75502 - ELEMENTAL PERCENTAGE AND MOLECULAR WEIGHT - 6 ELEMENT
Calculates percentages and molecular weight of compounds containing 6 elements or less.

75503 - CHN ANALYSIS [K VALUES]
Calculates K values given C, H and N, blank values, and percentages for a known standard.

75504 - CHN PERCENTAGES
Given C, H, and N values and using previously calculated K values and known blank values, calculates C, H and N percentages.

75505 - MOLECULAR WEIGHT BY VPO
Calculates molecular weight for an unknown based on a series of vapor pressure osmometer (VPO) readings at various dilutions by extrapolating least squares curve fit to infinite dilution.

75506 - MEMBRANE OSMOMETER
Determines the number-average molecular weight by extrapolating a least squares curve fit to infinite dilution.

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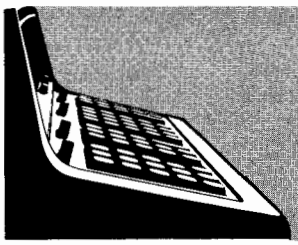


PART NO.
09100-75502

ELEMENTAL PERCENTAGE AND MOLECULAR WEIGHT
·6 ELEMENT

This program calculates relative elemental percentages of up to and including 6 elements. The atomic weight of the elements are programmed into the calculator. The total molecular weight of the compound is also calculated.

USER INSTRUCTIONS

ENTER PROGRAM (Starting Address is 0 - 0)

N_1
PRESS: GO TO (0) (4)
SET: [PROGRAM] [ ]
Enter program steps for atomic weight of N_1; maximum of 6 steps is allowed.
SET: [ ] [RUN]

N_2
PRESS: GO TO (1) (4)
SET: [PROGRAM] [ ]
Enter program steps for atomic weight of N_2 as before.
SET: [ ] [RUN]

N_3
PRESS: GO TO (2) (4)
SET: [PROGRAM] [ ]
Enter atomic weight of N_3 as before.
SET: [ ] [RUN]

N_4
PRESS: GO TO (3) (4)
SET: [PROGRAM] [ ]
Enter atomic weight of N_4 as before.
SET: [ ] [RUN]

N_5
PRESS: GO TO (4) (4)
SET: [PROGRAM] [ ]
Enter atomic weight of N_5 as before.
SET: [ ] [RUN]

N_6
PRESS: GO TO (5) (4)
SET: [PROGRAM] [ ]
Enter atomic weight of N_6 as before.
SET: [ ] [RUN]

PRESS: GO TO (0) (0) [or End]

PRESS: CONTINUE

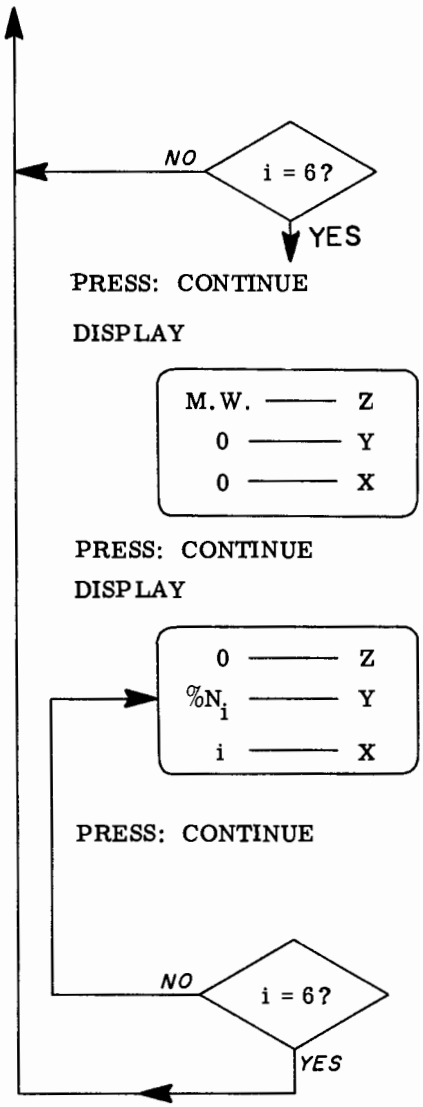
DISPLAY

0	Z
0	Y
i	X

(i indicates number of element to be entered)

ENTER DATA: $N_i \rightarrow X$ (N_i = the number of atoms of each element.)

USER INSTRUCTIONS con't



PRESS: CONTINUE

DISPLAY

M.W.	Z
0	Y
0	X

PRESS: CONTINUE

DISPLAY

0	Z
$\%N_i$	Y
i	X

PRESS: CONTINUE

NO
i = 6?
YES

Note: To reset problem with different elements, repeat user instructions; otherwise, enter new number of atoms of each element when initial display appears after completion of last problem.

