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AUSTRALIAN ATOMIC ENERGY COMMISSION

RESEARCH ESTABLISHMENT

LUCAS HEIGHTS

TABLES OF FUNCTIONS WHICH OCCUR IN THE THEORY OF THERMAL VIBRATIONS

by

A.W. Pryor

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ABSTRACT

Tables of the population function, the average energy function, the Einstein and Debye specific heat functions, and the Debye diffraction function are given. These functions are of value in elementary calculations of the specific heat and diffraction effects of crystals.

1. INTRODUCTION

Most of these functions are tabulated in various places. However, for convenience they have been re-calculated with short FORTRAN programmes and presented together.

2. THE FUNCTIONS

(i) The Bose-Einstein population function, defined by:

$$P(x) = (e^x - 1)^{-1}$$

(ii) The average energy function of a harmonic quantum oscillator, defined by:

$$\gamma(x) = x/2 + x/(e^x - 1) = x/2 \coth x/2$$

The average energy is $\epsilon(w,T) = kT\,\gamma(\hbar w/kT)$

(iii) The specific heat function for a quantum oscillator, defined by:

$$E(x) = x^2 e^x (e^x - 1)^{-2}$$

(iv) The specific heat of a Debye continuum, defined by:

$$C_v/3R = D(x) = 3/x^3 \int_0^x y^4 e^y (e^y - 1)^{-2}\, dy$$

(v) The diffraction function of a Debye continuum defined by:

$$\psi(x) = x/4 + 1/x \int_0^x y(e^y - 1)^{-1}\, dy$$

In all these functions x is to be interpreted as $\hbar w/kT$ or as θ_D/T where θ_D is the Debye Temperature.

3. METHOD OF CALCULATION

3.1 Large x (greater than 1.7)

The functions were calculated using the EXP routine and expanding the two integrals in power series of exponentials.

This Table is presented in intervals of 1/x from 1/x = .01 to 1/x = 0.6 in steps of .01.

3.2 Small x (less than 2.5)

The following power series were used:-

(i) $P(x) = 1/x - 1/2 + x/12 - x^3/6! + x^5/6.7! - x^7/30.\ 8!$

(ii) $\eta(x) = 1 + x^2/12 - x^4/6! + x^6/6.7! - x^8/30.\ 8!$

(iii) $E(x) = 1 - x^2/12 + x^4/240 - x^6/6048 + x^8/518400$

(iv) $D(x) = 1 - x^2/20 + x^4/560 - x^6/18144 + x^8/1900800$

(v) $\psi(x) = 1 + x^2/36 - x^4/30.5! + x^6/42.7! - x^8/30.9!$

NOTE that for E(x) this series does not converge fast enough and is 4% in error at x = 2.5 and 0.5% in error at x = 20. For the other series the error is less; the worst is D(x) for which the error is 0.15% at x = 2.5.

4. ACKNOWLEDGEMENTS

The FORTRAN programmes were written by Mr. A. Hewat (vacation student from Melbourne University).

