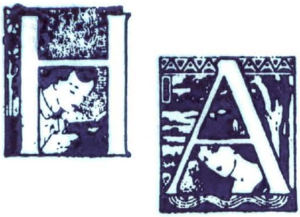
HEWLETT-PACKARD

HP-67/HP-97

Clinical Lab and Nuclear Medicine Pac



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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.

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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.

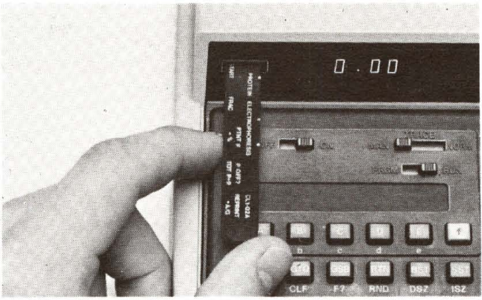


Figure 1a. HP-97

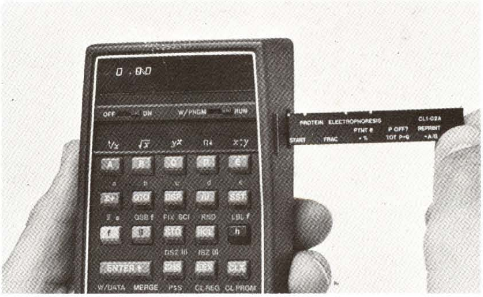


Figure 1b. HP-67

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 **CL x** 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.

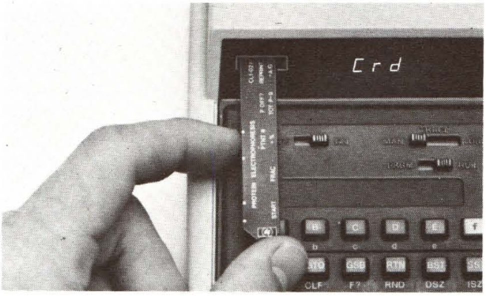


Figure 2a. HP-97

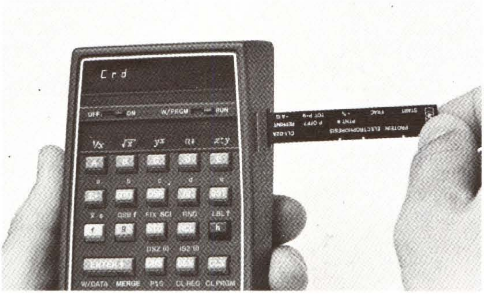


Figure 2b. HP-67

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
$\boxed{x}$ 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 ith 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).

Keystrokes:	**Outputs:**
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).

Keystrokes:	**Outputs:**
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 m^2) 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 m^2. 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: $0.7 \leqslant b \leqslant 3$

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)

$pK = 6.11$

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

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 °C.
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 corrected 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 R/S	BE (mEq/*l*) $[HCO_3^-]$(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$_A$O$_2$) 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:

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

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

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

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.

$$K = \begin{cases} 1 \text{ if no correction} \\[2ex] \dfrac{\text{NPC} - D \times (\text{Ptnt Predose Ct} - \text{Bck Predose Ct})}{\text{NPC}} & \text{if prior radioactivity} \\[2ex] \dfrac{\text{Std. Precount}}{\text{Dose Precount}} & \text{if different activities} \end{cases}$$

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.		
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).		
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.

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

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

where:

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

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

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

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 ***	(1st 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 ***	(1st 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 ***	(1st 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 ***	(1st of std. 2)
		1.00	

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 *** (1st 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 *** (1st 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 *** (1st of std. 5) 1.00
2221 D →	2221.00 *** 2.00

