y pairs, the t statistic may be found by pressing [C].

The t statistic for two means applies to independent random samples $\{x_1, x_2, \ldots, x_{n_1}\}$ and $\{y_1, y_2, \ldots, y_{n_2}\}$ drawn from two normal populations with unknown means μ_1, μ_2 and the same unknown variance σ^2. The t statistic is used to test the validity of the hypothesis that the populations means differ by some amount d (i.e., that $\mu_1 - \mu_2 = d$). Note that d may be chosen to be zero.

To operate this routine, the x-values should first be keyed in to key [D]. Error correction is available on key [f] [D]. After all x-values have been input, the value of d should be input to key [f] [E]. Then the y-values should be keyed in to key [D]. After input of all the y-values, the t statistic may be found by pressing [E].

Equations:

Paired t statistic

let

$$D_i = x_i - y_i$$

$$\bar{D} = \frac{1}{n}\sum_{i=1}^{n} D_i$$

$$s_D = \sqrt{\frac{\Sigma D_i^2 - \frac{1}{n}(\Sigma D_i)^2}{n - 1}}$$

$$s_{\bar{D}} = \frac{s_D}{\sqrt{n}}$$

The test statistic

$$t = \frac{\bar{D}}{s_{\bar{D}}}$$

which has n − 1 degrees of freedom (df) can be used to test the null hypothesis

$$H_o: \mu_1 = \mu_2$$

t statistic for two means

Define

$$\bar{x} = \frac{1}{n_1}\sum_{i=1}^{n_1} x_i$$

$$\bar{y} = \frac{1}{n_2}\sum_{i=1}^{n_2} y_i$$

$$t = \frac{\bar{x} - \bar{y} - d}{\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}\sqrt{\frac{\Sigma x_i^2 - n_1 x^2 + \Sigma y_i^2 - n_2 y^2}{n_1 + n_2 - 2}}}$$

We can use this t statistic which has the t distribution with $n_1 + n_2 - 2$ degrees of freedom (df) to test the null hypothesis

$$H_o: \mu_1 - \mu_2 = d$$

References:

(Paired t) B. Ostle, *Statistics in Research,* Iowa State University Press, 1963.

(t for two means) K.A. Brownlee, *Statistical Theory and Methodology in Science and Engineering,* John Wiley and Sons, 1965.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and 2 of program.			
2	Initialize.		A	
3	To allow output of data and			
	results, turn print function on.		f A	1.00
4	To turn print function off later.		f A	0.00
5	For t statistic for two means,			
	go to step 11; for paired t			
	statistic, go to step 6.			
	Paired t statistic			
6	Repeat this step for all data			
	pairs (i = 1, 2, ..., n):			
	Key in x- and y-values.	x_i	ENTER↑	
		y_i	B	i
7	To correct an erroneous entry.	x_k	ENTER↑	
		y_k	f B	i
8	Compute paired t statistic.		C	t
9	(optional) Compute degrees			
	of freedom, mean difference,			
	and standard deviation of D.		R/S	df
				$\bar{D}$.
				s_D
10	For a new case, go to step 2.			
	t statistic for two means			
11	Repeat this step for all			
	x-values (i = 1, 2, ..., n_1):			
	Key in x-value.	x_i	D	i
12	To correct an erroneous entry.	x_k	f D	i

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
13	Key in difference to be tested.	d	f E	d
14	Repeat this step for all			
	y-values (i = 1, 2, ..., n_2):			
	Key in y-value.	y_i	D	i
15	To correct an erroneous			
	entry.	y_k	f D	i
16	Compute t statistic for two			
	means.		E	t
17	(optional) Compute degrees			
	of freedom.		R/S	df
18	(optional) Change value of			
	d and repeat step 16.	d	STO 7	
19	For a new case go to step 2.			

Example 1:

The hemoglobin concentration in blood samples from six patients was measured by two different methods. Use the paired t-statistic to determine if there is a significant difference between the two methods of measurement.

	Method	
Sample	**1 (g/dl)**	**2 (g/dl)**
1	17.6	17.4
2	13.0	12.9
3	15.3	15.3
4	15.0	15.2
5	15.0	15.0
6	14.6	14.5

Keystrokes:	**Outputs:**
A ⟶	0.00
f A ⟶	1.00 (Print on)
17.6 ENTER↑ 17.4 B ⟶	17.60 *** (x_1)
	17.40 *** (y_1)
	1.00 (i = 1)

13 ENTER↑ 12.9 B	→	13.00 ***
		12.90 ***
		2.00
15.3 ENTER↑ 15.2 B	→	15.30 ***
		15.20 *** (Error!)
		3.00
15.3 ENTER↑ 15.2 f B	→	15.30 ***
		15.20 *** (Corrected)
		2.00
15.3 ENTER↑ 15.3 B	→	15.30 ***
		15.30 ***
		3.00
15 ENTER↑ 15.2 B	→	15.00 ***
		15.20 ***
		4.00
15 ENTER↑ 15 B	→	15.00 ***
		15.00 ***
		5.00
14.6 ENTER↑ 14.5 B	→	14.60 ***
		14.50 ***
		6.00
C	→	0.60 *** (t)
R/S	→	5.00 *** (df)
		0.03 *** ($\overline{D}$)
		0.14 *** (S_D)

To interpret these results, load *t Distribution* (CL1-19A) and find the cumulative distribution I(x) for x = 0.60 and 5 degrees of freedom.

Keystrokes:		**Outputs:**
5 A .60 D	→	0.43 *** (I (0.60))

The probability of $|t| > 0.60$ is thus 57%. We conclude that the hypothesis that the means are equal cannot be rejected.

Example 2:

Hemoglobin concentration was measured for nine male and seven female patients. Use the t-statistic for two means to test the hypothesis that the difference between the means is negligible (i.e., d = 0).

Hgb concentration (g/dl)	
Men	**Women**
13.8	11.9
16.9	14.4
16.5	13.7
17.7	16.8
16.0	11.7
17.4	14.9
13.4	12.3
17.9	
15.2	

Keystrokes:	Outputs:	
A →	0.00	
If example 1 has not just been run:		
f A →	1.00	(Print on)
13.8 D →	13.80 ***	(x_1)
	1.00	(i = 1)
16.9 D →	16.90 ***	
	2.00	
16.5 D →	16.50 ***	
	3.00	
17.7 D →	17.70 ***	
	4.00	
16 D →	16.00 ***	
	5.00	
17.4 D →	17.40 ***	
	6.00	
13.4 D →	13.40 ***	
	7.00	
17.9 D →	17.90 ***	
	8.00	
15.2 D →	15.20 ***	
	9.00	
0 f E →	0.00 ***	(d = 0)

11.9 **D** ⟶	11.90 *** (y_1)
	1.00 (i = 1)
14.4 **D** ⟶	14.40 ***
	2.00
13.7 **D** ⟶	13.70 ***
	3.00
16.8 **D** ⟶	16.80 ***
	4.00
11.7 **D** ⟶	11.70 ***
	5.00
14.9 **D** ⟶	14.90 ***
	6.00
12.3 **D** ⟶	12.30 ***
	7.00
E ⟶	2.76 *** (t)
R/S ⟶	14.00 *** (df)

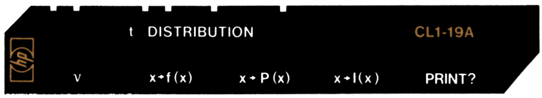
Load *t Distribution* (CL1-19A).

14 **A** 2.76 **D** ⟶	0.98 *** (I (2.76))

Thus the value of t is significant and we should reject the hypothesis that the average hemoglobin concentrations in males and females are equal.

Notes

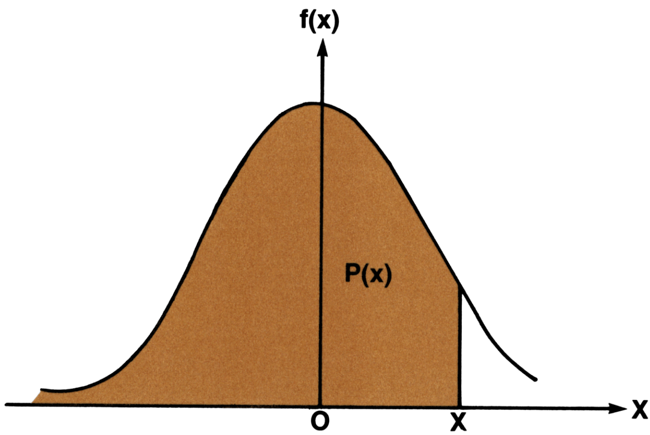
t DISTRIBUTION

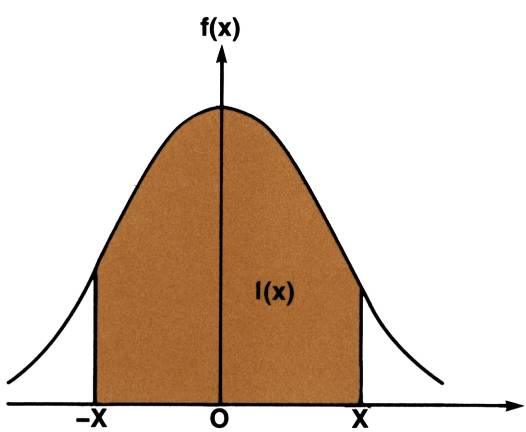


This program calculates three parameters of the t distribution given x and the degrees of freedom ν. The density function f(x) is computed as well as two measures of the area under the distribution curve, P(x) and, for $x > 0$, I(x), where

$$P(x) = \int_{-\infty}^{x} f(y)\, dy$$

$$\text{and } I(x) = \int_{-x}^{x} f(y)\, dy.$$





Equations:

$$f(x) = \frac{\Gamma\left(\frac{\nu+1}{2}\right)}{\sqrt{\pi\nu}\,\Gamma\left(\frac{\nu}{2}\right)} \left(1 + \frac{x^2}{\nu}\right)^{-\frac{\nu+1}{2}}$$

(1) ν even

$$I(x) = \sin\theta\left\{1 + \frac{1}{2}\cos^2\theta + \frac{1\cdot 3}{2\cdot 4}\cos^4\theta + \ldots + \frac{1\cdot 3\cdot 5\ldots(\nu-3)}{2\cdot 4\cdot 6\ldots(\nu-2)}\cos^{\nu-2}\theta\right\}$$

(2) ν odd

$$I(x) = \begin{cases} \frac{2\theta}{\pi} \text{ if } \nu = 1 \\ \frac{2\theta}{\pi} + \frac{2}{\pi}\cos\theta\left\{\sin\theta\left[1 + \frac{2}{3}\cos^2\theta + \ldots + \frac{2\cdot 4\ldots(\nu-3)}{1\cdot 3\ldots(\nu-2)}\cos^{\nu-3}\theta\right]\right\} \text{ if } \nu > 1 \end{cases}$$

where

$$\theta = \tan^{-1}\left(\frac{x}{\sqrt{\nu}}\right)$$

$$P(x) = \begin{cases} \frac{1 + I(x)}{2} \text{ if } x > 0 \\ \frac{1 - I(x)}{2} \text{ if } x \leq 0 \end{cases}$$

Remarks:

The program requires $\nu < 141$. Otherwise an erroneous overflow will result.