EXPANSION FOR X GREATER THAN 2, LESS THAN 100

X	1/X	P(X)	ETA(X)	E(X)	D(X)	PHI(X)
1.000E+02	1.000E-02	0.0	5.000E+01	0.0	7.793E-05	2.502E+01
5.000E+01	2.000E-02	0.0	2.500E+01	0.0	6.234E-04	1.253E+01
3.333E+01	3.000E-02	3.338E-15	1.667E+01	3.709E-12	2.104E-03	8.383E+00
2.500E+01	4.000E-02	1.389E-11	1.250E+01	8.680E-09	4.987E-03	6.316E+00
2.000E+01	5.000E-02	2.061E-09	1.000E+01	8.245E-07	9.741E-03	5.082E+00
1.667E+01	6.000E-02	5.778E-08	8.333E+00	1.605E-05	1.683E-02	4.265E+00
1.429E+01	7.000E-02	6.249E-07	7.143E+00	1.275E-04	2.669E-02	3.687E+00
1.250E+01	8.000E-02	3.727E-06	6.250E+00	5.823E-04	3.970E-02	3.257E+00
1.111E+01	9.000E-02	1.495E-05	5.556E+00	1.845E-03	5.607E-02	2.926E+00
1.000E+01	1.000E-01	4.540E-05	5.000E+00	4.540E-03	7.582E-02	2.664E+00
9.091E+00	1.100E-01	1.127E-04	4.546E+00	9.315E-03	9.874E-02	2.454E+00
8.333E+00	1.200E-01	2.404E-04	4.169E+00	1.670E-02	1.244E-01	2.280E+00
7.692E+00	1.300E-01	4.565E-04	3.850E+00	2.703E-02	1.524E-01	2.136E+00
7.143E+00	1.400E-01	7.911E-04	3.577E+00	4.039E-02	1.821E-01	2.015E+00
6.667E+00	1.500E-01	1.274E-03	3.342E+00	5.671E-02	2.130E-01	1.912E+00
6.250E+00	1.600E-01	1.934E-03	3.137E+00	7.570E-02	2.445E-01	1.823E+00
5.882E+00	1.700E-01	2.796E-03	2.958E+00	9.702E-02	2.761E-01	1.747E+00
5.556E+00	1.800E-01	3.881E-03	2.799E+00	1.202E-01	3.076E-01	1.680E+00
5.263E+00	1.900E-01	5.206E-03	2.659E+00	1.450E-01	3.385E-01	1.622E+00
5.000E+00	2.000E-01	6.784E-03	2.534E+00	1.707E-01	3.686E-01	1.571E+00
4.762E+00	2.100E-01	8.623E-03	2.422E+00	1.972E-01	3.978E-01	1.526E+00
4.545E+00	2.200E-01	1.073E-02	2.321E+00	2.241E-01	4.259E-01	1.485E+00
4.348E+00	2.300E-01	1.310E-02	2.231E+00	2.510E-01	4.528E-01	1.449E+00
4.167E+00	2.400E-01	1.575E-02	2.149E+00	2.777E-01	4.786E-01	1.417E+00
4.000E+00	2.500E-01	1.866E-02	2.075E+00	3.041E-01	5.031E-01	1.388E+00
3.846E+00	2.600E-01	2.183E-02	2.007E+00	3.299E-01	5.263E-01	1.362E+00
3.704E+00	2.700E-01	2.525E-02	1.945E+00	3.552E-01	5.484E-01	1.338E+00
3.571E+00	2.800E-01	2.893E-02	1.889E+00	3.797E-01	5.693E-01	1.317E+00
3.448E+00	2.900E-01	3.284E-02	1.837E+00	4.034E-01	5.890E-01	1.297E+00
3.333E+00	3.000E-01	3.699E-02	1.790E+00	4.262E-01	6.077E-01	1.280E+00
3.226E+00	3.100E-01	4.137E-02	1.746E+00	4.483E-01	6.253E-01	1.263E+00
3.125E+00	3.200E-01	4.596E-02	1.706E+00	4.694E-01	6.420E-01	1.248E+00
3.030E+00	3.300E-01	5.075E-02	1.669E+00	4.897E-01	6.577E-01	1.235E+00
2.941E+00	3.400E-01	5.575E-02	1.635E+00	5.091E-01	6.725E-01	1.222E+00
2.857E+00	3.500E-01	6.093E-02	1.603E+00	5.277E-01	6.865E-01	1.210E+00
2.778E+00	3.600E-01	6.630E-02	1.573E+00	5.455E-01	6.998E-01	1.200E+00
2.703E+00	3.700E-01	7.184E-02	1.546E+00	5.625E-01	7.123E-01	1.190E+00
2.632E+00	3.800E-01	7.755E-02	1.520E+00	5.787E-01	7.241E-01	1.180E+00
2.564E+00	3.900E-01	8.341E-02	1.496E+00	5.941E-01	7.353E-01	1.172E+00
2.500E+00	4.000E-01	8.943E-02	1.474E+00	6.089E-01	7.458E-01	1.164E+00

2.439E+00	4.100E-01	9.559E-02	1.453E+00	6.230E-01	7.558E-01	1.156E+00
2.381E+00	4.200E-01	1.019E-01	1.433E+00	6.364E-01	7.653E-01	1.149E+00
2.326E+00	4.300E-01	1.083E-01	1.415E+00	6.492E-01	7.742E-01	1.143E+00
2.273E+00	4.400E-01	1.149E-01	1.397E+00	6.615E-01	7.827E-01	1.137E+00
2.222E+00	4.500E-01	1.215E-01	1.381E+00	6.731E-01	7.908E-01	1.131E+00
2.174E+00	4.600E-01	1.283E-01	1.366E+00	6.843E-01	7.985E-01	1.126E+00
2.128E+00	4.700E-01	1.352E-01	1.352E+00	6.949E-01	8.057E-01	1.120E+00
2.083E+00	4.800E-01	1.422E-01	1.338E+00	7.051E-01	8.127E-01	1.116E+00
2.041E+00	4.900E-01	1.493E-01	1.325E+00	7.148E-01	8.192E-01	1.111E+00
2.000E+00	5.000E-01	1.565E-01	1.313E+00	7.241E-01	8.255E-01	1.107E+00
1.961E+00	5.100E-01	1.638E-01	1.302E+00	7.329E-01	8.315E-01	1.103E+00
1.923E+00	5.200E-01	1.712E-01	1.291E+00	7.414E-01	8.372E-01	1.099E+00
1.887E+00	5.300E-01	1.786E-01	1.280E+00	7.495E-01	8.427E-01	1.096E+00
1.852E+00	5.400E-01	1.862E-01	1.271E+00	7.573E-01	8.479E-01	1.092E+00
1.818E+00	5.500E-01	1.938E-01	1.261E+00	7.647E-01	8.529E-01	1.089E+00
1.786E+00	5.600E-01	2.015E-01	1.253E+00	7.718E-01	8.577E-01	1.086E+00
1.754E+00	5.700E-01	2.092E-01	1.244E+00	7.785E-01	8.624E-01	1.083E+00
1.724E+00	5.800E-01	2.170E-01	1.236E+00	7.852E-01	8.668E-01	1.080E+00
1.695E+00	5.900E-01	2.249E-01	1.229E+00	7.914E-01	8.711E-01	1.078E+00
1.667E+00	6.000E-01	2.329E-01	1.221E+00	7.974E-01	8.752E-01	1.075E+00