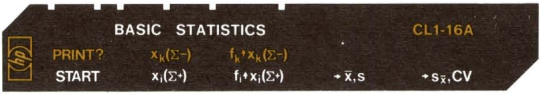
400 E →	2124.00 *** (Avg. for std. 5)
	0.17 *** (net B_5/B_0)
	400.00 *** (Conc. of std. 5)
	-1.59 *** (y_5)
	2.60 *** (x_5)
	5.00 (Std. 5)
1251 D →	1251.00 *** (1st of std. 6)
	1.00
1462 D →	1462.00 ***
	2.00
800 E →	1356.50 *** (Avg. for std. 6)
	0.10 *** (net B_6/B_0)
	800.00 *** (Conc. of std. 6)
	-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 *** (1st 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 *** (1st of unkn. 2)
	1.00

```
3400 f B  ──────────→   3400.00 ***
                           2.00

f C  ───────────────→   3335.00 *** (Avg. of unkn. 2)
                           0.29 *** (net B/B0)
                         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 $f_1, f_2, \ldots, f_n$.

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

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

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

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

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		

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. %)

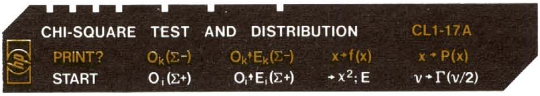
Example 2:

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

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

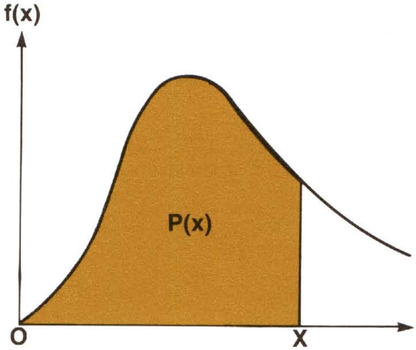
Chi-square distribution:

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:

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

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

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
25546
25592
25820
25569

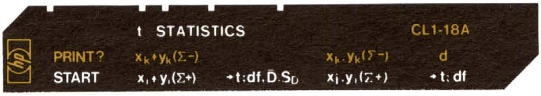
25553
25841
25560
25633
25464

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 ($\nu/2$))
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 *** $(\bar{D})$
	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)

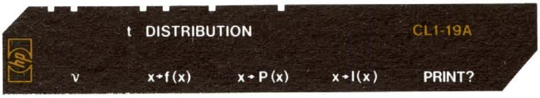
Load *t Distribution* (CL1-19A).

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

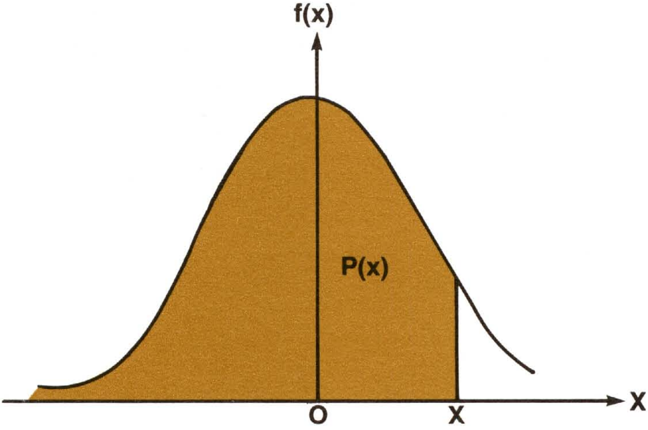
t DISTRIBUTION

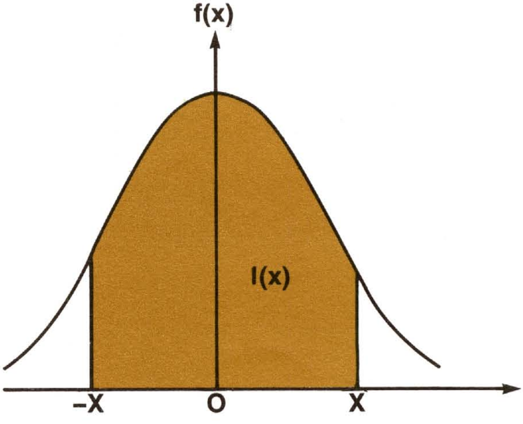


This program calculates three parameters of the t distribution given x and the degrees of freedom ν. The density function f(x) is computed as well as two measures of the area under the distribution curve, P(x) and, for $x > 0$, I(x), where

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

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





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

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

(2) ν odd

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

where

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

$$P(x) = \begin{cases} \dfrac{1 + I(x)}{2} \text{ if } x > 0 \\[2ex] \dfrac{1 - I(x)}{2} \text{ if } x \leqslant 0 \end{cases}$$

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.
002   STOD
003    F0?
004   PRTX     A.
005      2
006      -
007    CHS
008    10ˣ
009   STOE     %T.
010    F0?
011   PRTX
012    F0?
013    SPC
014    RTN
               -------------
015  *LBLB     %T → A.
016   STOE
017    F0?
018   PRTX     %T.
019    LOG
020    CHS
021      2
022      +
023   STOD
024    F0?
025   PRTX     A.
026    F0?
027    SPC
028    RTN
               -------------
029  *LBLC     + % Ts (-As).
030   STOC
031    F0?
032    SPC
033    F0?
034   PRTX
035   X<0?     For absorbance, GTO 3.
036   GTO3
037    LOG
038    CHS
039      2     For %Ts, compute As.
040      +
041   GTO0
                  ------
042  *LBL3
043    CHS
044  *LBL0
045   STOB     Store As.
046   RCLC     Display input.
047    RTN
               -------------
048  *LBLD     + % Tu (-Au).
049   STOA
050    F0?
051   PRTX     For absorbance, GTO 4.
052   X<0?
053   GTO4
054    LOG
055    CHS
056      2
```

```
057      +     For % Tu, compute Au.
058   GTO6        ------
059  *LBL4
060    CHS
061  *LBL6
062   STO9     Store Au.
063   RCLA     Display input.
064    RTN
               -------------
065  *LBLE
066   STO8     Cs → Cu.
067    F0?
068    SPC
069    F0?
070   PRTX
071   RCL9
072      ×     Cu = Cs x Au/As
073   RCLB
074      ÷
075   STO7
076    F0?
077   PRTX
078    F0?
079    SPC
080    RTN
               -------------
081  *LBLa
082      0     Clear for reprint.
083   STOA
084   STOB
085   STOC
086   STOD
087   STOE
088   STOI
089    RTN
               -------------
090  *LBLc     Patient ID = Ptnt # .01.
091    INT
092      .
093      0
094      1
095      +
096   STOI
097   PRTX
098    SPC
099    RTN
               -------------
100  *LBLd     Print toggle.
101    F0?
102   GTO0
103    SF0
104      1
105    RTN
106  *LBL0
107    CF0
108      0
109    RTN
               -------------
110  *LBLe     Reprint
111    SPC
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					FLAGS
A A→%T	B %T→A	C $+\%T_s\ (-A_s)$	D $+\%T_u\ (-A_u)$	E $C_s \rightarrow C_u$	0 Print
a Clear	b	c Ptnt #	d P off?	e Reprint	1
0 Used	1	2	3 Store A_s	4 Store A_u	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

Protein Electrophoresis

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

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?	F2 set indicates range error.
056	GTOE	

057	RTN	- - - - - - - - - - - -
058	*LBL1	Subroutine to find % and test if within normal range.
059	RCL0	
060	÷	
061	EEX	
062	2	$(\%)_i = \frac{LDH_i}{\sum_j LDH_j} \times 100$
063	×	
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
ΣLDH_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
A START	B LDH$_i$	C →%	D	E None	0 Print
a	b	c Ptnt#	d P off?	e Reprint	1
0 Used	1 %	2	3	4	2 Range error
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

L04-01

Body Surface Area

