HEWLETT hp PACKARD

HP-65

MEDICAL PAC 1

CAUTION:

For critical calculations the program(s) should be run twice to assure that no human or machine error has been introduced. This procedure must include reentry of the magnetic card(s), reinput of all data, and comparison of the results of the two calculations.

CONTENTS

INTRODUCTION

The HP-65 Medical Pac I consists of a group of programs which enable you to carry out common cardio-pulmonary and other medical calculations on the HP-65. Each program is a sequence of steps used for a particular calculation. These steps are permanently recorded on a magnetic card. When you pass the card through the program card reader, the lower slot on the right side of the HP-65, the program steps are read and automatically stored away in memory, ready to perform your calculation. They will remain there until you turn off the power, "read in" a program from another magnetic card, or depress keys while in **W/PRGM** mode. It isn't necessary to know or understand how the program was written in order to use it. However, if you are interested, there is a list of the steps for each program at the back of this manual, and an explanation of the various types of steps in the HP-65 Owner's Handbook.

The programs in Medical Pac I have been written to perform several types of medical calculations. The first group of nine cards contains programs to do unit conversions; for example, °F to °C, inches to centimeters, or drams (avoirdupois) to scruples (apothecary). A second group of nine cards contains programs to do calculations useful in the pulmonary function lab, such as percent of predicted vital capacity. Three additional programs carry out calculations used in setting up and adjusting a ventilator. Eight more programs do blood gas, acid-base and respiratory status calculations, such as base excess and alveolar-arterial O_2 difference. Another eight programs do calculations frequently required in a cath lab, such as cardiac output. In addition there is one special card used for convenient storage and recall of some of the patient's characteristics. A quick glance through this manual will give an idea of the scope of the programs included.

Much of their convenience and usefulness comes from the way the programs can be combined, and this will be illustrated by examples a little further on.

Using the Keyboard

When running Medical Pac I programs, only a few of the many keys on the HP-65 are actually used. To begin with, you may ignore all the yellow and blue labels. The only keys you'll usually need are the numeric keys, the five keys at the top labeled **A** through **E**, the decimal point, and the change sign key. The decimal point, [•], for example is used to input pH=7.38 into the calculator. The change sign key, [CHS], is used after a number is entered to make it negative (do not use the [−] key). [With a few of the programs, this is how you indicate to the calculator that you are using English units (inches, lbs., °F) rather than metric units (cm, kg, °C).] A few other keys may be useful at times, but aren't really necessary to use these programs. The W/PRGM–RUN switch must always be in RUN (except for the special case described in program 1–05A (ID)).

Running Programs

To run a program, pass the card through the card reader as described on page 9. You will then generally have to enter some data using the numeric keys, for example, a measurement made on the patient. The numbers appear in the display as you key them in. Then press the appropriate program key: one of the five lettered keys at the top. The desired answer to your problem may be immediately displayed, but more often it will be necessary to enter additional data before the desired result can be calculated. For most of the programs (except the unit conversions), the lettered keys are pressed sequentially from left to right. Between program execution steps, you will input a piece of data, record a displayed output, or both. The instructions for each individual program in this manual tell you exactly what to do, and point out any exceptions to the general procedure.

To help remind you of what to do at each step, abbreviated instructions are printed on the program cards themselves. Slipping the card into the upper slot on the right side of the HP-65 places the abbreviations directly above their respective keys. If the program requires you to key in a particular piece of data, the symbol for that data will be printed above the key. For example, if hemoglobin concentration is to be input, key in the data, then press the key labeled HGB. If a useful result is expected, it will be indicated on the card by an arrow pointing to the symbol for the result, for example, HGB→CONT means that blood oxygen content will be calculated after entering HGB and pressing the appropriate program key. If no new data needs to be keyed in to calculate a result, the abbreviation for the result is printed above the key with an arrow before it.

Running a program will make many of these points clearer. Try the blood acid-base status program, 1–12A (ACID). First turn on the HP-65. Then run the card through the lower slot from right to left to read in or "enter" the program. Now put the card in the upper slot. Notice that key [A] is labeled PCO_2. Let's suppose the patient's PCO_2 was measured to be 45 mmHg. Press [4] [5], making sure it is correctly displayed, and press [A]. Now enter the patient's pH. Suppose it was measured to be 7.35. Press [7] [•] [3] [5] and press [B]. Now enter the hemoglobin concentration, say 16 gm/100ml. Press [1] [6] and then press [C].

Notice that the label above key **D** has an arrow before it. That means no entry of data is required. Simply press **D**, and the total plasma CO_2 in mEq/*l* will be displayed, 25.39. Then press **E**, and the HP-65 will calculate and display the base excess, −1.36 mmol/*l* in this case.

Data Memory

In addition to the memory for the program, the HP-65 has another memory for data. This memory is not changed by reading in a new program, although it is erased if the calculator is turned off. The programs take advantage of data memory to store some of the entered and calculated data about a patient. Then, when another program is run, or the same program is run again, it is *usually* not necessary to reenter data already in the memory. Many of the programs will prompt you with the stored value when it is needed. If you wish to use it, simply press the next program key without making a new numeric entry. Of course, you can always enter a new value, which will be stored in memory in place of the old. To demonstrate this, do another calculation with program 1−12A (ACID). Enter a new PCO_2, say 40 mmHg. Press **A**. You will be prompted with the old value for pH, which is to be entered next. If you are not satisfied with the old value, 7.35, enter a new one, say 7.38. Press **B**. You will then be prompted with the old value of Hgb, 16 gm/100 ml. If this is unchanged, simply press **C**. You can then press **D** and **E** as before, and the new values for TCO_2 and BE will be calculated.

The data memory consists of nine separate "registers". Table I at the end of this manual (Page 80) shows where the various patient parameters are stored in the memory registers. Normally, you don't need to be concerned with these matters unless you are planning a new and more efficient sequence of programs which will not require re-entry of data.

Most of the programs in Medical Pac I can be run in any order. In a few cases, they *must* directly follow each other although the order may change (e.g. the weight conversion programs). In other cases, an exact order must be followed (e.g. the pulmonary function and ventilator setup programs).

Options

After each input of data, it is very important that you check the display to make sure that no error was made in pressing the keys. This will guarantee that the results will be calculated from the correct data. If you do note an error before you press the next program key, it may be corrected by pressing [CLX] (which clears the display to zero), then reentering the data. If you suspect an entry error, and the next program key has already been pressed, *it is best to start over at the beginning of the program.* However, it is not necessary to reload the card. In some of the programs, more than five program keys are needed. This has been resolved in a few cases by requiring that certain program keys be pressed more than once. In other cases, certain optional steps are accomplished by pressing the **RUN/STOP** key, R/S , in the lower right hand corner of the keyboard. These exceptions to the usual mode of operation are covered in detail in the particular program descriptions and operating instructions.

HP-65 Arithmetic

Even though a program is in the machine, the HP-65 can be used as a non-programmable calculator. (Check whether the program uses R_9 before using trigonometric functions or R→P, however.) Be sure the correct entry is in the display before pressing the next program key. This is frequently useful when a calculation is necessary to derive your next entry. For example, suppose the program calls for a hemoglobin concentration in gm/100 ml, but you have only measured hematocrit in %. Approximately

$$\text{Hgb} = \frac{\text{Hct}}{3}$$

Make the conversion on the HP-65 just prior to pressing the program key that enters Hgb into the program.

When using the HP-65 as a non-programmable calculator, all but the black keys are used. To do arithmetic on the calculator, key in the first number in your calculation. Then press [ENTER↑]. Key in the next number and then press the function you want to perform. For example, to convert 97°F to °C, the formula is:

$$T\,(^\circ C) = [T\,(^\circ F) - 32] \cdot \frac{5}{9}$$

Key in [5], Press [ENTER↑]
Key in [9], Press [÷]
Key in [9], [7] Press [ENTER↑]
Key in [3], [2] Press [−], [×]

The result, 36.11 °C, is displayed. If this temperature is the next entry called for in the program, simply press the appropriate program key.

The following examples use a series of programs to carry out the many calculations in a particular medical procedure. Included are examples from an adult cath lab, a pediatric cath lab, and a respiratory intensive care unit. These examples are fairly complicated. Before attempting them, read over the detailed instructions for each of the programs and try the included examples. In these examples, values stored in memory for later use are underlined. When recalled from memory (so that they do not need to be reentered), they are enclosed in brackets.

Adult Cath Lab Example

Note that cardiac output, calculated in 1–22A (DYE), is used in 1–20A (BSA), 1–24A (VALVE) and 1–27A (WORK). Body surface area, calculated in 1–20A (BSA), is used in 1–27A (WORK).

PROGRAM	INPUTS	OUTPUTS
1–22A(DYE)	Δt = 1 sec.; DC = 38, 67, 80, 73, 61, 48, 36, 29 Div; CAL = 0.11 mg/*l*/Div; DOSE = 5.6 mg	AREA = 532.60 Div sec; CAL x AREA = 58.59 mg/*l* CO = 5.73 *l*/min
1–20A(BSA)	Ht = –72.1 in.; Wt = –191 lb. (CO)	Ht = 183.13 cm; Wt = 86.82 kg; BSA = 2.09 m^2; CI = 2.74 *l*/min/m^2
1–24A(VALVE) Aortic	SEP = 0.2 sec; ΔP = 38, 45, 40, 31 mmHg; R–R = 0.92 sec (CO)	$\overline{\Delta P}$ = 38.50 mmHg; AREA = 1.59 cm^2
1–24A(VALVE) Mitral	DFP = 0.55 sec; ΔP = 10, 12, 8, 6, 2 mmHg; R–R = 0.94 sec; (CO)	$\overline{\Delta P}$ = 7.60 mmHg; AREA = –1.90 cm^2
1–27A(WORK)	P_{sys} = 155, 169, 165, 152, 138 mmHg; R–R = 0.92 sec; (CO) (BSA)	$\overline{\Delta P}$ = 155.80 mmHg; SW = 186.17 gm · m; SWI = 88.95 gm · m/m^2
1–26A(V_{MAX})	t = 0.01 sec; P_N = 14.8, 28.5, 51.7, 81.8, 105.6	MAX dP/dt = 3010 mmHg/sec; MAX dP/dt/P = 63.3 sec; V_{MAX} = 2.49 circ/sec

Pediatric Cath Lab Example

Note that body surface area calculated in 1–21A (BOYD) is used in 1–23A (FICK). Venous oxygen content, calculated the first time 1–14A (SAT) is run, is used in 1–23A (FICK). Hemoglobin, entered the first time 1–14A (SAT) is run, automatically reappears the second time. Especially note that arterial oxygen content is left in the display the second time 1–14A (SAT) is run, and is ready as the first entry in 1–23A (FICK). This is another method of transferring data between programs.

PROGRAM	INPUTS	OUTPUTS
1–21A(BOYD)	Ht = 55 cm; Wt = 4.2 kg	BSA = 0.26 m^2
1–14A(SAT) Venous	PO_2 = 30 mmHg; Sat. = 55%; Hgb = 18 gm/100 ml	Est. Sat. = 57.18% C_vO_2 = 13.36 Vol. %
1–14A(SAT) Arterial	PO_2 = 52 mmHg; Sat. = 84.5% (Hgb)	Est. Sat. = 86.86% C_aO_2 = 20.54 Vol.%
1–23A(FICK)	(C_aO_2); (C_vO_2); $\dot{V}O_2$ = 60 ml/min (BSA); HR = 95 BPM	CO = 0.84 *l*/min CI = 3.15 *l*/min/m^2 SV = 8.74 ml; SI = -33.14 ml/m^2
1–25A(ANA)	R–SYST = 55%; R–PUL = 62%; L–SYST = 84.5%; L–PUL = 97%	L–R SHUNT = 16.67% R–L SHUNT = -29.76%

Respiratory Intensive Care Example

This is an example of the types of complicated calculations that might be done in a respiratory intensive care situation with integral blood gas lab. Many entered and calculated parameters are used by later programs. Calculations start from uncorrected blood parameters and it is assumed that O_2 saturations are not measured. Venous blood parameters are computed first, so that arterial values will be left in memory for later use in the ventilation/perfusion calculations. O_2 saturation and content is calculated before temperature correction.

PROGRAM	INPUTS	OUTPUTS
Venous Blood		
1–12A(ACID)	PCO_2 = 44 mmHg; pH = 7.375; Hgb = 15 gm/100 ml	TCO_2 = 26.22 mmol/*l* BE = 0.01 mEq/*l*
1–13A(VPO_2)	PO_2 = 40 mmHg; (PCO_2); (pH); BT = 39°C	VPO_2 = 34.64 mmHg (in display, reg.)
1–14A(SAT)	(VPO_2); (Hgb)	Est. Sat. = 66.54%; C_vO_2 = 13.48 Vol. %
1–15A(ΔpH)	(PCO_2); (pH); (BT)	PCO_2 = 48.02 mmHg; pH = 7.35
1–16A(ΔPO_2)	(SAT); (PO_2); (BT)	PO_2 = 46.15 mmHg
Arterial Blood		
1–12A(ACID)	PCO_2 = 40 mmHg; pH = 7.4; (Hgb)	TCO_2 = 25.18 mmol/*l* BE = –0.04 mEq/*l*
1–13A(VPO_2)	PO_2 = 90 mmHg; (PCO_2); (pH); (BT)	VPO_2 = 80.59 mmHg (in display reg.)
1–14A(SAT)	(VPO_2); (Hgb)	Est. Sat. = 95.91% C_aO_2 = 19.53 Vol. %
1–15A(ΔpH)	(PCO_2); (pH); (BT)	PCO_2 = 43.65 mmHg; pH = 7.37
1–16A(ΔPO_2)	(SAT); (PO_2); (BT)	PO_2 = 102.19 mmHg
Ventilation/ Perfusion		
1–17A(V_D/V_T)	$\dot{V}CO_2$ = 240 ml/min; $\dot{V}O_2$ = 300 ml/min; (P_aCO_2); $\dot{V}_E$ = 7.4 *l*/min	R_Q = 0.80; $\dot{V}_A$ = 4.74 *l*/min; V_D/V_T = 0.36
1–18A(A–a)	P_IO_2 = 200 mmHg; (P_aO_2); (P_aCO_2); (R_Q)	A–a Diff = 46.12 mmHg; P_AO_2 = 148.31 mmHg (in display reg.)
1–14A(SAT)	(P_AO_2); (Hgb)	Sat. = 98.91% C_AO_2 = 20.34 Vol. % (in display reg.)
1–19A(PHYS)	(C_AO_2); (C_aO_2); (C_vO_2); ($\dot{V}O_2$)	CO = 4.96 *l*/min; SHUNT = 11.85%
1–20A(BSA)	Ht = –69 in.; Wt = 52 kg (CO)	Ht = 175.26 cm; BSA = 1.63 m^2; CI = 3.04 *l*/min/m^2.

For repetitive series of calculations we recommend that you make up a work sheet for recording the entries and results, and make copies of it. This will not only serve as a guide to insure that programs are run in the correct sequence, but it will also serve as a record of calculations completed. It should be in a format which will permit direct inclusion in the patient's record.

ENTERING A PROGRAM

From the card case supplied with this application pac, select a program card.

Set W/PRGM-RUN switch to RUN.

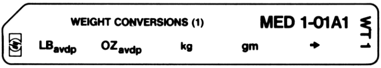
Turn the calculator ON. You should see 0.00

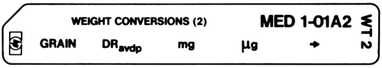
Gently insert the card (printed side up) in the right, lower slot as shown. When the card is part way in, the motor engages it and passes it out the left side of the calculator. Sometimes the motor engages but does not pull the card in. If this happens, push the card a little farther into the machine. Do not impede or force the card; let it move freely. (The display will flash if the card reads improperly. In this case, press [CLX] and reinsert the card.)

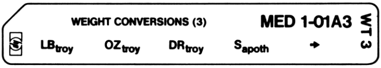
When the motor stops, remove the card from the left side of the calculator and insert it in the upper "window slot" on the right side of the calculator.

The program is now stored in the calculator. It remains stored until another program is entered or the calculator is turned off.

WEIGHT CONVERSIONS







The weight conversion package consists of three programs that allow conversion of weights from one unit of measure to another.

Conversion Factors:

WT 1

1 pound mass (avoirdupois) $\equiv 4.535\ 923\ 7 \times 10^2$ grams

1 ounce mass (avoirdupois) $= 2.834\ 952\ 313 \times 10^1$ grams

1 kilogram $\equiv 1 \times 10^3$ grams

WT 2

1 grain $\equiv 6.479\ 891 \times 10^{-2}$ grams

1 dram (avoirdupois) $=$ 1.771 845 195 grams

1 milligram $\equiv 1 \times 10^{-3}$ grams

1 microgram $\equiv 1 \times 10^{-6}$ grams

WT 3

1 pound mass (troy or apothecary) $\equiv 3.732\ 417\ 216 \times 10^2$ grams

1 ounce mass (troy or apothecary) $\equiv 3.110\ 347\ 68 \times 10$ grams

1 dram (troy or apothecary) $\equiv$ 3.887 934 6 grams

1 scruple (apothecary) $\equiv$ 1.295 978 2 grams

Reference:

Mechtly, *The International System of Units, Physical Constants and Conversion Factors,* Revised, NASA SP-7012, 1969

Detailed User Instructions:

To convert a quantity to a new unit system, the card which contains the units of the original quantity is entered according to the entering procedure. The quantity to be converted is keyed into the display, and the key corresponding to the units of the quantity is pressed. For example, if 5 pounds avoirdupois is to be converted, the WT 1 program is entered, [5] is pressed, and then [A] is pressed to define 5 as pounds avoirdupois. Next, the program card with the units to which the quantity is to be converted is entered according to the entering procedure without turning the calculator off. (If the units to be converted "to" are on the same card as the units to be converted "from", the new program card need not be reentered.) Next, press the [E] key, which signifies that the next key to be pressed is the desired units key. In the above example, if 5 pounds avoirdupois were to be converted to pounds troy, the WT 3 card would be entered, and [E] then [A] would be pressed. The calculator display would then contain 5 pounds avoirdupois converted to pounds troy.

Note:

Be sure that the quantity input is correctly displayed after the key defining the entry units is pressed.

Examples:

Convert 7 drams (avoirdupois) to milligrams

Answer: 12402.92 milligrams

Convert 4.39 pounds troy to kilograms

Answer: 1.64 kilograms

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter magnetic card with units				
	of quantity to be converted				
2	Input quantity and press key				
	corresponding to its units.				
	(For card WT1)				
	Pounds (avoirdupois)	quantity	A		quantity*
	or Ounces (avoirdupois)	quantity	B		quantity*
	or Kilograms	quantity	C		quantity*
	or Grams	quantity	D		quantity*
	(For card WT2)				
	Grains	quantity	A		quantity*
	or Drams (avoirdupois)	quantity	B		quantity*

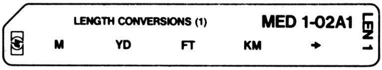
(Cont'd)

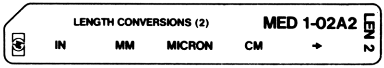
(Cont'd)

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
	or Milligrams	quantity	C		quantity*
	or Micrograms	quantity	D		quantity*
	(For card WT3)				
	Pounds (troy)	quantity	A		quantity*
	or Ounces (troy)	quantity	B		quantity*
	or Drams (troy)	quantity	C		quantity*
	or Scruples (apothecary)	quantity	D		quantity*
3	If the units desired are not in-				
	cluded on the first card entered,				
	enter the card with the desired				
	units.				
4	Calculate quantity in desired				
	units				
	(For card WT1)				
	Pounds (avoirdupois)		E	A	con. quan.
	Ounces (avoirdupois)		E	B	con. quan.
	or Kilograms		E	C	con. quan.
	or Grams		E	D	con. quan.
	(For card WT2)				
	Grains		E	A	con. quan.
	or Drams (avoirdupois)		E	B	con. quan.
	or Milligrams		E	C	con. quan.
	or Micrograms		E	D	con. quan.
	(For card WT3)				
	Pounds (troy)		E	A	con. quan.
	or Ounces (troy)		E	B	con. quan.
	or Drams (troy)		E	C	con. quan.
	or Scruples (apothecary)		E	D	con. quan.
5	For next conversion enter the				
	card containing the proper unit				
	key (if it was not the last card				
	entered) and go to step 2.				

***NOTE:** If quantity does not reappear turn machine off and repeat step 1.

LENGTH CONVERSIONS





The length conversion package consists of two programs that allow conversion of lengths from one unit of measure to another.

Conversion Factors:

LEN 1

1 m ≡ 1 x 10^2 centimeters

1 yard ≡ 9.144 x 10^1 centimeters

1 foot ≡ 3.048 x 10^1 centimeters

1 kilometer ≡ 1 x 10^5 centimeters

LEN 2

1 inch ≡ 2.54 centimeters

1 millimeter ≡ 1 x 10^{-1} centimeters

1 micrometer ≡ 1 x 10^{-4} centimeters

References:

Mechtly, *The International System of Units, Physical Constants and Conversion Factors,* Revised, NASA SP-7012, 1969

Detailed User Instructions:

To convert a quantity to a new unit system, the card which contains the units of the original quantity is entered according to the entering procedure. The quantity to be converted is keyed into the display, and the key corresponding to the units of the input quantity is pressed. For example, if 3 feet is to be converted, the LEN 1 program is entered [3] is pressed, and then [C] is pressed to define 3 as feet. Next, the program card with the units to which the quantity is to be converted is entered without turning the calculator off. (If the units to be converted "to" are on the same card as the units to be converted "from", a new program card need not be re-entered.) Next, press the E key, which signifies that the next key to be pressed is the desired units key. In the above example, if 3 feet were to be converted to inches, the LEN 2 card would be entered, and E then A would be pressed. The calculator display would then contain 3 feet converted to inches.