EXPANSION FOR X LESS THAN 2.5

X	1/X	P(X)	ETA(X)	E(X)	D(X)	PHI(X)
2.500E+00	4.000E-01	8.936E-02	1.473E+00	6.310E-01	7.446E-01	1.164E+00
2.490E+00	4.016E-01	9.034E-02	1.470E+00	6.326E-01	7.463E-01	1.163E+00
2.480E+00	4.032E-01	9.133E-02	1.467E+00	6.342E-01	7.480E-01	1.161E+00
2.470E+00	4.049E-01	9.234E-02	1.463E+00	6.359E-01	7.496E-01	1.160E+00
2.460E+00	4.065E-01	9.336E-02	1.460E+00	6.375E-01	7.513E-01	1.159E+00
2.450E+00	4.082E-01	9.439E-02	1.456E+00	6.392E-01	7.530E-01	1.158E+00
2.440E+00	4.098E-01	9.543E-02	1.453E+00	6.409E-01	7.546E-01	1.156E+00
2.430E+00	4.115E-01	9.648E-02	1.449E+00	6.426E-01	7.563E-01	1.155E+00
2.420E+00	4.132E-01	9.755E-02	1.446E+00	6.444E-01	7.580E-01	1.154E+00
2.410E+00	4.149E-01	9.863E-02	1.443E+00	6.461E-01	7.596E-01	1.153E+00
2.400E+00	4.167E-01	9.972E-02	1.439E+00	6.479E-01	7.613E-01	1.152E+00
2.390E+00	4.184E-01	1.008E-01	1.436E+00	6.497E-01	7.629E-01	1.150E+00
2.380E+00	4.202E-01	1.019E-01	1.433E+00	6.515E-01	7.646E-01	1.149E+00
2.370E+00	4.219E-01	1.031E-01	1.429E+00	6.533E-01	7.663E-01	1.148E+00
2.360E+00	4.237E-01	1.042E-01	1.426E+00	6.551E-01	7.679E-01	1.147E+00
2.350E+00	4.255E-01	1.054E-01	1.423E+00	6.570E-01	7.695E-01	1.146E+00
2.340E+00	4.274E-01	1.066E-01	1.419E+00	6.588E-01	7.712E-01	1.144E+00
2.330E+00	4.292E-01	1.077E-01	1.416E+00	6.607E-01	7.728E-01	1.143E+00
2.320E+00	4.310E-01	1.089E-01	1.413E+00	6.626E-01	7.745E-01	1.142E+00
2.310E+00	4.329E-01	1.102E-01	1.409E+00	6.645E-01	7.761E-01	1.141E+00

