HEWLETT-PACKARD

HP-67/HP-97

Clinical Lab and Nuclear Medicine Pac

HEWLETT hp PACKARD

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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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Clinical Chemistry

1. Beer's Law 01-01
   Converts between absorbance and % transmittance; solves for an unknown concentration given a standard concentration and the absorbance or % transmittance of the standard and unknown.
2. Protein Electrophoresis 02-01
   Given integration counts of a number of protein fractions, finds percentage of each. Calculation of weights optional.
3. LDH Isoenzymes 03-01
   Given values for the five LDH isoenzymes, finds activity of each as a percent of total. Compares results against normal values.
4. Body Surface Area 04-01
   Calculates an estimated BSA by method of Dubois or Boyd. Accepts either English or metric units.
5. Urea Clearance 05-01
   Calculates urea clearance with option of correcting for BSA.
6. Creatinine Clearance 06-01
   Calculates creatinine clearance with option of correcting for BSA.
7. Amniotic Fluid Assay 07-01
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8. Blood Acid-Base Status 08-01
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9. Oxygen Saturation and Content 09-01
   Finds oxygen saturation and content in blood given PO_2, PCO_2, pH, and body temperature.
10. Red Cell Indices 10-01
   Given hematocrit percent, red cell count, and hemoglobin, finds mean corpuscular volume, mean corpuscular hemoglobin, and mean corpuscular hemoglobin concentration.

Nuclear Medicine

11. Total Blood Volume 11-01
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12. Schilling Test 12-01
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13. Thyroid Uptake 13-01
   The radioisotope determination of thyroid uptake.
14. Radioactive Decay Corrections 14-01
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Radioimmunoassay

15. Radioimmunoassay 15-01
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16. Basic Statistics 16-01
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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.

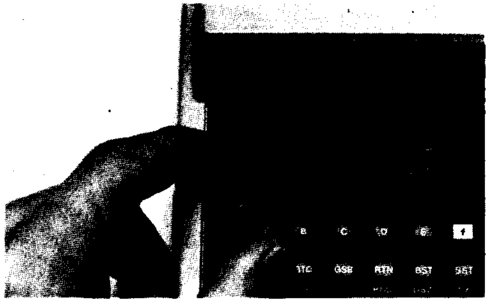


Figure 1a. HP-97

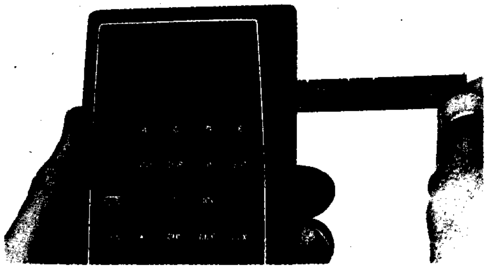


Figure 1b. HP-67

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.

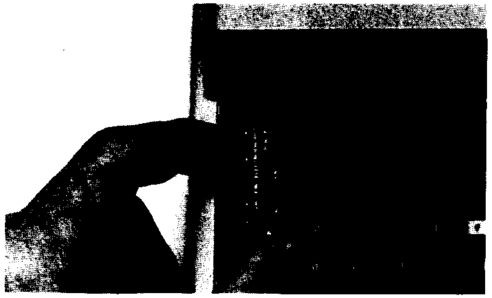


Figure 2a. HP-97

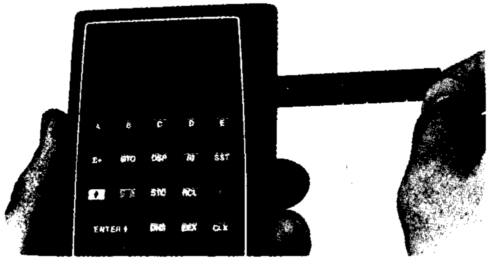


Figure 2b. HP-67

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).

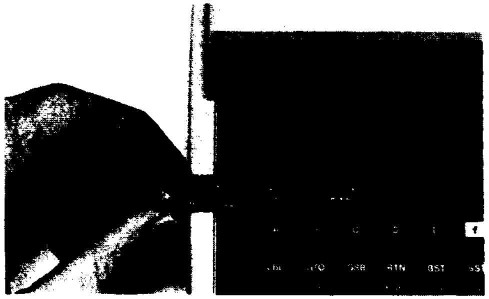


Figure 3a. HP-97

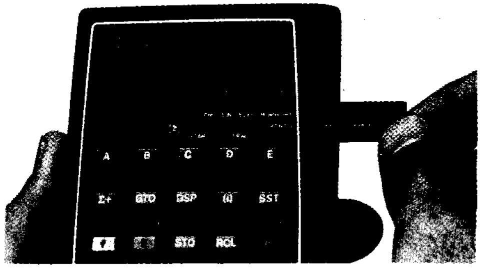


Figure 3b. HP-67

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			
	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.

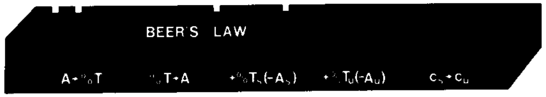
Step 10 is optional. You may press E to compute the albumin/globulin ratio. Press E now and find an A/G value of 1.63.

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.

