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Semiconductor Measurement Technology:

Automatic Determination of the Interstitial Oxygen Content of Silicon Wafers Polished on Both Sides

Warren K. Gladden, Stephen R. Stoughton,
Walter M. Duncan, and Aslun Raghbadi

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ABSTRACT

This Special Publication contains FORTRAN and PASCAL computer programs which implement an ASTM test method for the automatic determination of the interstitial oxygen content of silicon. The programs are to be used as illustrative examples by programmers wishing to implement the ASTM algorithm on their computers. The Publication also includes sample data that can be used to test the computer programs. The sample data are included in two forms: in print, and on an MS-DOS floppy disk.

Key words: algorithm; analysis of infrared spectra; computer programs; interstitial oxygen; silicon.

I. INTRODUCTION

This work is an outgrowth of an American Society for Testing and Materials (ASTM) project to automate test methods for the determination of the oxygen and carbon content in silicon using IR absorption. The ASTM task force on this project recommended a test procedure for obtaining the IR spectra and an algorithm for computing the oxygen content from the spectra. This test procedure has been proposed for adoption by ASTM Committee F-1 as a Standard Test Method. This Special Publication includes as examples a FORTRAN computer program and a PASCAL program, each of which implements the ASTM algorithm. The FORTRAN program was written at the National Institute of Standards and Technology, and the PASCAL program was written at Texas Instruments. Also included are example spectra that can be used to test any program written implementing the ASTM algorithm.

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The proposed ASTM method can be used to analyze IR spectra obtained on either dispersive (DIR) or Fourier-transform (FT-IR) infrared spectrophotometers. It can be used with samples ranging in thickness from 0.3 mm to 2.5 mm. The samples must be polished on both sides. The lower resistivity limits are 0.05 $\Omega\text{-cm}$ for n-type and 0.5 $\Omega\text{-cm}$ for p-type samples. There are no upper resistivity limits. The oxygen content of float-zoned silicon has been measured with resistivities well above 100 $\Omega\text{-cm}$. The range of oxygen concentrations measured by this method is 1×10^{16} to 2×10^{18} atoms/cm⁻³.

II. OUTLINE OF THE ALGORITHM

The interstitial oxygen content of silicon can be determined by measuring the net peak height of the oxygen vibrational absorption at 1107 cm⁻¹.[§] The transmittance through the sample, taking into account the additional intensity due to multiple reflections between the parallel polished surfaces of the sample, is given by ¶

$$T = \frac{(1 - R)^2 e^{-\alpha d}}{1 - R^2 e^{-2\alpha d}}, \quad (1)$$

and rearrangement of this equation yields the absorption coefficient as

$$\alpha = -\frac{1}{d} \ln \left\{ \frac{-0.49 + \sqrt{0.2401 + 0.36T^2}}{0.18T} \right\}, \quad (2)$$

where the silicon reflectivity, R , has been set equal to 0.30, its value over the carrier concentrations and frequencies considered here. Figure 1 shows a typical silicon transmittance spectrum and figure 2 shows the region about the oxygen peak where the transmittance data have been converted to absorption coefficient using eq (2). To determine this peak height, a baseline is drawn between the two minima, one on either side of the peak. The peak height is determined at 1107 cm⁻¹, and the baseline absorption is determined by finding the intercept of the baseline at 1107 cm⁻¹. The net peak height is then the difference between these two values of absorption coefficient. A calibration constant has been determined relating this net peak height to the quantity of interstitial oxygen in parts per million (atomic) using absolute techniques such as charge particle and/or photon activation

[§] See ASTM Test Method F 121, 1987 Annual Book of ASTM Standards, V. 10.05, p. 247.

[¶] See ASTM Standard Practices F 120, 1987 Annual Book of Standards, V. 10.05, p. 245.

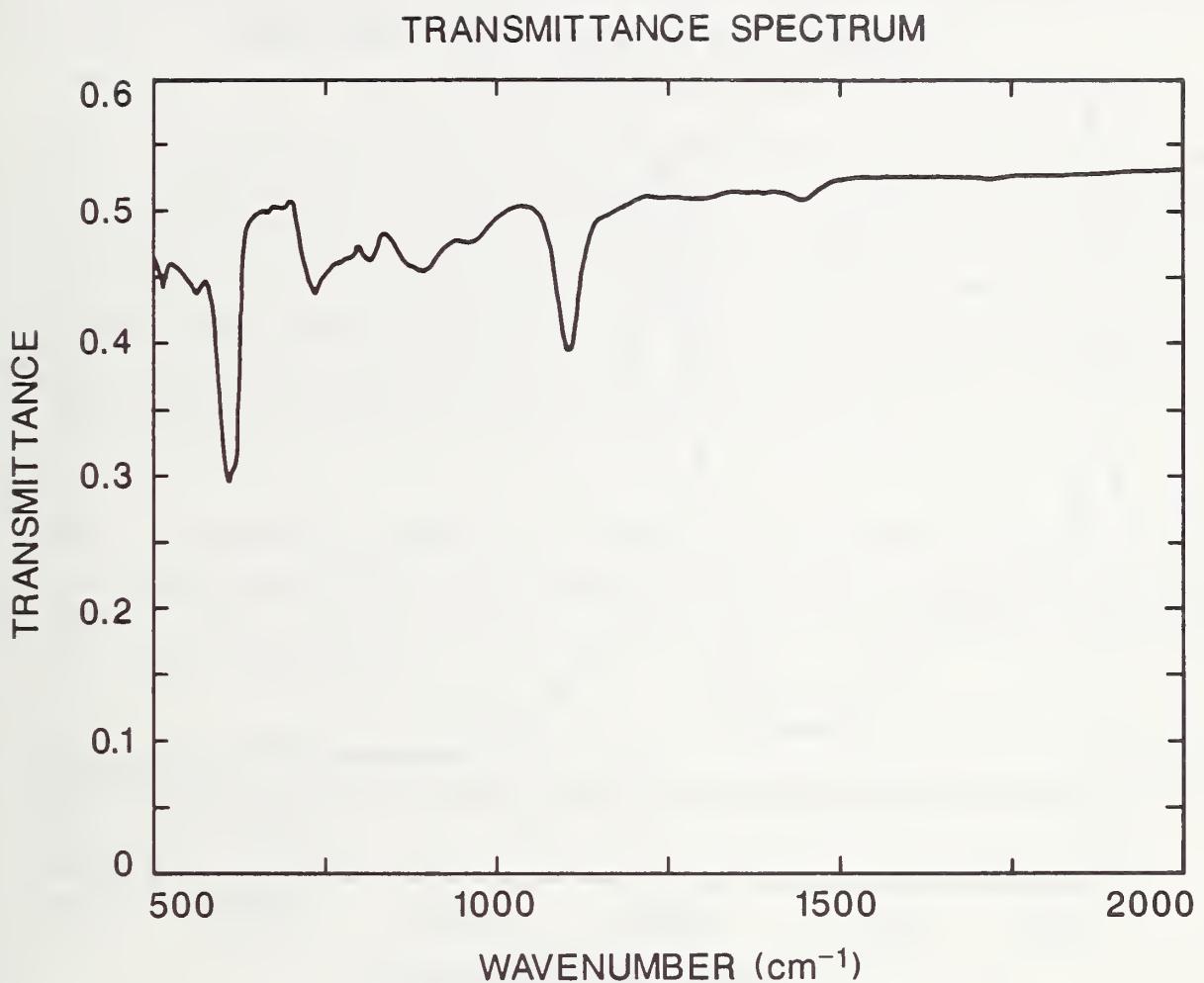


Figure 1: Transmittance spectrum of a p-type Czochralski silicon wafer with a resistivity of $9 \Omega\text{-cm}$ and an oxygen content of 20 parts per million (atomic).

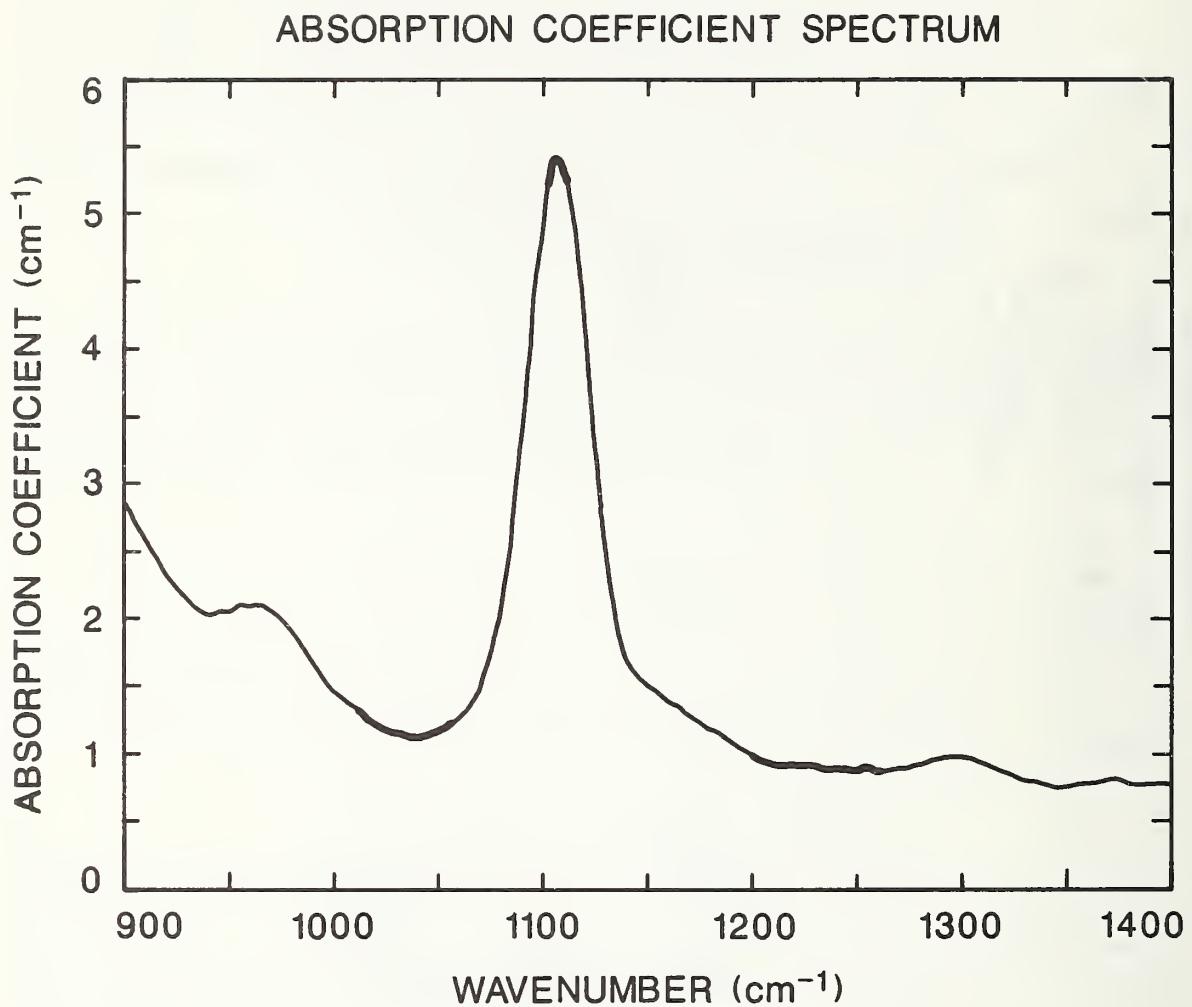


Figure 2: Absorption coefficient spectrum of a p-type Czochralski silicon wafer with a resistivity of $9 \Omega\text{-cm}$ and an oxygen content of 20 parts per million (atomic). The thick sections of the line indicate the wavenumber regions used to calculate the oxygen content (see page 2).

analysis. This constant is $6.28 \text{ cm}\cdot\text{ppma}$.⁺

This procedure was converted to a computer algorithm. The following is an outline of the algorithm.

- The measured IR transmittance of the sample is read from a data file and only those transmittances between 1000 and 1300 wavenumbers are stored. Three regions about the interstitial oxygen minimum, 1010 to 1060 cm^{-1} , 1200 to 1260 cm^{-1} , and 1090 to 1123 cm^{-1} , are considered for further analysis. The first two regions are used to determine the baseline for the minimum. By the method of least-squares, a third-order polynomial is fitted to the transmittance data in each of these two regions. For the absorption maximum, a fourth-order polynomial is used.
- The two transmittance maxima, the minimum, and the wavenumbers at which they occur are determined from the least-squares-fit curves. The transmittance values are denoted by T_{max1} , T_{peak} , and T_{max2} . The respective wavenumbers are denoted by σ_{max1} , σ_{peak} , and σ_{max2} .
- The baseline transmittance is determined from a linear interpolation between the two maxima of the form

$$T_{base}(\sigma) = T_1 + \frac{T_2 - T_1}{\sigma_2 - \sigma_1}(\sigma - \sigma_1).$$

- α_{peak} and α_{base} are determined by solving eq (2) using the appropriate calculated transmittance.
- The net absorption coefficient is calculated by

$$\alpha_{net} = \alpha_{peak} - \alpha_{base}.$$

⁺ A. Baghdadi, W. M. Bullis, M. C. Croarkin, Li Yue-zhen, R. I. Scace, R. W. Series, P. Stallhofer, and M. Watanabe, to be published in the Journal of the Electrochemical Society.

Lattice absorption at 1107 cm^{-1} due to lattice bands contributes an additional net absorption of 0.5 cm^{-1} ,[#] so the oxygen content is calculated by

$$\text{ppm atomic} = 6.28 \times (\alpha_{net} - 0.5).$$

This algorithm has been implemented in FORTRAN and PASCAL computer programs, which are listed in the sections IIIA and IIIB, respectively. These programs should only be considered as examples rather than as the approved methods for implementing the algorithm. Section IV contains four sample transmission spectra. These spectra (plus two more) have also been written on $5\frac{1}{4}\text{-in. MS-DOS}^{\circ}$ floppy disks that can be found in a pocket on the end of this Special Publication. Section V is a listing of the output from the FORTRAN and PASCAL programs listed in section III, as applied to all six sample spectra. The thicknesses of the silicon wafers used to produce the IR spectra are included in the output listed in section V. The oxygen contents determined for these spectra should match the oxygen contents listed in this output. Thus, these spectra can be used to test a computer program based upon the algorithm by comparing the oxygen content computed using the program to the listed oxygen content. The oxygen contents in section V are listed to four significant figures, rather than the three significant figures which is appropriate considering the precision of the IR measurement, in order to facilitate the comparison of computer programs.

[#] See ASTM Test Method F 121, 1988 Annual Book of ASTM Standards, V. 10.05, to be published.

[◦] Certain commercial equipment, instruments or materials are identified in this paper in order to adequately specify the experimental procedure. Such identification does not imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the materials or equipment identified are necessarily the best available for the purpose.

ANNOTATED PROGRAMS

Section IIIA. FORTRAN Program

PROGRAM ASTMDSP

```

C **** ASTMDSP ****
C *
C * THIS PROGRAM COMPUTES THE INTERSTITIAL OXYGEN CONTENT OF *
C * DOUBLE-SIDE POLISHED SILICON SAMPLES IN PARTS PER MILLION ATOMIC. *
C * THE PROCEDURE IS A MODIFICATION OF THAT PRESENTED IN THE GREY *
C * PAGES OF THE ASTM HANDBOOK. INSTEAD OF TAKING AVERAGE VALUES FOR *
C * THE TWO MAXIMA AND THE MINIMUM, A LEAST-SQUARES POLYNOMIAL IS FIT *
C * TO SEVERAL DATA POINTS AROUND EACH FEATURE. ALSO, THE WAVENUMBERS *
C * WHERE THE MAXIMA AND MINIMUM OCCUR ARE DETERMINED FROM THE FIT. A *
C * 3RD-ORDER POLYNOMIAL IS USED FOR THE MAXIMA AND A 4TH-ORDER *
C * POLYNOMIAL IS USED FOR THE MINIMUM. THE 4TH ORDER FIT WAS CHOSEN *
C * IN ORDER TO BE COMPATIBLE WITH THE PROCEDURE GIVEN IN THE ANNEX *
C * FOR THE OXYGEN DETERMINATION IN THIN SLICES.
C *
C * -----NOTE:
C * IT IS COMMON PRACTICE TO SPEAK OF THE INTERSTITIAL *
C * OXYGEN PEAK. THIS IS ONLY TRUE WHEN WORKING IN *
C * ABSORBANCE. ALL DATA REDUCTION IN THIS PROGRAM IS *
C * DONE IN TRANSMITTANCE, THUS WE SPEAK OF THE *
C * INTERSTITIAL OXYGEN MINIMUM.
C *
C **** ASTMDSP ****
DIMENSION ABSRB(500),FUNC(200),IFLAG(6),SIGMA(500),SPEC(600),W(6),
+ WAVE(600),WEIGHT(200),WORK(500)
CHARACTER*40 FILEIN,FILEOUT
DOUBLE PRECISION ANSWER(200)
INTEGER DAY,YEAR
REAL MAX1,MAX2,MINPK,MAXCAL,MINCAL,NET,NETABS,NODE(200)
DATA IFLAG,W,WEIGHT/6*0,1010.,1060.,1090.,1123.,1200.,1260.,
+ 200*1./
1001 FORMAT(3I2)
1002 FORMAT(A40)
1003 FORMAT(F10.4)
1011 FORMAT(1H1/' ASTMDSP ----- ',I2,'/',I2.'/',I2,
+ 35X,'PAGE ',I1)
1012 FORMAT(1H1/' ASTMDSP ----- ',I2,'/',I2.'/',I2,
+ 34X,'PAGE ',I2)
1013 FORMAT(' *****spectrum***** ',A40)
1014 FORMAT(' thickness is ',F6.4,'cm')
1015 FORMAT(' T(',F6.1,') = ',F6.4,' residual std. dev.=',E10.
+ 3,' T(',F6.1,') = ',F6.4,' residual std. dev.=',E10.3/' T
+ (',F6.1,') = ',F6.4,' residual std. dev.=',E10.3)
1016 FORMAT(' BASELINE TRANSMITTANCE AT ',F6.1,' WAVENUMBERS=',F7.4)
1017 FORMAT(' =====> ALPHA(BASE) = ',F5.3,' ALPHA(PEAK) = ',F7.5/)
1018 FORMAT(' NET ABSORBANCE PEAK HEIGHT = ',F8.6/)
1019 FORMAT(10X,'*****',/10X,'*****',/10X,'*****',/10X,'*****',
+ T IS ',F5.2,' PPMA */,10X,'*****',/10X,'*****')
NLINES=0
IPAGE=1
C ****
C * FILE 'MODEL.RES' IS USED FOR STORAGE OF THE RESULTS. THE OUTPUT *
C * IS PRINTED TO THIS FILE IN SUCH A WAY THAT YOU CAN OBTAIN A *
C * FORMATTED HARD-COPY OF THE FILE AT A LATER TIME.
C ****
C