2.300E+00	4.348E-01	1.114E-01	1.406E+00	6.664E-01	7.777E-01	1.140E+00
2.290E+00	4.367E-01	1.126E-01	1.403E+00	6.683E-01	7.794E-01	1.139E+00
2.280E+00	4.386E-01	1.139E-01	1.400E+00	6.703E-01	7.810E-01	1.137E+00
2.270E+00	4.405E-01	1.152E-01	1.396E+00	6.722E-01	7.826E-01	1.136E+00
2.260E+00	4.425E-01	1.165E-01	1.393E+00	6.742E-01	7.842E-01	1.135E+00
2.250E+00	4.444E-01	1.178E-01	1.390E+00	6.761E-01	7.858E-01	1.134E+00
2.240E+00	4.464E-01	1.191E-01	1.387E+00	6.781E-01	7.874E-01	1.133E+00
2.230E+00	4.484E-01	1.205E-01	1.384E+00	6.801E-01	7.891E-01	1.132E+00
2.220E+00	4.505E-01	1.218E-01	1.380E+00	6.821E-01	7.907E-01	1.131E+00
2.210E+00	4.525E-01	1.232E-01	1.377E+00	6.841E-01	7.923E-01	1.130E+00
2.200E+00	4.545E-01	1.246E-01	1.374E+00	6.861E-01	7.939E-01	1.128E+00
2.190E+00	4.566E-01	1.260E-01	1.371E+00	6.881E-01	7.955E-01	1.127E+00
2.180E+00	4.587E-01	1.274E-01	1.368E+00	6.902E-01	7.971E-01	1.126E+00
2.170E+00	4.608E-01	1.289E-01	1.365E+00	6.922E-01	7.987E-01	1.125E+00
2.160E+00	4.630E-01	1.303E-01	1.362E+00	6.942E-01	8.002E-01	1.124E+00
2.150E+00	4.651E-01	1.318E-01	1.358E+00	6.963E-01	8.018E-01	1.123E+00
2.140E+00	4.673E-01	1.333E-01	1.355E+00	6.984E-01	8.034E-01	1.122E+00
2.130E+00	4.695E-01	1.348E-01	1.352E+00	7.004E-01	8.050E-01	1.121E+00
2.120E+00	4.717E-01	1.364E-01	1.349E+00	7.025E-01	8.066E-01	1.120E+00
2.110E+00	4.739E-01	1.379E-01	1.346E+00	7.046E-01	8.081E-01	1.119E+00
2.100E+00	4.762E-01	1.395E-01	1.343E+00	7.066E-01	8.097E-01	1.117E+00
2.090E+00	4.785E-01	1.411E-01	1.340E+00	7.087E-01	8.113E-01	1.116E+00
2.080E+00	4.808E-01	1.428E-01	1.337E+00	7.108E-01	8.128E-01	1.115E+00
2.070E+00	4.831E-01	1.444E-01	1.334E+00	7.129E-01	8.144E-01	1.114E+00
2.060E+00	4.854E-01	1.461E-01	1.331E+00	7.150E-01	8.159E-01	1.113E+00
2.050E+00	4.878E-01	1.477E-01	1.328E+00	7.171E-01	8.175E-01	1.112E+00
2.040E+00	4.902E-01	1.495E-01	1.325E+00	7.192E-01	8.190E-01	1.111E+00
2.030E+00	4.926E-01	1.512E-01	1.322E+00	7.213E-01	8.206E-01	1.110E+00
2.020E+00	4.950E-01	1.529E-01	1.319E+00	7.235E-01	8.221E-01	1.109E+00
2.010E+00	4.975E-01	1.547E-01	1.316E+00	7.256E-01	8.236E-01	1.108E+00
2.000E+00	5.000E-01	1.565E-01	1.313E+00	7.277E-01	8.252E-01	1.107E+00
1.990E+00	5.025E-01	1.583E-01	1.310E+00	7.298E-01	8.267E-01	1.106E+00
1.980E+00	5.051E-01	1.602E-01	1.307E+00	7.319E-01	8.282E-01	1.105E+00
1.970E+00	5.076E-01	1.620E-01	1.304E+00	7.341E-01	8.297E-01	1.104E+00
1.960E+00	5.102E-01	1.639E-01	1.301E+00	7.362E-01	8.313E-01	1.103E+00
1.950E+00	5.128E-01	1.659E-01	1.298E+00	7.383E-01	8.328E-01	1.102E+00
1.940E+00	5.155E-01	1.678E-01	1.296E+00	7.404E-01	8.343E-01	1.101E+00
1.930E+00	5.181E-01	1.698E-01	1.293E+00	7.426E-01	8.358E-01	1.100E+00
1.920E+00	5.208E-01	1.718E-01	1.290E+00	7.447E-01	8.373E-01	1.099E+00
1.910E+00	5.236E-01	1.738E-01	1.287E+00	7.468E-01	8.388E-01	1.098E+00
1.900E+00	5.263E-01	1.759E-01	1.284E+00	7.490E-01	8.403E-01	1.097E+00
1.890E+00	5.291E-01	1.780E-01	1.281E+00	7.511E-01	8.418E-01	1.096E+00
1.880E+00	5.319E-01	1.801E-01	1.279E+00	7.532E-01	8.432E-01	1.095E+00
1.870E+00	5.348E-01	1.822E-01	1.276E+00	7.554E-01	8.447E-01	1.094E+00
1.860E+00	5.376E-01	1.844E-01	1.273E+00	7.575E-01	8.462E-01	1.093E+00
1.850E+00	5.405E-01	1.866E-01	1.270E+00	7.596E-01	8.477E-01	1.092E+00
1.840E+00	5.435E-01	1.888E-01	1.267E+00	7.617E-01	8.491E-01	1.091E+00
1.830E+00	5.464E-01	1.911E-01	1.265E+00	7.639E-01	8.506E-01	1.090E+00
1.820E+00	5.495E-01	1.933E-01	1.262E+00	7.660E-01	8.520E-01	1.089E+00
1.810E+00	5.525E-01	1.957E-01	1.259E+00	7.681E-01	8.535E-01	1.088E+00
1.800E+00	5.556E-01	1.980E-01	1.256E+00	7.702E-01	8.549E-01	1.087E+00
1.790E+00	5.587E-01	2.004E-01	1.254E+00	7.724E-01	8.564E-01	1.086E+00
1.780E+00	5.618E-01	2.028E-01	1.251E+00	7.745E-01	8.578E-01	1.085E+00