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

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

Remarks:

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

Reference:

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

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

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

Example:

The following integration counts are determined electrophoretically for serum proteins:

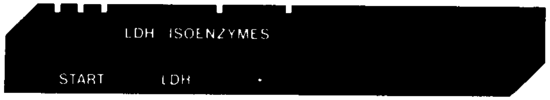
Albumin	67
α_1-globulin	4
α_2-globulin	10
β-globulin	14
γ-globulin	13

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

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

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

LDH ISOENZYMES



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

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

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

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

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

Equations:

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

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

Remarks:

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

Reference:

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

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

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
9	(optional) Obtain a reprint of			
	all data and results.*		f E	Ptnt # .03
				LDH$_1$
				...
				LDH$_5$
				LDH$_1$ %
				...
				LDH$_5$ %
	*A display of "Error" following			
	execution of this step			
	indicates a percentage			
	value that lies outside the			
	normal range for that			
	enzyme.			

Example:

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

Enzymes	Counts
LDH$_1$	95
LDH$_2$	120
LDH$_3$	85
LDH$_4$	15
LDH$_5$	22

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

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

C →	28.19 *** (% LDH$_1$)
	35.61 *** (% LDH$_2$)
	25.22 *** (% LDH$_3$)
	4.45 *** (% LDH$_4$)
	6.53 *** (% LDH$_5$)
	"Error"
CLx (clears "Error") →	0.00
f E →	10183.03 ***
	95.00 ***
	120.00 ***
	85.00 ***
	15.00 ***
	22.00 ***
	28.19 ***
	35.61 ***
	25.22 ***
	4.45 ***
	6.53 ***
	"Error"

A visual scan of the results indicates that the message "Error" resulted from the percentage value of LDH$_4$ (4.45%) being below the normal range (6%—16%).

BODY SURFACE AREA

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

To operate the program, the height in either cm or inches should be keyed in to **A**, and the weight in either kg or pounds keyed in to **B**. Then pressing **C** will allow the calculation of body surface area in m² by the method of Dubois; pressing **D** computes BSA in m² 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 m².

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

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

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 m². 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 (m²)
	• Boyd		**D**	BSA (m²)
9	(optional) Reprint all data			
	and results.		**f** **E**	Ptnt # .04
				Ht input
				Wt input
				BSA (m²)

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	***	(Pntnt 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:

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

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

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

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

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

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

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 m²) in register R_A. The program *Body Surface Area* (CL1-04A) automatically leaves BSA stored in R_A. If *Body Surface Area* has not been run immediately befroe this program, you will need to key in the BSA and press STO A.

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

Equations:

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

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

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

where

C_{creat} = creatinine clearance
U_{creat} = concentration of creatinine in urine
P_{creat} = concentration of creatinine in plasma

Remarks:

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

Reference:

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

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 of program.			
2	(optional) Initialize if reprint			
	desired.		f A	0.00
3	(optional) Key in patient			
	number.	Ptnt #	f C	Ptnt # .06
4	To suppress printing of data			
	and results, turn print			
	function off.		f D	0.00
5	To turn print function back			
	on later		f D	1.00
6	If BSA is required and *Body*			
	Surface Area has not been			
	run, key in BSA.	BSA (m²)	STO A	
7	If $\dot{V}$ is to be corrected for BSA.		f B	BSA (m²)
8	Perform either one of the			
	steps below:			
	• Key in urine volume and			
	time	V (ml)	ENTER↑	
		t (min)	A	$\dot{V}_{corr}$
	• Key in urine flow rate.	$\dot{V}$(ml/min)	B	$\dot{V}_{corr}$
9	Key in the concentration of			
	creatinine in urine.	U_{creat}	C	U_{creat}
10	Key in the concentration of			
	creatinine in plasma and find			
	the creatinine clearance.	P_{creat}	D	C_{creat}(ml/min)

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

Example 1:

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

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

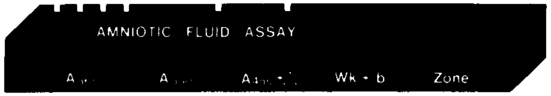
Example 2:

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

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

Notes

AMNIOTIC FLUID ASSAY



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

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

Equations:

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

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

where

$a = 0.91509$

Wk = week of gestation

Liley zones:

Zone I: $b < 0.7$

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

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

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

where

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

Hgb = hemoglobin concentration in g/100 ml

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

where

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

Remarks:

1. This program can also be used to correct PCO_2 and pH values from 37°C to body temperature. To do this, let x = (74 − BT) °C. Key in x to key **A**. Then input PCO_2 and pH to keys **B** and **C**, respectively. The number displayed after each of these steps is the value of the parameter corrected to body temperature. For example, if it is desired to correct a 37°C PCO_2 value of 45 mm Hg to a body temperature value with BT = 40°C, let x = 34. Key in 34, press **A**, key in 45, and press **B**. The corrected PCO_2 is found to be 51.31 mm Hg.
2. The equation to correct pH to 37°C values is a simplication of a formula from Severinghaus. It ignores the pH and BE dependent terms. This introduces a very small error except at extreme conditions of acid-base status and large temperature shifts. For example, at a pH of 7.2 or 7.6, the error is 0.0013 units per °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 cor-			
	rected to 37°C, key in body			
	temperature in °C.	BT (°C)	A	37 - BT
7	Key in partial pressure of CO_2 in			
	mm Hg.	PCO_2(mm Hg)	B	PCO_2 (37°)
8	Key in pH.	pH	C	pH (37°)
9	Find total plasma CO_2 in mmol/*l*.		D	TCO_2(mmol/*l*)
10	(optional) Key in hemoglobin			
	concentration and compute			
	base excess and $[HCO_3^-]$	Hgb(g/100ml)	E	BE (mEq/*l*)
			R/S	$[HCO_3^-]$(mmol/*l*)
11	To obtain a reprint.		f E	Ptnt # .08
				BT
				PCO_2
				pH
				TCO_2
				Hgb
				BE
				$[HCO_3^-]$

Example :

