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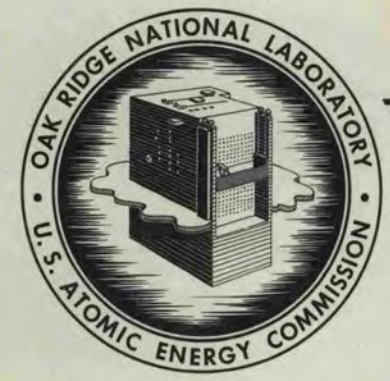
PULSE HEIGHT CALCULATIONS FOR A PARALLEL PLATE IONIZATION CHAMBER CONTAINING ELECTRON ATTACHING GASES

H. B. Eldridge



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ABSTRACT

When the pulse from a parallel plate electrode ionization chamber containing an attaching gas is examined with a linear pulse amplifier having the proper integration and differentiation time constants, the pulse height will be a simple analytic function of the attachment coefficient and the electron drift velocity.[1-3] In this report the expressions for the pulse height as a function of the partial pressure of the attaching gas, electron drift velocity, attachment coefficient, chamber geometry and amplifier time constants are evaluated and presented in tabular form.

INTRODUCTION AND METHOD

The time variation of the electrode potential in a parallel plane electrode ionization chamber containing an attaching gas is given by:[1]

$$g(t) = \frac{A}{\alpha f_1 Pd} \left[1 - \exp(-\alpha f_1 PWt)\right]$$

Since α, f_1, P, W, and d do not vary with time, one may write

$$g(t) = \frac{A}{F} \left[1 - \exp(-ft/\tau_o)\right]$$

where $f = \alpha f_1 Pd$; $\tau_o = d/W$; W = drift velocity of electrons; α = attachment coefficient; $f_1 P$ = partial pressure of attaching gas; and d = distance from electron source to collecting electrode.

If this pulse is observed with a linear pulse amplifier having a step function response given by[1] $(t/t_1)\exp(-t/t_1)$, where t_1 = amplifier differentiating and integrating time constant, then the output pulse will be given by

$$V(\tau) = \int_o^{\tau} \frac{dg(t)}{dt} \frac{(\tau-t)}{t_1} \exp[-(\tau-t)/t_1]dt \qquad \text{for } \tau < \tau_o$$

and by

$$V(\tau) = \int_o^{\tau_o} \frac{dg(t)}{dt} \frac{(\tau-t)}{t_1} \exp[-(\tau-t)/t_1]dt \qquad \text{for } \tau > \tau_o$$

Direct integration of these equations gives

$$V(\tau) = \frac{A \exp(-\tau/t_1)}{(\tau_o - t_1 f)} \left[\frac{\exp(u\tau)}{u} - \tau - \frac{1}{u}\right] \qquad \text{for } \tau < \tau_o \quad (1)$$

and

$$V(\tau) = \frac{A \exp(-\tau/t_1)}{(\tau_o - t_1 f)} \left[\{\exp(u\tau_o)-1\}\tau - \exp(u\tau_o)\left(\tau_o - \frac{1}{u}\right) - \frac{1}{u}\right] \qquad (2)$$

$$\text{for } \tau > \tau_o$$

where $u = (\tau_o - t_1 f)/t_1\tau_o$. For convenience in what follows, let $u = \tau/t_1$ $x = \tau_o/t_1$, and $y = \tau_o/t_1 - f$. To find the pulse height, one must find the maximum of the function $V(u)$ which may be accomplished by evaluating $V(u')$ where u' is given by the equations,

$$\frac{dV(u')}{du} = 0 \quad \text{and} \quad \frac{d^2V(u')}{du^2} < 0 \qquad (3)$$

However, the physical nature of the problem makes the second equation's evaluation unnecessary. The first derivative is indeterminate at f = x and is evidenced in the table to follow. The maximum may be evaluated at x = f = 0 and is e^{-1}. When Eq. (3) is evaluated for the two regions of u, one gets for the position of the maximum of V(u),

$$u' = (x/y - 1)\left[\exp\{(y/x)u'\} - 1\right] \qquad \text{for } u' < x \quad (4)$$

$$u' = \frac{\exp(y)\,(1 + x - x/y) - 1 + x/y}{\exp(y) - 1} \qquad \text{for } u' \geq x \quad (5)$$

One may note that Eq. (5) gives u' explicitly while Eq. (4) is transcendental and must be solved numerically.