Reference:

Abramowitz and Stegun, *Handbook of Mathematical Functions,* National Bureau of Standards, 1970.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2			
	of program.			
2	To allow printing of inputs,			
	turn print function on.		E	1.00
3	To turn print function off			
	later.		E	0.00
4	Key in degrees of freedom.	ν	A	ν
5	Key in x and compute either			
	• Density function	x	B	f(x)
	or			
	• Cumulative distribution	x	C	P(x)
	or			
	• Integral, −x to x (x > 0).	x	D	I(x)

Example 1:

Find the density function and P(x) for x = 1.6 with 9 degrees of freedom.

Keystrokes:	Outputs:
9 A →	9.00 (ν)
1.6 B →	0.11 *** (f (x))
1.6 C →	0.93 *** (P (x))

Example 2:

Find I(x) for x = 1.83 and ν = 11.

Keystrokes:	Outputs:
11 A →	11.00 (ν)
1.83 D →	0.91 *** (I (x))

Notes

Notes

PROGRAM LISTINGS

The following listings are included for your reference. A table of keycodes and keystrokes corresponding to the symbols used in the listings can be found in Appendix E of your Owner's Handbook.

Program **Page**

Beer's Law

001	*LBLA	A → %T.	057	+	For % T_u, compute A_u.
002	STOD		058	GTO0	------
003	F0?		059	*LBL4	
004	PRTX	A.	060	CHS	
005	2		061	*LBL0	
006	-		062	STO9	Store A_u.
007	CHS		063	RCLA	Display input.
008	10^x		064	RTN	------------
009	STOE	%T.	065	*LBLE	C_s → C_u.
010	F0?		066	STO8	
011	PRTX		067	F0?	
012	F0?		068	SPC	
013	SPC		069	F0?	
014	RTN	------------	070	PRTX	
015	*LBLB	%T → A.	071	RCL9	
016	STOE		072	×	$C_u = C_s \times \frac{A_u}{A_s}$
017	F0?		073	RCL8	
018	PRTX	%T.	074	÷	
019	LOG		075	STO7	
020	CHS		076	F0?	
021	2		077	PRTX	
022	+		078	F0?	
023	STOD		079	SPC	
024	F0?		080	RTN	------------
025	PRTX	A.	081	*LBLa	
026	F0?		082	0	Clear for reprint.
027	SPC		083	STOA	
028	RTN	------------	084	STOB	
029	*LBLC	+ % T_s ($-A_s$).	085	STOC	
030	STOC		086	STOD	
031	F0?		087	STOE	
032	SPC		088	STOI	
033	F0?		089	RTN	------------
034	PRTX		090	*LBLc	Patient ID = Ptnt # .01.
035	X<0?	For absorbance, GTO 3.	091	INT	
036	GTO3		092	.	
037	LOG		093	0	
038	CHS		094	1	
039	2	For %T_s, compute A_s.	095	+	
040	+		096	STOI	
041	GTO0	------	097	PRTX	
042	*LBL3		098	SPC	
043	CHS		099	RTN	------------
044	*LBL0		100	*LBLd	Print toggle.
045	STOB	Store A_s.	101	F0?	
046	RCLC	Display input.	102	GTO0	
047	RTN	------------	103	SF0	
048	*LBLD	+ % T_u ($-A_u$).	104	1	
049	STOA		105	RTN	
050	F0?		106	*LBL0	
051	PRTX	For absorbance, GTO 4.	107	CF0	
052	X<0?		108	0	
053	GTO4		109	RTN	------------
054	LOG		110	*LBLe	Reprint
055	CHS		111	SPC	
056	2		112	SPC	

REGISTERS

0	1	2	3	4	5	6	7	8	9
							C_u	C_s	A_u
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
Input to [D]	A_s	Input to [C]	A	% T	Ptnt # .01

113	RCLI	
114	INT	
115	.	
116	0	
117	1	
118	+	
119	PRTX	Patient ID.
120	SPC	
121	RCLD	A.
122	PRTX	
123	RCLE	%T.
124	PRTX	
125	SPC	
126	SPC	
127	RCLC	+ % T_s ($-A_s$).
128	PRTX	
129	RCLA	+ % T_u ($-A_u$).
130	PRTX	
131	SPC	
132	RCL8	C_s.
133	PRTX	
134	RCL7	C_u.
135	PRTX	
136	RTN	------------

LABELS

A A→%T	B %T→A	C +%T_s ($-A_s$)	D +%T_u ($-A_u$)	E C_s→C_u
a Clear	b	c Ptnt #	d P off?	e Reprint
0 Used	1	2	3 Store A_s	4 Store A_u
5	6	7	8	9

FLAGS

0	Print
1	
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☒	☐
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

L02-01

Protein Electrophoresis

Step	Key	Comment	Step	Key	Comment
001	*LBLA	Initialize.	057	STOI	Point to $Frac_1$.
002	2		058	*LBL6	
003	5		059	RCLi	
004	STOI		060	RCL0	
005	CLX		061	÷	
006	STO0		062	RCL2	$Gms = \frac{Fract_i}{\Sigma} \times T\ Pr$
007	STO1		063	x	
008	STO2		064	PRTX	
009	STO3		065	RCLI	
010	F0?		066	RCL1	
011	SPC		067	X=Y?	Down to R_{25-n}?
012	RTN		068	GTO0	Yes, exit.
013	*LBLB	Input fractions.	069	DSZI	No, decrement and
014	F0?		070	GTO6	loop again.
015	PRTX	$Fract_i \rightarrow R_{25-i}$.	071	*LBL0	
016	DSZI		072	CLX	Display 0.00 and return.
017	STOi		073	RTN	
018	ST+0	Accumulate Σ in R_0.	074	*LBLE	Compute A/G.
019	1		075	RCLE	
020	ST+1		076	RCLD	
021	RCL1	Display i.	077	RCLC	
022	RTN		078	+	$A/G = \frac{Fract_1}{\sum_{i=2}^{5} Fract_i}$
023	*LBLC	Output percents.	079	RCLB	
024	SPC		080	+	
025	RCLI	I now contains (25 − n).	081	RCLA	
026	STO1	Save in R_1.	082	+	
027	2		083	÷	
028	4		084	SPC	
029	STOI		085	PRTX	
030	*LBL9		086	RTN	
031	RCLi		087	*LBLc	
032	RCL0		088	INT	Patient ID = Ptnt # .02
033	÷		089	.	
034	EEX	$\% = \frac{Fract_i}{\Sigma} \times 100$.	090	0	
035	2		091	2	
036	x		092	+	
037	PRTX		093	STO3	
038	RCLI		094	SPC	
039	RCL1	Down to R_{25-n}?	095	PRTX	
040	X=Y?		096	SPC	
041	GTO0	Yes, exit.	097	RTN	
042	DSZI	No, decrement and	098	*LBLd	
043	GTO9	loop again.	099	F0?	Print toggle.
044	*LBL0		100	GTO0	
045	CLX	Display 0.00 and return.	101	SF0	
046	RTN		102	1	
047	*LBLD	Total protein.	103	RTN	
048	SPC		104	*LBL0	
049	SPC		105	CF0	
050	F0?		106	0	
051	PRTX		107	RTN	
052	F0?		108	*LBLe	Reprint
053	SPC		109	2	
054	STO2		110	4	
055	2		111	STOI	
056	4		112	SPC	

REGISTERS

0	1	2	3	4	5	6	7	8	9
Σ Fract	25 − n	Tot Pr	Ptnt # .02						

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
									$Fract_6$

A	B	C	D	E	I
$Fract_5$	$Fract_4$	$Fract_3$	$Fract_2$	$Fract_1$	Index

```
113     SPC
114     RCL3
115     INT
116     .
117     0
118     2
119     +
120     PRTX      Patient ID
121     SPC           ---------
122     *LBL7
123     RCLi
124     PRTX      Loop to print inputs.
125     RCLI
126     RCL1
127     X=Y?
128     GTO1
129     DSZI
130     GTO7          ---------
131     *LBL1
132     2
133     4
134     STOI
135     SPC
136     GSB9      Print %.
137     SPC
138     SPC
139     RCL2      If total protein = 0, skip to
140     X=0?      print A/G.
141     GTOE
142     PRTX      Otherwise print T Pr and
143     SPC       grams.
144     2
145     4
146     STOI
147     GSB8
148     GTOE      Print A/G.
```

LABELS					FLAGS
A Start	B Fract	C →%	D T Pr→g	E →A/G	0 Print
a	b	c Ptnt #	d P off?	e Reprint	1
0 Used	1 Used	2	3	4	2
5	6	7 Prt frac	8 Prt gms	9 Prt %	3

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☒	☐	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

LDH Isoenzymes

Step	Key	Comment
001	*LBLA	
002	2	Initialize.
003	5	
004	STOI	
005	CLX	
006	STO0	
007	STO1	
008	STO2	
009	RTN	------------
010	*LBLB	Input LDH values.
011	DSZI	$LDH_i \rightarrow R_{25-i}$
012	STOi	
013	ST+0	
014	F0?	Accumulate Σ in R_0.
015	PRTX	
016	1	
017	ST+1	
018	RCL1	Display i.
019	RTN	------------
020	*LBLC	Calculate and print
021	SPC	percentages.
022	3	
023	3	Max LDH_1 = 33.
024	ENT↑	
025	1	
026	8	Min LDH_1 = 18.
027	RCLE	LDH_1
028	GSB1	--------
029	4	
030	0	Max LDH_2 = 40.
031	ENT↑	
032	2	
033	8	Min LDH_2 = 28.
034	RCLD	LDH_2
035	GSB1	--------
036	3	
037	0	Max LDH_3 = 30.
038	ENT↑	
039	1	
040	8	Min LDH_3 = 18.
041	RCLC	LDH_3
042	GSB1	--------
043	1	
044	6	Max LDH_4 = 16.
045	ENT↑	
046	6	Min LDH_4 = 6.
047	RCLB	LDH_4
048	GSB1	--------
049	1	
050	3	Max LDH_5 = 13.
051	ENT↑	
052	2	Min LDH_5 = 2.
053	RCLA	LDH_5
054	GSB1	--------
055	F2?	
056	GTOE	F2 set indicates range error.