```

```

OPEN(UNIT=30,FILE=' MODEL.RES',STATUS='NEW')
C
C **** INPUT DATE, NAME OF TRANSMITTANCE FILE, AND THICKNESS OF WAFER. *
C ****
C
      WRITE(6,*) ' TODAY'S DATE----'
      READ(5,1001)MONTH,DAY,YEAR
  5  WRITE(6,*) ' NAME OF DSP TRANSMITTANCE DATA FILE.'
      READ(5,1002)FILEIN
      WRITE(6,*) ' THICKNESS OF WAFER.'
      READ(5,1003)TAU
      OPEN(UNIT=7,FILE=FILEIN,STATUS='OLD')
      IF(NLINES.EQ.0.AND.IPAGE.EQ.1) THEN
          WRITE(30,1011)MONTH,DAY,YEAR,IPAGE
          NLINES=NLINES+1
      END IF
      WRITE(30,*)'
      WRITE(30,*)'
      WRITE(30,1013)FILEIN
      WRITE(30,1014)TAU
C
C **** READ TRANSMITTANCE DATA AND SELECT THOSE DATA POINTS BETWEEN 1000 *
C **** AND 1300 WAVENUMBERS (INCLUSIVE).
C **** FORMAT OF DATA FILE:
C ****     (1) FIRST LINE CONTAINS THE NUMBER OF LINES OF DATA
C ****     (2) EACH SUBSEQUENT LINE CONTAINS THE COUNTER VALUE
C ****             CORRESPONDING TO THE LINE OF DATA, WAVENUMBER, AND
C ****             TRANSMITTANCE.
C ****
K=1
      READ(7,*)NCNT
      DO 10 I=1,NCNT
      READ(7,* ,ERR=115)LL,WAVENM,TRANSM
      IF((WAVENM.GE.1000.).AND.(WAVENM.LE.1300.)) THEN
          WAVE(K)=WAVENM
          SPEC(K)=TRANSM
          K=K+1
          GO TO 10
      ELSE IF (WAVENM.GT.1300.) THEN
          GOTO 15
      END IF
  10 CONTINUE
  15 NDP=K-1
C
C **** DETERMINE WAVENUMBER REGIONS FOR LEAST-SQUARES FIT OF *
C **** DATA AT MAXIMA AND MINIMUM ABOUT 1107 WAVENUMBER ABSORPTION *
C ****

```

```

MAXDEG=3
KNT=0
INDEX=-1
DO 100 I=1,NDP
  IF(WAVE(I).GE.W(1)) INDEX=2
  IF(WAVE(I).GE.W(3)) INDEX=4
  IF(WAVE(I).GE.W(5)) INDEX=6
  IF(INDEX.LT.0)GOTO 100
C
C ****
C * CREATE ARRAYS OF NODES AND FUNCTION VALUES FOR LEAST SQUARES FIT. *
C ****
C
C      IF(IFLAG(INDEX).EQ.1)GOTO 100
25 IF(KNT.EQ.0) ITST=INDEX
    IF(ITST.NE.INDEX) THEN
      KNT=0
      GO TO 25
    END IF
35 IF(WAVE(I).LE.W(INDEX)) THEN
    KNT=KNT+1
    NODE(KNT)=WAVE(I)
    IF(INDEX.EQ.4)NODE(KNT)=NODE(KNT)-1107.
    FUNC(KNT)=SPEC(I)
    GO TO 100
  END IF
C
C ****
C *          COMPUTE LEAST SQUARES FIT. *
C ****
C
C 45 IFLAG(INDEX)=1
EPS=-1.
  IF(INDEX.EQ.4) THEN
    MAXDEG=4
    CALL LEAST(KNT,NODE,FUNC,WEIGHT,EPS,MAXDEG,NDEG,WORK,ANSWER)
    II=INDEX-1
    GOTO 65
  ELSE
    MAXDEG=3
    CALL LEAST(KNT,NODE,FUNC,WEIGHT,EPS,MAXDEG,NDEG,WORK,ANSWER)
    II=INDEX-1
    WAVCAL=QKPRIM(WORK,MAXDEG)
    IF(WAVCAL.GE.W(II).AND.WAVCAL.LE.W(INDEX))GOTO 65
  END IF
C
C ****
C * ROUTINE TO USE INSTEAD OF DERIVATIVE PROCEDURE. THIS SECTION OF *
C * CODE IS NECESSARY SINCE IT IS POSSIBLE FOR THE FIT NOT TO HAVE A *
C * DISTINCT MIN OR MAX. *
C ****
C

```

```

STEP=(WAVE(2)-WAVE(1))/5.
WAVNUM=W(11)
KK=0
55 IF(WAVNUM.LE.W(INDEX)) THEN
    KK=KK+1
    ABSRB(KK)=EVAL(WAVNUM,MAXDEG,WORK,MAXDEG)
    SIGMA(KK)=WAVNUM
    WAVNUM=WAVNUM+STEP
    GO TO 55
END IF
WAVCAL=MAXCAL(SIGMA,ABSRB,KK)

C ****
C * COMPUTE RESIDUAL STANDARD DEVIATION OF THE FIT AND THE *
C * WAVENUMBERS AT WHICH MAXIMA AND MINIMUM OCCUR. *
C ****
C

65 SUM=0.
DO 70 J=1,KNT
SUM=SUM+(FUNC(J)-SNGL(ANSWER(J)))**2
70 CONTINUE
RESID=SQRT(SUM/FLOAT(KNT-1))
IF(INDEX.LT.1.OR.INDEX.GT.6) THEN
    GOTO 135
ELSE IF(INDEX.EQ.2) THEN
    WAVE1=WAVCAL
    MAX1=EVAL(WAVE1,MAXDEG,WORK,MAXDEG)
    R1=RESID
    GO TO 100
ELSE IF(INDEX.EQ.4) THEN
    CALL PEAKCL(MAXDEG,WORK,WAVEP,MINPK)
    R2=RESID
    GO TO 100
ELSE IF(INDEX.EQ.6) THEN
    WAVE2=WAVCAL
    MAX2=EVAL(WAVE2,MAXDEG,WORK,MAXDEG)
    R3=RESID
    ELSE
        GO TO 135
    END IF
100 CONTINUE
WRITE(30,1015)WAVE1,MAX1,R1,WAVEP,MINPK,R2,WAVE2,MAX2,R3

C ****
C * CALCULATE THE BASE TRANSMITTANCE AT 1107 WAVENUMBERS, AND THE *
C * ABSORPTION COEFFICIENTS AT THE PEAK AND BASE OF THE ABSORPTION. *
C ****
C

BASE=((WAVE2-WAVEP)*MAX1+(WAVEP-WAVE1)*MAX2)/(WAVE2-WAVE1)
ALFAB=DSPCOR(BASE,TAU)
ALFAP=DSFCOR(MINPK,TAU)
ALFNET=ALFAP-ALFAB

```

```

C **** OUTPUT REMAINING RESULTS ****
C
C
C      NETABS=ALFNET*TAU/2.303
C      PPM=(ALFNET-0.5)*6.28
C      WRITE(30,1016)WAVEP,BASE
C      WRITE(30,1017)ALFAB,ALFAP
C      WRITE(30,1018)NETABS
C      WRITE(30,1019)PPM
C
C **** RESET 'IFLAG' ARRAY. ****
C
C
C      DO 110 MM=1,6
C 110 IFLAG(MM)=0
C
C **** CHECK FOR FULL PAGE. ****
C
C
C      NLINES=NLINES+16
C      IF((NLINES+16).GE.60) THEN
C          NLINES=1
C          IPAGE=IPAGE+1
C          IF(IPAGE.LT.10) THEN
C              WRITE(30,1011)MONTH,DAY,YEAR,IPAGE
C          ELSE
C              WRITE(30,1012)MONTH,DAY,YEAR,IPAGE
C          END IF
C      END IF
C      GO TO 5
C
C **** ERROR MESSAGES AND TERMINATION. ****
C
C
C      115 WRITE(6,*) ' ERROR ENCOUNTERED IN READING DATA.'
C      GO TO 200
C      125 WRITE(6,*) ' WAVENUMBER CALCULATED IS OUTSIDE OF RANGE.'
C          WRITE(6,*) INDEX
C          NUM=3*MAXDEG
C          DO 130 JJ=1,NUM
C 130  WRITE(6,*)JJ,WORK(JJ)
C          GO TO 200
C      135 WRITE(6,*) ' HOW DID YOU CHANGE "INDEX"?????'
C      200 STOP
C      END

```

```

FUNCTION DSPCOR(A1,A2)
C
C **** THIS FUNCTION COMPUTES ABSORPTION COEFFICIENT BASED ON ****
C * THE DSP TRANSMITTANCE EQUATION. *
C ****
C
TERM=(-0.49+SQRT(0.2401+0.36*A1**2))/(0.18*A1)
DSPCOR=- ALOG10(TERM)*2.303/A2
RETURN
END

REAL FUNCTION MAXCAL(ARRAY1,ARRAY2,NUM)
C
C **** THIS FUNCTION FINDS THE MAXIMUM TRANSMITTANCE WITHIN THE ****
C * WAVENUMBER RANGE SPECIFIED BY THE W(I1) AND W(INDEX). *
C ****
C
DIMENSION ARRAY1(*),ARRAY2(*)
PEAK=0.25
DO 10 KNT=1,NUM
IF(ARRAY2(KNT).LT.PEAK)GOTO 10
MAXCAL=ARRAY1(KNT)
PEAK=ARRAY2(KNT)
10 CONTINUE
RETURN
END

REAL FUNCTION MINCAL(D)
C
C **** WHEN A FOURTH-ORDER POLYNOMIAL IS FIT TO THE OXYGEN TRANSMITTANCE ****
C * MINIMUM, THE RESULTING DERIVATIVE IS A CUBIC EQUATION. THE ****
C * THE SOLUTION OF THIS EQUATION, IN THE SUBROUTINE 'PEAKCL', IS 3 ****
C * ROOTS. THIS FUNCTION FINDS THE ROOT CLOSEST IN ABSOLUTE VALUE TO ****
C * 1107 WAVENUMBERS. THIS ROOT SHOULD BE THE WAVENUMBER OF THE ****
C * INTERSTITIAL OXYGEN MINIMA. *
C ****
C
DIMENSION D(3)
VALUE=ABS(D(1))
IK=1
DO 20 KK=2,3
IF(ABS(D(KK)).LT.VALUE) IK=KK
20 CONTINUE
MINCAL=D(IK)
RETURN
END

```

```

SUBROUTINE PEAKCL(NDEG,ARRAY,WAIVENM,VALUE)
C
C **** CODE TO DETERMINE COEFFICIENTS OF THE FOURTH-ORDER POLYNOMIAL ****
C * FITTED TO THE OXYGEN MINIMUM AND THEN SOLVE THE CUBIC EQUATION ****
C * FOR THE WAVENUMBER AT THE MINIMUM. ****
C ****
C
      REAL MINCAL
      DIMENSION ARRAY(*)
      COEFX3=4.*ARRAY(12)
C
      SUM=0.
      DO 100 JJ=4,1,-1
 100   SUM=SUM+ARRAY(JJ)
      COEFX2=-3.*ARRAY(12)*SUM+3.*ARRAY(11)
C
      SUM1=0.
      SUM2=0.
      SUM3=0.
      DO 200 JJ=4,2,-1
      SUM2=SUM2+ARRAY(JJ+3)
      SUM3=SUM3+ARRAY(JJ-1)
      JJM1=JJ-1
      DO 200 LL=JJM1,1,-1
 200   SUM1=SUM1+ARRAY(JJ)*ARRAY(LL)
      COEFX1=-2.*ARRAY(12)*(SUM1-SUM2)-2.*ARRAY(11)*SUM3+2.*ARRAY(10)
C
      SUM1=0.
      SUM2=0.
      SUM3=0.
      SUM4=0.
      DO 300 JJ=4,3,-1
      SUM2=SUM2+ARRAY(JJ-2)
      SUM3=SUM3+ARRAY(JJ+2)
      JJM1=JJ-1
      DO 300 LL=JJM1,2,-1
      JJM2=JJ-2
      DO 300 MM=JJM2,1,-1
 300   SUM1=ARRAY(JJ)*ARRAY(LL)*ARRAY(MM)
      DO 400 LL=3,2,-1
      LLM1=LL-1
      DO 400 MM=LLM1,1,-1
 400   SUM4=SUM4+ARRAY(LL)*ARRAY(MM)
      COEFX0=-ARRAY(12)*(SUM1-(ARRAY(4)*(ARRAY(5)+ARRAY(6)))+
      *          ARRAY(3)*ARRAY(5)+ARRAY(2)*ARRAY(7) +
      *          (ARRAY(1)*(ARRAY(6)+ARRAY(7))))+ARRAY(11)*(SUM4-SUM3)-
      *          ARRAY(10)*SUM2+ARRAY(9)
C
      A2=COEFX2/COEFX3
      A1=COEFX1/COEFX3
      A0=COEFX0/COEFX3

```

```

CALL CUBIC(A0,A1,A2,R1,R2,R3)
ROOT=MINCAL(R1,R2,R3)
WAVENM=1107.+ROOT
VALUE=EVAL(ROOT,NDEG,ARRAY,NDEG)
RETURN
END

FUNCTION QKPRIM(ARRAY,NUM)
C
C **** THIS FUNCTION COMPUTES THE WAVENUMBER AT WHICH THE FIRST *
C * DERIVATIVE OF THE 3RD-ORDER POLYNOMIAL LEAST SQUARES FIT IS ZERO. *
C ****
C
DIMENSION ARRAY(*)
A=3.*ARRAY(9)
SUM=0.
DO 10 II=NUM,1,-1
10 SUM=SUM+ARRAY(II)
B=-(2.*SUM*ARRAY(9)-2.*ARRAY(8))
SUM1=0.
DO 30 II=NUM,1,-1
NUM1=II-1
IF(NUM1.NE.0) THEN
  DO 20 KK=NUM1,1,-1
20  SUM1=SUM1+ARRAY(II)*ARRAY(KK)
END IF
30 CONTINUE
SUM2=0.
NUM2=2*NUM-2
NUM1=NUM+1
DO 40 II=NUM1,NUM2
40 SUM2=SUM2+ARRAY(II)
SUM3=ARRAY(1)+ARRAY(2)
C=ARRAY(9)*(SUM1-SUM2)-ARRAY(8)*SUM3+ARRAY(7)
ARGMNT=(B**2)-4.*A*C
IF(ARGMNT.GE.0) THEN
  TERM1=SQRT(ARGMNT)
  QKPRIM=(-B+TERM1)/(2.*A)
  IF(QKPRIM.LT.0.)QKPRIM=(-B-TERM1)/(2.*A)
  RETURN
ELSE
  QKPRIM=-1.
  RETURN
END IF
END

```

```

SUBROUTINE LEAST(M,X,F,W,EPS,MAXDEG,NDEG,ARRAY,R)
C
C THE SUBROUTINE LEAST AND THE FUNCTION EVAL CALCULATE THE LEAST
C SQUARES POLYNOMIAL APPROXIMATION TO A SET OF DATA SPECIFIED BY THE
C ARRAY OF M NODES, X, WITH CORRESPONDING FUNCTION VALUES AND WEIGHTS
C IN THE ARRAYS F AND W, RESPECTIVELY. THE WEIGHTS MUST ALL BE
C POSITIVE. THE POLYNOMIAL IS DETERMINED IN LEAST AND EVALUATED IN
C EVAL. ON INPUT EPS IS THE DESIRED WEIGHTED RMS ERROR. THE CODE
C INCREASES THE DEGREE OF THE FIT IN AN ATTEMPT TO MEET THIS ERROR
C REQUEST. ON RETURN EPS IS SET TO THE WEIGHTED RMS ERROR OF THE FIT.
C BECAUSE EPS IS USED FOR BOTH INPUT AND OUTPUT, IT MUST BE A VARIABLE
C IN THE CALLING PROGRAM. MAXDEG IS THE HIGHEST DEGREE ALLOWED AND MUST
C BE LESS THAN OR EQUAL TO (M-1). THE ACTUAL DEGREE OF THE FIT IS
C RETURNED IN NDEG. TO FORCE THE CODE TO USE THE PARTICULAR DEGREE
C MAXDEG, SET EPS NEGATIVE ON INPUT. THE DOUBLE PRECISION VECTOR R OF M
C WORDS OUTPUTS THE DOUBLE PRECISION VALUES OF THE POLYNOMIAL FIT AT
C EACH OF THE DATA POINTS X(I). THE VECTOR "ARRAY" SPECIFIES THE
C ORTHOGONAL POLYNOMIAL FIT AND PROVIDES WORKING STORAGE. THE DIMENSION
C OF ARRAY IN THE CALLING PROGRAM MUST BE AT LEAST 2*M+3*MAXDEG. THE
C ARRAYS X,F,W, ARRAY AND R MUST BE DIMENSION IN THE CALLING PROGRAM.
C
C
DIMENSION X(*),F(*),W(*),ARRAY(*)
DOUBLE PRECISION R(*),SUM,CK,TEMP
C
C INITIALIZE STORAGE AND CONSTANTS.
C
IB=MAXDEG+1
IBL2=MAXDEG-1
IC=IB+IBL2
IOL1=IC+MAXDEG
I1L1=IOL1+M
RM=M
TOL=RM*EPS**2
C
C CALCULATE CONSTANT FIT.
C
NDEG=0
S=0.
SUM=0.0D0
DO 1 I=1,M
S=S+W(I)
1 SUM=SUM+DBLE(W(I))*DBLE(F(I))
RNO=S
C
C CK IS THE COEFFICIENT C(0) HERE.
C
CK=SUM/RNO
ARRAY(IC)=CK
ERROR=0.0
DO 2 I=1,M
R(I)=CK
2 ERROR=ERROR+W(I)*SNGL(CK-DBLE(F(I)))**2
IF(NDEG.EQ.MAXDEG)GO TO 14
IF(EPS.LT.0.0)GO TO 3
IF(ERROR.LE.TOL)GO TO 14
C
C CALCULATE LINEAR FIT.
C
3 NDEG=1

```

```

ES=ERROR
SUM=0.0D0
DO 4 I=1,M
4   SUM=SUM+DBLE(W(I))*DBLE(X(I))
C
C   CALCULATE A(1).
C
C     ARRAY(1)=SUM/RNO
C
C   CALCULATE Q1(.).
C
C     S=0.0
C     SUM=0.0D0
C     DO 5 I=1,M
C       ARRAY(I1L1+I)=X(I)-ARRAY(1)
C       S=S+W(I)*ARRAY(I1L1+I)**2
C       TEMP=DBLE(F(I))-R(I)
C     5   SUM=SUM+DBLE(W(I))*DBLE(ARRAY(I1L1+I))*TEMP
C       RN1=S
C
C   CK IS THE COEFFICIENT C(1) HERE.
C
C     CK=SUM/RN1
C     ARRAY(IC+1)=CK
C
C   CALCULATE THE VALUE OF THE FIT AT THE DATA POINTS AND
C   ALSO THE RMS ERROR.
C
C     ERROR=0.0
C     DO 6 I=1,M
C       R(I)=R(I)+CK*DBLE(ARRAY(I1L1+I))
C     6   ERROR=ERROR+W(I)*SNGL(R(I)-DBLE(F(I)))**2
C       IF(ERROR.GT.ES.AND.EPS.GE.0.0)GO TO 12
C       IF(NDEG.EQ.MAXDEG)GO TO 14
C       IF(ERROR.LE.TOL.AND.EPS.GE.0.0)GO TO 14
C       DO 7 I=1,M
C     7   ARRAY(IOL1+I)=1.0
C       NDEG=2
C       K=2
C
C   GENERAL FIT.
C
C     8   ES=ERROR
C
C   CALCULATE B(K).
C
C     ARRAY(IBL2+K)=RN1/RNO
C
C   CALCULATE A(K).
C
C     SUM=0.0D0
C     DO 9 I=1,M
C     9   SUM=SUM+DBLE(W(I))*DBLE(X(I))*DBLE(ARRAY(I1L1+I))**2
C       ARRAY(K)=SUM/RN1
C
C   CALCULATE QK(.) OVERWRITING ON QK-2(.).
C
C     S=0.0
C     SUM=0.0D0