A program was developed for the IBM 7090 computer which found the pulse height as a function of x and f. The principal scheme was to evaluate u' using Eq. (5) and then determine if $u' \geq x$. If $u' \geq x$, one found the pulse height by substituting the u' so found into expression (2). However, if $u' < x$, when found using expression (5), expression (4) was used to determine a u' which was substituted into Eq. (1).

RESULTS

Pulse heights were computed for the following ranges of the parameters x and f:

$$0 \leq x \leq 5, \quad \text{in increments of } 1.0$$

$$0 \leq f \leq 5, \quad \begin{cases} \text{in increments of } 0.01 & 0 \leq f \leq 1.0 \\ \text{in increments of } 0.02 & 1.0 < f \leq 5.0 \end{cases}$$

The results are summarized in the following table where the elements of

the first column are different values of f, the elements of the first row are different values of x, and the elements of the second row are the normalization factors, N. For each value of x the pulse heights are normalized to the pulse height corresponding to f = 0, hence N equals the pulse height at f = 0. The remaining elements are the normalized pulse heights corresponding to the f which is the first element in the row and the x which is the first element in the column. Since the normalized pulse height is generally the quantity measured in an experiment, this quantity was tabulated.

Table I. Normalized Response of an Amplifier to Pulses from a Plane Parallel Ionization Chamber in Which Electron Capture Takes Place*

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
0.	1.000000	1.000000	1.000000	1.000000	1.000000	1.000000
0.010	0.995016	0.994990	0.994833	0.994508	0.994075	0.993615
0.020	0.990066	0.990015	0.989701	0.989056	0.988195	0.987279
0.030	0.985149	0.985072	0.984605	0.983644	0.982357	0.980991
0.040	0.980264	0.980163	0.979545	0.978270	0.976564	0.974750
0.050	0.975411	0.975287	0.974520	0.972935	0.970813	0.968557
0.060	0.970591	0.970443	0.969530	0.967638	0.965105	0.962411
0.070	0.965802	0.965632	0.964574	0.962380	0.959439	0.956312
0.080	0.961046	0.960853	0.959653	0.957159	0.953815	0.950258
0.090	0.956320	0.956107	0.954766	0.951976	0.948232	0.944251
0.100	0.951626	0.951391	0.949912	0.946830	0.942691	0.938289
0.110	0.946962	0.946708	0.945093	0.941721	0.937191	0.932373
0.120	0.942330	0.942055	0.940306	0.936649	0.931732	0.926501
0.130	0.937727	0.937434	0.935553	0.931613	0.926313	0.920674
0.140	0.933155	0.932844	0.930832	0.926613	0.920934	0.914891
0.150	0.928613	0.928284	0.926144	0.921649	0.915594	0.909151
0.160	0.924101	0.923754	0.921489	0.916721	0.910294	0.903455
0.170	0.919619	0.919254	0.916865	0.911827	0.905033	0.897802
0.180	0.915165	0.914785	0.912273	0.906969	0.899811	0.892192
0.190	0.910741	0.910345	0.907713	0.902146	0.894628	0.886624

*Elements of first column are values of f. Elements of first row are values of X. Elements of second row are normalization factors, N. Remaining elements are normalized pulse heights corresponding to particular values of X and f.