```
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  ×
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  ×
037  *LBL2
038  STOB      Store weight in kg.
039  RTN
               - - - - - - - - - - - -
040  *LBLC     Dubois BSA
041  RCLD
042  .
043  7
044  2
045  5
046  Yˣ
047  RCLB
048  .
049  4
050  2
051  5
052  Yˣ
053  ×
054  .
055  0
056  0
057  7
058  1
059  8
060  4
061  ×
062  STOA
063  F0?
064  PRTX
065  F0?
066  SPC
067  RTN
               - - - - - - - - - - - -
068  *LBLD     Boyd BSA
069  RCLD
070  .
071  3
072  Yˣ
073  RCLB
074  EEX
075  3
076  ×
077  ENT↑
078  LOG
079  .
080  0
081  1
082  8
083  8
084  ×
085  .
086  7
087  2
088  8
089  5
090  -
091  Yˣ
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
109  INT
110  .         Patient ID = Ptnt #.04
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 (m²)	Wt (kg)	Wt input	Ht (cm)	Ht input	Ptnt #.04

```
113      +
114   STOI
115    SPC
116   PRTX
117    RTN          - - - - - - - - - - - -
118  *LBLd          Print toggle
119    F0?
120   GTO0
121    SF0
122      1
123    RTN
124  *LBL0
125    CF0
126      0
127    RTN          - - - - - - - - - - - -
128  *LBLe          Reprint
129    SPC
130    SPC
131   RCLI
132    INT
133      .
134      0
135      4
136      +
137   PRTX          Patient ID
138    SPC
139   RCLE          Ht input
140   PRTX
141   RCLC          Wt input
142   PRTX
143    SPC
144   RCLA          BSA (m²)
145   PRTX
146    SPC
147    RTN
                    - - - - - - - - - - - -
```

LABELS					FLAGS
A Ht (+cm)	B Wt (+kg)	C →Dubois	D →Boyd	E	0 Print
a Clear	b	c Ptnt #	d P off?	e Reprint	1
0 P toggle	1 Store ht	2 Store wt	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