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

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

OXYGEN SATURATION AND CONTENT

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

Estimated saturation

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

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

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

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

Known saturation

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

Equations:

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

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

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

Remarks:

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

References:

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

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

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

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

Example 1:

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

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

Example 2:

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

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

Example 3:

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

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

Notes

RED CELL INDICES

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

The red cell count in millions per mm³ 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:

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

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

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

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 mm³.	Count (10^6/mm³)	A	Count
7	Key in hematocrit.	Hct (%)	B	Hct (%)
8	Key in hemoglobin in g/100ml and find mean corpuscular volume in μ^3.	Hgb (g/dl)	C	MCV (μ^3)
9	Compute mean corpuscular hemoglobin in pg ($\mu\mu$g).		D	MCH (pg)
10	Compute mean corpuscular hemoglobin concentration in g/dl (g/100ml).		E	MCHC (g/dl)
11	To obtain a reprint of data and results.		f E	Ptnt # .10 Count Hct (%) Hgb MCV MCH MCHC

Example:

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

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

Notes

TOTAL BLOOD VOLUME

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

Equations:

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

Remarks:

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

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

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

Reference:

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

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

Example:

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

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

Notes

SCHILLING TEST

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

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

Equations:

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

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

Dil = 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.

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

where

D is the radioactive decay factor.

Remarks:

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

Reference:

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

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

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

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

Example 1:

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

Keystrokes: **Outputs:**

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

Select ^{131}I as prior radioisotope.

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

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

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

Example 2:

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

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

RADIOACTIVE DECAY CORRECTIONS

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

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

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

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

Equations:

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

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

where:

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

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

Remarks:

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

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load side 1 and side 2.			
2	Select one of the fifteen radio-			
	isotopes and display half-life			
	in hours:			
	• Chromium—51 $(^{51}\mathrm{Cr})$		f A	667.20
	• Cobalt—57 $(^{57}\mathrm{Co})$		f B	6480.00
	• Technetium—99m $(^{99m}\mathrm{Tc})$		f C	6.00
	• Iodine—125 $(^{125}\mathrm{I})$		f D	1440.00
	• Iodine—131 $(^{131}\mathrm{I})$		f E	193.20
	• Cesium—137 $(^{137}\mathrm{Cs})$		E	262980.00
	• Hydrogen—3 $(^{3}\mathrm{H})$	1	D	107470.00
	• Carbon—14 $(^{14}\mathrm{C})$	2	D	50580000.00
	• Flourine—18 $(^{18}\mathrm{F})$	3	D	1.87
	• Phosphorus—32 $(^{32}\mathrm{P})$	4	D	343.20
	• Selenium—75 $(^{75}\mathrm{Se})$	5	D	2880.00
	• Strontium—85 $(^{85}\mathrm{Sr})$	6	D	1536.00
	• Indium—113m $(^{113m}\mathrm{In})$	7	D	1.73
	• Xenon—133 $(^{133}\mathrm{Xe})$	8	D	126.50
	• Mercury—197 $(^{197}\mathrm{Hg})$	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	($\overline{B}$)
				(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.

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

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

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

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

Grouped data:

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

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

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

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

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

Remarks:

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

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

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

Example 1:

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

Hemoglobin concentration (g/dl)

13.8	17.4
16.9	13.4
16.5	17.9
17.7	15.2
16.0	

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

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

Example 2:

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

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

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

CHI-SQUARE EVALUATION AND DISTRIBUTION

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

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

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

Equations:

Chi-square evaluation:

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

where:

O_i = observed frequency
E_i = expected frequency

If the expected values are equal

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

then

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

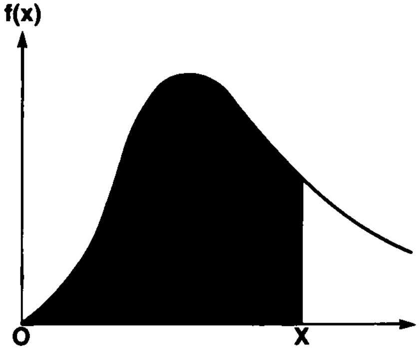
Chi-square distribution:

Chi-square density:

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

where:

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



Series approximation is used to evaluate the cumulative distribution

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

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

where:

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

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

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

Remarks:

1. In order to apply the goodness of fit test to a set of given data, it may be necessary to combine some classes to ensure that each expected frequency is not too small (not less than, say, 5).
2. The program for distribution requires that $\nu \leq 141$. 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 (ν/2))
5.10 f E	5.10 ***
	0.17 *** (P (χ^2))

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

Notes

t STATISTICS

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

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

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

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

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

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 $\boxed{D}$. Error correction is available on key $\boxed{f}$ $\boxed{D}$. After all x-values have been input, the value of d should be input to key $\boxed{f}$ $\boxed{E}$. Then the y-values should be keyed in to key $\boxed{D}$. After input of all the y-values, the t statistic may be found by pressing $\boxed{E}$.

