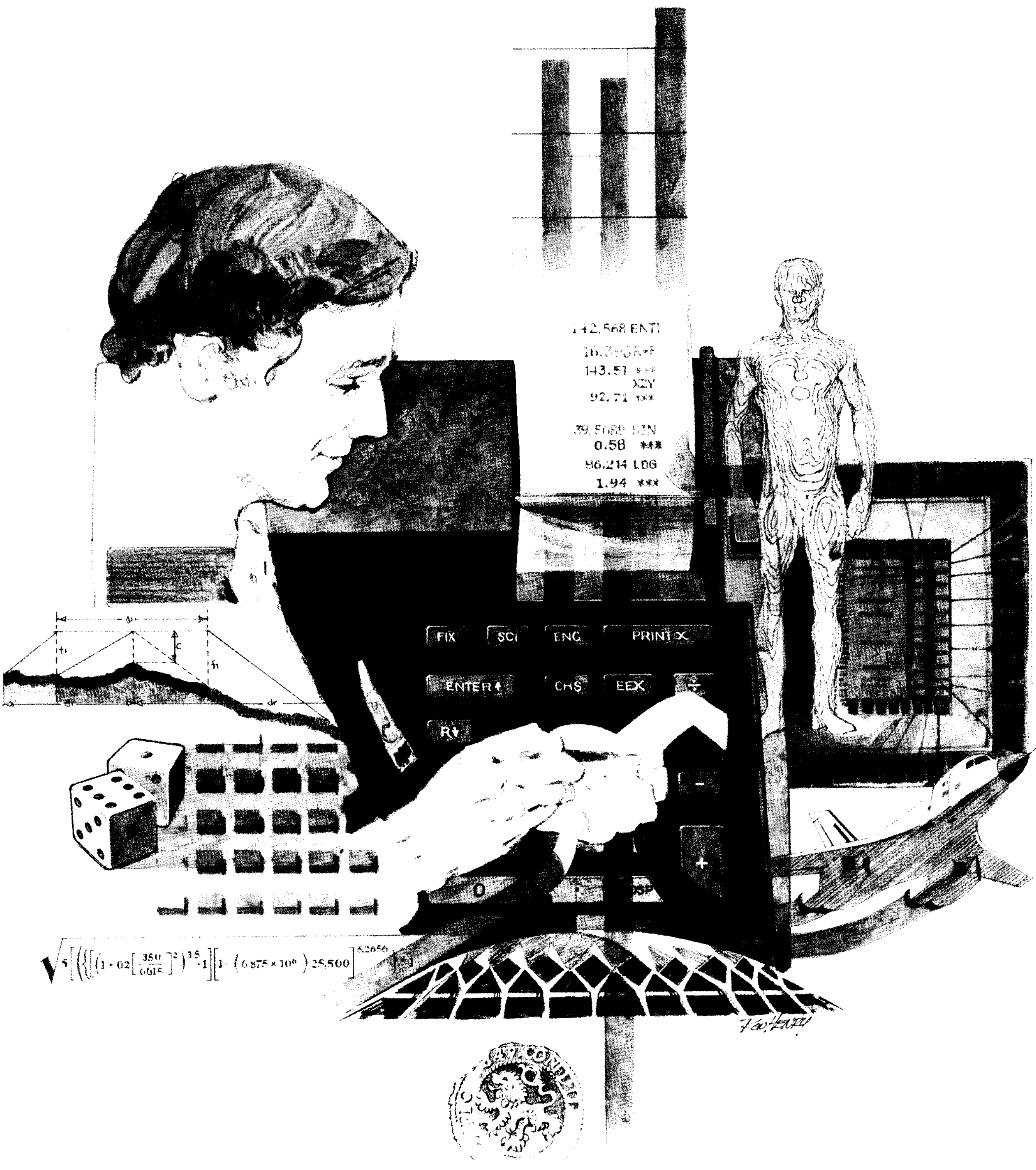
HEWLETT-PACKARD

HP-67/HP-97

Users' Library Solutions

Anesthesia



INTRODUCTION

In an effort to provide continued value to it's customers, Hewlett-Packard is introducing a unique service for the HP fully programmable calculator user. This service is designed to save you time and programming effort. As users are aware, Programmable Calculators are capable of delivering tremendous problem solving potential in terms of power and flexibility, but the real genie in the bottle is program solutions. HP's introduction of the first handheld programmable calculator in 1974 immediately led to a request for program **solutions** — hence the beginning of the HP-65 Users' Library. In order to save HP calculator customers time, users wrote their own programs and sent them to the Library for the benefit of other program users. In a short period of time over 5,000 programs were accepted and made available. This overwhelming response indicated the value of the program library and a Users' Library was then established for the HP-67/97 users.

To extend the value of the Users' Library, Hewlett-Packard is introducing a unique service—a service designed to save you time and money. The Users' Library has collected the best programs in the most popular categories from the HP-67/97 and HP-65 Libraries. These programs have been packaged into a series of low-cost books, resulting in substantial savings for our valued HP-67/97 users.

We feel this new software service will extend the capabilities of our programmable calculators and provide a great benefit to our HP-67/97 users.

A WORD ABOUT PROGRAM USAGE

Each program contained herein is reproduced on the standard forms used by the Users' Library. Magnetic cards are not included. The Program Description I page gives a basic description of the program. The Program Description II page provides a sample problem and the keystrokes used to solve it. The User Instructions page contains a description of the keystrokes used to solve problems in general and the options which are available to the user. The Program Listing I and Program Listing II pages list the program steps necessary to operate the calculator. The comments, listed next to the steps, describe the reason for a step or group of steps. Other pertinent information about data register contents, uses of labels and flags and the initial calculator status mode is also found on these pages. Following the directions in your HP-67 or HP-97 **Owners' Handbook and Programming Guide**, "Loading a Program" (page 134, HP-67; page 119, HP-97), key in the program from the Program Listing I and Program Listing II pages. A number at the top of the Program Listing indicates on which calculator the program was written (HP-67 or HP-97). If the calculator indicated differs from the calculator you will be using, consult Appendix E of your **Owner's Handbook** for the corresponding keycodes and keystrokes converting HP-67 to HP-97 keycodes and vice versa. No program conversion is necessary. The HP-67 and HP-97 are totally compatible, but some differences do occur in the keycodes used to represent some of the functions.

A program loaded into the HP-67 or HP-97 is not permanent—once the calculator is turned off, the program will not be retained. You can, however, permanently save any program by recording it on a blank magnetic card, several of which were provided in the Standard Pac that was shipped with your calculator. Consult your **Owner's Handbook** for full instructions. A few points to remember:

> The Set Status section indicates the status of flags, angular mode, and display setting. After keying in your program, review the status section and set the conditions as indicated before using or permanently recording the program.
>
> REMEMBER! To save the program permanently, **clip** the corners of the magnetic card once you have recorded the program. This simple step will protect the magnetic card and keep the program from being inadvertently erased.

As a part of HP's continuing effort to provide value to our customers, we hope you will enjoy our newest concept.

TABLE OF CONTENTS

Program Description I

Program Title Anesthesiology Parameters

Contributor's Name Charles W. BOLLINGER
Address 644 Longshaw Drive
City Bremerton **State** WASH **Zip Code** 98310

Program Description, Equations, Variables

Height, weight and age can be input in English or metric terms. Program computes and stores estimated blood volume for weight and age group (below or above 10 years old).
Given the number of drops per ml. of intravenous delivery system, one routine gives the sodium nitroprusside dose in mcg/min as well as recommended solution strength in percent and administration rate in drops/min.
Given the surgery starting time (hours and minutes since last intake, usually midnight) program calculates body surface area and normal fluid requirement (1500 ml/m²/24h) and deficit, then the surgical requirement (2500 ml/m²/24h) and will give surgical requirement and total deficit.
Given systolic and diastolic blood pressures, calculates mean arterial pressure
If a laboratory-determined blood volumes is available, it should be used in preference to figure calculated and stored in E. Enter Hct and BV in LBL d.
For repeat cases, of if no laboratory value available, enter Hct and use LBL D
When finding delivered concentration first time, use of routine LBL e will store vaporpressure for agent in use. Repeat performances require only diluent and kettle flows to LBL E, unless agent or temperature changes.

Operating Limits and Warnings

Use 24-hour clock. If a patient has been NPO since 0400 instead of 0000, and surgery begins at 0800, use "4.0" to enter Routine B.
If prevalent barometric pressure other than 760, alter program prior to use
Clinical: Acceptable loss assumes and depends on full hydration. Combining hydration figures (LBL B) and ABL (LBL D): when amount equal to ABL is shed, HCT will be 30%
Serum protein measured periodically – deficit replaced with albumin. Packed RBC's for Hct < 30%

Program Description II

Sketch(es)

Sample Problem(s)

① Patient is 68.5" tall, 175#, age 41 enter data

② Surgery begins at 9:15. Patient NPO since midnight. What is starting deficit + requirements? What is the status at 10:25? Pt has received 1100 ml intravenously, how is his hydration?

③ Patients hematocrit is 45%. What is acceptable loss? During procedure, hematocrit is found to be 25%. Hydration is good. How many ml. of packed RBC to transfuse? (negative sign indicates difference between acceptable loss and RBC's to infuse)

④ At this temperature, the vapor pressure of Wonderthane is 170. Diluent 2500 ml. Kettle flow 120. What is delivered concentration? Low flow technique: FD is 2000 ml, kettle flow 80:

⑤ Intravenous sets administer 12 drops/min. How is sodium nitroprusside to be given?

Solution(s)

① 68.5↑ 175#↑ 41 [f][a] → 5556 (Est. B.V).

② 9.15 [B] → 1.94 BSA m²

→ 121 ml EFR normally

→ -1122 Starting deficit ml.

→ 202 Surgical EFR

10:25 [R/S] → "236" Surgical deficit

→ -1358 Total deficit

1100 [+] → -258 Remaining deficit

③ 45 [D] → 1852 ml. ABL

25 [D] → -278 ml RBC

④ 2500↑ 120↑ 170[fe] → 1.4 %

2000↑ 80 [E] → 1.2%

⑤ 12 [f][b] → 192 μg/min

→ 0.01000 % sol

→ 23 drops/min

Reference(s) Mazze, Richard I: Intraoperative fluid therapy - ASA Refresher Course - 1976

Lawson, N.W. et. al: A dosage nomogram for sodium-nitroprusside-induced hypotension under anesthesia. Anes + Analg 55: 574-579, 1976

Bennett, Edward J: Fluid replacement in infants and children – ASA Refresher Course 1976

Furman, Eric J.: Acceptable blood loss computation – personal communication.

User Instructions

ANESTHESIA PARAMETERS

1 a: ENGLISH | b: gtt/ml | d: Hct ↑ EBV | e: FD ↑ FV ↑ PV 2

H ↑ W ↑ A | Time → T → R/S | MAP | Hct ↑ → ABL | FD ↑ FV ↑ → %

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Load program side 1 and side 2.				
2.	Enter patient data Height in inches or cm	H	ENTER ↑		
	Weight in pounds or kg	W	ENTER ↑		
	Age: if above entered in English units (inch/pound)	A	f	a	EBV
	if above entered in Metric units (cm/kg)	A	A		EBV
3.	To find body surface area and fluid factors:				
	Input start of surgery or time NPO	H.M	B		BSA (m²)
					Normal EFR (ml)
					Starting Deficit
					Surgical EFR
	For present status, input present time	H.M	R/S		"Surg Def"
	Fluid administered may be added to last figure for				Total Deficit
	balance figure (positive value, overload; negative, deficit)				
4.	For sodium nitroprusside administration, input number				
	of drops/ml of I.V. administration set	gtt/ml.	f	b	Admin: µg/min
	(recompute with different set type if drops too high				% solution
	or two low.)				Admin: gtt/min
5.	For mean arterial pressure Input systolic	Sys.	ENTER ↑		
	Input diastolic	Dias	C		M.A.P. mmHg
6.	For acceptable blood loss, input hematocrit	Hct	ENTER ↑		
	if EBV determined, input	EBV	f	d	ABL (ml)
	for new case, or if EBV not known, input hem	HCT	D		OR
					− RBC (ml)
7.	For delivered concentration, Input diluent flow	FD (ml)	ENTER ↑		
	Input kettle flow	FV (ml)	ENTER ↑		
	Input vapor press	PV (mmHg)	f	e	% conc.
	for new case, same agent, same temp:				
	Input diluent flow	FD (ml)	ENTER ↑		
	Input kettle flow	FV (ml)	E		% conc.