L05-01

Urea Clearance

Step	Key	Comment
001	*LBLA	
002	÷	V/t — — — — — — — —
003	*LBLB	
004	STOE	$\dot{V}$
005	F0?	
006	SPC	
007	F0?	
008	PRTX	
009	F2?	If F2 set, must correct
010	GTO0	for BSA.
011	GTO1	— — — — — — — —
012	*LBL0	
013	1	
014	.	
015	7	$\dot{V}_{corr} = \frac{1.73}{BSA}\dot{V}$
016	3	
017	RCLA	
018	÷	
019	×	— — — — — — — —
020	*LBL1	
021	STOD	Output
022	F0?	
023	PRTX	
024	F0?	
025	SPC	
026	RTN	— — — — — — — — — — — —
027	*LBLC	
028	STOC	U_{urea}
029	F0?	
030	PRTX	
031	RTN	
032	*LBLD	— — — — — — — — — — — —
033	STOB	
034	F0?	B_{urea}
035	PRTX	
036	F0?	
037	SPC	
038	2	If $\dot{V}_{corr} \leqslant 2$, take $\sqrt{\dot{V}}$ for
039	RCLD	
040	X≤Y?	$C_s = \frac{U\sqrt{\dot{V}}}{B}$.
041	√X	
042	RCLC	
043	RCLB	Otherwise $C_m = \frac{U\dot{V}}{B}$.
044	÷	
045	×	
046	STO9	Clearance
047	F0?	
048	PRTX	
049	RTN	— — — — — — — — — — — —
050	*LBLE	% mean normal
051	2	
052	RCLD	
053	X≤Y?	If $\dot{V}_{corr} \leqslant 2$, GTO 0 for
054	GTO0	standard.
055	RCL9	
056	1	
057	.	
058	3	Otherwise have maximum.
059	3	
060	×	
061	STO8	
062	F0?	
063	PRTX	
064	RTN	— — — — — — —
065	*LBL0	Standard
066	RCL9	
067	1	
068	.	
069	8	
070	5	
071	×	
072	STO8	
073	F0?	
074	PRTX	
075	RTN	— — — — — — — — — — —
076	*LBLa	
077	0	Clear for reprint.
078	STO8	
079	STOI	
080	RTN	— — — — — — — — — — —
081	*LBLb	
082	SF2	Set F2 to allow correction
083	RCLA	for BSA.
084	RTN	— — — — — — — — — — —
085	*LBLc	
086	INT	Patient ID = Ptnt # .05
087	.	
088	0	
089	5	
090	+	
091	STOI	
092	SPC	
093	PRTX	
094	RTN	— — — — — — — — — — —
095	*LBLd	
096	F0?	Print toggle
097	GTO0	
098	SF0	
099	1	
100	RTN	
101	*LBL0	
102	CF0	
103	0	
104	RTN	— — — — — — — — — — —
105	*LBLe	Reprint
106	SPC	
107	SPC	
108	RCLI	
109	INT	
110	.	
111	0	
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
115    SPC
116   RCLE
117   PRTX
118   RCLD
119   PRTX
120    SPC
121   RCLC
122   PRTX
123   RCLB
124   PRTX
125    SPC
126   RCL9
127   PRTX
128   RCL8
129   PRTX
130    SPC
131    RTN
```

Patient ID

$\dot{V}$

$\dot{V}_{corr}$

U_{urea}

B_{urea}

Clearance

% m.n.

- - - - - - - - - - - -

LABELS

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

FLAGS

0	Print
1	
2	Cor BSA?
3	

SET STATUS

FLAGS

	ON	OFF
0	☒	☐
1	☐	☒
2	☐	☒
3	☐	☒

TRIG

DEG	☒
GRAD	☐
RAD	☐

DISP

FIX	☒
SCI	☐
ENG	☐
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

L06-02

<table>
<tr><th colspan="5">LABELS</th><th>FLAGS</th><th colspan="3">SET STATUS</th></tr>
<tr><td>A $V\uparrow t$</td><td>B $\dot{V}$</td><td>C U_{creat}</td><td>D P_{creat}</td><td>E</td><td>0 Print</td><td>FLAGS</td><td>TRIG</td><td>DISP</td></tr>
<tr><td>a Clear</td><td>b Cor BSA?</td><td>c Ptnt #</td><td>d P off?</td><td>e Reprint</td><td>1</td><td rowspan="3">ON OFF
0 ☒ ☐
1 ☐ ☒
2 ☐ ☒
3 ☐ ☒</td><td rowspan="3">DEG ☒
GRAD ☐
RAD ☐</td><td rowspan="3">FIX ☒
SCI ☐
ENG ☐
n 2</td></tr>
<tr><td>0 Used</td><td>1 Exit $\dot{V}$</td><td>2</td><td>3</td><td>4</td><td>2 Cor BSA</td></tr>
<tr><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>3</td></tr>
</table>

Amniotic Fluid Assay

```
001  *LBLA
002    FIX
003   DSP2
004   STOE      A365
005    F0?
006    SPC
007    F0?
008   PRTX
009    RTN
                ------------
010  *LBLB
011   STOD      A550
012    F0?
013   PRTX
014    RTN
                ------------
015  *LBLC
016   STOC      A450
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      Δ A450
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      Δ A450 (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	Δ A_{450}	A_{450}	A_{550}	A_{365}	Ptnt # .07

```
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     A365
128    PRTX
129    RCLD     A550
130    PRTX
131    RCLC     A450
132    PRTX
133     SPC
134    RCLB     Δ A450
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					FLAGS
A A_{365}	B A_{550}	C $A_{450}\rightarrow\Delta$	D Wk→b	E Zone	0 Print
a Clear	b	c Ptnt #	d P off?	e Reprint	1
0 Used	1 Zone 1	2	3 Zone 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

Blood Acid-Base Status