EXAMPLE

Elements:	N_1(C)	N_2(H)	N_3(S)	N_4(N)	N_5(O)	N_6(Si)
At. Wt.:	12.01	1.008	32.07	14.01	16.00	28.09
# of Atoms	6	2	8	1	2	3

Solution:

% C = 15.63%
% H = .44%
% S = 55.66%
% N = 3.04%
% O = 6.94%
%Si = 18.28%

Molecular Weight = 460.92

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Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
0	0	CLEAR	20										
	1	1	01										
	2	STOP	41	N_1	0	0							ENTER N_1
	3	↑	27										
	4	CONTINUE	47										AREA FOR INSERTING ATOMIC WEIGHT OF N_1
	5												
	6												
	7												
	8												
	9	CONTINUE	47										
	a	×	36										CALCULATE PARTIAL MOLECULAR WEIGHT
	b	ACC +	60										
	c	y→( )	40										STORE X_1
	d	a	13										
1	0	↓	25										
	1	2	02										
	2	STOP	41	N_2	0	0							ENTER N_2
	3	↑	27										
	4	CONTINUE	47										AREA FOR INSERTING ATOMIC WEIGHT OF N_2
	5												
	6												
	7												
	8												
	9	CONTINUE	47										
	a	×	36										CALCULATE PARTIAL MOLECULAR WEIGHT
	b	ACC +	60										
	c	y→( )	40										STORE X_2
	d	b	14										
2	0	↓	25										
	1	3	03										
	2	STOP	41	N_3	0	0							ENTER N_3
	3	↑	27										
	4	CONTINUE	47										AREA FOR INSERTING ATOMIC WEIGHT OF N_3
	5												
	6												
	7												
	8												
	9	CONTINUE	47										
	a	×	36										CALCULATE PARTIAL MOLECULAR WEIGHT
	b	ACC +	60										
	c	y→( )	40										STORE X_3
	d	c	16										

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
3	0	↓	25										
	1	4	04										
	2	STOP	41	N_4	0	0							ENTER N_4
	3	↑	27										
	4	CONTINUE	47										AREA FOR INSERTING ATOMIC WEIGHT OF N_4
	5												
	6												
	7												
	8												
	9	CONTINUE	47										
	a	×	36										CALCULATE PARTIAL MOLECULAR WEIGHT
	b	ACC +	60										
	c	y→( )	40										STORE X_4
	d	d	17										
4	0	↓	25										
	1	5	05										
	2	STOP	41	N_5	0	0							ENTER N_5
	3	↑	27										
	4	CONTINUE	47										AREA FOR INSERTING ATOMIC WEIGHT OF N_5
	5												
	6												
	7												
	8												
	9	CONTINUE	47										
	a	×	36										CALCULATE PARTIAL MOLECULAR WEIGHT
	b	ACC +	60										
	c	y→( )	40										STORE X_5
	d	f	15										
5	0	↓	25										
	1	6	06										
	2	STOP	41	N_6	0	0							ENTER N_6
	3	↑	27										
	4	CONTINUE	47										AREA FOR INSERTING ATOMIC WEIGHT OF N_6
	5												
	6												
	7												
	8												
	9	CONTINUE	47										
	a	×	36										CALCULATE AND STORE TOTAL MOLECULAR WEIGHT
	b	e	12										
	c	x⇄y	30										
	d	+	33										

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Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
6	0	$x \rightleftarrows y$	30										
	1	$x \rightarrow ( )$	23										
	2	e	12										
	3	↑	27										CALCULATE MOLECULAR WEIGHT
	4	ENTER EXP	26										
	5	2	02										
	6	÷	35										
	7	↓	25										CALCULATE $\%N_6$
	8	÷	35										
	9	$y \rightleftarrows ( )$	24										
	a	a	13										CALCULATE $\%N_1$
	b	÷	35										
	c	$y \rightleftarrows ( )$	24										
	d	b	14										CALCULATE $\%N_2$
7	0	÷	35										
	1	$y \rightleftarrows ( )$	24										
	2	c	16										CALCULATE $\%N_3$
	3	÷	35										
	4	$y \rightleftarrows ( )$	24										
	5	d	17										CALCULATE $\%N_4$
	6	÷	35										
	7	$y \rightleftarrows ( )$	24										
	8	f	15										CALCULATE $\%N_5$
	9	÷	35										
	a	CLEAR x	37										
	b	$y \rightleftarrows ( )$	24										
	c	e	12										RECALL AND POSITION MOLECULAR WEIGHT
	d	↑	27										
8	0	STOP	41	0	0	M.W.							DISPLAY MOLECULAR WEIGHT
	1	b	14										
	2	↑	27										
	3	1	01										
	4	STOP	41	1	$\%N_1$	0							DISPLAY $\%N_1$
	5	$y \rightleftarrows ( )$	24										
	6	c	16										
	7	2	02										
	8	STOP	41	2	$\%N_2$	0							DISPLAY $\%N_2$
	9	$y \rightleftarrows ( )$	24										
	a	d	17										
	b	3	03										
	c	STOP	41	3	$\%N_3$	0							DISPLAY $\%N_3$
	d	$y \rightleftarrows ( )$	24										

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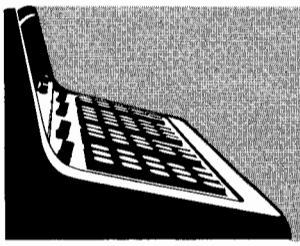
Step	Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a
90	f	15									
91	4	04									
92	STOP	41	4	%N_4	0	DISPLAY		% N_4			
93	y⇄( )	24									
94	e	12									
95	5	05									
96	STOP	41	5	%N_5	0	DISPLAY		%N_5			
97	y⇄( )	24									
98	a	13									
99	6	06									
9a	END	46	6	%N_6	0	DISPLAY		%N_6			
9b											
9c											
9d											
a0											
a1											
a2											
a3											
a4											
a5											
a6											
a7											
a8											
a9											
aa											
ab											
ac											
ad											
b0											
b1											
b2											
b3											
b4											
b5											
b6											
b7											
b8											
b9											
ba											
bb											
bc											
bd											



CHN ANALYSIS - K VALUES

PART NO.
09100-75503

This program calculates the K values (K_C, K_H, and K_N), for compounds containing carbon (C), hydrogen (H), and nitrogen (N), from blank values (B_C, B_H, and B_N), percentages of C, H, and N from a known standard ($\%C_s$, $\%H_s$, and $\%N_s$), and measured quantities of C, H, and N of the known standard (C_{s_i}, H_{s_i}, and N_{s_i}). Two sets of measurements of C-H-N quantities of the standard are normally taken, although one set of measurements is sufficient for operation of the program.