Step	Key	Comment
057	RTN	------------
058	*LBL1	Subroutine to find % and test if within normal range.
059	RCL0	
060	÷	
061	EEX	
062	2	
063	×	$(\%)_i = \frac{LDH_i}{\sum_j LDH_j} \times 100$
064	PRTX	
065	X⇄Y	
066	X>Y?	Min > %?
067	SF2	Yes, set flag 2.
068	R↓	
069	X>Y?	% > Max?
070	SF2	Yes, set flag 2.
071	RTN	------------
072	*LBLc	Patient ID = Ptnt #.03
073	INT	
074	.	
075	0	
076	3	
077	+	
078	STO2	
079	PRTX	
080	SPC	
081	RTN	------------
082	*LBLd	Print toggle
083	F0?	
084	GTO0	
085	SF0	
086	1	
087	RTN	
088	*LBL0	
089	CF0	
090	0	
091	RTN	------------
092	*LBLe	Reprint
093	SPC	
094	SPC	
095	RCL2	
096	INT	
097	.	
098	0	
099	3	
100	+	
101	PRTX	Ptnt #.03
102	SPC	
103	RCLE	LDH_1
104	PRTX	
105	RCLD	LDH_2
106	PRTX	
107	RCLC	LDH_3
108	PRTX	
109	RCLB	LDH_4
110	PRTX	
111	RCLA	LDH_5
112	PRTX	

REGISTERS

0	1	2	3	4	5	6	7	8	9
Σ LDH_i	i	Ptnt #.03							

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
LDH_5	LDH_4	LDH_3	LDH_2	LDH_1	Index

113 SPC 114 GTOC	Compute and print %.		

LABELS					FLAGS	SET STATUS		
A START	B LDH$_i$	C →%	D	E None	0 Print	FLAGS	TRIG	DISP
a	b	c Ptnt#	d P off?	e Reprint	1	ON OFF 0 ☒ ☐ 1 ☐ ☒ 2 ☐ ☒ 3 ☐ ☒	DEG ☒ GRAD ☐ RAD ☐	FIX ☒ SCI ☐ ENG ☐ n 2
0 Used	1 %	2	3	4	2 Range error			
5	6	7	8	9	3			

L04-01

Body Surface Area

Step	Key	Comment
001	*LBLA	Height (+cm, – in)
002	STOE	
003	F0?	
004	SPC	
005	F0?	
006	PRTX	
007	X>0?	If height in cm, GTO 1.
008	GTO1	
009	CHS	
010	2	
011	.	Convert inches to cm.
012	5	
013	4	
014	x	
015	*LBL1	
016	STOD	Store height in cm.
017	RTN	
018	*LBLB	Weight (+kg, – lb)
019	STOC	
020	F0?	
021	PRTX	
022	F0?	
023	SPC	
024	X>0?	If weight in kg, GTO 2.
025	GTO2	
026	CHS	
027	.	
028	4	
029	5	
030	3	Convert pounds to kg.
031	5	
032	9	
033	2	
034	3	
035	7	
036	x	
037	*LBL2	
038	STOB	Store weight in kg.
039	RTN	
040	*LBLC	Dubois BSA
041	RCLD	
042	.	
043	7	
044	2	
045	5	
046	Y^x	
047	RCLB	
048	.	
049	4	
050	2	
051	5	
052	Y^x	
053	x	
054	.	
055	0	
056	0	
057	7	
058	1	
059	8	
060	4	
061	x	
062	STOA	
063	F0?	
064	PRTX	
065	F0?	
066	SPC	
067	RTN	
068	*LBLD	Boyd BSA
069	RCLD	
070	.	
071	3	
072	Y^x	
073	RCLB	
074	EEX	
075	3	
076	x	
077	ENT↑	
078	LOG	
079	.	
080	0	
081	1	
082	8	
083	8	
084	x	
085	.	
086	7	
087	2	
088	6	
089	5	
090	-	
091	Y^x	
092	÷	
093	3	
094	1	
095	1	
096	8	
097	÷	
098	STOA	
099	F0?	
100	PRTX	
101	F0?	
102	SPC	
103	RTN	
104	*LBLa	Clear for reprint
105	0	
106	STOI	
107	RTN	
108	*LBLc	Patient ID = Ptnt #.04
109	INT	
110	.	
111	0	
112	4	

REGISTERS

0	1	2	3	4	5	6	7	8	9

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
BSA (m^2)	Wt (kg)	Wt input	Ht (cm)	Ht input	Ptnt #.04

Program	Comments
+	
STOI	
SPC	
PRTX	
RTN	------------
*LBLd	Print toggle
F0?	
GTO0	
SF0	
1	
RTN	
*LBL0	
CF0	
0	
RTN	------------
*LBLe	Reprint
SPC	
SPC	
RCLI	
INT	
.	
0	
4	
+	
PRTX	Patient ID
SPC	
RCLE	Ht input
PRTX	
RCLC	Wt input
PRTX	
SPC	
RCLA	BSA (m²)
PRTX	
SPC	
RTN	------------

LABELS

A	B	C	D	E
Ht (+cm)	Wt (+kg)	→Dubois	→Boyd	
a Clear	b	c Ptnt #	d P off?	e Reprint
0 P toggle	1 Store ht	2 Store wt	3	4
5	6	7	8	9

FLAGS

Flag	
0	Print
1	
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☒	☐
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

L05-01

Urea Clearance

Step	Key	Comment	Step	Key	Comment
001	*LBLA		057	.	
002	÷	V/t	058	3	Otherwise have maximum.
003	*LBLB		059	3	
004	STOE	$\dot{V}$	060	×	
005	F0?		061	STO8	
006	SPC		062	F0?	
007	F0?		063	PRTX	
008	PRTX		064	RTN	
009	F2?	If F2 set, must correct	065	*LBL0	Standard
010	GTO0	for BSA.	066	RCL9	
011	GTO1		067	1	
012	*LBL0		068	.	
013	1		069	8	
014	.		070	5	
015	7		071	×	
016	3	$\dot{V}_{corr} = \frac{1.73}{BSA}\dot{V}$	072	STO8	
017	RCLA		073	F0?	
018	÷		074	PRTX	
019	×		075	RTN	
020	*LBL1		076	*LBLa	
021	STOD	Output	077	0	Clear for reprint.
022	F0?		078	STO8	
023	PRTX		079	STOI	
024	F0?		080	RTN	
025	SPC		081	*LBLb	
026	RTN		082	SF2	Set F2 to allow correction
027	*LBLC		083	RCLA	for BSA.
028	STOC	U_{urea}	084	RTN	
029	F0?		085	*LBLc	
030	PRTX		086	INT	Patient ID = Ptnt # .05
031	RTN		087	.	
032	*LBLD		088	0	
033	STOB	B_{urea}	089	5	
034	F0?		090	+	
035	PRTX		091	STOI	
036	F0?		092	SPC	
037	SPC		093	PRTX	
038	2	If $\dot{V}_{corr} \leq 2$, take $\sqrt{\dot{V}}$ for	094	RTN	
039	RCLD		095	*LBLd	
040	X≤Y?	$C_s = \frac{U\sqrt{\dot{V}}}{B}$.	096	F0?	Print toggle
041	√X		097	GTO0	
042	RCLC		098	SF0	
043	RCLB	Otherwise $C_m = \frac{U\dot{V}}{B}$.	099	1	
044	÷		100	RTN	
045	×		101	*LBL0	
046	STO9	Clearance	102	CF0	
047	F0?		103	0	
048	PRTX		104	RTN	
049	RTN		105	*LBLe	Reprint
050	*LBLE	% mean normal	106	SPC	
051	2		107	SPC	
052	RCLD		108	RCLI	
053	X≤Y?	If $\dot{V}_{corr} \leq 2$, GTO 0 for	109	INT	
054	GTO0	standard.	110	.	
055	RCL9		111	0	
056	1		112	5	

REGISTERS

0	1	2	3	4	5	6	7	8	9
								% m.n.	C

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
BSA (m^2)	B_{urea}	U_{urea}	$\dot{V}_{corr}$ (ml/min)	$\dot{V}$ (ml/min)	Ptnt # .05

113	+	
114	PRTX	Patient ID
115	SPC	
116	RCLE	$\dot{V}$
117	PRTX	
118	RCLD	$\dot{V}_{corr}$
119	PRTX	
120	SPC	
121	RCLC	U_{urea}
122	PRTX	
123	RCLB	B_{urea}
124	PRTX	
125	SPC	
126	RCL9	Clearance
127	PRTX	
128	RCL8	% m.n.
129	PRTX	
130	SPC	
131	RTN	------------

LABELS					FLAGS
A V↑t	B $\dot{V}$	C U_{urea}	D B_{urea}→C	E →% m.n.	0 Print
a Clear	b Cor BSA?	c Ptnt #	d P off?	e Reprint	1
0 Used	1 Exit V	2	3	4	2 Cor BSA?
5	6	7	8	9	3

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☒	☐	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

Creatinine Clearance

```
001 *LBLA
002    ÷
003 *LBLB
004  STOE
005   F0?
006   SPC
007   F0?
008  PRTX
009   F2?
010  GTO0
011  GTO1
012 *LBL0
013     1
014     .
015     7
016     3
017  RCLA
018     ÷
019     x
020 *LBL1
021  STOD
022   F0?
023  PRTX
024   F0?
025   SPC
026   RTN
027 *LBLC
028  STOC
029   F0?
030  PRTX
031   RTN
032 *LBLD
033  STOB
034   F0?
035  PRTX
036  RCLC
037  RCLD
038     x
039  RCLB
040     ÷
041  STO9
042   F0?
043   SPC
044   F0?
045  PRTX
046   RTN
047 *LBLa
048     0
049  STOI
050   RTN
051 *LBLb
052   SF2
053  RCLA
054   RTN
055 *LBLc
056   INT
```

V/t

$\dot{V}$

If F2 set, must correct for BSA.

$\dot{V}_{corr} = \frac{1.73}{BSA}\dot{V}$

Output

U_{creat}

P_{creat}

$C = \frac{U\dot{V}}{P}$

Clear for reprint.