```
001  *LBLA     BT
002    F0?
003   PRTX
004    F0?
005    SPC
006      3
007      7
008    X⇄Y
009      -
010   STO9     37-BT
011    SF1     F1 set for BT.
012    RTN
               ------------
013  *LBLB     PCO2
014   STOE
015    F0?
016   PRTX
017    F1?     To correct for BT, GTO 0.
018   GTO0
019   GTO1     For 37°, GTO 1.
               --------
020  *LBL0
021   RCL9     Correct PCO2 to 37°.
022      .
023      0
024      1
025      9
026      x
027    10ˣ
028      x
               --------
029  *LBL1
030   STOD     PCO2 (37°C)
031    RTN
               ------------
032  *LBLC     pH
033   STOC
034    F0?
035   PRTX
036    F1?     To correct for BT, GTO 0.
037   GTO0
038   GTO2     For 37°, GTO 2.
               --------
039  *LBL0
040   RCL9     Correct pH to 37°
041      .
042      0
043      1
044      4
045      6
046      x
047      -
               --------
048  *LBL2
049   STOB     pH (37°C)
050    RTN
               ------------
051  *LBLD     Compute TCO2.
052   RCLB
053      6
054      .
055      1
056      1
057      -
058    10ˣ
059      .
060      0
061      3
062      0
063      7
064      x
065   STO5     s(10^(pH-pK))
066   LSTX
067      +
068   RCLD
069      x
070   STOA     TCO2
071    F0?
072   PRTX
073    CF1     Clear flag 1.
074    RTN
               ------------
075  *LBLE     Hgb
076   STO8
077    F0?
078    SPC
079    F0?
080   PRTX
081   RCL5
082   RCLD
083      x
084   STO6     [HCO3-]
085      9
086      .
087      5
088   ENT↑
089      1
090      .
091      6
092      3
093   RCL8
094      x
095      +
096      7
097      .
098      4
099   RCLB
100      -
101      x
102      -
103      2
104      4
105      -
106      1
107   RCL8
108      .
109      0
110      1
111      4
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

```
113      x
114      -
115      x
116   STO7          BE
117    F0?
118   PRTX
119    RTN
120   RCL6          [HCO3-]
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?          Print toggle
144   GTO0
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          PCO2-input
174   PRTX
175   RCLC          pH input
176   PRTX
177   RCLA          TCO2
178   PRTX
179    SPC
180   RCL8          Hgb
181   PRTX
182   RCL7          BE
183   PRTX
184   RCL6          [HCO3-]
185   PRTX
186    RTN
                    ------------
```

LABELS					FLAGS
A BT	B PCO_2	C pH	D TCO_2	E Hgb→BE	0 Print
a Clear	b	c Ptnt #	d P off?	e Reprint	1 BT
0 Used	1 PCO_2 (37)	2 pH (37)	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

Oxygen Saturation and Content

```
001  *LBLA        BT
002    F0?
003   PRTX
004      3
005      7
006    X⇄Y
007      -
008   STO9        37-BT
009   RCLD        Rcl PCO₂ (if input).
010    RTN
                  - - - - - - - - - - - -
011  *LBLB        PCO₂
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        PO₂ input
026   X<0?        If input < 0, consider as
027   GTO1        VPO₂.
028   RCL9        Otherwise compute VPO₂.
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        VPO₂
061   STOC
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        O₂ saturation (%).
109    SF2        F2 set to indicate
110    F0?        saturation computed.
111    SPC
112    F0?
```

REGISTERS

0	1	2	3	4	5	6	7 Sat	8 Hgb	9 37-BT
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A O₂ content	B pH(37)	C VPO₂	D PCO₂ (37)	E PO₂ input	I Ptnt # .09

```
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
121  GTO0     input it.
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  ×
135  1
136  3
137  4        Compute oxygen content.
138  ×
139  RCLC
140  3
141  1
142  ×
143  +
144  EEX
145  4
146  ÷
147  STOA     O2 content
148  F0?
149  PRTX
150  RTN
              - - - - - - - - - - - -
151  *LBLa    Initialize
152  0
153  STOC
154  STOE
155  STOI
156  RTN
              - - - - - - - - - - - -
157  *LBLb
158  3        Rcl BT
159  7
160  RCL9
161  -        BT = 37 – (37-BT)
162  RTN
              - - - - - - - - - - - -
163  *LBLc
164  INT      Patient ID = Ptnt # .09
165  .
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     PCO2
201  RCLB
202  PRTX     pH
203  RCLE
204  PRTX     PO2 input
205  SPC
206  RCL7
207  PRTX     Saturation
208  SPC
209  RCL8     Hemoglobin
210  PRTX
211  RCLA     Content
212  PRTX
213  RTN
              - - - - - - - - - - -
```

LABELS					FLAGS
A BT	B PCO_2	C pH	D PO_2 →Sat	E S↑Hgb→O_2	0 Print
a Clear	b →Rcl BT	c Ptnt #	d P off?	e Reprint	1
0 Used	1 VPO_2	2	3	4	2 Sat computed
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

L10-01

Red Cell Indices

```
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      Clear.
050      0
051   STOI
052   RTN
                - - - - - - - - - - - -
053  *LBLc      Patient ID = Ptnt # .10
054   INT
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 MCH	B MCV	C Hgb	D Hct (%)	E Count	I Ptnt # .10

L10-02

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			

L11-01

Total Blood Volume

```
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-
028   RCLE     Bck.
029   -
030   X⇄Y
031   RCLE     Net blood CPM = Blood
032   -        CPM- Bck.
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

L11-02

LABELS					FLAGS
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

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

L12-01

Schilling Test

```
001  *LBLA
002   STOE      Background counts.
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      .
058      1      Patient ID = Ptnt # .12
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 Urine CPM	B Urine Vol.	C Std. CPM	D Std. dilution	E Bck	I Ptnt # .12

L12-02

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

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

L14-01

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	$f = {\frac{1}{2}}^{t/\tau_{1/2}}$
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	x	$A = A_0 f$
017	÷	Calculate:	073	STOC	
018	STOA		074	RTN	
019	LN		075	*LBL0	
020	.	$t = \frac{\tau_{1/2} \ln f}{\ln 1/2}$	076	STOC	Store input A.
021	5		077	RTN	
022	LN		078	*LBLD	Isotopes 1–9.
023	÷		079	STOI	
024	RCLB		080	GSBi	
025	x		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	Convert t in hrs. to dd.hh for display.	086	7	^{51}Cr
031	ENT↑		087	.	
032	ENT↑		088	2	
033	2		089	STOB	
034	4		090	RTN	
035	x		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	^{99m}Tc
044	*LBL0		100	STOB	
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	x		106	0	
051	X⇄Y		107	STOB	
052	FRC		108	RTN	
053	EEX		109	*LBLe	
054	2		110	1	
055	x		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)