The following equations are used:

$$K_C = \frac{\%C_s}{\overline{C}_s - B_C}$$

$$K_H = \frac{\%H_s}{\overline{H}_s - B_H}$$

$$K_N = \frac{\%N_s}{\overline{N}_s - B_N}$$

where $\overline{M}_s \left[M = C, H, \text{ or } N \right]$ is the average of M_{s_1} and M_{s_2}.

If only one set of C-H-N quantities of the standard are used, then:

$$\overline{M}_s \left[M = C, H, \text{ or } N \right] = M_{s_1}$$

$$K_C = \frac{\%C_s}{C_1 - B_C} \quad \text{, etc.}$$

USER INSTRUCTIONS

ENTER PROGRAM (Starting Address is 0 - 0)

PRESS: GO TO (3) (1)

SET: | PROGRAM | |

ENTER: Program steps for the constant - $\%N_s$ (five spaces available).

SET: | | RUN |

PRESS: GO TO (4) (3)

SET: | PROGRAM | |

ENTER: Program steps for the constant - $\%C_s$ (five spaces available).

SET: | | RUN |

PRESS: GO TO (5) (3)

SET: | PROGRAM | |

ENTER: Program steps for the constant - $\%H_s$ (five spaces available).

SET: | | RUN |

PRESS: GO TO (0) (0) [or END]

PRESS: CONTINUE

DISPLAY

0	Z
0	Y
0	X

ENTER DATA: $B_N \longrightarrow Z$, $B_H \longrightarrow Y$, $B_C \longrightarrow X$

PRESS: CONTINUE

DISPLAY

0	Z
0	Y
1	X

ENTER DATA: $N_{s_1} \longrightarrow Z$, $H_{s_1} \longrightarrow Y$, $C_{s_1} \longrightarrow X$

PRESS: CONTINUE

DISPLAY

0	Z
0	Y
2	X

ENTER DATA: $N_{s_2} \longrightarrow Z$, $H_{s_2} \longrightarrow Y$, $C_{s_2} \longrightarrow X$

USER INSTRUCTIONS (con't)

PRESS: CONTINUE

DISPLAY

K_N	Z
K_H	Y
K_C	X

Note: If only one set of standard values is to be used, N_{s_2}, H_{s_2}, and C_{s_2} must be set to zero. Do not press "clear" at any time during program operation.

To reset program for a different standard, repeat user instructions.

EXAMPLES

(A) Only 1 set of standard values is available

Given: $\%C_s = 51.79$, $\%H_s = 5.07$, $\%N_s = 20.14$

$B_C = 1.6$, $B_H = 30$, $B_N = 1.0$

$C_{s_1} = 125.0$, $H_{s_1} = 119.5$, $N_{s_1} = 88.0$

Note: Since only 1 set of standards is available, the 2nd set of standards must be set to zero at the appropriate data input of the program. Do not press "CLEAR" to zero the 2nd set of standards.

Solution: $K_C = .420$, $K_H = .057$, $K_N = .231$

(B) Given: $\%C_s = 51.79$, $\%H_s = 5.07$, $\%N_s = 20.14$

$B_C = 1.6$, $B_H = 30$, $B_N = 1.0$

$C_{s_1} = 121.0$, $H_{s_1} = 121.5$, $N_{s_1} = 79.5$

$C_{s_2} = 120.5$, $H_{s_2} = 115.5$, $N_{s_2} = 79.5$

Solution: $K_C = .435$, $K_H = .057$, $K_N = .257$

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
0	0	CLEAR	20										
	1	x→( )	23										CLEAR DISPLAY AND STORAGE REGISTERS
	2	d	17										
	3	STOP	41	B_C	B_H	B_N							ENTER B_C, B_H AND B_N
	4	x→( )	23										
	5	a	13										
	6	y→( )	40										
	7	b	14										STORE B_C, B_H AND B_N
	8	ROLL ↓	31										
	9	y→( )	40										
	a	c	16										
	b	CLEAR	20										
	c	1	01										
	d	STOP	41	C_{S_i}	H_{S_i}	N_{S_i}							ENTER C_{S_i}'s H_{S_i}'s AND N_{S_i}'s
1	0	ACC +	60										
	1	CLEAR x	37										
	2	ROLL ↓	31										
	3	d	17										FORM ΣC_i, ΣH_i AND ΣN_i AND STORE
	4	+	33										
	5	y→( )	40										
	6	d	17										
	7	IF FLAG	43										
	8	2	02										BRANCH IF 2nd SET OF C, H AND N HAS BEEN ENTERED
	9	2	02										
	a	SET FLAG	54										SET FLAG AFTER 1st SET OF C, H AND N HAS BEEN ENTERED
	b	↓	25										
	c	2	02										
	d	GO TO( )( )	44										
2	0	0	00										BRANCH TO ENTER 2nd SET OF C, H AND N
	1	d	17										
	2	IF x=y	50										
	3	2	02										SET COUNTER TO SEE IF 2nd SET OF C, H AND N ARE ZERO
	4	9	11										
	5	2	02										
	6	GO TO( )(	44										SET COUNTER TO TWO IF 2nd SET OF C, H AND N ARE NOW ZERO.
	7	2	02										
	8	a	13										
	9	1	01										
	a	÷	35										
	b	x⇄y	30										
	c	↑	27										
	d	c	16										

