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| COMPANY | White Mountains Regional High School Whitefield, New Hampshire |
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GAS LAW PROGRAMS

DECUS Program Library Write-up

DECUS No. FOCAL8-83

FOCAL -

GAS LAW PROGRAMS

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CONSISTING OF:

IDEAL GAS PLOT P/V

IDEAL GAS VOLUME VS TEMPERATURE

REAL GAS VOLUME VS TEMPERATURE

IDEAL GAS PLOT P/V

ABSTRACT:

The experimental plot of pressure vs volume for any real gas sample yields data which do not fall on a straight line. Since there are typically too few data to get a good idea of the indicated curve, some assistance (or insight) is required.

This FOCAL program plots the relationship of an inverse proportionality and simultaneously plots the reciprocal of this relationship. Depending upon the input parameters, plotting can be varied to examine different portions of the inverse proportionality curve. In each instance, the reciprocal of this relationship plots as a straight line, whose slope can be varied to facilitate display and interpretation. The program will label the axes, whether or not the data start from zero on the pressure scale. Since group 1 serves no useful purpose other than to convey a succinct set of rules for using the program, it can be erased at any time to facilitate reentry into the operational program.

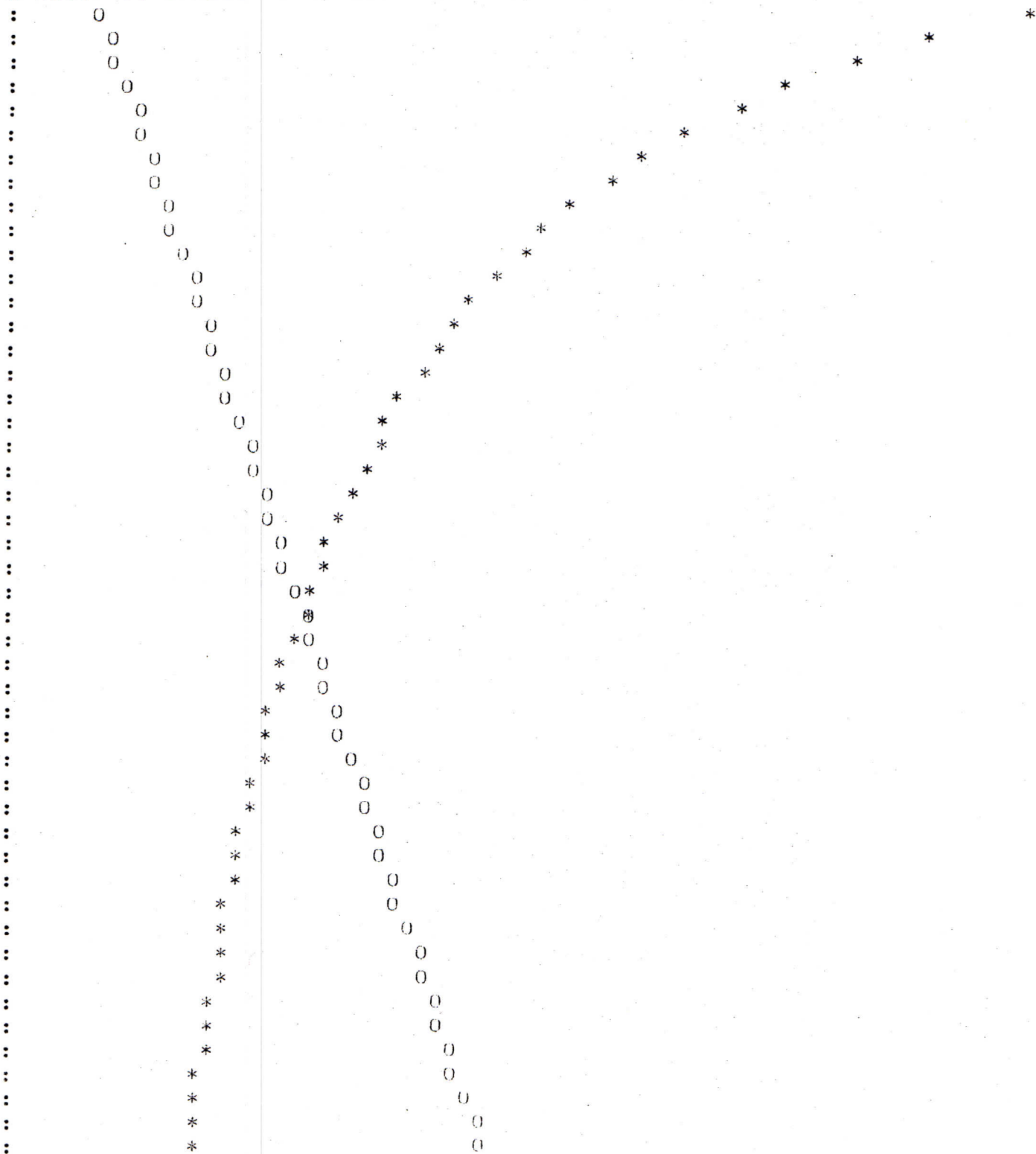
There has been no attempt made to "rig" the program to realistically handle experimental data since the intent was to be able to play with the input parameters intuitively in the search for insight and understanding.