Set F2 to allow correction for BSA.

```
057     .
058     0
059     6
060     +
061  STOI
062  PRTX
063   SPC
064   RTN
065 *LBLd
066   F0?
067  GTO0
068   SF0
069     1
070   RTN
071 *LBL0
072   CF0
073     0
074   RTN
075 *LBLe
076   SPC
077   SPC
078  RCLI
079   INT
080     .
081     0
082     6
083     +
084  PRTX
085   SPC
086  RCLE
087  PRTX
088  RCLD
089  PRTX
090   SPC
091  RCLC
092  PRTX
093  RCLB
094  PRTX
095   SPC
096  RCL9
097  PRTX
098   RTN
```

Patient ID = Ptnt # .06

Print toggle

Reprint

Patient ID

$\dot{V}$

$\dot{V}_{corr}$

U_{creat}

P_{creat}

C

REGISTERS

0	1	2	3	4	5	6	7	8	9
									C
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
BSA (m^2)	P_{creat}	U_{creat}	V_{corr} (ml/min)	V (ml/min)	Ptnt # .06

LABELS					FLAGS
A $V \uparrow t$	B $\dot{V}$	C U_{creat}	D P_{creat}	E	0 Print
a Clear	b Cor BSA?	c Ptnt #	d P off?	e Reprint	1
0 Used	1 Exit $\dot{V}$	2	3	4	2 Cor BSA
5	6	7	8	9	3

SET STATUS

FLAGS	ON	OFF
0	☒	☐
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

Amniotic Fluid Assay

Step	Key	Comment
001	*LBLA	
002	FIX	
003	DSP2	
004	STOE	A_{365}
005	F0?	
006	SPC	
007	F0?	
008	PRTX	
009	RTN	------------
010	*LBLB	
011	STOD	A_{550}
012	F0?	
013	PRTX	
014	RTN	------------
015	*LBLC	
016	STOC	A_{450}
017	F0?	
018	PRTX	
019	RCLE	
020	LN	
021	RCLD	
022	LN	
023	-	
024	.	
025	5	This changes if
026	4	different wavelengths
027	1	of light are used.
028	x	
029	RCLD	
030	LN	
031	+	
032	e^x	
033	-	
034	STOB	ΔA_{450}
035	F0?	
036	SPC	
037	F0?	
038	PRTX	
039	F0?	
040	SPC	
041	RTN	------------
042	*LBLD	
043	STOA	Week (x)
044	FIX	
045	DSP0	
046	F0?	
047	PRTX	
048	DSP2	
049	.	
050	9	
051	1	Slope constant a
052	5	
053	0	
054	9	
055	X⇄Y	
056	Y^x	a^x
057	RCLB	ΔA_{450} (y)
058	X⇄Y	
059	÷	
060	STO9	$b = y/a^x$
061	F0?	
062	PRTX	
063	RTN	------------
064	*LBLE	
065	3	
066	RCL9	
067	.	
068	7	
069	X>Y?	If $b < 0.7$, have zone 1.
070	GTO1	
071	R↓	
072	X>Y?	If $b > 3$, have zone 3.
073	GTO3	
074	2	Otherwise, have zone 2.
075	GTO0	
076	*LBL1	
077	1	
078	GTO0	
079	*LBL3	
080	3	
081	*LBL0	
082	STO8	Zone number
083	FIX	
084	DSP0	
085	F0?	
086	PRTX	
087	RTN	------------
088	*LBLa	
089	CLX	Initialize
090	STO8	
091	STO9	
092	STOA	
093	RTN	------------
094	*LBLc	
095	INT	Patient ID = Ptnt # .07
096	.	
097	0	
098	7	
099	+	
100	STOI	
101	PRTX	
102	SPC	
103	RTN	------------
104	*LBLd	
105	F0?	Print toggle
106	GTO0	
107	SF0	
108	1	
109	RTN	
110	*LBL0	
111	CF0	
112	0	

REGISTERS

0	1	2	3	4	5	6	7	8	9
								Zone	b

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
Week	ΔA_{450}	A_{450}	A_{550}	A_{365}	Ptnt # .07

Step	Key	Comment
113	RTN	-------------
114	*LBLe	Reprint
115	FIX	
116	DSP2	
117	SPC	
118	SPC	
119	RCLI	
120	INT	
121	.	
122	0	
123	7	
124	+	
125	PRTX	Ptnt # .07
126	SPC	
127	RCLE	A_{365}
128	PRTX	
129	RCLD	A_{550}
130	PRTX	
131	RCLC	A_{450}
132	PRTX	
133	SPC	
134	RCLB	ΔA_{450}
135	PRTX	
136	SPC	
137	RCLA	Week
138	DSP0	
139	PRTX	
140	RCL9	b
141	DSP2	
142	PRTX	
143	RCL8	Zone
144	DSP0	
145	PRTX	
146	RTN	-------------

LABELS

A A_{365}	B A_{550}	C $A_{450} \rightarrow \Delta$	D Wk→b	E Zone
a Clear	b	c Ptnt #	d P off?	e Reprint
0 Used	1 Zone 1	2	3 Zone 3	4
5	6	7	8	9

FLAGS

0	Print
1	
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☒	☐	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

Blood Acid-Base Status

Step	Key	Comments	Step	Key	Comments
001	*LBLA	BT	057	-	
002	F0?		058	10^x	
003	PRTX		059	.	
004	F0?		060	0	
005	SPC		061	3	
006	3		062	0	
007	7		063	7	
008	X⇄Y		064	x	
009	-		065	STO5	$s(10^{pH-pK})$
010	STO9	37-BT	066	LSTX	
011	SF1	F1 set for BT.	067	+	
012	RTN		068	RCLD	
013	*LBLB		069	x	
014	STOE	PCO_2	070	STOA	TCO_2
015	F0?		071	F0?	
016	PRTX		072	PRTX	
017	F1?	To correct for BT, GTO 0.	073	CF1	Clear flag 1.
018	GTO0		074	RTN	
019	GTO1	For 37°, GTO 1.	075	*LBLE	
020	*LBL0		076	STO8	Hgb
021	RCL9		077	F0?	
022	.	Correct PCO_2 to 37°.	078	SPC	
023	0		079	F0?	
024	1		080	PRTX	
025	9		081	RCL5	
026	x		082	RCLD	
027	10^x		083	x	
028	x		084	STO6	$[HCO_3^-]$
029	*LBL1		085	9	
030	STOD	PCO_2 (37°C)	086	.	
031	RTN		087	5	
032	*LBLC		088	ENT↑	
033	STOC	pH	089	1	
034	F0?		090	.	
035	PRTX		091	6	
036	F1?	To correct for BT, GTO 0.	092	3	
037	GTO0		093	RCL8	
038	GTO2	For 37°, GTO 2.	094	x	
039	*LBL0		095	+	
040	RCL9		096	7	
041	.	Correct pH to 37°	097	.	
042	0		098	4	
043	1		099	RCLB	
044	4		100	-	
045	6		101	x	
046	x		102	-	
047	-		103	2	
048	*LBL2		104	4	
049	STOB	pH (37°C)	105	-	
050	RTN		106	1	
051	*LBLD		107	RCL8	
052	RCLB	Compute TCO_2.	108	.	
053	6		109	0	
054	.		110	1	
055	1		111	4	
056	1		112	3	

REGISTERS

0	1	2	3	4	5	6	7	8	9
					$s(10^{pH-pK})$	$[HCO_3^-]$	BE	Hgb	37–BT

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
TCO_2	pH (37°)	pH input	PCO_2 (37°)	PCO_2 input	Ptnt # .08

Step	Key	Comment
113	x	
114	-	
115	x	
116	STO7	BE
117	F0?	
118	PRTX	
119	RTN	
120	RCL6	$[HCO_3^-]$
121	F0?	
122	PRTX	
123	RTN	
124	*LBLa	Initialize.
125	0	
126	STO6	
127	STO7	
128	STO8	
129	STO9	
130	STOI	
131	RTN	
132	*LBLc	
133	INT	Patient ID = Ptnt # .08.
134	.	
135	0	
136	8	
137	+	
138	STOI	
139	PRTX	
140	SPC	
141	RTN	
142	*LBLd	
143	F0?	
144	GTO0	Print toggle
145	SF0	
146	1	
147	RTN	
148	*LBL0	
149	CF0	
150	0	
151	RTN	
152	*LBLe	
153	SPC	Reprint
154	SPC	
155	RCLI	
156	INT	
157	.	
158	0	
159	8	
160	+	
161	PRTX	Patient ID
162	SPC	
163	RCL9	
164	X=0?	If no BT entered, GTO 0.
165	GTO0	
166	3	
167	7	
168	-	
169	CHS	
170	PRTX	BT
171	SPC	
172	*LBL0	
173	RCLE	PCO_2 input
174	PRTX	
175	RCLC	pH input
176	PRTX	
177	RCLA	TCO_2
178	PRTX	
179	SPC	
180	RCL8	Hgb
181	PRTX	
182	RCL7	BE
183	PRTX	
184	RCL6	$[HCO_3^-]$
185	PRTX	
186	RTN	

LABELS

A BT	B PCO_2	C pH	D TCO_2	E Hgb→BE
a Clear	b	c Ptnt #	d P off?	e Reprint
0 Used	1 PCO_2 (37)	2 pH (37)	3	4
5	6	7	8	9

FLAGS

0	Print
1	BT
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☒	☐	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

Oxygen Saturation and Content

Step	Key	Comment
001	*LBLA	BT
002	F0?	
003	PRTX	
004	3	
005	7	
006	X⇄Y	
007	-	
008	STO9	37-BT
009	RCLC	Rcl PCO_2 (if input).
010	RTN	------------
011	*LBLB	PCO_2
012	F0?	
013	PRTX	
014	STOD	
015	RCLB	Rcl pH (if input).
016	RTN	------------
017	*LBLC	pH
018	F0?	
019	PRTX	
020	STOB	
021	RTN	------------
022	*LBLD	
023	F0?	
024	PRTX	
025	STOE	PO_2 input
026	X<0?	If input < 0, consider as
027	GTO1	VPO_2.
028	RCL9	Otherwise compute VPO_2.
029	.	
030	0	
031	2	
032	4	
033	x	
034	RCLB	
035	7	
036	.	
037	4	
038	-	
039	.	
040	4	
041	8	
042	x	
043	+	
044	4	
045	0	
046	RCLD	
047	÷	
048	LOG	
049	.	
050	0	
051	6	
052	x	
053	+	
054	10^x	
055	RCLE	
056	x	
057	GTO0	-------
058	*LBL1	If input < 0, make positive
059	CHS	-------
060	*LBL0	
061	STOC	VPO_2
062	ENT↑	
063	ENT↑	
064	ENT↑	
065	1	
066	5	
067	-	
068	x	
069	2	
070	0	
071	4	
072	5	
073	+	
074	x	
075	2	Compute oxygen
076	EEX	saturation.
077	3	
078	+	
079	x	
080	STO7	
081	CLX	
082	1	
083	5	
084	-	
085	x	
086	2	
087	4	
088	0	
089	0	
090	+	
091	x	
092	3	
093	1	
094	1	
095	0	
096	0	
097	-	
098	x	
099	2	
100	4	
101	EEX	
102	5	
103	+	
104	EEX	
105	2	
106	÷	
107	ST÷7	
108	RCL7	O_2 saturation (%).
109	SF2	F2 set to indicate
110	F0?	saturation computed.
111	SPC	
112	F0?	