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

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

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

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

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 *** (D̄)
                              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 *** (x1)
                                   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 *** (y1)
                         1.00     (i = 1)
14.4 D  ────────────→   14.40 ***
                         2.00
13.7 D  ────────────→   13.70 ***
                         3.00
16.8 D  ────────────→   16.80 ***
                         4.00
11.7 D  ────────────→   11.70 ***
                         5.00
14.9 D  ────────────→   14.90 ***
                         6.00
12.3 D  ────────────→   12.30 ***
                         7.00
E  ─────────────────→    2.76 *** (t)
R/S  ───────────────→   14.00 *** (df)
```

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

```
14 A 2.76 D  ───────→    0.98 *** (I (2.76))
```

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

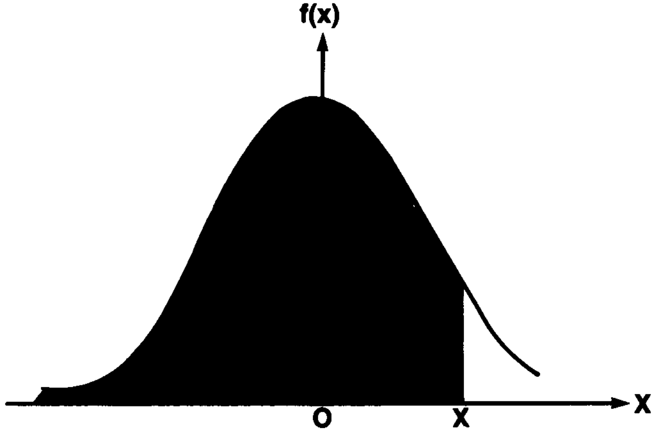
Notes

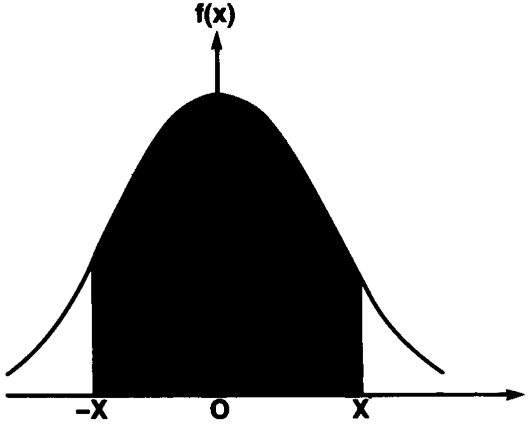
t DISTRIBUTION

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

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

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





Equations:

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

(1) ν even

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

(2) ν odd

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

where

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

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

Remarks:

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

Reference:

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

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

Example 1:

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

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

Example 2:

Find I(x) for x = 1.83 and ν = 11.

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

Notes

Notes

PROGRAM LISTINGS

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

Beer's Law

```
001  *LBLA     A → %T.
002   STOD
003    F0?
004   PRTX     A.
005      2
006      -
007    CHS
008   10^x
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     + % T_s (-A_s).
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 %T_s, compute A_s.
040      +
041   GTO0        ------
042  *LBL3
043    CHS
044  *LBL0
045   STOB     Store A_s.
046   RCLC     Display input.
047    RTN     -------------
048  *LBLD     + % T_u (-A_u).
049   STOA
050    F0?
051   PRTX
052   X<0?     For absorbance, GTO 4.
053   GTO4
054    LOG
055    CHS
056      2
057      +     For % T_u, compute A_u.
058   GTO0        ------
059  *LBL4
060    CHS
061  *LBL0
062   STO9     Store A_u.
063   RCLA     Display input.
064    RTN     -------------
065  *LBLE
066   STO8     C_s → C_u.
067    F0?
068    SPC
069    F0?
070   PRTX
071   RCL9
072      x     C_u = C_s x A_u / A_s.
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 C_u	8 C_s	9 A_u
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A Input to [D]	B A_s	C Input to [C]	D A	E % T	I 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→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	
0	☒	☐	
1	☐	☒	
2	☐	☒	
3	☐	☒	
TRIG			
DEG ☒			
GRAD ☐			
RAD ☐			
DISP			
FIX ☒			
SCI ☐			
ENG ☐			
n 2			

Protein Electrophoresis

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	$\text{Fract}_i \rightarrow R_{25-i}$.
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	$\% = \frac{\text{Fract}_i}{\Sigma} \times 100.$
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	*LBL8	
059	RCLi	
060	RCL0	
061	÷	
062	RCL2	$\text{Gms} = \frac{\text{Fract}_i}{\Sigma} \times \text{T Pr}$
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	GTO8	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	+	$\text{A/G} = \frac{\text{Fract}_1}{\sum_{i=2}^{5} \text{Fract}_i}$
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	
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.

REGISTERS

0 Σ Fract	1 25 − n	2 Tot Pr	3 Ptnt # .02	4	5	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9 Fract_6
A Fract_5	B Fract_4	C Fract_3	D Fract_2	E Fract_1	I Index				

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	RCLi	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	
059	RCL0	Subroutine to find % and test if within normal range.
060	÷	
061	EEX	
062	2	
063	×	$(\%)_i = \frac{LDH_i}{\sum_j LDH_j} \times 100$
064	PRTX	
065	X⇄Y	
066	X>Y?	
067	SF2	Min > %?
068	R↓	Yes, set flag 2.
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
093	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 Σ LDH_i	1 i	2 Ptnt # .03	3	4	5	6	7	8	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
A LDH_5	B LDH_4	C LDH_3	D LDH_2	E LDH_1	I Index				

113	SPC	Compute and print %.
114	GTOC	

LABELS

A START	B LDH_i	C →%	D	E None
a	b	c Ptnt#	d P off?	e Reprint
0 Used	1 %	2	3	4
5	6	7	8	9