```

```

DO 10 I=1,M
ARRAY(IOL1+I)=(X(I)-ARRAY(K))*ARRAY(I1L1+I)
1 -ARRAY(IBL2+K)*ARRAY(IOL1+I)
S=S+W(I)*ARRAY(IOL1+I)**2
TEMP=DBLE(F(I))-R(I)
10 SUM=SUM+DBLE(W(I))*DBLE(ARRAY(IOL1+I))*TEMP
RNO=RN1
RN1=S
C
C SWAP INDICES SO I1 REFERS TO STORAGE OF QK(.)
C AND IO TO QK-1(.).
C
IT=IOL1
IOL1=I1L1
I1L1=IT
C
C CK IS THE COEFFICIENT C(K) HERE.
C
CK=SUM/RN1
ARRAY(IC+K)=CK
C
C CALCULATE THE VALUE OF THE FIT AT THE DATA POINTS AND
C ALSO THE RMS ERROR.
C
ERROR=0.0
DO 11 I=1,M
R(I)=R(I)+CK*DBLE(ARRAY(I1L1+I))
11 ERROR=ERROR+W(I)*SNGL(R(I)-DBLE(F(I)))**2
IF(ERROR.GT.ES.AND.EPS.GE.0.0)GO TO 12
IF(NDEG.EQ.MAXDEG)GO TO 14
IF(ERROR.LE.TOL.AND.EPS.GE.0.0)GO TO 14
NDEG=NDEG+1
K=K+1
GO TO 8
C
C HERE IF ERROR INCREASED ON RAISING DEGREE.
C
12 NDEG=NDEG-1
ERROR=ES
DO 13 I=1,M
13 R(I)=R(I)-CK*DBLE(ARRAY(I1L1+I))
C
C EXIT.
C
14 EPS=SQRT(ERROR/RM)
RETURN
END
FUNCTION EVAL(Y,N,ARRAY,MAXDEG)
C
C THE FUNCTION EVAL EVALUATES THE ORTHOGONAL POLYNOMIAL
C FIT COMPUTED BY LEAST AND SPECIFIED BY THE VECTOR
C ARRAY. THE FIT OF DEGREE N IS EVALUATED AT THE ARGU-
C MENT Y. N MUST BE LESS THAN OR EQUAL TO NDEG AS
C RETURNED FROM LEAST. LEAST IS CALLED ONLY ONCE FOR
C EACH FIT, BUT EVAL IS CALLED ONCE FOR EACH ARGUMENT
C AT WHICH WE REQUIRE THE VALUE OF THE FIT. MAXDEG MUST
C HAVE THE SAME VALUE AS IN THE CALL TO LEAST.
C
DIMENSION ARRAY(1)

```

```

IB=MAXDEG+1
IC=MAXDEG+IB-1
C
C EVALUATE N=0,1 AS SPECIAL CASES.
C
1 IF(N.GT.0) GO TO 1
EVAL=ARRAY(IC)
RETURN
1 IF(N.GT.1) GO TO 2
EVAL=ARRAY(IC)+ARRAY(IC+1)*(Y-ARRAY(1))
RETURN
C
C GENERAL RECURRENCE RELATION.
C
2 DKP2=ARRAY(IC+N)
DKP1=ARRAY(IC+N-1)+(Y-ARRAY(N))*DKP2
NL2=N-2
IF(NL2.LT.1) GO TO 4
DO 3 L=1,NL2
K=1+NL2-L
DK=ARRAY(IC+K)+(Y-ARRAY(K+1))*DKP1
1 -ARRAY(IB+K)*DKP2
DKP2=DKP1
3 DKP1=DK
4 EVAL=ARRAY(IC)+(Y-ARRAY(1))*DKP1
1 -ARRAY(IB)*DKP2
RETURN
END

```

```

SUBROUTINE CUBIC(A0,A1,A2,R1,R2,R3)
C
C **** THIS SUBROUTINE WAS WRITTEN BY JERRY LOWNEY ****
C *          TO SOLVE THE CUBIC EQUATION:          *
C *          X^3 + A2*X^2 + A1*X + A0 = 0          *
C ****
C
C      COMPLEX X1,X2,X3,T,U,D,E,F
P=A2
Q=A1
R=A0
A=1./3*(3*Q-P**2)
B=1./27*(2*P**3-9*P*Q+27*R)
D=B**2/4+A**3/27
E=-B/2+CSQRT(D)
IF(E.EQ.(0,0)) THEN
    T=0
    GO TO 15
END IF
IF(AIMAG(E).EQ.0..AND.REAL(E).LT.0.)THEN
    T=-EXP(ALOG(CABS(E))/3)
    GO TO 15
END IF
T=CEXP(CLLOG(E)/3)
F=-B/2-CSQRT(D)
IF(F.EQ.(0,0)) THEN
    U=0
    GO TO 16
END IF
IF(AIMAG(F).EQ.0..AND.REAL(F).LT.0.)THEN
    U=-EXP(ALOG(CABS(F))/3)
    GO TO 16
END IF
U=CEXP(CLLOG(F)/3)
X1=T+U
X2=-.5*(T+U)+.5*(T-U)*CSQRT((-3,0))
X3=-.5*(T+U)-.5*(T-U)*CSQRT((-3,0))
R1=X1-P/3
R2=X2-P/3
R3=X3-P/3
RETURN
END

```

Section IIIB. PASCAL Program

ASTMDSP [Pascal Version]

```

program astmdsp(input,output,fn);

(*F-1 Proposal p 112*)
(*Interstitial Oxygen Content Of Silicon Slices By*)
(*Computer-Assisted Infrated Spectrophotometry*)
(*10/16/85*)
(*Double Side Polished*)
(*-----
*) (*----- Modified by Warren Gladden
(*)----- date: 8/21/87
(*----- *)
*)

const
  maxr=32;                                (*max data points in fit*)
  maxc=9;                                  (*max number of variables in fit*)

type
  sstring = packed array[1..40] of char;      (*filename type*)
  drayr   = array[1..maxr] of real;           (*array types for fits*)
  drayc   = array[1..maxc] of real;           (*          *)
  ddray1  = array[1..maxr,1..maxc] of real;    (*          *)
  ddray2  = array[1..maxc,1..maxc] of real;    (*          *)

var
  coef,nal                      :drayc;      (*ls fit vars*)
  x,y,yemp,
  dual                           :drayr;      (*ls vars*)
  x1:array[1..1001] of real;       (*wavenumber array*)
  y1:array[1..1001] of real;       (*transmittance array*)
  corco,yco,xco                 :real;       (*ls vars*)
  xint,xwave                     :real;       (*interpolate vars*)
  smax2,speak,tmax1,smax1,tmax2 :real;       (*astm vars*)
  tr,thk                         :real;       (*temp trans, thick*)
  rsdmax1,rsdmax2,rsdpeak        :real;       (*residual vars*)
  nmax1,nmax2,npeak              :real;       (*# pts fit*)
  apeak,abase,tpeak,temp,temp1   :real;       (*abs pk,base*)
  ppm,anet,latnet                :real;       (*conc var*)
  tbase,tb1,tb2                  :real;       (*baseline var*)
  a1,a2,a3,alphas                :real;       (*abs coef var*)
  e,del,firstx,roffset            :real;       (*uncertainty var*)
  sumy2,ysum2                     :real;       (*stan. dev. var*)
  nrow,ncol,num,noffset           :integer;    (*array sizes and degree*)
  startwave,endwave,wave1,wave2  :integer;    (*wavenumber limit for fit*)
  dummy,i,j,xtemp                :integer;    (*loop and temp. var*)
  fname,fnames,junk               :string[14]; (*filename, ref, samp*)
  fn                               :text;       (*file var*)
(*-----
*) procedure base;                      (*baseline @ oxygen*)
begin
  tb1:=smax2-speak;

```

```

tb2:=speak-smax1;
tbase:=tb1*tmax1+tb2*tmax2;
tbase:=tbase/(smax2-smax1);
end;
(*-----)
*) procedure alpha; (*absorption coefficient*)
begin
  a1:=-0.49+sqrt(0.2401+0.36*sqr(tr));
  a2:=a1/(0.18*tr);
  a3:=ln(a2);
  alphas:=-1/thk*a3;
end;
(*-----)
*) procedure uncertainty; (*non-symmetrical uncertainty*)
begin
  e:=(rsdmax1/(nmax1-4))+(rsdpeak/(npeak-5))+(rsdmax2/(nmax2-4));
  e:=2*sqrt(e);
end;
(*-----)
*) procedure standev; (*standard deviation*)
begin
  sumy2:=0;
  ysum2:=0;
  j:=0;
  for i:=1 to num do
  begin
    if (x1[i]>=2000) and (x1[i]<=2060) then
    begin
      sumy2:=y1[i]*y1[i]+sumy2;
      ysum2:=y1[i]+ysum2;
      j:=j+1;
    end;
  end;
  ysum2:=sqrt(ysum2);
  ysum2:=ysum2/j;
  sumy2:=sumy2-ysum2;
  sumy2:=sumy2/(j-2);
  sumy2:=sqrt(sumy2);
end;
(*-----)
*) procedure OpenInFile;
var
  OK :boolean;
begin
  repeat
    write('Enter name of transmittance file: ');
    readln(fname);
    assign(fn,fname);
    {$I-} reset(fn) {$I-};
    OK:=(IOresult = 0);
    if not OK then
      writeln('Cannot find file: ',fname);
  until OK;
end;

```

```

(*-----
*) procedure OpenFile;
begin
  assign(fn, fname);
  rewrite(fn);
end;
(*-----
*) procedure sorttrans;           (*move target trans values*)
begin
  for i:=1 to num do
  begin
    if (x1[i]>=wave1) and (x1[i]<=wave2) then
    begin
      if j=1 then startwave:=i;
      x[j]:=x1[i];
      y[j]:=y1[i];
      j:=j+1;
    end;
  end;
  nrow:=j-1;
  endwave:=startwave+j-2;
end;
(*-----
*) procedure minmax;           (*sort trans values*)
begin
  for i:=1 to nrow-1 do
    for j:=i+1 to nrow do
    begin
      if y[i]<y[j] then
      begin
        temp:=y[i]; temp1:=x[i];
        y[i]:=y[j]; x[i]:=x[j];
        y[j]:=temp; x[j]:=temp1;
      end;
    end;
  end;
end;
(*-----
*) procedure dataout;          (*output fit results to file*)
var
  i :integer;

begin
  writeln(fn,wave1,'      to ',wave2);
  writeln(fn);
  writeln(fn,'      y      ycalc      residual');
  writeln(fn);
  for i:=1 to nrow do
    writeln(fn,x[i]:7:4,'  ,y[i]:10:6,'  ,yemp[i]:10:6,dual[i]:9:3);
  writeln(fn);
  writeln(fn,'correlation coef is ',corco:8:5);
  writeln(fn);
  for i:=1 to ncol do
    writeln(fn,'coefficient ',coef[i]);

```

```

writeln(fn);
end;
(*-----
*) procedure s2          (*least squares fit to # of*)
    (var x:ddray1;        (*x,y points in nrow*)
     var y:drayr;
     var a:ddray2;
     var g:drayc;
     var nrow,ncol:integer);

var
    i,k,l :integer;

begin
    for k:=1 to ncol do
        begin
            for l:=1 to k do
                begin
                    a[k,l]:=0;
                    for i:=1 to nrow do
                        begin
                            a[k,l]:=a[k,l]+x[i,l]*x[i,k];
                            if k>l then a[l,k]:=a[k,l]
                        end
                    end;
                    g[k]:=0;
                    for i:=1 to nrow do
                        g[k]:=g[k]+y[i]*x[i,k]
                end
            end;
        end;
    end;
(*-----
*) procedure curve1      (var b      :ddray2;
                           y       :drayc;
                           var coef   :drayc;
                           ncol     :integer);

var
    w           :array[1..maxc,1..maxc] of real;
    cfile       :array[1..maxc,1..maxc] of integer;
    i,j,k,l,nv,rw,cl,n,11 :integer;
    sure,triad,keep,sum,t,ab,great :real;
(*-----
*) procedure xchng(var a,b:real);

var
    keep :real;

begin
    keep:=a;
    a:=b;
    b:=keep;
end;                      (*swap*)
(*-----
*) procedure curve2;

```

```

var
  i,j,k,l,11                      :integer;
(*-----
*) procedure curve3;

var
  l                               :integer;

begin
  if rw<>cl then
    begin
      sure:=-sure;
      for l:=1 to n do
        xchng(b[rw,l],b[cl,l]);
      if nv>0 then
        for l:=1 to nv do
          xchng(w[rw,l],w[cl,l])
    end
  end;

begin
  nv:=1;
  n:=ncol;
  for i:=1 to n do
    begin
      w[i,1]:=y[i];
      cfile[i,3]:=0
    end;
  sure:=1.0;
  for i:=1 to n do
    begin
      great:=0.0;
      for j:=1 to n do
        begin
          if cfile[j,3]<>1 then
            begin
              for k:=1 to n do
                begin
                  if cfile[k,3]<1 then
                    if abs(b[j,k])>great then
                      begin
                        rw:=j;
                        cl:=k;
                        great:=abs(b[j,k])
                      end
                end
              end
            end
          end;
        end;
      cfile[cl,3]:=cfile[cl,3]+1;
      cfile[i,1]:=rw;
      cfile[i,2]:=cl;
      curve3;
      triad:=b[cl,cl];
    end;
end;

```

```

sure:=sure*triad;
b[cl,cl]:=1.0;

for l:=1 to n do
  b[cl,l]:=b[cl,l]/triad;
if nv>0 then
  for l:=1 to nv do
    w[cl,l]:=w[cl,l]/triad;

for l1:=1 to n do
begin
  if l1<>cl then
    begin
      t:=b[l1,cl];
      b[l1,cl]:=0.0;
      for l:=1 to n do
        b[l1,l]:=b[l1,l]-b[cl,l]*t;
      if nv>0 then
        for l:=1 to nv do
          w[l1,l]:=w[l1,l]-w[cl,l]*t;
    end
  end
end;
begin
curve2;
for i:=1 to n do
begin
  l:=n-i+1;
  if cfile[l,1]<>cfi[l,2] then
    begin
      rw:=cfi[l,1];
      cl:=cfi[l,2];
      for k:=1 to n do
        xchng(b[k,rw],b[k,cl])
    end
  end;
  for i:=1 to n do
    coef[i]:=w[i,1];
end;
(*-----
*) procedure curve(x,y :drayr;
                   var yemp :drayr;
                   var dual :drayr;
                   var coef :drayc;
                   var nal :drayc;
                   nrow :integer;
                   var ncol :integer);

var
  xmatr :ddray1;
  a :ddray2;
  g :drayc;

```

```

i,j,nm :integer;
xi,yi,yc,srs,see,sum_y,sum_y2 :real;

begin
  for i:=1 to nrow do
    begin
      xi:=x[i];
      xmatr[i,1]:=1.0;
      for j:=2 to ncol do
        xmatr[i,j]:=xmatr[i,j-1]*xi
      end;
    s2(xmatr,y,a,g,nrow,ncol);
    curve1(a,g,coef,ncol);
    sum_y:=0.0;
    sum_y2:=0.0;
    srs:=0.0;
    for i:=1 to nrow do
      begin
        yi:=y[i];
        yc:=0.0;
        for j:=1 to ncol do
          yc:=yc+coef[j]*xmatr[i,j];
        yemp[i]:=yc;
        dual[i]:=yc-yi;
        srs:=srs+sqr(dual[i]);
        sum_y:=sum_y+yi;
        sum_y2:=sum_y2+yi*yi;
      end;
    corco:=sqrt(1.0-srs/(sum_y2-sqr(sum_y)/nrow));
    if nrow=ncol then nm:=1
    else nm:=nrow-ncol;
    see:=sqrt(srs/nm);
    for i:=1 to ncol do
      nal[i]:=see*sqrt(a[i,i])
    end;
(*-----
*) procedure polythree;
begin
  xco:=x[1]-2;
  temp:=0.0;
  temp1:=0.0;
  for i:=1 to 400 do
    begin
      xco:=xco+0.01;
      yco:=coef[1]+coef[2]*xco+coef[3]*sqr(xco)+coef[4]*xco*sqr(xco);
      if yco>temp then
        begin
          temp:=yco;
          temp1:=xco;
        end; (*if*)
    end; (*loop*)
  xtemp:=trunc(temp1);
  xint:=temp1-trunc(temp1);
  xwave:=x1[xtemp+startwave]+xint*1.925;

```

```

end; (*polythree*)
(*-----
*) procedure polyfour;
begin
  xco:=x[nrow]-2;
  temp:=10.0;
  temp1:=0.0;
  for i:=1 to 400 do
begin
  xco:=xco+0.01;
  yco:=coef[1]+coef[2]*xco+coef[3]*sqr(xco)+coef[4]*xco*sqr(xco)+coef[5]*sqr(xco)*
  if yco<temp then
  begin
    temp:=yco;
    temp1:=xco;
  end; (*if*)
end; (*loop*)
xtemp:=trunc(temp1);
xint:=temp1-trunc(temp1);
xwave:=x1[xtemp+startwave]+xint*1.925;
end; (*polyfour*)
(*-----
*) procedure ls1;
begin
  j:=1;
  wave1:=1010;
  wave2:=1060;
  sorttrans;
  for i:=1 to nrow do
  x[i]:=i;
  ncol:=3;
  begin
    ncol:=ncol+1;
    curve(x,y,yemp,dual,coef,nal,nrow,ncol);
    dataout;
  end;
  minmax;
  polythree;
  smax1:=xwave;
  tmax1:=temp;
  rsdmax1:=nal[1];
  nmax1:=nrow;
  writeln(fn);
  writeln(fn,'tmax1      ',tmax1);
  writeln(fn,'smax1      ',smax1);
  writeln(fn,'rsdmax1      ',rsdmax1);
  writeln(fn,'# pts. fit  ',nrow);
  writeln(fn);
end; (*ls1*)
(*-----
*) procedure ls2;
begin
  j:=1;
  wave1:=1090;

```

```

wave2:=1123;
sorttrans;
  for i:=1 to 17 do
    x[i]:=i;
  ncol:=4;
  begin
    ncol:=ncol+1;
    curve(x,y,yemp,dual,coef,nal,nrow,ncol);
    dataout;
  end;
minmax;
polyfour;
speak:=xwave;
tpeak:=temp;
rsdpeak:=nal[1];
npeak:=nrow;
writeln(fn);
writeln(fn,'tpeak      ',tpeak);
writeln(fn,'speak      ',speak);
writeln(fn,'rsdpeak      ',rsdpeak);
writeln(fn,'# pts. fit  ',nrow);
writeln(fn);
end; (*ls2*)
(*-----
*) procedure ls3;
begin
  j:=1;
  wave1:=1200;
  wave2:=1260;
  sorttrans;
  for i:=1 to 32 do
    x[i]:=i;
  ncol:=3;
  begin
    ncol:=ncol+1;
    curve(x,y,yemp,dual,coef,nal,nrow,ncol);
    dataout;
  end;
minmax;
polythree;
smax2:=xwave;
tmax2:=temp;
rsdmax2:=nal[1];
nmax2:=nrow;
writeln(fn);
writeln(fn,'tmax2      ',tmax2);
writeln(fn,'smax2      ',smax2);
writeln(fn,'rsdmax2      ',rsdmax2);
writeln(fn,'# pts. fit  ',nrow);
writeln(fn);
end; (*ls3*)
(*-----
*) procedure fileout;          (*output results*)
begin

```

```

fname:='resltd51.dat';
OpenFile;
writeln(fn,'sample file name      ',fnames);
writeln(fn,'thickness (mils)      ',thk/0.00254);
writeln(fn);
writeln(fn,'tbase                  ',tbase);
writeln(fn,'tpeak                  ',tpeak);
writeln(fn,'abase                  ',abase);
writeln(fn,'apeak                  ',apeak);
writeln(fn);
writeln(fn,'anet                  ',anet);
writeln(fn,'uncertainty            ',e);
writeln(fn,'standard deviation      ',sumy2);
writeln(fn,'ppm   (6.28)           ',ppm);
close(fn);
end;
(*-----
*) begin (*MAIN PROGRAM*)
  OpenInFile;
  fnames:=fname;
  readln(fn,num);
  writeln(num);
  for i:=1 to num do
  begin
    readln(fn,dummy,x1[i],y1[i]);
    if y1[i]>1.0 then y1[i]:=y1[i]/100;
  end;
  close(fn);
  del:=x1[2]-x1[1];
  firstx:=x1[1];
  roffset:=(firstx/del);                                (* noffset:=int(roffset);*)
  writeln(roffset,del,firstx);
  writeln('thickness (cm)  ');
  readln(thk);
  thk:=thk*1.0;

  fname:='least.dat';
  OpenFile;
  writeln(fn,'sample file name      ',fnames);
  writeln(fn,'thickness (cm)      ',thk/1.0);
  writeln(fn);
  ls1;
  ls2;
  ls3;
  close(fn);
  base;
  tr:=tbase;
  alpha;
  abase:=alphas;
  tr:=tpeak;
  alpha;
  apeak:=alphas;
  anet:=apeak-abase;
  latnet:=anet-0.5;

```

```
ppm:=latnet*6.28;
uncertainty;
standev;
writeln('OXYGEN PPM (6.28) ',ppm);
writeln;
writeln('UNCERTAINTY           ',e);
writeln;
writeln('STANDARD DEVIATION   ',sumy2);
fileout;
end.
```

Section IV. SAMPLE DATA

The data are listed in three columns, with two sets of three columns per page. The first column is just an index number. The second column lists the wavenumber, and the third column lists the transmittance at that wavenumber. The single integer number at the head of each spectrum is the number of data points in that spectrum.