Note:

Be sure that the quantity input is correctly displayed after the key defining the input unit is pressed.

Examples:

Convert 3 meters to feet.

Answer: 9.84 feet

Convert 1.23 yards to centimeters.

Answer: 112.47 centimeters

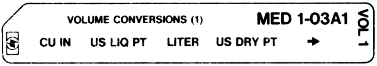
STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter magnetic card with units			
	of quantity to be converted.			
2	Input quantity and press key			
	corresponding to its units:			
	(For card LEN 1)			
	Meters	quantity	A	quantity*
	or Yards	quantity	B	quantity*
	or Feet	quantity	C	quantity*
	or Kilometers	quantity	D	quantity*
	(For card LEN 2)			
	Inches	quantity	A	quantity*
	or Millimeters	quantity	B	quantity*
	or Microns	quantity	C	quantity*
	or Centimeters	quantity	D	quantity*
3	If the units desired are not			
	included on the first card			
	entered, enter the card with the			
	desired units.			

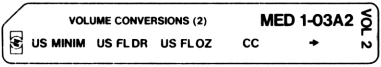
(Cont'd)

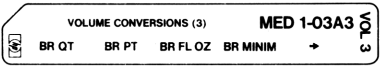
STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
4	Calculate quantity in desired				
	units				
	(For card LEN 1)				
	Meters		E	A	con. quan.
	or Yards		E	B	con. quan.
	or Feet		E	C	con. quan.
	or Kilometers		E	D	con. quan.
	(For card LEN 2)				
	Inches		E	A	con. quan.
	or Millimeters		E	B	con. quan.
	or Microns		E	C	con. quan.
	or Centimeters		E	D	con. quan.
5	For next conversion enter the				
	card containing the proper unit				
	key (if it was not the last card				
	entered) and go to step 2.				

***NOTE:** If quantity does not reappear turn machine off and repeat step 1.

VOLUME CONVERSIONS







The volume conversion package consists of three programs that allow conversion of volumes from one unit of measure to another.

Conversion Factors:

VOL 1

1 cubic inch ≡ 1.638 706 4 x 10^1 cubic centimeters

1 pint (U. S. liquid) ≡ 4.731 764 73 x 10^2 cubic centimeters

1 liter ≡ 1 x 10^3 cubic centimeters

1 pint (U.S. dry) = 5.506 104 714 x 10^2 cubic centimeters

VOL 2

1 minim (U.S. fluid) = 6.161 151 992 x 10^{-2} cubic centimeters

1 dram (U.S. fluid) = 3.696 691 195 cubic centimeters

1 ounce (U.S. fluid) = 2.957 352 956 x 10^1 cubic centimeters

VOL 3

1 quart (British) = 1.136 522 x 10^3 cubic centimeters

1 pint (British) = 5.682 609 2 x 10^2 cubic centimeters

1 ounce (British, fluid) = 2.841 305 x 10^1 cubic centimeters

1 minim (British) = 5.919 385 x 10^{-2} cubic centimeters

References:

Mechtly, *The International System of Units, Physical Constants and Conversion Factors,* Revised, NASA SP-7012, 1969, and *Handbook of Chemistry and Physics,* 50th Edition, Chemical Rubber Company, 1968.

Detailed User Instructions:

To convert a quantity to a new unit system, the card which contains the units of the original quantity is entered according to the entering procedure. The quantity to be converted is keyed into the display, and the key corresponding to the units of the quantity is pressed. For example, if 5 liters is to be converted, the VOL 1 program is entered, [5] is pressed, and then [C] is pressed to define 5 as liters. Next, the program card with the units to which the quantity is to be converted is entered according to the entering procedure without turning the calculator off. (If the units to be converted "to" are on the same card as the units to be converted "from", the new program card need not be reentered.) Next, press the [E] key, which signifies that the next key to be pressed is the desired units key. In the above example, if 5 liters were to be converted to British quarts, the VOL 3 card would be entered, and [E] then [A] would be pressed. The calculator display would then contain 5 liters converted to British quarts.

Note:

Be sure that the quantity input is displayed correctly after the key defining the entry units is pressed.

Examples:

Convert 4 U.S. fluid ounces to U.S. fluid drams.

Answer: 32 U.S. fluid drams

Convert 6.31 liters to British pints.

Answer: 11.10 British pints

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter magnetic card with units		[ ] [ ]	
	of quantity to be converted		[ ] [ ]	
2	Input quantity and press key		[ ] [ ]	
	corresponding to its units:		[ ] [ ]	
	(For card VOL 1)		[ ] [ ]	
	Cubic inches	quantity	[A] [ ]	quantity*
	or U.S. liq. pints	quantity	[B] [ ]	quantity*
	or Liters	quantity	[C] [ ]	quantity*
	or U.S. dry pints	quantity	[D] [ ]	quantity*
	(For card VOL 2)		[ ] [ ]	
	U.S. minim	quantity	[A] [ ]	quantity*

(Cont'd)

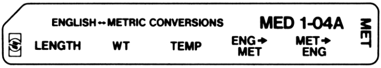
(Cont'd)

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
	or U.S. fl. drams	quantity	B		quantity*
	or U.S. fl. oz.	quantity	C		quantity*
	or Cubic centimeters	quantity	D		quantity*
	(For card VOL 3)				
	Br. quarts	quantity	A		quantity*
	or Br. pints	quantity	B		quantity*
	or Br. fl. oz.	quantity	C		quantity*
	or Br. minim	quantity	D		quantity*
3	If the units desired are not				
	included on the first card				
	entered, enter the card with the				
	desired units.				
4	Calculate quantity in desired				
	units				
	(For card VOL 1)				
	Cubic inches		E	A	con. quan.
	or U.S. liq. pints		E	B	con. quan.
	or Liters		E	C	con. quan.
	or U.S. dry pints		E	D	con. quan.
	(For card VOL 2)				
	U.S. minim		E	A	con. quan.
	or U.S. fl. drams		E	B	con. quan.
	or U.S. fl. oz.		E	C	con. quan.
	or Cubic centimeters		E	D	con. quan.
	(For card VOL 3)				
	Br. quarts		E	A	con. quan.
	or Br. pints		E	B	con. quan.
	or Br. fl. oz.		E	C	con. quan.
	or Br. minim		E	D	con. quan.
5	For next conversion enter the				
	card containing the proper unit				
	key (if it was not the last card				
	entered) and go to step 2.				

***NOTE:** If quantity does not reappear turn machine off and repeat step 1.

Notes

ENGLISH-METRIC CONVERSIONS



The English-metric conversion program allows conversion between commonly used English and metric units of length, weight, and temperature. The metric units of length are centimeters while the English units of length are inches. The metric units of weight are kilograms while the English units of weight are pounds (avoirdupois). The metric units of temperature are degrees Celsius (Centigrade), while the English units of temperature are degrees Fahrenheit.

Conversion Factors:

These factors, though not exact, give the accuracy generally required in medical work.

1 centimeter $\cong$ 0.3937 inch

1 kilogram $\cong$ 2.2 pounds

$$°F = 1.8 \cdot (°C) + 32$$

Detailed User Instructions:

Key in the quantity to be converted then press [A], [B] or [C] to define that quantity as length, weight, or temperature, then press letter [D] or [E] to convert the quantity from English to metric or metric to English, respectively. For example, if 23 pounds is to be converted to kilograms, key in [2] [3], press [B], and, since the conversion is from English units to metric units, press [D]. The display will then show the 23 pound weight converted to kilograms.

Examples:

Convert 70 inches to centimeters.

Answer: 177.80 centimeters

Convert 103° Fahrenheit to Celsius

Answer: 39.44 degrees Celsius

Convert 4 kilograms to pounds.

Answer: 8.80 pounds

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter MET		[ ] [ ]	
2	To convert length in inches	inches	[A] [ ]	inches
	to centimeters		[D] [ ]	centimeters
	or length in centimeters	centimeters	[A] [ ]	centimeters
	to inches		[E] [ ]	inches
	or weight in pounds	pounds	[B] [ ]	pounds
	to kilograms		[D] [ ]	kilograms
	or weight in kilograms	kilograms	[B] [ ]	kilograms
	to pounds		[E] [ ]	pounds
	or temperature °F	°F	[C] [ ]	°F
	to temperature °C		[D] [ ]	°C
	or temperature °C	°C	[C] [ ]	°C
	to temperature °F		[E] [ ]	°F
3	For next conversion go to		[ ] [ ]	
	step 2.		[ ] [ ]	

MASTER PATIENT IDENTIFICATION

MASTER PATIENT IDENTIFICATION			MED 1-05A		ID
ENTER	→HT	→WT	→AGE	→SEX	

This program is different from all others in Medical Pac I. It is used in a two-stage process. First an identification card unique to a particular patient is made, then the resulting ID card may be used whenever needed to put patient parameters into the HP-65 memory registers for use by other programs in this pac. The Patient ID program provides convenience and accuracy in fixed patient parameters when they must be available repeatedly, as in a series of tests in the pulmonary function lab, or repeated testing, as in the intensive care unit. It does no calculations itself except English-metric unit conversions for height and weight.

Conversion Factors:

1 kilogram = 2.2 pounds

1 inch = 2.54 centimeters

Making the Patient Identification Card:

Enter the Master Patient Identification card into the HP-65 in the usual way. After entering, but before pressing any button, move the **W/PRGM-RUN** switch to **W/PRGM**. Now, carefully input the height in centimeters (or in inches followed by [CHS]). Then press [ENTER↑]. Input the weight in kilograms (or in pounds followed by [CHS]). Press [ENTER↑] again. Input the age in years. Press [ENTER↑]. Input sex; 1 for male, 0 for female. Do *not* press [ENTER↑] after inputting the sex.

Now copy the data and program on to a new card which will become unique to the particular patient. To do this, take an unrecorded card with upper left corner intact, and run it through the HP-65. Move the **W/PRGM-RUN** switch back to **RUN**.

Confirm the data by loading the newly recorded card in the usual way. Press [A], then [B], [C], [D] and [E] to review the HT, WT, Age and Sex. Pressing [B] or [C] twice displays the data in English units with a minus sign.

If the data is entirely correct, write the patient's name on the card and cut off the upper left corner, preventing later changes in the card.

The total number of keystrokes permitted when inputting the patient data is limited to 16, including decimal points, [CHS] and [ENTER↑]. They may be divided among the parameters in any convenient way. See the example below.

If any error is made in the inputs while making the Patient ID card, start over at the beginning by loading the *Master Patient Identification Card* in **RUN MODE**.

Using the Patient Identification Card:

To use the Patient ID card for easy entry of patient parameters, it is only necessary to load the card and press [A]. The parameters may optionally be reviewed, in any order, by pressing [B] through [E], but this is not necessary prior to loading another program card. Pressing [B] or [C] twice will yield English units.

Note that this program changes all memory registers except R_2 and R_7. For that reason, its use in a series of chained programs should be carefully planned.

Example:

Enter Master ID card, then

Switch to **W/PRGM**.

[6] [9] [•] [2] [CHS] [ENTER↑]	(HT = 69.2 in.)
[1] [4] [2] [CHS] [ENTER↑]	(WT = 142 lbs.)
[4] [5] [ENTER↑]	(Age = 45 Yrs.)
[1]	(Sex = Male)

(Total 15 keystrokes)

Enter an unrecorded card in **W/PRGM** mode.

Switch to **RUN** mode.

Enter the Patient ID card you just recorded.

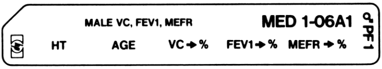
PRESS	**DISPLAY**
[A]	
[B]	HT = 175.77 cm.
[B]	HT = –69.2 in.
[C]	WT = 64.55 Kg.
[C]	WT = –142 lbs.
[D]	Age = 45 Yrs.
[E]	Sex = 1

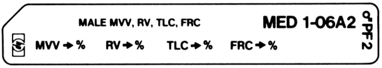
Do not clip the corner on this practice card. It may be used over for an actual patient if the corner is not clipped.

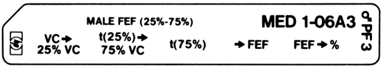
STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter ID*		[ ] [ ]	
2	Store patient data for execution		[ ] [ ]	
	by other programs or recall by		[ ] [ ]	
	this program		[A] [ ]	
3	Display height (optional)		[B] [ ]	+cm, –in
	and/or weight (optional)		[C] [ ]	+kg, –lb
	and/or age (optional)		[D] [ ]	years
	and/or sex (optional)		[E] [ ]	0–F, 1–M
4	It is now possible to use other		[ ] [ ]	
	programs in this pac which		[ ] [ ]	
	require the data specified with-		[ ] [ ]	
	out keying in the data.		[ ] [ ]	
			[ ] [ ]	
	*Note: Instructions assume		[ ] [ ]	
	card has been programmed		[ ] [ ]	
	with data.		[ ] [ ]	

Notes

MALE VITAL CAPACITY







The male pulmonary function testing package consists of three programs for male subjects. The programs provide the calculation of predicted and percent predicted values for vital capacity (VC), forced expiratory volume after one second (FEV_1), maximum expiratory flow rate (MEFR), maximum ventilatory volume after 12 seconds (MVV_{12}), residual volume (RV), total lung capacity (TLC), functional residual capacity (FRC), and forced expiratory flow from 25% to 75% ($FEF_{25\%-75\%}$).

Equations:

$$\text{Predicted VC} = (0.058 \cdot \text{Ht (cm)}) - (0.025 \cdot \text{AGE (years)}) - 4.24(l)$$

$$\text{Predicted FEV}_1 = (0.036 \cdot \text{Ht (cm)}) - (0.032 \cdot \text{AGE (years)}) - 1.26(l)$$

$$\text{Predicted MEFR} = (0.043 \cdot \text{Ht (cm)}) - (0.047 \cdot \text{AGE (years)}) + 2.07(l/s)$$

$$\text{Predicted MVV} = (0.9 \cdot \text{Ht (cm)}) - (1.51 \cdot \text{AGE (years)}) + 27(l)$$

$$\text{Predicted RV} = (0.03 \cdot \text{Ht (cm)}) + (0.015 \cdot \text{AGE (years)}) - 3.75(l)$$

$$\text{Predicted TLC} = (0.094 \cdot \text{Ht (cm)}) - (0.015 \cdot \text{AGE (years)}) - 9.17(l)$$

$$\text{Predicted FRC} = (0.051 \cdot \text{Ht (cm)}) - 5.05(l)$$

$$25\%\ \text{VC} = 0.25\ \text{VC}$$

$$75\%\ \text{VC} = 0.75\ \text{VC}$$

$$\Delta t = t_{75\%} - t_{25\%}$$

$$FEF = (0.5 \cdot VC)/\Delta t$$

$$\text{Predicted FEF} = (0.02 \cdot \text{Ht (cm)}) - (0.04 \cdot \text{AGE (years)}) + 2.0 (l/s)$$

References:

Morris, J. F., Koski, A., Johnson, L. C., *Amer. Rev. Resp. Dis.,* 1971, 103, 57.

Bates, et.al., *Respiratory Function in Disease,* W. G. Saunders Co., 1971.

Detailed User Instructions:

Both the male and female series of programs operate in the same manner. Enter male PF1. Then input height and age information for the calculation of predicted values by PF1, PF2, or PF3. After entering PF1, key in the patient's height in either centimeters or negative inches and press **A** which displays the patient's height in centimeters. Next, key in the patient's age, press **B**, and the age should be redisplayed. At this point, any of the predicted values can be calculated. All inputs proceed in the same way. For example, if it is desired to calculate the predicted and percent of the predicted value of vital capacity, key in the patient's measured vital capacity in liters, and press **C** to display the percent of the predicted value. To display the predicted value, press **R/S**. If it is only desired to obtain a predicted value, it does not matter what number is entered into the machine when the VC key is pressed. Simply press **C** and then **R/S** to obtain the predicted value. If the desired predicted value exists on PF2, card PF2 must be entered into the machine before proceeding.

PF3 operates in a slightly different manner. This program calculates the measured forced respiratory flow rate from the 25% and 75% points of a spirogram and then calculates predicted and percentage of predicted value. To calculate forced expiratory flow, enter PF3, then key in vital capacity as measured from the spirogram and press **A**. The display will show 25% of the vital capacity. Read the measured time at this volume from the spirogram, key in this time in seconds, and press **B**. The display will show 75% of the vital capacity. Measure the time at this volume from the spirogram, key in this time in seconds, and press **C**. The display should not change. Now press **D**. The display will be the measured forced expiratory flow rate in liters per second. Press **E**, and the display will now be a percentage of the predicted value of the FEF. Press **R/S** and the display will show the predicted value. If the FEF is already known, simply key in measured FEF and press **E** followed by **R/S** to obtain the percent of predicted value and predicted value.

Note:

If height and age data have been input through the use of a patient ID card, they need not be re-input into PF1.

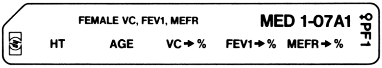
Example:

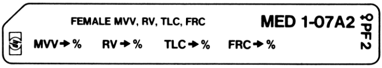
Calculate the predicted and percentage of predicted vital capacity, residual volume and forced expiratory flow for a male 6 feet tall, 28 years of age.

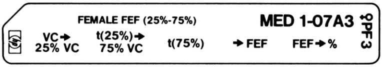
Card	Inputs	Outputs
♂PF1	height = –72 in.	height = 182.88 cm
	age = 28 years	age = 28 years
	measured VC = 5.2 *l*	% of predicted = 91.77%
		predicted VC = 5.67 *l*
♂PF2	measured RV = 2.0 *l*	% of predicted = 92.75%
		predicted RV = 2.16 *l*
♂PF3	measured VC = 5.2 *l*	25% VC = 1.3 *l*
	time from spirogram = 0.4 sec.	75% VC = 3.9 *l*
	time from spirogram = 1.0 sec.	FEF = 4.33 *l*/sec.
		% of predicted = 95.50%
		predicted FEF = 4.54 *l*/sec

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter male PF1				
2	Input height	+cm, –in	A		cm
3	Input age	years	B		years
4	Input vital capacity	liters	C		% predicted
	and/or display VC predicted		R/S		VC predicted
5	Input FEV_1	liters	D		% predicted
	and/or display FEV_1 predicted		R/S		FEV_1 predicted
6	Input MEFR	liters/min	E		% predicted
	and/or display MEFR predicted		R/S		MEFR predicted
7	Enter male PF2 and go to				
	step 8 or PF3 and go to step 13				
8	Input MVV	liters	A		% predicted
	and/or display MVV predicted		R/S		MVV predicted
9	Input RV	liters	B		% predicted
	and/or display RV predicted		R/S		RV predicted
10	Input TLC	liters	C		% predicted
	and/or display TLC predicted		R/S		TLC predicted
11	Input FRC	liters	D		% predicted
	and/or display FRC predicted		R/S		FRC predicted
12	Enter male PF3 and go to step				
	13 or PF1 and go to step 4.				
13	Input VC	liters	A		25% VC
14	Input time at 25%	seconds	B		75% VC
15	Input time at 75%	seconds	C		t at 75%
16	Compute FEF		D		FEF (*l*/sec)
17	Input FEF(meas)	liters/sec	E		% predicted
	and/or display FEF predicted		R/S		FEF predicted
18	Enter male PF1 and go to step				
	4 or input PF2 and go to step 8				

FEMALE VITAL CAPACITY







The female pulmonary function testing package consists of three programs for female subjects. The programs provide the calculation of predicted and percent predicted values for vital capacity (VC), forced expiratory volume after one second (FEV_1), maximum expiratory flow rate (MEFR), maximum ventilatory volume after 12 seconds (MVV_{12}), residual volume (RV), total lung capacity (TLC), functional residual capacity (FRC), and forced expiratory flow from 25% to 75% ($FEF_{25\%-75\%}$).