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLa	21 16 11	Store & convert patient data
002	STOC	35 13	
003	R↓	-31	
004	2	02	
005	.	-62	
006	2	02	
007	0	00	
008	5	05	
009	÷	-24	
010	STOB	35 12	
011	R↓	-31	
012	2	02	
013	.	-62	
014	5	05	
015	4	04	
016	×	-35	
017	GTO3	22 03	
018	*LBLA	21 11	
019	STOC	35 13	Store patient data
020	R↓	-31	
021	STOB	35 12	
022	R↓	-31	
023	*LBL3	21 03	
024	STOA	35 11	
025	RCLC	36 13	
026	1	01	Is the patient older than 10 years?
027	0	00	
028	X≤Y?	16-35	
029	FRC	16 44	Yes, eliminate addend. (wt. x 70)
030	7	07	
031	0	00	
032	+	-55	
033	RCLB	36 12	
034	×	-35	
035	STOE	35 15	
036	RTN	24	
037	*LBLb	21 16 12	
038	RCLC	36 13	
039	RCLB	36 12	Compute dose of sod. introprusside based on age/wt.
040	÷	-24	
041	2	02	
042	.	-62	
043	6	06	
044	3	03	
045	CHS	-22	
046	×	-35	
047	e^x	33	
048	7	07	
049	4	04	
050	8	08	
051	.	-62	
052	7	07	
053	×	-35	
054	PRTX	-14	
055	RND	16 24	
056	EEX	-23	

STEP	KEY ENTRY	KEY CODE	COMMENTS
057	2	02	Compare dose with constants to determine proper concentration
058	X≤Y?	16-35	
059	GTO1	22 01	
060	CLX	-51	
061	2	02	
062	5	05	
063	X≤Y?	16-35	
064	GTO2	22 02	
065	EEX	-23	
066	5	05	
067	÷	-24	
068	*LBL0	21 00	
069	DSP5	-63 05	
070	PRTX	-14	Display concentration in percent.
071	DSP0	-63 00	
072	CLX	-51	
073	LSTX	16-63	
074	÷	-24	Determine proper administration rate
075	×	-35	
076	PRTX	-14	
077	SPC	16-11	
078	RTN	24	
079	*LBL1	21 01	
080	1/X	52	
081	GTO0	22 00	
082	*LBL2	21 02	
083	2	02	
084	×	-35	
085	EEX	-23	
086	3	03	
087	÷	-24	
088	GTO0	22 00	
089	RTN	24	
090	*LBLB	21 12	
091	HMS→	16 36	
092	STO0	35 00	
093	RCLB	36 12	Compute body surface area.
094	.	-62	
095	4	04	
096	2	02	
097	5	05	
098	Y^x	31	
099	RCLA	36 11	
100	.	-62	
101	7	07	
102	2	02	
103	5	05	
104	Y^x	31	
105	.	-62	
106	0	00	
107	0	00	
108	7	07	
109	1	01	
110	8	08	
111	4	04	
112	×	-35	

REGISTERS

0 Start time/dec.	1 Vapor pressure	2	3	4	5	6	7	8	9
S0 hrs.	S1	S2	S3	S4	S5	S6	S7	S8	S9

A Height (cm)	B Weight (kg)	C Age (yr)	D BSA (M^2)	E EBV (ml)	I Used

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	×	-35	
114	DSP2	-63 02	
115	PRTX	-14	
116	DSP0	-63 00	
117	STOD	35 14	
118	1	01	Normal EFR is
119	5	05	$1500ml/m^2/24^h$
120	0	00	
121	0	00	
122	×	-35	
123	2	02	
124	4	04	
125	÷	-24	
126	PRTX	-14	
127	RCL0	36 00	
128	×	-35	
129	CHS	-22	
130	PRTX	-14	
131	RCLD	36 14	
132	2	02	Surgical EFR is
133	5	05	$2500ml/m^2/24^h$
134	0	00	
135	0	00	
136	×	-35	
137	2	02	
138	4	04	
139	÷	-24	
140	PRTX	-14	
141	SPC	16-11	
142	R/S	51	
143	HMS→	16 36	Find duration of
144	RCL0	36 00	surgery to present
145	-	-45	time
146	×	-35	
147	PSE	16 51	Show deficit gener-
148	-	-45	ated since start of
149	RTN	24	surgery
150	*LBLC	21 13	Display total defi-
151	STOI	35 46	cit
152	-	-45	Mean arterial
153	3	03	pressure:
154	÷	-24	$\frac{Sys-Dias}{3}+Dias$
155	RCLI	36 46	
156	+	-55	
157	RTN	24	
158	*LBLd	21 16 14	
159	STOE	35 15	Store est. blood
160	R↓	-31	vol. from labora-
161	*LBLD	21 14	tory determination
162	STOI	35 46	
163	RCLE	36 15	Find est. red cell
164	×	-35	mass
165	3	03	
166	0	00	
167	RCLE	36 15	Subtract est. red
168	×	-35	cell mass @ HCT 30%

STEP	KEY ENTRY	KEY CODE	COMMENTS
169	-	-45	Does pt. have less
170	X<0?	16-45	than HCT 30% - jump
171	GTO4	22 04	
172	RCLI	36 46	Divide acceptable
173	÷	-24	red cell loss by HCT
174	PRTX	-14	to find ABL
175	RTN	24	
176	*LBL4	21 04	Adjust figure for
177	EEX	-23	ml. red blood cell
178	2	02	deficit
179	÷	-24	
180	PRTX	-14	
181	RTN	24	
182	*LBLe	21 16 15	
183	STO1	35 01	Store vapor pressure
184	R↓	-31	
185	*LBLE	21 15	Calculate delivered
186	RCL1	36 01	concentration
187	×	-35	
188	X⇄Y	-41	
189	7	07	
190	6	06	
191	0	00	
192	RCL1	36 01	
193	-	-45	
194	×	-35	
195	÷	-24	
196	EEX	-23	
197	2	02	
198	×	-35	
199	DSP1	-63 01	
200	PRTX	-14	
201	DSP0	-63 00	
202	SPC	16-11	
203	RTN	24	
210			
220			

LABELS

A store data	B BSA EFR	C M.A.P.	D A.B.L.	E % conc
a convert & ~~store data~~	b Sod. nitro procs	c	d ABL Lab. EBV	e % conc. Pv supplied
0 Subr. cond	1 Comparison	2 Comparison	3 Compute EBV	4 Compute RBC
5 (b)	6	7	8	9

FLAGS

0	
1	
2	
3	

SET STATUS

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

Program Description I

Program Title ANESTHESIA PARAMETERS II

Contributor's Name CHARLES W. BOLLINGER
Address 644 LONGSHAW DRIVE
City BREMERTON **State** WASH **Zip Code** 98310

Program Description, Equations, Variables

THE ANTOINE EQUATION IS: $\log_{10} P = A + \frac{-B}{t+C}$ WHERE A, B, AND C ARE CONSTANTS FOR EACH AGENT. CONSTANTS THAT ARE AVAILABLE FOR VARIOUS AGENTS HAVE BEEN INCORPORATED. AS THE USER FINDS MORE FROM MANUFACTURER OR LITERATURE, HE CAN ADD THEM TO THE DATA BANKS AS FOLLOWS:

CONSTANT A: PLACE IN REGISTER S_x OF THE PAIR TO BE USED FOR THAT AGENT (SUCH AS R_9, S_9)

CONSTANT B: MULTIPLY BY 100, TAKE INTEGER, AND STORE IN R_x

CONSTANT C: DIVIDE BY 1000, TAKE FRACTION AND ADD TO R_x

EXAMPLE: CONSTANTS FOR ETHER ARE: A = 6.78574, B = 994.195, C = 220.0 — SEE HOW THIS RULE WAS FOLLOWED TO INSERT VALUES IN S_1 AND R_1 RESPECTIVELY.

DELIVERED CONCENTRATION AND TABLE ARE BASED ON OUTPUT CONCENTRATION AND TOTAL FLOW, AND ARE HIGHLY ACCURATE. IT IS ACKNOWLEGED THAT DELIVERY VIA A CIRCLE OR OTHER SUCH SYSTEM WILL ALTER CONCENTRATION. VALUES ARE FOR NON-REBREATHING SYSTEM.

IT SOMETIMES SURPRISES THE STUDENT TO DISCOVER THAT THE OUTPUT OF A VAPORIZER CAN BE MORE THAN TWICE INPUT, AS WITH ETHER. ROUTINE D GIVES BASIC DATA.

Operating Limits and Warnings

(1) BAROMETRIC PRESSURE USED IS 760. USE OTHER VALUES AS NECESSARY FOR AREAS OF DIFFERENT PREVAILING P_B. FOR LABORATORY ACCURACY, ROUTINE LBL E MAY BE USED TO STORE AND CONVERT P_B USING THE I-REGISTER AFTER P_V HAS BEEN COMPUTED

(2) WHEN A TABLE OF VAPOR PRESSURES HAS BEEN GENERATED, THE TEMPERATURE VALUE IN I-REGISTER WILL HAVE BEEN INCREMENTED AND NEW OR PREVIOUS VALUE MUST BE ENTERED FOR NEW CASE

Program Description II

Sketch(es)

Sample Problem(s)

① THE TEMPERATURE OF THE O.R. IS 68.5°F. WHAT IS Pv OF Halothane?

② STARTING WITH 18°C, INCREMENTS OF 0.5°C, WHAT ARE Pv's OF CHLOROFORM?

③ OR TEMP IS 21°C. HALOTHANE IS BEING GIVEN IN A KETTLE WITH A FLOW OF 85 ml. DILUENT FLOW IS 2.5 L. WHAT IS DELIVERED CONCENTRATION OF HALOTHANE?
KETTLE FLOW IS REDUCED TO 25 ML - WHAT IS NEW CONCENTRATION?

④ MAKE A TABLE FOR METHOXYFLURANE STARTING WITH KETTLE FLOW OF 20 ml AND INCREASING IN 20 ml INCREMENTS. DILUENT FLOW IS 2000. TEMP 20°

⑤ IF FLOW INTO KETTLE IS 150 ML, WHAT IS QUANTITY AND CONCENTRATION OF SATURATED VAPOR? (STILL METHOXYFLURANE)

Solution(s)

① 68.5 [f] [a] → °C
4 [B] → 20.3 °C
→ 245.6 Pv

② 18 [A] → 18 °C
2 [↑] 0.5 [f] [b] → 18 °C
→ 145.9 Pv
→ 18.5 °C
→ 149.1 Pv
etc

③ 21 [A] → 21 °C
4 [B] → 21
→ 253.2
2500 [↑] 85 [c] → 1.6 %
2500 [↑] 25 [c] → 0.49 %

④ 20 [A] → 20
5 [B] → 20
→ 22.72
2000 [↑] 20 [↑] 20 [↑][c] → 2000
→ 20
→ 0.03
→ 40
→ 0.06
etc

⑤ 150 [D] → 2.99 %
→ 154.62 ml

Reference(s)

de Jong, Rudolph H: Vapor Pressure Tables. Anesthesiology 34: 569-70, 1971
Nahrwald, M.L. et. al: Estimation of an equation relating saturated vapor pressure to temperature. Anesthesiology 39: 444-446, 1973

User Instructions

ANESTHESIA PARAMETERS II

1 a: °F   b: n↑Δt   c: F_D↑F_v↑ΔF_v 2

°C   n → P_v F_D↑F_v → %c F_v → C_v/F_o

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load program side 1 ~~and side 2~~				
2	Load data side 1 and side 2				
3	Input vaporizer temperature in Celsius	T(°c)	A		
	in Fahrenheit	T(°F)	f	a	T(°c)
4.	Input selection number:				
	1- Ether 6. Isoflurane	n	B		T(°c)
	2 Chloroform 7.				P_v
	3 Trichlorethylene 8				
	4. Halothane 9				
	5. Methoxyflurane 10				
5	For vapor pressure table:				
	Input selection number	n	ENTER↑		
	Input increments of temperature	Δt (°c)	f	b	(T (°c)
					P_v)
6	For delivered concentration				
	Input diluent flow	F_D(ml)	ENTER↑		
	Input flow through vaporizer	F_v(ml)	C		% conc
7.	For delivered concentration table:				
	Input diluent flow	F_D(ml)	ENTER↑		
	Input flow through vaporizer	F_v(ml)	ENTER↑		
	Input increments of flow through vaporizer	ΔF_v (ml)	f	c	F_D
					(F_v
					% conc)
8	For concentration of saturated vapor and output of vaporizer, input flow through vaporizers	F_v	D		% C_v
					F_o

LABELS					FLAGS
A Store °C	B Vapor Pressure	C % Deliv. Conc.	D C_v + F_o	E	0
a Convert °F to °C + store	b P_v table	c " table	d	e	1
0 Repeat P_v	1 Repeat Conc	2	3	4	2 Return to routine
5	6	7	8	9	3

SET STATUS					
FLAGS			TRIG		DISP
	ON	OFF			
0	☐	☒	DEG	☒	FIX ☒
1	☐	☒	GRAD	☐	SCI ☐
2	☐	☒	RAD	☐	ENG ☐
3	☐	☒			n 4

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLa	21 16 11	Convert °F to °C
002	3	03	
003	2	02	
004	-	-45	
005	5	05	
006	x	-35	
007	9	09	
008	÷	-24	
009	*LBLA	21 11	Store temp °C
010	STOE	35 15	
011	RTN	24	
012	*LBLB	21 12	Antoine equation
013	1	01	
014	-	-45	
015	STOI	35 46	Use (i) to extract constants
016	RCLi	36 45	
017	INT	16 34	
018	EEX	-23	
019	2	02	
020	÷	-24	
021	CHS	-22	
022	RCLi	36 45	
023	FRC	16 44	
024	EEX	-23	
025	3	03	
026	x	-35	
027	RCLE	36 15	
028	PRTX	-14	
029	+	-55	
030	÷	-24	
031	X⇄Y	-41	
032	1	01	10 x value in I will permit recall of corresponding S-reg
033	0	00	
034	+	-55	
035	STOI	35 46	
036	CLX	-51	
037	RCLi	36 45	
038	+	-55	
039	10^x	16 33	
040	STOD	35 14	
041	PRTX	-14	
042	SPC	16-11	
043	RTN	24	
044	*LBLb	21 16 12	
045	STOB	35 12	
046	R↓	-31	
047	STOC	35 13	n stored for re-use in table
048	*LBL0	21 00	
049	GSBB	23 12	
050	RCLE	36 15	
051	RCLB	36 12	
052	+	-55	
053	STOE	35 15	
054	RCLC	36 13	
055	GTO0	22 00	
056	*LBLc	21 16 13	

STEP	KEY ENTRY	KEY CODE	COMMENTS
057	STOB	35 12	
058	R↓	-31	
059	STOA	35 11	
060	X⇄Y	-41	
061	STOC	35 13	
062	PRTX	-14	Print Fo once at top of table
063	X⇄Y	-41	
064	PRTX	-14	
065	*LBL1	21 01	
066	GSBC	23 13	Go to compute deliv. conc.
067	PRTX	-14	
068	SPC	16-11	
069	DSP1	-63 01	Adjust display and print answer
070	RCLC	36 13	
071	RCLB	36 12	
072	RCLA	36 11	
073	+	-55	
074	STOA	35 11	
075	PRTX	-14	
076	GTO1	22 01	
077	*LBLC	21 13	
078	SF2	16 21 02	Set test-cleared flag to return from D before printing
079	GSBD	23 14	
080	R↓	-31	
081	+	-55	By going to D, actual output can be added to Fo for more accurate % conc.
082	LSTX	16-63	
083	R↑	16-31	
084	x	-35	
085	X⇄Y	-41	
086	÷	-24	
087	1	01	
088	X>Y?	16-34	Is concentration less than 1%?, display more decimal places
089	DSP2	-63 02	
090	R↓	-31	
091	RTN	24	
092	*LBLD	21 14	
093	7	07	
094	6	06	
095	0	00	
096	x	-35	
097	LSTX	16-63	
098	RCLD	36 14	
099	-	-45	
100	÷	-24	
101	RCLD	36 14	
102	7	07	
103	.	-62	
104	6	06	
105	÷	-24	
106	F2?	16 23 02	Flag 2 set? Yes- return before printing No- print results
107	RTN	24	
108	PRTX	-14	
109	R↓	-31	
110	PRTX	-14	
111	SPC	16-11	
112	RTN	24	

REGISTERS

0	1	2	3	4	5	6	7	8	9
99420.220	116303.2274	131500.230	107974.222	133947.213	105926.213				

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
6.78574	6.90328	7.02808	6.8468	7.08798	6.92546				

A	B	C	D	E	I
Fv Flow thru vaporizer	Increment flow ΔFv / Δt temp	Selection n / Fo Diluent	R Vapor Pressure	Temp (°C)	Used

Program Description I

Program Title 67 - PULMONARY MEDICINE/RESPIRATOR SETUP, DEADSPACE ADJUSTMENT

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak St. Apt. 3

City San Francisco **State** Calif. **Zip Code** 94117

Program Description, Equations, Variables This program approximates the results of the Radford nomogram, using the following formula:

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

For Males:

C_1 = 124 FOR WT. ≤ 8 KG
= 61 FOR WT. > 8 KG

C_2 = 193 FOR WT. ≤ 8 KG
= 249 FOR WT. > 8 KG

For Females:

C_1 = 124 FOR WT ≤ 8 KG
= 61 FOR WT > 8 KG BUT ≤ 23 KG
= 442 FOR WT >23 KG

C_2 = 193 FOR WT ≤ 8 KG
= 249 FOR WT > 8 KG BUT≤23 KG
= 272 FOR WT > 23 KG

TV_A = Alveolar tidal volume = $\frac{V_A}{r}$ ml, where r = breaths/minute

*TV_{bas} = Basal tidal volume = $(TV_A + \beta)$ where β = wt (lbs) if no tracheostomy present, but = 1/2 wt. (lbs) if one is present.

