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24.

Elements of Fides, their Variations by Jupiter and Table for the solution of *Kepler's* problem.

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(Communicated by Prof. *J. H. C. Coffin*, Superintendent of the American Nautical-Almanac.)

A. Elements.

1870 Jan. 0 Berlin M. T.

$$M = 70^{\circ}27'32''3$$

$$\pi = 65\ 45\ 21.4 \left. \vphantom{\begin{matrix} \pi \\ \Omega \\ i \end{matrix}} \right\} \text{M. Eq. Ep.}$$

$$\Omega = 8\ 16\ 2.3$$

$$i = 3\ 7\ 8.0$$

$$\varphi = 10\ 5\ 32.3$$

$$\mu = 826''0657.$$

B. Variations.

<u>0^h Berlin M. T.</u>	<u>t-1870,0</u>	<u>d i</u>	<u>d Ω</u>	<u>d φ</u>	<u>d π</u>	<u>d μ</u>	<u>∫ d μ</u>	<u>d M</u>
1870 Febr. 9	+ 40 ^d	0''	+ 2''	- 2''	+ 47''	-0''048	- 1''	- 44''
March 21		0	4	3	96	0.104	4	93
April 30		- 1	5	5	146	0.153	9	143
1871 April 25	480	- 4	- 25	- 48	+ 487	-0.537	- 140	- 537
June 4		4	32	53	509	0.563	162	569
July 14		4	39	58	528	0.584	185	598
1872 July 8	920	- 4	- 85	- 95	+ 682	-0.552	- 403	- 839
Aug. 17		4	87	99	705	0.521	424	870
Sept. 26		3	89	103	730	0.484	445	900
1873 Dec. 10	1440	- 3	- 88	-128	+ 992	-0.318	- 574	-1145
1874 Jan. 19		3	87	120	1062	0.414	589	1214
Febr. 28		3	85	111	1152	0.532	607	1306
1875 April 4	1920	-17	- 135	+ 97	+1924	-0.869	-1011	-2466
May 14		18	161	133	1931	0.709	1042	2503
June 23		20	188	167	1941	0.544	1067	2535
1876 July 27	2400	-22	- 335	+349	+2217	+0.376	-1049	-2788
Sept. 5		22	336	354	2223	0.386	1034	2786
Oct. 13		22	337	358	2223	0.383	1018	2777
1877 Nov. 19	2880	-24	- 347	+405	+2026	+0.014	- 932	-2575
Dec. 29		24	351	409	2011	-0.008	932	2566
1878 Febr. 7		24	355	412	1995	0.021	932	2557
1879 March 14	3360	-22	- 374	+449	+1672	+0.270	- 901	-2296
April 23		22	373	456	1639	0.319	889	2253
June 2		22	372	464	1607	0.369	876	2233
1880 May 27	3800	-22	- 373	+539	+1492	+0.747	- 668	-2077
July 6		22	374	545	1489	0.768	638	2065
Aug. 15		22	375	551	1484	0.780	607	2049

<u>0^h Berlin M. T.</u>	<u>$t-1870,0$</u>	<u>di</u>	<u>$d\Omega$</u>	<u>$d\varphi$</u>	<u>$d\pi$</u>	<u>$d\mu$</u>	<u>$\int d\mu$</u>	<u>dM</u>
1881 Sept. 19	+4280 ^d	-26''	- 367''	+614''	+ 813''	-0''009	- 388''	-1350''
Oct. 29		27	378	622	691	0.123	391	1254
Dec. 8		28	399	622	585	0.157	397	1179
1883 Febr. 21	4800	-30	- 519	+519	+ 63	+0.613	- 246	- 698
April 2		30	519	514	80	0.593	222	708
May 12		30	519	509	101	0.565	198	723
1884 May 6	5240	-32	- 542	+441	+ 238	+0.193	- 60	- 852
Juni 15		32	545	433	237	0.153	53	854
July 25		32	549	425	232	0.115	47	854
1885 Aug. 29	5720	-32	- 564	+371	+ 138	-0.050	- 51	- 833
Oct. 8		32	564	367	139	0.034	53	840
Nov. 17		32	564	362	141	0.007	53	849
1887 Jan. 31	6240	-32	- 567	+314	+ 226	+0.238	+ 26	- 919
March 12		32	564	313	282	0.182	34	969
April 21		33	561	311	359	0.102	40	1041
1888 April 15	6680	-53	- 749	+221	+1810	-1.238	- 158	-2748
May 25		58	834	217	2005	1.297	209	3019
July 4		62	933	221	2199	1.290	261	3292
1889 June 29	7120	-67	-1566	+363	+3848	+0.184	- 480	-5291
Aug. 8		66	1581	369	3966	0.310	470	5407
Sept. 17		66	1590	374	4063	0.411	456	5499
1890 Dec. 1	7640	-65	-1608	+426	+4264	+0.289	- 243	-5658
1891 Jan. 10		65	1610	433	4270	0.242	233	5670
Febr. 19		65	1612	439	4277	0.202	224	5683
1892 March 25	8120	-65	-1618	+498	+4256	+0.205	- 165	-5758
May 4		65	1619	505	4253	0.237	156	5764
June 13		66	1621	514	4253	0.273	146	5773
1893 June 8	8560	-66	-1660	+592	+4435	+0.700	+ 25	-5996
July 18		66	1666	599	4473	0.745	54	6034
Aug. 27		66	1671	604	4513	0.787	86	6072
1894 Oct. 1	9040	-67	-1691	+663	+4609	+0.695	+ 440	-6113
Nov. 10		67	1700	681	4568	0.561	466	6078
Dec. 20		68	1716	699	4521	0.426	485	6043
1896 March 5	9560	-65	-1883	+725	+3544	+1.030	+ 735	-5193
April 14		65	1883	724	3505	1.066	777	5145
May 23		64	1883	722	3477	1.088	821	5107
1897 May 18	10000	-65	-1887	+679	+3344	+0.925	+1197	-4912
June 27		65	1887	673	3323	0.887	1233	4888
Aug. 6		65	1887	666	3298	0.847	1268	4862
1898 Sept. 10	10480	-65	-1878	+629	+3006	+0.531	+1533	-4606
Oct. 20		65	1878	627	2988	0.524	1554	4598
Nov. 29		66	1879	625	2973	0.532	1576	4587
1900 Jan. 0	10957	-66	-1900	+580	+2811	+0.868	+1849	-4438