The obvious experimental conclusion would be to plot pressure vs the reciprocal of the experimental volume. If this were to yield a straight line (which is easier to determine since there is only one kind) then the original data must have been inversely proportional, and BOYLE'S LAW is corroborated. The manipulation is necessary since there are at least a large number of curves which might be argued from the limited data.


```

*G
IDEAL GAS IN QUADRANT ONE
PLOT OF PRESSURE VS VOLUME
GIVE POSITIVE VALUES FOR:
LOWEST PRESSURE
INCREMENT
HI PRESSURE
K IN PV=K
SLOPE OF RECIPROCAL PLOT
LPRESS,:10 IPRESS,:1 UPRESS,:100 K,:700 SLOPE:400

```



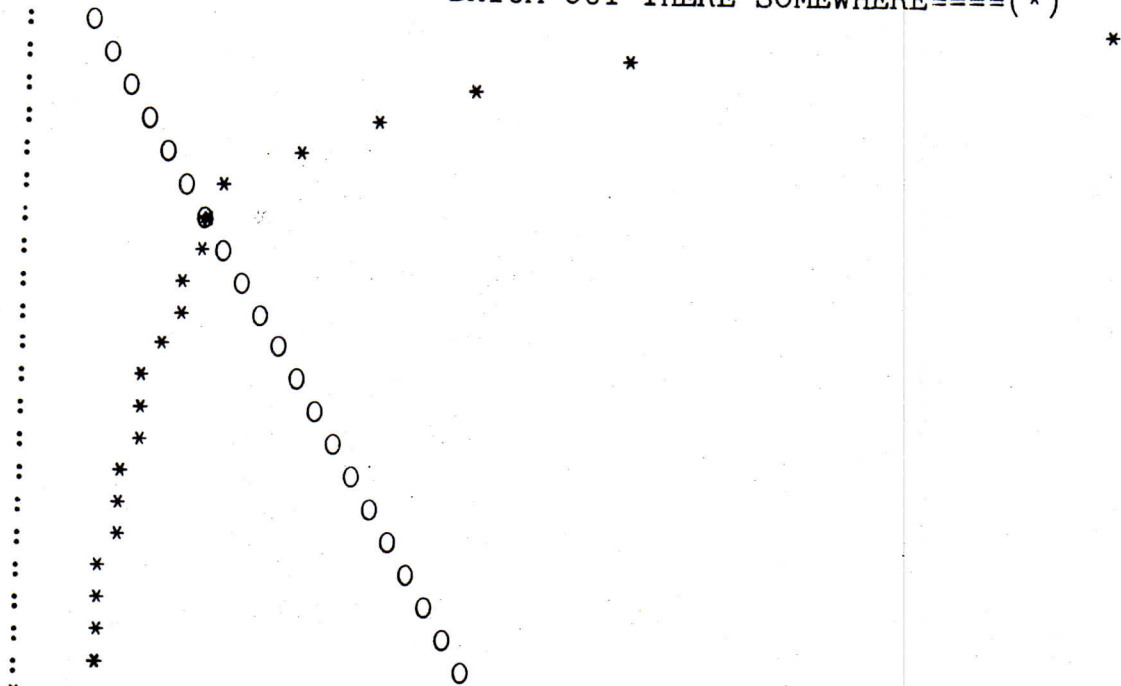
*GO
 IDEAL GAS IN QUADRANT ONE
 PLOT OF PRESSURE VS VOLUME
 GIVE POSITIVE VALUES FOR:
 LOWEST PRESSURE
 INCREMENT
 HI PRESSURE
 K IN $PV=K$
 SLOPE OF RECIPROCAL PLOT

LPRESS,: 0 IPRESS,: 1 UPRESS,: 20 K,: 70 SLOPE: 100

P
R
E
S
S
U
R
E

A
X
I
S

===VOLUME AXIS=====DATUM OUT THERE SOMEWHERE====(*)



* COMMENT * IS PLOT OF P VS V
 * COMMENT O IS PLOT OF 1/P VS V
 * COMMENT IF THE O'S PLOT A STRAIGHT LINE, THE *'S DESCRIBE
 * AN INVERSE PROPORTIONALITY.