Equations:

$$\text{Predicted VC} = (0.045 \cdot \text{Ht (cm)}) - (0.024 \cdot \text{AGE (years)}) - 2.852(l)$$

$$\text{Predicted FEV}_1 = (0.035 \cdot \text{Ht (cm)}) - (0.025 \cdot \text{AGE (years)}) - 1.932(l)$$

$$\text{Predicted MEFR} = (0.057 \cdot \text{Ht (cm)}) - (0.036 \cdot \text{AGE (years)}) - 2.532(l/\text{sec})$$

$$\text{Predicted MVV} = (0.762 \cdot \text{Ht (cm)}) - (0.81 \cdot \text{AGE (years)}) - 6.29(l)$$

$$\text{Predicted RV} = (0.024 \cdot \text{Ht (cm)}) + (0.012 \cdot \text{AGE (years)}) - 2.63(l)$$

$$\text{Predicted TLC} = (0.078 \cdot \text{Ht (cm)}) - (0.01 \cdot \text{AGE (years)}) - 7.36(l)$$

(If height is greater than 174 cm, 1 cm is added to the height before TLC is calculated.)

$$\text{Predicted FRC} = (0.047 \cdot \text{Ht (cm)}) - 4.86$$

$$25\%\ \text{VC} = 0.25\ \text{VC}$$

$$75\%\ \text{VC}\ 0.75\ \text{VC}$$

$$\Delta t = t_{75\%} - t_{25\%}$$

$$FEF = (0.5 \cdot VC)/\Delta t$$

$$\text{Predicted FEF} = (0.02 \cdot \text{Ht (cm)}) - (0.03 \cdot \text{AGE (years)}) - (0.00005 \cdot \text{AGE}^2 \text{ (years)}) + 1.3(l/\text{sec})$$

References:

Morris, J. F., Koski, A., Johnson, L. C., *Amer. Rev. Resp. Dis.,* 1971, 103, 57.

Bates, et.al., *Respiratory Function in Disease,* W. G. Saunders Co., 1971.

Detailed User Instructions:

Both the male and female series of programs operate in the same manner. Enter female PF1. Then input height and age information for the calculation of predicted values by PF1, PF2, or PF3. After entering PF1, key in the patient's height in either centimeters or negative inches and press **A** which displays the patient's height in centimeters. Next, key in the patient's age, press **B**, and the age should be redisplayed. At this point, any of the predicted values can be calculated. All inputs proceed in the same way. For example, if it is desired to calculate the predicted and percent of the predicted value of vital capacity, key in the patient's measured vital capacity in liters, press **C** to display the percent of the predicted value. To display the predicted value, press **R/S**. If it is only desired to obtain a predicted value, it does not matter what number is entered into the machine when the VC key is pressed. Simply press **C** and then **R/S** to obtain the predicted value. If the desired predicted value exists on PF2, card PF2 must be entered into the machine before proceeding.

PF3 operates in a slightly different manner. This program calculates the measured forced respiratory flow rate from the 25% and 75% points of a spirogram and then calculates predicted and percentage of predicted value. To calculate forced expiratory flow, enter PF3, then key in vital capacity as measured from the spirogram and press **A**. The display will show 25% of the vital capacity. Read the measured time at this volume from the spirogram, key in this time in seconds, and press **B**. The display will show 75% of the vital capacity. Measure the time at this volume from the spirogram, key in this time in seconds, and press **C**. The display should not change. Now press **D**. The display will be the measured forced expiratory flow rate in liters per second. Press **E** and the display will now be a percentage of the predicted value of the FEF. Press **R/S** and the display will show the predicted value. If the FEF is already known, simply key in measured FEF and press **E** followed by **R/S** to obtain the percent of predicted value and predicted value.

Note:

If height and age data have been input through the use of a master ID card, they need not be re-input into PF1.

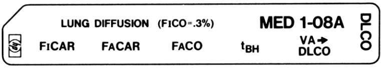
Example:

Calculate the predicted and percentage of predicted vital capacity residual volume and forced expiratory flow for a female 5 feet tall, 28 years of age.

Card	Inputs	Outputs
♀ PF1	height = –60 in. age = 28 years measured VC = 3.0 *l*	height = 152.40 cm age = 28 years % of predicted = 89.98% predicted VC = 3.33 *l*
♀ PF2	measured RV = 1.2 *l*	% of predicted = 88.00% predicted RV = 1.36 *l*
♀ PF3	measured VC = 3.0 *l* time from spirogram = 0.4 sec. time from spirogram = 1.0 sec.	25% VC = 0.75 *l* 75% VC = 2.25 *l* time from spirogram = 1.0 sec FEF = 2.50 *l*/sec % FEF predicted = 72.07% Predicted FEF = 3.47 *l*/sec

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter female PF1				
2	Input height	+cm, – in	A		cm
3	Input age	years	B		years
4	Input vital capacity	liters	C		% predicted
	and/or display VC predicted		R/S		VC predicted
5	Input FEV_1	liters	D		% predicted
	and/or display FEV_1 predicted		R/S		FEV_1 predicted
6	Input MEFR	liters/min	E		% predicted
	and/or display MEFR predicted		R/S		MEFR predicted
7	Enter female PF2 and go to				
	step 8 or PF3 and go to step 13				
8	Input MVV	liters	A		% predicted
	and/or display MVV predicted		R/S		MVV predicted
9	Input RV	liters	B		% predicted
	and/or display RV predicted		R/S		RV predicted
10	Input TLC	liters	C		% predicted
	and/or display TLC predicted		R/S		TLC predicted
11	Input FRC	liters	D		% predicted
	and/or display FRC predicted		R/S		FRC predicted
12	Enter female PF3 and go to				
	step 13 or PF1 and go to step 4				
13	Input VC	liters	A		25% VC
14	Input time at 25%	seconds	B		75% VC
15	Input time at 75%	seconds	C		t at 75%
16	Compute FEF		D		FEF (*l*/sec)
17	Input FEF (meas)	liters/sec	E		% predicted
	and/or display FEF predicted		R/S		FEF predicted
18	Enter female PF1 and go to				
	step 4 or input PF2 and go to				
	step 8				

LUNG DIFFUSION



The lung diffusion capacity program evaluates the equation to calculate DLCO using the single breath method. The initial concentration of carbon monoxide (F_ICO) is assumed to be 0.3%.

Equation Used:

$$DLCO = \frac{V_A(0.084)}{t_{BH}} \ln \frac{F_ACAR}{F_ICAR} \frac{0.3}{F_ACO}$$

Reference:

Comroe, et. al., *The Lung,* Year Book Medical Publishers Inc., 1962.

Detailed User Instructions:

The program requires five items of input information. They may be input in any order with the exception of the alveolar volume which must be input last. The program is operated as follows: Input initial concentration of carrier in percent (F_ICAR), press [A]. Input alveolar carrier concentration in percent (F_ACAR), press [B]. Input alveolar carbon monoxide concentration in percent (F_ACO), press [C]. Input breath hold time in seconds (t_{BH}), press [D]. Input alveolar volume in milliliters (V_A), press [E], and the display shows the lung diffusing capacity (DLCO).

Note:

If a different standard value for F_ICO is desired, modify the program as follows: Enter the program, press [GTO], [1], set the write/program run switch in the **W/PRGM** mode. Press [SST], [SST], [g], [DEL], [g], [DEL] to erase the value .3 from memory. Now input the desired concentration, such as .45 by simply pressing [•], [4], [5]. Return the calculator to the RUN mode and proceed as outlined above. To retain this value for F_ICO, simply record the program on a fresh card as outlined in the Quick Reference Guide.

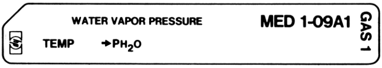
Example:

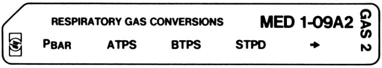
In this example the carrier gas is helium. Calculate the lung diffusing capacity, using an initial helium concentration of 10%, an alveolar helium concentration of 8%, an alveolar carbon monoxide concentration of 0.159%, an initial carbon monoxide concentration of 0.3%, a breath holding time of 10 seconds, and an alveolar volume of 4930 milliliters.

Answer: DLCO = 17.05 ml CO/min/mm Hg

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter DLCO		[ ] [ ]	
2	Input in any order		[ ] [ ]	
	$F_I CAR$	%	[A] [ ]	$F_I CAR$
	and $F_A CAR$	%	[B] [ ]	$F_A CAR$
	and $F_A CO$	%	[C] [ ]	$F_A CO$
	and t_{BH}	seconds	[D] [ ]	t_{BH}
3	Input V_A and calculate DLCO	V_A (ml)	[E] [ ]	DLCO

RESPIRATORY GAS CONVERSIONS





This package consists of two program cards which allow the user to convert among three commonly used systems of respiratory gas volume measurement. The first program calculates saturated water vapor pressure at a given ambient temperature; the result is used in converting to or from ambient conditions. GAS 1 may be used alone if only the partial pressure of water vapor is desired. GAS 2 is used for the actual conversion of the gas volumes.

Equations Used:

GAS 1

$$P_{H_2O} = 10^{a + bT_A^{-1} + cT_A^{-2} + dT_A^{-3}}$$

where

T_A = ambient temperature, K
a = 7.522 467
b = −1223.31
c = −222 613.7
d = 12 323 432.
P_{H_2O} = water vapor pressure, torr

GAS 2

$$V_{STPD} = \frac{P_{BAR} - P_{H_2O}}{T_A} V_{ATPS} \frac{273}{760}$$

$$V_{STPD} = \frac{(P_{BAR} - 47)}{310} V_{BTPS} \frac{273}{760}$$

$$V_{ATPS} = \frac{T_A}{(P_{BAR} - P_{H_2O})} V_{STPD} \frac{760}{273}$$

$$V_{BTPS} = \frac{310}{(P_{BAR} - 47)} V_{STPD} \frac{760}{273}$$

ATPS = Ambient temperature and pressure saturated with water vapor: $P = P_{BAR} - P_{H_2O}$, $T = T_A$

BTPS = Body temperature and pressure saturated with water vapor: $P_{H_2O} = 47$ mmHg, $T = 310K$

STPD = Standard temperature and pressure dry: P = 760 mmHg, T = 273K

P_{BAR} = Barometric pressure, mmHg or torr

V_{COND} = Volume at indicated conditions

References:

The water vapor pressure program is an approximation to the water vapor pressure table in *Scientific Tables* published by Ciba-Giegy Limited, 7th Edition, 1970, and is valid for temperatures from 0°C to 100°C.

The gas conversions are based on the ideal gas laws and closely approximate the tables in *Scientific Tables.*

Detailed User Instructions:

In order to convert between BTPS volumes and STPD volumes, only the GAS 2 program need be used. In such a case, enter the GAS 2 card, input the barometric pressure in millimeters of mercury and press [A]. Next, input the volume of the gas in either BTPS units or STPD units, and press either [C] or [D] to define the volume system. Next, press [E] and then either [D] or [C] depending on the conversion desired.

If conversion is desired to or from ATPS conditions, both GAS 1 and GAS 2 programs must be used. To do this, first enter the GAS 1 card. Next, input the ambient temperature (positive for °C, negative for °F), and press [A]. To obtain the partial pressure of water vapor at this temperature, press [B]. Next, enter the GAS 2 card without turning off the calculator. Input the barometric pressure in millimeters of mercury and press [A]. Next, input the volume to be converted, followed by the units of volume. (For example, if 5 liters STPD is to be converted, press [5] then press [D].) Next, press [E], then press the key corresponding to the system in which the volume is desired.

Examples:

Convert 4.3 liters BTPS at a barometric pressure of 743 mm Hg to the equivalent volume at STPD.

Answer: 3.47 liters STPD.

Convert a volume of 4.81 liters ATPS at 83° Fahrenheit and a pressure of 765 mm Hg to BTPS.

Answer: P_{H_2O} = 28.94 mm Hg

V = 5.07 liters BTPS.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	If conversion between BTPS		[ ] [ ]	
	and STPD only is needed go		[ ] [ ]	
	to step 4 otherwise enter GAS I		[ ] [ ]	
	and go to step 2		[ ] [ ]	
2	Input ambient temperature	°C or –°F	[A] [ ]	°C
3	Compute P_{H_2O}		[B] [ ]	P_{H_2O} (mmHg)
4	Enter GAS 2		[ ] [ ]	
5	Input P_{BAR}	P_{BAR} (mmHg)	[A] [ ]	P_{BAR} (mmHg)
	and volume at ATPS	volume	[B] [ ]	volume
	or volume at BTPS	volume	[C] [ ]	volume
	or volume at STPD	volume	[D] [ ]	volume
6	Compute desired volume at		[ ] [ ]	
	ATPS		[E] [B]	volume
	or BTPS		[E] [C]	volume
	or STPD		[E] [D]	volume
7	For new case with same water		[ ] [ ]	
	vapor conditions go to step 4		[ ] [ ]	
	otherwise go to step 1.		[ ] [ ]	

VENTILATOR SETUP

VENTILATOR SETUP (RADFORD)			MED 1-10A1		RAD 1
WT	SEX	RATE	→TVbas	DSv→TVc	

VENTILATOR SETUP CORRECTIONS			MED 1-10A2		RAD 2
TEMP	ALT	ACTIVE	TRACH	MET ACID	

This package consists of two program cards which allow calculation of the initial tidal volume for a ventilator patient. Program RAD 1 calculates an approximation to the Radford nomogram tidal volume with correction for ventilator dead space only. Program RAD 2 corrects the tidal volume obtained from RAD 1 for altitude, patient's temperature, daily activity, use of a tracheotomy tube, and metabolic acidosis in anesthesia.

Equations Used:

$$V_A = \text{Alveolar minute volume} = 10^{(C_1 \text{ LOG WT} + C_2)/100} \text{ ml/min.}$$

$$TV_A = \text{Alveolar tidal volume} = \frac{V_A}{r} \text{ ml}$$

$$TV_{bas} = \text{Basal tidal volume} = \left(TV_A + \text{Wt (lbs)}\right) \text{ ml}$$

$$TV_{corr} = \text{Basal tidal volume + ventilator dead space}$$

where r = breathing rate (breaths per minute)

For females

$$C_1 = \begin{cases} 124; Wt \leqslant 8kg \\ 61; 8kg < Wt \leqslant 23kg \\ 44.2; Wt > 23kg \end{cases}$$

$$C_2 = \begin{cases} 193; Wt \leqslant 8kg \\ 249; 8kg < Wt \leqslant 23kg \\ 272; Wt > 23kg \end{cases}$$

For males

$$C_1 = \begin{cases} 124; Wt \leqslant 8kg \\ 61; Wt > 8kg \end{cases}$$

$$C_2 = \begin{cases} 193; Wt \leqslant 8kg \\ 249; Wt > 8kg \end{cases}$$

MED 1-10A2

Corrections

Temperature: + 5% per °F above 99°F (rectal)
Altitude: + 5% per 2000′ above sea level
Activity: + 10%
Tracheotomy: $-\frac{1}{2}$ body weight in pounds
Metabolic acidosis in anesthesia: + 20%

Reference:

Radford, Edward P., "Ventilation Standards for Use in Aritificial Respiration," *Journal of Applied Physiology,* 7:451, 1955.

Detailed User Instructions:

To calculate the tidal volume required by a patient, enter RAD 1 into the calculator. Then input patient's weight in kilograms or pounds negatively. The patient's weight in kilograms will be displayed. Next, input patient's sex: [0] for female, or [1] for male, and press [B]. Input breathing rate at which the patient will be ventilated and press [C]. To calculate basal tidal volume (uncorrected) press [D]. This value is the tidal volume approximation to the Radford nomogram.

Next, input ventilator dead space, followed by [E], giving the tidal volume corrected for the ventilator dead space. At this point, enter RAD 2 without turning off the calculator.

Program RAD 2 applies the corrections specified in the Radford nomogram. Input patient's temperature in degrees Celsius or in degrees Fahrenheit negatively and press [A] to obtain the tidal volume corrected for patient temperature. Next input altitude in meters or in feet negatively and press [B] to obtain tidal volume corrected for altitude. To correct tidal volume for minor daytime activity of a non-comatose patient, press [C]. If patient is fitted with a tracheotomy or endotracheal tube, press [D] to obtain the corrected tidal volume. If the ventilator is being used during the administration of anesthesia and the patient exhibits metabolic acidosis, press [E] to obtain corrected tidal volume.

Note:

Apply only the corrections which apply to the patient for whom the program is being run.

Warning:

This program yields an approximation to the Radford nomogram. The nomogram may not be applied with confidence to patients with muscular activity or abnormal lung function.

Example:

Calculate the predicted tidal volume for a 170 pound comatose male having a breath rate of 15 breaths per minute, ventilator dead space of 25 milliliters, fever of 101° Fahrenheit, who is fitted with a tracheotomy tube and is located at sea level.

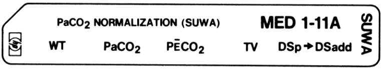
Answers:

From RAD 1 basal tidal volume = 462.15 ml
tidal volume corrected for ventilator dead space
= 487.15 ml

From RAD 2 final corrected tidal volume = 450.86 ml

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter RAD 1		[ ] [ ]	
2	Input weight	kg or −lb	[A] [ ]	kg
3	Input sex	0 = F, 1 = M	[B] [ ]	0 = F, 1 = M
4	Inpute rate	BR/min	[C] [ ]	BR/min
5	Calculate basal tidal volume	TV_{bas} (ml)	[D] [ ]	TV_{bas} (ml)
6	Input ventilator dead space	ml	[E] [ ]	TV_{corr} (ml)
7	Enter RAD 2		[ ] [ ]	
8	Input temperature	°C or −°F	[A] [ ]	TV_{corr} (ml)
9	Input altitude	m or − ft	[B] [ ]	TV_{corr} (ml)
10	For minor daytime activity		[ ] [ ]	
	(non comatose)		[C] [ ]	TV_{corr} (ml)
	or for tracheotomy		[D] [ ]	TV_{corr} (ml)
	or for metabolic acidosis during		[ ] [ ]	
	anesthesia		[E] [ ]	TV_{corr} (ml)

P_aCO_2 NORMALIZATION (SUWA)



The Arterial CO_2 Normalization Program calculates the additional dead space (DS_{ADD}) needed in a hypocapnic ventilator patient's breathing circuit to raise the arterial CO_2 partial pressure (P_aCO_2) to 40 millimeters of mercury (mmHg).

Equations Used:

$$DS_{ADD} = \frac{TV-DS}{40 - \Delta P_{CO_2}} (40 - P_aCO_2)$$

$$\Delta P_{CO_2} = P_aCO_2 - P_{\bar{E}}CO_2 \text{ or } P_aCO_2 - 5 \text{ if } P_{\bar{E}}CO_2 \text{ is not entered}$$

$$TV-DS = TV - [1.47\ Wt(kg) + DS_p]$$

Reference:

Suwa, Kunio; Geffin, Bennie; Pontoppidan, Henning; Bendixen, Henry; "A Nomogram for Dead Space Requirement During Prolonged Artificial Ventilation", *Anesthesiology,* v. 29, 1968 Nov–Dec.

Detailed User Instructions

To calculate the additional dead space for the hypocapnic patient, first input the patient's weight in kilograms, or in pounds followed by [CHS]. Press [A] to display the patient's weight in kilograms. Next, input the patient's P_aCO_2 in mmHg and press [B]. If the patient's lung status is abnormal, the mixed expired CO_2 partial pressure ($P_{\bar{E}}CO_2$) must be measured and input followed by [C]. If the patient's lung function is normal, this step may be bypassed, and the $P_{\bar{E}}CO_2$ is assumed to be 5 millimeters of mercury less than the P_aCO_2. Next, input the patient's present tidal volume in milliliters, and press [D]. Finally, input the present ventilator dead space in milliliters and press [E]. The display now contains the additional rebreathing dead space which must be added to the patient's circuit to achieve P_aCO_2 normalization.

Warning:

The additional dead space required by this program must be inserted into the patient's breathing circuit *without* changing the ventilator rate or tidal volume.

Measure and input the mixed expired CO_2 partial pressure if lung function is abnormal.

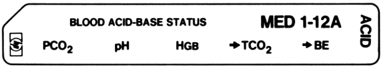
Example

Calculate the additional dead space required by a 50 kilogram patient with a P_aCO_2 of 25 mmHg with normal lung status having a tidal volume of 900 ml and a present dead space of 25 ml.

Answer: 343.50 milliliters of additional dead space

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter SUWA		[ ] [ ]	
2	Input patient weight	kg or – lb	[A] [ ]	Wt (kg)
3	Input P_aCO_2	mmHg	[B] [ ]	P_aCO_2 (mmHg)
4	If patient lung status is normal		[ ] [ ]	
	go to step 5. Otherwise input		[ ] [ ]	
	$P_{\bar{E}}CO_2$	mmHg	[C] [ ]	$P_{\bar{E}}CO_2$
5	Input present tidal volume	TV (ml)	[D] [ ]	TV (ml)
6	Input present dead space and		[ ] [ ]	
	calculate additional dead space.	DS_p (ml)	[E] [ ]	DS_{add} (ml)

BLOOD ACID-BASE STATUS



This program computes total plasma CO_2 and base excess from PCO_2, pH and hemoglobin concentration.

Equations:

Total plasma CO_2 is calculated from the Henderson–Hasselbalch equation:

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

where

TCO_2 = total CO_2 in plasma, mmol/*l*

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

PCO_2 = partial pressure of CO_2 in the blood, mmHg

pK = 6.11

This does not take into account the small temperature dependence of both s and pK, nor the pH dependence of pK. For this reason, the formula for TCO_2 will be most accurate if 37°C values for PCO_2 and pH are used.

The base excess is calculated from an equation suggested by Siggaard-Andersen:

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

where

$[BE]_b$ = Base Excess in m Eq/*l* of blood

Hbg = Hemoglobin concentration in g/100 ml

and plasma $[HCO_3^-]$ is calculated from the Hendersen-Hasselbalch equation in the form

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

Siggaard-Andersen used 38°C values for PCO_2 and pH. Only small errors will result from using 37°C values, but body temperature corrected values should not be used if the patient has any significant hyper or hypothermia. If only body temperature values are known, program 1-15A (ΔpH) may be used to correct them back to 37°C. (See the special instructions for that program.)