REGISTERS

0	1	2	3	4	5	6	7	8	9
							Sat	Hgb	37-BT

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
O_2 content	pH (37)	VPO_2	PCO_2 (37)	PO_2 input	Ptnt # .09

Step	Key	Comment
113	PRTX	
114	F0?	
115	SPC	
116	RTN	
117	RCL8	Rcl Hgb (if input).
118	R/S	
		- - - - - - - - - - - -
119	*LBLE	
120	F2?	If Sat. computed, do not input it.
121	GTO0	
122	X⇄Y	
123	STO7	Otherwise store Sat.
124	F0?	
125	PRTX	
126	F0?	
127	SPC	
128	X⇄Y	- - - - - - - -
129	*LBL0	
130	STO8	Store Hgb.
131	F0?	
132	PRTX	
133	RCL7	
134	x	
135	1	
136	3	
137	4	Compute oxygen content.
138	x	
139	RCLC	
140	3	
141	1	
142	x	
143	+	
144	EEX	
145	4	
146	÷	
147	STOA	O_2 content
148	F0?	
149	PRTX	
150	RTN	
		- - - - - - - - - - - -
151	*LBLa	Initialize
152	0	
153	STOC	
154	STOE	
155	STOI	
156	RTN	
157	*LBLb	
		- - - - - - - - - - - -
158	3	
159	7	Rcl BT
160	RCL9	
161	-	BT = 37 − (37-BT)
162	RTN	
163	*LBLc	
		- - - - - - - - - - - -
164	INT	
165	.	Patient ID = Ptnt # .09
166	0	
167	9	
168	+	
169	PRTX	
170	SPC	
171	STOI	
172	RTN	- - - - - - - - - - - -
173	*LBLd	Print toggle
174	F0?	
175	GTO0	
176	SF0	
177	1	
178	RTN	
179	*LBL0	
180	CF0	
181	0	
182	RTN	- - - - - - - - - - - -
183	*LBLe	Reprint
184	SPC	
185	SPC	
186	RCLI	
187	INT	
188	.	
189	0	
190	9	
191	+	
192	PRTX	Patient ID
193	SPC	
194	3	
195	7	
196	RCL9	
197	-	
198	PRTX	BT
199	RCLD	
200	PRTX	PCO_2
201	RCLB	
202	PRTX	pH
203	RCLE	
204	PRTX	PO_2 input
205	SPC	
206	RCL7	
207	PRTX	Saturation
208	SPC	
209	RCL8	Hemoglobin
210	PRTX	
211	RCLA	Content
212	PRTX	
213	RTN	
		- - - - - - - - - - - -

LABELS

A	B	C	D	E
BT	PCO_2	pH	PO_2 → Sat	S↑Hgb → O_2
a Clear	b → Rcl BT	c Ptnt #	d P off?	e Reprint
0 Used	1 VPO_2	2	3	4
5	6	7	8	9

FLAGS

Flag	Use
0	Print
1	
2	Sat computed
3	

SET STATUS

FLAGS	ON	OFF
0	☒	☐
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

L10-01

Red Cell Indices

Step	Key	Comment
001	*LBLA	
002	STOE	Count.
003	F0?	
004	PRTX	
005	RTN	
006	*LBLB	
007	STOD	Hematocrit (%).
008	F0?	
009	PRTX	
010	RTN	
011	*LBLC	
012	STOC	Hemoglobin.
013	F0?	
014	PRTX	
015	F0?	
016	SPC	
017	RCLD	
018	1	Compute MCV.
019	0	
020	x	
021	RCLE	
022	÷	
023	STOB	MCV.
024	F0?	
025	PRTX	
026	RTN	
027	*LBLD	Compute MCH.
028	RCLC	
029	1	
030	0	
031	x	
032	RCLE	
033	÷	
034	STOA	MCH.
035	F0?	
036	PRTX	
037	RTN	
038	*LBLE	Compute MCHC.
039	RCLC	
040	EEX	
041	2	
042	x	
043	RCLD	
044	÷	
045	STO9	MCHC.
046	F0?	
047	PRTX	
048	RTN	
049	*LBLa	
050	0	Clear.
051	STOI	
052	RTN	
053	*LBLc	
054	INT	Patient ID = Ptnt # .10
055	.	
056	1	
057	+	
058	STOI	
059	PRTX	
060	SPC	
061	RTN	
062	*LBLd	Print toggle.
063	F0?	
064	GTO0	
065	SF0	
066	1	
067	RTN	
068	*LBL0	
069	CF0	
070	0	
071	RTN	
072	*LBLe	Reprint.
073	SPC	
074	SPC	
075	RCLI	
076	INT	
077	.	
078	1	
079	+	
080	PRTX	Patient ID.
081	SPC	
082	RCLE	Count.
083	PRTX	
084	RCLD	Hct (%)
085	PRTX	
086	RCLC	Hgb
087	PRTX	
088	SPC	
089	RCLB	MCV
090	PRTX	
091	RCLA	MCH
092	PRTX	
093	RCL9	MCHC
094	PRTX	
095	RTN	

REGISTERS

0	1	2	3	4	5	6	7	8	9
									MCHC

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
MCH	MCV	Hgb	Hct (%)	Count	Ptnt # .10

LABELS					FLAGS	SET STATUS		
A Count	B Hct (%)	C Hgb→MCV	D →MCH	E →MCHC	0 Print	FLAGS	TRIG	DISP
a Clear	b	c Ptnt #	d P off?	e Reprint	1	ON OFF 0 ☒ ☐ 1 ☐ ☒ 2 ☐ ☒ 3 ☐ ☒	DEG ☒ GRAD ☐ RAD ☐	FIX ☒ SCI ☐ ENG ☐ n 2
0 Used	1	2	3	4	2			
5	6	7	8	9	3			

Total Blood Volume

Step	Key	Comments
001	*LBLA	
002	STOE	Background counts.
003	F0?	
004	PRTX	
005	RTN	
006	*LBLB	
007	STOD	Volume injected.
008	F0?	
009	PRTX	
010	RTN	
011	*LBLC	
012	STOC	Standard dilution.
013	F0?	
014	PRTX	
015	RTN	
016	*LBLD	
017	STOB	Standard CPM.
018	F0?	
019	PRTX	
020	RTN	
021	*LBLE	
022	STOA	Whole blood CPM.
023	F0?	
024	PRTX	
025	F0?	
026	SPC	
027	RCLB	Net Std. CPM = Std. CPM-Bck.
028	RCLE	
029	-	
030	X⇄Y	
031	RCLE	Net blood CPM = Blood CPM- Bck.
032	-	
033	÷	
034	RCLC	
035	x	
036	RCLD	
037	x	Total blood volume.
038	STO9	
039	F0?	
040	PRTX	
041	RTN	
042	*LBLa	
043	0	Initialize.
044	STOE	
045	STOI	
046	RTN	
047	*LBLc	
048	INT	Patient ID = Ptnt # .11
049	.	
050	1	
051	1	
052	+	
053	STOI	
054	PRTX	
055	SPC	
056	RTN	
057	*LBLd	Print toggle
058	F0?	
059	GTO0	
060	SF0	
061	1	
062	RTN	
063	*LBL0	
064	CF0	
065	0	
066	RTN	
067	*LBLe	Reprint
068	SPC	
069	SPC	
070	RCLI	
071	INT	
072	.	
073	1	
074	1	
075	+	
076	PRTX	Patient ID
077	SPC	
078	RCLE	Bck
079	PRTX	
080	RCLD	Vol. injected
081	PRTX	
082	RCLC	Std. dilution
083	PRTX	
084	RCLB	Std. CPM
085	PRTX	
086	RCLA	Blood CPM
087	PRTX	
088	SPC	
089	RCL9	Total blood volume
090	PRTX	
091	RTN	

REGISTERS

0	1	2	3	4	5	6	7	8	9
									TBV

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
Blood CPM	Std. CPM	Std. dilution	Vol. injected	Bck	Ptnt # .11

LABELS					FLAGS	SET STATUS
A Bck	B Vol. inj.	C Std. dil.	D Std. CPM	E CPM→TBV	0 Print	
a Clear	b	c Ptnt #	d P off?	e Reprint	1	
0 Toggle	1	2	3	4	2	
5	6	7	8	9	3	

FLAGS	ON	OFF	TRIG		DISP	
0	☒	☐	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

Schilling Test

Step	Key	Comment
001	*LBLA	Background counts.
002	STOE	
003	F0?	
004	PRTX	
005	RTN	
006	*LBLB	
007	STOD	Standard dilution.
008	F0?	
009	PRTX	
010	RTN	
011	*LBLC	
012	STOC	Standard counts.
013	F0?	
014	PRTX	
015	RTN	
016	*LBLD	
017	STOB	Urine volume. (V)
018	F0?	
019	PRTX	
020	RTN	
021	*LBLE	
022	STOA	Urine counts. (U)
023	F0?	
024	PRTX	
025	1	1 U
026	X⇄Y	U 1
027	RCLE	Bck U 1
028	-	Net 1
029	1	1 Net 1
030	RCLB	V 1 Net 1
031	X≤Y?	Is V ≤ 1?
032	R↓	Yes, eliminate V.
033	×	No, V > 1, multiply by V.
034	×	
035	RCLC	
036	RCLE	
037	-	Net std. counts.
038	÷	
039	RCLD	
040	÷	
041	EEX	
042	2	Convert to %.
043	×	
044	STO9	% of dose excreted.
045	F0?	
046	SPC	
047	F0?	
048	PRTX	
049	RTN	
050	*LBLa	
051	.0	Initialize.
052	STOE	
053	STOI	
054	RTN	
055	*LBLc	
056	INT	
057	.	Patient ID = Ptnt # .12
058	1	
059	2	
060	+	
061	STOI	
062	PRTX	
063	SPC	
064	RTN	
065	*LBLd	Print toggle
066	F0?	
067	GTO0	
068	SF0	
069	1	
070	RTN	
071	*LBL0	
072	CF0	
073	0	
074	RTN	
075	*LBLe	Reprint
076	SPC	
077	SPC	
078	RCLI	
079	INT	
080	.	
081	1	
082	2	
083	+	
084	PRTX	Patient ID
085	SPC	
086	RCLE	Bck
087	PRTX	
088	RCLD	Std. dilution
089	PRTX	
090	RCLC	Std. CPM
091	PRTX	
092	RCLB	Urine vol.
093	PRTX	
094	RCLA	Urine CPM
095	PRTX	
096	SPC	
097	RCL9	% excreted
098	PRTX	
099	RTN	