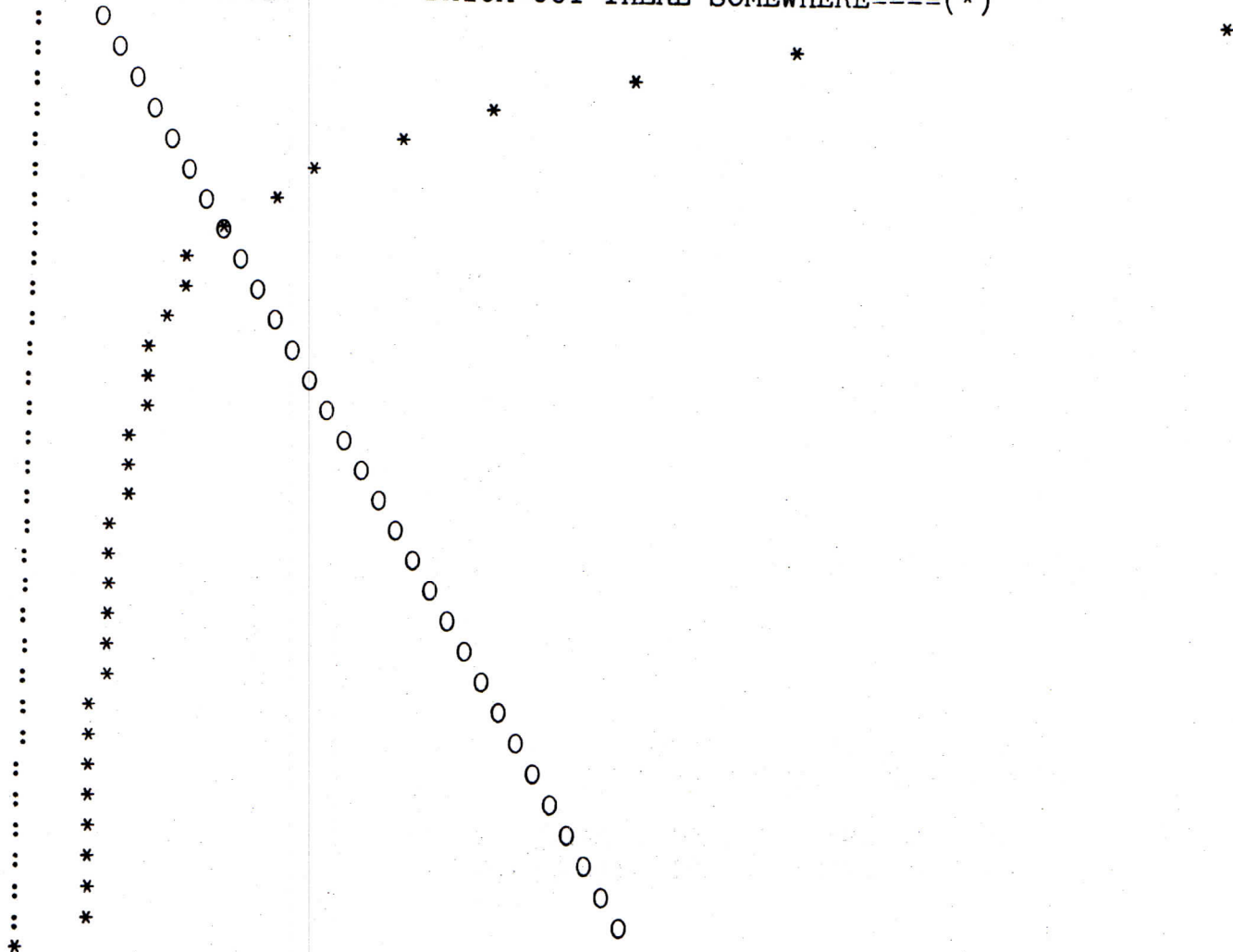
*GO
 IDEAL GAS IN QUADRANT ONE
 PLOT OF PRESSURE VS VOLUME
 GIVE POSITIVE VALUES FOR:
 LOWEST PRESSURE
 INCREMENT
 HI PRESSURE
 K IN $PV=K$
 SLOPE OF RECIPROCAL PLOT

