ASTRONOMY & ASTROPHYSICS
SUPPLEMENT SERIES

OCTOBER **1988,** PAGE 47

Astron. Astrophys. Suppl. Ser. **75,** 47-51 (1988)

Atomic partition functions for titanium and vanadium (*)

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Received September 29, 1987; accepted March 24, 1988

Summary. — More realistic numerical values of the atomic partition functions, $U^{(r)}$, for Ti-I, Ti-II, Ti-III, V-I, V-II, and V-III are given for a wide range of the physical conditions of astrophysical and laboratory plasmas.

Key words: atomic partition functions — titanium — vanadium — plasma.

1. Introduction.

In previous papers (Halenka and Grabowski, 1977, 1984, hereafter Paper I and II, respectively) the general procedure of calculation of more realistic numerical values of the atomic partition functions (APF) has been described and applied to tin and iron. The novelty consists in taking into account all the bound quantum states of a system under consideration (atom or ion), and among them the states above the « normal » continuum. Effect of these last, many-electron excitation states, on APF-values $U^{(r)}$ ($r = 0, 1, \ldots$, for neutral atom, single charged ion, etc.) is especially strong in the elements of low « normal » ionization energy and of complex energetic structure, as elements of the transition groups. The calculated APFs for chromium confirm this particularly (Halenka and Grabowski, 1986). The aim of this paper is to obtain the realistic APF values for Ti-I — Ti-III and V-I — V-III.

2. Calculations.

We remind that the formalism used in Papers I and II demands preliminary calculations of $U^{(r+2)}$ and $U^{(r+1)}$ values in order to get the reliable $U^{(r)}$ ones. To the calculations, the values of the energetic levels of Ti-I — Ti-V (Corliss and Sugar, 1979) and V-I — V-V (Sugar and Corliss, 1978) have been used; the levels of scandium (Sugar and Corliss, 1980), chromium (Sugar and Corliss, 1977; Ekberg and Engstrom, 1982), manganese (Corliss and Sugar, 1977) and iron (Reader and Sugar, 1975) served as comparative data. Thousand levels of titanium and vanadium have been supplemented using approximation methods described in Papers I and II.

(*) This work was performed under the partial sponsorship of the Polish Academy of Sciences.
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To calculate the numerical values of APF, the levels have been divided into groups as noted below (the symbols are the same as in Papers I and II):

Ti-V and V-V: $\alpha^{(5)}$-group: the levels appearing in the aforementioned papers.

Ti-IV — Ti-I (with $k = 0$) and V-IV — V-I (with $k = 1$): $\alpha^{(r)}$-group: sequences on the ground parent term of configuration $3p^6 3d^{(4+k-r)}$ [including the levels of the configuration $3p^6 3d^{(5+k-r)}$ with proper coefficients of the fractional parentage, G_{1j}] and furthermore, the sequences on the parent terms $3d^{(2+k)}4s\,(^{(4+k)}F,\ ^{(2+k)}F)$, i.e. $\alpha'^{(1)}$ and $\alpha''^{(1)}$ groups, respectively.

$\beta^{(r)}$-group: sequences on the parent of the configuration $3p^6 3d^{(4+k-r)}$ (except $\alpha^{(r)}$ sequence) [discrete summation over the levels of the configurations: $3d^{(5+k-r)}$ (with coefficients G_{pj}, $p > 1$), $3d^{(5+k-r)}4s$, 4p and 5s, 5p for Ti-I only; the comparative sequence $\alpha^{(r)}$] and, furthermore, the sequences on the parent terms of the configurations $3d^{(3+k-r)}4s$ for $r = 1, 2$ (except $\alpha'^{(r)}$ and $\alpha''^{(r)}$ sequences) [discrete summation over the levels of the configurations: $3d^{(3+k-r)}4p$, 5s, 5p and $3d^{(3+k-r)}4s^2$].

$\gamma^{(r)}$-group: remaining sequences [the reference sequence $-\alpha^{(r)}$ for $r = 2, 3, 4$ and $\alpha''^{(r)}$ for $r = 1$].

The coefficients of the fractional parentage, G_{pj}, have been calculated according to Sobelman (1979).