PART NO 09100-75503

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
3	0	−	34										
	1	CONTINUE	47										
	2	CONTINUE	47										
	3	·	21										
	4	CONTINUE	47										CALCULATE AND STORE K_N
	5	CONTINUE	47										*STEPS 3-1 THROUGH 3-5 ARE*
	6	x⇄y	30										*THE BLANK SPACES FOR*
	7	÷	35										*ENTERING % N_s*
	8	y→( )	40										
	9	d	17										
	a	f	15										
	b	ROLL ↑	22										
	c	÷	35										
	d	x⇄y	30										
4	0	↑	27										
	1	a	13										
	2	−	34										
	3	CONTINUE	47										
	4	CONTINUE	47										CALCULATE AND STORE K_C
	5	·	21										*STEPS 4-3 THROUGH 4-7 ARE*
	6	CONTINUE	47										*THE BLANK SPACES FOR*
	7	CONTINUE	47										*ENTERING % C_s*
	8	x⇄y	30										
	9	÷	35										
	a	y→( )	40										
	b	f	15										
	c	e	12										
	d	ROLL ↑	22										
5	0	÷	35										
	1	b	14										
	2	−	34										
	3	CONTINUE	47										
	4	CONTINUE	47										
	5	·	21										CALCULATE AND STORE K_H
	6	CONTINUE	47										*STEPS 5-3 THROUGH 5-7 ARE*
	7	CONTINUE	47										*THE BLANK SPACES FOR*
	8	x⇄y	30										*ENTERING % H_s*
	9	÷	35										
	a	y→( )	40										
	b	e	12										
	c	d	17										RECALL AND POSITION K_C, K_H AND K_N FOR DISPLAY
	d	x⇄y	30										

Step	Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a
6 0	ROLL ↑	22									
1	END	46	K_C	K_H	K_N	DISPLAY					
2											
3											
4											
5											
6											
7											
8											
9											
a											
b											
c											
d											
0											
1											
2											
3											
4											
5											
6											
7											
8											
9											
a											
b											
c											
d											
0											
1											
2											
3											
4											
5											
6											
7											
8											
9											
a											
b											
c											
d											

Step	Key	Code	Display			Storage					
			x	y	z	f	e	d	c	b	a
0											
1											
2											
3											
4											
5											
6											
7											
8											
9											
a											
b											
c											
d											
0											
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a											
b											
c											
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0											
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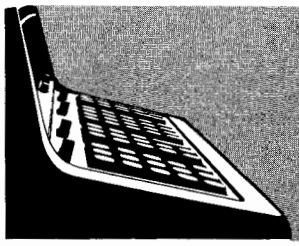
8											
9											
a											
b											
c											
d											



PART NO.
09100-75504

CHN PERCENTAGES

Percentages of carbon (C), hydrogen (H), and nitrogen (N) in an unknown substance are calculated from measured quantities of C, H, and N, blank values (B_C, B_H, and B_N), and K values (K_C, K_H, K_N) which may be calculated with the K value program (09100-75503). K and B values must be stored prior to program operation either manually by the operator, or automatically by the use of the K value program.

The following equations are used:

$$\% C_1 = K_C (C_1 - B_C)$$

$$\% C_2 = K_C (C_2 - B_C)$$

or, in general:

$$\% M_1 \left[M = C, H, \text{ or } N\right] = K_M (M_1 - B_M)$$

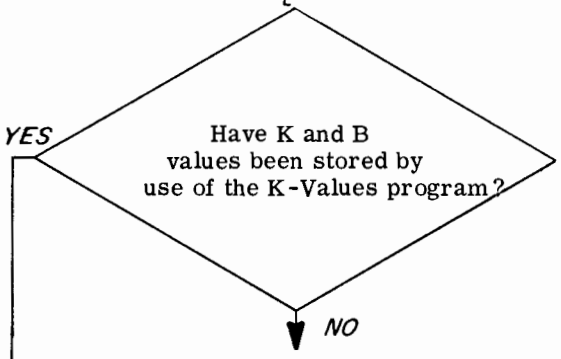
$$\% M_2 \left[M = C, H, \text{ or } N\right] = K_M (M_2 - B_M)$$

The percentage evaluation is considered successful if M_1 and M_2 differ by .3% or less.

If only one set of CHN measurements are available, then C_2, H_2, and N_2 may be made any value at the corresponding data input. In this case only $\% C_1$, $\% H_1$, and $\% N_1$ are useful information; disregard answers for $\% C_2$, $\% H_2$, and $\% N_2$.

USER INSTRUCTIONS

ENTER PROGRAM [(Starting Address is 0 - 0)]



ENTER DATA: $K_N \rightarrow Z$, $K_H \rightarrow Y$, $K_C \rightarrow X$

PRESS: x → f y → e R↓ y → d

ENTER DATA: $B_N \rightarrow Z$, $B_H \rightarrow Y$, $B_C \rightarrow X$

PRESS: x → a y → b R↓ y → c

PRESS: GO TO (0) (0) [or END]

PRESS: CONTINUE

DISPLAY

0	Z
0	Y
1	X

ENTER DATA: $N_1 \rightarrow Z$, $H_1 \rightarrow Y$, $C_1 \rightarrow X$

PRESS: CONTINUE

DISPLAY

0	Z
0	Y
2	X

ENTER DATA: $N_2 \rightarrow Z$, $H_2 \rightarrow Y$, $C_2 \rightarrow X$

USER INSTRUCTIONS (con't)

Note: If only one C-H-N set is available, N_2, H_2, and C_2 may be set to zero or any other value--Simply disregard the solutions for $\% C_2$, $\% H_2$, and $\% N_2$.