LPRESS,:0 IPRESS,:1 UPRESS,:30 K,:70 SLOPE:70

P
R
E
S
S
U
R
E

A
X
I
S

===VOLUME AXIS=====DATUM OUT THERE SOMEWHERE====(*)

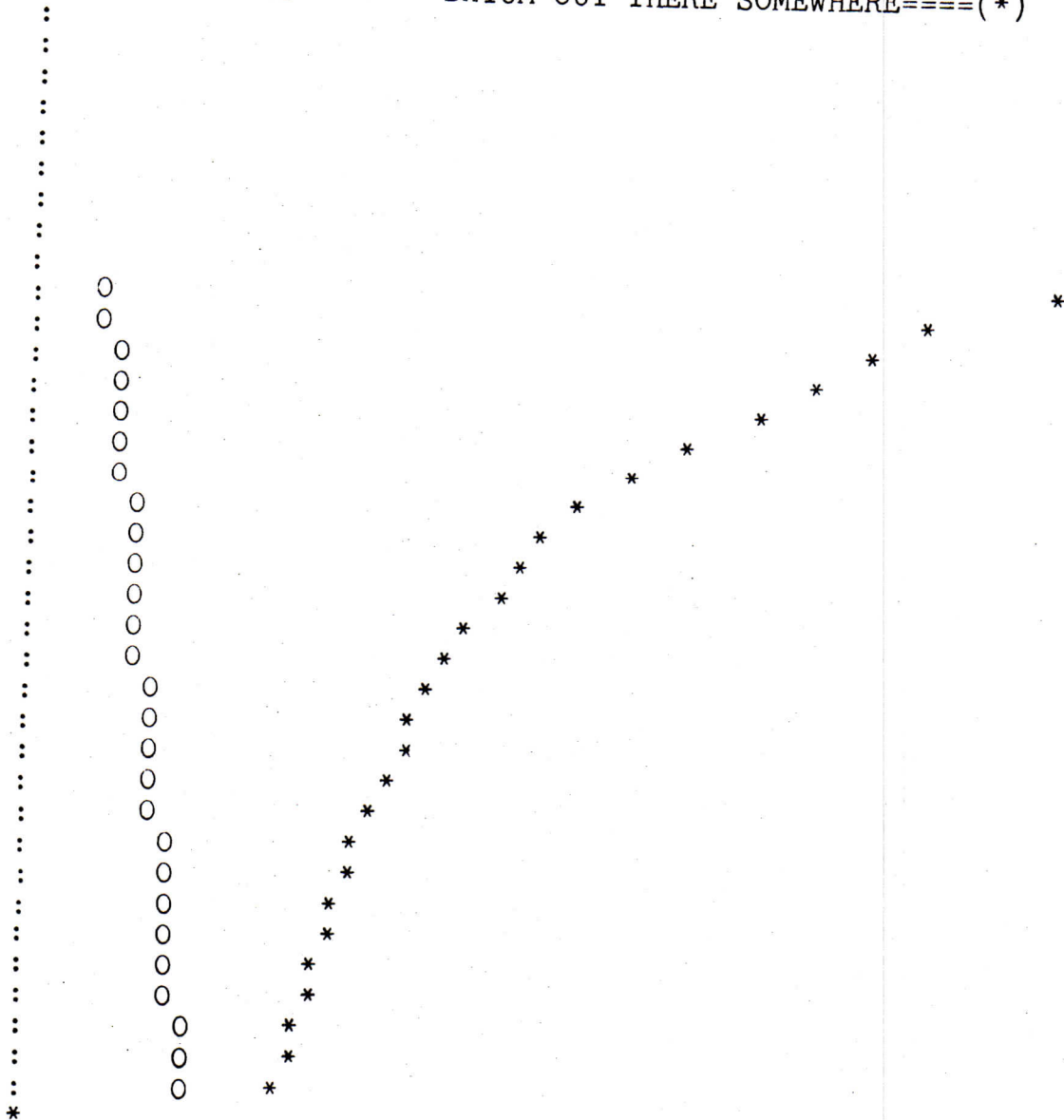


G
 LPRESS,:10 IPRESS,:35 UPRESS,:?01.00 @ 02.02
 *G
 LPRESS,:10 IPRESS,:1 UPRESS,:35 K,:500 SLOPE:90

P
R
E
S
S
U
R
E

A
X
I
S

==VOLUME AXIS=====DATUM OUT THERE SOMEWHERE====(*)