```
113       .
114       2
115    STOB
116     RTN
----------------------------
117   *LBLE
118       2
119       6
120       2         137Cs
121       9
122       8
123       0
124    STOB
125     RTN
----------------------------
126   *LBL1
127       1
128       0
129       7         3H
130       4
131       7
132       0
133     RTN
----------------------------
134   *LBL2
135       5
136       0
137       5         14C
138       8
139     EEX
140       4
141     RTN
----------------------------
142   *LBL3
143       1
144       .         18F
145       8
146       7
147     RTN
----------------------------
148   *LBL4
149       3
150       4
151       3         32P
152       .
153       2
154     RTN
----------------------------
155   *LBL5
156       2
157       8         75Se
158       8
159       0
160     RTN
----------------------------
161   *LBL6
162       1
163       5         85Sr
164       3
165       6
166     RTN
----------------------------
167   *LBL7
168       1
169       .
170       7         113mIn
171       3
172     RTN
----------------------------
173   *LBL8
174       1
175       2         133Xe
176       6
177       .
178       5
179     RTN
----------------------------
180   *LBL9
181       6         197Hg
182       5
183     RTN
----------------------------
```

LABELS

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

FLAGS

0	
1	
2	
3	Data entry

SET STATUS

FLAGS

	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG

DEG	☒
GRAD	☐
RAD	☐

DISP

FIX	☒
SCI	☐
ENG	☐
n	2

Radioimmunoassay

```
001  *LBLA      Initialize.
002    P⇄S
003   CLRG
004    P⇄S
005   GTO2      ------------------
006  *LBLB      Non-specific binding
007   GSBD      counts (NSB).
008    RTN
009   GSB1
010   STOE      Average NSB.
011    RTN      ------------------
012  *LBLC      Zero dose counts (B₀).
013   GSBD
014    RTN
015   GSB1
016   STOD      Average B₀.
017    RTN      ------------------
018  *LBL1      Compute average counts.
019   RCL8
020   RCL9
021      ÷
022   STOI      B̄ = ΣB/n
023    F0?
024    SPC
025    F0?
026   PRTX      B̄
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
038  *LBLD      unknowns.
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      B̄ = ΣB/n
051      0
052   STO8
053   STO9
054     R↓
055    F0?
056    SPC
```

```
057    F0?      B̄
058   PRTX
059   RCLE
060      -
061   RCLD
062   RCLE
063      -      net B/B₀
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
084    F0?      regression.
085    SPC
086    RTN      ------------------
087  *LBLa      Compute r, m, b.
088   RCLΣ
089      ×
090    P⇄S
091   RCL9
092      ÷
093   RCL8
094    X⇄Y
095      -
096   STOB      Σxy – (Σx Σy)/n
097   ENT↑
098   ENT↑
099    P⇄S
100      S
101      ×
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 ΣB, used	9 n, used
S0	S1	S2	S3	S4 Σx	S5 Σx^2	S6 Σy	S7 Σy^2	S8 Σxy	S9 n

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

113	X^2	
114	RCL9	
115	÷	
116	-	
117	÷	
118	STOB	
119	PRTX	m
120	P⇄S	
121	$\bar{x}$	
122	RCLB	
123	×	
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	
157	STO8	Calculate logit (y).
158	RCLC	
159	-	
160	RCLB	
161	÷	x (log conc.) = $(y - b)/m$
162	STO9	
163	10^x	
164	PRTX	
165	SPC	Estimated concentration.
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	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					FLAGS
A Start	B NSB; →$\overline{NSB}$	C B_0; →$\bar{B}_0$	D Std B	E Std conc	0 Print
a →r, m, b	b Unkn B	c → Conc	d Print?	e Plot?	1 Plot
0 Used	1 Find $\bar{B}$	2 Clear ΣB	3 Logit	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