While Thomas has shown that this equation may produce large errors for very abnormal conditions, it matches the Siggaard-Andersen nomogram for $[BE]_b$, to within ± 1 mEq/1 in most cases.

References:

Siggaard-Andersen, "Titratable Acid or Base of Body Fluids," *Annals New York Academy of Sciences* 133: 41–48, 1966.

Thomas, L.J. Jr., "Algorithms for Selected Blood Acid-Base and Blood Gas Calculations," *J. Appl. Physiol.* 33: 154–158, 1972.

Detailed User Instructions

If PCO_2 has been previsouly stored, it may be recalled after entering the program card by pressing **R/S**. If not, input PCO_2 and press **A**. The pH will be recalled if previously stored. If not, input pH and press **B**. The Hgb will be recalled if previously input. If not, input Hgb and press **C**.

Press **D** to obtain TCO_2 in mmol/1. Press **E** to obtain $[BE]_b$ in mEq/1. **D** must be pressed before **E**. The plasma $[HCO_3^-]$ may be obtained by pressing [RCL] [8].

Example:

PCO_2 = 45 mmHg

pH = 7.35

Hgb = 16 g/100 ml

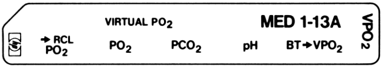
Answer: TCO_2 = 25.39 mmol/*l*

$[BE]_b$ = −1.36 mEq/*l*

$[HCO_3^-]$ = 24.01 mmol/*l*

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter ACID		[ ]	[ ]	
2	If PCO_2 is stored		[R/S]	[ ]	PCO_2
3	Input PCO_2	PCO_2	[A]	[ ]	pH (if stored)
4	Input pH	pH	[B]	[ ]	Hgb (if stored)
5	Input Hgb	Hgb (gm/100 ml)	[C]	[ ]	Hgb (gm/100 ml)
6	Calculate TCO_2		[D]	[ ]	TCO_2 (mmol/*l*)
7	Calculate BE		[E]	[ ]	BE (mEq/*l*)
8	Recall $[HCO_3^-]$		[RCL]	[8]	(mmol/*l*)

VIRTUAL PO_2



This program computes virtual PO_2 for use in estimating O_2 saturation. Generally, if calculating both venous and arterial saturations, it will be more convenient to calculate venous values first, as arterial values are frequently needed in other programs and, thus, will be left in the storage registers after both calculations.

Equation:

The equation solved is

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

which 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.

Warning:

Virtual PO_2 is not in any way a real physiologic PO_2. Its only function is for use in estimating O_2 saturation, and it should never be confused with PO_2 corrected to body temperature. Furthermore, it must always be calculated from blood parameters measured at or corrected to 37°C.

References:

Thomas, L.J. Jr., "Algorithms for Selected Blood Acid-Base and Blood Gas Calculations", *J. Appl. Physiol.* 33: 154–158, 1972.

Kelman, G. Richard, "Digital Computer Subroutine for the Conversion of Oxygen Tension into Saturation", *J. Appl. Physiol* 21: 1375–1376, 1966.

Detailed User Instructions:

Input PO_2, PCO_2, and pH *measured at 37°C.* Input body temperature in degrees C. If PO_2 has been previously input, recall it by pressing **A** then press **B**. Otherwise, input PO_2 and press **B**. For each variable after PO_2, stored values will be recalled. If none have been input, recalled values will generally be zero. It is important to input pH and body temperature exactly, as these have a great influence on the calculation of virtual PO_2. Errors, especially in body temperature, can result in large errors in VPO_2 and, hence, estimated saturation. PCO_2 has relatively little influence. Press the buttons from left to right and do not skip any. The virtual PO_2 remains in the display for immediate entry into program 1–14A (SAT). It is *not* stored in place of the measured PO_2. The PO_2, PCO_2, and pH remain in memory. Note that separate storage registers are not maintained for arterial and venous values, only the most recent ones will be stored.

Example:

PO_2 = 75 mmHg

PCO_2 = 45 mmHg

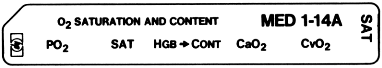
pH = 7.35

BT = 40°C

Answer: VPO_2 = 59.71 mmHg

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter VPO_2			
2	If PO_2 was previously input			
	recall it		A	PO_2 (mmHg)
3	Input PO_2 if it was not recalled			
	in step 2	PO_2 (mmHg)	B	PCO_2 (if stored)
4	Input PCO_2 if it was not			
	recalled in step 3	PCO_2 (mmHg)	C	pH (if stored)
5	Input pH if it was not recalled			
	in step 4	pH	D	BT (if stored)
6	Input BT if it was not recalled			
	in step 5	BT(°C)	E	VPO_2 (mmHg)
7	Go to program 1–14A SAT.			

OXYGEN SATURATION AND CONTENT



This program estimates O_2 saturation of blood from virtual PO_2 or alveolar P_AO_2 and computes O_2 content. If the actual O_2 saturation is known, O_2 content may be computed directly.

Equations:

The part of the program for estimating O_2 saturation is based on the polynomial curve fit of Thomas, where VPO_2 is in mmHg.

$$O_2Sat = \frac{(VPO_2)^4 - 15(VPO_2)^3 + 2045(VPO_2)^2 + 2000(VPO_2)}{(VPO_2)^4 - 15(VPO_2)^3 + 2400(VPO_2)^2 - 31{,}100(VPO_2) + 2{,}400{,}000}$$

This calculation assumes that the oxygen dissociation curve for the hemoglobin is normal. The O_2 content is computed from

$$C_xO_2\,(\text{Vol.\%}) = 1.34 \cdot \frac{SAT(\%)}{100} \cdot Hgb\,(g/100ml) + 0.0031\,PO_2\,(mmHg)$$

Warning:

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.

Reference:

Thomas, L.J. Jr., "Algorithms for Selected Blood Acid-Base and Blood Gas Calculations", *J. Appl. Physiol.* 33: 154–158, 1972.

Detailed Users Instructions:

To compute O_2 content, input the PO_2, O_2 saturation, and hemoglobin concentration. After PO_2 is input, an estimated O_2 saturation is calculated, based on a standard dissociation curve. This will only be meaningfull if a virtual PO_2 from program 1-13A (VPO_2) was input. The estimated O_2 saturation may be accepted simply by pressing **B**, or a measured value can be input. If Hgb was previously input, it will be recalled. If the calculated O_2 content is to be stored as arterial or venous for later use in Fick cardiac output or physiologic shunt calculations, press the appropriate button. Regardless of which content is computed first, C_aO_2 is left in the display for convenience in case program 1-25A (ANA) is to be run next.

If O_2 saturation of blood is to be estimated from PO_2, it is important to input the virtual PO_2 found in program 1-13A (VPO_2). A large error can result from inputting measured PO_2 without the corrections. The program may be used to compare estimated O_2 saturation with measured O_2 saturation, to obtain a rough idea of the variation of the dissociation curve from normal. This will be especially sensitive with partly unsaturated venous blood where the slope of the curve is fairly steep. When computing content for purposes of estimating physiologic shunt and Fick cardiac output, it is always best to measure the saturation. Small variations in the dissociation curve can cause considerable error in the shunt and cardiac output calculations and because the effect is not the same on venous blood as on the higher saturation arterial blood.

The calculated O_2 content includes both the dissolved oxygen and the hemoglobin bound oxygen. If only O_2 saturation was measured, and not PO_2, an estimated PO_2 should be input to obtain the maximum accuracy in the content calculation. The estimate for PO_2 need only be rough as the effect is very small, unless the patient is breathing an oxygen-enriched atmosphere and PO_2 is well above 100 mmHg.

To compute equivalent alveolar blood O_2 content, enter the equivalent P_AO_2, rather than the virtual PO_2. The P_AO_2 can be calculated in program 1-18A (A–a). In this case, the resulting O_2 content should not be stored as either arterial or venous, but simply left in the display register for use at the beginning of program 1-19A (PHYS), which should be executed next. Thus, the over-all sequence should be to compute venous content first, arterial content second, and alveolar content last. The physiologic shunt and Fick program, 1–19A (PHYS), may then be run without having to enter any new O_2 content data.

Example:

PO_2 = 75 mmHg
Hgb = 16 gm/100 ml

Answers: Est. Sat. = 95.08%

O_2 Cont. = 20.62 vol. %

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter SAT		[ ] [ ]	
2	Input virtual PO_2 or alveolar		[ ] [ ]	
	P_AO_2	PO_2 (mmHg)	[A] [ ]	est SAT(%)
3	Input est SAT % from step 2		[ ] [ ]	
	and recall Hgb if previously		[ ] [ ]	
	stored (Use actual SAT if		[ ] [ ]	
	known)	est SAT%	[B] [ ]	Hgb(if stored)
4	Input Hgb	Hgb(gm/100ml)	[C] [ ]	C_xO_2 (vol%)
5	If calculated O_2 content is to		[ ] [ ]	
	be stored as arterial	C_aO_2 (vol %)	[D] [ ]	C_aO_2 (vol %)
	or as venous	C_vO_2 (vol %)	[E] [ ]	C_aO_2 (vol %)

ANAEROBIC PCO_2 AND pH CHANGE

ANAEROBIC PCO_2 AND pH CHANGE			MED 1-15A		▷ pH
→RCL PCO_2	PCO_2 (37°)	pH (37°)	BT→PCO_2 (BT)	→pH (BT)	

Corrections of PCO_2 and pH for anaerobic temperature change are calculated. The equation for pH is a simplification 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 pH units per °C.

Equations Used:

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

$$pH(BT) = pH(37) - 0.0146\,(T-37)$$

Reference:

Severinghaus, John W., "Blood Gas Calculator", *J. Appl. Physiol.*, 21 (3): 1108-1116, 1966

Detailed User Instructions

This program corrects PCO_2 and pH, measured at 37°C, to body temperature. It replaces 37°C values in memory with the body temperature values. Therefore, calculation based on the 37°C values in programs 1–12A (ACID) and 1–13A (VPO_2) should be accomplished before this program or program 1–16A (ΔPO_2) is run.

If PCO_2(37°) was previously stored in memory, it can be recalled by pressing **A**. If not, skip **A** and input PCO_2(37°). Press **B**; if pH (37°) was previously stored, it will appear. If not, input it. Press **C**, if body temperature was previously stored, it will appear. If not, input it in °*C*. Press **D**; PCO_2(BT) will appear and be stored in memory. Press **E**; pH(BT) will appear and be stored in memory.

This program may also be used to convert PCO_2 and pH between any two temperatures, for example, from body temperature to 37°C. To do this, first determine what the desired temperature change is in °C. Add this to 37°C algebraically, and input the result as BT. For example, suppose values known at 41°C are to be converted to 37°C. The temperature change is –4°C; this, when added to 37°C, results in 33°C. Executing the program with BT = 33°C will then result in 37°C values for PCO_2 and pH.

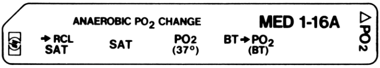
Example

PCO_2 = 45 mmHg
pH = 7.35
BT = 40°C

Answers: PCO_2(BT = 51.31 mmHg
pH(BT) = 7.31

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter ΔpH		[ ] [ ]	
2	If PCO_2 was previously stored		[ ] [ ]	
	recall it		[A] [ ]	PCO_2
3	Input PCO_2(37°)	PCO_2(mmHg)	[B] [ ]	pH(if stored)
4	Input pH(37°)	pH(37°)	[C] [ ]	BT(if stored)
5	Input BT and calculate PCO_2		[ ] [ ]	
	(BT)	BT(°C)	[D] [ ]	PCO_2 (mmHg)
6	Compute pH(BT)		[E] [ ]	pH(BT)

ANAEROBIC PO_2 CHANGE



This program corrects PO_2, measured at 37°C, to Body Temperature.

Equation Used:

Correction of PO_2 for anaerobic temperature change is calculated taking into account the exchange of oxygen between $HgbO_2$ and the dissolved state at high saturation. Below 80% Sat., the relation is approximately

$$\frac{\Delta \text{Log } PO_2}{\Delta T} = 0.031$$

This factor falls at higher saturations, approaching 0.006 at 100% Sat. The curve given by Severinghaus has been approximated by the following equation in this program.

$$\frac{\Delta \log PO_2}{\Delta T} = \frac{3130 - 62.5 \text{ Sat} + 0.312008 \text{ Sat}^2}{100{,}000 - 1993 \text{ Sat} + 9.9313 \text{ Sat}^2}$$

Reference:

Severinghaus, John W., "Blood Gas Calculator", *J. Appl. Physiol.*, 21 (3): 1108-1116, 1966

Detailed User Instructions:

If Sat. was previously stored in memory, it can be recalled by pressing **A**. If not, skip **A** and input Sat. Press **B**. If PO_2 (37°) was previously stored, it will appear. If not, input it. Press **C**. If body temperature was previously stored, it will appear. If not, input it in °C. Press **D**. PO_2(BT) will appear and be stored in memory.

PO_2(BT) replaces the 37°C value in memory with the body temperature value. Therefore, calculation based on the 37°C values in programs 1–13A (VPO_2) and 1–14A (SAT) should be accomplished before this program is run. If O_2 saturation has not been measured, it should be estimated by using programs 1–13A (VPO_2) and 1–14A (SAT).

This program may also be used to convert PO_2 between any two temperatures, for example, from body temperature to 37°C. To do this, first determine what the desired temperature change is in °C. Add this to 37°C algebraically, and enter the result as BT. For example, suppose values known at 41°C are to be converted to 37°C. The temperature change is –4°C. Add this to 37°C, resulting in 33°C. Executing the program with BT = 33°C will then result in the 37°C value for PO_2.

Example:

Sat. = 90%

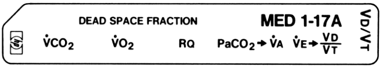
PO_2 = 75 mmHg

BT = 40°C

Answer: PO_2(BT) = 92.31 mmHg

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter ΔPO_2		[ ] [ ]	
2	If it was previously stored		[ ] [ ]	
	recall SAT		[A] [ ]	SAT(%)
3	Input SAT%	SAT%	[B] [ ]	PO_2 (if stored)
4	Input PO_2 (37°)	PO_2 (mmHg)	[C] [ ]	BT(if stored)
5	Input BT and compute PO_2 (BT)	BT(°C)	[D] [ ]	PO_2 (mmHg)

DEAD SPACE FRACTION



This program calculates respiratory exchange ratio, alveolar minute volume, and ratio of dead space to tidal volume.

Equations Used:

Respiratory exchange ratio,

$$R_Q = \frac{\dot{V}CO_2\ (\text{ml/min STPD})}{\dot{V}O_2\ (\text{ml/min STPD})}$$

Alveolar minute volume,

$$\dot{V}_A(l/\text{min BTPS}) = \frac{0.863\ \dot{V}CO_2\ (\text{ml/min STPD})}{P_aCO_2\ (\text{mmHg})}$$

Ratio of dead space to tidal volume,

$$V_D/V_T = \frac{\dot{V}_E - \dot{V}_A\ (l/\text{min BTPS})}{\dot{V}_E\ (l/\text{min BTPS})}$$

These may be found in most standard texts on respiratory gas exchange.

Reference:

Otis, A. B., *Handbook of Physiology,* VOL 1, Sec 3, p. 681–698

Detailed User Instructions

CO_2 output ($\dot{V}CO_2$) and O_2 uptake ($\dot{V}O_2$) are input in milliliters per minute, STPD. If the experimental values are not measured in STPD, they should be converted prior to input. The HP-65 may be used as a four-function calculator between input entries for purposes of unit conversion. If a separate program is to be used for conversion the conversion should be done prior to running this series of programs, as some patient data may be lost from memory. The values of $\dot{V}CO_2$ and $\dot{V}O_2$ are stored in memory for use by later programs. If $\dot{V}O_2$ has been previously stored by the Fick calculation program, it will be recalled automatically. After R_Q appears, press **C** to store $\dot{V}CO_2$ and $\dot{V}O_2$. PCO_2 will appear if previously stored.

The $\dot{V}_A$ is output (displayed) in liters per minute BTPS. If, after computing $\dot{V}_A$, it is desired to calculate the ventilation/perfusion ratio ($\dot{V}_A/\dot{Q}$), and $\dot{Q}$(CO) is already known, simply enter $\dot{Q}$, press [÷], and the $\dot{V}_A/\dot{Q}$ ratio will be displayed. Input total ventilation, $\dot{V}_E$ in *l*/min. BTPS. The V_D/V_T ratio will appear. To compute actual dead space, utilize the HP-65 as a four-function calculator and either multiply by tidal volume, if known, or enter $\dot{V}_E$ again, divide by respiratory rate to obtain tidal volume, and then press [×] to obtain actual dead space volume.

It is possible to input R_Q and either $\dot{V}CO_2$ or $\dot{V}O_2$, rather than both $\dot{V}CO_2$ and $\dot{V}O_2$. When doing this, press only the button for which data is being input. For example, input $\dot{V}O_2$, press **B**, input R_Q, press **C**. The HP-65 will calculate the missing $\dot{V}CO_2$ and store both $\dot{V}CO_2$ and $\dot{V}O_2$.

Since $\dot{V}O_2$ is not needed in the calculation of $\dot{V}_A$ and V_D/V_T, it need not be input if R_Q is not desired. In this case, input $\dot{V}CO_2$, press **A** input P_aCO_2, press **D**, input $\dot{V}_E$, press **E**. $\dot{V}CO_2$ will not be stored in memory in this case.

Example

$\dot{V}CO_2$ = 266 ml/min STPD

$\dot{V}O_2$ = 280 ml/min STPD

P_aCO_2 = 45 mmHg

$\dot{V}_E$ = 7 *l*/min BTPS

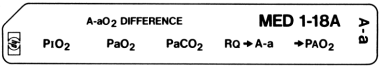
Answers: R_Q = 0.95

$\dot{V}_A$ = 5.10 *l*/min BTPS

V_D/V_T = 0.27

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter V_D/V_T		[ ]	[ ]	
2	Input $\dot{V}CO_2$	$\dot{V}CO_2$(mil/min)	[A]	[ ]	$\dot{V}O_2$ (if stored)
3	Input $\dot{V}O_2$	$\dot{V}O_2$ (ml/min)	[B]	[ ]	R_Q
4	Input R_Q if not displayed	R_Q	[C]	[ ]	P_aCO_2(if stored)
5	Input P_aCO_2 and calculate $\dot{V}_A$	P_aCO_2 (mmHg)	[D]	[ ]	$\dot{V}_A$ (*l*/min)
6	Input $\dot{V}_E$ and calculate V_D/V_T	$\dot{V}_E$ (*l*/min)	[E]	[ ]	V_D/V_T

A-a O_2 DIFFERENCE



This program calculates the difference between alveolar and arterial oxygen concentration. One approximation has been made in the equation for P_AO_2. In the third term, which is a small correction factor, the F_IO_2 has been derived by dividing the P_IO_2 by 760, the nominal barometric pressure at sea level. The error introduced will be negligible unless measurements are being made at a very high altitude and very high inspired oxygen tension.

Equations Used:

$$\text{A–a } O_2 \text{ Diff.} = P_AO_2 - P_aO_2 \text{ (mmHg)}$$

$$P_AO_2 = P_IO_2 - \frac{P_aCO_2}{R_Q} + \frac{P_IO_2}{760} \cdot P_aCO_2 \cdot \frac{1-R_Q}{R_Q} \text{ (mmHg)}$$

where

$$P_IO_2 = \frac{F_IO_2(\%)}{100} \cdot P_{\text{Barometer}} \text{ (mmHg)}$$

$$R_Q = \frac{\dot{V}CO_2 \text{ (ml/min STPD)}}{\dot{V}O_2 \text{ (ml/min STPD)}}$$

Reference:

West, John B., *Ventilation/Blood Flow and Gas Exchange,* 2nd ed., Blackwell Scientific Publication, Oxford, 1970.

Detailed User Instructions

The inspired oxygen tension must be input in mmHg. If the inspired oxygen is known as a fractional amount (F_IO_2), it may be converted to P_IO_2 by multiplying the fraction by the actual barometric pressure. At sea level, the nominal barometric pressure is 760 mmHg. However, it varies as much as plus or minus 5% with the weather, and much more with altitude. The HP-65 may be used as a four-function calculator to multiply the fractional inspired oxygen by the barometric pressure to derive P_IO_2. If the fractional oxygen is expressed as a percent, it will be necessary first to divide by 100 to obtain a fraction. For example, input 22(%), press [ENTER↑], input 100, press [÷], input barometric pressure, press [×] to derive P_IO_2. Note that weather bureau reports of barometric pressure are normally given corrected to sea level. This is not the barometric pressure needed here unless the location is actually near sea level. Atmospheric pressure falls about 25 mmHg per 300 m. (1000 ft.) above sea level.