$TV_{corr} = TV_{bas}$ + (mechanical deadspace) + (mandatory ventilator deadspace) + (tracheostomy deadspace, if one is present)

TV_{vent} = Ventilator tidal volume = $TV_{corr} + \Delta \cdot TV_{corr}$, where Δ = corrections, as follows:

Δ = sum of following		Condition
1)	.05 (T/°F)-99	If T(9=) > 99
2)	2.5×10^{-5} (alt. in feet)	
3)	.10	If patient has slight muscular activity in daytime
4)	.20	If metabolic acidosis is present, such as in anesthesia

*NOTE: β = upper respiratory deadspace, cc.

Operating Limits and Warnings TV_{bas} AND ALL VALUES listed below it (see above) are interpreted slightly differently than in the Radford paper, in that the correction for tracheostomy is applied at the level of TV_{bas} rather than later, at the level of TV_{corr}. The following are the usual ranges of r based on age.:

Infants	30-50
Children	18-30
Adults	8-18

Nomogram may not be applied with confidence to patients with abnormal lung function or muscular activity.

Program Description I

Program Title 67-Pulmonary Medicine/Respirator Setup, Deadspace

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak St., Apt. 3

City San Francisco **State** CA **Zip Code** 94117

Program Description, Equations, Variables The program /RSO approximates the nomogram of SUWA et. al. or deadspace required to normalize PCO_2 when the patient has a low PCO_2 (respiratory alkalosis) according to the following formula:

$$[\text{mechanical deadspace}] = \frac{40 - Pa_{1}CO_2}{40 - \alpha} \left(TV_{vent} - \text{mandatory deadspace} - \text{tracheostomy deadspace} - \text{anatomical deadspace}\right)$$

← Starting value of PCO_2

Note that "mandatory deadspace" is that deadspace which cannot be eliminated from the ventilatory apparatus; if a tracheostomy is present, anatomical deadspace = 1/2 wt./lbs); otherwise, it equals wt./lbs.).

$\alpha = 35$ if pulmonary function normal; otherwise

$\alpha = (Pa_{1CO_2} - P_{\bar{E}CO_2})$ where $P_{\bar{E}}CO_2 = PCO_2$ in mixed expired gas. Normal PCO_2 is assumed to be 40.

This program part does not store the resulting mech.deadspace estimate for use by the previously described program part.

Operating Limits and Warnings The original SUWA et al. paper assumed that anatomical deadspace = 2/3 wt. (lb) when a tracheostomy was present. This program thus may estimate slightly higher deadspace values when a trach.is present. The part of the program described on page 1/6 may give slightly lower estimates of TV vent than those in the original Radford paper.

Program Description II

Sketch(es)

Sample Problem(s) 1) Given male, wt. = 170 lb., tracheostomy present, no activity (coma), no acidosis, sea level, body temp = 101°F, mandatory ventilator deadspace = 25 cc, added (mechanical) deadspace = 0, calculate TV_{vent} (Resp. rate = 15)

2) If same pt. has PCO_2 = 25 later, how much deaospace should be added? Assume normal pulmonary function. Use TV_{vent} = 442 as calculated in problem 1 above.

Solution(s)

1) 0[A] 101[CHS][B]0[f][B]15[C]25[CHS][ENT ↑]
170[CHS][f][C]0[D][f][D] → 442 TV_{vent}
402 $TV_{corr.}$
377 $TV_{bas.}$
292 TV_A
4377 V_A

2) 442 [CHS][f][D]
25 [E] → 142 deadspace
332 (TV_{vent} -DS)

Reference(s) Based on 2 programs in HP-65 Library: (193, 194);

1) Radford, J. Appl. Physiol., 7-451 (1955)
2) Suwa et al., Anesthesiology, 29 = 1206 (1968).

User Instructions

PULM, MEDICINE: VENTILATOR SETUP & DEADSPACE ADJUSTMENT					
0, ACTIV. 1, MET-ACID	ALT.	WT.	TV_{vent}	ABNORM.	
0:MALE1:FEMALE	TEMP.	RES. RATE	MECH. D.S.	NORM.	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter sides 1 & 2 of Card				
2	To calculate ventilatory tidal volume:				
	1) Input sex (0=male; 1=female)	0 or 1	A		0 or 1
	2) If & only if pt. has slight muscular				
	function in daytime, enter "0"	0	f	a	0
	3) If & only if pt. is in state ov metabolic				
	acidosis (as in anesthesia) enter "1"	1	f	a	1
	4) Input body temp (-°F or °C)	- °F or °C	B		°F
	5) Input altitude (m or -f)	m or -f	f	b	f
	6) Input respirations per minute	n(resp/m)	c		n
	7) Input either:				
	a) (Tracheostomy + Mandatory ventilator	Vent DS			
	deadspace) if tracheostomy present, or		CHS	ENT ↑	
	b) (Ventilator mand. deadsp.) if no trach &	Vent DS	ENT ↑		
	8) Input wt (Kg or - lb)	Kg or - lb	f	c	
	9) Input mechanical (added) deadspace	cc	D		
	10) Calculate and display:		f	d	
	1) TV_{vent}				
	2) $TV_{corr.}$				
	3) TV_{bas}				
	4) TVa				
	5) Va				
3	To estimate deadspace (mechanical) needed to				
	raise PCO: to 40:				
	1) Do steps 7, 8, 9 as above				
	2) Input - (TV_{vent})	-(TV_{vent})	f	d	TV_{vent}
	3) If pulmonary ftn normal, input PCO_2				
	and calculate results :	PCO_2	E		*
	4) If pulm ftn is abnormal, input PCO_2				
	followed by $PECO_2$ and calculate	PCO_2, $PECO_2$	f	e	*
	*Results displayed as:				
	Deadspace (cc) flashing, followed by [TV_{vent}-				
	all deadspace values], followed by deadspace				
	in steady register.				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STOI	35 46	
003	RTN	24	
004	*LBLa	21 16 11	
005	1	01	
006	X=Y?	16-33	
007	SF1	16 21 01	
008	CLX	-51	
009	X=Y?	16-33	
010	SF0	16 21 00	
011	RTN	24	
012	*LBLB	21 12	
013	X<0?	16-45	
014	GTO0	22 00	
015	1	01	
016	.	-62	
017	8	08	
018	x	-35	
019	3	03	
020	2	02	
021	+	-55	
022	CHS	-22	
023	*LBL0	21 00	
024	CHS	-22	
025	STO1	35 01	
026	RTN	24	
027	*LBLb	21 16 12	
028	X<0?	16-45	
029	GTO1	22 01	
030	.	-62	
031	3	03	
032	0	00	
033	5	05	
034	÷	-24	
035	CHS	-22	
036	*LBL1	21 01	
037	CHS	-22	
038	STO2	35 02	
039	RTN	24	
040	*LBLC	21 13	
041	STO3	35 03	
042	RTN	24	
043	*LBLc	21 16 13	
044	.	-62	
045	4	04	
046	5	05	
047	3	03	
048	6	06	
049	X⇄Y	-41	
050	X<0?	16-45	
051	GTO2	22 02	
052	STOC	35 13	
053	X⇄Y	-41	
054	÷	-24	
055	STO4	35 04	
056	GTO3	22 03	
057	*LBL2	21 02	
058	CHS	-22	
059	STO4	35 04	
060	x	-35	
061	STOC	35 13	
062	*LBL3	21 03	
063	R↓	-31	
064	X>0?	16-44	
065	GTO4	22 04	
066	2	02	
067	ST÷4	35-24 04	
068	R↓	-31	
069	*LBL4	21 04	
070	ABS	16 31	
071	STO5	35 05	
072	RTN	24	
073	*LBLD	21 14	
074	STOD	35 14	
075	RTN	24	
076	*LBLd	21 16 14	
077	X<0?	16-45	
078	GTO6	22 06	
079	8	08	
080	RCLC	36 13	
081	X≤Y?	16-35	
082	GTO2	22 02	
083	GTOi	22 45	
084	*LBL0	21 00	
085	6	06	
086	1	01	
087	STOA	35 11	
088	2	02	
089	4	04	
090	9	09	
091	STOB	35 12	
092	GTO3	22 03	
093	*LBL1	21 01	
094	2	02	
095	3	03	
096	X⇄Y	-41	
097	X≤Y?	16-35	
098	GTO0	22 00	
099	4	04	
100	4	04	
101	.	-62	
102	2	02	
103	STOA	35 11	
104	2	02	
105	7	07	
106	2	02	
107	STOB	35 12	
108	GTO3	22 03	
109	*LBL2	21 02	
110	1	01	
111	2	02	
112	4	04	

REGISTERS

0	1	2	3	4	5	6	7	8	9
TV_{vent}	Temp (°F)	Alt-(f)	Resp. Rate	ANATOMICAL DEADSPACE	TRACH + VENT. D. SP	TV_{corr}	TV_{bas}	TV_A	V_A
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
C_1	C_2	WT(KG)	Mechanical Deadspace	Temp.	Sex 0=Male 1=Female

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	STOA	35 11	
114	1	01	
115	9	09	
116	3	03	
117	STOB	35 12	
118	*LBL3	21 03	
119	RCLC	36 13	
120	LOG	16 32	
121	RCLA	36 11	
122	x	-35	
123	RCLB	36 12	
124	+	-55	
125	EEX	-23	
126	2	02	
127	÷	-24	
128	10^x	16 33	
129	STO9	35 09	
130	RCL3	36 03	
131	÷	-24	
132	STO8	35 08	
133	RCL4	36 04	
134	+	-55	
135	STO7	35 07	
136	RCL5	36 05	
137	+	-55	
138	RCLD	36 14	
139	+	-55	
140	STO6	35 06	
141	RCL2	36 02	
142	4	04	
143	EEX	-23	
144	2	02	
145	÷	-24	
146	STO0	35 00	
147	CLX	-51	
148	RCL1	36 01	
149	9	09	
150	9	09	
151	-	-45	
152	X<0?	16-45	
153	GTO4	22 04	
154	5	05	
155	x	-35	
156	ST+0	35-55 00	
157	*LBL4	21 04	
158	CLX	-51	
159	1	01	
160	0	00	
161	F0?	16 23 00	
162	ST+0	35-55 00	
163	2	02	
164	x	-35	
165	F1?	16 23 01	
166	ST+0	35-55 00	
167	CLX	-51	
168	RCL0	36 00	

STEP	KEY ENTRY	KEY CODE	COMMENTS
169	%	55	
170	+	-55	
171	STO0	35 00	
172	*LBL5	21 05	
173	RCL0	36 00	
174	PRTX	-14	
175	RCL6	36 06	
176	PRTX	-14	
177	RCL7	36 07	
178	PRTX	-14	
179	RCL8	36 08	
180	PRTX	-14	
181	RCL9	36 09	
182	PRTX	-14	
183	R/S	51	
184	GTO5	22 05	
185	*LBL6	21 06	
186	CHS	-22	
187	RCLD	36 14	
188	-	-45	
189	RCL4	36 04	
190	-	-45	
191	RCL5	36 05	
192	-	-45	
193	STO8	35 08	
194	RTN	24	
195	*LBLE	21 15	
196	3	03	
197	5	05	
198	*LBL7	21 07	
199	STOE	35 15	
200	R↓	-31	
201	4	04	
202	0	00	
203	-	-45	
204	CHS	-22	
205	RCLE	36 15	
206	÷	-24	
207	RCL8	36 08	
208	x	-35	
209	PRTX	-14	
210	RCL8	36 08	
211	PRTX	-14	
212	R↓	-31	
213	RTN	24	
214	*LBLe	21 16 15	
215	X⇄Y	-41	
216	ENT↑	-21	
217	ENT↑	-21	
218	R↑	16-31	
219	-	-45	
220	4	04	
221	0	00	
222	-	-45	
223	CHS	-22	
224	GTO7	22 07	

LABELS					FLAGS
A USED	B USED	C USED	D USED	E USED	0 USED
a USED	b USED	c USED	d USED	e USED	1 USED
0 USED	1 USED	2 USED	3 USED	4 USED	2 USED
5 USED	6 USED	7 USED	8 ------	9 ------	3 NOT USED

SET STATUS

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

Program Description I

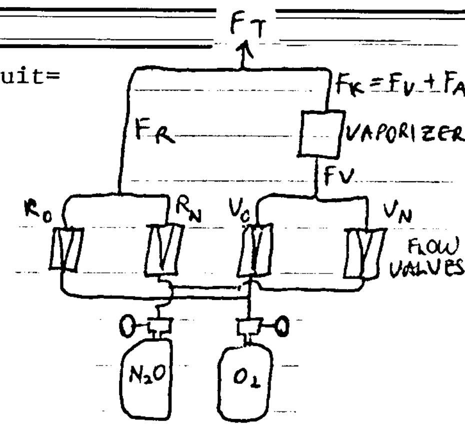
Program Title 67 - COPPER KETTLE ANESTHETIC REGULATION

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak St. # 3

City San Franciscc **State** Calif. **Zip Code** 94117

Program Description, Equations, Variables Given anesthetic circuit=



Where: F_T = Total gas flow to patient circuit
F_K = Flow out of vaporizer = F_V+F_A
F_R = Flow into vaporizer (O_2+N_2O)
F_A = Flow of anesthetic out of vaporizer
F_R = F_T-F_K = remainder flow
R_O = Remainder flow of oxygen
R_N = Remainder flow of N2O
V_O = Vaporizer flow of oxygen
V_N = Vaporizer flow of N_2O

A = Anesthetic, by %, desired in final mixture of gases (F_t) then, the value of F_V required to provide A% of anesthetic is: $F_V=(PA/PV) \cdot F_T \cdot (A/100)$ Where
PA = Atmospheric pressure
PV = Partial pr. of anesthetic

Atmos. pr. can be estimated by: $PA = 760.938 \cdot e^{-1.2421 \times 10^{-4}}$, (meters altitude) which is obtained as an exponential fit to the ICAO STD. atmosphere table (reference No. 1). The mg/ml anesthetic in final gas mix = W =

$$\frac{(\text{gram molecular weight}) \cdot PA \cdot (A/100)}{(273.15 + {}^\circ C) \cdot 62.359}$$

Anesthetic liquid usage rate (min/ml)= $\dfrac{(\text{specific gravity of liquid, gm/ml}) \cdot 1000}{W \cdot F_T}$

Gibbs correction of Pv for P_A is:

$$PV\ (\text{correction}) = \exp\left\{\frac{\dfrac{\text{molecular weight}}{\text{specific grav.} \cdot 1000}(P_A - 760)}{(O_K) \cdot 6.236 \times 10^4} + \ln(P_V)\right\}$$

$F_K=F_V+F_A = \left(\frac{P_V+P_A}{P_A}\right) \cdot F_V$, $S_O = F_R=F_T - \left(\frac{P_V+P_A}{P_A}\right) \cdot F_V$

Also: P_V is calculated from the Antoine equation as: $\log P_V = A' - \dfrac{B}{T(^\circ K)+C}$, where A' (not to be confused with A, above), B & C are constants for a given anesthetic agent.