Sample:	D07					
	840					
261	501.401	0.46960		318	611.324	0.29407
262	503.330	0.46700		319	613.253	0.29794
263	505.258	0.46442		320	615.181	0.30223
264	507.187	0.46066		321	617.109	0.30424
265	509.115	0.45473		322	619.038	0.30586
266	511.044	0.44725		323	620.966	0.31074
267	512.972	0.44130		324	622.895	0.32582
268	514.901	0.44220		325	624.823	0.35559
269	516.829	0.44576		326	626.752	0.39533
270	518.758	0.44822		327	628.680	0.43551
271	520.686	0.45390		328	630.609	0.46502
272	522.615	0.45969		329	632.537	0.47996
273	524.543	0.46176		330	634.466	0.48596
274	526.471	0.46235		331	636.394	0.48837
275	528.400	0.46203		332	638.323	0.49016
276	530.328	0.46114		333	640.251	0.49234
277	532.257	0.46034		334	642.180	0.49368
278	534.185	0.45943		335	644.108	0.49471
279	536.114	0.45866		336	646.036	0.49555
280	538.042	0.45804		337	647.965	0.49591
281	539.971	0.45698		338	649.893	0.49675
282	541.899	0.45474		339	651.822	0.49760
283	543.828	0.45230		340	653.750	0.49810
284	545.756	0.45063		341	655.679	0.49854
285	547.685	0.44929		342	657.607	0.49898
286	549.613	0.44864		343	659.536	0.49959
287	551.542	0.44810		344	661.464	0.49968
288	553.470	0.44630		345	663.393	0.49990
289	555.398	0.44405		346	665.321	0.49975
290	557.327	0.44202		347	667.250	0.49796
291	559.255	0.44026		348	669.178	0.49785
292	561.184	0.43863		349	671.107	0.50024
293	563.112	0.43723		350	673.035	0.50163
294	565.041	0.43681		351	674.963	0.50216
295	566.969	0.43722		352	676.892	0.50297
296	568.898	0.43896		353	678.820	0.50352
297	570.826	0.44246		354	680.749	0.50305
298	572.755	0.44637		355	682.677	0.50219
299	574.683	0.44892		356	684.606	0.50201
300	576.612	0.44954		357	686.534	0.50235
301	578.540	0.44934		358	688.463	0.50276
302	580.469	0.44890		359	690.391	0.50286
303	582.397	0.44707		360	692.320	0.50254
304	584.326	0.44355		361	694.248	0.50323
305	586.254	0.43886		362	696.177	0.50546
306	588.182	0.43340		363	698.105	0.50767
307	590.111	0.42661		364	700.034	0.50817
308	592.039	0.41782		365	701.962	0.50730
309	593.968	0.40774		366	703.890	0.50631
310	595.896	0.39597		367	705.819	0.50468
311	597.825	0.38115		368	707.747	0.50161
312	599.753	0.36256		369	709.676	0.49768
313	601.682	0.34260		370	711.604	0.49243
314	603.610	0.32663		371	713.533	0.48546
315	605.539	0.31448		372	715.461	0.47828
316	607.467	0.30306		373	717.390	0.47242
317	609.396	0.29526		374	719.318	0.46809
				375	721.247	0.46433
				376	723.175	0.46016

377	725.104	0.45587	436	838.883	0.48299
378	727.032	0.45224	437	840.812	0.48252
379	728.961	0.44886	438	842.740	0.48117
380	730.889	0.44554	439	844.669	0.47958
381	732.817	0.44276	440	846.597	0.47846
382	734.746	0.43980	441	848.526	0.47769
383	736.674	0.43686	442	850.454	0.47675
384	738.603	0.43605	443	852.382	0.47558
385	740.531	0.43816	444	854.311	0.47381
386	742.460	0.44186	445	856.239	0.47217
387	744.388	0.44549	446	858.168	0.47083
388	746.317	0.44848	447	860.096	0.46848
389	748.245	0.45117	448	862.025	0.46577
390	750.174	0.45307	449	863.953	0.46384
391	752.102	0.45431	450	865.882	0.46251
392	754.031	0.45566	451	867.810	0.46162
393	755.959	0.45651	452	869.739	0.46074
394	757.888	0.45704	453	871.667	0.45976
395	759.816	0.45794	454	873.596	0.45898
396	761.745	0.45926	455	875.524	0.45840
397	763.673	0.46062	456	877.453	0.45814
398	765.601	0.46116	457	879.381	0.45767
399	767.530	0.46109	458	881.309	0.45655
400	769.458	0.46123	459	883.238	0.45538
401	771.387	0.46151	460	885.166	0.45449
402	773.315	0.46171	461	887.095	0.45431
403	775.244	0.46163	462	889.023	0.45481
404	777.172	0.46167	463	890.952	0.45488
405	779.101	0.46222	464	892.880	0.45447
406	781.029	0.46290	465	894.809	0.45435
407	782.958	0.46355	466	896.737	0.45475
408	784.886	0.46413	467	898.666	0.45508
409	786.815	0.46439	468	900.594	0.45530
410	788.743	0.46463	469	902.523	0.45612
411	790.672	0.46507	470	904.451	0.45761
412	792.600	0.46578	471	906.380	0.45901
413	794.528	0.46716	472	908.308	0.46016
414	796.457	0.46973	473	910.236	0.46137
415	798.385	0.47269	474	912.165	0.46300
416	800.314	0.47414	475	914.093	0.46478
417	802.242	0.47344	476	916.022	0.46641
418	804.171	0.47130	477	917.950	0.46779
419	806.099	0.46875	478	919.879	0.46885
420	808.028	0.46692	479	921.807	0.46997
421	809.956	0.46560	480	923.736	0.47143
422	811.885	0.46432	481	925.664	0.47271
423	813.813	0.46300	482	927.593	0.47343
424	815.742	0.46196	483	929.521	0.47395
425	817.670	0.46176	484	931.450	0.47474
426	819.599	0.46219	485	933.378	0.47570
427	821.527	0.46323	486	935.307	0.47667
428	823.455	0.46511	487	937.235	0.47742
429	825.384	0.46756	488	939.163	0.47766
430	827.312	0.47035	489	941.092	0.47777
431	829.241	0.47370	490	943.020	0.47796
432	831.169	0.47722	491	944.949	0.47769
433	833.098	0.47986	492	946.877	0.47711
434	835.026	0.48132	493	948.806	0.47686
435	836.955	0.48239	494	950.734	0.47682

495	952.663	0.47634	554	1066.442	0.49577
496	954.591	0.47555	555	1068.371	0.49413
497	956.520	0.47529	556	1070.299	0.49227
498	958.448	0.47553	557	1072.228	0.49030
499	960.377	0.47556	558	1074.156	0.48766
500	962.305	0.47536	559	1076.085	0.48458
501	964.234	0.47537	560	1078.013	0.48105
502	966.162	0.47577	561	1079.942	0.47694
503	968.090	0.47627	562	1081.870	0.47217
504	970.019	0.47666	563	1083.798	0.46656
505	971.947	0.47733	564	1085.727	0.46026
506	973.876	0.47826	565	1087.655	0.45329
507	975.804	0.47913	566	1089.584	0.44575
508	977.733	0.47996	567	1091.512	0.43788
509	979.661	0.48104	568	1093.441	0.42984
510	981.590	0.48221	569	1095.369	0.42187
511	983.518	0.48332	570	1097.298	0.41427
512	985.447	0.48455	571	1099.226	0.40762
513	987.375	0.48575	572	1101.155	0.40221
514	989.304	0.48692	573	1103.083	0.39798
515	991.232	0.48838	574	1105.012	0.39523
516	993.161	0.48969	575	1106.940	0.39405
517	995.089	0.49079	576	1108.869	0.39428
518	997.017	0.49185	577	1110.797	0.39610
519	998.946	0.49266	578	1112.725	0.39932
520	1000.874	0.49337	579	1114.654	0.40384
521	1002.803	0.49408	580	1116.582	0.40977
522	1004.731	0.49472	581	1118.511	0.41668
523	1006.660	0.49550	582	1120.439	0.42433
524	1008.588	0.49630	583	1122.368	0.43274
525	1010.517	0.49681	584	1124.296	0.44144
526	1012.445	0.49720	585	1126.225	0.45002
527	1014.374	0.49795	586	1128.153	0.45796
528	1016.302	0.49895	587	1130.082	0.46495
529	1018.231	0.49967	588	1132.010	0.47091
530	1020.159	0.50038	589	1133.939	0.47589
531	1022.088	0.50105	590	1135.867	0.47999
532	1024.016	0.50145	591	1137.796	0.48322
533	1025.944	0.50199	592	1139.724	0.48583
534	1027.873	0.50242	593	1141.652	0.48783
535	1029.801	0.50244	594	1143.581	0.48921
536	1031.730	0.50266	595	1145.509	0.49030
537	1033.658	0.50295	596	1147.438	0.49132
538	1035.587	0.50319	597	1149.366	0.49233
539	1037.515	0.50343	598	1151.295	0.49310
540	1039.444	0.50351	599	1153.223	0.49364
541	1041.372	0.50333	600	1155.152	0.49431
542	1043.301	0.50303	601	1157.080	0.49511
543	1045.229	0.50285	602	1159.009	0.49594
544	1047.158	0.50273	603	1160.937	0.49662
545	1049.086	0.50239	604	1162.866	0.49698
546	1051.015	0.50183	605	1164.794	0.49730
547	1052.943	0.50132	606	1166.723	0.49781
548	1054.871	0.50111	607	1168.651	0.49837
549	1056.800	0.50069	608	1170.579	0.49881
550	1058.728	0.49976	609	1172.508	0.49930
551	1060.657	0.49881	610	1174.436	0.49998
552	1062.585	0.49780	611	1176.365	0.50071
553	1064.514	0.49681	612	1178.293	0.50142

613	1180.222	0.50189	672	1294.001	0.50787
614	1182.150	0.50200	673	1295.930	0.50792
615	1184.079	0.50221	674	1297.858	0.50812
616	1186.007	0.50274	675	1299.787	0.50813
617	1187.936	0.50346	676	1301.715	0.50794
618	1189.864	0.50419	677	1303.644	0.50810
619	1191.793	0.50478	678	1305.572	0.50853
620	1193.721	0.50539	679	1307.501	0.50889
621	1195.650	0.50601	680	1309.429	0.50915
622	1197.578	0.50655	681	1311.358	0.50936
623	1199.506	0.50716	682	1313.286	0.50971
624	1201.435	0.50776	683	1315.214	0.51023
625	1203.363	0.50819	684	1317.143	0.51061
626	1205.292	0.50861	685	1319.071	0.51082
627	1207.220	0.50901	686	1321.000	0.51122
628	1209.149	0.50933	687	1322.928	0.51174
629	1211.077	0.50969	688	1324.857	0.51212
630	1213.006	0.50997	689	1326.785	0.51265
631	1214.934	0.51005	690	1328.714	0.51327
632	1216.863	0.50998	691	1330.642	0.51348
633	1218.791	0.51005	692	1332.571	0.51350
634	1220.720	0.51017	693	1334.499	0.51353
635	1222.648	0.51010	694	1336.428	0.51361
636	1224.577	0.50998	695	1338.356	0.51396
637	1226.505	0.50992	696	1340.285	0.51428
638	1228.433	0.50992	697	1342.213	0.51443
639	1230.362	0.50994	698	1344.141	0.51459
640	1232.290	0.51012	699	1346.070	0.51465
641	1234.219	0.51048	700	1347.998	0.51461
642	1236.147	0.51074	701	1349.927	0.51454
643	1238.076	0.51078	702	1351.855	0.51443
644	1240.004	0.51074	703	1353.784	0.51436
645	1241.933	0.51070	704	1355.712	0.51432
646	1243.861	0.51064	705	1357.641	0.51420
647	1245.790	0.51059	706	1359.569	0.51402
648	1247.718	0.51066	707	1361.498	0.51388
649	1249.647	0.51079	708	1363.426	0.51366
650	1251.575	0.51089	709	1365.355	0.51346
651	1253.504	0.51082	710	1367.283	0.51335
652	1255.432	0.51071	711	1369.212	0.51327
653	1257.360	0.51073	712	1371.140	0.51330
654	1259.289	0.51092	713	1373.068	0.51328
655	1261.217	0.51102	714	1374.997	0.51315
656	1263.146	0.51093	715	1376.925	0.51315
657	1265.074	0.51068	716	1378.854	0.51337
658	1267.003	0.51056	717	1380.782	0.51381
659	1268.931	0.51055	718	1382.711	0.51427
660	1270.860	0.51057	719	1384.639	0.51427
661	1272.788	0.51048	720	1386.568	0.51387
662	1274.717	0.51019	721	1388.496	0.51363
663	1276.645	0.50994	722	1390.425	0.51374
664	1278.574	0.50988	723	1392.353	0.51375
665	1280.502	0.50955	724	1394.282	0.51365
666	1282.431	0.50910	725	1396.210	0.51381
667	1284.359	0.50887	726	1398.139	0.51402
668	1286.287	0.50878	727	1400.067	0.51414
669	1288.216	0.50850	728	1401.995	0.51427
670	1290.144	0.50814	729	1403.924	0.51414
671	1292.073	0.50792	730	1405.852	0.51394

731	1407.781	0.51388	790	1521.561	0.52416
732	1409.709	0.51374	791	1523.489	0.52417
733	1411.638	0.51358	792	1525.417	0.52428
734	1413.566	0.51347	793	1527.346	0.52438
735	1415.495	0.51326	794	1529.274	0.52457
736	1417.423	0.51295	795	1531.203	0.52483
737	1419.352	0.51267	796	1533.131	0.52492
738	1421.280	0.51257	797	1535.060	0.52489
739	1423.209	0.51238	798	1536.988	0.52458
740	1425.137	0.51191	799	1538.917	0.52418
741	1427.066	0.51141	800	1540.845	0.52420
742	1428.994	0.51095	801	1542.774	0.52441
743	1430.922	0.51048	802	1544.702	0.52452
744	1432.851	0.51000	803	1546.631	0.52467
745	1434.779	0.50952	804	1548.559	0.52470
746	1436.708	0.50900	805	1550.488	0.52466
747	1438.636	0.50851	806	1552.416	0.52489
748	1440.565	0.50808	807	1554.344	0.52515
749	1442.493	0.50774	808	1556.273	0.52492
750	1444.422	0.50751	809	1558.201	0.52432
751	1446.350	0.50751	810	1560.130	0.52407
752	1448.279	0.50763	811	1562.058	0.52440
753	1450.207	0.50780	812	1563.987	0.52477
754	1452.136	0.50819	813	1565.915	0.52494
755	1454.064	0.50864	814	1567.844	0.52497
756	1455.993	0.50903	815	1569.772	0.52493
757	1457.921	0.50944	816	1571.701	0.52489
758	1459.849	0.51000	817	1573.629	0.52490
759	1461.778	0.51082	818	1575.558	0.52494
760	1463.706	0.51173	819	1577.486	0.52512
761	1465.635	0.51277	820	1579.415	0.52523
762	1467.563	0.51373	821	1581.343	0.52513
763	1469.492	0.51440	822	1583.271	0.52508
764	1471.420	0.51513	823	1585.200	0.52516
765	1473.349	0.51603	824	1587.128	0.52524
766	1475.277	0.51696	825	1589.057	0.52529
767	1477.206	0.51785	826	1590.985	0.52518
768	1479.134	0.51858	827	1592.914	0.52508
769	1481.063	0.51921	828	1594.842	0.52518
770	1482.991	0.51980	829	1596.771	0.52524
771	1484.920	0.52036	830	1598.699	0.52525
772	1486.848	0.52092	831	1600.628	0.52528
773	1488.777	0.52136	832	1602.556	0.52530
774	1490.705	0.52176	833	1604.485	0.52532
775	1492.634	0.52206	834	1606.413	0.52535
776	1494.562	0.52220	835	1608.342	0.52531
777	1496.490	0.52234	836	1610.270	0.52530
778	1498.419	0.52277	837	1612.198	0.52528
779	1500.347	0.52334	838	1614.127	0.52519
780	1502.276	0.52356	839	1616.055	0.52514
781	1504.204	0.52333	840	1617.984	0.52536
782	1506.133	0.52331	841	1619.912	0.52554
783	1508.061	0.52369	842	1621.841	0.52531
784	1509.990	0.52403	843	1623.769	0.52509
785	1511.918	0.52416	844	1625.698	0.52523
786	1513.847	0.52423	845	1627.626	0.52535
787	1515.775	0.52438	846	1629.555	0.52542
788	1517.704	0.52441	847	1631.483	0.52549
789	1519.632	0.52430	848	1633.412	0.52546