3. Results and conclusions.

The $U^{(r)}$ values have been calculated in the temperature range $2000\ \text{K} \leqslant T \leqslant 40000\ \text{K}$, for the lowering of the ionization energy (LIE) in the range $0.01\ \text{eV} \leqslant \Delta E^{(r)} \leqslant 2\ \text{eV}$. The range of the physical conditions for which the numerical values of APF are calculated, is substantially wider compared with that assumed by other authors — we have shifted the lower limit of LIE value, $\Delta E^{(r)}$, from 0.1 eV down to 0.01 eV. The $\Delta E^{(r)}$ range from 0.1 down to 0.01 eV, as enlarged in this paper, corresponds to standard physical conditions in the stellar atmospheres and, partially, to laboratory arc plasma conditions. In the range $0.1\ \text{eV} \leqslant \Delta E^{(r)} \leqslant 2\ \text{eV}$ the presented values of $U^{(r)}$ are equal or greater, and the ratios $U^{(r+1)}/U^{(r)}$ are equal or smaller as compared with corresponding values published earlier (e.g. Drawin and Felenbok, 1965 ; Czernichowski, 1968 ; Irwin, 1981).

The discrepancies of these quantities, taken properly from our tables and from above mentioned papers, increase : (i) when $\Delta E^{(r)}$ decreases at $T = \text{const.}$, and also (ii) when T increases at $\Delta E^{(r)} = \text{const}$.

The discrepancies between partition with and without states above the « normal » ionization limit have similar character as the discrepancies for the partition function of He with and without doubly excited states found in the calculation performed by Drawin (1971). [For titanium, these discrepancies are smallest when Czernichowski's, 1968, APFs are used as a reference. This is clear because this author calculated APF-values on the basis of energy-level tables widely supplemented by him, although using one common ionization energy — the « normal » one, diminished by a LIE-value in the temperature range to 15000 K.]

The influence of the more realistic APF values on the ionization balance, the equation of state, and stratification of the matter in the stellar atmospheres has preliminarily been discussed in the papers : Grabowski and Halenka, 1984 ; Halenka *et al.*, 1984 ; and Grabowski, 1984.

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TABLE I. — *The atomic partition functions for Ti-I.*

T[K]	Lowering of the ionization energy [eV]					
	.01	.05	.10	.25	.50	1.0
2000	.1834E2	.1834E2	.1834E2	.1834E2	.1834E2	.1834E2
3000	.2082E2	.2082E2	.2082E2	.2082E2	.2082E2	.2082E2
4000	.2440E2	.2439E2	.2439E2	.2439E2	.2439E2	.2439E2
5000	.2962E2	.2943E2	.2942E2	.2941E2	.2941E2	.2941E2
5500	.3349E2	.3262E2	.3257E2	.3254E2	.3253E2	.3252E2
6000	.3949E2	.3642E2	.3624E2	.3613E2	.3610E2	.3607E2
6500	.5005E2	.4109E2	.4057E2	.4026E2	.4017E2	.4010E2
7000	.6959E2	.4709E2	.4577E2	.4501E2	.4479E2	.4463E2
7500	.1053E3	.5513E2	.5218E2	.5052E2	.5004E2	.4972E2
8000	.1679E3	.6625E2	.6024E2	.5696E2	.5601E2	.5541E2
8500	.2721E3	.8186E2	.7057E2	.6453E2	.6282E2	.6176E2
9000	.4370E3	.1037E3	.8391E2	.7350E2	.7059E2	.6884E2
9500	.6869E3	.1341E3	.1012E3	.8414E2	.7947E2	.7671E2
10000	.1052E4	.1754E3	.1233E3	.9680E2	.8960E2	.8543E2
10500	.1573E4	.2307E3	.1516E3	.1118E3	.1012E3	.9510E2
11000	.2306E4	.3033E3	.1872E3	.1296E3	.1143E3	.1058E3
11500	.3334E4	.3970E3	.2316E3	.1505E3	.1292E3	.1175E3
12000	.4792E4	.5162E3	.2863E3	.1750E3	.1461E3	.1304E3
12500	.6900E4	.6660E3	.3533E3	.2036E3	.1651E3	.1446E3
13000	.1002E5	.8528E3	.4344E3	.2367E3	.1865E3	.1600E3
13500	.1472E5	.1084E4	.5322E3	.2749E3	.2104E3	.1769E3
14000	.2192E5	.1371E4	.6496E3	.3187E3	.2371E3	.1952E3
14500	.3296E5	.1727E4	.7904E3	.3688E3	.2669E3	.2151E3
15000	.4984E5	.2169E4	.9592E3	.4260E3	.3000E3	.2367E3
16000	.1136E6	.3417E4	.1406E4	.5651E3	.3772E3	.2853E3
17000	.2507E6	.5408E4	.2057E4	.7446E3	.4716E3	.3418E3
18000	.5266E6	.8615E4	.3016E4	.9762E3	.5867E3	.4074E3
19000	.1048E7	.1377E5	.4438E4	.1276E4	.7267E3	.4832E3
20000	.1984E7	.2195E5	.6537E4	.1663E4	.8970E3	.5707E3