L16-01

Basic Statistics

```
001  *LBLA     Clear Σ registers
002    P⇄S
003      0
004   STO4
005   STO5
006   STO6
007   STO7
008   STO8
009   STO9
010    P⇄S
011    RTN
               ------------
012  *LBLB     xi (Σ+)
013    F0?
014   PRTX
015     Σ+
016    RTN
               ------------
017  *LBLb     xk (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     fi
033    X⇄Y
034   PRTX     xi
035  *LBL1        -------
036   ENT↑
037   ENT↑     xi   xi   xi   fi
038      x
039     R↑     fi   xi²  xi   fi
040   ST+9     Σfi
041      x
042   ST+5     Σfixi²
043     R↓
044      x
045   ST+4     Σfixi
046      1
047   ST+6
048   RCL6     n
049    P⇄S
050    RTN
               ------------
051  *LBLc     Grouped data—correct
052    P⇄S     error.
053    F0?
054   GTO0
055   GTO1        -------
056  *LBL0
```

```
057    SPC     Print
058    X⇄Y
059   PRTX     fk
060    X⇄Y
061   PRTX     xk
062  *LBL1        ------
063   ENT↑
064   ENT↑
065      x
066     R↑
067   ST-9     Σfi
068      x
069   ST-5     Σfixi²
070     R↓
071      x
072   ST-4     Σfixi
073      1
074   ST-6
075   RCL6     i
076    P⇄S
077    RTN
               ----------
078  *LBLD     Find mean and
079    SPC     standard deviation.
080      x̄
081   PRTX
082      s
083   PRTX
084    RTN
               ----------
085  *LBLE     Find standard error and
086    SPC     coefficient of variation.
087      s
088    P⇄S
089   RCL9
090    P⇄S
091     √X
092      ÷
093   PRTX     sx̄
094      x̄
095      s
096   LSTX
097      ÷
098    EEX
099      2
100      x
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 ($\Sigma+$)	C $f_i \uparrow x_i$ ($\Sigma+$)	D $\rightarrow \bar{x}$, s	E $\rightarrow s_{\bar{x}}$, CV	0 Print
a Print?	b x_k ($\Sigma-$)	c $f_k \uparrow x_k$ ($\Sigma-$)	d	e	1
0 Print	1 Sums	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

Chi-square Evaluation and Distribution

001	*LBLA	Start.
002	CF1	
003	CLRG	
004	2	
005	0	
006	STOI	I points to R_A.
007	RTN	
008	*LBLB	Input 0_i ($\Sigma+$).
009	SF1	
010	GSB4	F1 set for equal E_i.
011	RCLB	
012	X⇄Y	
013	+	
014	STOB	$\Sigma 0_i$
015	LSTX	
016	X²	
017	RCLC	
018	+	
019	STOC	$\Sigma 0_i^2$
020	1	
021	ST+i	
022	RCLi	i
023	RTN	
024	*LBLb	Correct erroneous 0_k ($\Sigma-$).
025	GSB7	
026	GSB7	
027	GSB8	
028	GSB7	
029	RCLB	
030	X⇄Y	
031	-	
032	STOB	
033	LSTX	
034	X²	
035	RCLC	
036	-	
037	CHS	
038	STOC	
039	1	
040	ST-i	
041	RCLi	
042	RTN	
043	*LBLC	Input $0_i \uparrow E_i$ ($\Sigma+$).
044	CF1	
045	GSB9	
046	STOC	
047	-	
048	X²	
049	RCLC	
050	÷	
051	RCLB	
052	+	
053	STOB	$\Sigma \frac{(0_i - E_i)^2}{E_i}$
054	1	
055	ST+i	
056	RCLi	i
057	RTN	
058	*LBLc	Correct erroneous $0_k \uparrow E_k$ ($\Sigma-$).
059	GSB7	
060	GSB9	
061	GSB7	
062	STOC	
063	-	
064	X²	
065	RCLC	
066	÷	
067	RCLB	
068	-	
069	CHS	
070	STOB	
071	1	
072	ST-i	
073	RCLi	
074	RTN	
075	*LBLD	Calculate χ^2.
076	F1?	
077	GTO0	If equal E_i, GTO 1.
078	RCLB	Recall χ^2.
079	GSB4	
080	R/S	
081	GTO6	"Error"
082	*LBL0	Calculate χ^2 for equal E_i.
083	RCLA	
084	RCLC	
085	x	
086	RCLB	
087	÷	
088	LSTX	
089	-	
090	GSB4	χ^2
091	R/S	
092	RCLB	Calculate E.
093	RCLA	
094	÷	
095	GSB8	
096	GSB7	
097	RTN	
098	*LBL9	
099	X⇄Y	Print contents of Y- and X-registers if F0 set.
100	GSB4	
101	X⇄Y	
102	GSB6	
103	RTN	
104	*LBL4	
105	GSB7	Space and print.
106	*LBL8	
107	F0?	
108	PRTX	Print.
109	RTN	
110	*LBL7	
111	F0?	Space
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	$\Sigma 0_i$, $\Sigma (0_i - E_i)^2/E_i$	$\Sigma 0_i^2$, E_i			20

```
113     RTN    - - - - - - - - - - - - -
114   *LBLE    ν→Γ (ν/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!    (ν/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 → f(x)
157     SF1
158   *LBL5
159    GSB8
160    STOB
161    RCLA
162       1
163       -
164      Yˣ
165    RCLB
166       2
167       ÷
168     CHS
```

```
169      eˣ
170       x
171       2
172    RCLA
173      Yˣ
174       ÷
175    RCLC
176       ÷
177    STOE
178     F1?
179    GSB8
180     F1?
181    GSB7
182     RTN    - - - - - - - - - -
183   *LBLe    x → 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					FLAGS
A Start	B 0_i (Σ+)	C $0_i \uparrow E_i$ (Σ+)	D $\rightarrow \underline{\chi}^2$; E	E ν→Γ (ν/2)	0 Print
a Print?	b 0_k (Σ–)	c $0_k \uparrow E_k$ (Σ–)	d x → f(x)	e x → P(x)	1 Used
0 Used	1 Used	2 Used	3 Used	4 Print, spc	2
5 Used	6	7 Space	8 Print x	9 Print x, y	3