FLAGS

0 Print
1
2 Range error
3

SET STATUS

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

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      x
015  *LBL1
016   STOD    Store height in cm.
017    RTN    - - - - - - - - - - - - -
018  *LBLB    Weight (+kg, - lb)
019   STOC
020    F0?
021   PRTX
022    F0?
023    SPC
024   X>0?    If weight in kg, GTO 2.
025   GTO2
026    CHS
027      .
028      4
029      5
030      3    Convert pounds to kg.
031      5
032      9
033      2
034      3
035      7
036      x
037  *LBL2
038   STOB    Store weight in kg.
039    RTN    - - - - - - - - - - - - -
040  *LBLC    Dubois BSA
041   RCLD
042      .
043      7
044      2
045      5
046     Yˣ
047   RCLB
048      .
049      4
050      2
051      5
052     Yˣ
053      x
054      .
055      0
056      0
057      7
058      1
059      8
060      4
061      x
062   STOA
063    F0?
064   PRTX
065    F0?
066    SPC
067    RTN    - - - - - - - - - - - - -
068  *LBLD    Boyd BSA
069   RCLD
070      .
071      3
072     Yˣ
073   RCLB
074    EEX
075      3
076      x
077   ENT↑
078    LOG
079      .
080      0
081      1
082      8
083      8
084      x
085      .
086      7
087      2
088      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 BSA (m^2)	B Wt (kg)	C Wt input	D Ht (cm)	E Ht input	I 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 (m^2)
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
0	☒	☐
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

Urea Clearance

```
001  *LBLA
002     ÷        V/t - - - - - - - -
003  *LBLB
004   STOE       V̇
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
016      3       V̇corr = (1.73/BSA) V̇
017   RCLA
018      ÷
019      x       - - - - - - - -
020  *LBL1
021   STOD       Output
022    F0?
023   PRTX
024    F0?
025    SPC
026    RTN       - - - - - - - - - - -
027  *LBLC
028   STOC       Uurea
029    F0?
030   PRTX
031    RTN       - - - - - - - - - - -
032  *LBLD
033   STOB       Burea
034    F0?
035   PRTX
036    F0?
037    SPC
038      2       If V̇corr ≤ 2, take √V̇ for
039   RCLD
040   X≤Y?       Cs = U√V̇ / B
041     √X
042   RCLC
043   RCLB       Otherwise Cm = UV̇ / B.
044      ÷
045      x
046   STO9       Clearance
047    F0?
048   PRTX
049    RTN       - - - - - - - - - - -
050  *LBLE       % mean normal
051      2
052   RCLD
053   X≤Y?       If V̇corr ≤ 2, GTO 0 for
054   GTO0       standard.
055   RCL9
056      1
057      .
058      3       Otherwise have maximum.
059      3
060      x
061   STO8
062    F0?
063   PRTX
064    RTN       - - - - - - -
065  *LBL0       Standard
066   RCL9
067      1
068      .
069      8
070      5
071      x
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       Print toggle
096    F0?
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 % m.n.	9 C
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
BSA (m²)	Burea	Uurea	V̇corr (ml/min)	V̇ (ml/min)	Ptnt # .05

```
113      +
114   PRTX       Patient ID
115    SPC
116   RCLE       V̇
117   PRTX
118   RCLD       V̇corr
119   PRTX
120    SPC
121   RCLC       Uurea
122   PRTX
123   RCLB       Burea
124   PRTX
125    SPC
126   RCL9       Clearance
127   PRTX
128   RCL8       % m.n.
129   PRTX
130    SPC
131    RTN       - - - - - - - - - - -
```

LABELS					FLAGS
A V↑t	B V̇	C Uurea	D Burea→C	E →% m.n.	0 Print
a Clear	b Cor BSA?	c Ptnt #	d P off?	e Reprint	1
0 Used	1 Exit V	2	3	4	2 Cor BSA?
5	6	7	8	9	3

SET STATUS

FLAGS	ON	OFF
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 BSA (m²)	B P_{creat}	C U_{creat}	D $\dot{V}_{corr}$ (ml/min)	E $\dot{V}$ (ml/min)	I Ptnt # .06

LABELS

A V↑t	B $\dot{V}$	C U_{creat}	D P_{creat}	E
a Clear	b Cor BSA?	c Ptnt #	d P off?	e Reprint
0 Used	1 Exit $\dot{V}$	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

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 Zone	9 b
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

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

```
113    RTN      - - - - - - - - - - - -
114  *LBLe
115    FIX      Reprint
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

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

FLAGS

0	Print
1	
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☒	☐
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
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
022      .      Correct PCO2 to 37°.
023      0
024      1
025      9
026      x
027    10^x
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    10^x
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
076   STO8      Hgb
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   RCL8
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      Patient ID = Ptnt # .08.
133    INT
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      Reprint
153    SPC
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

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

FLAGS

0	Print
1	BT
2	
3	

SET STATUS

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

Oxygen Saturation and Content

```
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    10ˣ
055   RCLE
056      x
```

```
057   GTO0      --------
058  *LBL1      If input < 0, make positive
059    CHS      --------
060  *LBL0
061   STOC      VPO2
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 O_2 content	B pH(37)	C VPO_2	D PCO_2 (37)	E PO_2 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      x
135      1
136      3
137      4      Compute oxygen content.
138      x
139   RCLC
140      3
141      1
142      x
143      +
144    EEX
145      4
146      ÷
147   STOA      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

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

FLAGS

0	Print
1	
2	Sat computed
3	

SET STATUS

FLAGS	ON	OFF
0	☒	☐
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

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

LABELS					FLAGS
A Count	B Hct (%)	C Hgb→MCV	D →MCH	E →MCHC	0 Print
a Clear	b	c Ptnt #	d P off?	e Reprint	1
0 Used	1	2	3	4	2
5	6	7	8	9	3

SET STATUS

FLAGS	ON	OFF
0	☒	☐
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

Total Blood Volume