TABLE II. — *The atomic partition functions for Ti-II.*

T[K]	Lowering of the ionization energy [eV]					
	.01	.05	.10	.25	.50	1.0
2000	.3734E2	.3734E2	.3734E2	.3734E2	.3734E2	.3734E2
5000	.5542E2	.5542E2	.5542E2	.5542E2	.5542E2	.5542E2
8000	.7244E2	.7242E2	.7242E2	.7242E2	.7242E2	.7242E2
9000	.7828E2	.7815E2	.7814E2	.7814E2	.7814E2	.7814E2
10000	.8475E2	.8399E2	.8394E2	.8392E2	.8391E2	.8391E2
10500	.8866E2	.8700E2	.8690E2	.8684E2	.8683E2	.8682E2
11000	.9348E2	.9012E2	.8992E2	.8981E2	.8978E2	.8977E2
11500	.9981E2	.9342E2	.9303E2	.9282E2	.9277E2	.9274E2
12000	.1085E3	.9698E2	.9628E2	.9590E2	.9581E2	.9576E2
12500	.1208E3	.1009E3	.9971E2	.9906E2	.9891E2	.9883E2
13000	.1383E3	.1054E3	.1034E3	.1023E3	.1021E2	.1020E3
13500	.1631E3	.1106E3	.1074E3	.1057E3	.1053E3	.1052E3
14000	.1978E3	.1168E3	.1119E3	.1093E3	.1087E3	.1084E3
14500	.2458E3	.1244E3	.1170E3	.1131E3	.1122E3	.1118E3
15000	.3108E3	.1336E3	.1227E3	.1171E3	.1159E3	.1153E3
16000	.5112E3	.1588E3	.1372E3	.1262E3	.1238E3	.1226E3
17000	.8447E3	.1968E3	.1570E3	.1370E3	.1326E3	.1305E3
18000	.1370E4	.2528E3	.1843E3	.1502E3	.1427E3	.1391E3
19000	.2161E4	.3331E3	.2215E3	.1663E3	.1543E3	.1486E3
20000	.3320E4	.4451E3	.2714E3	.1861E3	.1676E3	.1591E3
21000	.4992E4	.5970E3	.3370E3	.2104E3	.1832E3	.1707E3
22000	.7420E4	.7983E3	.4220E3	.2401E3	.2013E3	.1836E3
23000	.1103E5	.1060E4	.5301E3	.2761E3	.2222E3	.1979E3
24000	.1659E5	.1396E4	.6658E3	.3194E3	.2464E3	.2137E3
25000	.2545E5	.1824E4	.8344E3	.3709E3	.2743E3	.2313E3
26000	.3996E5	.2369E4	.1042E4	.4320E3	.3061E3	.2507E3
27000	.6398E5	.3065E4	.1299E4	.5040E3	.3425E3	.2721E3
28000	.1037E6	.3960E4	.1615E4	.5884E3	.3838E3	.2958E3
29000	.1685E6	.5127E4	.2006E4	.6872E3	.4306E3	.3217E3
30000	.2728E6	.6662E4	.2493E4	.8029E3	.4835E3	.3502E3
31000	.4377E6	.8704E4	.3105E4	.9383E3	.5432E3	.3815E3
32000	.6944E6	.1144E5	.3878E4	.1097E4	.6106E3	.4158E3
33000	.1089E7	.1511E5	.4861E4	.1284E4	.6866E3	.4533E3