REGISTERS

0	1	2	3	4	5	6	7	8	9
									%

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
Urine CPM	Urine Vol.	Std. CPM	Std. dilution	Bck	Ptnt # .12

LABELS					FLAGS
A Bck	B Std. dil.	C Std. CPM	D Urine Vol.	E CPM→%	0 Print
a Clear	b	c Ptnt #	d P off?	e Reprint	1
0 Toggle	1	2	3	4	2
5	6	7	8	9	3

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☒	☐	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

Thyroid Uptake

001	*LBLA		057	RCLC	
002	STOE	Standard Counts.	058	RCLB	
003	F0?		059	-	
004	PRTX		060	+	
005	RTN		061	LSTX	
006	*LBLB		062	÷	
007	STOD	Standard Background.	063	ST×9	
008	F0?		064	RCL9	Corrected uptake.
009	PRTX		065	F0?	
010	RCLE		066	PRTX	
011	X⇄Y		067	RTN	
012	-	Std. Cts. – Std. Bck.	068	*LBLb	Correction for different
013	RTN		069	F0?	activities.
014	*LBLC		070	SPC	
015	STOC	Patient Counts.	071	X⇄Y	
016	F0?		072	F0?	
017	PRTX		073	PRTX	Standard precounts.
018	RTN		074	X⇄Y	
019	*LBLD		075	F0?	
020	STOB	Patient Background.	076	PRTX	Dose precounts.
021	F0?		077	÷	
022	PRTX		078	ST×9	
023	RCLC		079	RCL9	Corrected uptake.
024	X⇄Y		080	F0?	
025	-	Ptnt. Cts. – Ptnt. Bck.	081	PRTX	
026	RTN		082	RTN	
027	*LBLE	Compute uptake.	083	*LBLc	Patient ID = Ptnt # .13
028	RCLC		084	INT	
029	RCLB		085	.	
030	-		086	1	
031	RCLE		087	3	
032	RCLD		088	+	
033	-		089	STOI	
034	÷		090	PRTX	
035	EEX		091	SPC	
036	2		092	RTN	
037	×		093	*LBLd	
038	STO9	% Uptake.	094	F0?	Print toggle
039	F0?		095	GTO0	
040	SPC		096	SF0	
041	F0?		097	1	
042	PRTX		098	RTN	
043	RTN		099	*LBL0	
044	*LBLa		100	CF0	
045	F0?	Correction for prior	101	0	
046	SPC	radioactivity.	102	RTN	
047	X⇄Y		103	*LBLe	Reprint
048	F0?		104	SPC	
049	PRTX	Patient predose counts.	105	SPC	
050	X⇄Y		106	RCLI	
051	F0?		107	INT	
052	PRTX	Background predose counts.	108	.	
053	-		109	1	
054	RCLA	Decay factor.	110	3	
055	×		111	+	
056	CHS		112	PRTX	Patient ID

REGISTERS

0	1	2	3	4	5	6	7	8	9
									% Uptake

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
Decay factor	Ptnt. Bck	Ptnt. Cts.	Std. Bck	Std. Cts.	Ptnt # .13

113 SPC			
114 RCLE	Std. Cts.		
115 PRTX			
116 RCLD	Std. Bck.		
117 PRTX			
118 RCLC	Ptnt. Cts.		
119 PRTX			
120 RCLB	Ptnt. Bck.		
121 PRTX			
122 SPC			
123 RCL9	% Uptake		
124 PRTX			
125 RTN	------------		

LABELS					FLAGS
A Std. CPM	B Std. Bck.	C Ptnt. CPM	D Ptnt. Bck.	E →% Up	0 Print
a Rad C↑Bk	b Pre Sd↑D	c Ptnt #	d P off?	e Reprint	1
0 Toggle	1	2	3	4	2
5	6	7	8	9	3

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☒	☐	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

Radioactive Decay Corrections

001	*LBLA	Initial activity (A_0).	057	STOD	Store t (hrs).
002	F3?		058	RCLB	
003	GTO0		059	÷	
004	RCLC	Calculate: $A_0 = A/f$	060	.	Store decay factor
005	RCLA		061	5	
006	÷		062	X⇄Y	
007	STOE		063	Y^x	$f = \left(\frac{1}{2}\right)^{t/\tau_{1/2}}$
008	RTN	- - - - - - - -	064	STOA	
009	*LBL0		065	R↑	Display t as input.
010	STOE	Store input A_0.	066	RTN	- - - - - - - - - - -
011	RTN	- - - - - - - - - - - -	067	*LBLC	Present activity (A).
012	*LBLB	Time in days. hours.	068	F3?	
013	F3?		069	GTO0	
014	GTO0		070	RCLE	Calculate:
015	RCLC		071	RCLA	
016	RCLE		072	×	$A = A_0 f$
017	÷	Calculate:	073	STOC	
018	STOA		074	RTN	- - - - - - - -
019	LN	$t = \frac{\tau_{1/2} \ln f}{\ln 1/2}$	075	*LBL0	
020	.		076	STOC	Store input A.
021	5		077	RTN	- - - - - - - - - - -
022	LN		078	*LBLD	Isotopes 1 – 9.
023	÷		079	STOI	
024	RCLB		080	GSBi	
025	×		081	STOB	Store $\tau_{1/2}$.
026	STOD	Store t (hours).	082	RTN	- - - - - - - - - - -
027	2		083	*LBLa	
028	4		084	6	
029	÷		085	6	
030	INT		086	7	^{51}Cr
031	ENT↑	Convert t in hrs. to dd.hh for display.	087	.	
032	ENT↑		088	2	
033	2		089	STOB	
034	4		090	RTN	- - - - - - - - - - -
035	×		091	*LBLb	
036	RCLD		092	6	
037	X⇄Y		093	4	
038	−		094	8	^{57}Co
039	EEX		095	0	
040	2		096	STOB	
041	÷		097	RTN	- - - - - - - - - - -
042	+		098	*LBLc	
043	RTN	- - - - - - - -	099	6	
044	*LBL0		100	STOB	^{99m}Tc
045	ENT↑	Time input.	101	RTN	
046	ENT↑		102	*LBLd	- - - - - - - - - - -
047	INT		103	1	
048	2		104	4	
049	4	Convert from dd.hh format to hours.	105	4	^{125}I
050	×		106	0	
051	X⇄Y		107	STOB	
052	FRC		108	RTN	- - - - - - - - - - -
053	EEX		109	*LBLe	
054	2		110	1	
055	×		111	9	^{131}I
056	+		112	3	

REGISTERS

0	1	2	3	4	5	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
Decay factor (A/A_0)	$\tau_{1/2}$ (hours)	A	t (hours)	A_0	Isotope no. (1 – 9)

```
.
2
STOB
RTN
```

```
*LBLE
2
6
2
9
8
0
STOB
RTN
```

^{137}Cs

```
*LBL1
1
0
7
4
7
0
RTN
```

^{3}H

```
*LBL2
5
0
5
8
EEX
4
RTN
```

^{14}C

```
*LBL3
1
.
8
7
RTN
```

^{18}F

```
*LBL4
3
4
3
.
2
RTN
```

^{32}P

```
*LBL5
2
8
8
0
RTN
```

^{75}Se

```
*LBL6
1
5
3
6
RTN
```

^{85}Sr

```
*LBL7
1
.
7
3
RTN
```

^{113m}In

```
*LBL8
1
2
6
.
5
RTN
```

^{133}Xe

```
*LBL9
6
5
RTN
```

^{197}Hg

LABELS					FLAGS
A A_0	B t (dd.hh)	C A	D Isotope #	E ^{137}Cs	0
a ^{51}Cr	b ^{57}Co	c ^{99m}Tc	d ^{125}I	e ^{131}I	1
0 Inputs	1 ^{3}H	2 ^{14}C	3 ^{18}F	4 ^{32}P	2
5 ^{75}Se	6 ^{85}Sr	7 ^{113m}In	8 ^{133}Xe	9 ^{197}Hg	3 Data entry

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

Radioimmunoassay

Step	Key	Comment
001	*LBLA	Initialize.
002	P⇄S	
003	CLRG	
004	P⇄S	
005	GTO2	
006	*LBLB	Non-specific binding counts (NSB).
007	GSBD	
008	RTN	
009	GSB1	
010	STOE	Average NSB.
011	RTN	
012	*LBLC	Zero dose counts (B_0).
013	GSBD	
014	RTN	
015	GSB1	
016	STOD	Average B_0.
017	RTN	
018	*LBL1	Compute average counts.
019	RCL8	
020	RCL9	
021	÷	
022	STOI	$\bar{B} = \Sigma B/n$
023	F0?	
024	SPC	
025	F0?	
026	PRTX	$\bar{B}$
027	F0?	
028	SPC	
029	F0?	
030	SPC	
031	*LBL2	Clear for n, ΣB
032	0	
033	STO8	
034	STO9	
035	R↓	
036	RTN	
037	*LBLb	Counts for standards and unknowns.
038	*LBLD	
039	F0?	
040	PRTX	
041	ST+8	
042	1	
043	ST+9	
044	RCL9	
045	RTN	
046	*LBLE	Standard concentration.
047	RCL8	
048	RCL9	
049	÷	
050	STOI	$\bar{B} = \Sigma B/n$
051	0	
052	STO8	
053	STO9	
054	R↓	
055	F0?	
056	SPC	
057	F0?	$\bar{B}$
058	PRTX	
059	RCLE	
060	-	
061	RCLD	
062	RCLE	
063	-	net B/B_0
064	÷	
065	F1?	
066	PRTX	
067	F0?	
068	SPC	
069	R↓	
070	F0?	
071	PRTX	Concentration.
072	F0?	
073	SPC	
074	LOG	log conc. (x).
075	GSB3	logit (y).
076	F1?	
077	PRTX	Print logit.
078	X⇄Y	
079	F1?	
080	PRTX	Print log conc.
081	F1?	
082	SPC	
083	Σ+	Sum x- and y-values for regression.
084	F0?	
085	SPC	
086	RTN	
087	*LBLa	Compute r, m, b.
088	RCLΣ	
089	x	
090	P⇄S	
091	RCL9	
092	÷	
093	RCL8	
094	X⇄Y	
095	-	
096	STOB	$\Sigma xy - (\Sigma x\ \Sigma y)/n$
097	ENT↑	
098	ENT↑	
099	P⇄S	
100	S	
101	x	
102	÷	
103	P⇄S	
104	RCL9	
105	1	
106	-	
107	÷	
108	STOA	
109	PRTX	
110	RCLB	
111	RCL5	
112	RCL4	