Operating Limits and Warnings: The maximal value of A attainable is: $A_{MAX} = PV/(P_A+P_V)$. If this is exceeded by the operator, A_{MAX} will be displayed, flashing, when one attemps to compute F_V.

Program Description II

Sketch(es)

Sample Problem(s) Given the Antoine constants for enflurane, or A=6.98840 B=1107.839, and C=213.063 ;at an altitude of 4500 feet, at 25°C, given F_T = 3000 cc/min and A=3% (for induction purposes). Mol wt. of enflurane = 184.5, Spec. gravity = 1.52.

Solution(s) 6.9884[ENT ↑]1107.839[ENT↑] 213.063[A] 184.5[ENT ↑] 1.52[f][A]
4500[CHS][B] → 641.84 P_A, mm Hg
25[C] → 216.20 P_V, mm Hg
3000[D] 3[f][D] → 267.19 F_V, cc/min.
[R/S] → 2642.81 F_R cc/min:
[R/S] → 25.20 Amax %
[E] → 2.65 USE RATE, min/ml. [R/S] → 0.19 mg/ml
[f][E] → 216.20 P_V corr., mm Hg. [R/S] → 7.710629327-05
Correction is always minute in practice, showing rigorous nature of Dalton's law of partial pressures!

Reference(s)

1) Scientific Tables, Diem & Lentner, Documenta Geigy, 7th Edition, Basle (Switz.), 1972, page 252

2) Rodgers, R. C. & G. E. Hill, in prep. (1976)

User Instructions

COPPER KETTLE ANESTHETIC REGULATION CARD 1/1

1	M.W. ↑ SP.Gr.	PA	PV	A% → FV, FR	P_{Vcorr} Δ%	2
	A ↑ B ↑ C	ALT	T(°C)	F_T	→USE RATE	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	If ntoine constants are to be entered				
	automatically from card, input side 1 of card				
	of any of the specific agent cards				
	written by present author.	Author			
2	Enter card (both sides) "Copper Kettle"				
3	If #1 not done, input A',B, & C.	A'	ENT ↑		
		B	ENT ↑		
		C	A		
4	If #1 not done, input mol. wt. & specific	M.W.	ENT ↑		
	gravity of volatile agent	SP. GRAV.	f	A	M. W.
5	Do <u>either</u>:				
	a. Input altitude in meters or -feet to				
	estimate atmospheric pr. P_A	m, -f	B		P_A (mm Hg)
	b. Input barometric P_A mm Hg	P_A	f	B	P_A (mm Hg)
6	Do <u>either</u>: **				
	a. Unit T (°C) to calculate vapor pressure	T(C°)	C		Pv (mm Hg)
	b. Input vapor pressure of anesthetic	mm/Hg			
	directly.	Pv	f	C	Pv (mm Hg)
7	Input total flow to patient circuit	F_t	D		F_t (cc/min)
8	Input A, % of anesthetic vapor desired in				
final	mixture, calculate FV (flow to vaporizer)	A(%)	f	D	Fv (cc/min)
9	Display F_R (remainder flow)*		R/S		F_R (cc/min)
10	Calculate min/ml of LIQUID ANESTHETIC (USE				
	RATE)		E		min/ml
11	To calculate time remaining, input ml. agent				
	left & press x (optional)	ml	x		min.
12	To calculate mg of anesth.vapor per ml final				
	gas mix:		R/S		mg/ml
13	To calculate Gibbs - corrected valve of P_V				
	for P_A;		f	E	Pv (corr.)
14	To calculate % CH from Pv (corr) to P_V		R/S		% corr.
15	May change data entered in any steps, and redo				
	Steps 8-14 at will				
*16	May display A_{MAX} after Step 9		R/S		A_{MAX}
**17	If $P_V \geq P_A$ (i.e., anesthetic is a <u>gas</u> at a				
	given T) program will stop and flash P_A				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO2	35 02	C → (2)
003	R↓	-31	
004	STO1	35 01	
005	R↓	-31	B → (1)
006	STO0	35 00	
007	RTN	24	A' → (0)
008	*LBLa	21 16 11	
009	STO4	35 04	Spec, grav, → (4)
010	R↓	-31	
011	STO3	35 03	
012	RTN	24	Mol. wt. → (3)
013	*LBLB	21 12	
014	X>0?	16-44	
015	GTO1	22 01	
016	CHS	-22	
017	.	-62	
018	3	03	
019	0	00	
020	4	04	
021	8	08	
022	×	-35	
023	*LBL1	21 01	
024	1	01	Alt. is now in
025	.	-62	meters
026	2	02	
027	4	04	
028	1	01	
029	CHS	-22	
030	EEX	-23	
031	4	04	
032	CHS	-22	
033	×	-35	
034	e^x	33	
035	7	07	
036	6	06	
037	0	00	
038	.	-62	
039	9	09	
040	3	03	
041	8	08	
042	×	-35	
043	PRTX	-14	
044	*LBLb	21 16 12	
045	STO5	35 05	PA → (5)
046	RTN	24	
047	*LBLC	21 13	
048	STO8	35 08	T (C°) → (8)
049	RCL2	36 02	
050	+	-55	
051	RCL1	36 01	
052	X⇄Y	-41	
053	÷	-24	
054	RCL0	36 00	
055	-	-45	
056	CHS	-22	
057	10^x	16 33	
058	*LBLc	21 16 13	
059	RCL5	36 05	
060	X>Y?	16-34	See if PV ≥ PA
061	GTO5	22 05	
062	*LBL4	21 04	
063	PSE	16 51	Display flashing
064	GTO4	22 04	"PA"
065	*LBL5	21 05	
066	X⇄Y	-41	
067	STO6	35 06	P_V → (6)
068	PRTX	-14	
069	RTN	24	
070	*LBLD	21 14	
071	STO7	35 07	
072	RTN	24	FT → (7)
073	*LBLd	21 16 14	
074	RCL6	36 06	
075	RCL5	36 05	
076	RCL6	36 06	
077	+	-55	
078	÷	-24	
079	EEX	-23	
080	2	02	
081	×	-35	
082	X⇄Y	-41	
083	X>Y?	16-34	
084	GTO2	22 02	
085	EEX	-23	
086	2	02	
087	÷	-24	
088	STO9	35 09	
089	RCL5	36 05	(A/100) → (9)
090	×	-35	
091	RCL6	36 06	
092	÷	-24	
093	RCL7	36 07	
094	×	-35	
095	PRTX	-14	
096	R/S	51	Fv in X, A_{MAX}
097	RCL5	36 05	in y
098	RCL6	36 06	
099	+	-55	
100	RCL5	36 05	
101	÷	-24	
102	×	-35	
103	RCL7	36 07	
104	-	-45	
105	CHS	-22	
106	PRTX	-14	
107	R/S	51	F_R in X
108	R↓	-31	
109	PRTX	-14	
110	RTN	24	A_{MAX} in X
111	*LBL2	21 02	
112	X⇄Y	-41	

REGISTERS

0	1	2	3	4	5	6	7	8	9
A'	B	C	MOL-WT	SPEC-GRAV.	PA	P_V	F_T	T(°C)	A/100
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I
T(°K)	W				

97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	*LBL3	21 03	
114	PSE	16 51	Display flashing
115	GTO3	22 03	"A_{MAX}"
116	*LBLE	21 15	
117	RCL3	36 03	
118	RCL5	36 05	
119	×	-35	
120	RCL9	36 09	
121	×	-35	
122	RCL8	36 08	
123	2	02	
124	7	07	
125	3	03	
126	.	-62	
127	1	01	
128	5	05	
129	+	-55	
130	STOA	35 11	
131	÷	-24	(°K) → (A)
132	6	06	
133	2	02	
134	.	-62	
135	3	03	
136	5	05	
137	9	09	
138	÷	-24	
139	STOB	35 12	
140	RCL7	36 07	W = (mg/ml) of
141	×	-35	vapor → (B)
142	EEX	-23	
143	3	03	
144	X⇄Y	-41	
145	÷	-24	
146	RCL4	36 04	
147	×	-35	
148	PRTX	-14	
149	R/S	51	Use Rate (min/nl)
150	RCLB	36 12	
151	PRTX	-14	
152	RTN	24	
153	*LBLe	21 16 15	
154	RCL3	36 03	
155	RCL4	36 04	
156	÷	-24	
157	EEX	-23	
158	3	03	
159	÷	-24	
160	RCL5	36 05	
161	7	07	
162	6	06	
163	0	00	
164	-	-45	
165	×	-35	
166	RCLA	36 11	
167	÷	-24	
168	6	06	

STEP	KEY ENTRY	KEY CODE	COMMENTS
169	.	-62	
170	2	02	
171	3	03	
172	6	06	
173	EEX	-23	
174	4	04	
175	÷	-24	
176	RCL6	36 06	
177	LN	32	
178	+	-55	
179	e^x	33	
180	PRTX	-14	
181	R/S	51	Display P_V (corr.)
182	RCL6	36 06	
183	%CH	16 55	
184	PRTX	-14	% change from
185	RTN	24	P_y (corr) to P_V
186	R/S	51	

LABELS

A A'↑ B↑C	B $-\frac{m}{f}$ } P_A	C T(°C)→ P_V	D F_t	E min/ml mg/ml
a MW ↑ S.G.	b P_A	c P_V	d A →$F_V F_A A_{AN}$	e P_V corr% Δ
0	1 Used	2 Used	3 Used	4 Used
5 Used	6	7	8	9

FLAGS

0	
1	
2	
3	

SET STATUS

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

Program Description I

Program Title 67 - ANESTHESIA: ANTOINE VALUES FROM EXPERIMENTAL DATA

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak St. #3

City San Francisco **State** Calif. **Zip Code** 94117

Program Description, Equations, Variables The Antoine equation uses the 3 constants A, B, & C to express vapor pressure (P_V) as a function of temperature (T, °C) =

$$\text{Log}\ (P_V) = A - \frac{B}{T+C}$$

This can be changed to:

$$T \cdot \text{Log}(P_V) = A \cdot T + (-C)\ \log\ (P_V) + (AC-B)$$

which is of the form $Z = a_o + a_{1x} + a_2 y$ or a multiple linear regression formula, with $Z = T \cdot \log(P_V)$, $y = \log\ (P_V)$ and $X = T(°C)$. This program calculates A, B & C on the basis of such a multiple linear regression.

Operating Limits and Warnings

Program Description II

Sketch(es)

Sample Problem(s)

1)

T (°C)	P_V/mm Hg
17.3	151.2
28.3	250.1
36.2	349.4
42.4	449.5
47.8	551.2
52.2	649.3
56.4	752.9

2) Given T = 17.3, estimate P_V from equation.

Solution(s)

1) 17.3[ENT ↑] 151.2[A] 28.3[ENT ↑] 250.1[A] 36.2[ENT ↑] 349.4[A] 42.4[ENT ↑] 449.5[A] 47.8[ENT ↑] 551.2[A] 52.2[ENT ↑] 649.3[A] 56.4[ENT ↑] 752.9[A] → 7

[D] → 6.98840 A

[R/S] → 1107.839B

[R/S] → 213.063 C

2) 17.3[E] → 151.11 T(°C) approx.

Reference(s)

User Instructions

	INT.	ANTOINE	VALUES	
	$T(°C) \uparrow P_V$	$T(°C) \uparrow P_V$	LAST	
1	$\Sigma+$	$\Sigma-$	$\Sigma-$	A,B,C	$T(°C) \uparrow P_V$ (st.) 2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Enter Card both sides				
2	Initialize registers		f	a	0.00
3	Input T(°C), then vapor pressure	T(°C)	ENT ↑		
	(P_V) and do sums = display "n", the				
	running # of data points	P_V	A		n
4	To correct errors, either:				
	1) Enter erroneous T & P_V and:	T(°C)	ENT ↑		
	or	P_V	B		n
	2) Cancel out last data set summed:		C		n
5	Calculate A, B, C of				
	Antoine equation:		D		A
			R/S		B
			R/S		C
6	Test formula: Given T(°C), estimate				
	P_V	T(°C)	E		P_V (est.)
7	Return to #2 if desired, or to steps 3-6.				