TABLE III. — *The atomic partition functions for Ti-III.*

T[K]	Lowering of the ionization energy [eV]					
	.05	.10	.25	.50	1.00	2.00
2000	.1779E2	.1779E2	.1779E2	.1779E2	.1779E2	.1779E2
8000	.2330E2	.2330E2	.2330E2	.2330E2	.2330E2	.2330E2
12000	.2670E2	.2670E2	.2670E2	.2670E2	.2670E2	.2670E2
14000	.2826E2	.2826E2	.2826E2	.2826E2	.2826E2	.2826E2
15000	.2901E2	.2901E2	.2901E2	.2901E2	.2901E2	.2901E2
16000	.2974E2	.2974E2	.2974E2	.2974E2	.2974E2	.2974E2
16500	.3010E2	.3010E2	.3010E2	.3010E2	.3010E2	.3010E2
17000	.3046E2	.3046E2	.3046E2	.3046E2	.3046E2	.3046E2
17500	.3081E2	.3081E2	.3081E2	.3081E2	.3081E2	.3081E2
18000	.3117E2	.3116E2	.3116E2	.3116E2	.3116E2	.3116E2
18500	.3153E2	.3152E2	.3151E2	.3151E2	.3151E2	.3151E2
19000	.3188E2	.3187E2	.3186E2	.3186E2	.3186E2	.3186E2
19500	.3224E2	.3222E2	.3221E2	.3220E2	.3220E2	.3220E2
20000	.3261E2	.3257E2	.3255E2	.3255E2	.3255E2	.3255E2
21000	.3337E2	.3329E2	.3325E2	.3324E2	.3323E2	.3323E2
22000	.3421E2	.3403E2	.3395E2	.3393E2	.3392E2	.3392E2
23000	.3515E2	.3481E2	.3467E2	.3463E2	.3461E2	.3460E2
24000	.3629E2	.3567E2	.3541E2	.3534E2	.3531E2	.3529E2
25000	.3770E2	.3664E2	.3619E2	.3607E2	.3602E2	.3599E2
26000	.3953E2	.3777E2	.3703E2	.3682E2	.3675E2	.3670E2
27000	.4193E2	.3913E2	.3794E2	.3761E2	.3750E2	.3743E2
28000	.4511E2	.4078E2	.3895E2	.3845E2	.3828E2	.3817E2
29000	.4931E2	.4282E2	.4010E2	.3934E2	.3909E2	.3893E2
30000	.5484E2	.4537E2	.4141E2	.4031E2	.3995E2	.3972E2
31000	.6205E2	.4856E2	.4292E2	.4137E2	.4085E2	.4054E2
32000	.7133E2	.5252E2	.4469E2	.4253E2	.4182E2	.4139E2
33000	.8317E2	.5744E2	.4675E2	.4382E2	.4286E2	.4228E2
34000	.9810E2	.6350E2	.4918E2	.4526E2	.4398E2	.4321E2
35000	.1167E3	.7092E2	.5201E2	.4687E2	.4519E2	.4420E2
36000	.1397E3	.7993E2	.5534E2	.4867E2	.4650E2	.4522E2
37000	.1680E3	.9081E2	.5922E2	.5069E2	.4792E2	.4631E2
38000	.2025E3	.1039E3	.6374E2	.5296E2	.4947E2	.4746E2
39000	.2444E3	.1194E3	.6897E2	.5550E2	.5116E2	.4867E2
40000	.2951E3	.1379E3	.7502E2	.5835E2	.5301E2	.4995E2