REGISTERS

0	1	2	3	4	5	6	7	8	9
								ΣB, used	n, used

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
				Σx	Σx^2	Σy	Σy^2	Σxy	n

A	B	C	D	E	I
r	Used, m	b	B_0	NSB	$\bar{B}$

Step	Key	Comment
113	X^2	
114	RCL9	
115	÷	
116	-	
117	÷	
118	STOB	
119	PRTX	m
120	P⇄S	
121	$\bar{x}$	
122	RCLB	
123	x	
124	-	
125	STOC	$b = \bar{y} - m\bar{x}$
126	PRTX	
127	SPC	
128	SPC	
129	RCLA	
130	RCLB	
131	RCLC	
132	RTN	
133	*LBLc	Compute concentration of unknown.
134	RCL8	
135	RCL9	
136	÷	
137	STOI	$\bar{B} = \Sigma B/n$
138	0	
139	STO8	
140	STO9	
141	R↓	
142	F0?	
143	SPC	
144	F0?	
145	PRTX	$\bar{B}$
146	RCLE	
147	-	
148	RCLD	
149	RCLE	
150	-	
151	÷	net B/B_0
152	F1?	
153	PRTX	
154	F0?	
155	SPC	
156	GSB3	Calculate logit (y).
157	STO8	
158	RCLC	
159	-	
160	RCLB	
161	÷	x (log conc.) = (y − b)/m
162	STO9	
163	10^x	
164	PRTX	Estimated concentration.
165	SPC	
166	RCL8	
167	F1?	
168	PRTX	Print logit (y).
169	RCL9	
170	F1?	
171	PRTX	Print log conc. (x).
172	F1?	
173	SPC	
174	R↓	
175	R↓	
176	F0?	
177	SPC	
178	GTO2	
179	*LBL3	Logit calculation.
180	RCLI	
181	RCLE	
182	-	
183	RCLD	$\text{Logit} = \ln\left(\frac{B - NSB}{B_0 - B}\right)$
184	RCLI	
185	-	
186	÷	
187	LN	
188	RTN	
189	*LBLd	Print toggle.
190	F0?	
191	GTO0	
192	SF0	
193	1	
194	RTN	
195	*LBL0	
196	CF0	
197	0	
198	RTN	
199	*LBLe	Plot toggle.
200	F1?	
201	GTO0	
202	SF1	
203	1	
204	RTN	
205	*LBL0	
206	CF1	
207	0	
208	RTN	

LABELS

A Start	B NSB; →$\overline{NSB}$	C B_0; →$\bar{B}_0$	D Std B	E Std conc
a →r, m, b	b Unkn B	c → Conc	d Print?	e Plot?
0 Used	1 Find $\bar{B}$	2 Clear ΣB	3 Logit	4
5	6	7	8	9

FLAGS

0	Print
1	Plot
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

Basic Statistics

Step	Key	Comments
001	*LBLA	Clear Σ registers
002	P⇄S	
003	0	
004	ST04	
005	ST05	
006	ST06	
007	ST07	
008	ST08	
009	ST09	
010	P⇄S	
011	RTN	
012	*LBLB	x_i (Σ+)
013	F0?	
014	PRTX	
015	Σ+	
016	RTN	
017	*LBLb	x_k (Σ−)
018	F0?	
019	SPC	
020	F0?	
021	PRTX	
022	Σ-	
023	RTN	
024	*LBLC	Grouped data.
025	P⇄S	
026	F0?	
027	GTO0	
028	GTO1	
029	*LBL0	Print
030	SPC	
031	X⇄Y	
032	PRTX	f_i
033	X⇄Y	
034	PRTX	x_i
035	*LBL1	
036	ENT↑	
037	ENT↑	x_i x_i x_i f_i
038	×	
039	R↑	f_i x_i^2 x_i f_i
040	ST+9	Σf_i
041	×	
042	ST+5	$\Sigma f_i x_i^2$
043	R↓	
044	×	
045	ST+4	$\Sigma f_i x_i$
046	1	
047	ST+6	
048	RCL6	n
049	P⇄S	
050	RTN	
051	*LBLc	Grouped data—correct error.
052	P⇄S	
053	F0?	
054	GTO0	
055	GTO1	
056	*LBL0	
057	SPC	Print
058	X⇄Y	
059	PRTX	f_k
060	X⇄Y	
061	PRTX	x_k
062	*LBL1	
063	ENT↑	
064	ENT↑	
065	×	
066	R↑	
067	ST-9	Σf_i
068	×	
069	ST-5	$\Sigma f_i x_i^2$
070	R↓	
071	×	
072	ST-4	$\Sigma f_i x_i$
073	1	
074	ST-6	
075	RCL6	i
076	P⇄S	
077	RTN	
078	*LBLD	Find mean and standard deviation.
079	SPC	
080	$\bar{x}$	
081	PRTX	
082	S	
083	PRTX	
084	RTN	
085	*LBLE	Find standard error and coefficient of variation.
086	SPC	
087	S	
088	P⇄S	
089	RCL9	
090	P⇄S	
091	√X	
092	÷	
093	PRTX	$s_{\bar{x}}$
094	$\bar{x}$	
095	S	
096	LSTX	
097	÷	
098	EEX	
099	2	
100	×	
101	PRTX	C. V.%
102	RTN	
103	*LBLa	Print toggle
104	F0?	
105	GTO0	
106	SF0	
107	1	
108	RTN	
109	*LBL0	
110	CF0	
111	0	
112	RTN	

REGISTERS

0	1	2	3	4	5	6	7	8	9

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
				Σx	Σx^2	Used	Used	Used	n, Σf_i

A	B	C	D	E	I

LABELS					FLAGS
A START	B x_i (Σ+)	C $f_i \uparrow x_i$ (Σ+)	D $\rightarrow \bar{x}$, s	E $\rightarrow s_{\bar{x}}$, CV	0 Print
a Print?	b x_k (Σ−)	c $f_k \uparrow x_k$ (Σ−)	d	e	1
0 Print	1 Sums	2	3	4	2
5	6	7	8	9	3

SET STATUS				
FLAGS			TRIG	DISP
	ON	OFF		
0	☐	☒	DEG ☒	FIX ☒
1	☐	☒	GRAD ☐	SCI ☐
2	☐	☒	RAD ☐	ENG ☐
3	☐	☒		n 2

Chi-square Evaluation and Distribution

001	*LBLA	Start.	057	RTN	
002	CF1		058	*LBLc	Correct erroneous $O_k \uparrow E_k$ (Σ−).
003	CLRG		059	GSB7	
004	2		060	GSB9	
005	0		061	GSB7	
006	STOI	I points to R_A.	062	STOC	
007	RTN		063	-	
008	*LBLB	Input O_i (Σ+).	064	X²	
009	SF1		065	RCLC	
010	GSB4	F1 set for equal E_i.	066	÷	
011	RCLB		067	RCLB	
012	X⇄Y		068	-	
013	+		069	CHS	
014	STOB	ΣO_i	070	STOB	
015	LSTX		071	1	
016	X²		072	ST-i	
017	RCLC		073	RCLi	
018	+		074	RTN	
019	STOC	ΣO_i^2	075	*LBLD	Calculate χ^2.
020	1		076	F1?	
021	ST+i		077	GTO0	If equal E_i, GTO 1.
022	RCLi	i	078	RCLB	Recall χ^2.
023	RTN		079	GSB4	
024	*LBLb	Correct erroneous O_k (Σ−).	080	R/S	
025	GSB7		081	GTO6	"Error"
026	GSB7		082	*LBL0	
027	GSB8		083	RCLA	Calculate χ^2 for equal E_i.
028	GSB7		084	RCLC	
029	RCLB		085	x	
030	X⇄Y		086	RCLB	
031	-		087	÷	
032	STOB		088	LSTX	
033	LSTX		089	-	
034	X²		090	GSB4	χ^2
035	RCLC		091	R/S	
036	-		092	RCLB	Calculate E.
037	CHS		093	RCLA	
038	STOC		094	÷	
039	1		095	GSB8	
040	ST-i		096	GSB7	
041	RCLi		097	RTN	
042	RTN		098	*LBL9	
043	*LBLC	Input $O_i \uparrow E_i$ (Σ+).	099	X⇄Y	Print contents of Y- and X-registers if F0 set.
044	CF1		100	GSB4	
045	GSB9		101	X⇄Y	
046	STOC		102	GSB8	
047	-		103	RTN	
048	X²		104	*LBL4	
049	RCLC		105	GSB7	Space and print.
050	÷		106	*LBL8	
051	RCLB		107	F0?	
052	+	$\Sigma \frac{(O_i - E_i)^2}{E_i}$	108	PRTX	Print.
053	STOB		109	RTN	
054	1		110	*LBL7	
055	ST+i		111	F0?	Space
056	RCLi	i	112	SPC	

REGISTERS

0	1	2	3	4	5	6	7	8	9

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
n	ΣO_i, $\Sigma (O_i - E_i)^2/E_i$	ΣO_i^2, E_i			20