The stored PO_2 will be recalled. If this is the arterial P_aO_2, simply press [B]. Otherwise, input the value and press [B]. Repeat for PCO_2, using [C]. If CO_2 output and O_2 uptake were previously input, R_Q will be computed and recalled. Otherwise, input R_Q and press [D]. The A–aO_2 difference will now appear on the display. To derive P_AO_2 press [E]. This value is left in the display register and is ready for input into program 1–14A (SAT) if alveolar O_2 content and physiologic shunt are to be calculated.

Example

P_IO_2 = 150 mmHg

P_aO_2 = 100 mmHg

P_aCO_2 = 45 mmHg

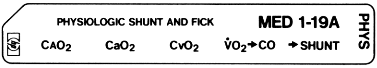
R_Q = 0.95

Answers: A–a Diff. = 3.10 mmHg

P_AO_2 = 103.10 mmHg

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter A–a				
2	Input P_IO_2	P_IO_2 (mmHg)	A		PO_2 (if stored)
3	Input P_aO_2	P_aO_2 (mmHg)	B		PCO_2 (if stored)
4	Input P_aCO_2	P_aCO_2 (mmHg)	C		R_Q (if stored)
5	Input R_Q and calculate A–a	R_Q	D		A-aO_2 (mmHg)
6	Calculate P_AO_2		E		P_AO_2 (mmHg)

PHYSIOLOGIC SHUNT AND FICK



The Fick cardiac output and physiologic shunt fraction are calculated from arterial, venous and alveolar oxygen concentration and oxygen uptake.

Equations Used:

$$CO\ (l/\text{min}) = \frac{\dot{V}O_2\ (\text{ml/min STPD}) \cdot 100(\%)}{(C_aO_2 - C_vO_2\ (\text{vol. }\%)) \cdot 1000\ (\text{ml}/l)}$$

$$\text{Phys. Shunt} = \frac{C_AO_2 - C_aO_2}{C_AO_2 - C_VO_2}$$

These are the standard Fick cardiac output and physiologic shunt equations. If measured O_2 saturations are used in calculating the O_2 contents, these equations will be accurate.

Warning:

If the content values have been derived from saturation estimates based on PO_2 measurements for arterial and venous blood, the results should be viewed with caution unless the patient's oxygen dissociation curve has been established to be normal.

Reference:

Comroe, Julius H., Jr., et al, *The Lung,* 2nd ed., Year Book Medical Publishers, Inc., Chicago, 1962, p. 345

Yang, Sing San, et al, *From Cardiac Catheterization Data to Hemodynamic Parameters,* F.A. Davis Co., Phil., 1972, p. 21.

Detailed User Instructions:

If arterial and venous O_2 contents have been previously calculated and stored, and if program 1–14A (SAT) has been used immediately previous to calculate equivalent alveolar content, then it will not be necessary to re-enter any content values. The C_AO_2 will be in the display register ready for entry. If the values are not stored, they may simply be entered. The $\dot{V}O_2$, oxygen uptake, will be recalled if previously entered. If not, it should be entered in ml/min. STPD. The Fick cardiac output results from pressing **D**. Pressing **E** will cause the physiologic blood shunt to be displayed, expressed as a percent.

After cardiac output is calculated, stroke volume may be calculated by dividing by heart rate and multiplying by 1000 (to convert from *l* to ml). Alternatively, cardiac index may be calculated by dividing by body surface area.

If the program is to be used to calculate cardiac output only, it is not necessary to input C_AO_2. However, **A** should be pressed to start the program anyway.

Example:

C_AO_2 = 20 vol. %

C_aO_2 = 18 vol. %

C_VO_2 = 15 vol. %

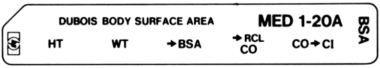
$\dot{V}O_2$ = 250 ml/min. STPD

Answer: CO = 8.33 *l*/min.

Shunt = 40.00%

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter PHYS		[ ] [ ]	
2	Input C_AO_2	C_AO_2 (Vol.%)	[A] [ ]	C_aO_2 (if stored)
3	Input C_aO_2	C_aO_2 (Vol.%)	[B] [ ]	C_vO_2 (if stored)
4	Input C_vO_2	C_vO_2 (Vol.%)	[C] [ ]	$\dot{V}O_2$ (if stored)
5	Input $\dot{V}O_2$ and calculate CO	$\dot{V}O_2$ (ml/min)	[D] [ ]	CO(*l*/min)
6	Calculate shunt %		[E] [ ]	shunt %

DUBOIS BODY SURFACE AREA



This program calculates body surface area using the Dubois formula and, given cardiac output, the cardiac index can also be calculated.

Equations Used:

$$BSA(m^2) = Ht(cm)^{0.725} \cdot Wt(kg)^{0.425} \cdot 71.84 \cdot 10^{-4}$$

$$CI = CO\ (l/min)/BSA(m^2)$$

Warning:

The Dubois BSA formula is undefined and should not be used for children with a BSA less than $0.6m^2$. If the result is less than 0.6, use the Boyd BSA Program 1–21A (BOYD) instead.

Detailed User Instructions:

The height and weight may be input in either metric or English units. If English units are used, they must be input as negative values. This is accomplished by pressing [CHS] after the number is input, but before the program button is pressed. The metric equivalent will appear in the display.

Press [C] to obtain body surface area, which also will be stored in the calculator's memory. If cardiac output has been previously calculated, it may be recalled by pressing [D]. Alternatively, it may simply be input. In either case, pressing [E] will yield cardiac index.

If the patient's ID program 1–05A (ID) is run prior to this one, height and weight remain in memory. In that case, skip [A] and [B], Press [C] to yield BSA.

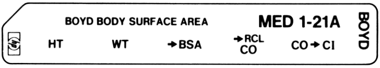
Example:

Ht = –60 in. or 152.40 cm
Wt = –100 lbs. or 45.45 kg
CO = 5 *l*/min.

Answer: BSA = 1.39 m^2
CI = 3.59 *l*/min./m^2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter BSA		[ ] [ ]	
2	Input patient height	Ht(+cm or–in)	[A] [ ]	Ht(cm)
3	Input patient weight	Wt(+kg or–lb)	[B] [ ]	Wt(kg)
4	Calculate BSA		[C] [ ]	BSA(m^2)
5	If CO is stored recall it		[D] [ ]	CO(*l*/min)
6	Input CO and calculate CI	CO(*l*/min)	[E] [ ]	CI(*l*/min/in^2)

BOYD BODY SURFACE AREA



This program calculates BSA using the Boyd formula (valid for infants as well as adults).

Equations Used:

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

$$CI = CO\ (l/min)/BSA(m^2)$$

Reference:

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

Detailed User Instructions

The height and weight may be input in either metric or English units. If English units are used, they must be input as negative values. This is accomplished by pressing [CHS] after the number is input, but before the program button is pressed. The metric equivalent will appear in the display.

Press [C] to obtain body surface area, which will also be stored in the calculator's memory. If cardiac output has been previously calculated, it may be recalled by pressing [D]. Alternatively, it may be input. In either case, pressing [E] will yield cardiac index.

If patient's ID program 1–05A (ID) is run prior to this one, height and weight remain in memory. In that case, skip [A] and [B]. Press [C] to yield BSA.

The HP-65 may be used as a four-function calculator between program buttons; provided the correct value is in the display register before the next program button is pressed. For example, to input 35 lbs., 6 oz., the value must be expressed in lbs. Input 6, press [ENTER↑], input 16, press [÷], input 35, press [+], resulting in 35.38 lbs. Now simply press [CHS], to indicate lbs, then [B].

Example

Ht = –60 in. or 152.40 cm

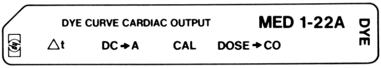
Wt = –100 lbs. or 45.45 kg

CO = 5 *l*/min.

Answers: BSA = 1.40 m^2
CI = 3.57 *l*/min./m^2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter BOYD		[ ] [ ]	
2	Input patient height	HT(+cm or – in)	[A] [ ]	HT(cm)
3	Input patient weight	WT(+kg or – lb)	[B] [ ]	WT(kg)
4	Calculate BSA		[C] [ ]	BSA(m^2)
5	If CO was previously stored		[ ] [ ]	
	recall it		[D] [ ]	CO(*l*/min)
6	Input CO and calculate CI	CO(*l*/min)	[E] [ ]	CI(*l*/min/m^2)

DYE CURVE CARDIAC OUTPUT



This program computes the area of the first part of the curve by trapezoidal rule integration. The part after the last point is calculated from an exponential projection based on the first measured point below 65% of the peak measured point; and the first measured point after that which is below 45% of the peak. This not only avoids problems of indicator recirculation in most cases, but also limits the amount of data to be input. Thus it is important to have a measured point which is below 45% of the peak, but before recirculation becomes obvious. If this isn't possible, an approximation can be obtained by guessing at the curve without recirculation and entering these values.

Equation Used:

$$CO(l/\text{min}) = \frac{\text{DOSE (mg)} \cdot 60\ (\text{sec/min})}{\text{CAL (mg}/l/\text{div)} \cdot \text{AREA (div sec)}}$$

Warning:

Although this program leaves CO stored in memory, it erases all other stored patient data, including BSA.

Reference:

Yang, Sing San, et al, *From Cardiac Catheterization Data to Hemodynamic Parameters* , F. A. Davis Co., Phil., 1972.

Detailed User Instructions

This program calculates cardiac output from measurements taken directly from an indicator dilution curve. To obtain accurate results, it is important to measure the curve at frequent intervals. Generally, about ten points on the curve, equally spaced in time between onset and the 40%-of-peak point on the downslope, will be adequate. Choose a measurement time interval accordingly. Input the interval (Δt) and press **A**.

Input the values measured from the curve (DC) and press **B** after each. The units of measurement are arbitrary; for example, divisions on the paper or volts, so long as the same units are used in inputting the calibration. The values are measured relative to the baseline, or starting level, of the curve. After each input entry, the display will indicate the number of points input.

As points on the downslope are input, the program compares each with the peak value. When the first point whose value is less than 65% of the peak value is found, it is stored for later use in the exponential projection as indicated by a minus sign preceding the displayed value representing the number of points input.

When a point having a value less than 45% of the peak value is input, the program automatically makes the exponential projection and displays the area under the curve, rather than the number of points entered.

At this time, input the CAL value. If indocyanine green dye is being used, it will generally be measured as milligrams of dye per liter of the patient's blood per division or unit of curve measurement. For other indicators, equivalent calibration factors must be determined.

Finally, input the dose of indicator given. For dye, this will usually be in mg. Press **D**, and cardiac output in *l*/min. will result. CO is stored in memory.

Example

Δt = 1 sec.

DC = 5, 20, 45, 60, 50, 38, 28, 20 div.

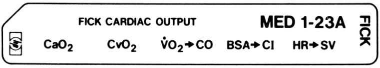
CAL = 0.2 mg/*l*/div.

DOSE = 3 mg

Answers: A = 318.32 div. sec.
CO = 2.82 *l*/min.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter DYE		[ ] [ ]	
2	Input Δt	Δt(sec)	[A] [ ]	Δt(sec)
3	Repeat step 3 for each DC		[ ] [ ]	
	value measured from the curve	$DC_1 ... DC_{n-1}$ (Div)	[B] [ ]	1 .... (n–1)
	After the 45% or less DC value		[ ] [ ]	
	is input	DC n	[B] [ ]	area(Div · sec)
4	Input CAL	CAL (mg/*l*/Div)	[C] [ ]	CAL x area
5	Input DOSE and calculate CO	DOSE (mg)	[D] [ ]	CO(*l*/min)

FICK CARDIAC OUTPUT



This program computes cardiac output by the Fick method, stroke volume and cardiac index.

Equations Used:

$$CO(l/\text{min}) = \frac{\dot{V}O_2\ (\text{ml/min STPD}) \cdot 100(\%)}{(C_aO_2 - C_vO_2)(\text{vol.}\%) \cdot 1000\ (\text{ml}/l)}$$

$$SV(\text{ml/beat}) = \frac{CO(l/\text{min}) \cdot 1000\ (\text{ml}/l)}{HR\ (\text{beats/min})}$$

$$CI(l/\text{min/m}^2) = \frac{CO(l/\text{min})}{BSA(\text{m}^2)}$$

$$SI(\text{ml/m}^2) = \frac{SV(\text{ml})}{BSA(\text{m}^2)}$$

Reference:

Yang, Sing San, et al, *From Cardiac Catheterization Data to Hemodynamic Parameters,* F. A. Davis Co., Phil., 1972.

Detailed User Instructions

If program 1–14A (SAT) has been run immediately previously, to calculate either arterial or venous O_2 content, C_aO_2 will be in the display register. To start, simply press **A**. If C_aO_2 is not in the display register, but has been previously stored, it may be recalled by pressing **R/S** after entering the program card. Proceed as usual by inputting values or accepting recalled values for each parameter. Be sure $\dot{V}O_2$ is in ml/min STPD.

To calculate cardiac index–assuming BSA has been previously stored–press **R/S** to recall BSA, then press **D**. Alternatively, enter

BSA and press **D**. To calculate stroke volume enter heart rate and press **E**. Pressing **R/S** at this point will yield stroke index, with a minus sign, to avoid confusion with SV. Pressing **R/S** again returns to a display of SV.

Example

CaC_2 = 18 vol. %

CvO_2 = 15 vol. %

$\dot{V}O_2$ = 250 ml/min. STPD

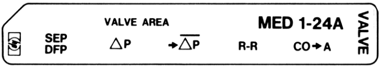
BSA = $2m^2$

HR = 60 BPM

Answers: CO = 8.33 *l*/min.
CI = 4.17 *l*/min./m^2
SV = 138.84 ml
SI = –69.42 ml/m^2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter FICK		[ ] [ ]	
2	If CaO_2 was stored previously		[R/S] [ ]	CaO_2
3	Input CaO_2	CaO_2 (Vol.%)	[A] [ ]	CvO_2 (if stored)
4	Input CvO_2	CvO_2 (Vol.%)	[B] [ ]	$\dot{V}O_2$ (if stored)
5	Input $\dot{V}O_2$ and calculate CO	$\dot{V}O_2$ (ml/min)	[C] [ ]	CO(*l*/min)
6	If BSA was stored previously		[R/S] [ ]	BSA(m^2)
7	Input BSA and calculate CI	BSA(m^2)	[D] [ ]	CI(*l*/min/m^2)
8	Input heart rate and calculate		[ ] [ ]	
	SV and SI	HR(BPM)	[E] [ ]	SV(ml)
9	Display SI		[R/S] [ ]	SI(ml/m^2)

VALVE AREA



This program calculates the areas of heart valves across which the pressure gradient has been measured.

Equations Used:

$$\text{Valve Area (cm}^2\text{)} = \frac{\text{Mean Flow}}{0.0445\ \sqrt{\text{mean gradient}}}$$

where

$$\text{Mean Flow } (l/\text{sec}) = \frac{\text{CO } (l/\text{min}) \cdot \text{R–R (sec)}}{\text{Valve Open Time (sec/beat)} \cdot 60 \text{ (sec/min)}}$$

$$\text{Mitral Valve Area only} = \frac{\text{Valve Area}}{0.7}$$

Reference:

Gorlin, R.; Gorlin, S. G., "Hydraulic Formula for Calculation of the Area of the Stenotic Mitral Valve, Other Cardiac Valves, and Central Circulatory Shunts", *American Heart Journal,* Jan. 1957, VOL. 41, No. 1

Detailed User Instructions

Input the time duration, in seconds, of blood flow through the valve of interest; that is, the systolic ejection period (SEP) for outflow tract valves or the diastolic filling period (DFP) for A–V valves. Press **A**.

This program permits averaging of a number of pressure gradients across the valve measured at different times while the valve is open. If the pressure gradient is to be measured at a number of different times, the time intervals should be equally spaced across the duration of the valve opening to obtain a true average. Simply input each value of pressure difference, (ΔP), in mmHg, and press **B** after each. The display will then show the number of input entries made. When all input entries have been made, press **C**. The average of all the ΔP values will be displayed ($\overline{\Delta P}$). If only one pressure gradient measurement is to be input, because averaging has been accomplished by some other means, simply input the value, press **B** and then press **C**. The input value will be displayed.

Input the R–R interval, in seconds, and press **D**. Cardiac output, if previously stored, will be recalled. If not, input it. Pressing **E** will display the valve area, in cm^2, except in the case of mitral valves. A different constant is used for mitral valves; this is applied by pressing **R/S**. A mitral area is indicated by a minus sign preceding the displayed value.

Example:

DFP (mitral valve) = 0.55 sec

ΔP = 10, 12, 8, 6, 2 mmHg

R–R = 0.94 sec

CO = 5.73 *l*/min.

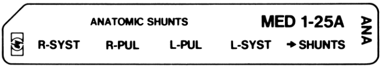
Push **E** then **R/S** for mitral valve area.

Answers: $\overline{\Delta P}$ = 7.60 mmHg

Area = –1.90 cm^2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter VALVE				
2	Input SEP or DFP	seconds	A		SEP or DFP
3	Repeat step 3 for each value of				
	ΔP to be averaged	$\Delta P_1 ... \Delta P_n$(mmHg)	B		1 ... n
4	Calculate $\overline{\Delta P}$		C		$\overline{\Delta P}$ (mmHg)
5	Input R–R	R–R(sec)	D		CO(if stored)
6	Input CO and calculate area	CO(*l*/min)	E		area(cm^2)
7	If mitral valve		R/S		Mit. area(cm^2)

ANATOMIC SHUNTS



This program calculates left-to-right and right-to-left shunts and displays them as a percentage. The program uses the method of allegations and can calculate bi-directional shunts.

Equations Used:

$$\text{R–L shunt (\%)} = \frac{(\text{L–PUL}) - (\text{L–SYST})}{(\text{L–PUL}) - (\text{R–SYST})} \cdot 100$$

$$\text{L–R shunt (\%)} = \frac{(\text{R–PUL}) - (\text{R–SYST})}{(\text{L–PUL}) - (\text{R–SYST})} \cdot 100$$

Reference:

Zimmerman, H. A., *Intravascular Catheterization,* Charles C. Thomas, Springfield, Ill. 1966.

Detailed User Instructions

The program assumes oxygen concentration values taken from four sites in the cardiovascular system. Since these sites may be various chambers in the heart or great vessels, they are labeled right systemic, right pulmonary, left pulmonary and left systemic. For example, suppose oxygen concentration values are known for the right atrium, pulmonary artery, left ventricle, and aorta; then the right systemic site would be the right atrium, the right pulmonary site would be the pulmonary artery, the left pulmonary site would be the left ventricle, and the left systemic site would be the aorta.

Input right systemic value, press **A**. Input right pulmonary value, press **B**. Input left pulmonary value, press **C**. Input left systemic value, press **D**. Note that it is possible to enter either oxygen contents or saturations, assuming hematocrit does not change during the sampling interval. Once all four sites have been input, press **E** to obtain the percent left-to-right shunt. If no shunt is calculated, 0 is displayed. Press **E** again to obtain the right-to-left shunt. Left-to-right shunts are reported as positive numbers, and right-to-left shunts as negative numbers. Each time **E** is pressed, either a left-to-right or right-to-left shunt will be displayed.

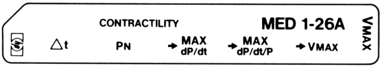
Example

Calculate the left-to-right or right-to-left shunts for a patient having the following oxygen saturation values at the listed sites. Right atrium, 85%; pulmonary artery, 88%; left atrium, 95%; left ventricle, 93%.

Answers: L–R shunt = 30.00%
R–L shunt = –20.00%

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter ANA			
2	Input R–SYST	R–SYST(%)	A	R–SYST(%)
3	Input R–PUL	R–PUL(%)	B	R–PUL(%)
4	Input L–PUL	L–PUL(%)	C	L–PUL(%)
5	Input L–SYST	L–SYST(%)	D	L–SYST(%)
6	Calculate L–R		E	L–R(+ %)
7	Calculate R–L		E	R–L(– %)
	(Pressing E will display L–R			
	and R–L alternately)			

CONTRACTILITY



This program calculates indices of left ventricular contractility based on pressure rise during isovolumetric contraction.

Equations Used:

P_N = most recently entered pressure (mmHg)

P_{N-1} = next previously entered pressure

Δt = time interval between pressure measurements (sec)

P_P = pressure at which dP/dt/P is calculated

$$\Delta P = P_N - P_{N-1}$$

$$\frac{dP}{dt} = \frac{\Delta P}{\Delta t} \text{ mmHg/sec}$$

$$P_P = \frac{P_N + P_{N-1}}{2}$$

$$dP/dt/P = \frac{dP/dt}{P_P} \text{ sec}^{-1}$$

$P_M = P_P$ where dP/dt/P is a maximum

$$V_{MAX} = \frac{1}{30} \frac{(P_{P\,LAST} \bullet \text{MAX } dP/dt/P) - (P_M \bullet dP/dt/P_{LAST})}{P_{P\,LAST} - P_M}$$

dP/dt is calculated as the difference between successive pressure inputs divided by the time interval, Δt. The largest value found is stored as maximum dP/dt.

dP/dt/P is calculated for each pair of successive inputs, by first determining dP/dt as above, then dividing by the mean of the two pressures. The largest value found is stored as maximum dP/dt/P.