PRESS: CONTINUE

DISPLAY

$\% C_2$	Z
$\% C_1$	Y
1	X

PRESS: CONTINUE

DISPLAY

$\% H_2$	Z
$\% H_1$	Y
2	X

PRESS: CONTINUE

DISPLAY

$\% N_2$	Z
$\% N_1$	Y
3	X

To reset problem for different C, H, and N samples.

To reset program for different sets of K and B, repeat user instructions.

EXAMPLES

(A)

Example (A) of the K-value program (09100-75503) has previously been run, and the K and B values have already been stored.

Data: $C_1 = 118.3$, $H_1 = 75.0$, $N_1 = 49.1$
$C_2 = 128.6$, $H_2 = 69.7$, $N_2 = 53.4$

Solution: $\%C_1 = 48.98$, $\%C_2 = 53.30$
$\%H_1 = 2.55$, $\%H_2 = 2.25$
$\%N_1 = 11.13$, $\%N_2 = 12.13$

(B)

The K-value program (09100-75503) has not been run; K and B values must therefore be stored manually. (see "user instructions").

Data: $B_C = 2.1$, $B_H = 28$, $B_N = 3$
$K_C = .520$, $K_H = .102$, $K_N = .235$
$C_1 = 132.1$, $H_1 = 92.0$, $N_1 = 57.9$

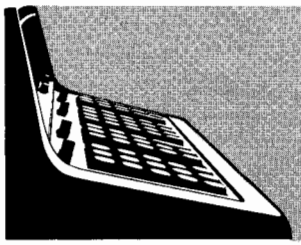
Solution: $\%C_1 = 67.6$
$\%H_1 = 6.53$
$\%N_1 = 12.90$

Note: Disregard answers for $\%C_2$, $\%H_2$, and $\%N_2$ since a second set of C-H-N was not available.

PART NO 09100 75504

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
0	0	CLEAR x	37										
	1	↑	27										
	2	↑	27										
	3	1	01										
	4	STOP	41	C_1	H_1	N_1							ENTER 1st SET OF C,H,& N
	5	x→( )	23										STORE C_1, H_1 AND N_1
	6	9	11										
	7	y→( )	40										
	8	8	10										
	9	ROLL ↓	31										
	a	y→( )	40										
	b	7	07										
	c	CLEAR x	37										
	d	↑	27										
1	0	↑	27										
	1	2	02										
	2	STOP	41	C_2	H_2	N_2							ENTER 2nd SET OF C,H,& N
	3	x→( )	23										STORE C_2
	4	6	06										
	5	b	14										
	6	−	34										
	7	e	12										
	8	×	36										
	9	y⇄( )	24										
	a	8	10										CALCULATE AND STORE % H_2 AND % H_1
	b	b	14										
	c	−	34										
	d	e	12										
2	0	×	36										
	1	y⇄( )	24										
	2	9	11										
	3	a	13										
	4	−	34										
	5	f	15										
	6	×	36										
	7	y⇄( )	24										
	8	6	06										CALCULATE AND STORE % C_1 AND % C_2
	9	a	13										
	a	−	34										
	b	f	15										
	c	×	36										
	d	y⇄( )	24										

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a
3	0	7	07									
	1	C	16									
	2	−	34									
	3	d	17									
	4	×	36									
	5	C	16									
	6	x⇄y	30	CALCULATE AND STORE % N_1 AND % N_2			% N_2					
	7	ROLL ↓	31									
	8	−	34									
	9	d	17									
	a	×	36									
	b	y⇄( )	24									
	c	6	06									
	d	↓	25									
4	0	y⇄( )	24									
	1	7	07	RECALL AND POSITION % C_1 AND % C_2 FOR DISPLAY.								
	2	↑	27									
	3	1	01									
	4	STOP	41	1	% C_1	% C_2						
	5	y⇄( )	24									
	6	8	10									
	7	↑	27	RECALL AND POSITION % H_1 AND % H_2 FOR DISPLAY.								
	8	y⇄( )	24									
	9	9	11									
	a	2	02									
	b	STOP	41	2	% H_1	% H_2						
	c	y⇄( )	24									
	d	6	06									
5	0	↑	27	RECALL AND POSITION % N_1 AND % N_2 FOR DISPLAY.								
	1	y⇄( )	24									
	2	7	07									
	3	3	03									
	4	END	46	3	% N_1	% N_2						
	5											
	6											
	7											
	8											
	9											
	a											
	b											
	c											
	d											



PART NO.
09100-75505

MOLECULAR WEIGHT BY VPO

Data obtained from the vapor pressure osmometer (VPO) is used to calculate either the depression constant (K_d) for a substance with standard molecular weight, or the molecular weight (MW) of an unknown substance. In normal application, VPO readings (V) for various concentrations (C) of a substance with known molecular weight are taken, and K_d is determined. The molecular weight of an unknown substance may then be determined from VPO readings obtained from various concentrations of the unknown, and from the previously determined K_d.