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLa	21 16 11	
002	CLRG	16-53	
003	P⇄S	16-51	
004	CLRG	16-53	
005	RTN	24	
006	*LBLA	21 11	
007	DSP2	-63 02	
008	LOG	16 32	
009	GSBe	23 16 15	
010	ST+1	35-55 01	
011	RCLB	36 12	
012	×	-35	
013	ST+2	35-55 02	
014	RCLA	36 11	
015	RCLC	36 13	
016	×	-35	
017	ST+3	35-55 03	
018	RCLB	36 12	
019	RCLA	36 11	
020	Σ+	56	
021	RTN	24	
022	*LBLB	21 12	
023	LOG	16 32	
024	*LBL1	21 01	
025	GSBe	23 16 15	
026	ST-1	35-45 01	
027	RCLB	36 12	
028	×	-35	
029	ST-2	35-45 02	
030	RCLA	36 11	
031	RCLC	36 13	
032	×	-35	
033	ST-3	35-45 03	
034	RCLB	36 12	
035	RCLA	36 11	
036	Σ-	16 56	
037	RTN	24	
038	*LBLC	21 13	
039	RCLA	36 11	
040	RCLB	36 12	
041	GTO1	22 01	
042	*LBLD	21 14	
043	RCL3	36 03	
044	RCL2	36 02	
045	RCL1	36 01	
046	P⇄S	16-51	
047	STO1	35 01	
048	R↓	-31	
049	STO2	35 02	
050	R↓	-31	
051	STO3	35 03	
052	RCL5	36 05	
053	RCL9	36 09	
054	×	-35	
055	RCL4	36 04	
056	X²	53	

STEP	KEY ENTRY	KEY CODE	COMMENTS
057	-	-45	
058	RCL2	36 02	
059	RCL9	36 09	
060	×	-35	
061	RCL6	36 06	
062	RCL1	36 01	
063	×	-35	
064	-	-45	
065	×	-35	
066	STOD	35 14	
067	RCL8	36 08	
068	RCL9	36 09	
069	×	-35	
070	RCL4	36 04	
071	RCL6	36 06	
072	×	-35	
073	-	-45	
074	RCL3	36 03	
075	RCL9	36 09	
076	×	-35	
077	RCL4	36 04	
078	RCL1	36 01	
079	×	-35	
080	-	-45	
081	×	-35	
082	STOE	35 15	
083	RCL5	36 05	
084	RCL9	36 09	
085	×	-35	
086	RCL4	36 04	
087	X²	53	
088	-	-45	
089	RCL9	36 09	
090	RCL7	36 07	
091	×	-35	
092	RCL6	36 06	
093	X²	53	
094	-	-45	
095	×	-35	
096	RCL8	36 08	
097	RCL9	36 09	
098	×	-35	
099	RCL4	36 04	
100	RCL6	36 06	
101	×	-35	
102	-	-45	
103	X²	53	
104	-	-45	
105	RCLD	36 14	
106	RCLE	36 15	
107	-	-45	
108	X⇄Y	-41	
109	÷	-24	
110	CHS	-22	
111	STOI	35 46	
112	RCL3	36 03	

REGISTERS

0	1	2	3	4	5	6	7	8	9
	Σz	Σyz	Σxz						

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

A	B	C	D	E	I
LST X	LST y	LST Z	A	B	C

'97 Program Listing II

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	RCL9	36 09	
114	×	-35	
115	RCL4	36 04	
116	RCL1	36 01	
117	×	-35	
118	-	-45	
119	RCL8	36 08	
120	RCL9	36 09	
121	×	-35	
122	RCL4	36 04	
123	RCL6	36 06	
124	×	-35	
125	-	-45	
126	RCLI	36 46	
127	×	-35	
128	+	-55	
129	RCL5	36 05	
130	RCL9	36 09	
131	×	-35	
132	RCL4	36 04	
133	X^2	53	
134	-	-45	
135	÷	-24	
136	STOD	35 14	
137	RCL4	36 04	
138	×	-35	
139	RCLI	36 46	
140	CHS	-22	
141	RCL6	36 06	
142	×	-35	
143	+	-55	
144	RCL1	36 01	
145	-	-45	
146	CHS	-22	
147	RCL9	36 09	
148	÷	-24	
149	RCLD	36 14	
150	RCLI	36 46	
151	×	-35	
152	CHS	-22	
153	+	-55	
154	CHS	-22	
155	STOE	35 15	
156	RCLD	36 14	
157	DSP5	-63 05	
158	R/S	51	
159	RCLE	36 15	
160	DSP3	-63 03	
161	R/S	51	
162	RCLI	36 46	
163	RTN	24	
164	*LBLE	21 15	
165	RCLI	36 46	
166	+	-55	
167	RCLE	36 15	
168	X⇄Y	-41	

STEP	KEY ENTRY	KEY CODE	COMMENTS
169	÷	-24	
170	RCLD	36 14	
171	-	-45	
172	CHS	-22	
173	10^x	16 33	
174	DSP2	-63 02	
175	RTN	24	
176	*LBLe	21 16 15	
177	STOB	35 12	
178	X⇄Y	-41	
179	STOA	35 11	
180	×	-35	
181	STOC	35 13	
182	RTN	24	
183	R/S	51	

LABELS					FLAGS
A Used	B Used	C Used	D Used	E Used	0
a Used	b	c	d	e Used	1
0	1	2	3	4	2
5	6	7	8	9	3

SET STATUS

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

VAPOR PRESSURE PROGRAM COMMENTS

The remaining nine programs in this collection calculate vapor pressure at a desired temperature and Gibbs - corrected vapor pressure for specific compounds of interest to anesthesiologists. With one exception*, they all employ an identical program for the calculation. However, different constants must be stored in the calculator memory registers for each different compound.

The user may wish to make a separate card for each compound with the data stored on one side of the card and the program on the other, or he may wish to record the program once on a single side of a card and employ separate data cards for the constants for each compound (two compounds to a card). In either case, the program need only be keyed in once, the program card(s) recorded and data recorded by storing the constants in the registers as shown in the Register Contents listings.

*The exception is the program for cyclopropane, which does not contain the routine for the Gibbs - corrected vapor pressure since its boiling point, (33°C), below named ambient temperature. This 51-step program is identical with the first 51 steps of the other vapor pressure programs.

Program Description I

Program Title 67 - ANESTHESIA: VAPOR PRESSURE OF WATER (RODGERS)

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak Street, Apt. 3

City San Francisco **State** CA **Zip Code** 94117

Program Description, Equations, Variables The vapor pressure of water can be expressed by an Antoine equation:

$$\log_{10} P \text{ (mm Hg)} = 8.04343 - \frac{1716.984}{T(°C) + 232.538}$$

Atmospheric pressure may be input directly or estimated on the basis of Altitude As 2:

$$P_A \text{ (mm Hg)} = 760.938 \cdot e^{-1.241 \times 10^{-4} \text{ (alt. in meter)}}$$

The Gibbs - corrected P_V value is:

$$P_V \text{ (corr.)} = \exp\left\{ \frac{\frac{\text{mol. wt.}}{\text{spec. grav.} \cdot 1000}(P_A - 760)}{(°K) \cdot 6.236 \times 10^4} + \ln (P_V) \right\}$$

Operating Limits and Warnings Antoine constants were fit to data from -5 to 135°C, and calculated valves deviate from the data by < 1%.

When preparing recorded magnetic card, constants for storage in registers are loaded on Side 1, Program on Side 2.

Program Description II

Sketch(es)

Sample Problem(s)

1) T = 0°C, find P_V
2) T = 80°C, Find P_V
3) Altitude = 4500 feet, find P_A
4) Altitude = 1000 meters, find P_A
5) Calculate $P_{V\ corr}$ + % correction for 35°C and 2500 feet altitude.

Solution(s)

1) 0[A] → 4.57 mm Hg, [R/S] → 0.01 Atm., P_V
2) 80[A] → 354.61 mm Hg,
   [R/S] → 0.47 Atm., P_V
3) 4500[CHS][B] → 641.84 mm Hg, P_A
4) 1000[B] → 672.13 mm Hg, P_A
5) 35[A]2500[CHS][B][C] → 42.24 mm Hg, P_V corr.
   [R/S] → 6.439602080-06, % corr.

Reference(s)

1) Rodgers R. C. & G. E. Hill, in Prep., 1976
2) ICAO Std. Atm. Table, in SCIENTIFIC TABLES, Diem & Lentner CIBA-Geigy, Basle, 1972, page 252

User Instructions

VAPOR PRESS ORE OF WATER

1 ENTER P_A 2

$T \rightarrow P_V$ | $ALT \rightarrow P_A$ | P_VCORR.%

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load side 1 of card to store constants for use				
	with "copper kettle anesthesia regulation"				
	program if desired.				
2	Use "copper kettle anesthesia" regulation				
	program as desired.				
	or				
1'	Load sides 1 & 2				
2'	Input temp. & calculate vapor pressure	T, °C.	A		P_V, (mm Hg)
	Optional: convert P_V to Atm.		R/S		P_V, (Atm.)
3'	Do either:				
	a. Input altitude (meters +, or feet-)	m, or $-F_t$	B		P_A (mm Hg)
	b. Input Atm. pressure from barometer	P_A, mmHg	f	B	P_A (mm Hg)
4'	Calculate Gibbs - corrected P_V		C		P_V (corr.)
5'	Calculate % correction		R/S		% corr.
	NOTE: When preparing recorded magnetic card				
	from program register listings on				
	following pages, perform the following				
	steps:				
1	Load registers 0 through 4 with constants shown.				
2	With calculator in "run" mode, press "write data"				
	key & pass Side 1 of blank card through card				
	reader.				
3	Record program on Side 2 of card in usual manner.				

SET STATUS

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

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO7	35 07	T(°C) → (7)
003	RCL2	36 02	
004	+	-55	
005	RCL1	36 01	
006	X⇄Y	-41	
007	÷	-24	
008	RCL0	36 00	
009	−	-45	
010	CHS	-22	
011	10^x	16 33	
012	STO6	35 06	
013	R/S	51	P_V → (6)
014	7	07	
015	6	06	
016	0	00	
017	÷	-24	
018	RTN	24	Display atm.
019	*LBLB	21 12	
020	X>0?	16-44	
021	GTO1	22 01	
022	CHS	-22	
023	.	-62	
024	3	03	
025	0	00	
026	4	04	
027	8	08	
028	x	-35	
029	*LBL1	21 01	
030	1	01	Alt.(in meters) now
031	.	-62	
032	2	02	
033	4	04	
034	1	01	
035	CHS	-22	
036	EEX	-23	
037	4	04	
038	CHS	-22	
039	x	-35	
040	e^x	33	
041	7	07	
042	6	06	
043	0	00	
044	.	-62	
045	9	09	
046	3	03	
047	8	08	
048	x	-35	
049	STO5	35 05	
050	RTN	24	P_A → (5)
051	*LBLb	21 16 12	
052	STO5	35 05	
053	RTN	24	P_A → (5)
054	*LBLC	21 13	
055	RCL3	36 03	
056	RCL4	36 04	
057	÷	-24	
058	EEX	-23	
059	3	03	
060	÷	-24	
061	RCL5	36 05	
062	7	07	
063	6	06	
064	0	00	
065	−	-45	
066	x	-35	
067	RCL7	36 07	
068	2	02	
069	7	07	
070	3	03	
071	.	-62	
072	1	01	
073	5	05	
074	+	-55	
075	÷	-24	
076	6	06	
077	.	-62	
078	2	02	
079	3	03	
080	6	06	
081	EEX	-23	
082	4	04	
083	÷	-24	
084	RCL6	36 06	
085	LN	32	
086	+	-55	
087	e^x	33	
088	R/S	51	
089	RCL6	36 06	Display P_V (corr.)
090	%CH	16 55	
091	RTN	24	Display % corr.
092	R/S	51	

REGISTER CONTENTS

8.043430000	0
1716.984000	1
232.5380000	2
18.02000000	3
1.000000000	4
0.000000000	5
0.000000000	6
0.000000000	7
0.000000000	8
0.000000000	9

REGISTERS

0	1	2	3	4	5	6	7	8	9
8.04343	1716.984	232.538	18.02	1.000	P_A	Pv	T(°C)		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title 67 - ANESTHESIA: VAPOR PRESSURE OF HALOTHANE

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak Street, Apt. 3

City San Francisco **State** CA **Zip Code** 94117

Program Description, Equations, Variables The vapor pressure of halothane can be described by an Antoine equation:

$$\log P \text{ (mm Hg)} = 6.76799 - \frac{1043.697}{T(°C)+218.262}$$

Atmospheric pressure may be input directly or estimated on the basis of altitude as:

$$P_A \text{ (mm Hg)} = 760.938 \cdot e^{-1.241 \cdot 10^{-4} \text{ (alt. in meter)}}$$

The Gibbs - corrected P_V value is:

$$P_V \text{ (corrected)} = \exp\left\{ \frac{\frac{\text{mol wt.}}{\text{spec. grav.} \cdot 1000}(P_A - 760)}{(°K) \cdot 6.23 \times 10^4} + \ln (P_V) \right\}$$

Operating Limits and Warnings Antoine constants were fit to data from -50 to 56°C, and calculated values deviate from the data by < 3% (< 1% for T > - 40°C).

When preparing recorded magnetic card; constants for storage in registers are loaded on Side 1, Program on Side 2.

Program Description II

Sketch(es)

Sample Problem(s)

1) T = 50°C, find P_V
2) T = 20°C
3) Given altitude = 4500 ft., find P_A
4) Given altitude = 1000 m., find P_A
5) Calculate P_V corr & % corr for halothane at 35°C, 2500 ft.

Solution(s)

1) 50[A] → 754.05 mm Hg, [R/S] → 0.99 Atm. (P_V)
2) 20[A] → 244.08 mm Hg, [R/S] → 0.32 Atm. (P_V)
3) 4500[CHS][B] → 641.84 mm Hg (P_A)
4) 1000[B] → 672.13 mm Hg (P_A)
5) 35[A] 2500[CHS][B][C] → 443.58 mm Hg(P_V corr)
   [R/S] → 3.740016511 - 05% corr.

Reference(s)

1) Rodgers, R. C. & G. E. Hill, in preparation (1976).
2) ICAO Std. atm. table, in SCIENTIFIC TABLES, Diem & Lentner, CIBA -, Geigy, Basle (1972), page 252.

User Instructions

VAPOR PRESSURE OF HALOTHANE

1		ENTER P_A		2
	$T \rightarrow P_V$	$ALT \rightarrow P_A$	P_V corr.%	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Side 1 of card to store constants for use				
	with "copper kettle anesthesia regulation"				
	program if desired.				
2	Use "copper kettle anesthesia regulation"				
	program as desired.				
	or				
1'	Load sides 1 & 2				
2'	Input temp. & calculate vapor pressure	T, °C	A		P_V, (mm Hg)
	Optional: Convert P_V to Atm.		R/S		P_V, (Atm.)
3'	Do either:				
	a) Input altitude (meters +, or feet-)	M, or-Ft	B		P_A (mm Hg)
	b) Input atm. pressure from barometer	P_A, mmHg	f	B	P_A (mm Hg)
4'	Calculate Gibbs - corrected P_V		C		P_V (corr.)
5'	Calculate % correction		R/S		% corr.
	NOTE: When preparing recorded magnetic card from program register listings on following pages perform the following steps:				
1	Load registers 0 through 4 with constants shown.				
2	With calculator in "run" mode press "write data" key & pass side 1 of blank card through card reader.				
3	Record program on Side 2 of card in usual manner.				