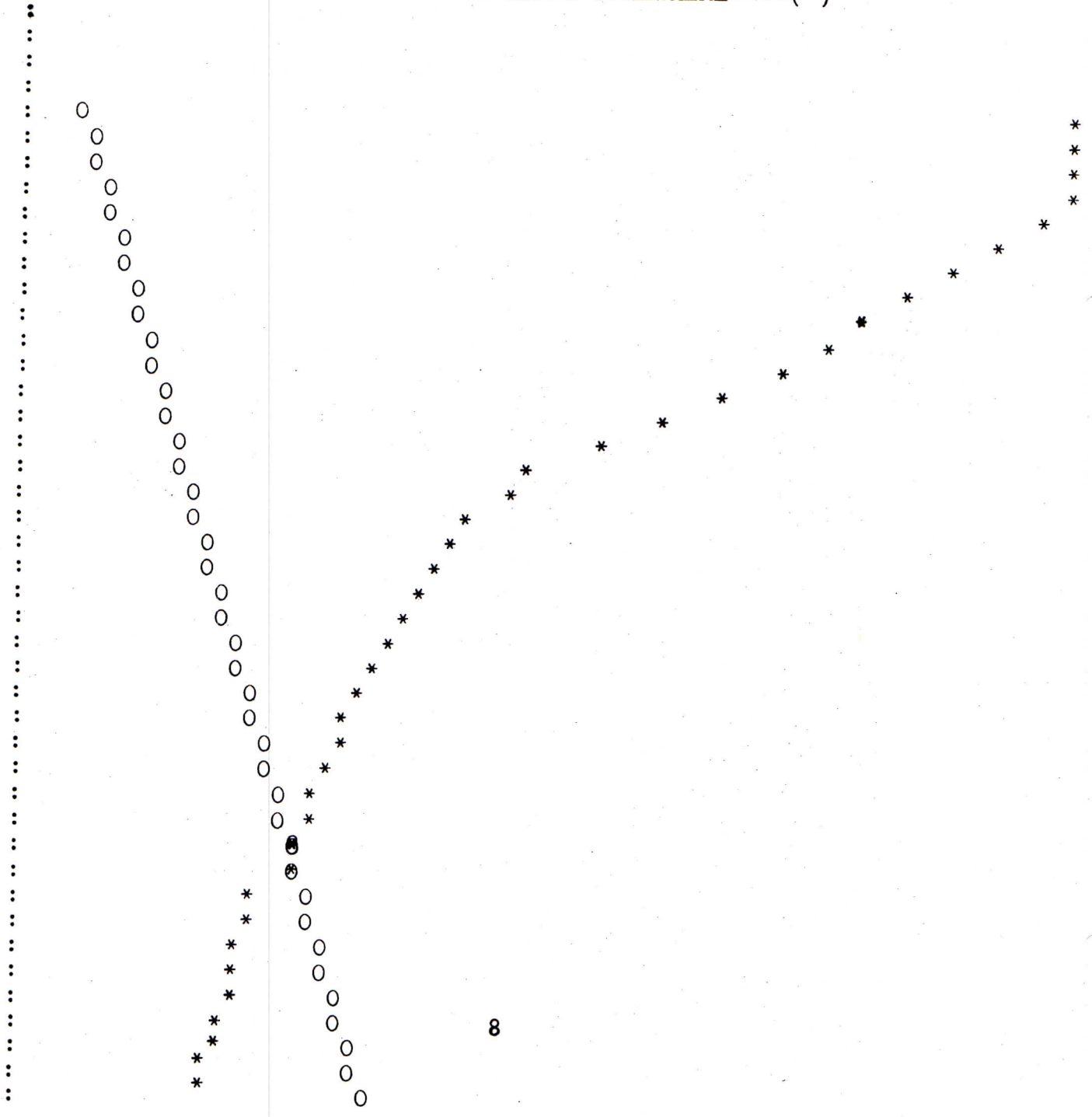


G
LPRESS,:5 IPRESS,:1 UPRESS,:4 K,:600 SLOPE:300

P
R
E
S
S
U
R
E

A
X
I
S

===VOLUME AXIS=====DATUM OUT THERE SOMEWHERE===(*)