V_{MAX} is found in this program by a linear projection of the downslope of the dP/dt/P vs. P curve back to P = 0, and by dividing the resulting dP/dt/P by 30. The projection is based on the point at which the maximum dP/dt/P was found, and the last point input. The constant is controversial, values between about 28 and 32 having appeared in the literature. The value 30 is used in this program.

Reference:

Yang, Sing San, et al, *From Cardiac Catheterization Data to Hemodynamic Parameters,* F. A. Davis Co., Phil., 1972.

Detailed User Instructions

The indices of left ventricular contractility calculated by this program are based on the pressure rise during isovolumetric contraction. Measurements, equally spaced in time, should be input for the isovolumetric phase only. Inputting values from the systolic ejection period can cause significant errors. Generally, between 5 and 10 pressure measurements should be input, and the time interval between measurements, Δt, chosen accordingly. Too few measurements will cause the maximum values to be missed. Too many will introduce excessive "noise" resulting in errors.

Input Δt in seconds, for example, .005. Press **A**. Input left ventricular pressure measurements in mmHg; press **B** after each. After each input except the first, dP/dt/P for the two most recent points will be displayed. When all points have been input, press **C**, **D** and **E** in any order to obtain the corresponding results–maximum dP/dt, maximum dP/dt/P and V_{MAX}, maximum velocity of the contractile element at zero pressure in circumferences or lengths/sec.

If the contractility parameters are to be calculated using developed pressure, or any pressure reference other than zero, perform the subtraction before entering pressure values .

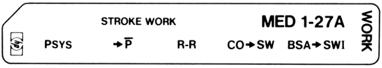
Example

Find maximum dP/dt, maximum dP/dt/P and maximum ventricular contractility if Δt is 0.005 seconds and P_N is 10, 20, 40, 60, and 80 mmHg.

Answers: maximum dP/dt = 4000 mmHg/sec.
Max dP/dt/P = 133.3 sec^{-1}
V_{MAX} = 5.14 circ/sec

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter V_{max}				
2	Input Δt	Δt(seconds)	A		Δt(seconds)
3	Repeat step 3 for each P_n	P_1 ... P_n	B		dP/dt/P(sec^{-1})
4	Calculate maximum dP/dt		C		dP/dt(mmHg/sec)
5	Calculate maximum dP/dt/P		D		dP/dt/P(sec^{-1})
6	Calculate V_{max}		E		V_{max} (circ/sec)

STROKE WORK



This program calculates stroke work (SW) and stroke work index (SWI). For stroke work based on systolic minus end-diastolic pressure, perform subtraction before data input.

Equations Used:

$$SW(gm \cdot m) = \frac{13.6 \cdot P(mmHg) \cdot CO(l/min) \cdot R\!-\!R(sec)}{60\ (sec/min)}$$

$$SWI(gm \cdot m/m^2) = \frac{SW(gm \cdot m)}{BSA(m^2)}$$

Reference:

Yang, Sing San, et al, *From Cardiac Catheterization Data to Hemodynamic Parameters,* F. A. Davis Co., Phil., 1972.

Detailed User Instructions

The mean systolic pressure, $\overline{P}$, is required for stroke work calculation. The program will average pressures measured at equal time intervals through systole to obtain the mean. Input the pressure measurements and press A after each. The number of inputs will be displayed. When all inputs have been made, press B to obtain the mean systolic pressure.

If averaging is accomplished by other means, and only a single value is input, press A and then B. If an error is made in the pressure inputs, restart program by pressing B and rekey the input data.

Input the R–R interval in seconds and press C. If cardiac output has been previously stored in memory, it will be recalled; if not, input it now. Press D, and stroke work in gm • m will be displayed. To obtain stroke work index divide by BSA. If BSA has been stored press R/S to recall it. Otherwise, input BSA. Press E, and stroke work index will be displayed in gm • m/m^2.

Example

P_{sys} = 100, 110 mmHg

R–R = 1 sec

CO = 5 l/min.

BSA = 2 m^2

Answers: $\overline{P}$ = 105 mmHg

SW = 119.00 gm · m

SWI = 59.50 gm · m/m^2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Enter WORK		[ ] [ ]	
2	Repeat step 2 for each value of		[ ] [ ]	
	P_{sys}(mmHg)	$P_{sys_1}, \ldots, P_{sys_n}$	[A] [ ]	1 .... n
3	Calculate $\overline{P}$		[B] [ ]	$\overline{P}$ (mmHg)
4	Input R–R	R–R(sec)	[C] [ ]	CO(if stored)
5	Input CO and calculate stroke		[ ] [ ]	
	work	CO(l/min)	[D] [ ]	SW(gm · m)
6	If BSA was previously stored		[R/S] [ ]	BSA(m^2)
7	Input BSA and calculate SWI	BSA(m^2)	[E] [ ]	SWI(gm · m/m^2)

APPENDIX

Designing a Program Sequence

This section covers some guidelines for setting up a series of programs which will be run repeatedly. The general rule, of course, is that programs which yield intermediate results must be run before the programs which use those results. To avoid reentry of data, pay attention to the use of the memory registers. Table I (Pages 80–81) shows how the programs use the registers. Note that R_1 and R_8 are used as scratch pad registers by nearly all programs. [An exception is that O_2 saturation may be passed from 1–14A (SAT) to 1–16A (ΔPO_2) or vice versa in R_8, provided no program except 1–15A (ΔpH) is run in between.] Note that 1–22A (DYE), while it stores cardiac output, erases all other stored values including body surface area.

An attempt has been made to make many of the programs compatible. Thus, the pulmonary function lab programs use a common set of memory designations, as do the blood gas, acid-base and respiratory function programs. However, the two sets cannot be readily mixed.

Many times it is convenient to pass parameters between programs by using the display register. This is particularly true of virtual PO_2 between 1–13A (VPO_2) and 1–14A (SAT), alveolar PO_2 between 1–18A (A–a) and 1–14A (SAT), alveolar oxygen content between 1–14A (SAT) and 1–19A (PHYS), and arterial oxygen content between 1–14A (SAT) and 1–23A (FICK). These are all illustrated in the examples in the introduction of this pac. Data is never passed in the unseen registers of the stack (Y, Z, T).

TABLE I
MEMORY REGISTER USAGE

	PROGRAM	R1	R2	R3	R4	R5	R6	R7	R8	R9
1–01	WT 1	Tag							gm	Used
	WT 2	Tag							gm	Used
	WT 3	Tag							gm	Used
1–02	LEN 1	Tag							cm	Used
	LEN 2	Tag							cm	Used
1–03	VOL 1	Tag							cc	Used
	VOL 2	Tag							cc	Used
	VOL 3	Tag							cc	Used
1–04	MET	Input	Const. 2						Const. 1	
1–05	ID	Ht Toggle		Sex	Age	Ht	Wt		Wt Toggle	Used
1–06	♂PF 1	Used			Age	Ht (cm)				Used
	♂PF 2	Used			Age	Ht (cm)				
	♂PF 3	Used	Used		Age	Ht (cm)				
1–07	♀PF 1	Used			Age	Ht (cm)				Used
	♀PF 2	Used			Age	Ht (cm)				Used
	♀PF 3	Used	Used		Age	Ht (cm)				
1–08	DLCO	F_ICAR	F_ACAR	F_ACO					t_{BH}	
1–09	GAS 1	$\frac{1}{T}$ (K^{-1})	T (K)						T(°C),P_{H_2O}	Used
	GAS 2	P_{BAR}	T (K)	V_{STPD}	Used				P_{H_2O}	
1–10	RAD 1	TV (ml)	2.2	Sex			Wt (kg)		Rate	Used
	RAD 2	TV (ml)					Wt (kg)			Used

1–11	SUWA	P_aCO_2					Wt (kg)	TV (ml)	P_ECO_2	Used
1–12	ACID	Used				100 PCO_2 + PO_2/1000	1000 pH + BT/1000		Used	Hgb
1–13	PO_2	Used				100 PCO_2 + PO_2/1000	1000 pH + BT/1000		1000	
1–14	SAT	PO_2		C_vO_2	C_aO_2				$(PO_2)^2$,SAT	Hgb
1–15	ΔpH	ΔT°C)				100 PCO_2 + PO_2/1000	1000 pH + BT/1000			
1–16	ΔPO_2	BT(°C)				100 PCO_2 + PO_2/1000	1000 pH + BT/1000		SAT	
1–17	V_D/V_T	VCO_2, V_A	$\dot{V}O_2$ + $\dot{V}CO_2$/10000			100 PCO_2 + PO_2/1000			VO_2	
1–18	A–a	P_aCO_2 P_AO_2	$\dot{V}O_2$ + $\dot{V}CO_2$/10000			100 PCO_2 + PO_2/1000			P_IO_2	Hgb
1–19	PHYS	C_AO_2	$\dot{V}O_2$ + $\dot{V}CO_2$/10000	C_VO_2	C_aO_2			100 CO + BSA/100	CO	
1–20	BSA	BSA				Ht	Wt	100 CO + BSA/100		Used
1–21	BOYD	BSA				Ht	Wt	100 CO + BSA/100		Used
1–22	DYE	SD	Used	D65	–N65	Cleared	Cleared	ΔT,100 CO	–N, –N45	Used
1–23	FICK	CO, SV	$\dot{V}O_2$ + $\dot{V}CO_2$/10000	C_VO_2	C_aO_2			100 CO + BSA/100	BSA	
1–24	VALVE	$\Sigma\Delta P, \overline{\Delta P}$						100 CO + BSA/100	–N,S/M, A	T(°C)
1–25	ANA	R·SYST	R·PUL			L·PUL	L·SYST		Toggle	Used
1–26	V_{MAX}	P_N	dP/dt/P	MaxdP/dt	MaxdP/dt/P	P_M	Δt		P_P	Used
1–27	WORK	BSA, $\Sigma P, \overline{P}$						100 CO + BSA/100	–N,R–R	SW

PROGRAM LISTINGS

WEIGHT CONVERSIONS (1)

CODE	KEYS
23	LBL
11	A
04	4
05	5
03	3
83	•
05	5
09	9
02	2
03	3
07	7
22	GTO
01	1
23	LBL
12	B
02	2
08	8
83	•
03	3
04	4
09	9
05	5
02	2
03	3
01	1
03	3
22	GTO
01	1
23	LBL
13	C
43	EEX
03	3
22	GTO
01	1
23	LBL

CODE	KEYS
14	D
01	1
23	LBL
01	1
31	f
61	TF 1
22	GTO
02	2
35 07	g x⇄y
71	x
33 08	STO 8
03	3
33 01	STO 1
35 00	g LST X
24	RTN
23	LBL
02	2
34 08	RCL 8
35 07	g x⇄y
81	÷
32	f^{-1}
51	SF 1
03	3
34 01	RCL 1
35 21	g x≠y
00	0
81	÷
35 08	g R↓
35 08	g R↓
24	RTN
23	LBL
15	E
31	f
51	SF 1
24	RTN

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	Tag	R_4		R_7	
R_2		R_5		R_8	gm
R_3		R_6		R_9	Used

WEIGHT CONVERSIONS (2)

CODE	KEYS
23	LBL
11	A
83	•
00	0
06	6
04	4
07	7
09	9
08	8
09	9
01	1
22	GTO
01	1
23	LBL
12	B
01	1
83	•
07	7
07	7
01	1
08	8
04	4
05	5
01	1
09	9
05	5
22	GTO
01	1
23	LBL
13	C
83	•
00	0
00	0
01	1
22	GTO

CODE	KEYS
01	1
23	LBL
14	D
43	EEX
42	CHS
06	6
23	LBL
01	1
31	f
61	TF 1
22	GTO
02	2
35 07	g x⇄y
71	x
33 08	STO 8
03	3
33 01	STO 1
35 00	g LST X
24	RTN
23	LBL
02	2
34 08	RCL 8
35 07	g x⇄y
81	÷
32	f^{-1}
51	SF 1
03	3
34 01	RCL 1
35 21	g x≠y
00	0
81	÷
35 08	g R↓
35 08	g R↓
24	RTN
23	LBL

CODE	KEYS
15	E
31	f
51	SF 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Tag	R_4	R_7
R_2	R_5	R_8 gm
R_3	R_6	R_9 Used

WEIGHT CONVERSIONS (3)

CODE	KEYS
23	LBL
11	A
03	3
07	7
03	3
83	•
02	2
04	4
01	1
07	7
02	2
01	1
06	6
22	GTO
01	1
23	LBL
12	B
03	3
01	1
83	•
01	1
00	0
03	3
04	4
07	7
06	6
08	8
22	GTO
01	1
23	LBL
13	C
03	3
83	•
08	8
08	8

CODE	KEYS
07	7
09	9
03	3
04	4
06	6
22	GTO
01	1
23	LBL
14	D
01	1
83	•
02	2
09	9
05	5
09	9
07	7
08	8
02	2
23	LBL
01	1
31	f
61	TF 1
22	GTO
02	2
35 07	g x⇄y
71	x
33 08	STO 8
03	3
33 01	STO 1
35 00	g LST X
24	RTN
23	LBL
02	2
34 08	RCL 8
35 07	g x⇄y

CODE	KEYS
81	÷
32	f^{-1}
51	SF 1
03	3
34 01	RCL 1
35 21	g x≠y
00	0
81	÷
35 08	g R↓
35 08	g R↓
24	RTN
23	LBL
15	E
31	f
51	SF 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Tag	R_4	R_7
R_2	R_5	R_8 gm
R_3	R_6	R_9 Used

LENGTH CONVERSIONS (1)

CODE	KEYS
23	LBL
11	A
01	1
00	0
00	0
22	GTO
01	1
23	LBL
12	B
09	9
01	1
83	•
04	4
04	4
22	GTO
01	1
23	LBL
13	C
03	3
00	0
83	•
04	4
08	8
22	GTO
01	1
23	LBL
14	D
43	EEX
05	5
23	LBL
01	1
31	f
61	TF 1
22	GTO
02	2

CODE	KEYS
35 07	g x⇄y
71	x
33 08	STO 8
05	5
33 01	STO 1
35 00	g LST X
24	RTN
23	LBL
02	2
34 08	RCL 8
35 07	g x⇄y
81	÷
32	f^{-1}
51	SF 1
05	5
34 01	RCL 1
35 21	g x≠y
00	0
81	÷
35 08	g R↓
35 08	g R↓
24	RTN
23	LBL
15	E
31	f
51	SF 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Tag	R_4	R_7
R_2	R_5	R_8 cm
R_3	R_6	R_9 Used

LENGTH CONVERSIONS (2)

CODE	KEYS
23	LBL
11	A
02	2
83	·
05	5
04	4
22	GTO
01	1
23	LBL
12	B
83	·
01	1
22	GTO
01	1
23	LBL
13	C
83	·
00	0
00	0
00	0
01	1
22	GTO
01	1
23	LBL
14	D
01	1
23	LBL
01	1
31	f
61	TF 1
22	GTO
02	2
35 07	g x⇄y
71	x
33 08	STO 8

CODE	KEYS
05	5
33 01	STO 1
35 00	g LST X
24	RTN
23	LBL
02	2
34 08	RCL 8
35 07	g x⇄y
81	÷
32	f^{-1}
51	SF 1
05	5
34 01	RCL 1
35 21	g x≠y
00	0
81	÷
35 08	g R↓
35 08	g R↓
24	RTN
23	LBL
15	E
31	f
51	SF 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Tag	R_4	R_7
R_2	R_5	R_8 cm
R_3	R_6	R_9 Used

VOLUME CONVERSIONS (1)

CODE	KEYS
23	LBL
11	A
01	1
06	6
83	•
03	3
08	8
07	7
00	0
06	6
04	4
22	GTO
01	1
23	LBL
12	B
04	4
07	7
03	3
83	•
01	1
07	7
06	6
04	4
07	7
03	3
22	GTO
01	1
23	LBL
13	C
01	1
00	0
00	0
00	0
22	GTO
01	1

CODE	KEYS
23	LBL
14	D
05	5
05	5
00	0
83	•
06	6
01	1
00	0
04	4
07	7
01	1
04	4
23	LBL
01	1
31	f
61	TF 1
22	GTO
02	2
35 07	g x⇄y
71	x
33 08	STO 8
04	4
33 01	STO 1
35 00	g LST X
24	RTN
23	LBL
02	2
34 08	RCL 8
35 07	g x⇄y
81	÷
32	f^{-1}
51	SF 1
04	4
34 01	RCL 1

CODE	KEYS
35 21	g x≠y
00	0
81	÷
35 08	g R↓
35 08	g R↓
24	RTN
23	LBL
15	E
31	f
51	SF 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Tag	R_4	R_7
R_2	R_5	R_8 cc
R_3	R_6	R_9 Used

VOLUME CONVERSIONS (2)

CODE	KEYS
23	LBL
11	A
06	6
01	1
06	6
01	1
01	1
05	5
01	1
09	9
09	9
02	2
43	EEX
42	CHS
01	1
01	1
22	GTO
01	1
23	LBL
12	B
03	3
83	•
06	6
09	9
06	6
06	6
09	9
01	1
01	1
09	9
05	5
22	GTO
01	1
23	LBL
13	C

CODE	KEYS
02	2
09	9
83	•
05	5
07	7
03	3
05	5
02	2
09	9
05	5
06	6
22	GTO
01	1
23	LBL
14	D
01	1
23	LBL
01	1
31	f
61	TF 1
22	GTO
02	2
35 07	g x⇄y
71	x
33 08	STO 8
04	4
33 01	STO 1
35 00	g LST X
24	RTN
23	LBL
02	2
34 08	RCL 8
35 07	g x⇄y
81	÷
32	f^{-1}

CODE	KEYS
51	SF 1
04	4
34 01	RCL 1
35 21	g x≠y
00	0
81	÷
35 08	g R↓
35 08	g R↓
24	RTN
23	LBL
15	E
31	f
51	SF 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Tag	R_4	R_7
R_2	R_5	R_8 cc
R_3	R_6	R_9 Used

VOLUME CONVERSIONS (3)

CODE	KEYS
23	LBL
11	A
01	1
01	1
03	3
06	6
83	•
05	5
02	2
02	2
22	GTO
01	1
23	LBL
12	B
05	5
06	6
08	8
83	•
02	2
06	6
00	0
09	9
02	2
22	GTO
01	1
23	LBL
13	C
02	2
08	8
83	•
04	4
01	1
03	3
00	0
05	5

CODE	KEYS
22	GTO
01	1
23	LBL
14	D
83	•
00	0
05	5
09	9
01	1
09	9
03	3
08	8
05	5
23	LBL
01	1
31	f
61	TF 1
22	GTO
02	2
35 07	g x⇄y
71	x
33 08	STO 8
04	4
33 01	STO 1
35 00	g LST X
24	RTN
23	LBL
02	2
34 08	RCL 8
35 07	g x⇄y
81	÷
32	f^{-1}
51	SF 1
04	4
34 01	RCL 1

CODE	KEYS
35 21	g x≠y
00	0
81	÷
35 08	g R↓
35 08	g R↓
24	RTN
23	LBL
15	E
31	f
51	SF 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Tag	R_4	R_7
R_2	R_5	R_8 cc
R_3	R_6	R_9 Used

ENGLISH-METRIC CONVERSIONS

CODE	KEYS
23	LBL
11	A
33 01	STO 1
83	•
03	3
09	9
03	3
07	7
33 08	STO 8
00	0
33 02	STO 2
34 01	RCL 1
24	RTN
23	LBL
12	B
33 01	STO 1
02	2
83	•
02	2
33 08	STO 8
00	0
33 02	STO 2
34 01	RCL 1
24	RTN
23	LBL
13	C
33 01	STO 1
01	1
83	•
08	8
33 08	STO 8
03	3
02	2
33 02	STO 2
34 01	RCL 1

CODE	KEYS
24	RTN
23	LBL
14	D
34 01	RCL 1
34 02	RCL 2
51	–
34 08	RCL 8
81	÷
33 01	STO 1
24	RTN
23	LBL
15	E
34 01	RCL 1
34 08	RCL 8
71	x
34 02	RCL 2
61	+
33 01	STO 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Input	R_4	R_7
R_2 Constant #2	R_5	R_8 Constant #1
R_3	R_6	R_9

MASTER PATIENT IDENTIFICATION

CODE	KEYS
33 03	STO 3
35 08	g R↓
33 04	STO 4
44	CLX
35 07	g x⇄y
35 24	g x>y
22	GTO
01	1
42	CHS
02	2
83	•
02	2
81	÷
23	LBL
01	1
33 06	STO 6
35 08	g R↓
35 07	g x⇄y
33 01	STO 1
33 08	STO 8
35 24	g x>y
33 05	STO 5
24	RTN
42	CHS
02	2
83	•
05	5
04	4
71	x
33 05	STO 5
24	RTN
23	LBL
12	B
00	0
34 01	RCL 1

CODE	KEYS
35 23	g x=y
22	GTO
02	2
44	CLX
33 01	STO 1
34 05	RCL 5
24	RTN
23	LBL
02	2
34 05	RCL 5
02	2
83	•
05	5
04	4
33 01	STO 1
81	÷
42	CHS
24	RTN
23	LBL
13	C
00	0
34 08	RCL 8
35 23	g x=y
22	GTO
03	3
44	CLX
33 08	STO 8
34 06	RCL 6
24	RTN
23	LBL
03	3
34 06	RCL 6
02	2
83	•
02	2