```
001  *LBLA      Background counts.
002   STOE
003    F0?
004   PRTX
005    RTN      - - - - - - - - - - - - -
006  *LBLB      Volume injected.
007   STOD
008    F0?
009   PRTX
010    RTN      - - - - - - - - - - - - -
011  *LBLC      Standard dilution.
012   STOC
013    F0?
014   PRTX
015    RTN      - - - - - - - - - - - - -
016  *LBLD      Standard CPM.
017   STOB
018    F0?
019   PRTX
020    RTN      - - - - - - - - - - - - -
021  *LBLE      Whole blood CPM.
022   STOA
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      Initialize.
043      0
044   STOE
045   STOI
046    RTN      - - - - - - - - - - - - -
047  *LBLc      Patient ID = Ptnt # .11
048    INT
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 Blood CPM	B Std. CPM	C Std. dilution	D Vol. injected	E Bck	I Ptnt # .11

LABELS

A Bck	B Vol. inj.	C Std. dil.	D Std. CPM	E CPM→TBV
a Clear	b	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

Schilling Test

```
001  *LBLA      Background counts.
002   STOE
003    F0?
004   PRTX
005    RTN      ---------------
006  *LBLB
007   STOD      Standard dilution.
008    F0?
009   PRTX
010    RTN      ---------------
011  *LBLC
012   STOC      Standard counts.
013    F0?
014   PRTX
015    RTN      ---------------
016  *LBLD
017   STOB      Urine volume. (V)
018    F0?
019   PRTX
020    RTN      ---------------
021  *LBLE
022   STOA      Urine counts. (U)
023    F0?
024   PRTX
025      1      1     U
026    X⇄Y      U     1
027   RCLE      Bck   U     1
028      -      Net   1
029      1      1     Net   1
030   RCLB      V     1     Net   1
031   X≤Y?      Is V ≤ 1?
032     R↓      Yes, eliminate V.
033      ×      No, V > 1, multiply by V.
034      ×
035   RCLC
036   RCLE
037      -      Net std. counts.
038      ÷
039   RCLD
040      ÷
041    EEX
042      2      Convert to %.
043      ×
044   STO9      % of dose excreted.
045    F0?
046    SPC
047    F0?
048   PRTX
049    RTN      ---------------
050  *LBLa      Initialize.
051      0
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				

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
094    F0?     Print toggle
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	TRIG		DISP	
0	☒	☐	DEG	☒	FIX	☒
1	☐	☒	GRAD	☐	SCI	☐
2	☐	☒	RAD	☐	ENG	☐
3	☐	☒			n	2

Radioactive Decay Corrections

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

REGISTERS

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

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

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

Radioimmunoassay

001	*LBLA	Initialize.
002	F⇄S	
003	CLRG	
004	F⇄S	
005	GT02	
006	*LBLB	Non-specific binding
007	GSBD	counts (NSB).
008	RTN	
009	GSB1	
010	STOE	Average NSB.
011	RTN	
012	*LBLC	Zero dose counts (B_0).
013	GSBD	
014	RTN	
015	GSB1	
016	STOD	Average B_0.
017	RTN	
018	*LBL1	Compute average counts.
019	RCL8	
020	RCL9	
021	÷	
022	STOI	$\bar{B} = \Sigma B/n$
023	F0?	
024	SPC	
025	F0?	
026	PRTX	$\bar{B}$
027	F0?	
028	SPC	
029	F0?	
030	SPC	
031	*LBL2	Clear for n, ΣB
032	0	
033	STO8	
034	STO9	
035	R↓	
036	RTN	
037	*LBLb	Counts for standards and
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	$\bar{B} = \Sigma B/n$
051	0	
052	STO8	
053	STO9	
054	R↓	
055	F0?	
056	SPC	

057	F0?	$\bar{B}$
058	PRTX	
059	RCLE	
060	-	
061	RCLD	
062	RCLE	
063	-	net B/B_0
064	÷	
065	F1?	
066	PRTX	
067	F0?	
068	SPC	
069	R↓	
070	F0?	
071	PRTX	Concentration.
072	F0?	
073	SPC	
074	LOG	log conc. (x).
075	GSB3	logit (y).
076	F1?	
077	PRTX	Print logit.
078	X⇄Y	
079	F1?	
080	PRTX	Print log conc.
081	F1?	
082	SPC	
083	Σ+	Sum x- and y-values for
084	F0?	regression.
085	SPC	
086	RTN	
087	*LBLa	Compute r, m, b.
088	RCLΣ	
089	x	
090	P⇄S	
091	RCL9	
092	÷	
093	RCL8	
094	X⇄Y	
095	-	
096	STOB	$\Sigma xy - (\Sigma x\ \Sigma y)/n$
097	ENT↑	
098	ENT↑	
099	P⇄S	
100	S	
101	x	
102	÷	
103	P⇄S	
104	RCL9	
105	1	
106	-	
107	÷	
108	STOA	
109	PRTX	
110	RCLB	
111	RCL5	
112	RCL4	

REGISTERS

0	1	2	3	4	5	6	7	8 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	x	
124	-	
125	STOC	$b = \bar{y} - m\bar{x}$
126	PRTX	
127	SPC	
128	SPC	
129	RCLA	
130	RCLB	
131	RCLC	
132	RTN	
133	*LBLc	Compute concentration of
134	RCL8	unknown.
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	-	net B/B_0
151	÷	
152	F1?	
153	PRTX	
154	F0?	
155	SPC	
156	GSB3	Calculate logit (y).
157	STO8	
158	RCLC	
159	-	
160	RCLB	x (log conc.) $= (y - b)/m$
161	÷	
162	STO9	
163	10^x	
164	PRTX	Estimated concentration.
165	SPC	
166	RCL8	
167	F1?	
168	PRTX	Print logit (y).

169	RCL9	
170	F1?	
171	PRTX	Print log conc. (x).
172	F1?	
173	SPC	
174	R↓	
175	R↓	
176	F0?	
177	SPC	
178	GT02	
179	*LBL3	Logit calculation.
180	RCLI	
181	RCLE	
182	-	
183	RCLD	$\text{Logit} = \ln\left(\frac{B - NSB}{B_0 - B}\right)$
184	RCLI	
185	-	
186	÷	
187	LN	
188	RTN	
189	*LBLd	Print toggle.
190	F0?	
191	GTO0	
192	SF0	
193	1	
194	RTN	
195	*LBL0	
196	CF0	
197	0	
198	RTN	
199	*LBLe	Plot toggle.
200	F1?	
201	GTO0	
202	SF1	
203	1	
204	RTN	
205	*LBL0	
206	CF1	
207	0	
208	RTN	

LABELS

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

FLAGS

0	Print
1	Plot
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

Basic Statistics