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
0.200	0.906346	0.905934	0.903184	0.897357	0.889482	0.881098
0.210	0.901980	0.901553	0.898687	0.892602	0.884375	0.875662
0.220	0.897642	0.897201	0.894220	0.887881	0.879305	0.870343
0.230	0.893332	0.892877	0.889784	0.883194	0.874272	0.865135
0.240	0.889051	0.888582	0.885378	0.878540	0.869276	0.860032
0.250	0.884797	0.884316	0.881003	0.873919	0.864317	0.855031
0.260	0.880571	0.880077	0.876657	0.869332	0.859395	0.850125
0.270	0.876372	0.875867	0.872341	0.864777	0.854508	0.845312
0.280	0.872201	0.871684	0.868055	0.860254	0.849658	0.840587
0.290	0.868057	0.867528	0.863798	0.855763	0.844843	0.835946
0.300	0.863939	0.863400	0.859570	0.851305	0.840063	0.831387
0.310	0.859849	0.859300	0.855371	0.846878	0.835319	0.826906
0.320	0.855784	0.855226	0.851200	0.842482	0.830609	0.822501
0.330	0.851746	0.851178	0.847058	0.838118	0.825934	0.818168
0.340	0.847734	0.847158	0.842944	0.833785	0.821293	0.813904
0.350	0.843748	0.843163	0.838858	0.829482	0.816685	0.809709
0.360	0.839788	0.839195	0.834800	0.825210	0.812112	0.805579
0.370	0.835853	0.835253	0.830769	0.820968	0.807572	0.801512
0.380	0.831944	0.831336	0.826766	0.816756	0.803065	0.797506
0.390	0.828059	0.827445	0.822790	0.812574	0.798591	0.793559

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
0.400	0.824200	0.823579	0.818841	0.808422	0.794150	0.789669
0.410	0.820365	0.819739	0.814919	0.804298	0.789744	0.785836
0.420	0.816555	0.815923	0.811023	0.800204	0.785397	0.782056
0.430	0.812770	0.812132	0.807153	0.796139	0.781115	0.778329
0.440	0.809008	0.808366	0.803310	0.792103	0.776897	0.774652
0.450	0.805271	0.804625	0.799492	0.788095	0.772741	0.771025
0.460	0.801557	0.800907	0.795701	0.784115	0.768645	0.767447
0.470	0.797867	0.797214	0.791935	0.780163	0.764606	0.763915
0.480	0.794201	0.793544	0.788194	0.776239	0.760625	0.760429
0.490	0.790558	0.789898	0.784478	0.772343	0.756698	0.756987
0.500	0.786939	0.786276	0.780788	0.768474	0.752825	0.753589
0.510	0.783342	0.782677	0.777122	0.764632	0.749004	0.750232
0.520	0.779768	0.779102	0.773481	0.760817	0.745234	0.746917
0.530	0.776217	0.775549	0.769864	0.757029	0.741513	0.743643
0.540	0.772688	0.772019	0.766271	0.753267	0.737841	0.740407
0.550	0.769182	0.768512	0.762703	0.749532	0.734216	0.737210
0.560	0.765698	0.765028	0.759158	0.745823	0.730637	0.734050
0.570	0.762236	0.761565	0.755638	0.742140	0.727103	0.730927
0.580	0.758796	0.758125	0.752140	0.738483	0.723612	0.727839
0.590	0.755377	0.754707	0.748666	0.734851	0.720164	0.724787

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
0.600	0.751981	0.751311	0.745216	0.731245	0.716759	0.721768
0.610	0.748605	0.747937	0.741788	0.727664	0.713394	0.718783
0.620	0.745251	0.744584	0.738383	0.724108	0.710069	0.715831
0.630	0.741918	0.741253	0.735001	0.720577	0.706783	0.712911
0.640	0.738606	0.737942	0.731641	0.717070	0.703535	0.710022
0.650	0.735314	0.734653	0.728304	0.713588	0.700325	0.707164
0.660	0.732043	0.731385	0.724989	0.710130	0.697152	0.704336
0.670	0.728793	0.728138	0.721695	0.706697	0.694014	0.701537
0.680	0.725563	0.724911	0.718424	0.703287	0.690911	0.698767
0.690	0.722354	0.721705	0.715174	0.699900	0.687843	0.696026
0.700	0.719164	0.718519	0.711946	0.696538	0.684808	0.693312
0.710	0.715994	0.715353	0.708739	0.693199	0.681807	0.690626
0.720	0.712844	0.712207	0.705554	0.689882	0.678837	0.687966
0.730	0.709714	0.709081	0.702389	0.686589	0.675900	0.685333
0.740	0.706603	0.705975	0.699246	0.683319	0.672993	0.682726
0.750	0.703511	0.702888	0.696123	0.680072	0.670118	0.680143
0.760	0.700439	0.699821	0.693020	0.676847	0.667272	0.677586
0.770	0.697386	0.696773	0.689938	0.673644	0.664455	0.675053
0.780	0.694351	0.693745	0.686877	0.670463	0.661667	0.672544
0.790	0.691336	0.690735	0.683835	0.667305	0.658908	0.670058