TABLE IV. — *The atomic partition functions for V-I.*

T[K]	Lowering of the ionization energy [eV]					
	.01	.05	.10	.25	.50	1.0
2000	.2871E2	.2871E2	.2871E2	.2871E2	.2871E2	.2871E2
3000	.3591E2	.3591E2	.3591E2	.3591E2	.3591E2	.3591E2
4000	.4266E2	.4266E2	.4266E2	.4266E2	.4266E2	.4266E2
5000	.5048E2	.5028E2	.5026E2	.5025E2	.5025E2	.5025E2
5500	.5565E2	.5477E2	.5470E2	.5466E2	.5465E2	.5464E2
6000	.6308E2	.6000E2	.5975E2	.5964E2	.5960E2	.5957E2
6500	.7517E2	.6623E2	.6551E2	.6520E2	.6510E2	.6501E2
7000	.9657E2	.7411E2	.7230E2	.7153E2	.7130E2	.7110E2
7500	.1347E3	.8448E2	.8047E2	.7878E2	.7826E2	.7786E2
8000	.2009E3	.9861E2	.9051E2	.8712E2	.8611E2	.8534E2
8500	.3106E3	.1182E3	.1031E3	.9680E2	.9495E2	.9360E2
9000	.4847E3	.1456E3	.1191E3	.1081E3	.1049E3	.1027E3
9500	.7496E3	.1834E3	.1395E3	.1214E3	.1162E3	.1127E3
10000	.1139E4	.2351E3	.1655E3	.1371E3	.1290E3	.1236E3
10500	.1696E4	.3045E3	.1986E3	.1556E3	.1435E3	.1355E3
11000	.2482E4	.3962E3	.2404E3	.1774E3	.1598E3	.1485E3
11500	.3584E4	.5153E3	.2925E3	.2030E3	.1783E3	.1626E3
12000	.5143E4	.6681E3	.3572E3	.2331E3	.1992E3	.1779E3
12500	.7388E4	.8623E3	.4366E3	.2682E3	.2226E3	.1945E3
13000	.1070E5	.1107E4	.5333E3	.3090E3	.2489E3	.2125E3
13500	.1568E5	.1416E4	.6508E3	.3562E3	.2784E3	.2319E3
14000	.2331E5	.1805E4	.7927E3	.4108E3	.3134E3	.2529E3
14500	.3507E5	.2297E4	.9640E3	.4736E3	.3482E3	.2754E3
15000	.5317E5	.2923E4	.1171E4	.5456E3	.3891E3	.2997E3
15500	.8083E5	.3726E4	.1421E4	.6282E3	.4346E3	.3258E3
16000	.1225E6	.4761E4	.1725E4	.7227E3	.4852E3	.3539E3
17000	.2750E6	.7850E4	.2546E4	.9549E3	.6035E3	.4166E3
18000	.5885E6	.1308E5	.3778E4	.1259E4	.7490E3	.4889E3
19000	.1193E7	.2186E5	.5642E4	.1660E4	.9278E3	.5724E3
20000	.2296E7	.3631E5	.8454E4	.2190E4	.1147E4	.6677E3
21000	.4228E7	.5943E5	.1266E5	.2889E4	.1418E4	.7804E3
22000	.7536E7	.9544E5	.1884E5	.3812E4	.1751E4	.9093E3

TABLE V. — *The atomic partition functions for V-II.*

T[K]	Lowering of the ionization energy [eV]					
	.01	.05	.10	.25	.50	1.0
2000	.2598E2	.2598E2	.2598E2	.2598E2	.2598E2	.2598E2
5000	.4323E2	.4323E2	.4323E2	.4323E2	.4323E2	.4323E2
8000	.6364E2	.6363E2	.6363E2	.6363E2	.6363E2	.6363E2
9000	.7138E2	.7129E2	.7128E2	.7128E2	.7128E2	.7128E2
10000	.7995E2	.7932E2	.7928E2	.7926E2	.7925E2	.7925E2
10500	.8492E2	.8350E2	.8341E2	.8337E2	.8335E2	.8335E2
11000	.9082E2	.8784E2	.8765E2	.8756E2	.8754E2	.8753E2
11500	.9824E2	.9240E2	.9203E2	.9185E2	.9181E2	.9178E2
12000	.1081E3	.9726E2	.9658E2	.9624E2	.9617E2	.9612E2
12500	.1218E3	.1025E3	.1014E3	.1008E3	.1006E2	.1005E2
13000	.1411E3	.1084E3	.1064E3	.1054E3	.1052E2	.1051E3
13500	.1685E3	.1152E3	.1119E3	.1103E3	.1099E3	.1097E3
14000	.2073E3	.1231E3	.1179E3	.1153E3	.1148E3	.1145E3
14500	.2614E3	.1324E3	.1246E3	.1207E3	.1198E3	.1193E3
15000	.3358E3	.1438E3	.1321E3	.1263E3	.1250E3	.1244E3
16000	.5709E3	.1747E3	.1507E3	.1389E3	.1363E3	.1350E3
17000	.9745E3	.2214E3	.1759E3	.1536E3	.1488E3	.1464E3
18000	.1629E4	.2912E3	.2107E3	.1714E3	.1629E3	.1588E3
19000	.2640E4	.3928E3	.2586E3	.1933E3	.1792E3	.1725E3
20000	.4149E4	.5375E3	.3238E3	.2202E3	.1981E3	.1873E3
21000	.6357E4	.7375E3	.4112E3	.2537E3	.2202E3	.2045E3
22000	.9580E4	.1008E4	.5262E3	.2949E3	.2460E3	.2233E3
23000	.1437E5	.1367E4	.6752E3	.3455E3	.2763E3	.2444E3
24000	.2172E5	.1838E4	.8653E3	.4072E3	.3116E3	.2680E3
25000	.3345E5	.2451E4	.1105E4	.4818E3	.3528E3	.2944E3
26000	.5282E5	.3252E4	.1405E4	.5714E3	.4006E3	.3239E3
27000	.8537E5	.4303E4	.1780E4	.6784E3	.4558E3	.3569E3
28000	.1403E6	.5701E4	.2246E4	.8056E3	.5194E3	.3936E3
29000	.2323E6	.7587E4	.2830E4	.9564E3	.5924E3	.4346E3
30000	.3840E6	.1017E5	.3564E4	.1135E4	.6760E3	.4800E3
31000	.6296E6	.1373E5	.4496E4	.1347E4	.7716E3	.5306E3
32000	.1020E7	.1869E5	.5687E4	.1598E4	.8808E3	.5867E3