```
001  *LBLA     Clear Σ registers
002   P⇄S
003     0
004  STO4
005  STO5
006  STO6
007  GTO7
008  STO8
009  STO9
010   P⇄S
011   RTN      - - - - - - - - - - - - -
012  *LBLB     x_i (Σ+)
013   F0?
014  PRTX
015    Σ+
016   RTN      - - - - - - - - - - - - -
017  *LBLb     x_k (Σ-)
018   F0?
019   SPC
020   F0?
021  PRTX
022    Σ-
023   RTN      - - - - - - - - - - - - -
024  *LBLC     Grouped data.
025   P⇄S
026   F0?
027  GTO0
028  GTO1          - - - - - - -
029  *LBL0     Print
030   SPC
031   X⇄Y
032  PRTX      f_i
033   X⇄Y
034  PRTX      x_i - - - - - - -
035  *LBL1
036  ENT↑
037  ENT↑
038     ×      x_i   x_i   x_i   f_i
039    R↑
040  ST+9      f_i   x_i^2 x_i   f_i
041     ×      Σf_i
042  ST+5      Σf_i x_i^2
043    R↓
044     ×
045  ST+4      Σf_i x_i
046     1
047  ST+6
048  RCL6
049   P⇄S      n
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      f_k
060   X⇄Y
061  PRTX      x_k - - - - - - -
062  *LBL1
063  ENT↑
064  ENT↑
065     ×
066    R↑
067  ST-9      Σf_i
068     ×
069  ST-5      Σf_i x_i^2
070    R↓
071     ×
072  ST-4      Σf_i x_i
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      s_x̄
094     x̄
095     S
096  LSTX
097     ÷
098   EEX
099     2
100     ×
101  PRTX      C. V.%
102   RTN      - - - - - - - - - - - -
103  *LBLa     Print toggle
104   F0?
105  GTO0
106   SF0
107     1
108   RTN
109  *LBL0
110   CF0
111     0
112   RTN
```

REGISTERS

0	1	2	3	4	5	6	7	8	9
S0	S1	S2	S3	S4 Σx	S5 Σx^2	S6 Used	S7 Used	S8 Used	S9 n, Σf_i

A	B	C	D	E	I

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

SET STATUS

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

L17-01

Chi-square Evaluation and Distribution

Step	Key	Comment
001	*LBLA	Start.
002	CF1	
003	CLRG	
004	2	
005	0	
006	STOI	I points to R_A.
007	RTN	
008	*LBLB	Input O_i (Σ+).
009	SF1	
010	GSB4	F1 set for equal E_i.
011	RCLB	
012	X⇄Y	
013	+	
014	STOB	ΣO_i
015	LSTX	
016	X²	
017	RCLC	
018	+	
019	STOC	ΣO_i^2
020	1	
021	ST+i	
022	RCLi	i
023	RTN	
024	*LBLb	Correct erroneous O_k (Σ−).
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 $O_i \uparrow E_i$ (Σ+).
044	CF1	
045	GSB9	
046	STOC	
047	-	
048	X²	
049	RCLC	
050	÷	
051	RCLB	
052	+	$\Sigma \frac{(O_i - E_i)^2}{E_i}$
053	STOB	
054	1	
055	ST+i	
056	RCLi	i

Step	Key	Comment
057	RTN	
058	*LBLc	Correct erroneous $O_k \uparrow E_k$ (Σ−).
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	
083	RCLA	Calculate χ^2 for equal E_i.
084	RCLC	
085	x	
086	RCLB	
087	÷	
088	LSTX	
089	-	χ^2
090	GSB4	
091	R/S	Calculate E.
092	RCLB	
093	RCLA	
094	÷	
095	GSB8	
096	GSB7	
097	RTN	
098	*LBL9	Print contents of Y- and X-registers if F0 set.
099	X⇄Y	
100	GSB4	
101	X⇄Y	
102	GSB8	
103	RTN	
104	*LBL4	Space and print.
105	GSB7	
106	*LBL8	
107	F0?	Print.
108	PRTX	
109	RTN	
110	*LBL7	Space
111	F0?	
112	SPC	

REGISTERS

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

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

L17-02

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

Step	Key	Comment
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	$x \rightarrow P(x)$
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	*LBLa	Print toggle
216	F0?	
217	GTO0	
218	SF0	
219	1	
220	RTN	
221	*LBL0	
222	CF0	
223	0	
224	RTN	

LABELS

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

FLAGS

0	Print
1	Used
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

t Statistics