1.770E+00	5.650E-01	2.053E-01	1.248E+00	7.766E-01	8.592E-01	1.084E+00
1.760E+00	5.682E-01	2.078E-01	1.246E+00	7.787E-01	8.607E-01	1.084E+00
1.750E+00	5.714E-01	2.103E-01	1.243E+00	7.808E-01	8.621E-01	1.083E+00
1.740E+00	5.747E-01	2.129E-01	1.240E+00	7.829E-01	8.635E-01	1.082E+00
1.730E+00	5.780E-01	2.155E-01	1.238E+00	7.850E-01	8.649E-01	1.081E+00
1.720E+00	5.814E-01	2.181E-01	1.235E+00	7.871E-01	8.663E-01	1.080E+00
1.710E+00	5.848E-01	2.208E-01	1.233E+00	7.892E-01	8.677E-01	1.079E+00
1.700E+00	5.882E-01	2.235E-01	1.230E+00	7.913E-01	8.691E-01	1.078E+00
1.690E+00	5.917E-01	2.263E-01	1.227E+00	7.934E-01	8.705E-01	1.077E+00
1.680E+00	5.952E-01	2.291E-01	1.225E+00	7.955E-01	8.719E-01	1.076E+00
1.670E+00	5.988E-01	2.319E-01	1.222E+00	7.976E-01	8.733E-01	1.075E+00
1.660E+00	6.024E-01	2.348E-01	1.220E+00	7.997E-01	8.747E-01	1.075E+00
1.650E+00	6.061E-01	2.377E-01	1.217E+00	8.017E-01	8.760E-01	1.074E+00
1.640E+00	6.098E-01	2.407E-01	1.215E+00	8.038E-01	8.774E-01	1.073E+00
1.630E+00	6.135E-01	2.437E-01	1.212E+00	8.059E-01	8.788E-01	1.072E+00
1.620E+00	6.173E-01	2.467E-01	1.210E+00	8.079E-01	8.801E-01	1.071E+00
1.610E+00	6.211E-01	2.498E-01	1.207E+00	8.100E-01	8.815E-01	1.070E+00
1.600E+00	6.250E-01	2.530E-01	1.205E+00	8.120E-01	8.828E-01	1.069E+00
1.590E+00	6.289E-01	2.562E-01	1.202E+00	8.141E-01	8.841E-01	1.069E+00
1.580E+00	6.329E-01	2.594E-01	1.200E+00	8.161E-01	8.855E-01	1.068E+00
1.570E+00	6.369E-01	2.627E-01	1.197E+00	8.181E-01	8.868E-01	1.067E+00
1.560E+00	6.410E-01	2.660E-01	1.195E+00	8.202E-01	8.881E-01	1.066E+00
1.550E+00	6.452E-01	2.694E-01	1.193E+00	8.222E-01	8.894E-01	1.065E+00
1.540E+00	6.494E-01	2.729E-01	1.190E+00	8.242E-01	8.907E-01	1.064E+00
1.530E+00	6.536E-01	2.764E-01	1.188E+00	8.262E-01	8.920E-01	1.064E+00
1.520E+00	6.579E-01	2.799E-01	1.186E+00	8.282E-01	8.933E-01	1.063E+00
1.510E+00	6.623E-01	2.835E-01	1.183E+00	8.302E-01	8.946E-01	1.062E+00
1.500E+00	6.667E-01	2.872E-01	1.181E+00	8.322E-01	8.959E-01	1.061E+00
1.490E+00	6.711E-01	2.909E-01	1.179E+00	8.342E-01	8.972E-01	1.060E+00
1.480E+00	6.757E-01	2.947E-01	1.176E+00	8.362E-01	8.985E-01	1.060E+00
1.470E+00	6.803E-01	2.986E-01	1.174E+00	8.381E-01	8.997E-01	1.059E+00
1.460E+00	6.849E-01	3.025E-01	1.172E+00	8.401E-01	9.010E-01	1.058E+00
1.450E+00	6.897E-01	3.065E-01	1.169E+00	8.421E-01	9.023E-01	1.057E+00
1.440E+00	6.944E-01	3.105E-01	1.167E+00	8.440E-01	9.035E-01	1.056E+00
1.430E+00	6.993E-01	3.146E-01	1.165E+00	8.459E-01	9.048E-01	1.056E+00
1.420E+00	7.042E-01	3.188E-01	1.163E+00	8.479E-01	9.060E-01	1.055E+00
1.410E+00	7.092E-01	3.230E-01	1.160E+00	8.498E-01	9.072E-01	1.054E+00
1.400E+00	7.143E-01	3.273E-01	1.158E+00	8.517E-01	9.085E-01	1.053E+00
1.390E+00	7.194E-01	3.317E-01	1.156E+00	8.536E-01	9.097E-01	1.053E+00
1.380E+00	7.246E-01	3.361E-01	1.154E+00	8.555E-01	9.109E-01	1.052E+00
1.370E+00	7.299E-01	3.407E-01	1.152E+00	8.574E-01	9.121E-01	1.051E+00
1.360E+00	7.353E-01	3.453E-01	1.150E+00	8.593E-01	9.133E-01	1.050E+00
1.350E+00	7.407E-01	3.500E-01	1.147E+00	8.612E-01	9.145E-01	1.050E+00
1.340E+00	7.463E-01	3.547E-01	1.145E+00	8.630E-01	9.157E-01	1.049E+00
1.330E+00	7.519E-01	3.596E-01	1.143E+00	8.649E-01	9.168E-01	1.048E+00
1.320E+00	7.576E-01	3.645E-01	1.141E+00	8.668E-01	9.180E-01	1.048E+00
1.310E+00	7.634E-01	3.695E-01	1.139E+00	8.686E-01	9.192E-01	1.047E+00
1.300E+00	7.692E-01	3.746E-01	1.137E+00	8.704E-01	9.203E-01	1.046E+00
1.290E+00	7.752E-01	3.798E-01	1.135E+00	8.722E-01	9.215E-01	1.045E+00
1.280E+00	7.813E-01	3.851E-01	1.133E+00	8.741E-01	9.226E-01	1.045E+00
1.270E+00	7.874E-01	3.905E-01	1.131E+00	8.759E-01	9.238E-01	1.044E+00
1.260E+00	7.937E-01	3.960E-01	1.129E+00	8.777E-01	9.249E-01	1.043E+00
1.250E+00	8.000E-01	4.016E-01	1.127E+00	8.794E-01	9.260E-01	1.043E+00
1.240E+00	8.065E-01	4.072E-01	1.125E+00	8.812E-01	9.271E-01	1.042E+00