TABLE VI. — *The atomic partition functions for V-III.*

T[K]	Lowering of the ionization energy [eV]					
	.05	.10	.25	.50	1.0	2.0
2000	.2226E2	.2226E2	.2226E2	.2226E2	.2226E2	.2226E2
8000	.3140E2	.3140E2	.3140E2	.3140E2	.3140E2	.3140E2
12000	.3945E2	.3945E2	.3945E2	.3945E2	.3945E2	.3945E2
14000	.4307E2	.4307E2	.4307E2	.4307E2	.4307E2	.4307E2
15000	.4484E2	.4484E2	.4484E2	.4484E2	.4484E2	.4484E2
16000	.4658E2	.4658E2	.4658E2	.4658E2	.4658E2	.4658E2
16500	.4744E2	.4744E2	.4744E2	.4744E2	.4744E2	.4744E2
17000	.4830E2	.4830E2	.4830E2	.4830E2	.4830E2	.4830E2
17500	.4915E2	.4915E2	.4915E2	.4915E2	.4915E2	.4915E2
18000	.5001E2	.5000E2	.5000E2	.5000E2	.5000E2	.5000E2
18500	.5086E2	.5085E2	.5085E2	.5085E2	.5084E2	.5085E2
19000	.5172E2	.5170E2	.5169E2	.5169E2	.5169E2	.5169E2
19500	.5258E2	.5255E2	.5253E2	.5253E2	.5253E2	.5253E2
20000	.5345E2	.5340E2	.5338E2	.5337E2	.5337E2	.5337E2
21000	.5522E2	.5511E2	.5507E2	.5506E2	.5505E2	.5505E2
22000	.5710E2	.5687E2	.5678E2	.5675E2	.5674E2	.5674E2
23000	.5916E2	.5869E2	.5851E2	.5846E2	.5844E2	.5543E2
24000	.6151E2	.6063E2	.6029E2	.6020E2	.6016E2	.6014E2
25000	.6433E2	.6275E2	.6215E2	.6198E2	.6192E2	.6188E2
26000	.6783E2	.6513E2	.6410E2	.6381E2	.6371E2	.6365E2
27000	.7234E2	.6789E2	.6619E2	.6571E2	.6555E2	.6545E2
28000	.7823E2	.7117E2	.6846E2	.6771E2	.6746E2	.6730E2
29000	.8603E2	.7515E2	.7099E2	.6983E2	.6945E2	.6921E2
30000	.9624E2	.8004E2	.7382E2	.7210E2	.7153E2	.7118E2
31000	.1099E3	.8613E2	.7706E2	.7456E2	.7373E2	.7322E2
32000	.1277E3	.9371E3	.8979E2	.7724E2	.7607E2	.7535E2
33000	.1506E3	.1032E2	.8513E2	.8018E2	.7856E2	.7757E2
34000	.1800E3	.1149E3	.9020E2	.8345E2	.8124E2	.7990E2
35000	.2173E3	.1294E3	.9615E2	.8708E2	.8413E2	.8235E2
36000	.2642E3	.1472E3	.1031E3	.9115E2	.8725E2	.8493E2
37000	.3227E3	.1690E3	.1113E3	.9571E2	.9065E2	.8766E2
38000	.3953E3	.1954E3	.1209E3	.1008E3	.9436E2	.9055E2
39000	.4850E3	.2273E3	.1322E3	.1066E3	.9840E3	.9361E2
40000	.5956E3	.2656E3	.1452E3	.1131E3	.1028E3	.9686E2