FOCAL -

IDEAL GAS VOLUME VS TEMPERATURE

This FOCAL program explores the CHARLES LAW relationship for an ideal gas. On the presumption that the gas will change by $1/273.16$ of its volume at 0°C . for each 1°C . change in temperature, a gas volume is input and the temperature increment by which the sample will be reduced in temperature. The program will plot volume and temperature until it senses a negative volume. Since negative volume has no physical meaning, the temperature associated with it probably doesn't either, and the last temperature must be within the temperature increment of an absolute zero temperature. Provision is made to input a low temperature limit for the plot to add an element of discovery to the proceedings by enabling a realistic search for the zero volume intercept.

The initial volume is scaled to fit the TTY page, but the data table printed on each line gives the actual values of temperature and volume. Overprinting the data table is intentional to give maximum plotting space since the search for the intercept within 0.1°C . will yield a display about 12 yards long (and require about 4 hours on the PDP-8/S).

C-FUCAL , 8/68

```
01.02 T "IDEAL GAS VOLUME VS TEMPERATURE"!
01.14 T "TEMP REDUCED STARTING AT 0 DEG. C."!
01.06 T "GIVE POSITIVE VALUES FOR:"!
01.08 T "    VOLUME AT 0 C. IN ARBITRARY UNITS"!
01.10 T "    NEG. TEMP. INCREMENT"!
01.12 T "    LOW TEMP. LIMIT OF PLOT"!
01.14 C ERASE 1 WILL RETAIN ESSENTIAL PROGRAM
```

```
02.02 S T=0;A "INITIAL VOL",IV,"TEMP INCR",IT,"LOW LIMIT",LT
02.03 T "";C BELL LINE
02.04 T !"T!"E!"M!"P!"A!"X!"I!"S!";S QV=IV;DO 6.09
02.06 S V=68;F M=0,IT,LT;DO 6
02.07 I (QV)2.08,2.08;T "THIS IS NOT WITHIN TEMP INCR OF ABS ZERO";Q
02.08 I "SINCE NEG VOLUME HAS NO PHYSICAL MEANING,TEMPERATURES"!
02.09 I "RELATED TO THESE WOULD HAVE NO PHYSICAL MEANING, AND OUR"!
02.10 T "ZERO VOLUME INTERCEPT MUST BE WITHIN THE TEMP INCREMENT"!
02.11 I "OF AN ABSOLUTE ZERO TEMPERATURE"!;Q
```

```

06.03 C I (QV)2.03,2.08,6.04
06.04 T ":" %4.01 T," C. V",QV,#
06.06 F K=0,V;T " "
06.07 T "(X)";S V=V-[70*IT/273.16]
06.08 S QV=QV-[1V*IT/273.16];S T=T-IT;R
06.09 T " : I WILL PLOT INITIAL VOLUME AT FULL SCALE - - -"!
*****

```

FOCAL -

REAL GAS VOLUME VS TEMPERATURE

This FOCAL program accepts experimental sets of volume and temperature information, performs a LEAST SQUARES REGRESSION FIT to a straight line, and extrpolates and plots this line to a zero volume intercept. The temperature associated with the last positive volume as temperature is reduced is compared with the accepted value for absolute zero, and the percentage deviation typed out. The least squares regression program is also listed separately.

The magnitude of the extrapolation indicates that high percentages of deviation are to be expected from limited input data.

.....

[illegible]

*****A

*W

C-FOCAL , 8/68

01.10 T "CURVE FITTING BY LEAST SQUARE REGRESSION",!!

01.20 T "N=NUMBER OF DATUM POINTS",!

01.30 T "X=ABSCISSA, Y=ORDINATE",!

03.10 S SX=0;S SY=0;S SM=0;S SE=0;S A1=0;S A0=0

03.20 A ?N?,!;F K=1,N;A ?X,Y?,!;D 6

04.10 S A1=[N*SM-SX*SY]/[N*SE-SX^2]

04.20 S A0=[SY-A1*SX]/N

05.10 T "A1",A1," A0",A0,!!!," Y",A1,"*X+",A0,!;0

06.10 S SX=SX+X

06.20 S SY=SY+Y

06.30 S SM=SM+X*Y

06.40 S SE=SE+X^2