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
0.800	0.688339	0.687744	0.680814	0.664168	0.656176	0.667595
0.810	0.685360	0.684772	0.677812	0.661053	0.653471	0.665156
0.820	0.682400	0.681819	0.674830	0.657959	0.650794	0.662738
0.830	0.679459	0.678884	0.671867	0.654887	0.648142	0.660343
0.840	0.676535	0.675967	0.668924	0.651836	0.645517	0.657969
0.850	0.673630	0.673069	0.666000	0.648806	0.642917	0.655616
0.860	0.670742	0.670189	0.663095	0.645802	0.640342	0.653284
0.870	0.667872	0.667327	0.660209	0.642829	0.637791	0.650973
0.880	0.665019	0.664482	0.657342	0.639887	0.635265	0.648682
0.890	0.662185	0.661655	0.654494	0.636975	0.632762	0.646411
0.900	0.659367	0.658846	0.651664	0.634094	0.630282	0.644159
0.910	0.656567	0.656053	0.648853	0.631242	0.627826	0.641927
0.920	0.653784	0.653280	0.646060	0.628419	0.625392	0.639713
0.930	0.651018	0.650522	0.643285	0.625624	0.622980	0.637519
0.940	0.648268	0.647781	0.640528	0.622857	0.620590	0.635342
0.950	0.645536	0.645054	0.637789	0.620118	0.618222	0.633184
0.960	0.642820	0.642344	0.635068	0.617406	0.615875	0.631044
0.970	0.640121	0.639652	0.632364	0.614720	0.613549	0.628921
0.980	0.637438	0.636953	0.629678	0.612060	0.611243	0.626815
0.990	0.634771	0.634218	0.627009	0.609426	0.608957	0.624727

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
1.000	0.632121	-0.	0.624357	0.606817	0.606691	0.622655
1.020	0.626868	0.626445	0.619105	0.601674	0.602218	0.618562
1.040	0.621678	0.621292	0.613921	0.596626	0.597821	0.614532
1.060	0.616551	0.616188	0.608802	0.591672	0.593497	0.610565
1.080	0.611486	0.611148	0.603750	0.586809	0.589245	0.606659
1.100	0.606481	0.606166	0.598761	0.582032	0.585063	0.602812
1.120	0.601536	0.601246	0.593837	0.577341	0.580949	0.599023
1.140	0.596650	0.596385	0.588975	0.572733	0.576900	0.595290
1.160	0.591822	0.591582	0.584174	0.568204	0.572915	0.591612
1.180	0.587052	0.586838	0.579435	0.563753	0.568992	0.587986
1.200	0.582338	0.582150	0.574755	0.559378	0.565130	0.584413
1.220	0.577680	0.577519	0.570135	0.555076	0.561327	0.580890
1.240	0.573077	0.572943	0.565573	0.550846	0.557581	0.577417
1.260	0.568529	0.568422	0.561068	0.546685	0.553892	0.573992
1.280	0.564033	0.563955	0.556620	0.542592	0.550257	0.570614
1.300	0.559591	0.559541	0.552228	0.538564	0.546675	0.567281
1.320	0.555201	0.555179	0.547890	0.534601	0.543145	0.563994
1.340	0.550861	0.550870	0.543607	0.530700	0.539666	0.560750
1.360	0.546573	0.546611	0.539377	0.526860	0.536236	0.557549
1.380	0.542334	0.542402	0.535199	0.523079	0.532854	0.554389