SET STATUS

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

t Statistics

Start.

```
001  *LBLA
002      0
003   ST01
004   ST02
005   ST03
006    RTN
```

Print toggle.

```
007  *LBLa
008    F0?
009   GT00
010    SF0
011      1
012    RTN
013  *LBL0
014    CF0
015      0
016    RTN
```

Input x_i, y_i for paired t.

```
017  *LBLB
018    F0?
019   GSB9
020      -
021   ST+2
022     X²
023   ST+3
024   RCL1
025      1
026      +
027   ST01
028    RTN
```

Correct x_k, y_k for paired t.

```
029  *LBLb
030    F0?
031   GSB9
032      -
033   ST-2
034     X²
035   ST-3
036   RCL1
037      1
038      -
039   ST01
040    RTN
```

Compute paired t.

```
041  *LBLC
042   RCL2
043   RCL1
044      ÷
```

$\bar{D}$

```
045   STOA
046   RCL3
047   RCL2
048     X²
049   RCL1
050      ÷
051      -
052   RCL1
053      1
054      -
```

df

```
055   STOC
056      ÷
057     √X
```

s_D

```
058   STOB
059   RCL1
060     √X
061      ÷
062      ÷
```

t

```
063    SPC
064   PRTX
065    R/S
066   RCLC
067   PRTX
068   RCLA
069   PRTX
070   RCLB
071   PRTX
072    RTN
```

Input x_i or y_i for t for two means.

```
073  *LBLD
074   GSB0
075   ST+2
076     X²
077   ST+3
078   RCL1
079      1
080      +
081   ST01
082    RTN
```

Correct x_k or y_k for t for two means.

```
083  *LBLd
084   GSB1
085   GSB0
086   ST-2
087     X²
088   ST-3
089   RCL1
090      1
091      -
092   ST01
093    RTN
```

Input d.

```
094  *LBLe
095   ST07
096   RCL1
```

Save n_1, Σx, Σx^2.

```
097   ST04
098   RCL2
099   ST05
100   RCL3
101   ST06
102      0
```

Clear for Σy.

```
103   ST01
104   ST02
105   ST03
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			

```
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  ST08
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
153   R/S        t
154  RCL8
155  PRTX        df
156   SPC
157   RTN
             ---------------
158 *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					FLAGS
A Start	B $x_i\uparrow y_i$ (Σ+)	C →t, ...	D x_i, y_i (Σ+)	E →t; df	0 Print
a Print?	b $x_k\uparrow y_k$ (Σ−)	c	d x_k, y_k (Σ−)	e d	1
0 Used	1 Space	2	3	4	2
5	6	7	8	9 Output	3

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			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      x
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      x
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      x
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 ν, ν − 1	1	2 θ	3 Used	4 Used	5 Used	6 Used	7 R	8 Used	9 f(x)
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A x	B Used	C Used	D ν	E	I

```
113  STOI
114     1
115  ST06
                  ------
116 *LBL3
117  RCL3
118     x
119  RCL5
120     1
121     +
122     x
123  LSTX
124     1
125     +
126  ST05
127     ÷
128  ST+6
129  DSZI
130  GTO3
131  RCL6
132  RCL4
133     x
134   F1?
135   RTN
136  RCLA
137  GTO6
                  ------
138 *LBL4        ν odd.
139  RCL2
140     2
141     x
142    Pi
143     ÷
144  ST07
145  RCL0
146     1
147  ST05
148  ST-0
149  X=Y?
150  GTO9
151   SF1
152  GSBb
153   CF1
154  RCL2
155   COS
156     x
157     2
158     x
159    Pi
160     ÷
161  RCL7
162     +
163  RCLA
164  GTO6
165   RTN
                  ------
166 *LBL9
167  RCL7
168  RCLA
```

```
                  -----
169  GTO6
170 *LBL8
171  RCL4
172  RCLA
                  -----
173 *LBL6        Exit.
174   DEG
175  X>0?
176  GTO0        Compute P(x) from
177   X⇄Y        R(x) for x ≤ 0.
178     1
179     -
180   CHS
181     2
182     ÷
183  GTO7
                  -----
184 *LBL0        Compute P(x) for
185   X⇄Y        x > 0.
186     1
187     +
188     2
189     ÷
                  -----
190 *LBL7        If F2 set, return to
191   F2?        LBL D.
192   RTN
193  PRTX
194   SPC
195   RTN
                  ----------
196 *LBLD        x → I(x)
197  GSB5
198   SF2
199   ABS
200   CHS
201  GSBc        P(−x)
202     2
203     x
204     1
205   X⇄Y        1 − 2P(−x)
206     -
207  PRTX        I(x)
208   SPC
209   RTN
                  ----------
210 *LBL5        Print.
211   F0?
212  PRTX
213   RTN
                  ----------
214 *LBLE        Print toggle.
215   F0?
216  GTO0
217   SF0
218     1
219   RTN
220 *LBL0
221   CF0
222     0
223   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	ON	OFF	TRIG		DISP	
0	☐	☒	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

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● B C D E