The same procedure is used to calculate either K_d or MW. In both cases, a linear regression is performed with V/C and C as the dependent and independent variables respectively. The regression is similar to that of the regression program (09100-70803) for equations of the form $Y = mx + b$; in this case the defining equation is $V/C = mc + b$, where m is the slope of the V/C versus C curve. The V/C versus C curve is then extrapolated to infinite dilution (C = 0) to obtain the Y = V/C intercept (b); i.e. $\lim_{c \to 0} V/C = b$.

K_d is then calculated using the equation:

$K_d = b(MW)$ where MW, in this case, is the molecular weight of a known substance.

Likewise, MW may be calculated by the equation:

$MW = \frac{K_d}{b}$ where now MW is the molecular weight (of an unknown substance) which is to be determined.

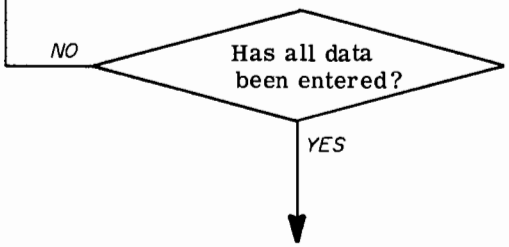
A correlation coefficient (r) is also calculated. r is a measure of reproducibility and also how ideal the system is.

USER INSTRUCTIONS

ENTER PROGRAM (Starting Address is 0 - 0)
PRESS: GO TO (0) (0) [or END]
PRESS: CONTINUE
DISPLAY

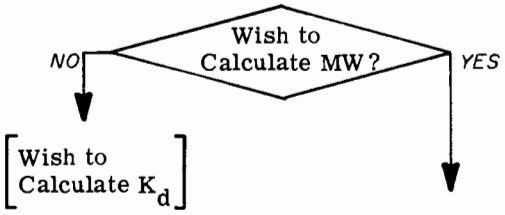
0	Z
0	Y
i	X

ENTER DATA: $V_i \rightarrow Y$, $C_i \rightarrow X$
PRESS: CONTINUE



PRESS: SET FLAG
PRESS: CONTINUE
DISPLAY

0	Z
1	Y
0	X



ENTER DATA: MW → X
PRESS: SET FLAG
PRESS: CONTINUE
DISPLAY

m	Z
r	Y
K_d	X

ENTER DATA: $K_d \rightarrow X$
PRESS: CONTINUE
DISPLAY

m	Z
r	Y
MW	X

To reset problem

EXAMPLES

(A) Calculate K_d for the following standard molecular weight, and set of VPO and C readings.

Data: MW = 1500

i	V_i	C_i
1	500	34
2	330	24
3	205	16
4	125	8

Solution: m = -.017
r = -.156
K_d = 21858.377

(B) Calculate MW for the following data:

Data: K_d = 337.576

i	V_i	C_i
1	56.10	121.95
2	23.85	57.32
3	11.45	27.85
4	5.68	13.72

Solution: m = .0005
r = .9419
MW = 843.5813

PART NO 09100-75505

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
0	0	CLEAR	20										CLEAR DISPLAY AND STORAGE REGISTERS.
	1	$x\rightarrow( )$	23										
	2	d	17										
	3	$x\rightarrow( )$	23										
	4	c	16										
	5	$x\rightarrow( )$	23										
	6	b	14										
	7	1	01										INITIALIZE COUNTER
	8	$x\rightarrow( )$	23										
	9	a	13										
	a	STOP	41	C_i	V_i	0							ENTER DATA
	b	IF FLAG	43										BRANCH IF ALL DATA HAS BEEN ENTERED
	c	3	03										
	d	5	05										
1	0	÷	35										CALCULATE $\Sigma X = \Sigma C$ AND $\Sigma Y = \Sigma V$
	1	ACC +	60										
	2	↑	27										CALCULATE ΣX^2
	3	×	36										
	4	$x\rightleftarrows y$	30										
	5	$y\rightleftarrows( )$	24										
	6	d	17										
	7	+	33										
	8	$y\rightleftarrows( )$	24										
	9	d	17										
	a	↓	25										CALCULATE ΣXY
	b	×	36										
	c	b	14										
	d	+	33										
2	0	$y\rightarrow( )$	40										CALCULATE ΣY^2
	1	b	14										
	2	ROLL ↑	22										
	3	↑	27										
	4	×	36										
	5	c	16										
	6	+	33										
	7	$y\rightarrow( )$	40										
	8	c	16										
	9	a	13										INCREMENT COUNTER
	a	↑	27										
	b	1	01										
	c	+	33										
	d	CLEAR x	37										

FROM 3-4

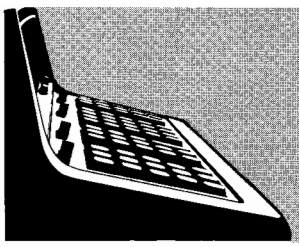
Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
3	0	↑	27										
	1	ROLL ↑	22										
	2	GO TO( )( )	44										BRANCH TO ENTER NEXT SET OF DATA
	3	0	00										
	4	8	10										
	5	a	13										DECREMENT COUNTER
	6	↑	27										
	7	1	01										
	8	−	34										
	9	e	12										CALCULATE $\bar{Y}$
	a	x⇄y	30										
	b	÷	35										
	c	y⇄( )	24										CALCULATE $\bar{X}$
	d	f	15										
4	0	÷	35										
	1	x→( )	23										STORE $\bar{X}$ AND n
	2	a	13										
	3	y→( )	40										
	4	e	12										
	5	×	36										CALCULATE $\Sigma(X-\bar{X})^2$
	6	e	12										
	7	×	36										
	8	d	17										
	9	x⇄y	30										
	a	−	34										
	b	y⇄( )	24										
	c	c	16										
	d	f	15										
5	0	↑	27										
	1	×	36										CALCULATE $\Sigma(Y-\bar{Y})^2$
	2	a	13										
	3	×	36										
	4	↓	25										
	5	−	34										
	6	y⇄( )	24										
	7	b	14										
	8	↑	27										
	9	RCL	61										
	a	×	36										
	b	a	13										
	c	×	36										
	d	↓	25										