CODE	KEYS
33 08	STO 8
71	x
42	CHS
24	RTN
23	LBL
14	D
34 04	RCL 4
24	RTN
23	LBL
15	E
34 03	RCL 3
24	RTN
23	LBL
11	A
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Ht. Toggle	R_4 Age	R_7
R_2	R_5 Ht	R_8 Wt. Toggle
R_3 Sex	R_6 Wt	R_9 Used

MALE VC, FEV1, MEFR

CODE	KEYS
23	LBL
11	A
41	↑
35	g
06	ABS
35 23	g x=y
33 05	STO 5
24	RTN
02	2
83	•
05	5
04	4
71	x
33 05	STO 5
24	RTN
23	LBL
12	B
33 04	STO 4
24	RTN
23	LBL
13	C
41	↑
83	•
00	0
05	5
08	8
34 05	RCL 5
71	x
83	•
00	0
02	2
05	5
34 04	RCL 4
71	x
51	–

CODE	KEYS
04	4
83	•
02	2
04	4
01	1
51	–
22	GTO
01	1
23	LBL
14	D
41	↑
83	•
00	0
03	3
06	6
34 05	RCL 5
71	x
83	•
00	0
03	3
02	2
34 04	RCL 4
71	x
51	–
01	1
83	•
02	2
06	6
51	–
22	GTO
01	1
23	LBL
15	E
41	↑
83	•

CODE	KEYS
00	0
04	4
03	3
34 05	RCL 5
71	x
83	•
00	0
04	4
07	7
34 04	RCL 4
71	x
51	–
02	2
83	•
00	0
07	7
61	+
23	LBL
01	1
33 01	STO 1
81	÷
43	EEX
02	2
71	x
84	R/S
34 01	RCL 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Used	R_4 Age in years	R_7
R_2	R_5 Ht (cm)	R_8
R_3	R_6	R_9 Used

MALE MVV, RV, TLC, FRC

CODE	KEYS
23	LBL
11	A
83	•
09	9
34 05	RCL 5
71	x
01	1
83	•
05	5
01	1
34 04	RCL 4
71	x
51	–
02	2
07	7
61	+
22	GTO
01	1
23	LBL
12	B
83	•
00	0
03	3
34 05	RCL 5
71	x
83	•
00	0
01	1
05	5
34 04	RCL 4
71	x
61	+
03	3
83	•
07	7

CODE	KEYS
05	5
51	–
22	GTO
01	1
23	LBL
13	C
83	•
00	0
09	9
04	4
34 05	RCL 5
71	x
83	•
00	0
01	1
05	5
34 04	RCL 4
71	x
51	–
09	9
83	•
01	1
07	7
51	–
22	GTO
01	1
23	LBL
14	D
83	•
00	0
05	5
01	1
34 05	RCL 5
71	x
05	5

CODE	KEYS
83	•
00	0
05	5
51	–
23	LBL
01	1
33 01	STO 1
81	÷
43	EEX
02	2
71	x
84	R/S
34 01	RCL 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Used	R_4 Age in years	R_7
R_2	R_5 Ht (cm)	R_8
R_3	R_6	R_9

MALE FEF (25%-75%)

CODE	KEYS
23	LBL
11	A
41	↑
33 01	STO 1
83	•
02	2
05	5
71	x
24	RTN
23	LBL
12	B
41	↑
83	•
07	7
05	5
34 01	RCL 1
71	x
24	RTN
23	LBL
13	C
41	↑
35 09	g R↑
51	–
33 02	STO 2
35 08	g R↓
24	RTN
23	LBL
14	D
34 01	RCL 1
83	•
05	5
71	x
34 02	RCL 2
81	÷
24	RTN

CODE	KEYS
23	LBL
15	E
41	↑
83	•
00	0
02	2
34 05	RCL 5
71	x
83	•
00	0
04	4
34 04	RCL 4
71	x
51	–
02	2
61	+
33 01	STO 1
81	÷
43	EEX
02	2
71	x
84	R/S
34 01	RCL 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Used	R_4 Age in years	R_7
R_2 Used	R_5 Ht (cm)	R_8
R_3	R_6	R_9

FEMALE VC, FEV1, MEFR

CODE	KEYS
23	LBL
11	A
41	↑
35	g
06	ABS
35 23	g x=y
33 05	STO 5
24	RTN
02	2
83	•
05	5
04	4
71	x
33 05	STO 5
24	RTN
23	LBL
12	B
33 04	STO 4
24	RTN
23	LBL
13	C
41	↑
83	•
00	0
04	4
05	5
34 05	RCL 5
71	x
83	•
00	0
02	2
04	4
34 04	RCL 4
71	x
51	–

CODE	KEYS
02	2
83	•
08	8
05	5
02	2
51	–
22	GTO
01	1
23	LBL
14	D
41	↑
83	•
00	0
03	3
05	5
34 05	RCL 5
71	x
83	•
00	0
02	2
05	5
34 04	RCL 4
71	x
51	–
01	1
83	•
09	9
03	3
02	2
51	–
22	GTO
01	1
23	LBL
15	E
41	↑

CODE	KEYS
83	•
00	0
05	5
07	7
34 05	RCL 5
71	x
83	•
00	0
03	3
06	6
34 04	RCL 4
71	x
51	–
02	2
83	•
05	5
03	3
02	2
51	–
23	LBL
01	1
33 01	STO 1
81	÷
43	EEX
02	2
71	x
84	R/S
34 01	RCL 1
24	RTN
35 01	g NOP

R_1 Used	R_4 Age in years	R_7
R_2	R_5 Ht (cm)	R_8
R_3	R_6	R_9 Used

FEMALE MVV, RV, TLC, FRC

CODE	KEYS	CODE	KEYS	CODE	KEYS
23	LBL	61	+	01	1
11	A	02	2	23	LBL
83	•	83	•	14	D
07	7	06	6	41	↑
06	6	03	3	83	•
02	2	51	–	00	0
34 05	RCL 5	22	GTO	04	4
71	x	01	1	07	7
83	•	23	LBL	34 05	RCL 5
08	8	13	C	71	x
01	1	01	1	04	4
34 04	RCL 4	07	7	83	•
71	x	04	4	08	8
51	–	34 05	RCL 5	06	6
06	6	35 24	g x>y	51	–
83	•	01	1	23	LBL
02	2	61	+	01	1
09	9	35 07	g x⇄y	33 01	STO 1
51	–	35 08	g R↓	81	÷
22	GTO	83	•	43	EEX
01	1	00	0	02	2
23	LBL	07	7	71	x
12	B	08	8	84	R/S
83	•	71	x	34 01	RCL 1
00	0	34 04	RCL 4	24	RTN
02	2	43	EEX	35 01	g NOP
04	4	02	2	35 01	g NOP
34 05	RCL 5	81	÷	35 01	g NOP
71	x	51	–	35 01	g NOP
83	•	07	7	35 01	g NOP
00	0	83	•		
01	1	03	3		
02	2	06	6		
34 04	RCL 4	51	–		
71	x	22	GTO		

R_1	Used	R_4	Age in years	R_7	
R_2		R_5	Ht (cm)	R_8	
R_3		R_6		R_9	Used

FEMALE FEF (25%-75%)

CODE	KEYS	CODE	KEYS	CODE	KEYS
23	LBL	23	LBL	35 01	g NOP
11	A	15	E	35 01	g NOP
41	↑	41	↑	35 01	g NOP
33 01	STO 1	83	•	35 01	g NOP
83	•	00	0	35 01	g NOP
02	2	02	2	35 01	g NOP
05	5	34 05	RCL 5	35 01	g NOP
71	x	71	x	35 01	g NOP
24	RTN	83	•	35 01	g NOP
23	LBL	00	0	35 01	g NOP
12	B	03	3	35 01	g NOP
41	↑	34 04	RCL 4	35 01	g NOP
83	•	71	x	35 01	g NOP
07	7	51	–	35 01	g NOP
05	5	05	5	35 01	g NOP
34 01	RCL 1	43	EEX	35 01	g NOP
71	x	42	CHS	35 01	g NOP
24	RTN	05	5	35 01	g NOP
23	LBL	34 04	RCL 4	35 01	g NOP
13	C	71	x	35 01	g NOP
41	↑	34 04	RCL 4	35 01	g NOP
35 09	g R↑	71	x	35 01	g NOP
51	–	51	–	35 01	g NOP
33 02	STO 2	01	1	35 01	g NOP
35 08	g R↓	83	•	35 01	g NOP
24	RTN	03	3	35 01	g NOP
23	LBL	61	+	35 01	g NOP
14	D	33 01	STO 1	35 01	g NOP
34 01	RCL 1	81	÷	35 01	g NOP
83	•	43	EEX	35 01	g NOP
05	5	02	2		
71	x	71	x		
34 02	RCL 2	84	R/S		
81	÷	34 01	RCL 1		
24	RTN	24	RTN		

R_1 Used	R_4 Age in years	R_7
R_2 Used	R_5 Ht (cm)	R_8
R_3	R_6	R_9

LUNG DIFFUSION

CODE	KEYS
23	LBL
11	A
33 01	STO 1
24	RTN
23	LBL
12	B
33 02	STO 2
24	RTN
23	LBL
13	C
33 03	STO 3
24	RTN
23	LBL
14	D
33 08	STO 8
24	RTN
23	LBL
15	E
41	↑
83	•
00	0
08	8
04	4
71	x
34 08	RCL 8
81	÷
34 02	RCL 2
41	↑
34 01	RCL 1
81	÷
23	LBL
01	1
83	•
03	3
34 03	RCL 3

CODE	KEYS
81	÷
71	x
31	f
07	LN
71	x
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 $F_I CAR$	R_4	R_7
R_2 $F_A CAR$	R_5	R_8 t_{BH}
R_3 $F_A CO$	R_6	R_9

WATER VAPOR PRESSURE

CODE	KEYS
23	LBL
11	A
00	0
35 07	g x⇄y
35 24	g x>y
33 08	STO 8
24	RTN
03	3
02	2
61	+
01	1
83	•
08	8
42	CHS
81	÷
33 08	STO 8
24	RTN
23	LBL
12	B
34 08	RCL 8
02	2
07	7
03	3
61	+
33 02	STO 2
35	g
04	1/x
33 01	STO 1
07	7
83	•
05	5
02	2
02	2
04	4
06	6

CODE	KEYS
07	7
41	↑
01	1
02	2
02	2
03	3
83	•
03	3
01	1
34 01	RCL 1
71	x
51	–
02	2
02	2
02	2
06	6
01	1
03	3
83	•
07	7
34 01	RCL 1
41	↑
71	x
71	x
51	–
01	1
02	2
03	3
02	2
03	3
04	4
03	3
02	2
34 01	RCL 1
71	x

CODE	KEYS
34 01	RCL 1
41	↑
71	x
71	x
61	+
32	f^{-1}
08	LOG
33 08	STO 8
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 1/T (K^{-1})	R_4	R_7
R_2 T (K)	R_5	R_8 T (°C), P_{H_2O}
R_3	R_6	R_9 Used

RESPIRATORY GAS CONVERSIONS

CODE	KEYS
23	LBL
11	A
33 01	STO 1
24	RTN
23	LBL
12	B
31	f
61	TF 1
22	GTO
01	1
33 04	STO 4
34 02	RCL 2
34 01	RCL 1
34 08	RCL 8
23	LBL
04	4
51	—
81	÷
81	÷
83	•
03	3
05	5
09	9
02	2
71	x
33 03	STO 3
34 04	RCL 4
24	RTN
23	LBL
01	1
34 03	RCL 3
34 02	RCL 2
34 01	RCL 1
34 08	RCL 8
23	LBL

CODE	KEYS
03	3
51	—
81	÷
71	x
02	2
83	•
07	7
08	8
04	4
71	x
32	f^{-1}
51	SF 1
24	RTN
23	LBL
13	C
31	f
61	TF 1
22	GTO
02	2
33 04	STO 4
03	3
01	1
00	0
34 01	RCL 1
04	4
07	7
22	GTO
04	4
23	LBL
02	2
34 03	RCL 3
03	3
01	1
00	0
34 01	RCL 1

CODE	KEYS
04	4
07	7
22	GTO
03	3
23	LBL
14	D
32	f^{-1}
61	TF 1
33 03	STO 3
24	RTN
34 03	RCL 3
32	f^{-1}
51	SF 1
24	RTN
23	LBL
15	E
31	f
51	SF 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 P_{BAR}	R_4 Used	R_7
R_2 T (K)	R_5	R_8 P_{H_2O}
R_3 V_{STPD}	R_6	R_9

VENTILATOR SETUP (RADFORD)

CODE	KEYS
23	LBL
11	A
00	0
35 07	g x⇄y
35 24	g x>y
33 06	STO 6
24	RTN
02	2
83	•
02	2
42	CHS
81	÷
33 06	STO 6
24	RTN
23	LBL
12	B
33 03	STO 3
24	RTN
23	LBL
13	C
33 08	STO 8
24	RTN
23	LBL
14	D
00	0
34 03	RCL 3
35 23	g x=y
22	GTO
01	1
23	LBL
02	2
08	8
34 06	RCL 6
35 22	g x≤y
22	GTO

CODE	KEYS
03	3
02	2
04	4
09	9
41	↑
06	6
01	1
22	GTO
04	4
23	LBL
03	3
01	1
09	9
03	3
41	↑
01	1
02	2
04	4
23	LBL
04	4
34 06	RCL 6
31	f
08	LOG
71	x
61	+
43	EEX
02	2
81	÷
32	f^{-1}
08	LOG
34 08	RCL 8
81	÷
34 06	RCL 6
02	2
83	

CODE	KEYS
02	2
71	x
61	+
33 01	STO 1
24	RTN
23	LBL
01	1
02	2
03	3
34 06	RCL 6
35 22	g x≤y
22	GTO
02	2
02	2
07	7
02	2
41	↑
04	4
04	4
83	•
02	2
22	GTO
04	4
23	LBL
15	E
34 01	RCL 1
61	+
33 01	STO 1
24	RTN
35 01	g NOP

R_1 TV	R_4	R_7
R_2 2.2	R_5	R_8 Rate (B/min)
R_3 Sex	R_6 Wt (kg)	R_9 Used

VENTILATOR SETUP CORRECTIONS

CODE	KEYS
23	LBL
11	A
00	0
35 07	g x⇄y
35 22	g x≤y
22	GTO
01	1
01	1
83	•
08	8
71	x
03	3
02	2
61	+
42	CHS
23	LBL
01	1
42	CHS
09	9
09	9
51	–
00	0
35 24	g x>y
34 01	RCL 1
24	RTN
61	+
83	•
00	0
05	5
71	x
34 01	RCL 1
71	x
34 01	RCL 1
61	+
33 01	STO 1

CODE	KEYS
24	RTN
23	LBL
12	B
00	0
35 07	g x⇄y
35 22	g x≤y
22	GTO
02	2
03	3
83	•
02	2
08	8
42	CHS
71	x
23	LBL
02	2
42	CHS
02	2
43	EEX
03	3
81	÷
34 01	RCL 1
71	x
83	•
00	0
05	5
71	x
34 01	RCL 1
61	+
33 01	STO 1
24	RTN
23	LBL
13	C
34 01	RCL 1
83	•

CODE	KEYS
01	1
71	x
34 01	RCL 1
61	+
33 01	STO 1
24	RTN
23	LBL
14	D
34 01	RCL 1
34 06	RCL 6
01	1
83	•
01	1
71	x
51	–
33 01	STO 1
24	RTN
23	LBL
15	E
34 01	RCL 1
83	•
02	2
71	x
34 01	RCL 1
61	+
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 TV (ml)	R_4	R_7
R_2	R_5	R_8
R_3	R_6 Wt (kg)	R_9 Used

P_aCO_2 NORMALIZATION (SUWA)

CODE	KEYS
23	LBL
11	A
00	0
35 07	g $x \rightleftarrows y$
35 24	g $x > y$
33 06	STO 6
24	RTN
02	2
83	•
02	2
42	CHS
81	÷
33 06	STO 6
24	RTN
23	LBL
12	B
33 01	STO 1
05	5
51	−
33 08	STO 8
34 01	RCL 1
24	RTN
23	LBL
13	C
33 08	STO 8
24	RTN
23	LBL
14	D
33 07	STO 7
24	RTN
23	LBL
15	E
34 06	RCL 6
01	1
83	•

CODE	KEYS
04	4
07	7
71	x
61	+
34 07	RCL 7
35 07	g $x \rightleftarrows y$
51	−
04	4
00	0
34 01	RCL 1
34 08	RCL 8
51	−
51	−
81	÷
04	4
00	0
34 01	RCL 1
51	−
71	x
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 P_aCO_2 (mmHg)	R_4	R_7 TV (ml)
R_2	R_5	R_8 $P_{\bar{E}}CO_2$ (mmHg)
R_3	R_6 Wt (kg)	R_9 Used

BLOOD ACID-BASE STATUS

CODE	KEYS
34 05	RCL 5
43	EEX
02	2
81	÷
84	R/S
23	LBL
11	A
43	EEX
02	2
71	x
31	f
83	INT
34 05	RCL 5
32	f^{-1}
83	INT
61	+
33 05	STO 5
34 06	RCL 6
43	EEX
03	3
81	÷
24	RTN
23	LBL
12	B
43	EEX
03	3
71	x
31	f
83	INT
34 06	RCL 6
32	f^{-1}
83	INT
61	+
33 06	STO 6
34	RCL

CODE	KEYS
09	9
24	RTN
23	LBL
13	C
33	STO
09	9
24	RTN
23	LBL
14	D
34 06	RCL 6
43	EEX
03	3
81	÷
33 01	STO 1
06	6
83	•
01	1
01	1
51	–
32	f^{-1}
08	LOG
34 05	RCL 5
03	3
02	2
05	5
07	7
81	÷
71	x
33 08	STO 8
35 00	g LST X
61	+
24	RTN
23	LBL
15	E
34	RCL

CODE	KEYS
09	9
01	1
83	•
06	6
03	3
71	x
09	9
83	•
05	5
61	+
34 01	RCL 1
07	7
83	•
04	4
51	–
71	x
34 08	RCL 8
61	+
02	2
04	4
51	–
01	1
34	RCL
09	9
07	7
00	0
81	÷
51	–
71	x
24	RTN

R_1 Used	R_4	R_7
R_2	R_5 Used	R_8 Used
R_3	R_6 Used	R_9 Hgb

VIRTUAL PO_2

CODE	KEYS
23	LBL
11	A
34 05	RCL 5
32	f^{-1}
83	INT
43	EEX
03	3
71	x
24	RTN
23	LBL
12	B
43	EEX
03	3
33 08	STO 8
81	÷
33 01	STO 1
34 05	RCL 5
43	EEX
02	2
81	÷
24	RTN
23	LBL
13	C
43	EEX
02	2
71	x
31	f
83	INT
34 01	RCL 1
61	+
33 05	STO 5
34 06	RCL 6
34 08	RCL 8
81	÷
24	RTN

CODE	KEYS
23	LBL
14	D
34 08	RCL 8
71	x
31	f
83	INT
33 01	STO 1
34 06	RCL 6
32	f^{-1}
83	INT
34 08	RCL 8
71	x
24	RTN
23	LBL
15	E
41	↑
41	↑
34 08	RCL 8
81	÷
34 01	RCL 1
61	+
33 06	STO 6
34 08	RCL 8
81	÷
07	7
83	•
04	4
51	—
04	4
08	8
71	x
35 07	g x⇄y
03	3
07	7
51	—

CODE	KEYS
02	2
83	•
04	4
71	x
51	—
04	4
43	EEX
03	3
34 05	RCL 5
81	÷
31	f
08	LOG
06	6
71	x
61	+
43	EEX
02	2
81	÷
32	f^{-1}
08	LOG
11	A
71	x
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 Used	R_4	R_7
R_2	R_5 Used	R_8 1000
R_3	R_6 Used	R_9

OXYGEN SATURATION AND CONTENT

CODE	KEYS
23	LBL
11	A
33 01	STO 1
41	↑
71	x
33 08	STO 8
41	↑
71	x
34 08	RCL 8
34 01	RCL 1
71	x
01	1
05	5
71	x
51	—
41	↑
41	↑
34 08	RCL 8
02	2
04	4
00	0
00	0
71	x
61	+
35 07	g x⇄y
34 08	RCL 8
02	2
00	0
04	4
05	5
71	x
61	+
34 01	RCL 1
02	2
43	EEX

CODE	KEYS
03	3
71	x
61	+
35 07	g x⇄y
34 01	RCL 1
03	3
01	1
01	1
00	0
00	0
71	x
51	—
02	2
04	4
43	EEX
05	5
61	+
81	÷
43	EEX
02	2
71	x
33 08	STO 8
24	RTN
23	LBL
12	B
33 08	STO 8
34	RCL
09	9
24	RTN
23	LBL
13	C
33	STO
09	9
34 08	RCL 8
01	1