849	1635.340	0.52541	908	1749.120	0.52641
850	1637.269	0.52558	909	1751.048	0.52664
851	1639.197	0.52578	910	1752.977	0.52691
852	1641.125	0.52573	911	1754.905	0.52717
853	1643.054	0.52561	912	1756.833	0.52733
854	1644.982	0.52551	913	1758.762	0.52746
855	1646.911	0.52546	914	1760.690	0.52749
856	1648.839	0.52557	915	1762.619	0.52755
857	1650.768	0.52550	916	1764.547	0.52766
858	1652.696	0.52520	917	1766.476	0.52769
859	1654.625	0.52530	918	1768.404	0.52766
860	1656.553	0.52567	919	1770.333	0.52753
861	1658.482	0.52583	920	1772.261	0.52748
862	1660.410	0.52572	921	1774.190	0.52757
863	1662.339	0.52553	922	1776.118	0.52767
864	1664.267	0.52555	923	1778.047	0.52772
865	1666.196	0.52571	924	1779.975	0.52768
866	1668.124	0.52583	925	1781.904	0.52766
867	1670.052	0.52593	926	1783.832	0.52773
868	1671.981	0.52602	927	1785.760	0.52784
869	1673.909	0.52604	928	1787.689	0.52794
870	1675.838	0.52602	929	1789.617	0.52785
871	1677.766	0.52597	930	1791.546	0.52773
872	1679.695	0.52602	931	1793.474	0.52771
873	1681.623	0.52600	932	1795.403	0.52773
874	1683.552	0.52571	933	1797.331	0.52777
875	1685.480	0.52562	934	1799.260	0.52783
876	1687.409	0.52592	935	1801.188	0.52790
877	1689.337	0.52612	936	1803.117	0.52797
878	1691.266	0.52609	937	1805.045	0.52794
879	1693.194	0.52597	938	1806.974	0.52784
880	1695.123	0.52575	939	1808.902	0.52778
881	1697.051	0.52559	940	1810.831	0.52785
882	1698.979	0.52543	941	1812.759	0.52798
883	1700.908	0.52525	942	1814.688	0.52802
884	1702.836	0.52522	943	1816.616	0.52809
885	1704.765	0.52516	944	1818.544	0.52824
886	1706.693	0.52483	945	1820.473	0.52826
887	1708.622	0.52461	946	1822.401	0.52815
888	1710.550	0.52452	947	1824.330	0.52799
889	1712.479	0.52444	948	1826.258	0.52797
890	1714.407	0.52427	949	1828.187	0.52810
891	1716.336	0.52381	950	1830.115	0.52821
892	1718.264	0.52349	951	1832.044	0.52829
893	1720.193	0.52360	952	1833.972	0.52825
894	1722.121	0.52376	953	1835.901	0.52814
895	1724.050	0.52372	954	1837.829	0.52820
896	1725.978	0.52366	955	1839.758	0.52837
897	1727.906	0.52365	956	1841.686	0.52840
898	1729.835	0.52389	957	1843.615	0.52847
899	1731.763	0.52414	958	1845.543	0.52856
900	1733.692	0.52427	959	1847.471	0.52862
901	1735.620	0.52457	960	1849.400	0.52863
902	1737.549	0.52496	961	1851.328	0.52851
903	1739.477	0.52516	962	1853.257	0.52835
904	1741.406	0.52540	963	1855.185	0.52831
905	1743.334	0.52581	964	1857.114	0.52848
906	1745.263	0.52608	965	1859.042	0.52873
907	1747.191	0.52624	966	1860.971	0.52892

967	1862.899	0.52900	1026	1976.679	0.53081
968	1864.828	0.52891	1027	1978.607	0.53083
969	1866.756	0.52876	1028	1980.536	0.53074
970	1868.685	0.52880	1029	1982.464	0.53066
971	1870.613	0.52895	1030	1984.393	0.53066
972	1872.542	0.52912	1031	1986.321	0.53079
973	1874.470	0.52917	1032	1988.250	0.53090
974	1876.398	0.52906	1033	1990.178	0.53101
975	1878.327	0.52900	1034	1992.106	0.53111
976	1880.255	0.52904	1035	1994.035	0.53121
977	1882.184	0.52903	1036	1995.963	0.53122
978	1884.112	0.52912	1037	1997.892	0.53115
979	1886.041	0.52927	1038	1999.820	0.53113
980	1887.969	0.52925	1039	2001.749	0.53108
981	1889.898	0.52913	1040	2003.677	0.53094
982	1891.826	0.52917	1041	2005.606	0.53087
983	1893.755	0.52929	1042	2007.534	0.53097
984	1895.683	0.52937	1043	2009.463	0.53124
985	1897.612	0.52940	1044	2011.391	0.53145
986	1899.540	0.52932	1045	2013.320	0.53149
987	1901.469	0.52927	1046	2015.248	0.53156
988	1903.397	0.52930	1047	2017.177	0.53158
989	1905.325	0.52938	1048	2019.105	0.53143
990	1907.254	0.52949	1049	2021.033	0.53140
991	1909.182	0.52949	1050	2022.962	0.53151
992	1911.111	0.52945	1051	2024.890	0.53147
993	1913.039	0.52949	1052	2026.819	0.53134
994	1914.968	0.52964	1053	2028.747	0.53135
995	1916.896	0.52978	1054	2030.676	0.53166
996	1918.825	0.52970	1055	2032.604	0.53183
997	1920.753	0.52958	1056	2034.533	0.53177
998	1922.682	0.52966	1057	2036.461	0.53170
999	1924.610	0.52982	1058	2038.390	0.53165
1000	1926.539	0.52987	1059	2040.318	0.53159
1001	1928.467	0.52982	1060	2042.247	0.53147
1002	1930.396	0.52986	1061	2044.175	0.53145
1003	1932.324	0.52997	1062	2046.104	0.53161
1004	1934.252	0.53007	1063	2048.032	0.53181
1005	1936.181	0.53021	1064	2049.960	0.53186
1006	1938.109	0.53027	1065	2051.889	0.53190
1007	1940.038	0.53016	1066	2053.817	0.53204
1008	1941.966	0.53013	1067	2055.746	0.53214
1009	1943.895	0.53010	1068	2057.674	0.53204
1010	1945.823	0.52996	1069	2059.603	0.53186
1011	1947.752	0.52991	1070	2061.531	0.53179
1012	1949.680	0.53010	1071	2063.460	0.53177
1013	1951.609	0.53036	1072	2065.388	0.53176
1014	1953.537	0.53047	1073	2067.317	0.53199
1015	1955.466	0.53043	1074	2069.245	0.53225
1016	1957.394	0.53035	1075	2071.174	0.53222
1017	1959.323	0.53033	1076	2073.102	0.53220
1018	1961.251	0.53038	1077	2075.031	0.53215
1019	1963.179	0.53050	1078	2076.959	0.53206
1020	1965.108	0.53067	1079	2078.887	0.53208
1021	1967.036	0.53073	1080	2080.816	0.53220
1022	1968.965	0.53059	1081	2082.744	0.53221
1023	1970.893	0.53056	1082	2084.673	0.53223
1024	1972.822	0.53057	1083	2086.601	0.53242
1025	1974.750	0.53064	1084	2088.530	0.53262

1085	2090.458	0.53247
1086	2092.387	0.53230
1087	2094.315	0.53235
1088	2096.244	0.53232
1089	2098.172	0.53228
1090	2100.101	0.53234
1091	2102.029	0.53239
1092	2103.958	0.53249
1093	2105.886	0.53258
1094	2107.814	0.53258
1095	2109.743	0.53251
1096	2111.671	0.53237
1097	2113.600	0.53240
1098	2115.528	0.53230
1099	2117.457	0.53218
1100	2119.385	0.53245

Sample:	D12					
602						
501	964.234	0.49003		558	1074.156	0.50541
502	966.162	0.49035		559	1076.085	0.50212
503	968.090	0.49108		560	1078.013	0.49817
504	970.019	0.49175		561	1079.942	0.49355
505	971.947	0.49243		562	1081.870	0.48833
506	973.876	0.49335		563	1083.798	0.48228
507	975.804	0.49438		564	1085.727	0.47535
508	977.733	0.49546		565	1087.655	0.46771
509	979.661	0.49669		566	1089.584	0.45924
510	981.590	0.49791		567	1091.512	0.45028
511	983.518	0.49917		568	1093.441	0.44132
512	985.447	0.50055		569	1095.369	0.43255
513	987.375	0.50208		570	1097.298	0.42423
514	989.304	0.50354		571	1099.226	0.41666
515	991.232	0.50485		572	1101.155	0.41035
516	993.161	0.50603		573	1103.083	0.40570
517	995.089	0.50711		574	1105.012	0.40268
518	997.017	0.50840		575	1106.940	0.40144
519	998.946	0.50978		576	1108.869	0.40198
520	1000.874	0.51085		577	1110.797	0.40421
521	1002.803	0.51183		578	1112.725	0.40799
522	1004.731	0.51270		579	1114.654	0.41300
523	1006.660	0.51347		580	1116.582	0.41922
524	1008.588	0.51419		581	1118.511	0.42687
525	1010.517	0.51474		582	1120.439	0.43576
526	1012.445	0.51517		583	1122.368	0.44555
527	1014.374	0.51566		584	1124.296	0.45540
528	1016.302	0.51649		585	1126.225	0.46488
529	1018.231	0.51759		586	1128.153	0.47408
530	1020.159	0.51850		587	1130.082	0.48238
531	1022.088	0.51906		588	1132.010	0.48932
532	1024.016	0.51951		589	1133.939	0.49504
533	1025.944	0.52010		590	1135.867	0.49954
534	1027.873	0.52069		591	1137.796	0.50286
535	1029.801	0.52098		592	1139.724	0.50550
536	1031.730	0.52127		593	1141.652	0.50780
537	1033.658	0.52176		594	1143.581	0.50968
538	1035.587	0.52204		595	1145.509	0.51125
539	1037.515	0.52196		596	1147.438	0.51266
540	1039.444	0.52182		597	1149.366	0.51379
541	1041.372	0.52187		598	1151.295	0.51458
542	1043.301	0.52206		599	1153.223	0.51527
543	1045.229	0.52203		600	1155.152	0.51620
544	1047.158	0.52181		601	1157.080	0.51706
545	1049.086	0.52134		602	1159.009	0.51770
546	1051.015	0.52066		603	1160.937	0.51819
547	1052.943	0.52016		604	1162.866	0.51881
548	1054.871	0.51983		605	1164.794	0.51940
549	1056.800	0.51926		606	1166.723	0.51990
550	1058.728	0.51851		607	1168.651	0.52043
551	1060.657	0.51772		608	1170.579	0.52111
552	1062.585	0.51680		609	1172.508	0.52201
553	1064.514	0.51554		610	1174.436	0.52286
554	1066.442	0.51402		611	1176.365	0.52341
555	1068.371	0.51246		612	1178.293	0.52383
556	1070.299	0.51061		613	1180.222	0.52428
557	1072.228	0.50825		614	1182.150	0.52474
				615	1184.079	0.52537
				616	1186.007	0.52606

617	1187.936	0.52678	676	1301.715	0.53080
618	1189.864	0.52753	677	1303.644	0.53115
619	1191.793	0.52825	678	1305.572	0.53159
620	1193.721	0.52882	679	1307.501	0.53176
621	1195.650	0.52936	680	1309.429	0.53189
622	1197.578	0.53005	681	1311.358	0.53214
623	1199.506	0.53079	682	1313.286	0.53247
624	1201.435	0.53141	683	1315.214	0.53286
625	1203.363	0.53195	684	1317.143	0.53335
626	1205.292	0.53239	685	1319.071	0.53383
627	1207.220	0.53268	686	1321.000	0.53430
628	1209.149	0.53300	687	1322.928	0.53471
629	1211.077	0.53342	688	1324.857	0.53496
630	1213.006	0.53383	689	1326.785	0.53531
631	1214.934	0.53405	690	1328.714	0.53590
632	1216.863	0.53399	691	1330.642	0.53633
633	1218.791	0.53379	692	1332.571	0.53654
634	1220.720	0.53368	693	1334.499	0.53661
635	1222.648	0.53374	694	1336.428	0.53672
636	1224.577	0.53388	695	1338.356	0.53707
637	1226.505	0.53402	696	1340.285	0.53745
638	1228.433	0.53406	697	1342.213	0.53748
639	1230.362	0.53396	698	1344.141	0.53735
640	1232.290	0.53403	699	1346.070	0.53727
641	1234.219	0.53435	700	1347.998	0.53731
642	1236.147	0.53462	701	1349.927	0.53732
643	1238.076	0.53467	702	1351.855	0.53719
644	1240.004	0.53460	703	1353.784	0.53704
645	1241.933	0.53453	704	1355.712	0.53698
646	1243.861	0.53447	705	1357.641	0.53679
647	1245.790	0.53442	706	1359.569	0.53635
648	1247.718	0.53456	707	1361.498	0.53606
649	1249.647	0.53474	708	1363.426	0.53602
650	1251.575	0.53479	709	1365.355	0.53595
651	1253.504	0.53465	710	1367.283	0.53579
652	1255.432	0.53449	711	1369.212	0.53559
653	1257.360	0.53441	712	1371.140	0.53538
654	1259.289	0.53439	713	1373.068	0.53531
655	1261.217	0.53436	714	1374.997	0.53547
656	1263.146	0.53433	715	1376.925	0.53555
657	1265.074	0.53433	716	1378.854	0.53563
658	1267.003	0.53433	717	1380.782	0.53564
659	1268.931	0.53423	718	1382.711	0.53546
660	1270.860	0.53397	719	1384.639	0.53521
661	1272.788	0.53355	720	1386.568	0.53517
662	1274.717	0.53312	721	1388.496	0.53539
663	1276.645	0.53289	722	1390.425	0.53557
664	1278.574	0.53284	723	1392.353	0.53563
665	1280.502	0.53269	724	1394.282	0.53583
666	1282.431	0.53239	725	1396.210	0.53605
667	1284.359	0.53196	726	1398.139	0.53612
668	1286.287	0.53159	727	1400.067	0.53617
669	1288.216	0.53128	728	1401.995	0.53630
670	1290.144	0.53106	729	1403.924	0.53639
671	1292.073	0.53107	730	1405.852	0.53632
672	1294.001	0.53114	731	1407.781	0.53615
673	1295.930	0.53099	732	1409.709	0.53609
674	1297.858	0.53085	733	1411.638	0.53599
675	1299.787	0.53077	734	1413.566	0.53572

735	1415.495	0.53528	794	1529.274	0.54764
736	1417.423	0.53492	795	1531.203	0.54772
737	1419.352	0.53474	796	1533.131	0.54767
738	1421.280	0.53462	797	1535.060	0.54760
739	1423.209	0.53433	798	1536.988	0.54742
740	1425.137	0.53399	799	1538.917	0.54713
741	1427.066	0.53362	800	1540.845	0.54706
742	1428.994	0.53308	801	1542.774	0.54722
743	1430.922	0.53246	802	1544.702	0.54751
744	1432.851	0.53185	803	1546.631	0.54775
745	1434.779	0.53114	804	1548.559	0.54778
746	1436.708	0.53061	805	1550.488	0.54763
747	1438.636	0.53034	806	1552.416	0.54751
748	1440.565	0.53010	807	1554.344	0.54749
749	1442.493	0.52983	808	1556.273	0.54728
750	1444.422	0.52963	809	1558.201	0.54689
751	1446.350	0.52947	810	1560.130	0.54691
752	1448.279	0.52936	811	1562.058	0.54733
753	1450.207	0.52941	812	1563.987	0.54776
754	1452.136	0.52988	813	1565.915	0.54796
755	1454.064	0.53044	814	1567.844	0.54791
756	1455.993	0.53074	815	1569.772	0.54777
757	1457.921	0.53128	816	1571.701	0.54775
758	1459.849	0.53221	817	1573.629	0.54765
759	1461.778	0.53308	818	1575.558	0.54749
760	1463.706	0.53404	819	1577.486	0.54769
761	1465.635	0.53503	820	1579.415	0.54799
762	1467.563	0.53600	821	1581.343	0.54797
763	1469.492	0.53699	822	1583.271	0.54783
764	1471.420	0.53773	823	1585.200	0.54775
765	1473.349	0.53840	824	1587.128	0.54768
766	1475.277	0.53937	825	1589.057	0.54770
767	1477.206	0.54041	826	1590.985	0.54774
768	1479.134	0.54137	827	1592.914	0.54783
769	1481.063	0.54214	828	1594.842	0.54796
770	1482.991	0.54272	829	1596.771	0.54802
771	1484.920	0.54321	830	1598.699	0.54811
772	1486.848	0.54355	831	1600.628	0.54810
773	1488.777	0.54383	832	1602.556	0.54803
774	1490.705	0.54436	833	1604.485	0.54807
775	1492.634	0.54486	834	1606.413	0.54806
776	1494.562	0.54511	835	1608.342	0.54807
777	1496.490	0.54516	836	1610.270	0.54818
778	1498.419	0.54538	837	1612.198	0.54825
779	1500.347	0.54576	838	1614.127	0.54812
780	1502.276	0.54596	839	1616.055	0.54778
781	1504.204	0.54590	840	1617.984	0.54777
782	1506.133	0.54593	841	1619.912	0.54803
783	1508.061	0.54636	842	1621.841	0.54793
784	1509.990	0.54693	843	1623.769	0.54778
785	1511.918	0.54712	844	1625.698	0.54782
786	1513.847	0.54712	845	1627.626	0.54773
787	1515.775	0.54716	846	1629.555	0.54778
788	1517.704	0.54724	847	1631.483	0.54789
789	1519.632	0.54731	848	1633.412	0.54779
790	1521.561	0.54723	849	1635.340	0.54763
791	1523.489	0.54716	850	1637.269	0.54773
792	1525.417	0.54727	851	1639.197	0.54803
793	1527.346	0.54745	852	1641.125	0.54829

853	1643.054	0.54829	912	1756.833	0.54995
854	1644.982	0.54800	913	1758.762	0.55011
855	1646.911	0.54780	914	1760.690	0.55009
856	1648.839	0.54798	915	1762.619	0.55010
857	1650.768	0.54786	916	1764.547	0.55031
858	1652.696	0.54740	917	1766.476	0.55048
859	1654.625	0.54763	918	1768.404	0.55056
860	1656.553	0.54828	919	1770.333	0.55045
861	1658.482	0.54848	920	1772.261	0.55038
862	1660.410	0.54832	921	1774.190	0.55045
863	1662.339	0.54822	922	1776.118	0.55048
864	1664.267	0.54837	923	1778.047	0.55045
865	1666.196	0.54854	924	1779.975	0.55044
866	1668.124	0.54841	925	1781.904	0.55036
867	1670.052	0.54837	926	1783.832	0.55029
868	1671.981	0.54849	927	1785.760	0.55039
869	1673.909	0.54849	928	1787.689	0.55065
870	1675.838	0.54847	929	1789.617	0.55068
871	1677.766	0.54847	930	1791.546	0.55038
872	1679.695	0.54857	931	1793.474	0.55027
873	1681.623	0.54852	932	1795.403	0.55043
874	1683.552	0.54817	933	1797.331	0.55054
875	1685.480	0.54820	934	1799.260	0.55052
876	1687.409	0.54872	935	1801.188	0.55049
877	1689.337	0.54904	936	1803.117	0.55059
878	1691.266	0.54901	937	1805.045	0.55066
879	1693.194	0.54859	938	1806.974	0.55061
880	1695.123	0.54807	939	1808.902	0.55066
881	1697.051	0.54788	940	1810.831	0.55076
882	1698.979	0.54784	941	1812.759	0.55076
883	1700.908	0.54785	942	1814.688	0.55080
884	1702.836	0.54796	943	1816.616	0.55087
885	1704.765	0.54794	944	1818.544	0.55087
886	1706.693	0.54771	945	1820.473	0.55077
887	1708.622	0.54750	946	1822.401	0.55072
888	1710.550	0.54735	947	1824.330	0.55067
889	1712.479	0.54720	948	1826.258	0.55066
890	1714.407	0.54678	949	1828.187	0.55076
891	1716.336	0.54627	950	1830.115	0.55075
892	1718.264	0.54618	951	1832.044	0.55077
893	1720.193	0.54638	952	1833.972	0.55095
894	1722.121	0.54645	953	1835.901	0.55093
895	1724.050	0.54651	954	1837.829	0.55072
896	1725.978	0.54661	955	1839.758	0.55077
897	1727.906	0.54661	956	1841.686	0.55085
898	1729.835	0.54668	957	1843.615	0.55094
899	1731.763	0.54674	958	1845.543	0.55106
900	1733.692	0.54678	959	1847.471	0.55111
901	1735.620	0.54716	960	1849.400	0.55111
902	1737.549	0.54764	961	1851.328	0.55108
903	1739.477	0.54783	962	1853.257	0.55104
904	1741.406	0.54813	963	1855.185	0.55102
905	1743.334	0.54877	964	1857.114	0.55106
906	1745.263	0.54921	965	1859.042	0.55107
907	1747.191	0.54921	966	1860.971	0.55102
908	1749.120	0.54908	967	1862.899	0.55091
909	1751.048	0.54917	968	1864.828	0.55092
910	1752.977	0.54955	969	1866.756	0.55103
911	1754.905	0.54982	970	1868.685	0.55119