1.230E+00	8.130E-01	4.130E-01	1.123E+00	8.830E-01	9.283E-01	1.041E+00
1.220E+00	8.197E-01	4.189E-01	1.121E+00	8.847E-01	9.294E-01	1.041E+00
1.210E+00	8.264E-01	4.249E-01	1.119E+00	8.865E-01	9.305E-01	1.040E+00
1.200E+00	8.333E-01	4.310E-01	1.117E+00	8.882E-01	9.315E-01	1.039E+00
1.190E+00	8.403E-01	4.372E-01	1.115E+00	8.900E-01	9.326E-01	1.039E+00
1.180E+00	8.475E-01	4.436E-01	1.113E+00	8.917E-01	9.337E-01	1.038E+00
1.170E+00	8.547E-01	4.500E-01	1.112E+00	8.934E-01	9.348E-01	1.038E+00
1.160E+00	8.621E-01	4.566E-01	1.110E+00	8.951E-01	9.358E-01	1.037E+00
1.150E+00	8.696E-01	4.634E-01	1.108E+00	8.968E-01	9.369E-01	1.036E+00
1.140E+00	8.772E-01	4.702E-01	1.106E+00	8.984E-01	9.379E-01	1.036E+00
1.130E+00	8.850E-01	4.772E-01	1.104E+00	9.001E-01	9.390E-01	1.035E+00
1.120E+00	8.929E-01	4.843E-01	1.102E+00	9.017E-01	9.400E-01	1.034E+00
1.110E+00	9.009E-01	4.916E-01	1.101E+00	9.034E-01	9.410E-01	1.034E+00
1.100E+00	9.091E-01	4.990E-01	1.099E+00	9.050E-01	9.420E-01	1.033E+00
1.090E+00	9.174E-01	5.065E-01	1.097E+00	9.066E-01	9.430E-01	1.033E+00
1.080E+00	9.259E-01	5.142E-01	1.095E+00	9.082E-01	9.440E-01	1.032E+00
1.070E+00	9.346E-01	5.221E-01	1.094E+00	9.098E-01	9.450E-01	1.031E+00
1.060E+00	9.434E-01	5.301E-01	1.092E+00	9.114E-01	9.460E-01	1.031E+00
1.050E+00	9.524E-01	5.383E-01	1.090E+00	9.130E-01	9.470E-01	1.030E+00
1.040E+00	9.615E-01	5.467E-01	1.089E+00	9.146E-01	9.479E-01	1.030E+00
1.030E+00	9.709E-01	5.552E-01	1.087E+00	9.161E-01	9.489E-01	1.029E+00
1.020E+00	9.804E-01	5.640E-01	1.085E+00	9.176E-01	9.499E-01	1.029E+00
1.010E+00	9.901E-01	5.729E-01	1.084E+00	9.192E-01	9.508E-01	1.028E+00
1.000E+00	1.000E+00	5.820E-01	1.082E+00	9.207E-01	9.517E-01	1.028E+00
9.900E-01	1.010E+00	5.913E-01	1.080E+00	9.222E-01	9.527E-01	1.027E+00
9.800E-01	1.020E+00	6.008E-01	1.079E+00	9.237E-01	9.536E-01	1.026E+00
9.700E-01	1.031E+00	6.105E-01	1.077E+00	9.252E-01	9.545E-01	1.026E+00
9.600E-01	1.042E+00	6.205E-01	1.076E+00	9.266E-01	9.554E-01	1.025E+00
9.500E-01	1.053E+00	6.306E-01	1.074E+00	9.281E-01	9.563E-01	1.025E+00
9.400E-01	1.064E+00	6.410E-01	1.073E+00	9.295E-01	9.572E-01	1.024E+00
9.300E-01	1.075E+00	6.517E-01	1.071E+00	9.309E-01	9.581E-01	1.024E+00
9.200E-01	1.087E+00	6.626E-01	1.070E+00	9.324E-01	9.589E-01	1.023E+00
9.100E-01	1.099E+00	6.737E-01	1.068E+00	9.338E-01	9.598E-01	1.023E+00
9.000E-01	1.111E+00	6.851E-01	1.067E+00	9.352E-01	9.606E-01	1.022E+00
8.900E-01	1.124E+00	6.968E-01	1.065E+00	9.365E-01	9.615E-01	1.022E+00
8.800E-01	1.136E+00	7.088E-01	1.064E+00	9.379E-01	9.623E-01	1.021E+00
8.700E-01	1.149E+00	7.210E-01	1.062E+00	9.392E-01	9.632E-01	1.021E+00
8.600E-01	1.163E+00	7.336E-01	1.061E+00	9.406E-01	9.640E-01	1.020E+00
8.500E-01	1.176E+00	7.465E-01	1.059E+00	9.419E-01	9.648E-01	1.020E+00
8.400E-01	1.190E+00	7.597E-01	1.058E+00	9.432E-01	9.656E-01	1.019E+00
8.300E-01	1.205E+00	7.732E-01	1.057E+00	9.445E-01	9.664E-01	1.019E+00
8.200E-01	1.220E+00	7.871E-01	1.055E+00	9.458E-01	9.672E-01	1.019E+00
8.100E-01	1.235E+00	8.013E-01	1.054E+00	9.471E-01	9.679E-01	1.018E+00
8.000E-01	1.250E+00	8.160E-01	1.053E+00	9.483E-01	9.687E-01	1.018E+00
7.900E-01	1.266E+00	8.310E-01	1.051E+00	9.496E-01	9.695E-01	1.017E+00
7.800E-01	1.282E+00	8.464E-01	1.050E+00	9.508E-01	9.702E-01	1.017E+00
7.700E-01	1.299E+00	8.622E-01	1.049E+00	9.520E-01	9.710E-01	1.016E+00
7.600E-01	1.316E+00	8.785E-01	1.048E+00	9.532E-01	9.717E-01	1.016E+00
7.500E-01	1.333E+00	8.953E-01	1.046E+00	9.544E-01	9.724E-01	1.016E+00
7.400E-01	1.351E+00	9.125E-01	1.045E+00	9.556E-01	9.731E-01	1.015E+00
7.300E-01	1.370E+00	9.302E-01	1.044E+00	9.568E-01	9.739E-01	1.015E+00
7.200E-01	1.389E+00	9.484E-01	1.043E+00	9.579E-01	9.746E-01	1.014E+00
7.100E-01	1.408E+00	9.671E-01	1.042E+00	9.590E-01	9.752E-01	1.014E+00