SET STATUS

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

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO7	35 07	
003	RCL2	36 02	T(°C) → (7)
004	+	-55	
005	RCL1	36 01	
006	X⇄Y	-41	
007	÷	-24	
008	RCL0	36 00	
009	-	-45	
010	CHS	-22	
011	10^x	16 33	
012	STO6	35 06	P_V → (6)
013	R/S	51	
014	7	07	Display mm Hg
015	6	06	
016	0	00	
017	÷	-24	
018	RTN	24	
019	*LBLB	21 12	Display (atm.)
020	X>0?	16-44	
021	GTO1	22 01	
022	CHS	-22	
023	.	-62	
024	3	03	
025	0	00	
026	4	04	
027	8	08	
028	x	-35	
029	*LBL1	21 01	
030	1	01	
031	.	-62	Alt. in meters now
032	2	02	
033	4	04	
034	1	01	
035	CHS	-22	
036	EEX	-23	
037	4	04	
038	CHS	-22	
039	x	-35	
040	e^x	33	
041	7	07	
042	6	06	
043	0	00	
044	.	-62	
045	9	09	
046	3	03	
047	8	08	
048	x	-35	
049	STO5	35 05	
050	RTN	24	
051	*LBLb	21 16 12	P_A → (5)
052	STO5	35 05	
053	RTN	24	
054	*LBLC	21 13	P_A → (5)
055	RCL3	36 03	
056	RCL4	36 04	
057	÷	-24	
058	EEX	-23	
059	3	03	
060	÷	-24	
061	RCL5	36 05	
062	7	07	
063	6	06	
064	0	00	
065	-	-45	
066	x	-35	
067	RCL7	36 07	
068	2	02	
069	7	07	
070	3	03	
071	.	-62	
072	1	01	
073	5	05	
074	+	-55	
075	÷	-24	
076	6	06	
077	.	-62	
078	2	02	
079	3	03	
080	6	06	
081	EEX	-23	
082	4	04	
083	÷	-24	
084	RCL6	36 06	
085	LN	32	
086	+	-55	
087	e^x	33	
088	R/S	51	Display P_V(com.)
089	RCL6	36 06	
090	%CH	16 55	Display % CH.
091	RTN	24	
092	R/S	51	

REGISTER COMMENTS

6.767990000	0
1043.697000	1
218.2620000	2
197.4000000	3
1.860000000	4
0.000000000	5
0.000000000	6
0.000000000	7
0.000000000	8
0.000000000	9

REGISTERS

0	1	2	3	4	5	6	7	8	9
6.76799	1043.697	218.262	197.4	1.86	P_A	P_V	T(°C)		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title 67 - Anesthesia: Vapor pressure of diethyl ether

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak Str., Apt. 3

City San Francisco **State** CA **Zip Code** 94117

Program Description, Equations, Variables The vapor pressure of diethyl ether can be described by an Antoine equation:

$$\log P\ (\text{mm/Hg}) = 7.02683 - \frac{1109.577}{T(°C) + 233.155}$$

Atmospheric pressure may be input directly or estimated on the basis of altitude as

$$P_A\ (\text{mm/Hg}) = 760.938 \cdot e^{-1.24 \times 10^{-4}\ (\text{alt. in meters})}$$

The Gibbs - corrected P_V value is:

$$P_V\ (\text{corrected}) = \exp\left\{ \frac{\frac{\text{mol wt.}}{\text{spec grav} \bullet 1000}(P_A - 760)}{(°K) \cdot 6.236 \times 10^4} + \ln(P_V) \right\}$$

Operating Limits and Warnings Antoine constants were fit to data from -100 to 50°C, and calculated values deviate from data by < .7%.

When preparing magnetic card; constants for storage in registers are loaded on Side 1, Program on Side 2.

Program Description II

Sketch(es)

Sample Problem(s)

1) T = 30°C, find P_V
2) T = 10°C, find P_V
3) Given altitude = 4500 ft. find P_A
4) Given altitude = 1000 m, find P_A
5) Calculate P_V corr. for 35°C and 2500 feet alt.

Solution(s)

1) 30[A] → 646.24 mm Hg, [R/S] → 0.85 Atm., P_V
2) 10[A] → 290.79 mm Hg,
   [R/S] → 0.38 Atm., P_V
3) 4500[CHS][B] → 641.84 mm Hg, P_A
4) 1000[B] → 672.13 mm Hg, P_A
5) 35[A] 2500[CHS][B][C] → 774.48 mmHg, P_V corr.
   [R/S] → 3.632113697-05, % corr.

Reference(s)

1) Rodgers, R. C., & G. E. Hill, in Prep. (1976)
2) ICAO Std. Atm. Table, in <u>Scientific Tables</u>, Diem & Lentner, Ciba Geigy, Basle (1972), page 252.

User Instructions

VAPOR PRESSURE OF DIETHYL ETHER

1					2
	ENTER P_A			
$T \rightarrow P_V$	$ALT \rightarrow P_A$	P_V corr.%		

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Side 1 of card to store constants for use				
	with "copper kettle anesthesia regulation"				
	program if desired.				
2	Use "copper kettle anesthesia regulation"				
	program as desired.				
	or				
1'	Load sides 1 & 2				
2'	Input temp. & calculate vapor pressure	T, °C	A		P_V, (mm Hg)
	Optional: Convert P_V to Atm.		R/S		P_V, (Atm.)
3'	Do either:				
	A) Input altitude (meters +, or feet-)	m, or-Ft	B		P_A (mm Hg)
	B) Input atm. pressure from barometer	P_A, mm Hg	f	B	P_A (mm Hg)
4'	Calculate gibbs - corrected P_V		C		P_V (corr.)
5'	Calculate % correction		R/S		% corr.
	NOTE: When preparing recorded magnetic card				
	from program register listings on				
	following pages perform the following				
	steps:				
1	Load registers 0 through 4 with constants shown.				
2	With calculator in "run" mode press "write data"				
	key and pass Side 1 of blank card through				
	card reader.				
3	Record program on Side 2 of card in usual manner.				

SET STATUS

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

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO7	35 07	
003	RCL2	36 02	T(°C) → (7)
004	+	-55	
005	RCL1	36 01	
006	X⇄Y	-41	
007	÷	-24	
008	RCL0	36 00	
009	-	-45	
010	CHS	-22	
011	10^x	16 33	
012	STO6	35 06	
013	R/S	51	P_V → (6)
014	7	07	Display mm/tg
015	6	06	
016	0	00	
017	÷	-24	
018	RTN	24	
019	*LBLB	21 12	Display Atm.
020	X>0?	16-44	
021	GTO1	22 01	
022	CHS	-22	
023	.	-62	
024	3	03	
025	0	00	
026	4	04	
027	8	08	
028	x	-35	
029	*LBL1	21 01	
030	1	01	Alt. in meters now
031	.	-62	
032	2	02	
033	4	04	
034	1	01	
035	CHS	-22	
036	EEX	-23	
037	4	04	
038	CHS	-22	
039	x	-35	
040	e^x	33	
041	7	07	
042	6	06	
043	0	00	
044	.	-62	
045	9	09	
046	3	03	
047	8	08	
048	x	-35	
049	STO5	35 05	
050	RTN	24	P_A → (5)
051	*LBLb	21 16 12	
052	STO5	35 05	
053	RTN	24	P_A → (5)
054	*LBLC	21 13	
055	RCL3	36 03	
056	RCL4	36 04	

STEP	KEY ENTRY	KEY CODE	COMMENTS
057	÷	-24	
058	EEX	-23	
059	3	03	
060	÷	-24	
061	RCL5	36 05	
062	7	07	
063	6	06	
064	0	00	
065	-	-45	
066	x	-35	
067	RCL7	36 07	
068	2	02	
069	7	07	
070	3	03	
071	.	-62	
072	1	01	
073	5	05	
074	+	-55	
075	÷	-24	
076	6	06	
077	.	-62	
078	2	02	
079	3	03	
080	6	06	
081	EEX	-23	
082	4	04	
083	÷	-24	
084	RCL6	36 06	
085	LN	32	
086	+	-55	
087	e^x	33	
088	R/S	51	Display P_V/corr.)
089	RCL6	36 06	
090	%CH	16 55	Disp. % corr.
091	RTN	24	
092	R/S	51	

REGISTER CONTENTS

7.026830000	0
1109.577000	1
233.1550000	2
74.10000000	3
0.720000000	4
0.000000000	5
0.000000000	6
0.000000000	7
0.000000000	8
0.000000000	9

REGISTERS

0	1	2	3	4	5	6	7	8	9
7,02683	1109.577	233.155	74.1	.72	P_A	P_V	T(°C)		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title 67 - Anesthesia: Vapor pressure of Methoxyflurane

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak Street, Apt. 3

City San Francisco **State** CA **Zip Code** 94117

Program Description, Equations, Variables The vapor pressure of methoxyflurane can be described by an Antoine equation:

$$\log P \text{ (mm Hg)} = 7.08219 - \frac{1336.579}{T(°C)+213.480}$$

Atmospheric pressure for the Gibbs-corrected calculation of P_V may be entered directly or estimated as :

$$P_A = 760.938 \cdot e^{-1.24 \times 10^{-4} \text{ (alt in meter)}}$$

The Gibbs-corrected P_V value is:

$$P_V \text{ (corrected)} = \exp\left\{\frac{\frac{\text{mol. wt.}}{\text{spec; gravity} \cdot 1000}(P_A - 760)}{(°K) \cdot 6.236 \times 10^4} + \ln (P_V)\right\}$$

Operating Limits and Warnings Antoine constants were fit to data from 6.27 → 104.65°C, and calculated values deviate from the data by < .02%.

When preparing recorded magnetic card; constants for storage in registers are loaded on Side 1, program on Side 2.

Program Description II

Sketch(es)

Sample Problem(s)

1) T = 100°C, find P_V
2) T=40°C, find P_V
3) Given altitude = 4500 ft., find P_A
4) Given altitude = 1000 m., find P_A
5) Calculate P_V corr at 35°C and 2500 feet altitude.

Solution(s)

1) 100[A] → 658.43 mm Hg, [R/S] → 0.87 Atm., P_V
2) 40[A] → 64.46 mm Hg,
   [R/S] → 0.08 Atm., P_V
3) 4500[CHS][B] → 641.84 mm Hg, P_A
4) 1000 [B] → 672.13 mm Hg, P_A
5) 35[A] 2500[CHS][B][C] → 50.49 mm Hg, P_V corr.
   R/S → 4.104123050-05 % corr.

Reference(s)

1) Rodgers, R. C. & G. E. Hill, in preparation (1976).
2) ICAO STD. Atm. Table SCIENTIFIC TABLES, Diem & Lentner, Ciba- Geigy, Basle (1972) Page 252.

User Instructions

VAPOR PRESSURE OF METHOXYFLURANE

	ENTER P_A			
$T \rightarrow P_V$	$ALT \rightarrow P_A$	P_V corr.%		

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Side 1 of card to store constants for use				
	with "copper kettle anesthesia regulation"				
	program if desired.				
2	Use "copper kettle anesthesia regulation"				
	program as desired.				
	or				
1'	Load Sides 1 & 2.				
2'	Input temp. & calculate vapor pressure	T, °C	A		P_V, (mm Hg)
	Optional: Convert P_V to Atm.		R/S		P_V, (Atm.)
3'	Do either:				
	A. Input altitude (meters +, or feet-)	m, or-Ft.	B		P_A (mm Hg)
	B. Input atm. pressure from barometer	P_A, mm Hg	f	B	P_A (mm Hg)
4	Calculate gibbs - corrected P_V		C		P_V (corr.)
5'	Calculate % correction		R/S		% corr.
	NOTE: When preparing recorded magnetic card from program register listings on following pages, perform the following steps:				
1	Load registers 0 through 4 with constants shown.				
2	With calculator in "run" mode, press "write data" key & pass Side 1 of blank card through card reader.				
3	Record program on Side 2 of card in usual manner.				

SET STATUS

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

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO7	35 07	T(°C) → (7)
003	RCL2	36 02	
004	+	-55	
005	RCL1	36 01	
006	X⇄Y	-41	
007	÷	-24	
008	RCL0	36 00	
009	-	-45	
010	CHS	-22	
011	10ˣ	16 33	
012	STO6	35 06	P_V → (6)
013	R/S	51	Display (mm Hg)
014	7	07	
015	6	06	
016	0	00	
017	÷	-24	
018	RTN	24	Display (atm.)
019	*LBLB	21 12	
020	X>0?	16-44	
021	GTO1	22 01	
022	CHS	-22	
023	.	-62	
024	3	03	
025	0	00	
026	4	04	
027	8	08	
028	x	-35	
029	*LBL1	21 01	Aly. in meters now
030	1	01	
031	.	-62	
032	2	02	
033	4	04	
034	1	01	
035	CHS	-22	
036	EEX	-23	
037	4	04	
038	CHS	-22	
039	x	-35	
040	eˣ	33	
041	7	07	
042	6	06	
043	0	00	
044	.	-62	
045	9	09	
046	3	03	
047	8	08	
048	x	-35	
049	STO5	35 05	P_A → (5)
050	RTN	24	
051	*LBLb	21 16 12	
052	STO5	35 05	P_A → (5)
053	RTN	24	
054	*LBLC	21 13	
055	RCL3	36 03	
056	RCL4	36 04	
057	÷	-24	
058	EEX	-23	
059	3	03	
060	÷	-24	
061	RCL5	36 05	
062	7	07	
063	6	06	
064	0	00	
065	-	-45	
066	x	-35	
067	RCL7	36 07	
068	2	02	
069	7	07	
070	3	03	
071	.	-62	
072	1	01	
073	5	05	
074	+	-55	
075	÷	-24	
076	6	06	
077	.	-62	
078	2	02	
079	3	03	
080	6	06	
081	EEX	-23	
082	4	04	
083	÷	-24	
084	RCL6	36 06	
085	LN	32	
086	+	-55	
087	eˣ	33	
088	R/S	51	Display P_V (corr.)
089	RCL6	36 06	
090	%CH	16 55	Disp. % Δ
091	RTN	24	
092	R/S	51	

REGISTER CONTENTS

7.082190000	0
1336.579000	1
213.4800000	2
165.0000000	3
1.420000000	4
0.000000000	5
0.000000000	6
0.000000000	7
0.000000000	8
0.000000000	9

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REGISTERS

0	1	2	3	4	5	6	7	8	9
7.08219	1336.579	213.480	165.0	1.42	P_A	P_V	T(°C)		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title ANESTHESIA: VAPOR PRESSURE OF ENFLURANE

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak Str., Apt. 3

City San Francisco **State** CA **Zip Code** 94117

Program Description, Equations, Variables The vapor pressure of enflurane can be described by an Antoine equation:

$$\log P \text{ (mm Hg)} = 6.98840 - \frac{1107.839}{T(°C)+213.063}$$

With < .3% deviation from experimental data over the range 17.3 → 56.4°C.