971	1870.613	0.55120	1030	1984.393	0.55225
972	1872.542	0.55120	1031	1986.321	0.55205
973	1874.470	0.55130	1032	1988.250	0.55198
974	1876.398	0.55128	1033	1990.178	0.55215
975	1878.327	0.55127	1034	1992.106	0.55229
976	1880.255	0.55126	1035	1994.035	0.55237
977	1882.184	0.55114	1036	1995.963	0.55237
978	1884.112	0.55115	1037	1997.892	0.55225
979	1886.041	0.55135	1038	1999.820	0.55208
980	1887.969	0.55145	1039	2001.749	0.55200
981	1889.898	0.55144	1040	2003.677	0.55212
982	1891.826	0.55151	1041	2005.606	0.55222
983	1893.755	0.55160	1042	2007.534	0.55226
984	1895.683	0.55151	1043	2009.463	0.55236
985	1897.612	0.55143	1044	2011.391	0.55233
986	1899.540	0.55144	1045	2013.320	0.55229
987	1901.469	0.55142	1046	2015.248	0.55232
988	1903.397	0.55136	1047	2017.177	0.55236
989	1905.325	0.55132	1048	2019.105	0.55243
990	1907.254	0.55138	1049	2021.033	0.55238
991	1909.182	0.55157	1050	2022.962	0.55221
992	1911.111	0.55171	1051	2024.890	0.55218
993	1913.039	0.55173	1052	2026.819	0.55229
994	1914.968	0.55166	1053	2028.747	0.55240
995	1916.896	0.55157	1054	2030.676	0.55240
996	1918.825	0.55150	1055	2032.604	0.55233
997	1920.753	0.55146	1056	2034.533	0.55243
998	1922.682	0.55149	1057	2036.461	0.55231
999	1924.610	0.55163	1058	2038.390	0.55205
1000	1926.539	0.55171	1059	2040.318	0.55204
1001	1928.467	0.55177	1060	2042.247	0.55217
1002	1930.396	0.55181	1061	2044.175	0.55235
1003	1932.324	0.55170	1062	2046.104	0.55237
1004	1934.252	0.55157	1063	2048.032	0.55238
1005	1936.181	0.55158	1064	2049.960	0.55258
1006	1938.109	0.55177	1065	2051.889	0.55270
1007	1940.038	0.55189	1066	2053.817	0.55267
1008	1941.966	0.55178	1067	2055.746	0.55268
1009	1943.895	0.55170	1068	2057.674	0.55264
1010	1945.823	0.55175	1069	2059.603	0.55263
1011	1947.752	0.55175	1070	2061.531	0.55264
1012	1949.680	0.55173	1071	2063.460	0.55269
1013	1951.609	0.55173	1072	2065.388	0.55272
1014	1953.537	0.55182	1073	2067.317	0.55266
1015	1955.466	0.55193	1074	2069.245	0.55251
1016	1957.394	0.55189	1075	2071.174	0.55247
1017	1959.323	0.55190	1076	2073.102	0.55255
1018	1961.251	0.55186	1077	2075.031	0.55255
1019	1963.179	0.55184	1078	2076.959	0.55246
1020	1965.108	0.55190	1079	2078.887	0.55254
1021	1967.036	0.55204	1080	2080.816	0.55258
1022	1968.965	0.55216	1081	2082.744	0.55245
1023	1970.893	0.55219	1082	2084.673	0.55249
1024	1972.822	0.55208	1083	2086.601	0.55274
1025	1974.750	0.55200	1084	2088.530	0.55288
1026	1976.679	0.55193	1085	2090.458	0.55287
1027	1978.607	0.55197	1086	2092.387	0.55279
1028	1980.536	0.55212	1087	2094.315	0.55282
1029	1982.464	0.55225	1088	2096.244	0.55282

1089	2098.172	0.55283
1090	2100.101	0.55277
1091	2102.029	0.55254
1092	2103.958	0.55256
1093	2105.886	0.55267
1094	2107.814	0.55260
1095	2109.743	0.55263
1096	2111.671	0.55272
1097	2113.600	0.55272
1098	2115.528	0.55259
1099	2117.457	0.55248
1100	2119.385	0.55256

Sample:	D26		358	688.463	0.51088
	800		359	690.391	0.51164
301	578.540	0.45869	360	692.320	0.51219
302	580.469	0.45896	361	694.248	0.51265
303	582.397	0.45797	362	696.177	0.51454
304	584.326	0.45554	363	698.105	0.51688
305	586.254	0.45139	364	700.034	0.51756
306	588.182	0.44603	365	701.962	0.51659
307	590.111	0.43980	366	703.890	0.51525
308	592.039	0.43209	367	705.819	0.51401
309	593.968	0.42246	368	707.747	0.51192
310	595.896	0.41030	369	709.676	0.50838
311	597.825	0.39499	370	711.604	0.50306
312	599.753	0.37663	371	713.533	0.49626
313	601.682	0.35829	372	715.461	0.48957
314	603.610	0.34327	373	717.390	0.48379
315	605.539	0.33037	374	719.318	0.47910
316	607.467	0.31856	375	721.247	0.47542
317	609.396	0.31155	376	723.175	0.47155
318	611.324	0.31199	377	725.104	0.46750
319	613.253	0.31679	378	727.032	0.46400
320	615.181	0.32038	379	728.961	0.46109
321	617.109	0.32150	380	730.889	0.45875
322	619.038	0.32284	381	732.817	0.45638
323	620.966	0.32778	382	734.746	0.45334
324	622.895	0.34335	383	736.674	0.45027
325	624.823	0.37286	384	738.603	0.44855
326	626.752	0.41071	385	740.531	0.45012
327	628.680	0.44801	386	742.460	0.45404
328	630.609	0.47592	387	744.388	0.45757
329	632.537	0.49068	388	746.317	0.46058
330	634.466	0.49610	389	748.245	0.46335
331	636.394	0.49801	390	750.174	0.46540
332	638.323	0.49958	391	752.102	0.46684
333	640.251	0.50159	392	754.031	0.46799
334	642.180	0.50326	393	755.959	0.46883
335	644.108	0.50422	394	757.888	0.46950
336	646.036	0.50476	395	759.816	0.47015
337	647.965	0.50526	396	761.745	0.47121
338	649.893	0.50586	397	763.673	0.47207
339	651.822	0.50661	398	765.601	0.47256
340	653.750	0.50694	399	767.530	0.47301
341	655.679	0.50697	400	769.458	0.47314
342	657.607	0.50728	401	771.387	0.47349
343	659.536	0.50787	402	773.315	0.47389
344	661.464	0.50897	403	775.244	0.47391
345	663.393	0.50905	404	777.172	0.47437
346	665.321	0.50599	405	779.101	0.47504
347	667.250	0.50381	406	781.029	0.47507
348	669.178	0.50704	407	782.958	0.47485
349	671.107	0.51046	408	784.886	0.47478
350	673.035	0.51128	409	786.815	0.47472
351	674.963	0.51181	410	788.743	0.47499
352	676.892	0.51190	411	790.672	0.47590
353	678.820	0.51171	412	792.600	0.47718
354	680.749	0.51190	413	794.528	0.47847
355	682.677	0.51203	414	796.457	0.48078
356	684.606	0.51183	415	798.385	0.48404
357	686.534	0.51118	416	800.314	0.48584

417	802.242	0.48480	476	916.022	0.47843
418	804.171	0.48233	477	917.950	0.48000
419	806.099	0.48029	478	919.879	0.48138
420	808.028	0.47874	479	921.807	0.48247
421	809.956	0.47701	480	923.736	0.48321
422	811.885	0.47560	481	925.664	0.48392
423	813.813	0.47444	482	927.593	0.48513
424	815.742	0.47334	483	929.521	0.48637
425	817.670	0.47305	484	931.450	0.48736
426	819.599	0.47359	485	933.378	0.48817
427	821.527	0.47490	486	935.307	0.48846
428	823.455	0.47693	487	937.235	0.48885
429	825.384	0.47906	488	939.163	0.48963
430	827.312	0.48151	489	941.092	0.49026
431	829.241	0.48453	490	943.020	0.49037
432	831.169	0.48756	491	944.949	0.49000
433	833.098	0.48988	492	946.877	0.48963
434	835.026	0.49121	493	948.806	0.48965
435	836.955	0.49186	494	950.734	0.48952
436	838.883	0.49216	495	952.663	0.48911
437	840.812	0.49206	496	954.591	0.48879
438	842.740	0.49143	497	956.520	0.48839
439	844.669	0.49016	498	958.448	0.48811
440	846.597	0.48903	499	960.377	0.48808
441	848.526	0.48813	500	962.305	0.48831
442	850.454	0.48692	501	964.234	0.48846
443	852.382	0.48569	502	966.162	0.48840
444	854.311	0.48456	503	968.090	0.48879
445	856.239	0.48308	504	970.019	0.48958
446	858.168	0.48118	505	971.947	0.49042
447	860.096	0.47914	506	973.876	0.49126
448	862.025	0.47742	507	975.804	0.49199
449	863.953	0.47584	508	977.733	0.49276
450	865.882	0.47398	509	979.661	0.49373
451	867.810	0.47234	510	981.590	0.49483
452	869.739	0.47112	511	983.518	0.49620
453	871.667	0.47040	512	985.447	0.49746
454	873.596	0.47002	513	987.375	0.49862
455	875.524	0.46967	514	989.304	0.49991
456	877.453	0.46921	515	991.232	0.50110
457	879.381	0.46846	516	993.161	0.50213
458	881.309	0.46768	517	995.089	0.50309
459	883.238	0.46736	518	997.017	0.50410
460	885.166	0.46704	519	998.946	0.50528
461	887.095	0.46672	520	1000.874	0.50620
462	889.023	0.46660	521	1002.803	0.50668
463	890.952	0.46678	522	1004.731	0.50716
464	892.880	0.46729	523	1006.660	0.50799
465	894.809	0.46755	524	1008.588	0.50879
466	896.737	0.46781	525	1010.517	0.50912
467	898.666	0.46822	526	1012.445	0.50938
468	900.594	0.46837	527	1014.374	0.50998
469	902.523	0.46853	528	1016.302	0.51060
470	904.451	0.46930	529	1018.231	0.51135
471	906.380	0.47070	530	1020.159	0.51226
472	908.308	0.47223	531	1022.088	0.51275
473	910.236	0.47340	532	1024.016	0.51306
474	912.165	0.47481	533	1025.944	0.51358
475	914.093	0.47670	534	1027.873	0.51414

535	1029.801	0.51438	594	1143.581	0.50171
536	1031.730	0.51450	595	1145.509	0.50321
537	1033.658	0.51490	596	1147.438	0.50446
538	1035.587	0.51519	597	1149.366	0.50551
539	1037.515	0.51514	598	1151.295	0.50633
540	1039.444	0.51509	599	1153.223	0.50694
541	1041.372	0.51504	600	1155.152	0.50774
542	1043.301	0.51500	601	1157.080	0.50854
543	1045.229	0.51496	602	1159.009	0.50921
544	1047.158	0.51463	603	1160.937	0.50972
545	1049.086	0.51410	604	1162.866	0.51017
546	1051.015	0.51349	605	1164.794	0.51050
547	1052.943	0.51296	606	1166.723	0.51077
548	1054.871	0.51269	607	1168.651	0.51137
549	1056.800	0.51238	608	1170.579	0.51212
550	1058.728	0.51167	609	1172.508	0.51265
551	1060.657	0.51059	610	1174.436	0.51316
552	1062.585	0.50921	611	1176.365	0.51377
553	1064.514	0.50798	612	1178.293	0.51451
554	1066.442	0.50687	613	1180.222	0.51507
555	1068.371	0.50564	614	1182.150	0.51524
556	1070.299	0.50397	615	1184.079	0.51555
557	1072.228	0.50173	616	1186.007	0.51606
558	1074.156	0.49890	617	1187.936	0.51664
559	1076.085	0.49548	618	1189.864	0.51739
560	1078.013	0.49149	619	1191.793	0.51803
561	1079.942	0.48683	620	1193.721	0.51867
562	1081.870	0.48161	621	1195.650	0.51942
563	1083.798	0.47565	622	1197.578	0.51988
564	1085.727	0.46892	623	1199.506	0.52024
565	1087.655	0.46169	624	1201.435	0.52062
566	1089.584	0.45373	625	1203.363	0.52095
567	1091.512	0.44506	626	1205.292	0.52146
568	1093.441	0.43641	627	1207.220	0.52195
569	1095.369	0.42777	628	1209.149	0.52234
570	1097.298	0.41940	629	1211.077	0.52264
571	1099.226	0.41216	630	1213.006	0.52283
572	1101.155	0.40614	631	1214.934	0.52291
573	1103.083	0.40174	632	1216.863	0.52285
574	1105.012	0.39901	633	1218.791	0.52297
575	1106.940	0.39753	634	1220.720	0.52304
576	1108.869	0.39778	635	1222.648	0.52285
577	1110.797	0.39984	636	1224.577	0.52286
578	1112.725	0.40316	637	1226.505	0.52303
579	1114.654	0.40820	638	1228.433	0.52305
580	1116.582	0.41477	639	1230.362	0.52296
581	1118.511	0.42246	640	1232.290	0.52288
582	1120.439	0.43097	641	1234.219	0.52302
583	1122.368	0.44007	642	1236.147	0.52324
584	1124.296	0.44954	643	1238.076	0.52335
585	1126.225	0.45902	644	1240.004	0.52343
586	1128.153	0.46810	645	1241.933	0.52333
587	1130.082	0.47617	646	1243.861	0.52329
588	1132.010	0.48266	647	1245.790	0.52345
589	1133.939	0.48787	648	1247.718	0.52362
590	1135.867	0.49200	649	1249.647	0.52381
591	1137.796	0.49531	650	1251.575	0.52394
592	1139.724	0.49815	651	1253.504	0.52398
593	1141.652	0.50017	652	1255.432	0.52395

653	1257.360	0.52371	712	1371.140	0.52592
654	1259.289	0.52354	713	1373.068	0.52565
655	1261.217	0.52362	714	1374.997	0.52567
656	1263.146	0.52379	715	1376.925	0.52588
657	1265.074	0.52394	716	1378.854	0.52622
658	1267.003	0.52391	717	1380.782	0.52655
659	1268.931	0.52383	718	1382.711	0.52661
660	1270.860	0.52366	719	1384.639	0.52639
661	1272.788	0.52333	720	1386.568	0.52600
662	1274.717	0.52307	721	1388.496	0.52584
663	1276.645	0.52292	722	1390.425	0.52612
664	1278.574	0.52281	723	1392.353	0.52635
665	1280.502	0.52264	724	1394.282	0.52636
666	1282.431	0.52238	725	1396.210	0.52639
667	1284.359	0.52213	726	1398.139	0.52651
668	1286.287	0.52179	727	1400.067	0.52668
669	1288.216	0.52135	728	1401.995	0.52694
670	1290.144	0.52116	729	1403.924	0.52709
671	1292.073	0.52106	730	1405.852	0.52680
672	1294.001	0.52104	731	1407.781	0.52642
673	1295.930	0.52106	732	1409.709	0.52648
674	1297.858	0.52111	733	1411.638	0.52655
675	1299.787	0.52130	734	1413.566	0.52643
676	1301.715	0.52145	735	1415.495	0.52614
677	1303.644	0.52148	736	1417.423	0.52548
678	1305.572	0.52154	737	1419.352	0.52501
679	1307.501	0.52165	738	1421.280	0.52497
680	1309.429	0.52202	739	1423.209	0.52489
681	1311.358	0.52238	740	1425.137	0.52474
682	1313.286	0.52274	741	1427.066	0.52445
683	1315.214	0.52331	742	1428.994	0.52392
684	1317.143	0.52372	743	1430.922	0.52333
685	1319.071	0.52390	744	1432.851	0.52268
686	1321.000	0.52410	745	1434.779	0.52209
687	1322.928	0.52449	746	1436.708	0.52167
688	1324.857	0.52510	747	1438.636	0.52149
689	1326.785	0.52575	748	1440.565	0.52132
690	1328.714	0.52624	749	1442.493	0.52089
691	1330.642	0.52647	750	1444.422	0.52060
692	1332.571	0.52665	751	1446.350	0.52067
693	1334.499	0.52681	752	1448.279	0.52074
694	1336.428	0.52688	753	1450.207	0.52086
695	1338.356	0.52709	754	1452.136	0.52111
696	1340.285	0.52731	755	1454.064	0.52118
697	1342.213	0.52727	756	1455.993	0.52111
698	1344.141	0.52728	757	1457.921	0.52166
699	1346.070	0.52726	758	1459.849	0.52286
700	1347.998	0.52719	759	1461.778	0.52385
701	1349.927	0.52716	760	1463.706	0.52464
702	1351.855	0.52698	761	1465.635	0.52553
703	1353.784	0.52687	762	1467.563	0.52638
704	1355.712	0.52695	763	1469.492	0.52700
705	1357.641	0.52678	764	1471.420	0.52749
706	1359.569	0.52647	765	1473.349	0.52822
707	1361.498	0.52620	766	1475.277	0.52932
708	1363.426	0.52605	767	1477.206	0.53042
709	1365.355	0.52601	768	1479.134	0.53138
710	1367.283	0.52595	769	1481.063	0.53213
711	1369.212	0.52599	770	1482.991	0.53260

771	1484.920	0.53306	830	1598.699	0.53802
772	1486.848	0.53346	831	1600.628	0.53826
773	1488.777	0.53368	832	1602.556	0.53817
774	1490.705	0.53391	833	1604.485	0.53794
775	1492.634	0.53433	834	1606.413	0.53780
776	1494.562	0.53475	835	1608.342	0.53773
777	1496.490	0.53485	836	1610.270	0.53776
778	1498.419	0.53506	837	1612.198	0.53795
779	1500.347	0.53564	838	1614.127	0.53795
780	1502.276	0.53604	839	1616.055	0.53757
781	1504.204	0.53576	840	1617.984	0.53756
782	1506.133	0.53531	841	1619.912	0.53801
783	1508.061	0.53562	842	1621.841	0.53817
784	1509.990	0.53630	843	1623.769	0.53808
785	1511.918	0.53653	844	1625.698	0.53803
786	1513.847	0.53662	845	1627.626	0.53798
787	1515.775	0.53660	846	1629.555	0.53822
788	1517.704	0.53642	847	1631.483	0.53837
789	1519.632	0.53641	848	1633.412	0.53804
790	1521.561	0.53652	849	1635.340	0.53768
791	1523.489	0.53668	850	1637.269	0.53785
792	1525.417	0.53681	851	1639.197	0.53827
793	1527.346	0.53684	852	1641.125	0.53853
794	1529.274	0.53715	853	1643.054	0.53850
795	1531.203	0.53733	854	1644.982	0.53818
796	1533.131	0.53714	855	1646.911	0.53791
797	1535.060	0.53711	856	1648.839	0.53798
798	1536.988	0.53691	857	1650.768	0.53769
799	1538.917	0.53637	858	1652.696	0.53709
800	1540.845	0.53616	859	1654.625	0.53744
801	1542.774	0.53636	860	1656.553	0.53832
802	1544.702	0.53685	861	1658.482	0.53868
803	1546.631	0.53734	862	1660.410	0.53860
804	1548.559	0.53745	863	1662.339	0.53841
805	1550.488	0.53726	864	1664.267	0.53858
806	1552.416	0.53712	865	1666.196	0.53879
807	1554.344	0.53708	866	1668.124	0.53856
808	1556.273	0.53672	867	1670.052	0.53849
809	1558.201	0.53598	868	1671.981	0.53858
810	1560.130	0.53600	869	1673.909	0.53847
811	1562.058	0.53693	870	1675.838	0.53863
812	1563.987	0.53751	871	1677.766	0.53897
813	1565.915	0.53757	872	1679.695	0.53915
814	1567.844	0.53751	873	1681.623	0.53881
815	1569.772	0.53747	874	1683.552	0.53820
816	1571.701	0.53761	875	1685.480	0.53828
817	1573.629	0.53754	876	1687.409	0.53885
818	1575.558	0.53700	877	1689.337	0.53916
819	1577.486	0.53696	878	1691.266	0.53930
820	1579.415	0.53750	879	1693.194	0.53895
821	1581.343	0.53771	880	1695.123	0.53833
822	1583.271	0.53769	881	1697.051	0.53801
823	1585.200	0.53788	882	1698.979	0.53778
824	1587.128	0.53806	883	1700.908	0.53766
825	1589.057	0.53810	884	1702.836	0.53786
826	1590.985	0.53796	885	1704.765	0.53797
827	1592.914	0.53778	886	1706.693	0.53785
828	1594.842	0.53780	887	1708.622	0.53773
829	1596.771	0.53787	888	1710.550	0.53755