CODE	KEYS
03	3
04	4
71	x
71	x
34 01	RCL 1
03	3
01	1
71	x
61	+
43	EEX
04	4
42	CHS
71	x
24	RTN
23	LBL
14	D
33 04	STO 4
24	RTN
23	LBL
15	E
33 03	STO 3
34 04	RCL 4
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 PO_2	R_4 C_aO_2	R_7
R_2	R_5	R_8 $(PO_2)^2$, SAT
R_3 C_vO_2	R_6	R_9 Hgb

ANAEROBIC PCO_2 AND pH CHANGE

CODE	KEYS
23	LBL
11	A
34 05	RCL 5
43	EEX
02	2
81	÷
24	RTN
23	LBL
12	B
43	EEX
02	2
71	x
31	f
83	INT
34 05	RCL 5
32	f^{-1}
83	INT
61	+
33 05	STO 5
34 06	RCL 6
43	EEX
03	3
81	÷
24	RTN
23	LBL
13	C
43	EEX
03	3
71	x
31	f
83	INT
34 06	RCL 6
32	f^{-1}
83	INT
61	+

CODE	KEYS
33 06	STO 6
35 00	g LSTX
43	EEX
03	3
71	x
24	RTN
23	LBL
14	D
03	3
07	7
51	–
33 01	STO 1
83	•
00	0
01	1
09	9
71	x
32	f^{-1}
08	LOG
34 05	RCL 5
71	x
31	f
83	INT
34 05	RCL 5
32	f^{-1}
83	INT
61	+
33 05	STO 5
43	EEX
02	2
81	÷
24	RTN
23	LBL
15	E
34 01	RCL 1

CODE	KEYS
03	3
07	7
61	+
43	EEX
03	3
81	÷
34 06	RCL 6
34 01	RCL 1
01	1
04	4
83	•
06	6
71	x
51	–
31	f
83	INT
61	+
33 06	STO 6
43	EEX
03	3
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 ΔT	R_4	R_7
R_2	R_5 Used	R_8
R_3	R_6 Used	R_9

ANAEROBIC PO_2 CHANGE

CODE	KEYS
23	LBL
11	A
34 08	RCL 8
24	RTN
23	LBL
12	B
33 08	STO 8
34 05	RCL 5
15	E
24	RTN
23	LBL
13	C
43	EEX
03	3
81	÷
34 05	RCL 5
31	f
83	INT
61	+
33 05	STO 5
34 06	RCL 6
15	E
24	RTN
23	LBL
14	D
33 01	STO 1
43	EEX
03	3
81	÷
34 06	RCL 6
31	f
83	INT
61	+
33 06	STO 6
34 08	RCL 8

CODE	KEYS
34 08	RCL 8
71	x
83	•
03	3
01	1
02	2
00	0
00	0
08	8
71	x
34 08	RCL 8
06	6
02	2
83	•
05	5
71	x
51	–
03	3
01	1
03	3
00	0
61	+
34 08	RCL 8
34 08	RCL 8
71	x
09	9
83	•
09	9
03	3
01	1
03	3
71	x
34 08	RCL 8
01	1
09	9

CODE	KEYS
09	9
03	3
71	x
51	–
43	EEX
05	5
61	+
81	÷
34 01	RCL 1
03	3
07	7
51	–
71	x
32	f^{-1}
08	LOG
34 05	RCL 5
15	E
71	x
13	C
34 05	RCL 5
15	E
24	RTN
23	LBL
15	E
32	f^{-1}
83	INT
43	EEX
03	3
71	x
24	RTN

R_1	BT (°C)	R_4		R_7	
R_2		R_5	Used	R_8	SAT
R_3		R_6	Used	R_9	

DEAD SPACE FRACTION

CODE	KEYS
23	LBL
11	A
31	f
51	SF 1
33 01	STO 1
34 02	RCL 2
24	RTN
23	LBL
12	B
31	f
71	SF 2
33 08	STO 8
32	f^{-1}
61	TF 1
44	CLX
24	RTN
34 01	RCL 1
35 07	g x⇄y
81	÷
24	RTN
23	LBL
13	C
32	f^{-1}
61	TF 1
22	GTO
01	1
31	f
81	TF 2
22	GTO
02	2
34 01	RCL 1
35 07	g x⇄y
81	÷
33 08	STO 8
23	LBL

CODE	KEYS
02	2
34 01	RCL 1
43	EEX
04	4
81	÷
32	f^{-1}
83	INT
34 08	RCL 8
31	f
83	INT
61	+
33 02	STO 2
32	f^{-1}
51	SF 1
32	f^{-1}
71	SF 2
34 05	RCL 5
43	EEX
02	2
81	÷
24	RTN
23	LBL
14	D
34 01	RCL 1
83	•
08	8
06	6
03	3
71	x
35 07	g x⇄y
81	÷
35 00	g LSTX
43	EEX
02	2
71	x

CODE	KEYS
31	f
83	INT
34 05	RCL 5
32	f^{-1}
83	INT
61	+
33 05	STO 5
35 08	g R↓
33 01	STO 1
24	RTN
23	LBL
15	E
41	↑
41	↑
34 01	RCL 1
51	–
35 07	g x⇄y
81	÷
24	RTN
23	LBL
01	1
32	f^{-1}
81	TF 2
44	CLX
81	÷
34 08	RCL 8
71	x
33 01	STO 1
22	GTO
02	2

R_1 $\dot{V}CO_2$, V_A	R_4	R_7
R_2 Used	R_5 Used	R_8 $\dot{V}O_2$
R_3	R_6	R_9

A–aO_2 DIFFERENCE

CODE	KEYS
23	LBL
11	A
33 08	STO 8
34 05	RCL 5
32	f^{-1}
83	INT
43	EEX
03	3
71	x
24	RTN
23	LBL
12	B
43	EEX
03	3
81	÷
34 05	RCL 5
31	f
83	INT
61	+
33 05	STO 5
43	EEX
02	2
81	÷
24	RTN
23	LBL
13	C
33 01	STO 1
43	EEX
02	2
71	x
31	f
83	INT
34 05	RCL 5
32	f^{-1}
83	INT

CODE	KEYS
61	+
33 05	STO 5
34	RCL
09	9
34 02	RCL 2
32	f^{-1}
83	INT
34 02	RCL 2
31	f
83	INT
00	0
35 23	g x=y
22	GTO
01	1
35 08	g R↓
43	EEX
04	4
81	÷
81	÷
23	LBL
01	1
35 09	g R↑
33	STO
09	9
35 08	g R↓
24	RTN
23	LBL
14	D
34 01	RCL 1
42	CHS
35 07	g x⇄y
81	÷
35 00	g LST X
35	g
04	1/x

CODE	KEYS
01	1
51	–
34 01	RCL 1
71	x
34 08	RCL 8
07	7
06	6
00	0
81	÷
71	x
61	+
34 08	RCL 8
61	+
33 01	STO 1
34 05	RCL 5
32	f^{-1}
83	INT
43	EEX
03	3
71	x
51	–
24	RTN
23	LBL
15	E
34 01	RCL 1
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 P_aCO_2, P_AO_2	R_4	R_7
R_2 Used	R_5 Used	R_8 P_IO_2
R_3	R_6	R_9 Hgb

PHYSIOLOGIC SHUNT AND FICK

CODE	KEYS
23	LBL
11	A
33 01	STO 1
34 04	RCL 4
24	RTN
23	LBL
12	B
33 04	STO 4
34 03	RCL 3
24	RTN
23	LBL
13	C
33 03	STO 3
34 02	RCL 2
24	RTN
23	LBL
14	D
31	f
83	INT
34 02	RCL 2
32	f^{-1}
83	INT
61	+
33 02	STO 2
34 04	RCL 4
34 03	RCL 3
51	–
81	÷
01	1
00	0
81	÷
33 08	STO 8
43	EEX
02	2
71	x
31	f
83	INT
34 07	RCL 7
32	f^{-1}
83	INT
61	+
33 07	STO 7
34 08	RCL 8
24	RTN
23	LBL
15	E
34 01	RCL 1
34 04	RCL 4
51	–
34 01	RCL 1
34 03	RCL 3
51	–
81	÷
43	EEX
02	2
71	x
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	$C_A O_2$	R_4	$C_a O_2$	R_7	Used
R_2	Used	R_5		R_8	CO
R_3	$C_v O_2$	R_6		R_9	

DUBOIS BODY SURFACE AREA

CODE	KEYS
23	LBL
11	A
00	0
35 07	g x⇄y
35 24	g x>y
33 05	STO 5
24	RTN
42	CHS
02	2
83	•
05	5
04	4
71	x
33 05	STO 5
24	RTN
23	LBL
12	B
00	0
35 07	g x⇄y
35 24	g x>y
33 06	STO 6
24	RTN
42	CHS
02	2
83	•
02	2
81	÷
33 06	STO 6
24	RTN
23	LBL
13	C
34 05	RCL 5
83	•
07	7
02	2

CODE	KEYS
05	5
35	g
05	y^x
34 06	RCL 6
83	•
04	4
02	2
05	5
35	g
05	y^x
71	x
01	1
03	3
09	9
83	•
02	2
81	÷
33 01	STO 1
43	EEX
02	2
81	÷
34 07	RCL 7
31	f
83	INT
61	+
33 07	STO 7
34 01	RCL 1
24	RTN
23	LBL
14	D
34 07	RCL 7
43	EEX
02	2
81	÷
24	RTN

CODE	KEYS
23	LBL
15	E
43	EEX
02	2
71	x
31	f
83	INT
34 07	RCL 7
32	f^{-1}
83	INT
61	+
33 07	STO 7
35 00	g LST X
81	÷
43	EEX
04	4
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 BSA	R_4	R_7 Used
R_2	R_5 Ht	R_8
R_3	R_6 Wt	R_9 Used

BOYD BODY SURFACE AREA

CODE	KEYS
23	LBL
11	A
00	0
35 07	g x⇄y
35 24	g x>y
33 05	STO 5
24	RTN
42	CHS
02	2
83	•
05	5
04	4
71	x
33 05	STO 5
24	RTN
23	LBL
12	B
00	0
35 07	g x⇄y
35 24	g x>y
33 06	STO 6
24	RTN
42	CHS
02	2
83	•
02	2
81	÷
33 06	STO 6
24	RTN
23	LBL
13	C
34 05	RCL 5
83	•
03	3
35	g

CODE	KEYS
05	y^x
34 06	RCL 6
43	EEX
03	3
71	x
41	↑
31	f
08	LOG
83	•
00	0
01	1
08	8
08	8
71	x
83	•
07	7
02	2
08	8
05	5
51	–
35	g
05	y^x
81	÷
03	3
01	1
01	1
08	8
81	÷
33 01	STO 1
43	EEX
02	2
81	÷
34 07	RCL 7
31	f
83	INT

CODE	KEYS
61	+
33 07	STO 7
34 01	RCL 1
24	RTN
23	LBL
14	D
34 07	RCL 7
43	EEX
02	2
81	÷
24	RTN
23	LBL
15	E
43	EEX
02	2
71	x
31	f
83	INT
34 07	RCL 7
32	f^{-1}
83	INT
61	+
33 07	STO 7
35 00	g LST X
81	÷
43	EEX
04	4
81	÷
24	RTN
35 01	g NOP

R_1 BSA	R_4	R_7 Used
R_2	R_5 Ht	R_8
R_3	R_6 Wt	R_9 Used

DYE CURVE CARDIAC OUTPUT

CODE	KEYS
23	LBL
11	A
31	f
43	REG
33 07	STO 7
24	RTN
23	LBL
12	B
35	g
83	DSZ
33	STO
61	+
01	1
34 02	RCL 2
35 24	g x>y
22	GTO
01	1
35 07	g x⇄y
33 02	STO 2
35 07	g x⇄y
32	f^{-1}
51	SF 1
23	LBL
01	1
31	f
61	TF 1
22	GTO
02	2
83	•
06	6
05	5
71	x
35 24	g x>y
22	GTO
03	3

CODE	KEYS
34 08	RCL 8
42	CHS
24	RTN
23	LBL
03	3
35 07	g x⇄y
33 03	STO 3
34 08	RCL 8
33 04	STO 4
31	f
51	SF 1
24	RTN
23	LBL
02	2
83	•
04	4
05	5
71	x
35 22	g x≤y
34 08	RCL 8
24	RTN
35 08	g R↓
33 02	STO 2
34 04	RCL 4
34 08	RCL 8
51	–
34 03	RCL 3
34 02	RCL 2
81	÷
31	f
07	LN
81	÷
83	•
05	5
51	–

CODE	KEYS
71	x
34 01	RCL 1
61	+
34 07	RCL 7
71	x
32	f^{-1}
51	SF 1
33 02	STO 2
24	RTN
23	LBL
13	C
34 02	RCL 2
71	x
33 02	STO 2
24	RTN
23	LBL
14	D
34 02	RCL 2
81	÷
06	6
43	EEX
03	3
71	x
31	f
83	INT
33 07	STO 7
43	EEX
02	2
81	÷
24	RTN

R_1 SD	R_4 –N65	R_7 ΔT, 100 CO
R_2 Used	R_5 Cleared	R_8 –N, –N45
R_3 D65	R_6 Cleared	R_9 Used

FICK CARDIAC OUTPUT

CODE	KEYS
34 04	RCL 4
84	R/S
23	LBL
11	A
33 04	STO 4
34 03	RCL 3
24	RTN
23	LBL
12	B
33 03	STO 3
34 02	RCL 2
24	RTN
23	LBL
13	C
31	f
83	INT
41	↑
41	↑
34 02	RCL 2
32	f^{-1}
83	INT
61	+
33 02	STO 2
44	CLX
34 04	RCL 4
34 03	RCL 3
51	–
81	÷
01	1
00	0
81	÷
33 01	STO 1
43	EEX
02	2
71	x

CODE	KEYS
31	f
83	INT
34 07	RCL 7
32	f^{-1}
83	INT
61	+
33 07	STO 7
34 01	RCL 1
24	RTN
34 07	RCL 7
32	f^{-1}
83	INT
43	EEX
02	2
71	x
84	R/S
23	LBL
14	D
33 08	STO 8
43	EEX
02	2
81	÷
34 07	RCL 7
31	f
83	INT
61	+
33 07	STO 7
43	EEX
02	2
81	÷
34 08	RCL 8
81	÷
24	RTN
23	LBL
15	E

CODE	KEYS
34 07	RCL 7
35 07	g x⇄y
81	÷
01	1
00	0
71	x
33 01	STO 1
24	RTN
23	LBL
01	1
34 07	RCL 7
32	f^{-1}
83	INT
43	EEX
02	2
71	x
81	÷
42	CHS
84	R/S
34 01	RCL 1
84	R/S
22	GTO
01	1
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 CO, SV	R_4 C_aO_2	R_7 Used
R_2 Used	R_5	R_8 BSA
R_3 C_vO_2	R_6	R_9

VALVE AREA

CODE	KEYS
23	LBL
11	A
33	STO
09	9
32	f^{-1}
51	SF 1
24	RTN
23	LBL
12	B
32	f^{-1}
61	TF 1
22	GTO
01	1
33	STO
61	+
01	1
35	g
83	DSZ
34 08	RCL 8
42	CHS
24	RTN
23	LBL
01	1
33 01	STO 1
31	f
51	SF 1
01	1
42	CHS
33 08	STO 8
01	1
24	RTN
23	LBL
13	C
34 01	RCL 1
34 08	RCL 8

CODE	KEYS
42	CHS
81	÷
32	f^{-1}
51	SF 1
33 01	STO 1
24	RTN
23	LBL
14	D
34	RCL
09	9
35 07	g x⇄y
81	÷
06	6
00	0
71	x
33 08	STO 8
34 07	RCL 7
43	EEX
02	2
81	÷
24	RTN
23	LBL
15	E
41	↑
41	↑
43	EEX
02	2
71	x
31	f
83	INT
34 07	RCL 7
32	f^{-1}
83	INT
61	+
33 07	STO 7

CODE	KEYS
35 08	g R↓
34 08	RCL 8
81	÷
83	•
00	0
04	4
04	4
05	5
81	÷
34 01	RCL 1
31	f
09	$\sqrt{x}$
81	÷
32	f^{-1}
51	SF 1
33 08	STO 8
24	RTN
23	LBL
02	2
83	•
07	7
81	÷
42	CHS
84	R/S
34 08	RCL 8
84	R/S
22	GTO
02	2
35 01	g NOP
35 01	g NOP

R_1 $\Sigma\Delta P$, $\overline{\Delta P}$	R_4	R_7 Used
R_2	R_5	R_8 –N, S/M, A
R_3	R_6	R_9 T

ANATOMIC SHUNTS

CODE	KEYS
23	LBL
11	A
33 01	STO 1
33 08	STO 8
24	RTN
23	LBL
12	B
33 02	STO 2
33 08	STO 8
24	RTN
23	LBL
13	C
33 05	STO 5
33 08	STO 8
24	RTN
23	LBL
14	D
33 06	STO 6
33 08	STO 8
24	RTN
23	LBL
15	E
35	g
83	DSZ
22	GTO
01	1
34 05	RCL 5
34 06	RCL 6
51	–
34 05	RCL 5
34 01	RCL 1
51	–
81	÷
43	EEX
02	2

CODE	KEYS
71	x
41	↑
35	g
06	ABS
35 23	g x=y
42	CHS
24	RTN
44	CLX
24	RTN
23	LBL
01	1
01	1
33 08	STO 8
34 02	RCL 2
34 01	RCL 1
51	–
34 05	RCL 5
34 01	RCL 1
51	–
81	÷
43	EEX
02	2
71	x
41	↑
35	g
06	ABS
35 23	g x=y
24	RTN
35 01	g NOP
44	CLX
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

CODE	KEYS
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1	R-SYST	R_4		R_7	
R_2	R-Pul	R_5	L-Pul	R_8	Toggle
R_3		R_6	L-SYST	R_9	Used

CONTRACTILITY

CODE	KEYS
23	LBL
11	A
33 06	STO 6
44	CLX
33 01	STO 1
33 03	STO 3
33 04	STO 4
33 05	STO 5
34 06	RCL 6
21	DSP
83	•
03	3
24	RTN
23	LBL
12	B
21	DSP
83	•
01	1
34 01	RCL 1
35 07	g x⇄y
33 01	STO 1
35 07	g x⇄y
00	0
35 23	g x=y
35 01	g NOP
24	RTN
35 08	g R↓
51	—
41	↑
41	↑
34 06	RCL 6
81	÷
34 03	RCL 3
35 07	g x⇄y
35 24	g x>y

CODE	KEYS
33 03	STO 3
35 01	g NOP
34 01	RCL 1
35 09	g R↑
02	2
81	÷
51	—
33 08	STO 8
81	÷
33 02	STO 2
34 04	RCL 4
35 07	g x⇄y
35 22	g x≤y
24	RTN
35 01	g NOP
33 04	STO 4
35 00	g LST X
33 05	STO 5
35 08	g R↓
24	RTN
23	LBL
13	C
34 03	RCL 3
21	DSP
83	•
00	0
24	RTN
23	LBL
14	D
34 04	RCL 4
21	DSP
83	•
01	1
24	RTN
23	LBL

CODE	KEYS
15	E
21	DSP
83	•
02	2
34 08	RCL 8
34 04	RCL 4
71	x
34 05	RCL 5
34 02	RCL 2
71	x
51	—
34 08	RCL 8
34 05	RCL 5
51	—
00	0
35 23	g x=y
24	RTN
35 01	g NOP
35 08	g R↓
81	÷
03	3
00	0
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 P_N	R_4 Max dP/dt/P	R_7
R_2 dP/dt/P	R_5 P_M	R_8 P_P
R_3 Max dP/dt	R_6 Δt	R_9 Used

STROKE WORK

CODE	KEYS
23	LBL
11	A
32	f^{-1}
61	TF 1
22	GTO
01	1
33	STO
61	+
01	1
35	g
83	DSZ
34 08	RCL 8
42	CHS
24	RTN
23	LBL
01	1
33 01	STO 1
01	1
42	CHS
33 08	STO 8
31	f
51	SF 1
01	1
24	RTN
23	LBL
12	B
34 01	RCL 1
34 08	RCL 8
42	CHS
81	÷
33 01	STO 1
32	f^{-1}
51	SF 1
24	RTN
23	LBL

CODE	KEYS
13	C
33 08	STO 8
34 07	RCL 7
43	EEX
02	2
81	÷
24	RTN
23	LBL
14	D
41	↑
41	↑
43	EEX
02	2
71	x
31	f
83	INT
34 07	RCL 7
32	f^{-1}
83	INT
61	+
33 07	STO 7
35 08	g R↓
34 08	RCL 8
71	x
06	6
00	0
81	÷
34 01	RCL 1
71	x
01	1
03	3
83	•
06	6
71	x
33	STO

CODE	KEYS
09	9
32	f^{-1}
51	SF 1
24	RTN
34 07	RCL 7
32	f^{-1}
83	INT
43	EEX
02	2
71	x
84	R/S
23	LBL
15	E
33 01	STO 1
43	EEX
02	2
81	÷
34 07	RCL 7
31	f
83	INT
61	+
33 07	STO 7
34	RCL
09	9
34 01	RCL 1
81	÷
24	RTN
35 01	g NOP
35 01	g NOP
35 01	g NOP

R_1 ΣP, $\overline{P}$, BSA	R_4	R_7 Used
R_2	R_5	R_8 –N, R-R
R_3	R_6	R_9 SW

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