Step	Key	Comments
113	RTN	– – – – – – – – – – – –
114	*LBLE	$\nu \to \Gamma(\nu/2)$
115	GSB8	
116	1	
117	STOC	
118	X⇄Y	
119	2	
120	÷	
121	STOA	
122	INT	
123	LSTX	
124	X≠Y?	If ν is odd, GTO 1.
125	GTO1	
126	1	
127	-	
128	N!	$(\nu/2 - 1)!$
129	GSB8	
130	GSB7	
131	STOC	
132	R/S	– – – – – –
133	*LBL1	ν odd.
134	.	
135	5	
136	X=Y?	
137	GTO2	
138	X⇄Y	
139	1	
140	-	
141	RCLC	
142	X⇄Y	
143	x	
144	STOC	
145	LSTX	
146	GTO1	– – – – – –
147	*LBL2	
148	Pi	
149	√X	
150	RCLC	
151	x	
152	STOC	
153	GSB8	
154	GSB7	
155	R/S	– – – – – – – – – – – –
156	*LBLd	$x \to f(x)$
157	SF1	
158	*LBL5	
159	GSB8	
160	STOB	
161	RCLA	
162	1	
163	-	
164	Y^x	
165	RCLB	
166	2	
167	÷	
168	CHS	

Step	Key	Comments
169	e^x	
170	x	
171	2	
172	RCLA	
173	Y^x	
174	÷	
175	RCLC	
176	÷	
177	STOE	
178	F1?	
179	GSB8	
180	F1?	
181	GSB7	
182	RTN	– – – – – – – – – –
183	*LBLe	$x \to P(x)$
184	CF1	
185	GSB5	First find f(x).
186	RCLB	
187	RCLA	
188	÷	
189	RCLE	
190	x	
191	STOE	
192	2	
193	RCLA	
194	x	
195	STOI	
196	1	
197	STOD	– – – – –
198	*LBL3	Sum terms of series.
199	RCLB	
200	RCLI	
201	2	
202	+	
203	STOI	
204	÷	
205	RCLD	
206	x	
207	STOD	
208	+	
209	X≠Y?	
210	GTO3	
211	RCLE	
212	x	
213	GSB8	
214	RTN	– – – – – – – – – –
215	*LBLc	Print toggle
216	F0?	
217	GTO0	
218	SF0	
219	1	
220	RTN	
221	*LBL0	
222	CF0	
223	0	
224	RTN	

LABELS

A Start	B 0_i (Σ+)	C $0_i \uparrow E_i$ (Σ+)	D $\to \chi^2$; E	E $\nu \to \Gamma(\nu/2)$
a Print?	b 0_k (Σ−)	c $0_k \uparrow E_k$ (Σ−)	d $x \to f(x)$	e $x \to P(x)$
0 Used	1 Used	2 Used	3 Used	4 Print, spc
5 Used	6	7 Space	8 Print x	9 Print x, y

FLAGS

0	Print
1	Used
2	
3	

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

t Statistics

Step	Key	Comment
001	*LBLA	Start.
002	0	
003	STO1	
004	STO2	
005	STO3	
006	RTN	
007	*LBLa	Print toggle.
008	F0?	
009	GTO0	
010	SF0	
011	1	
012	RTN	
013	*LBL0	
014	CF0	
015	0	
016	RTN	
017	*LBLB	Input x_i, y_i for paired t.
018	F0?	
019	GSB9	
020	-	
021	ST+2	
022	X²	
023	ST+3	
024	RCL1	
025	1	
026	+	
027	STO1	
028	RTN	
029	*LBLb	Correct x_k, y_k for paired t.
030	F0?	
031	GSB9	
032	-	
033	ST-2	
034	X²	
035	ST-3	
036	RCL1	
037	1	
038	-	
039	STO1	
040	RTN	
041	*LBLC	Compute paired t.
042	RCL2	
043	RCL1	
044	÷	
045	STOA	$\bar{D}$
046	RCL3	
047	RCL2	
048	X²	
049	RCL1	
050	÷	
051	-	
052	RCL1	
053	1	
054	-	
055	STOC	df
056	÷	
057	√X	
058	STOB	s_D
059	RCL1	
060	√X	
061	÷	
062	÷	
063	SPC	t
064	PRTX	
065	R/S	
066	RCLC	
067	PRTX	
068	RCLA	
069	PRTX	
070	RCLB	
071	PRTX	
072	RTN	
073	*LBLD	Input x_i or y_i for t for two means.
074	GSB0	
075	ST+2	
076	X²	
077	ST+3	
078	RCL1	
079	1	
080	+	
081	STO1	
082	RTN	
083	*LBLd	Correct x_k or y_k for t for two means.
084	GSB1	
085	GSB0	
086	ST-2	
087	X²	
088	ST-3	
089	RCL1	
090	1	
091	-	
092	STO1	
093	RTN	
094	*LBLe	Input d.
095	STO7	
096	RCL1	
097	STO4	Save n_1, Σx, Σx^2.
098	RCL2	
099	STO5	
100	RCL3	
101	STO6	
102	0	
103	STO1	Clear for Σy.
104	STO2	
105	STO3	
106	RCL7	
107	GSB1	
108	GSB0	
109	GSB1	
110	RTN	
111	*LBLE	Compute t for two means.
112	RCL6	

REGISTERS

0	1	2	3	4	5	6	7	8	9
	n	Used	Used	n_1	Σx	Σx^2	d	df	

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
$\bar{D}$	s_D	df			

Step	Key	Comments
113	RCL5	
114	X²	
115	RCL4	
116	÷	
117	-	
118	RCL3	
119	+	
120	RCL2	
121	X²	
122	RCL1	
123	÷	
124	-	
125	RCL1	
126	RCL4	
127	+	
128	2	
129	-	
130	STO8	
131	÷	
132	√X	
133	RCL1	
134	1/X	
135	RCL4	
136	1/X	
137	+	
138	√X	
139	×	
140	RCL5	
141	RCL4	
142	÷	
143	RCL2	
144	RCL1	
145	÷	
146	-	
147	RCL7	
148	-	
149	X⇄Y	
150	÷	
151	SPC	
152	PRTX	t
153	R/S	
154	RCL8	
155	PRTX	df
156	SPC	
157	RTN	
159	*LBL9	Print contents of X and Y.
159	X⇄Y	
160	F0?	
161	SPC	
162	GSB0	
163	X⇄Y	
164	*LBL0	
165	F0?	
166	PRTX	
167	RTN	
168	*LBL1	Space.
169	F0?	
170	SPC	
171	RTN	

LABELS

A Start	B $x_i \uparrow y_i$ (Σ+)	C →t, ...	D x_i, y_i (Σ+)	E →t; df
a Print?	b $x_k \uparrow y_k$ (Σ−)	c	d x_k, y_k (Σ−)	e d
0 Used	1 Space	2	3	4
5	6	7	8	9 Output

FLAGS

0	Print
1	
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

t Distribution

```
001  *LBLA     Input ν.
002   GSB5
003   STOD
004   RTN
               ------------
005  *LBLB     x → f(x)
006   GSB5
007   STOA
008   RCLD
009   GSBa
010   STOB
011   RCLD
012      1
013      +
014   GSBa
015   STOC
016   RCLA
017   RCLC
018   RCLB
019      ÷
020     Pi
021   RCLD
022      ×
023     √X
024      ÷
025      1
026   RCLA
027     X²
028   RCLD
029      ÷
030      +
031   RCLD
032      1
033      +
034      2
035      ÷
036    CHS
037     Yˣ
038      ×
039   STO9
040   PRTX
041    SPC
042    RTN
               ------------
043  *LBLa     Compute Γ (ν/2).
044      1
045   STO3
046    X⇄Y
047      2
048      ÷
049   STO1
050    INT
051   LSTX
052   X≠Y?
053   GTO1
054      1
055      -
056     N!
057   STO3
058    RTN
               -----
059  *LBL1     ν odd.
060      .
061      5
062   X=Y?
063   GTO2
064    X⇄Y
065      1
066      -
067   ST×3
068   GTO1
               -----
069  *LBL2
070     Pi
071     √X
072   RCL3
073      ×
074   STO3
075    RTN
               ------------
076  *LBLC     x → P(x)
077   GSB5
               -----
078  *LBLc     Enter here from LBL D.
079    CF1
080   STOA
081    ABS
082   RCLD
083   STO0
084    RAD
085     √X
086      ÷
087  TAN⁻¹
088   STO2
089   RCL0
090      2
091      ÷
092    INT
093   LSTX
094   X≠Y?
095   GTO4
096      0
097   STO5
               -----
098  *LBLb     ν even.
099   RCL2
100    COS
101     X²
102   STO3
103   RCL2
104    SIN
105   STO4
106   RCL0
107      2
108   X=Y?
109   GTO8
110      ÷
111      1
112      -
```

REGISTERS

0	1	2	3	4	5	6	7	8	9
ν, ν − 1		θ	Used	Used	Used	Used	R	Used	f(x)

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
x	Used	Used	ν		

```
STOI
1
STO6              ------
*LBL3
RCL3
x
RCL5
1
+
x
LSTX
1
+
STO5
÷
ST+6
DSZI
GTO3
RCL6
RCL4
x
F1?
RTN
RCLA
GTO6              ------
*LBL4             ν odd.
RCL2
2
x
Pi
÷
STO7
RCL0
1
STO5
ST-0
X=Y?
GTO9
SF1
GSBb
CF1
RCL2
COS
x
2
x
Pi
÷
RCL7
+
RCLA
GTO6
RTN               ------
*LBL9
RCL7
RCLA
```

```
GTO6              -----
*LBL8
RCL4
RCLA              -----
*LBL6             Exit.
DEG
X>0?
GTO0              Compute P(x) from
X⇄Y               R(x) for x ≤ 0.
1
-
CHS
2
÷
GTO7              -----
*LBL0             Compute P(x) for
X⇄Y               x > 0.
1
+
2
÷                 -----
*LBL7             If F2 set, return to
F2?               LBL D.
RTN
PRTX
SPC
RTN               ----------
*LBLD             x → I(x)
GSB5
SF2
ABS
CHS
GSBc              P(−x)
2
x
1
X⇄Y               1 − 2P(−x)
-
PRTX              I(x)
SPC
RTN               ----------
*LBL5             Print.
F0?
PRTX
RTN               ----------
*LBLE             Print toggle.
F0?
GTO0
SF0
1
RTN
*LBL0
CF0
0
RTN               ----------
```

LABELS					FLAGS
A ν	B x → f(x)	C x → P(x)	D x → I(x)	E Print?	0 Print
a Γ (ν/2)	b ν even	c x → P(x)	d	e	1 Call b
0 Used	1 Used	2 Used	3 Used	4 Used	2 Call c
5 Print	6 Exit	7 Output P	8 Used	9 Used	3

SET STATUS		
FLAGS	TRIG	DISP
ON OFF		
0 ☐ ☒	DEG ☒	FIX ☒
1 ☐ ☒	GRAD ☐	SCI ☐
2 ☐ ☒	RAD ☐	ENG ☐
3 ☐ ☒		n 2

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