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
1.400	0.538145	0.538243	0.531074	0.519356	0.529519	0.551271
1.420	0.534004	0.534133	0.527000	0.515689	0.526231	0.548192
1.440	0.529911	0.530070	0.522976	0.512077	0.522987	0.545153
1.460	0.525866	0.526056	0.519001	0.508519	0.519788	0.542152
1.480	0.521866	0.522088	0.515076	0.505013	0.516631	0.539188
1.500	0.517913	0.518166	0.511199	0.501558	0.513516	0.536260
1.520	0.514005	0.514290	0.507369	0.498153	0.510442	0.533369
1.540	0.510142	0.510459	0.503586	0.494797	0.507409	0.530513
1.560	0.506323	0.506672	0.499850	0.491488	0.504414	0.527691
1.580	0.502547	0.502929	0.496158	0.488226	0.501458	0.524902
1.600	0.498815	0.499229	0.492512	0.485009	0.498540	0.522147
1.620	0.495124	0.495571	0.488910	0.481837	0.495659	0.519424
1.640	0.491476	0.491956	0.485352	0.478708	0.492813	0.516732
1.660	0.487868	0.488381	0.481837	0.475621	0.490003	0.514072
1.680	0.484301	0.484848	0.478364	0.472576	0.487228	0.511442
1.700	0.480774	0.481354	0.474933	0.469572	0.484486	0.508842
1.720	0.477287	0.477901	0.471543	0.466608	0.481778	0.506271
1.740	0.473839	0.474486	0.468193	0.463682	0.479102	0.503729
1.760	0.470429	0.471110	0.464884	0.460795	0.476458	0.501216
1.780	0.467057	0.467772	0.461614	0.457945	0.473845	0.498730

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N / f	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
1.800	0.463723	0.464471	0.458383	0.455132	0.471263	0.496271
1.820	0.460425	0.461208	0.455191	0.452354	0.468711	0.493838
1.840	0.457164	0.457981	0.452036	0.449612	0.466189	0.491432
1.860	0.453939	0.454790	0.448918	0.446904	0.463695	0.489052
1.880	0.450750	0.451634	0.445836	0.444229	0.461230	0.486697
1.900	0.447596	0.448514	0.442791	0.441588	0.458793	0.484366
1.920	0.444476	0.445428	0.439783	0.438979	0.456383	0.482061
1.940	0.441390	0.442376	0.436805	0.436402	0.454001	0.479779
1.960	0.438338	0.439358	0.433867	0.433856	0.451644	0.477520
1.980	0.435319	0.436373	0.430941	0.431340	0.449314	0.475285
2.000	0.432332	0.433421	-0.	0.428855	0.447008	0.473072
2.020	0.429379	0.430501	0.425255	0.426398	0.444728	0.470882
2.040	0.426457	0.427613	0.422468	0.423971	0.442473	0.468714
2.060	0.423566	0.424756	0.419700	0.421572	0.440241	0.466567
2.080	0.420707	0.421931	0.416979	0.419201	0.438034	0.464442
2.100	0.417878	0.419136	0.414287	0.416857	0.435849	0.462338
2.120	0.415079	0.416371	0.411631	0.414540	0.433688	0.460254
2.140	0.412311	0.413636	0.409010	0.412249	0.431549	0.458190
2.160	0.409572	0.410931	0.406420	0.409984	0.429432	0.456147
2.180	0.406862	0.408254	0.403863	0.407744	0.427337	0.454123