889	1712.479	0.53733	948	1826.258	0.54164
890	1714.407	0.53689	949	1828.187	0.54178
891	1716.336	0.53626	950	1830.115	0.54190
892	1718.264	0.53601	951	1832.044	0.54186
893	1720.193	0.53629	952	1833.972	0.54198
894	1722.121	0.53662	953	1835.901	0.54199
895	1724.050	0.53680	954	1837.829	0.54183
896	1725.978	0.53694	955	1839.758	0.54195
897	1727.906	0.53704	956	1841.686	0.54197
898	1729.835	0.53717	957	1843.615	0.54189
899	1731.763	0.53695	958	1845.543	0.54199
900	1733.692	0.53677	959	1847.471	0.54213
901	1735.620	0.53722	960	1849.400	0.54226
902	1737.549	0.53777	961	1851.328	0.54232
903	1739.477	0.53802	962	1853.257	0.54223
904	1741.406	0.53841	963	1855.185	0.54226
905	1743.334	0.53905	964	1857.114	0.54229
906	1745.263	0.53955	965	1859.042	0.54225
907	1747.191	0.53969	966	1860.971	0.54228
908	1749.120	0.53966	967	1862.899	0.54240
909	1751.048	0.53975	968	1864.828	0.54246
910	1752.977	0.54018	969	1866.756	0.54227
911	1754.905	0.54055	970	1868.685	0.54211
912	1756.833	0.54069	971	1870.613	0.54228
913	1758.762	0.54078	972	1872.542	0.54245
914	1760.690	0.54084	973	1874.470	0.54257
915	1762.619	0.54087	974	1876.398	0.54266
916	1764.547	0.54104	975	1878.327	0.54264
917	1766.476	0.54107	976	1880.255	0.54269
918	1768.404	0.54105	977	1882.184	0.54274
919	1770.333	0.54099	978	1884.112	0.54275
920	1772.261	0.54086	979	1886.041	0.54280
921	1774.190	0.54090	980	1887.969	0.54275
922	1776.118	0.54103	981	1889.898	0.54270
923	1778.047	0.54104	982	1891.826	0.54272
924	1779.975	0.54125	983	1893.755	0.54270
925	1781.904	0.54144	984	1895.683	0.54266
926	1783.832	0.54139	985	1897.612	0.54270
927	1785.760	0.54130	986	1899.540	0.54280
928	1787.689	0.54133	987	1901.469	0.54296
929	1789.617	0.54119	988	1903.397	0.54310
930	1791.546	0.54094	989	1905.325	0.54299
931	1793.474	0.54083	990	1907.254	0.54289
932	1795.403	0.54111	991	1909.182	0.54299
933	1797.331	0.54140	992	1911.111	0.54304
934	1799.260	0.54149	993	1913.039	0.54312
935	1801.188	0.54140	994	1914.968	0.54317
936	1803.117	0.54131	995	1916.896	0.54300
937	1805.045	0.54120	996	1918.825	0.54299
938	1806.974	0.54131	997	1920.753	0.54309
939	1808.902	0.54158	998	1922.682	0.54300
940	1810.831	0.54170	999	1924.610	0.54306
941	1812.759	0.54170	1000	1926.539	0.54322
942	1814.688	0.54183	1001	1928.467	0.54343
943	1816.616	0.54190	1002	1930.396	0.54356
944	1818.544	0.54189	1003	1932.324	0.54341
945	1820.473	0.54184	1004	1934.252	0.54343
946	1822.401	0.54170	1005	1936.181	0.54364
947	1824.330	0.54165	1006	1938.109	0.54371

1007	1940.038	0.54362	1066	2053.817	0.54494
1008	1941.966	0.54346	1067	2055.746	0.54487
1009	1943.895	0.54339	1068	2057.674	0.54500
1010	1945.823	0.54358	1069	2059.603	0.54503
1011	1947.752	0.54372	1070	2061.531	0.54494
1012	1949.680	0.54372	1071	2063.460	0.54508
1013	1951.609	0.54361	1072	2065.388	0.54506
1014	1953.537	0.54363	1073	2067.317	0.54492
1015	1955.466	0.54377	1074	2069.245	0.54494
1016	1957.394	0.54389	1075	2071.174	0.54493
1017	1959.323	0.54403	1076	2073.102	0.54494
1018	1961.251	0.54409	1077	2075.031	0.54493
1019	1963.179	0.54400	1078	2076.959	0.54489
1020	1965.108	0.54393	1079	2078.887	0.54504
1021	1967.036	0.54404	1080	2080.816	0.54517
1022	1968.965	0.54424	1081	2082.744	0.54519
1023	1970.893	0.54420	1082	2084.673	0.54529
1024	1972.822	0.54405	1083	2086.601	0.54532
1025	1974.750	0.54418	1084	2088.530	0.54538
1026	1976.679	0.54425	1085	2090.458	0.54548
1027	1978.607	0.54412	1086	2092.387	0.54541
1028	1980.536	0.54398	1087	2094.315	0.54523
1029	1982.464	0.54404	1088	2096.244	0.54503
1030	1984.393	0.54415	1089	2098.172	0.54497
1031	1986.321	0.54405	1090	2100.101	0.54511
1032	1988.250	0.54416	1091	2102.029	0.54507
1033	1990.178	0.54436	1092	2103.958	0.54492
1034	1992.106	0.54432	1093	2105.886	0.54503
1035	1994.035	0.54434	1094	2107.814	0.54530
1036	1995.963	0.54429	1095	2109.743	0.54544
1037	1997.892	0.54423	1096	2111.671	0.54538
1038	1999.820	0.54440	1097	2113.600	0.54524
1039	2001.749	0.54448	1098	2115.528	0.54524
1040	2003.677	0.54446	1099	2117.457	0.54537
1041	2005.606	0.54442	1100	2119.385	0.54540
1042	2007.534	0.54438			
1043	2009.463	0.54461			
1044	2011.391	0.54474			
1045	2013.320	0.54467			
1046	2015.248	0.54462			
1047	2017.177	0.54457			
1048	2019.105	0.54450			
1049	2021.033	0.54454			
1050	2022.962	0.54460			
1051	2024.890	0.54462			
1052	2026.819	0.54467			
1053	2028.747	0.54476			
1054	2030.676	0.54504			
1055	2032.604	0.54498			
1056	2034.533	0.54464			
1057	2036.461	0.54448			
1058	2038.390	0.54466			
1059	2040.318	0.54483			
1060	2042.247	0.54491			
1061	2044.175	0.54496			
1062	2046.104	0.54504			
1063	2048.032	0.54510			
1064	2049.960	0.54503			
1065	2051.889	0.54498			

Sample:	D36					
	801					
300	576.612	0.48351		357	686.534	0.53106
301	578.540	0.48454		358	688.463	0.53072
302	580.469	0.48465		359	690.391	0.53056
303	582.397	0.48359		360	692.320	0.53096
304	584.326	0.48132		361	694.248	0.53248
305	586.254	0.47797		362	696.177	0.53445
306	588.182	0.47333		363	698.105	0.53526
307	590.111	0.46655		364	700.034	0.53473
308	592.039	0.45803		365	701.962	0.53382
309	593.968	0.44822		366	703.890	0.53273
310	595.896	0.43689		367	705.819	0.53114
311	597.825	0.42363		368	707.747	0.52866
312	599.753	0.40745		369	709.676	0.52567
313	601.682	0.38996		370	711.604	0.52189
314	603.610	0.37484		371	713.533	0.51672
315	605.539	0.36203		372	715.461	0.51033
316	607.467	0.35046		373	717.390	0.50437
317	609.396	0.34313		374	719.318	0.49988
318	611.324	0.34290		375	721.247	0.49641
319	613.253	0.34759		376	723.175	0.49334
320	615.181	0.35153		377	725.104	0.49008
321	617.109	0.35291		378	727.032	0.48621
322	619.038	0.35417		379	728.961	0.48300
323	620.966	0.35908		380	730.889	0.48065
324	622.895	0.37410		381	732.817	0.47798
325	624.823	0.40217		382	734.746	0.47517
326	626.752	0.43800		383	736.674	0.47337
327	628.680	0.47309		384	738.603	0.47292
328	630.609	0.49883		385	740.531	0.47423
329	632.537	0.51246		386	742.460	0.47717
330	634.466	0.51778		387	744.388	0.48020
331	636.394	0.51938		388	746.317	0.48250
332	638.323	0.52025		389	748.245	0.48485
333	640.251	0.52141		390	750.174	0.48674
334	642.180	0.52253		391	752.102	0.48744
335	644.108	0.52388		392	754.031	0.48834
336	646.036	0.52506		393	755.959	0.48963
337	647.965	0.52597		394	757.888	0.49069
338	649.893	0.52667		395	759.816	0.49134
339	651.822	0.52671		396	761.745	0.49142
340	653.750	0.52638		397	763.673	0.49158
341	655.679	0.52658		398	765.601	0.49202
342	657.607	0.52739		399	767.530	0.49259
343	659.536	0.52798		400	769.458	0.49346
344	661.464	0.52805		401	771.387	0.49405
345	663.393	0.52846		402	773.315	0.49398
346	665.321	0.52779		403	775.244	0.49413
347	667.250	0.52602		404	777.172	0.49463
348	669.178	0.52676		405	779.101	0.49528
349	671.107	0.52896		406	781.029	0.49534
350	673.035	0.52998		407	782.958	0.49496
351	674.963	0.53081		408	784.886	0.49512
352	676.892	0.53103		409	786.815	0.49562
353	678.820	0.53062		410	788.743	0.49614
354	680.749	0.53046		411	790.672	0.49678
355	682.677	0.53054		412	792.600	0.49718
356	684.606	0.53090		413	794.528	0.49800
				414	796.457	0.50035
				415	798.385	0.50307

416	800.314	0.50437	475	914.093	0.49439
417	802.242	0.50355	476	916.022	0.49600
418	804.171	0.50134	477	917.950	0.49722
419	806.099	0.49916	478	919.879	0.49816
420	808.028	0.49767	479	921.807	0.49902
421	809.956	0.49654	480	923.736	0.50007
422	811.885	0.49526	481	925.664	0.50112
423	813.813	0.49371	482	927.593	0.50181
424	815.742	0.49271	483	929.521	0.50223
425	817.670	0.49298	484	931.450	0.50318
426	819.599	0.49369	485	933.378	0.50432
427	821.527	0.49464	486	935.307	0.50479
428	823.455	0.49608	487	937.235	0.50479
429	825.384	0.49781	488	939.163	0.50486
430	827.312	0.50033	489	941.092	0.50478
431	829.241	0.50364	490	943.020	0.50490
432	831.169	0.50648	491	944.949	0.50520
433	833.098	0.50822	492	946.877	0.50494
434	835.026	0.50935	493	948.806	0.50436
435	836.955	0.51036	494	950.734	0.50414
436	838.883	0.51091	495	952.663	0.50382
437	840.812	0.51042	496	954.591	0.50336
438	842.740	0.50917	497	956.520	0.50330
439	844.669	0.50767	498	958.448	0.50335
440	846.597	0.50684	499	960.377	0.50313
441	848.526	0.50656	500	962.305	0.50308
442	850.454	0.50584	501	964.234	0.50332
443	852.382	0.50472	502	966.162	0.50369
444	854.311	0.50316	503	968.090	0.50406
445	856.239	0.50129	504	970.019	0.50426
446	858.168	0.49961	505	971.947	0.50483
447	860.096	0.49807	506	973.876	0.50567
448	862.025	0.49654	507	975.804	0.50634
449	863.953	0.49515	508	977.733	0.50669
450	865.882	0.49382	509	979.661	0.50717
451	867.810	0.49260	510	981.590	0.50824
452	869.739	0.49112	511	983.518	0.50965
453	871.667	0.48969	512	985.447	0.51071
454	873.596	0.48904	513	987.375	0.51160
455	875.524	0.48872	514	989.304	0.51285
456	877.453	0.48846	515	991.232	0.51403
457	879.381	0.48816	516	993.161	0.51492
458	881.309	0.48722	517	995.089	0.51600
459	883.238	0.48621	518	997.017	0.51698
460	885.166	0.48564	519	998.946	0.51746
461	887.095	0.48559	520	1000.874	0.51797
462	889.023	0.48598	521	1002.803	0.51880
463	890.952	0.48613	522	1004.731	0.51950
464	892.880	0.48586	523	1006.660	0.52009
465	894.809	0.48573	524	1008.588	0.52063
466	896.737	0.48599	525	1010.517	0.52095
467	898.666	0.48632	526	1012.445	0.52132
468	900.594	0.48660	527	1014.374	0.52201
469	902.523	0.48719	528	1016.302	0.52285
470	904.451	0.48814	529	1018.231	0.52341
471	906.380	0.48912	530	1020.159	0.52390
472	908.308	0.49006	531	1022.088	0.52452
473	910.236	0.49115	532	1024.016	0.52498
474	912.165	0.49262	533	1025.944	0.52516

534	1027.873	0.52518		593	1141.652	0.51418
535	1029.801	0.52540		594	1143.581	0.51526
536	1031.730	0.52587		595	1145.509	0.51606
537	1033.658	0.52609		596	1147.438	0.51706
538	1035.587	0.52612		597	1149.366	0.51817
539	1037.515	0.52628		598	1151.295	0.51904
540	1039.444	0.52635		599	1153.223	0.51973
541	1041.372	0.52621		600	1155.152	0.52035
542	1043.301	0.52631		601	1157.080	0.52082
543	1045.229	0.52643		602	1159.009	0.52126
544	1047.158	0.52620		603	1160.937	0.52167
545	1049.086	0.52571		604	1162.866	0.52203
546	1051.015	0.52517		605	1164.794	0.52251
547	1052.943	0.52468		606	1166.723	0.52308
548	1054.871	0.52444		607	1168.651	0.52351
549	1056.800	0.52415		608	1170.579	0.52398
550	1058.728	0.52343		609	1172.508	0.52460
551	1060.657	0.52285		610	1174.436	0.52520
552	1062.585	0.52246		611	1176.365	0.52574
553	1064.514	0.52189		612	1178.293	0.52626
554	1066.442	0.52089		613	1180.222	0.52668
555	1068.371	0.51945		614	1182.150	0.52697
556	1070.299	0.51772		615	1184.079	0.52733
557	1072.228	0.51602		616	1186.007	0.52780
558	1074.156	0.51408		617	1187.936	0.52838
559	1076.085	0.51152		618	1189.864	0.52894
560	1078.013	0.50849		619	1191.793	0.52945
561	1079.942	0.50512		620	1193.721	0.52987
562	1081.870	0.50132		621	1195.650	0.53042
563	1083.798	0.49683		622	1197.578	0.53109
564	1085.727	0.49164		623	1199.506	0.53160
565	1087.655	0.48592		624	1201.435	0.53196
566	1089.584	0.47975		625	1203.363	0.53234
567	1091.512	0.47319		626	1205.292	0.53265
568	1093.441	0.46629		627	1207.220	0.53298
569	1095.369	0.45937		628	1209.149	0.53347
570	1097.298	0.45295		629	1211.077	0.53381
571	1099.226	0.44741		630	1213.006	0.53397
572	1101.155	0.44279		631	1214.934	0.53408
573	1103.083	0.43904		632	1216.863	0.53400
574	1105.012	0.43652		633	1218.791	0.53387
575	1106.940	0.43551		634	1220.720	0.53373
576	1108.869	0.43583		635	1222.648	0.53371
577	1110.797	0.43735		636	1224.577	0.53388
578	1112.725	0.44005		637	1226.505	0.53404
579	1114.654	0.44397		638	1228.433	0.53408
580	1116.582	0.44884		639	1230.362	0.53415
581	1118.511	0.45455		640	1232.290	0.53412
582	1120.439	0.46110		641	1234.219	0.53417
583	1122.368	0.46834		642	1236.147	0.53437
584	1124.296	0.47592		643	1238.076	0.53458
585	1126.225	0.48342		644	1240.004	0.53470
586	1128.153	0.49029		645	1241.933	0.53472
587	1130.082	0.49619		646	1243.861	0.53471
588	1132.010	0.50088		647	1245.790	0.53467
589	1133.939	0.50470		648	1247.718	0.53466
590	1135.867	0.50813		649	1249.647	0.53465
591	1137.796	0.51083		650	1251.575	0.53475
592	1139.724	0.51270		651	1253.504	0.53495