```
001  *LBLA      Start.
002      0
003   STO1
004   STO2
005   STO3
006    RTN      -------------
007  *LBLa      Print toggle.
008    F0?
009   GTO0
010    SF0
011      1
012    RTN
013  *LBL0
014    CF0
015      0
016    RTN      -------------
017  *LBLB      Input x_i, y_i for paired t.
018    F0?
019   GSB9
020      -
021   ST+2
022     X²
023   ST+3
024   RCL1
025      1
026      +
027   STO1
028    RTN      -------------
029  *LBLb      Correct x_k, y_k for paired
030    F0?      t.
031   GSB9
032      -
033   ST-2
034     X²
035   ST-3
036   RCL1
037      1
038      -
039   STO1
040    RTN      -------------
041  *LBLC      Compute paired t.
042   RCL2
043   RCL1
044      ÷
045   STOA      D̄
046   RCL3
047   RCL2
048     X²
049   RCL1
050      ÷
051      -
052   RCL1
053      1
054      -
055   STOC      df
056      ÷
057     √X
058   STOB      s_D
059   RCL1
060     √X
061      ÷
062      ÷
063    SPC      t
064   PRTX
065    R/S
066   RCLC
067   PRTX
068   RCLA
069   PRTX
070   RCLB
071   PRTX
072    RTN      -------------
073  *LBLD      Input x_i or y_i for t for
074   GSB0      two means.
075   ST+2
076     X²
077   ST+3
078   RCL1
079      1
080      +
081   STO1
082    RTN      -------------
083  *LBLd      Correct x_k or y_k for t
084   GSB1      for two means.
085   GSB0
086   ST-2
087     X²
088   ST-3
089   RCL1
090      1
091      -
092   STO1
093    RTN      -------------
094  *LBLe      Input d.
095   STO7
096   RCL1
097   STO4      Save n_1, Σx, Σx².
098   RCL2
099   STO5
100   RCL3
101   STO6
102      0      Clear for Σy.
103   STO1
104   STO2
105   STO3
106   RCL7
107   GSB1
108   GSB0
109   GSB1
110    RTN      -------------
111  *LBLE      Compute t for two means.
112   RCL6
113   RCL5
114     X²
115   RCL4
116      ÷
117      -
118   RCL3
119      +
120   RCL2
121     X²
122   RCL1
123      ÷
124      -
125   RCL1
126   RCL4
127      +
128      2
129      -
130   STO8
131      ÷
132     √X
133   RCL1
134    1/X
135   RCL4
136    1/X
137      +
138     √X
139      ×
140   RCL5
141   RCL4
142      ÷
143   RCL2
144   RCL1
145      ÷
146      -
147   RCL7
148      -
149    X⇄Y
150      ÷
151    SPC
152   PRTX
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      -------------
```

REGISTERS

0	1 n	2 Used	3 Used	4 n_1	5 Σx	6 Σx^2	7 d	8 df	9
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

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

LABELS

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

FLAGS

0	Print
1	
2	
3	

SET STATUS

FLAGS	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

TRIG	
DEG	☒
GRAD	☐
RAD	☐

DISP	
FIX	☒
SCI	☐
ENG	☐
n	2

t Distribution

```
001  *LBLA      Input ν.
002   GSB5
003   STOD
004    RTN      -------------
005  *LBLB      x → f(x)
006   GSB5
007   STOA
008   RCLD
009   GSBa
010   STOE
011   RCLD
012      1
013      +
014   GSBa
015   STOC
016   RCLA
017   RCLC
018   RCLE
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      ν odd.
059  *LBL1
060      .
061      5
062   X=Y?
063   GTO2
064    X⇄Y
065      1
066      -
067   STx3
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   STOI
112      1
```

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   STO6
114   DSZI          ------
115   GTO3
116   GTOd
117  *LBL3
118   RCL3
119      x
120   RCL5
121      1
122      +
123      x
124   LSTX
125      1
126      +
127   STO5
128      ÷
129   ST+6
130   DSZI
131   GTO3
132   RCL6
133  *LBLd
134   RCL4
135      x
136    F1?
137    RTN          ------
138   RCLA      ν odd.
139   GTO6
140  *LBL4
141   RCL2
142      2
143      x
144     Pi
145      ÷
146   STO7
147   RCL0
148      1
149   STO5
150   X=Y?
151   GTO9
152    SF1
153   GSBb
154    CF1
155   RCL2
156    COS
157      x
158      2
159      x
160     Pi
161      ÷
162   RCL7
163      +
164   RCLA
165   GTO6
166    RTN          ------
167  *LBL9
168   RCL7
169   RCLA          ------
170   GTO6
171  *LBL8
172   RCL4          ------
173   RCLA      Exit.
174  *LBL6
175    DEG
176   X>0?      Compute P(x) from
177   GTO0      R(x) for x ≤ 0.
178    X⇄Y
179      1
180      -
181    CHS
182      2
183      ÷          ------
184   GTO7      Compute P(x) for
185  *LBL0      x > 0.
186    X⇄Y
187      1
188      +
189      2          ------
190      ÷
191  *LBL7      If F2 set, return to
192    F2?      LBL D.
193    RTN
194   PRTX
195    SPC
196    RTN      -------------
197  *LBLD      x → I(x)
198   GSB5
199    SF2
200    ABS
201    CHS
202   GSBc      P(−x)
203      2
204      x
205      1
206    X⇄Y      1 − 2P(−x)
207      -
208   PRTX      I(x)
209    SPC
210    RTN      -------------
211  *LBL5      Print.
212    F0?
213   PRTX
214    RTN      -------------
215  *LBLE      Print toggle.
216    F0?
217   GTO0
218    SF0
219      1
220    RTN
221  *LBL0
222    CF0
223      0
224    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 Used	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