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N / f	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
2.200	0.404180	0.405606	0.401338	0.405530	0.425263	0.452118
2.220	0.401527	0.402987	0.398844	0.403340	0.423211	0.450132
2.240	0.398903	0.400395	0.396381	0.401174	0.421179	0.448165
2.260	0.396305	0.397831	0.393948	0.399031	0.419168	0.446217
2.280	0.393735	0.395294	0.391544	0.396912	0.417176	0.444286
2.300	0.391192	0.392783	0.389169	0.394816	0.415205	0.442374
2.320	0.388675	0.390299	0.386823	0.392742	0.413252	0.440479
2.340	0.386185	0.387842	0.384504	0.390690	0.411319	0.438601
2.360	0.383720	0.385410	0.382213	0.388660	0.409405	0.436740
2.380	0.381281	0.383003	0.379949	0.386651	0.407509	0.434896
2.400	0.378868	0.380621	0.377711	0.384663	0.405632	0.433069
2.420	0.376479	0.378265	0.375499	0.382696	0.403772	0.431258
2.440	0.374114	0.375932	0.373312	0.380750	0.401930	0.429463
2.460	0.371774	0.373624	0.371151	0.378823	0.400106	0.427684
2.480	0.369458	0.371340	0.369014	0.376916	0.398298	0.425921
2.500	0.367166	0.369079	0.366901	0.375028	0.396508	0.424173
2.520	0.364897	0.366841	0.364812	0.373160	0.394734	0.422440
2.540	0.362651	0.364626	0.362746	0.371310	0.392977	0.420723
2.560	0.360428	0.362434	0.360703	0.369478	0.391236	0.419019
2.580	0.358227	0.360264	0.358683	0.367665	0.389510	0.417331

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
f \ N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
2.600	0.356049	0.358116	0.356685	0.365870	0.387801	0.415657
2.620	0.353892	0.355990	0.354709	0.364092	0.386107	0.413997
2.640	0.351757	0.353885	0.352754	0.362332	0.384428	0.412351
2.660	0.349644	0.351802	0.350820	0.360589	0.382764	0.410719
2.680	0.347551	0.349739	0.348907	0.358862	0.381115	0.409100
2.700	0.345480	0.347697	0.347015	0.357152	0.379480	0.407495
2.720	0.343428	0.345675	0.345142	0.355459	0.377860	0.405903
2.740	0.341398	0.343674	0.343289	0.353782	0.376254	0.404324
2.760	0.339387	0.341692	0.341456	0.352120	0.374662	0.402758
2.780	0.337396	0.339730	0.339642	0.350474	0.373084	0.401204
2.800	0.335425	0.337788	0.337847	0.348843	0.371520	0.399663
2.820	0.333473	0.335864	0.336070	0.347227	0.369969	0.398135
2.840	0.331540	0.333959	0.334311	0.345627	0.368431	0.396619
2.860	0.329626	0.332073	0.332571	0.344041	0.366906	0.395114
2.880	0.327731	0.330206	0.330848	0.342470	0.365394	0.393622
2.900	0.325854	0.328357	0.329142	0.340912	0.363895	0.392142
2.920	0.323995	0.326525	0.327454	0.339372	0.362409	0.390673
2.940	0.322155	0.324711	0.325782	0.337836	0.360934	0.389215
2.960	0.320332	0.322915	0.324127	0.336313	0.359473	0.387769
2.980	0.318526	0.321136	0.322489	0.334724	0.358023	0.386334

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
3.000	0.316738	0.319375	0.320867	-0.	0.356585	0.384910
3.020	0.314967	0.317630	0.319260	0.331884	0.355158	0.383497
3.040	0.313212	0.315901	0.317669	0.330395	0.353744	0.382095
3.060	0.311475	0.314189	0.316094	0.328952	0.352341	0.380703
3.080	0.309754	0.312494	0.314534	0.327514	0.350949	0.379322
3.100	0.308049	0.310814	0.312989	0.326091	0.349568	0.377952
3.120	0.306360	0.309151	0.311458	0.324681	0.348199	0.376591
3.140	0.304687	0.307503	0.309942	0.323281	0.346840	0.375241
3.160	0.303030	0.305870	0.308441	0.321893	0.345492	0.373900
3.180	0.301388	0.304253	0.306953	0.320517	0.344154	0.372570
3.200	0.299762	0.302650	0.305480	0.319153	0.342827	0.371249
3.220	0.298151	0.301063	0.304020	0.317801	0.341511	0.369939
3.240	0.296554	0.299491	0.302574	0.316459	0.340205	0.368637
3.260	0.294973	0.297932	0.301141	0.315129	0.338909	0.367345
3.280	0.293406	0.296389	0.299722	0.313810	0.337622	0.366063
3.300	0.291854	0.294859	0.298315	0.312502	0.336346	0.364789
3.320	0.290316	0.293344	0.296921	0.311205	0.335079	0.363525
3.340	0.288791	0.291842	0.295540	0.309919	0.333822	0.362270
3.360	0.287281	0.290354	0.294171	0.308643	0.332575	0.361023
3.380	0.235785	0.288880	0.292815	0.307377	0.331337	0.359786