FROM-0-d

PART NO 09100 - 75505

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a
6	0	−	34									
	1	c	16	CALCULATE AND STORE r								
	2	↑	27									
	3	↓	25									
	4	√x	76									
	5	÷	35									
	6	b	14									
	7	√x	76									
	8	÷	35									
	9	y→( )	40									
	a	a	13									
	b	c	16									
	c	ROLL ↑	22									
	d	x⇄y	30	CALCULATE AND STORE m								
7	0	÷	35									
	1	y→( )	40									
	2	b	14									
	3	e	12									
	4	×	36									
	5	f	15									
	6	x⇄y	30	CALCULATE AND STORE b								
	7	−	34									
	8	y→( )	40									
	9	c	16									
	a	CLEAR	20									
	b	1	01									
	c	x⇄y	30									
	d	STOP	41	MW or K_d	0	0	ENTER DATA					−MW or K_d
8	0	↑	27									
	1	c	16	RECALL b								
	2	IF FLAG	43									
	3	×	36	CALCULATE K_d IF FLAG IS SET, OTHERWISE CALCULATE MW								
	4	×	36									
	5	÷	35									
	6	b	14									
	7	↑	27	RECALL m AND r AND POSITION FOR DISPLAY.								
	8	a	13									
	9	ROLL ↑	22									
	a	END	46	MW or K_d	r	m	DISPLAY					
	b											
	c											
	d											

Step	Key	Code	Display			Storage					
			x	y	z	f	e	d	c	b	a
0											
1											
2											
3											
4											
5											
6											
7											
8											
9											
a											
b											
c											
d											
0											
1											
2											
3											
4											
5											
6											
7											
8											
9											
a											
b											
c											
d											
0											
1											
2											
3											
4											
5											
6											
7											
8											
9											
a											
b											
c											
d											



PART NO.
09100-75506

MEMBRANE OSMOMETER

The membrane osmometer is used to obtain data for calculation of either the constant RT (R = gas constant, T = absolute temperature), or the number average molecular weight ($\overline{M}_n$). In normal application, osmotic pressure (P) measurements are taken for various concentrations (C) of a substance with known $\overline{M}_n$, and RT is subsequently calculated. The number average molecular weight of an unknown substance may then be determined from membrane osmometer measurements of P obtained from various concentrations of the unknown, and from the previously determined RT.

The same procedure is used to calculate either RT or $\overline{M}_n$. In both cases, a linear regression is performed with $(P/C)^{1/2}$ and C as the dependent and independent variables respectively. The regression is similar to that of the regression program (09100-70803) for equations of the form $y = mx + b$; in this case the defining equation is $P/C = mc + \frac{RT}{\overline{M}_n}$, where m is the slope of the (P/C) versus C curve. The $(P/C)^{1/2}$ versus C curve is then extrapolated to infinite dilution (c=0) to obtain the Y = P/C intercept (b), i.e. $\lim_{c \to 0} P/C = b$. $(P/C)^{1/2}$ rather than P/C is used in the regression to avoid extrapolation error when the P/C and C data results in a P/C versus C plot with pronounced curvature. In many cases where the first power plot has pronounced curvature, the square-root plot will produce a straight line suitable for extrapolation. The desired intercept (b) of the P/C versus C curve is then the square of the $(P/C)^{1/2}$ versus C intercept.

RT is calculated using the equations:

$RT = \overline{M}_n$ (b) where $\overline{M}_n$ is a known number average molecular weight.

Likewise, $\overline{M}_n$ may be calculated by the equation:

$\overline{M}_n = \frac{RT}{b}$ where now $\overline{M}_n$ is the number average molecular weight (of an unknown substance) which is to be determine.

A correlation coefficient (r) is also calculated. r is a measure of reproducibility and also how ideal the system is.

USER INSTRUCTION

ENTER PROGRAM (Starting Address is 0 - 0)

PRESS: END

PRESS: CONTINUE

DISPLAY

0	Z
0	Y
i	X

ENTER DATA: $P_i \rightarrow Y$, $C_i \rightarrow X$

PRESS: CONTINUE

Has all data been entered?

NO → PRESS: CONTINUE

YES →

PRESS: SET FLAG

PRESS: CONTINUE

DISPLAY

0	Z
1	Y
0	X

Wish to calculate $\overline{M}_n$?