Atmospheric pressure is entered directly or estimated by an experimental fit to the ICAO Std. atmosphere Table (2):

$$P_A = 760.938 \cdot e^{-1.24 \times 10^{-4} \text{ (meters altitude)}}$$

Gibbs correction of P_V for P_A =

$$P_V \text{ (corrected)} = \exp\left\{ \frac{\frac{\text{mol. weight}}{\text{spec} \cdot \text{grav} \cdot 1000} (P_A - 760)}{(°K) \cdot 6.236 \cdot 10^4} + \ln (P_V) \right\}$$

Operating Limits and Warnings No warranty of accuracy can be made for temps outside the above range.

When preparing recorded magnetic card; constants for storage in registers are loaded on Side 1, Program on Side 2.

Program Description II

Sketch(es)

Sample Problem(s)

1) T = 50°C, find P_V
2) T = 20°C, find P_V
3) Given altitude = 4500 ft., find P_A
4) Given altitude = 1000 m, find P_A
5) Calculate $PV_{corr.}$ for 35°C & 2500 feet altitude.

Solution(s)

1) 50[A] → 598.54 mmHg, [R/S] → 0.79 Atm., P_V
2) 20[A] → 171.80 mm Hg
   [R/S] → 0.23 Atm., P_V
3) 4500[CHS][B] → 641.84 mm Hg, P_A
4) 1000[B] → 672.13 mm Hg, P_A
5) 35[A] 2500[CHS][B][C] → 333.00 mm Hg, $P_{Vcorr.}$
   [R/S] → 4.285311567-05, % corr.

Reference(s)

User Instructions

VAPOR PRESSURE OF ENFLURANE

1				2
$T \rightarrow P_V$	ENTER P_A $ALT \rightarrow P_A$	$P_{V corr.}$ %		

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Side 1 of card to store constants for use				
	with "copper kettle anesthesia regulation"				
	program if desired.				
2	Use "copper kettle anesthesia regulation"				
	program as desired.				
	or				
1'	Load Sides 1 & 2				
2'	Input temp. & calculate vapor pressure	T, °C	A		P_V, (mm Hg)
	Optional: Convert P_V to Atm.		R/S		P_V, (Atm.)
3'	Do either:				
	A) Input altitude (meters +, or feet-)	m, or Ft-	B		P_A (mm Hg)
	B) Input atm. pressure from barometer	P_A, mm Hg	f	B	P_A (mm Hg)
4'	Calculate Gibbs - corrected P_V		C		P_V (corr)
5'	Calculate % correction		R/S		% corr.
	NOTE: When preparing recorded magnetic card				
	from program register listings on				
	following pages, perform the following				
	steps:				
1	Load registers 0 through 4 with constants				
	shown.				
2	With calculator in "run" mode press "write				
	data" key and pass Side 1 of blank card through				
	card reader.				
3	Record program on Side 2 of card in usual				
	manner.				

SET STATUS

FLAGS	ON	OFF	TRIG		DISP	
0	[ ]	[x]	DEG	[x]	FIX	[x]
1	[ ]	[x]	GRAD	[ ]	SCI	[ ]
2	[ ]	[x]	RAD	[ ]	ENG	[ ]
3	[ ]	[x]			n	2

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO7	35 07	T(°C) → (7)
003	RCL2	36 02	
004	+	-55	
005	RCL1	36 01	
006	X⇄Y	-41	
007	÷	-24	
008	RCL0	36 00	
009	-	-45	
010	CHS	-22	
011	10^x	16 33	
012	STO6	35 06	P_V → (6)
013	R/S	51	
014	7	07	Display (mm Hg)
015	6	06	
016	0	00	
017	÷	-24	
018	RTN	24	
019	*LBLB	21 12	Display (atm.)
020	X>0?	16-44	
021	GTO1	22 01	
022	CHS	-22	
023	.	-62	
024	3	03	
025	0	00	
026	4	04	
027	8	08	
028	x	-35	
029	*LBL1	21 01	
030	1	01	Alt. in meters now.
031	.	-62	
032	2	02	
033	4	04	
034	1	01	
035	CHS	-22	
036	EEX	-23	
037	4	04	
038	CHS	-22	
039	x	-35	
040	e^x	33	
041	7	07	
042	6	06	
043	0	00	
044	.	-62	
045	9	09	
046	3	03	
047	8	08	
048	x	-35	
049	STO5	35 05	P_A → (5)
050	RTN	24	
051	*LBLb	21 16 12	
052	STO5	35 05	D_A → (5)
053	RTN	24	
054	*LBLC	21 13	
055	RCL3	36 03	
056	RCL4	36 04	

STEP	KEY ENTRY	KEY CODE	COMMENTS
057	÷	-24	
058	EEX	-23	
059	3	03	
060	÷	-24	
061	RCL5	36 05	
062	7	07	
063	6	06	
064	0	00	
065	-	-45	
066	x	-35	
067	RCL7	36 07	
068	2	02	
069	7	07	
070	3	03	
071	.	-62	
072	1	01	
073	5	05	
074	+	-55	
075	÷	-24	
076	6	06	
077	.	-62	
078	2	02	
079	3	03	
080	6	06	
081	EEX	-23	
082	4	04	
083	÷	-24	
084	RCL6	36 06	
085	LN	32	
086	+	-55	
087	e^x	33	
088	R/S	51	Display P_V (corr.)
089	RCL6	36 06	
090	%CH	16 55	Disp. % A
091	RTN	24	
092	R/S	51	

REGISTER CONTENTS

6.988400000	0
1107.839000	1
213.0630000	2
184.5000000	3
1.520000000	4
0.000000000	5
0.000000000	6
0.000000000	7
0.000000000	8
0.000000000	9
0.000000000	A

110

REGISTERS

0	1	2	3	4	5	6	7	8	9
6.98840	1107.839	213.063	184.5	1.52	P_A	P_V	T(°C)		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title 67-Anesthesia: Vapor Pressure of Fluroxene

Contributor's Name Richard C. Rodgers, M.D.

Address 2045 Oak Street #3

City San Francisco **State** CA **Zip Code** 94117

Program Description, Equations, Variables

The vapor pressure of fluroxene can be described by an Antoine equation:

$$\log_{10} P(\text{mm Hg}) = 4.25274 - \frac{136.8463}{T(°C) + 56.1910}$$

Atmospheric pressure may be input directly or estimated on the basis of altitude as =

$$P_A\ (\text{mm Hg}) = 700.938 \cdot e^{-1.241 \times 10^{-4}(\text{alt. in meters})}$$

The Gibbs - corrected P_V value is:

$$P_V\ (\text{corrected}) = \exp\left\{\frac{\frac{\text{mol. wt.}}{\text{sp. grav.} \cdot 1000}\ (P_A - 760)}{(°k)\ \cdot\ 6.236 \times 10^4} + \ln\ (P_V)\right\}$$

Operating Limits and Warnings

Antoine constants were fit to data from 20 to 43.2 °C, and calculated values deviate from data by < 7.4%. This error is relatively large due to the paucity of data from which the constants are drawn.

When preparing recorded magnetic card; constants for storage in registers are loaded on side 1, program on side 2.

Program Description II

Sketch(es)

Sample Problem(s)

1. T = 40°C, Find P_V

2. T = 20°C, Find P_V

3. Given Altitude = 4500 feet, Find P_A

4. Given Altitude = 1000 Meters, Find P_A

5. Find P_V corr & % corr. for 35°C and 2500 Feet Altitude.

Solution(s)

1. 40[A] -----------> 676.22 mm Hg, [R/S] ----------->0.89 Atm., P_V
2. 20[A] -----------> 286.18 mm Hg, [R/S] ----------->0.38 Atm., P_V
3. 4500 [CHS] [B] ----------> 641.84 mm Hg, P_A
4. 1000 [B] ----------------> 672.13 mm Hg, P_A
5. 35[A] 2500[CHS] [B][C] --> 565.05 mm Hg, P_V corr.
   [R/S] --> 3.928881328 - 05, % corr.

Reference(s)

1. Rodgers, A.C., & G.F. Hill, in Prep. (1976).
2. ICAO STD. ATM. Table, in Scientific Tables, Diem & Lentner, Ciba-Geigy, Basle (1972), p. 252.

User Instructions

VAPOR PRESSURE OF FLUROXENE

Enter P_A

1 | $T \rightarrow P_V$ | $ALT \rightarrow P_A$ | P_V corr.% | 2

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Load side 1 of card to store constants for use with "Copper Kettle Anesthesia Regulation" program if desired.				
2.	Use "Copper Kettle Anesthesia" regulation program as desired				
	OR				
1'	Load sides 1 & 2				
2'	Input temp & calculate vapor pressure	T,°C	A		P_V,(mm Hg)
	Optional: convert P_V to Atm.		R/S		P_V,(Atm.)
3'	Do either:				
	a) Input altitude (meters +, or feet -)	m, or ft-	B		P_A(mm Hg)
	b) Input Atm. pressure from barometer	P_A, mm Hg	f	B	P_A(mm Hg)
4'	Calculate Gibbs - Corrected P_V		C		P_V(corr.)
5'	Calculate % correction		R/S		% corr.
	NOTE: When preparing recorded magnetic card from program register listings on following pages perform the following steps:				
	1. Load registers 0 thru 4 with constants shown.				
	2. With calculator in "Run" mode press "Write Data" key & pass side 1 of blank card thru card reader.				
	3. Record program on side 2 of card in usual manner.				

SET STATUS

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

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	T (°C) → (7)
002	STO7	35 07	
003	RCL2	36 02	
004	+	-55	
005	RCL1	36 01	
006	X⇄Y	-41	
007	÷	-24	
008	RCL0	36 00	
009	-	-45	
010	CHS	-22	
011	10^x	16 33	P_V → 16)
012	STO6	35 06	
013	R/S	51	Display mm Hg
014	7	07	
015	6	06	
016	0	00	
017	÷	-24	
018	RTN	24	Display Atm.
019	*LBLB	21 12	
020	X>0?	16-44	
021	GTO1	22 01	
022	CHS	-22	
023	.	-62	
024	3	03	
025	0	00	
026	4	04	
027	8	08	
028	x	-35	Alt. in meters now
029	*LBL1	21 01	
030	1	01	
031	.	-62	
032	2	02	
033	4	04	
034	1	01	
035	CHS	-22	
036	EEX	-23	
037	4	04	
038	CHS	-22	
039	x	-35	
040	e^x	33	
041	7	07	
042	6	06	
043	0	00	
044	.	-62	
045	9	09	
046	3	03	
047	8	08	
048	x	-35	P_A → (5)
049	STO5	35 05	
050	RTN	24	
051	*LBLb	21 16 12	P_A → (5)
052	STO5	35 05	
053	RTN	24	
054	*LBLC	21 13	
055	RCL3	36 03	
056	RCL4	36 04	
057	÷	-24	
058	EEX	-23	
059	3	03	
060	÷	-24	
061	RCL5	36 05	
062	7	07	
063	6	06	
064	0	00	
065	-	-45	
066	x	-35	
067	RCL7	36 07	
068	2	02	
069	7	07	
070	3	03	
071	.	-62	
072	1	01	
073	5	05	
074	+	-55	
075	÷	-24	
076	6	06	
077	.	-62	
078	2	02	
079	3	03	
080	6	06	
081	EEX	-23	
082	4	04	
083	÷	-24	
084	RCL6	36 06	
085	LN	32	
086	+	-55	
087	e^x	33	
088	R/S	51	Display P_V(corr.)
089	RCL6	36 06	
090	%CH	16 55	Display % corr.
091	RTN	24	
092	R/S	51	

REGISTER CONTENTS

4.252740000	0
136.8463000	1
56.19100000	2
126.0000000	3
1.130000000	4
0.000000000	5
0.000000000	6
0.000000000	7
0.000000000	8
0.000000000	9

REGISTERS

0	1	2	3	4	5	6	7	8	9
4.25274	136.8463	56.1910	126.0	1.13	P_A	P_V	T(°C)		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title 67 - ANESTHESIA: VAPOR PRESSURE OF CYCLOPROPANE

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oak Street, Apt. 3

City San Francisco **State** CA **Zip Code** 94117

Program Description, Equations, Variables The vapor pressure of cyclopropane can be described by an Antoine equation =

$$\log_{10} P_V \text{ (mm Hg)} = 6.64481 - \frac{723.3158}{T(°C) + 225.699}$$

Other programs in this series calculate a correction for P_V based on atmospheric pressure. However, since the boiling point of cyclopropane is so low (-33°C), this is not done in this program.

Operating Limits and Warnings Antoine constants were fit to data from -116.8 to -33.5°C, and calculated values deviate from data by < 1%.

When preparing recorded magnetic card; constants for storage in registers are loaded on Side 1, program on Side 2.

Program Description II

Sketch(es)

Sample Problem(s)

1) $T = -33°C$, find P_V
2) $T = -60°C$, find P_V
3) Given altitude = 4500 feet, find P_A
4) Given altitude = 1000 meter, find P_A

Solution(s)

1) 33[CHS][A] → 778.41 mm Hg, [R/S] → 1.02 Atm., P_V
2) 60[CHS][A] → 190.36mm Hg, [R/S] → 0.25 Atm., P_V
3) 4500[CHS][B] → 641.84 mm Hg, P_A
4) 1000 [B] → 672.13 mm Hg, P_A

Reference(s)

1) Rodgers, R. C. & G. E. Hill, in prep. (1976).
2) ICAO Std. Atm. Table, in SCIENTIFIC TABLES, Diem & Lentner, CIBA-Geigy, Basle (1972), Page 252.

User Instructions

VAPOR PRESSURE OF CYCLOPROPANE

1 ENTER P_A 2

T → P_V | ALT → P_A | $P_{V\,corr.}$ %

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load Side 1 of card to store constants for use				
	with "copper kettle anesthesia regulation"				
	program if desired.				
2	Use "copper kettle anesthesia regulation"				
	program as desired.				
	OR				
1'	Load Sides 1 and 2.				
2'	Input temp. & calculate vapor pressure	T, °C	A		P_V, (mmHg)
	Optional: Convert P_V to Atm.		R/S		P_V, (Atm.)
3'	Do either:				
	A) Input altitude (meters +, or feet −)	m, or Ft −	B		P_A (mm Hg)
	B) Input atm. pressure from barometer	P_A, mm Hg	f	B	P_A (mm Hg)
	NOTE: When preparing recorded magnetic card				
	from program and register listings on				
	following pages, perform the following				
	steps:				
1	Load Registers 0 through 4 with constants				
	shown.				
2	With calculator in "run" mode, press "write				
	data" key and pass Side 1 of blank card through				
	card reader.				
3	Record program on Side 2 of card in usual				
	manner.				