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
3.400	0.284302	0.287419	0.291470	0.306122	0.330108	0.358557
3.420	0.282833	0.285971	0.290138	0.304876	0.328889	0.357337
3.440	0.281377	0.284536	0.288818	0.303641	0.327678	0.356125
3.460	0.279934	0.283114	0.287509	0.302416	0.326476	0.354922
3.480	0.278504	0.281705	0.286211	0.301200	0.325284	0.353727
3.500	0.277087	0.280309	0.284925	0.299994	0.324100	0.352541
3.520	0.275682	0.278925	0.283650	0.298798	0.322925	0.351362
3.540	0.274290	0.277553	0.282387	0.297611	0.321758	0.350192
3.560	0.272911	0.276193	0.281134	0.296433	0.320600	0.349029
3.580	0.271543	0.274845	0.279892	0.295264	0.319450	0.347875
3.600	0.270188	0.273510	0.278660	0.294105	0.318309	0.346728
3.620	0.268845	0.272186	0.277439	0.292954	0.317175	0.345589
3.640	0.267513	0.270873	0.276229	0.291813	0.316050	0.344458
3.660	0.266193	0.269572	0.275028	0.290680	0.314933	0.343334
3.680	0.264885	0.268282	0.273838	0.289556	0.313824	0.342218
3.700	0.263588	0.267004	0.272657	0.288440	0.312722	0.341109
3.720	0.262303	0.265736	0.271487	0.287333	0.311628	0.340007
3.740	0.261028	0.264480	0.270326	0.286234	0.310542	0.338913
3.760	0.259765	0.263234	0.269175	0.285144	0.309463	0.337826
3.780	0.258513	0.261999	0.268033	0.284061	0.308392	0.336746

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
3.800	0.257271	0.260774	0.266901	0.282987	0.307328	0.335673
3.820	0.256040	0.259560	0.265778	0.281920	0.306272	0.334607
3.840	0.254819	0.258356	0.264664	0.280862	0.305223	0.333548
3.860	0.253609	0.257163	0.263559	0.279811	0.304181	0.332495
3.880	0.252410	0.255979	0.262463	0.278768	0.303147	0.331450
3.900	0.251220	0.254806	0.261376	0.277733	0.302118	0.330411
3.920	0.250041	0.253642	0.260297	0.276705	0.301093	0.329379
3.940	0.248871	0.252488	0.259227	0.275685	0.300090	0.328353
3.960	0.247711	0.251344	0.258166	0.274672	0.299073	0.327334
3.980	0.246562	0.250209	0.257113	0.273667	0.298005	0.326321
4.000	0.245421	0.249084	0.256068	0.272668-0.		0.325314
4.020	0.244290	0.247968	0.255032	0.271677	0.296127	0.324314
4.040	0.243169	0.246861	0.254003	0.270693	0.295124	0.323320
4.060	0.242057	0.245763	0.252983	0.269716	0.294144	0.322332
4.080	0.240954	0.244674	0.251970	0.268745	0.293180	0.321350
4.100	0.239860	0.243594	0.250966	0.267782	0.292212	0.320375
4.120	0.238776	0.242523	0.249969	0.266825	0.291261	0.319405
4.140	0.237700	0.241461	0.248980	0.265875	0.290310	0.318441
4.160	0.236633	0.240407	0.247998	0.264932	0.289368	0.317484
4.180	0.235575	0.239362	0.247024	0.263995	0.288432	0.316532