YES →

ENTER DATA: RT → X

PRESS: SET FLAG

PRESS: CONTINUE

DISPLAY

m	Z
r	Y
$\overline{M}_n$	X

[Wish to calculate RT] →

ENTER DATA: $\overline{M}_n \rightarrow X$

PRESS: CONTINUE

DISPLAY

m	Z
r	Y
RT	X

To reset problem:

EXAMPLES

(A) Determine RT for a substance with known number average molecular weight ($\overline{M}_n$) using the following data:

Data: $\overline{M}_n = 1.2 \times 10^5$

i	P_i	C_i
1	.58	2
2	1.75	5
3	4.45	10
4	12.64	20

Solution: m = .014
r = .998
RT = 32,185.017

(B) Calculate $\overline{M}_n$ for an unknown substance using the following data:

Data: $RT = 3.65 \times 10^4$

i	P_i	C_i
1	.67	2.2
2	1.50	4.3
3	3.72	8.4
4	10.41	18.6

Solution: m = .012
r = .977
$\overline{M}_n$ = 124,403.599

PART NO 09100-75506

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
0	0	CLEAR	20										
	1	$x\rightarrow()$	23										
	2	d	17										
	3	$x\rightarrow()$	23										CLEAR DISPLAY AND STORAGE REGISTERS.
	4	c	16										
	5	$x\rightarrow()$	23										
	6	b	14										
	7	1	01										
	8	$x\rightarrow()$	23										INITIALIZE COUNTER
	9	a	13										
	a	STOP	41	C	P	0							ENTER DATA
	b	IF FLAG	43										
	c	3	03										BRANCH IF ALL DATA HAS BEEN ENTERED
	d	8	10										
1	0	÷	35										
	1	ROLL ↓	31										CALCULATE $(P/C)^{1/2}$
	2	$\sqrt{x}$	76										
	3	ROLL ↑	22										
	4	ACC +	60										CALCULATE $\Sigma C = \Sigma X$ AND $\Sigma (P/C)^{1/2} = \Sigma Y$
	5	↑	27										
	6	×	36										
	7	$x\rightleftarrows y$	30										
	8	$y\rightleftarrows()$	24										CALCULATE ΣX^2
	9	d	17										
	a	+	33										
	b	$y\rightleftarrows()$	24										
	c	d	17										
	d	↓	25										
2	0	×	36										
	1	b	14										CALCULATE ΣXY
	2	+	33										
	3	$y\rightarrow()$	40										
	4	b	14										
	5	ROLL ↑	22										
	6	↑	27										
	7	×	36										
	8	c	16										CALCULATE ΣY^2
	9	+	33										
	a	$y\rightarrow()$	40										
	b	c	16										
	c	a	13										
	d	↑	27										INCREMENT COUNTER

FROM 3-7

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
3	0	1	01										
	1	+	33										
	2	CLEAR x	37										
	3	↑	27										
	4	ROLL ↑	22										
	5	GO TO( )( )	44										
	6	0	00										BRANCH TO ENTER NEXT SET OF DATA.
	7	8	10										
	8	a	13										
	9	↑	27										
	a	1	01										DECREMENT AND STORE COUNTER.
	b	−	34										
	c	y→( )	40										
	d	a	13										
4	0	e	12										
	1	x⇄y	30										CALCULATE $\bar{Y}$
	2	÷	35										
	3	y⇄( )	24										
	4	f	15										
	5	÷	35										CALCULATE AND STORE $\bar{X}$
	6	y→( )	40										
	7	e	12										
	8	×	36										
	9	e	12										
	a	×	36										
	b	d	17										CALCULATE AND STORE $\Sigma (X-\bar{X})^2$.
	c	x⇄y	30										
	d	−	34										
5	0	y⇄( )	24										
	1	c	16										
	2	f	15										
	3	↑	27										
	4	×	36										
	5	a	13										
	6	×	36										CALCULATE AND STORE $\Sigma (Y-\bar{Y})^2$.
	7	↓	25										
	8	−	34										
	9	y⇄( )	24										
	a	b	14										
	b	↑	27										
	c	RCL	61										
	d	×	36										

FROM 0-d

Step		Key	Code	Display x	Display y	Display z	Storage f	Storage e	Storage d	Storage c	Storage b	Storage a	
6	0	a	13										
	1	×	36										
	2	↓	25										
	3	−	34										
	4	c	16										
	5	↑	27										CALCULATE AND STORE r.
	6	↓	25										
	7	$\sqrt{x}$	76										
	8	÷	35										
	9	b	14										
	a	$\sqrt{x}$	76										
	b	÷	35										
	c	y→( )	40										
	d	a	13										
7	0	c	16										
	1	ROLL ↑	22										
	2	x≷y	30										CALCULATE AND STORE m.
	3	÷	35										
	4	y→( )	40										
	5	b	14										
	6	e	12										
	7	×	36										
	8	f	15										
	9	x≷y	30										CALCULATE AND STORE C.
	a	−	34										
	b	y→( )	40										
	c	c	16										
	d	CLEAR	20										
8	0	1	01										
	1	x≷y	30										
	2	STOP	41	$\bar{M}_n$ or RT	0	0							ENTER DATA: $\bar{M}_n$ or RT
	3	↑	27										RECALL b
	4	c	16										
	5	IF FLAG	43										BRANCH IF $\bar{M}_n$ IS TO BE CALCULATED.
	6	8	10										
	7	d	17										
	8	×	36										CALCULATE RT
	9	×	36										
	a	GOTO( )( )	44										BRANCH TO RECALL r AND m.
	b	9	11										
	c	1	01										
	d	÷	35										CALCULATE $\bar{M}_n$

PART NO 09100-75506

Step	Key	Code	Display x	Display y	Display z	Storage f	e	d	c	b	a
9 0	÷	35									
1	*b*	14									
2	↑	27	RECALL r AND m AND POSITION								
3	*a*	13	FOR DISPLAY								
4	ROLL ↑	22									
5	END	46	RT or $\bar{M}_n$	r	m	DISPLAY					
6											
7											
8											
9											
a											
b											
c											
d											
0											
1											
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