SET STATUS

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

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO7	35 07	T(°C) → (7)
003	RCL2	36 02	
004	+	-55	
005	RCL1	36 01	
006	X⇄Y	-41	
007	÷	-24	
008	RCL0	36 00	
009	-	-45	
010	CHS	-22	
011	10ˣ	16 33	
012	STO6	35 06	P_V → (0)
013	R/S	51	
014	7	07	Display mm Hg
015	6	06	
016	0	00	
017	÷	-24	
018	RTN	24	
019	*LBLB	21 12	Display atm.
020	X>0?	16-44	
021	GTO1	22 01	
022	CHS	-22	
023	.	-62	
024	3	03	
025	0	00	
026	4	04	
027	8	08	
028	x	-35	
029	*LBL1	21 01	
030	1	01	
031	.	-62	Alt. in meters now
032	2	02	
033	4	04	
034	1	01	
035	CHS	-22	
036	EEX	-23	
037	4	04	
038	CHS	-22	
039	x	-35	
040	eˣ	33	
041	7	07	
042	6	06	
043	0	00	
044	.	-62	
045	9	09	
046	3	03	
047	8	08	
048	x	-35	
049	STO5	35 05	
050	RTN	24	P_A → (5)
051	R/S	51	

REGISTER CONTENTS

6.644810000	0
723.3158000	1
225.6990000	2
42.08000000	3
1.450000000	4
0.000000000	5
0.000000000	6
0.000000000	7
0.000000000	8
0.000000000	9

060

080

090

100

110

REGISTERS

0	1	2	3	4	5	6	7	8	9
6.64481	723.3158	225.699	42.08	1.45					

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title Anesthesia: Vapor Pressure of Trichloroethylene

Contributor's Name Richard C. Rodgers, M.D.

Address 2045 Oak Street #3

City San Francisco **State** California **Zip Code** 94117

Program Description, Equations, Variables

The vapor pressure• of trichloroethylene can be described by an Antoine Equation:

$$\log P \text{ (mm Hg)} = 6.83694 - \frac{1198.477}{T(°C) + 276.436}$$

with <.7% deviation from experimental data over the range -20 to 100 °C.

Atmospheric pressure is entered directly or estimated by an exponential fit to the ICAO STD. Atmospheric tables(2):

$$P_A = 760.938 \cdot e^{-1.241 \times 10^{-4} \text{ (alt. in meters)}}$$

Gibbs - corrected P_V is:

$$P_V\text{(corrected)} = \exp\left\{ \frac{\frac{\text{mol. weight}}{\text{spec. grow} \cdot 1000}(P_A - 760)}{(°k) \cdot 6.236 \times 10^4} + \ln (P_V) \right\}$$

Operating Limits and Warnings

When preparing recorded magnetic card; constants for storage in registers are loaded on side 1, program on side 2.

Program Description II

Sketch(es)

Sample Problem(s)

1. $T = 80°C$, find P_V
2. $T = 40°C$, find P_V
3. Given Altitude = 4500 ft., find P_A
4. Given Altitude = 1000 m, find P_A
5. Calculate P_V corr. & % corr. for 35°C & 2500 feet Altitude.

Solution(s)

1. 80[A] ---------> 622.28 mm Hg, [R/S] ----------------> 0.82 Atm., P_V
2. 40[A] ---------> 145.66 mm Hg, [R/S] ----------------> 0.19 Atm., P_V
3. 4500[CHS] [B]--> 641.84 mm Hg, P_A
4. 1000[B] -------> 672.13 mm Hg, P_A
5. 35[A] 2500[CHS] [B] [C] -----------> 117.60 mm Hg, P_V corr.
   [R/S] -----------> 3.171743266-05, % corr.

Reference(s)

User Instructions

VAPOR PRESSURE OF TRICHLOROETHYLENE

1					2
T	P_V	Enter P_A / Alt	P_A	P_V corr%	

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1.	Load side 1 of card to store constants for use with "Copper Kettle Anesthesia Regulation" program if desired				
2.	Use "Copper Kettle Anesthesia" regulation program as desired				
	OR				
1'	Load sides 1 and 2				
2'	Input temp & calculate vapor pressure	T,°C	A		P_V,(mm Hg)
	Optional: Convert P_V to Atm.		R/S		P_V,(Atm.)
3'	Do either:				
	a) Input altitude (meters +, or feet-)	m, or ft-	B		P_A,(mm Hg)
	b) Input Atm. pressure from Barometer	P_A, mm Hg	f	B	P_A,(mm Hg)
4'	Calculate Gibbs - correct P_V		C		P_V (corr.)
5'	Calculate % correction		R/S		% corr.

NOTE: When preparing recorded magnetic card from program register listings on following pages perform the follwoing steps:

1. Load registers 0 thru 4 with constants shown.
2. With calculator in "Run" mode press "Write Data" key & pass side 1 or blank card thru card reader.
3. Record program on side 2 of card in usual manner.

SET STATUS

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

97 Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	T(°C) → (7)
002	STO7	35 07	
003	RCL2	36 02	
004	+	-55	
005	RCL1	36 01	
006	X⇄Y	-41	
007	÷	-24	
008	RCL0	36 00	
009	-	-45	
010	CHS	-22	
011	10^x	16 33	P_V → (6)
012	STO6	35 06	
013	R/S	51	Display (mm Hg)
014	7	07	
015	6	06	
016	0	00	
017	÷	-24	
018	RTN	24	Display (Atm)
019	*LBLB	21 12	
020	X>0?	16-44	
021	GTO1	22 01	
022	CHS	-22	
023	.	-62	
024	3	03	
025	0	00	
026	4	04	
027	8	08	
028	×	-35	Alt. in meters now
029	*LBL1	21 01	
030	1	01	
031	.	-62	
032	2	02	
033	4	04	
034	1	01	
035	CHS	-22	
036	EEX	-23	
037	4	04	
038	CHS	-22	
039	×	-35	
040	e^x	33	
041	7	07	
042	6	06	
043	0	00	
044	.	-62	
045	9	09	
046	3	03	
047	8	08	
048	×	-35	
049	STO5	35 05	P_A → (5)
050	RTN	24	
051	*LBLb	21 16 12	
052	STO5	35 05	P_A → (5)
053	RTN	24	
054	*LBLC	21 13	
055	RCL3	36 03	
056	RCL4	36 04	

STEP	KEY ENTRY	KEY CODE	COMMENTS
057	÷	-24	
058	EEX	-23	
059	3	03	
060	÷	-24	
061	RCL5	36 05	
062	7	07	
063	6	06	
064	0	00	
065	-	-45	
066	×	-35	
067	RCL7	36 07	
068	2	02	
069	7	07	
070	3	03	
071	.	-62	
072	1	01	
073	5	05	
074	+	-55	
075	÷	-24	
076	6	06	
077	.	-62	
078	2	02	
079	3	03	
080	6	06	
081	EEX	-23	
082	4	04	
083	÷	-24	
084	RCL6	36 06	
085	LN	32	
086	+	-55	
087	e^x	33	
088	R/S	51	Display P_V (corr.)
089	RCL6	36 06	
090	%CH	16 55	Display % Δ
091	RTN	24	
092	R/S	51	

	REGISTER	CONTENTS

CONTENTS	REGISTER
6.836940000	0
1198.477000	1
216.4360000	2
131.4000000	3
1.460000000	4
0.000000000	5
0.000000000	6
0.000000000	7
0.000000000	8
0.000000000	9

REGISTERS

0	1	2	3	4	5	6	7	8	9
6.83694	1198.477	216.436	131.4	1.46	P_A	P_V	T(°C)		

S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

Program Description I

Program Title 67 - ANESTHESIA: VAPOR PRESSURE OF ETHYL CHLORIDE

Contributor's Name Richard C. Rodgers, M. D.

Address 2045 Oar St., Apt. 3

City San Francisco **State** CA **Zip Code** 94117

Program Description, Equations, Variables The vapor pressure of ethyl chloride can be described by an antoine equation:

$$\log_{10} P(\text{mm Hg}) = 7.39046 - \frac{1296.620}{T(°C) + 269.157}$$

Atmospheric pressure may be input directly or estimated on the basis of altitude as:

$$P_A(\text{mm Hg}) = 760.938 \cdot e^{-1.24 \times 10^{-4}(\text{alt. in meter})}$$

The Gibbs-corrected P_V value is:

$$P_V \text{ (corrected)} = \exp\left\{ \frac{\frac{\text{mol wt.}}{\text{sp. grav} \cdot 1000} (P_A - 760)}{(O_K) \cdot 6.236 \times 10^4} + \ln (P_V) \right\}$$

Operating Limits and Warnings Antoine constants were fit to data from 12.3 to 187.2°C, and calculated values deviate from data by < 3.0%. This is an unusually large error for an Antoine fit and is due to the mediocre quality of the experimental data used.

When preparing recorded magnetic card; constants for storage in registers are loaded on Side 1, program on Side 2.

Program Description II

Sketch(es)

Sample Problem(s)

1) T = 15°C, find P_V
2) T = -10°C, find P_V
3) Given altitude = 4500 ft., find P_A
4) Given altitude = 1000 M., find P_A
5) Calculate P_V corr for 10°C and 2500 feet altitude.

Solution(s)

1) 15[A] → 836.44 mm/Hg, [R/S] → 1.10 Atm., P_V
2) 10[CHS][A] → 310.04 mm Hg [R/S] → 0.41 Atm., P_V
3) 4500[CHS][B] → 641.84 mm Hg, P_A
4) 1000[B] → 672.13 mm Hg, P_A
5) 10[A] 2500[CHS][B][C] → 695.68 mm Hg, P_V corr. [R/S] → 2.695202564-05, % corr.

Reference(s)

1) Rodgers, R. C. and G. E. Hill, in prep. (1976)
2) ICAO Std. Atm. Table, in SCIENTIFIC TABLES, Diem & Lentner, Ciba - Geigy, Basle (1972), Page 252

User Instructions

VAPOR PRESSURE OF ETHYL CHLORIDE

1 | 2

$T \rightarrow P_V$ | ENTER P_A / ALT $\rightarrow P_A$ | P_V corr.%

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS		OUTPUT DATA/UNITS
1	Load Side 1 of card to store constants for use				
	with "copper kettle anesthesia regulation"				
	program if desired.				
2	Use "copper kettle anesthesia regulation"				
	program as desired.				
	or				
1'	Load Sides 1 & 2				
2'	Input temp. & calculate vapor pressure	T, °C	A		P_V, (mm Hg)
	Optional: Convert P_V to Atm.		R/S		P_V, (Atm.)
3'	Do either:				
	A. Input altitude (meters +, or feet-)	m, or Ft-	B		P_A (mm Hg)
	B. Input atm. pressure from barometer	P_A, mm Hg	f	B	P_A (mm Hg)
4'	Calculate Gibbs - corrected P_V		C		P_V (corr.)
5'	Calculate % correction		R/S		% corr.
	NOTE: When preparing recorded magnetic card				
	from program and register listings on				
	following pages, perform the following				
	steps:				
1	Load Registers 0 through 4 with constants				
	shown.				
2	With calculator in "run" mode press "write				
	data" key and pass Side 1 of blank card				
	through card reader.				
3	Record program on Side 2 of card in usual				
	manner.				

SET STATUS

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

Program Listing I

97

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	
002	STO7	35 07	
003	RCL2	36 02	T(°C) → (7)
004	+	-55	
005	RCL1	36 01	
006	X⇄Y	-41	
007	÷	-24	
008	RCL0	36 00	
009	-	-45	
010	CHS	-22	
011	10^x	16 33	
012	STO6	35 06	P_V → (6)
013	R/S	51	
014	7	07	Display mm Hg
015	6	06	
016	0	00	
017	÷	-24	
018	RTN	24	Display Atm.
019	*LBLB	21 12	
020	X>0?	16-44	
021	GTO1	22 01	
022	CHS	-22	
023	.	-62	
024	3	03	
025	0	00	
026	4	04	
027	8	08	
028	x	-35	
029	*LBL1	21 01	
030	1	01	Alt. in meters now
031	.	-62	
032	2	02	
033	4	04	
034	1	01	
035	CHS	-22	
036	EEX	-23	
037	4	04	
038	CHS	-22	
039	x	-35	
040	e^x	33	
041	7	07	
042	6	06	
043	0	00	
044	.	-62	
045	9	09	
046	3	03	
047	8	08	
048	x	-35	
049	STO5	35 05	P_A → (5)
050	RTN	24	
051	*LBLb	21 16 12	
052	STO5	35 05	
053	RTN	24	P_A → (5)
054	*LBLC	21 13	
055	RCL3	36 03	
056	RCL4	36 04	
057	÷	-24	
058	EEX	-23	
059	3	03	
060	÷	-24	
061	RCL5	36 05	
062	7	07	
063	6	06	
064	0	00	
065	-	-45	
066	x	-35	
067	RCL7	36 07	
068	2	02	
069	7	07	
070	3	03	
071	.	-62	
072	1	01	
073	5	05	
074	+	-55	
075	÷	-24	
076	6	06	
077	.	-62	
078	2	02	
079	3	03	
080	6	06	
081	EEX	-23	
082	4	04	
083	÷	-24	
084	RCL6	36 06	
085	LN	32	
086	+	-55	
087	e^x	33	
088	R/S	51	Display P_V (corr.)
089	RCL6	36 06	
090	%CH	16 55	Display % corr.
091	RTN	24	
092	R/S	51	

REGISTER CONTENTS

7.390460000	0
1269.620000	1
269.1570000	2
64.52000000	3
0.921000000	4
0.000000000	5
0.000000000	6
0.000000000	7
0.000000000	8
0.000000000	9

110

REGISTERS

0	1	2	3	4	5	6	7	8	9
7.39046	1269.620	269.157	64.52	.921	P_A	P_V	T(°C)		
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9

A	B	C	D	E	I

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EE (Lab)
Industrial Engineering
Aeronautical Engineering
Control Systems
Beams and Columns
High-Level Math
Test Statistics
Geometry
Reliability/QA
Medical Practitioner
Anesthesia
Cardiac
Pulmonary
Chemistry
Optics
Physics
Earth Sciences
Energy Conservation
Space Science
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Games of Chance
Aircraft Operation
Avigation
Calendars
Photo Dark Room
COGO-Surveying
Astrology
Forestry

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ANESTHESIA: VAPOR PRESSURE OF DIETHYL ETHER

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ANESTHESIA: VAPOR PRESSURE OF ENFLURANE

ANESTHESIA: VAPOR PRESSURE OF FLUROXENE

ANESTHESIA: VAPOR PRESSURE OF CYCLOPROPANE

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