7.000E-01	1.429E+00	9.864E-01	1.041E+00	9.601E-01	9.759E-01	1.014E+00
6.900E-01	1.449E+00	1.006E+00	1.039E+00	9.613E-01	9.766E-01	1.013E+00
6.800E-01	1.471E+00	1.027E+00	1.038E+00	9.623E-01	9.773E-01	1.013E+00
6.700E-01	1.493E+00	1.048E+00	1.037E+00	9.634E-01	9.779E-01	1.012E+00
6.600E-01	1.515E+00	1.070E+00	1.036E+00	9.645E-01	9.786E-01	1.012E+00
6.500E-01	1.538E+00	1.092E+00	1.035E+00	9.655E-01	9.792E-01	1.012E+00
6.400E-01	1.563E+00	1.115E+00	1.034E+00	9.666E-01	9.798E-01	1.011E+00
6.300E-01	1.587E+00	1.139E+00	1.033E+00	9.676E-01	9.804E-01	1.011E+00
6.200E-01	1.613E+00	1.164E+00	1.032E+00	9.686E-01	9.810E-01	1.011E+00
6.100E-01	1.639E+00	1.190E+00	1.031E+00	9.696E-01	9.816E-01	1.010E+00
6.000E-01	1.667E+00	1.216E+00	1.030E+00	9.705E-01	9.822E-01	1.010E+00
5.900E-01	1.695E+00	1.244E+00	1.029E+00	9.715E-01	9.828E-01	1.010E+00
5.800E-01	1.724E+00	1.272E+00	1.028E+00	9.724E-01	9.834E-01	1.009E+00
5.700E-01	1.754E+00	1.302E+00	1.027E+00	9.734E-01	9.839E-01	1.009E+00
5.600E-01	1.786E+00	1.332E+00	1.026E+00	9.743E-01	9.845E-01	1.009E+00
5.500E-01	1.818E+00	1.364E+00	1.025E+00	9.752E-01	9.850E-01	1.008E+00
5.400E-01	1.852E+00	1.397E+00	1.024E+00	9.761E-01	9.856E-01	1.008E+00
5.300E-01	1.887E+00	1.431E+00	1.023E+00	9.769E-01	9.861E-01	1.008E+00
5.200E-01	1.923E+00	1.466E+00	1.022E+00	9.778E-01	9.866E-01	1.007E+00
5.100E-01	1.961E+00	1.503E+00	1.022E+00	9.786E-01	9.871E-01	1.007E+00
5.000E-01	2.000E+00	1.541E+00	1.021E+00	9.794E-01	9.876E-01	1.007E+00
4.900E-01	2.041E+00	1.581E+00	1.020E+00	9.802E-01	9.881E-01	1.007E+00
4.800E-01	2.083E+00	1.623E+00	1.019E+00	9.810E-01	9.886E-01	1.006E+00
4.700E-01	2.128E+00	1.667E+00	1.018E+00	9.818E-01	9.890E-01	1.006E+00
4.600E-01	2.174E+00	1.712E+00	1.018E+00	9.826E-01	9.895E-01	1.006E+00
4.500E-01	2.222E+00	1.760E+00	1.017E+00	9.833E-01	9.899E-01	1.006E+00
4.400E-01	2.273E+00	1.809E+00	1.016E+00	9.840E-01	9.904E-01	1.005E+00
4.300E-01	2.326E+00	1.861E+00	1.015E+00	9.847E-01	9.908E-01	1.005E+00
4.200E-01	2.381E+00	1.916E+00	1.015E+00	9.854E-01	9.912E-01	1.005E+00
4.100E-01	2.439E+00	1.973E+00	1.014E+00	9.861E-01	9.916E-01	1.005E+00
4.000E-01	2.500E+00	2.033E+00	1.013E+00	9.868E-01	9.920E-01	1.004E+00
3.900E-01	2.564E+00	2.097E+00	1.013E+00	9.874E-01	9.924E-01	1.004E+00
3.800E-01	2.632E+00	2.163E+00	1.012E+00	9.881E-01	9.928E-01	1.004E+00
3.700E-01	2.703E+00	2.233E+00	1.011E+00	9.887E-01	9.932E-01	1.004E+00
3.600E-01	2.778E+00	2.308E+00	1.011E+00	9.893E-01	9.935E-01	1.004E+00
3.500E-01	2.857E+00	2.386E+00	1.010E+00	9.899E-01	9.939E-01	1.003E+00
3.400E-01	2.941E+00	2.469E+00	1.010E+00	9.904E-01	9.942E-01	1.003E+00
3.300E-01	3.030E+00	2.558E+00	1.009E+00	9.910E-01	9.946E-01	1.003E+00
3.200E-01	3.125E+00	2.652E+00	1.009E+00	9.915E-01	9.949E-01	1.003E+00
3.100E-01	3.226E+00	2.752E+00	1.008E+00	9.920E-01	9.952E-01	1.003E+00
3.000E-01	3.333E+00	2.858E+00	1.007E+00	9.925E-01	9.955E-01	1.002E+00
2.900E-01	3.448E+00	2.972E+00	1.007E+00	9.930E-01	9.958E-01	1.002E+00
2.800E-01	3.571E+00	3.095E+00	1.007E+00	9.935E-01	9.961E-01	1.002E+00
2.700E-01	3.704E+00	3.226E+00	1.006E+00	9.939E-01	9.964E-01	1.002E+00
2.600E-01	3.846E+00	3.368E+00	1.006E+00	9.944E-01	9.966E-01	1.002E+00
2.500E-01	4.000E+00	3.521E+00	1.005E+00	9.948E-01	9.969E-01	1.002E+00
2.400E-01	4.167E+00	3.687E+00	1.005E+00	9.952E-01	9.971E-01	1.002E+00
2.300E-01	4.348E+00	3.867E+00	1.004E+00	9.956E-01	9.974E-01	1.001E+00
2.200E-01	4.545E+00	4.064E+00	1.004E+00	9.960E-01	9.976E-01	1.001E+00
2.100E-01	4.762E+00	4.279E+00	1.004E+00	9.963E-01	9.978E-01	1.001E+00