652	1255.432	0.53518	711	1369.212	0.53777
653	1257.360	0.53542	712	1371.140	0.53765
654	1259.289	0.53552	713	1373.068	0.53753
655	1261.217	0.53544	714	1374.997	0.53769
656	1263.146	0.53554	715	1376.925	0.53784
657	1265.074	0.53559	716	1378.854	0.53802
658	1267.003	0.53536	717	1380.782	0.53828
659	1268.931	0.53529	718	1382.711	0.53815
660	1270.860	0.53534	719	1384.639	0.53763
661	1272.788	0.53518	720	1386.568	0.53736
662	1274.717	0.53498	721	1388.496	0.53757
663	1276.645	0.53473	722	1390.425	0.53780
664	1278.574	0.53434	723	1392.353	0.53803
665	1280.502	0.53410	724	1394.282	0.53827
666	1282.431	0.53416	725	1396.210	0.53831
667	1284.359	0.53401	726	1398.139	0.53827
668	1286.287	0.53365	727	1400.067	0.53834
669	1288.216	0.53350	728	1401.995	0.53845
670	1290.144	0.53340	729	1403.924	0.53847
671	1292.073	0.53336	730	1405.852	0.53841
672	1294.001	0.53346	731	1407.781	0.53835
673	1295.930	0.53331	732	1409.709	0.53839
674	1297.858	0.53298	733	1411.638	0.53851
675	1299.787	0.53303	734	1413.566	0.53834
676	1301.715	0.53321	735	1415.495	0.53787
677	1303.644	0.53332	736	1417.423	0.53733
678	1305.572	0.53354	737	1419.352	0.53689
679	1307.501	0.53386	738	1421.280	0.53681
680	1309.429	0.53413	739	1423.209	0.53695
681	1311.358	0.53435	740	1425.137	0.53672
682	1313.286	0.53465	741	1427.066	0.53625
683	1315.214	0.53489	742	1428.994	0.53590
684	1317.143	0.53507	743	1430.922	0.53540
685	1319.071	0.53538	744	1432.851	0.53473
686	1321.000	0.53586	745	1434.779	0.53419
687	1322.928	0.53639	746	1436.708	0.53392
688	1324.857	0.53683	747	1438.636	0.53366
689	1326.785	0.53716	748	1440.565	0.53327
690	1328.714	0.53763	749	1442.493	0.53295
691	1330.642	0.53817	750	1444.422	0.53270
692	1332.571	0.53838	751	1446.350	0.53273
693	1334.499	0.53823	752	1448.279	0.53303
694	1336.428	0.53825	753	1450.207	0.53308
695	1338.356	0.53854	754	1452.136	0.53306
696	1340.285	0.53869	755	1454.064	0.53328
697	1342.213	0.53875	756	1455.993	0.53345
698	1344.141	0.53881	757	1457.921	0.53379
699	1346.070	0.53871	758	1459.849	0.53466
700	1347.998	0.53869	759	1461.778	0.53555
701	1349.927	0.53878	760	1463.706	0.53612
702	1351.855	0.53871	761	1465.635	0.53688
703	1353.784	0.53855	762	1467.563	0.53795
704	1355.712	0.53850	763	1469.492	0.53861
705	1357.641	0.53819	764	1471.420	0.53885
706	1359.569	0.53768	765	1473.349	0.53953
707	1361.498	0.53768	766	1475.277	0.54058
708	1363.426	0.53793	767	1477.206	0.54152
709	1365.355	0.53775	768	1479.134	0.54231
710	1367.283	0.53762	769	1481.063	0.54297

770	1482.991	0.54361	829	1596.771	0.54824
771	1484.920	0.54424	830	1598.699	0.54819
772	1486.848	0.54453	831	1600.628	0.54819
773	1488.777	0.54460	832	1602.556	0.54825
774	1490.705	0.54498	833	1604.485	0.54801
775	1492.634	0.54552	834	1606.413	0.54791
776	1494.562	0.54572	835	1608.342	0.54815
777	1496.490	0.54573	836	1610.270	0.54814
778	1498.419	0.54594	837	1612.198	0.54804
779	1500.347	0.54626	838	1614.127	0.54800
780	1502.276	0.54657	839	1616.055	0.54778
781	1504.204	0.54634	840	1617.984	0.54787
782	1506.133	0.54576	841	1619.912	0.54834
783	1508.061	0.54604	842	1621.841	0.54836
784	1509.990	0.54688	843	1623.769	0.54795
785	1511.918	0.54716	844	1625.698	0.54782
786	1513.847	0.54719	845	1627.626	0.54800
787	1515.775	0.54741	846	1629.555	0.54808
788	1517.704	0.54738	847	1631.483	0.54807
789	1519.632	0.54716	848	1633.412	0.54792
790	1521.561	0.54714	849	1635.340	0.54764
791	1523.489	0.54714	850	1637.269	0.54761
792	1525.417	0.54700	851	1639.197	0.54801
793	1527.346	0.54718	852	1641.125	0.54824
794	1529.274	0.54773	853	1643.054	0.54807
795	1531.203	0.54781	854	1644.982	0.54789
796	1533.131	0.54767	855	1646.911	0.54794
797	1535.060	0.54786	856	1648.839	0.54800
798	1536.988	0.54741	857	1650.768	0.54757
799	1538.917	0.54646	858	1652.696	0.54695
800	1540.845	0.54636	859	1654.625	0.54730
801	1542.774	0.54688	860	1656.553	0.54830
802	1544.702	0.54746	861	1658.482	0.54869
803	1546.631	0.54801	862	1660.410	0.54853
804	1548.559	0.54792	863	1662.339	0.54840
805	1550.488	0.54749	864	1664.267	0.54858
806	1552.416	0.54755	865	1666.196	0.54863
807	1554.344	0.54771	866	1668.124	0.54823
808	1556.273	0.54722	867	1670.052	0.54810
809	1558.201	0.54650	868	1671.981	0.54835
810	1560.130	0.54655	869	1673.909	0.54834
811	1562.058	0.54714	870	1675.838	0.54839
812	1563.987	0.54752	871	1677.766	0.54859
813	1565.915	0.54780	872	1679.695	0.54872
814	1567.844	0.54783	873	1681.623	0.54862
815	1569.772	0.54774	874	1683.552	0.54808
816	1571.701	0.54798	875	1685.480	0.54803
817	1573.629	0.54789	876	1687.409	0.54872
818	1575.558	0.54747	877	1689.337	0.54897
819	1577.486	0.54766	878	1691.266	0.54870
820	1579.415	0.54792	879	1693.194	0.54834
821	1581.343	0.54784	880	1695.123	0.54791
822	1583.271	0.54796	881	1697.051	0.54762
823	1585.200	0.54811	882	1698.979	0.54734
824	1587.128	0.54802	883	1700.908	0.54724
825	1589.057	0.54807	884	1702.836	0.54752
826	1590.985	0.54824	885	1704.765	0.54772
827	1592.914	0.54819	886	1706.693	0.54778
828	1594.842	0.54814	887	1708.622	0.54774

888	1710.550	0.54740	947	1824.330	0.55047
889	1712.479	0.54719	948	1826.258	0.55034
890	1714.407	0.54676	949	1828.187	0.55046
891	1716.336	0.54604	950	1830.115	0.55055
892	1718.264	0.54600	951	1832.044	0.55047
893	1720.193	0.54641	952	1833.972	0.55051
894	1722.121	0.54641	953	1835.901	0.55075
895	1724.050	0.54633	954	1837.829	0.55091
896	1725.978	0.54657	955	1839.758	0.55099
897	1727.906	0.54668	956	1841.686	0.55083
898	1729.835	0.54663	957	1843.615	0.55051
899	1731.763	0.54641	958	1845.543	0.55053
900	1733.692	0.54613	959	1847.471	0.55102
901	1735.620	0.54646	960	1849.400	0.55127
902	1737.549	0.54720	961	1851.328	0.55106
903	1739.477	0.54746	962	1853.257	0.55092
904	1741.406	0.54765	963	1855.185	0.55089
905	1743.334	0.54820	964	1857.114	0.55082
906	1745.263	0.54861	965	1859.042	0.55103
907	1747.191	0.54876	966	1860.971	0.55130
908	1749.120	0.54889	967	1862.899	0.55138
909	1751.048	0.54902	968	1864.828	0.55142
910	1752.977	0.54932	969	1866.756	0.55136
911	1754.905	0.54964	970	1868.685	0.55110
912	1756.833	0.54986	971	1870.613	0.55105
913	1758.762	0.54999	972	1872.542	0.55138
914	1760.690	0.55009	973	1874.470	0.55164
915	1762.619	0.55021	974	1876.398	0.55160
916	1764.547	0.55023	975	1878.327	0.55163
917	1766.476	0.55016	976	1880.255	0.55161
918	1768.404	0.55021	977	1882.184	0.55133
919	1770.333	0.54991	978	1884.112	0.55136
920	1772.261	0.54961	979	1886.041	0.55150
921	1774.190	0.54984	980	1887.969	0.55136
922	1776.118	0.55020	981	1889.898	0.55144
923	1778.047	0.55028	982	1891.826	0.55174
924	1779.975	0.55023	983	1893.755	0.55178
925	1781.904	0.55022	984	1895.683	0.55172
926	1783.832	0.55034	985	1897.612	0.55177
927	1785.760	0.55053	986	1899.540	0.55177
928	1787.689	0.55058	987	1901.469	0.55189
929	1789.617	0.55025	988	1903.397	0.55207
930	1791.546	0.54997	989	1905.325	0.55186
931	1793.474	0.55015	990	1907.254	0.55167
932	1795.403	0.55042	991	1909.182	0.55186
933	1797.331	0.55048	992	1911.111	0.55190
934	1799.260	0.55054	993	1913.039	0.55169
935	1801.188	0.55051	994	1914.968	0.55185
936	1803.117	0.55056	995	1916.896	0.55212
937	1805.045	0.55073	996	1918.825	0.55216
938	1806.974	0.55065	997	1920.753	0.55218
939	1808.902	0.55046	998	1922.682	0.55223
940	1810.831	0.55061	999	1924.610	0.55209
941	1812.759	0.55067	1000	1926.539	0.55204
942	1814.688	0.55046	1001	1928.467	0.55223
943	1816.616	0.55055	1002	1930.396	0.55224
944	1818.544	0.55084	1003	1932.324	0.55202
945	1820.473	0.55080	1004	1934.252	0.55208
946	1822.401	0.55061	1005	1936.181	0.55227

1006	1938.109	0.55239	1065	2051.889	0.55379
1007	1940.038	0.55255	1066	2053.817	0.55367
1008	1941.966	0.55248	1067	2055.746	0.55363
1009	1943.895	0.55224	1068	2057.674	0.55374
1010	1945.823	0.55229	1069	2059.603	0.55365
1011	1947.752	0.55236	1070	2061.531	0.55353
1012	1949.680	0.55225	1071	2063.460	0.55348
1013	1951.609	0.55227	1072	2065.388	0.55351
1014	1953.537	0.55244	1073	2067.317	0.55379
1015	1955.466	0.55259	1074	2069.245	0.55418
1016	1957.394	0.55271	1075	2071.174	0.55420
1017	1959.323	0.55273	1076	2073.102	0.55388
1018	1961.251	0.55259	1077	2075.031	0.55376
1019	1963.179	0.55255	1078	2076.959	0.55383
1020	1965.108	0.55272	1079	2078.887	0.55374
1021	1967.036	0.55270	1080	2080.816	0.55371
1022	1968.965	0.55267	1081	2082.744	0.55368
1023	1970.893	0.55298	1082	2084.673	0.55358
1024	1972.822	0.55303	1083	2086.601	0.55374
1025	1974.750	0.55289	1084	2088.530	0.55399
1026	1976.679	0.55313	1085	2090.458	0.55393
1027	1978.607	0.55321	1086	2092.387	0.55374
1028	1980.536	0.55286	1087	2094.315	0.55385
1029	1982.464	0.55276	1088	2096.244	0.55406
1030	1984.393	0.55284	1089	2098.172	0.55413
1031	1986.321	0.55281	1090	2100.101	0.55403
1032	1988.250	0.55304	1091	2102.029	0.55385
1033	1990.178	0.55328	1092	2103.958	0.55375
1034	1992.106	0.55311	1093	2105.886	0.55371
1035	1994.035	0.55292	1094	2107.814	0.55366
1036	1995.963	0.55309	1095	2109.743	0.55361
1037	1997.892	0.55335	1096	2111.671	0.55373
1038	1999.820	0.55342	1097	2113.600	0.55400
1039	2001.749	0.55334	1098	2115.528	0.55400
1040	2003.677	0.55318	1099	2117.457	0.55393
1041	2005.606	0.55320	1100	2119.385	0.55393
1042	2007.534	0.55343			
1043	2009.463	0.55348			
1044	2011.391	0.55336			
1045	2013.320	0.55336			
1046	2015.248	0.55337			
1047	2017.177	0.55334			
1048	2019.105	0.55343			
1049	2021.033	0.55349			
1050	2022.962	0.55330			
1051	2024.890	0.55321			
1052	2026.819	0.55337			
1053	2028.747	0.55350			
1054	2030.676	0.55359			
1055	2032.604	0.55358			
1056	2034.533	0.55360			
1057	2036.461	0.55358			
1058	2038.390	0.55361			
1059	2040.318	0.55361			
1060	2042.247	0.55345			
1061	2044.175	0.55354			
1062	2046.104	0.55377			
1063	2048.032	0.55372			
1064	2049.960	0.55369			

Section V. RESULTS

*****spectrum***** modeld07
thickness is 0.0603cm

T(1038.7) = 0.5033 residual std. dev.= 0.152E-03
T(1107.9) = 0.3939 residual std. dev.= 0.844E-04
T(1259.8) = 0.5110 residual std. dev.= 0.233E-03

BASELINE TRANSMITTANCE AT 1107.9 WAVENUMBERS= 0.5057
====> ALPHA(BASE) = 0.877 ALPHA(PEAK) = 4.51057

NET ABSORBANCE PEAK HEIGHT = 0.095142

* OXYGEN CONTENT IS 19.68 PPMA *

*****spectrum***** modeld12
thickness is 0.0588cm

T(1040.5) = 0.5221 residual std. dev.= 0.192E-03
T(1107.8) = 0.4015 residual std. dev.= 0.255E-03
T(1259.8) = 0.5346 residual std. dev.= 0.242E-03

BASELINE TRANSMITTANCE AT 1107.8 WAVENUMBERS= 0.5259
====> ALPHA(BASE) = 0.336 ALPHA(PEAK) = 4.33700

NET ABSORBANCE PEAK HEIGHT = 0.102129

* OXYGEN CONTENT IS 21.99 PPMA *

*****spectrum***** modeld26
thickness is 0.0552cm

T(1039.3) = 0.5151 residual std. dev.= 0.189E-03
T(1107.8) = 0.3974 residual std. dev.= 0.146E-03
T(1259.8) = 0.5241 residual std. dev.= 0.241E-03

BASELINE TRANSMITTANCE AT 1107.8 WAVENUMBERS= 0.5179
====> ALPHA(BASE) = 0.593 ALPHA(PEAK) = 4.78783

NET ABSORBANCE PEAK HEIGHT = 0.100500

* OXYGEN CONTENT IS 23.21 PPMA *

*****spectrum***** model d36
thickness is 0.0476cm

T(1039.3) = 0.5264 residual std. dev.= 0.172E-03
T(1107.9) = 0.4355 residual std. dev.= 0.995E-04
T(1259.8) = 0.5357 residual std. dev.= 0.207E-03

BASELINE TRANSMITTANCE AT 1107.9 WAVENUMBERS= 0.5292
====> ALPHA(BASE) = 0.303 ALPHA(Peak) = 3.82890

NET ABSORBANCE PEAK HEIGHT = 0.072947

* OXYGEN CONTENT IS 19.00 PPMA *

*****spectrum***** model d37
thickness is 0.0602cm

T(1041.2) = 0.5117 residual std. dev.= 0.146E-03
T(1108.0) = 0.4043 residual std. dev.= 0.168E-03
T(1259.8) = 0.5224 residual std. dev.= 0.211E-03

BASELINE TRANSMITTANCE AT 1108.0 WAVENUMBERS= 0.5149
====> ALPHA(BASE) = 0.624 ALPHA(Peak) = 4.12879

NET ABSORBANCE PEAK HEIGHT = 0.091619

* OXYGEN CONTENT IS 18.87 PPMA *

*****spectrum***** model d51
thickness is 0.0596cm

T(1040.5) = 0.5201 residual std. dev.= 0.164E-03
T(1107.9) = 0.4033 residual std. dev.= 0.102E-03
T(1259.8) = 0.5301 residual std. dev.= 0.249E-03

BASELINE TRANSMITTANCE AT 1107.9 WAVENUMBERS= 0.5232
====> ALPHA(BASE) = 0.405 ALPHA(Peak) = 4.20695

NET ABSORBANCE PEAK HEIGHT = 0.098407

* OXYGEN CONTENT IS 20.74 PPMA *

sample file name	modeld07.dat
thickness (mils)	2.3740157480E+01
tbase	5.0573972500E-01
tpeak	3.9389457650E-01
a _{base}	8.7606295310E-01
a _{peak}	4.5103899343E+00
a _{net}	3.6343269812E+00
uncertainty	1.0735350129E-02
standard deviation	5.2676600221E+02
ppm (6.28)	1.9683573442E+01

sample file name	modeld12.dat
thickness (mils)	2.3149606299E+01
tbase	5.2596866007E-01
tpeak	4.0144105833E-01
a _{base}	3.3447332586E-01
a _{peak}	4.3352775874E+00
a _{net}	4.0008042615E+00
uncertainty	1.5548042721E-02
standard deviation	5.2676600221E+02
ppm (6.28)	2.1985050762E+01

sample file name	modeld26.dat
thickness (mils)	2.1732283465E+01
tbase	5.1786107475E-01
tpeak	3.9734250844E-01
a _{base}	5.9342275614E-01
a _{peak}	4.7850185869E+00
a _{net}	4.1915958308E+00
uncertainty	1.2867481063E-02
standard deviation	5.2676600221E+02
ppm (6.28)	2.3183221817E+01

FEDERAL INFORMATION PROCESSING STANDARD SOFTWARE SUMMARY

01. Summary date			02. Summary prepared by (Name and Phone) Aslan Baghdadi 975-2062			03. Summary action New <input checked="" type="checkbox"/> Replacement <input type="checkbox"/> Deletion <input type="checkbox"/> Previous Internal Software ID				
Yr. 8	Mo. 8	Day 0 5 1 1	05. Software title Automatic Determination of the Oxygen Content of Silicon Wafers Polished on Both Sides							
Yr. 8	Mo. 8	Day 0 5 1 1	06. Short title DSPOX			07. Internal Software ID DSPOX				
08. Software type <input type="checkbox"/> Automated Data System <input checked="" type="checkbox"/> Computer Program <input type="checkbox"/> Subroutine/Module		09. Processing mode <input type="checkbox"/> Interactive <input type="checkbox"/> Batch <input type="checkbox"/> Combination	10. Application area <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top;"> General <input type="checkbox"/> Computer Systems <input type="checkbox"/> Support/Utility <input type="checkbox"/> Scientific/Engineering <input type="checkbox"/> Bibliographic/Textual </td> <td style="width: 50%; vertical-align: top;"> Specific <input type="checkbox"/> Management/ Business <input type="checkbox"/> Process Control <input type="checkbox"/> Other </td> </tr> </table>			General <input type="checkbox"/> Computer Systems <input type="checkbox"/> Support/Utility <input type="checkbox"/> Scientific/Engineering <input type="checkbox"/> Bibliographic/Textual	Specific <input type="checkbox"/> Management/ Business <input type="checkbox"/> Process Control <input type="checkbox"/> Other			
General <input type="checkbox"/> Computer Systems <input type="checkbox"/> Support/Utility <input type="checkbox"/> Scientific/Engineering <input type="checkbox"/> Bibliographic/Textual	Specific <input type="checkbox"/> Management/ Business <input type="checkbox"/> Process Control <input type="checkbox"/> Other									
11. Submitting organization and address Semiconductor Electronics Division National Institute of Standards & Technology Gaithersburg, MD 20899						12. Technical contact(s) and phone Aslan Baghdadi 301/975-2062				
13. Narrative <p>These programs implement an ASTM Standard Test Method for the Determination of the Oxygen Content of Silicon Wafers That are Polished on Both Sides. The data are initially obtained on a computer-assisted infrared spectrometer.</p>										
14. Keywords Infrared, IR, oxygen, silicon spectrum										
15. Computer manuf'r and model 1. VAX 11/785 2. IBM AT		16. Computer operating system 1. VMS 4.7 2. DOS 3.2		17. Programing language(s) 1. FORTRAN 2. TURBO PASCAL		18. Number of source program statements				
19. Computer memory requirements		20. Tape drives		21. Disk/Drum units		22. Terminals				
23. Other operational requirements										
24. Software availability Available <input checked="" type="checkbox"/> <input type="checkbox"/>				25. Documentation availability Available <input checked="" type="checkbox"/> <input type="checkbox"/>						
26. FOR SUBMITTING ORGANIZATION USE										

U.S. Department of Commerce
National Institute of Standards and Technology
(formerly National Bureau of Standards)
Gaithersburg, MD 20899

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