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
f						
4.200	0.234525	0.238325	0.246057	0.263065	0.287501	0.315585
4.220	0.233484	0.237296	0.245097	0.262141	0.286577	0.314645
4.240	0.232451	0.236276	0.244145	0.261223	0.285658	0.313710
4.260	0.231427	0.235264	0.243200	0.260312	0.284745	0.312781
4.280	0.230411	0.234260	0.242261	0.259407	0.283838	0.311857
4.300	0.229403	0.233264	0.241330	0.258508	0.282937	0.310939
4.320	0.228403	0.232276	0.240406	0.257615	0.282041	0.310026
4.340	0.227411	0.231295	0.239489	0.256728	0.281151	0.309119
4.360	0.226427	0.230322	0.238578	0.255847	0.280267	0.308216
4.380	0.225451	0.229357	0.237674	0.254972	0.279388	0.307320
4.400	0.224483	0.228400	0.236776	0.254103	0.278515	0.306428
4.420	0.223522	0.227450	0.235886	0.253240	0.277647	0.305542
4.440	0.222569	0.226507	0.235001	0.252382	0.276784	0.304661
4.460	0.221623	0.225571	0.234123	0.251530	0.275927	0.303785
4.480	0.220685	0.224643	0.233251	0.250684	0.275075	0.302914
4.500	0.219754	0.223722	0.232386	0.249843	0.274228	0.302048
4.520	0.218830	0.222808	0.231527	0.249008	0.273386	0.301187
4.540	0.217913	0.221901	0.230674	0.248178	0.272549	0.300331
4.560	0.217004	0.221001	0.229827	0.247354	0.271718	0.299480
4.580	0.216102	0.220108	0.228986	0.246534	0.270891	0.298633

Table I. Continued

X	0.0	1.0	2.0	3.0	4.0	5.0
f \ N	0.367879	0.353224	0.316132	0.270666	0.227772	0.192027
4.580	0.216102	0.220108	0.228986	0.246534	0.270891	0.298633
4.600	0.215206	0.219222	0.228150	0.245721	0.270070	0.297792
4.620	0.214318	0.218342	0.227321	0.244912	0.269253	0.296955
4.640	0.213436	0.217469	0.226498	0.244109	0.268441	0.296123
4.660	0.212561	0.216602	0.225680	0.243310	0.267635	0.295296
4.680	0.211693	0.215742	0.224868	0.242517	0.266832	0.294473
4.700	0.210831	0.214889	0.224062	0.241729	0.266035	0.293654
4.720	0.209976	0.214042	0.223261	0.240946	0.265243	0.292840
4.740	0.209127	0.213201	0.222466	0.240168	0.264454	0.292031
4.760	0.208285	0.212366	0.221676	0.239394	0.263671	0.291227
4.780	0.207449	0.211537	0.220891	0.238625	0.262892	0.290427
4.800	0.206619	0.210715	0.220112	0.237862	0.262118	0.289630
4.820	0.205795	0.209899	0.219338	0.237103	0.261348	0.288839
4.840	0.204978	0.209088	0.218570	0.236349	0.260583	0.288051
4.860	0.204167	0.208284	0.217807	0.235599	0.259822	0.287266
4.880	0.203361	0.207485	0.217048	0.234855	0.259066	0.286490
4.900	0.202562	0.206692	0.216295	0.234114	0.258313	0.285711
4.920	0.201769	0.205905	0.215547	0.233378	0.257566	0.284939
4.940	0.200981	0.205124	0.214804	0.232647	0.256822	0.284159
4.960	0.200199	0.204348	0.214066	0.231920	0.256083	0.283386
4.980	0.199423	0.203578	0.213333	0.231198	0.255347	0.282571
5.000	0.198653	0.202813	0.212604	0.230480	0.254616-0.	

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