X	1/X	P(X)	ETA(X)	E(X)	D(X)	PHI(X)
2.000E-01	5.000E+00	4.517E+00	1.003E+00	9.967E-01	9.980E-01	1.001E+00
1.900E-01	5.263E+00	4.779E+00	1.003E+00	9.970E-01	9.982E-01	1.001E+00
1.800E-01	5.556E+00	5.071E+00	1.003E+00	9.973E-01	9.984E-01	1.001E+00
1.700E-01	5.882E+00	5.397E+00	1.002E+00	9.976E-01	9.986E-01	1.001E+00
1.600E-01	6.250E+00	5.763E+00	1.002E+00	9.979E-01	9.987E-01	1.001E+00
1.500E-01	6.667E+00	6.179E+00	1.002E+00	9.981E-01	9.989E-01	1.001E+00
1.400E-01	7.143E+00	6.655E+00	1.002E+00	9.984E-01	9.990E-01	1.001E+00
1.300E-01	7.692E+00	7.203E+00	1.001E+00	9.986E-01	9.992E-01	1.000E+00
1.200E-01	8.333E+00	7.843E+00	1.001E+00	9.988E-01	9.993E-01	1.000E+00
1.100E-01	9.091E+00	8.600E+00	1.001E+00	9.990E-01	9.994E-01	1.000E+00
1.000E-01	1.000E+01	9.508E+00	1.001E+00	9.992E-01	9.995E-01	1.000E+00
9.000E-02	1.111E+01	1.062E+01	1.001E+00	9.993E-01	9.996E-01	1.000E+00
8.000E-02	1.250E+01	1.201E+01	1.001E+00	9.995E-01	9.997E-01	1.000E+00
7.000E-02	1.429E+01	1.379E+01	1.000E+00	9.996E-01	9.998E-01	1.000E+00
6.000E-02	1.667E+01	1.617E+01	1.000E+00	9.997E-01	9.998E-01	1.000E+00
5.000E-02	2.000E+01	1.950E+01	1.000E+00	9.998E-01	9.999E-01	1.000E+00
4.000E-02	2.500E+01	2.450E+01	1.000E+00	9.999E-01	9.999E-01	1.000E+00
3.000E-02	3.333E+01	3.284E+01	1.000E+00	9.999E-01	1.000E+00	1.000E+00
2.000E-02	5.000E+01	4.950E+01	1.000E+00	1.000E+00	1.000E+00	1.000E+00