C. Table for the correction c to be added to the auxiliary anomaly v' .

Argument = M ; For $M > 180^\circ$ the Argument is $360^\circ - M$ and the sign of c to be reversed.

$e = 0,1750$; $\Delta e = +0,0001$; $\frac{\Delta c}{\Delta e^2}$ in units of the 5th decimal.

Arg.	c	Diff.	$\frac{\Delta c}{\Delta e}$	$\frac{\Delta c}{\Delta e^2}$	Arg.	c	Diff.	$\frac{\Delta c}{\Delta e}$	$\frac{\Delta c}{\Delta e^2}$
0°	0''0		0''000	0	21°	+1422''3		+1''867	+76
	+ 40.2	+40''2	+0.055			1444.1	+21.8	1.891	
1	80.4	40.2	0.110	+ 5	22	1465.1	21.0	1.914	77
	120.4	40.0	0.166			1485.4	20.3	1.936	
2	160.4	40.0	0.221	10	23	1504.9	19.5	1.956	78
	200.4	40.0	0.276			1523.7	18.8	1.975	
3	240.3	39.9	0.330	15	24	1541.6	17.9	1.994	78
	280.0	39.7	0.385			1558.8	17.2	2.011	
4	319.5	39.5	0.439	20	25	1575.1	16.3	2.026	78
	358.8	39.3	0.493			1590.7	15.6	2.040	
5	398.0	39.2	0.546	25	26	1605.4	14.7	2.054	78
	436.9	38.9	0.599			1619.4	14.0	2.066	
6	475.5	38.6	0.652	29	27	1632.5	13.1	2.076	78
	513.9	38.4	0.704			1644.9	12.4	2.085	
7	552.0	38.1	0.756	34	28	1656.4	11.5	2.094	77
	589.8	37.8	0.807			1667.1	10.7	2.101	
8	627.2	37.4	0.857	38	29	1677.0	9.9	2.106	76
	664.3	37.1	0.907			1686.0	9.0	2.111	
9	701.0	36.7	0.957	43	30	1694.3	8.3	2.114	75
	737.3	36.3	1.005			1701.8	7.5	2.116	
10	773.2	35.9	1.053	47	31	1708.4	6.6	2.117	74
	808.7	35.5	1.100			1714.2	5.8	2.117	
11	843.7	35.0	1.146	51	32	1719.2	5.0	2.115	72
	878.2	34.5	1.192			1723.4	4.2	2.112	
12	912.2	34.0	1.237	54	33	1726.9	3.5	2.108	70
	945.7	33.5	1.281			1729.5	2.6	2.103	
13	978.7	33.0	1.323	58	34	1731.3	1.8	2.097	68
	1011.2	32.5	1.365			1732.3	1.0	2.090	
14	1043.1	31.9	1.406	61	35	1732.6	+ 0.3	2.082	66
	1074.4	31.3	1.446			1732.0	- 0.6	2.073	
15	1105.1	30.7	1.485	64	36	1730.7	1.3	2.062	64
	1135.2	30.1	1.523			1728.7	2.0	2.051	
16	1164.7	29.5	1.560	67	37	1725.8	2.9	2.039	61
	1193.5	28.8	1.595			1722.2	3.6	2.025	
17	1221.7	28.2	1.630	69	38	1717.9	4.3	2.011	58
	1249.2	27.5	1.664			1712.9	5.0	1.995	
18	1276.0	26.8	1.696	71	39	1707.1	5.8	1.979	55
	1302.2	26.2	1.727			1700.5	6.6	1.962	
19	1327.7	25.5	1.758	73	40	1693.3	7.2	1.944	52
	1352.4	24.7	1.787			1685.4	7.9	1.925	
20	1376.4	24.0	1.815	75	41	1676.7	8.7	1.905	49
	1399.7	23.3	1.841			1667.4	9.3	1.884	
21	+1422.3	+22.6	+1.867	+76	42	+1657.4	-10.0	+1.863	+46

Arg.	c	Diff.	$\frac{\Delta c}{\Delta e}$	$\frac{\Delta c}{\Delta e^2}$
42 ⁰	+1657''4	-10''7	+1''863	+46
	1646.7	11.3	1.841	
43	1635.4	11.9	1.818	43
	1623.5	12.6	1.794	
44	1610.9	13.3	1.769	39
	1597.6	13.8	1.744	
45	1583.8	14.5	1.718	36
	1569.3	15.0	1.691	
46	1554.3	15.6	1.664	32
	1538.7	16.2	1.636	
47	1522.5	16.7	1.608	29
	1505.8	17.3	1.579	
48	1488.5	17.8	1.549	25
	1470.7	18.4	1.519	
49	1452.3	18.8	1.488	22
	1433.5	19.3	1.457	
50	1414.2	19.9	1.426	18
	1394.3	20.3	1.394	
51	1374.0	20.7	1.361	15
	1353.3	21.2	1.328	
52	1332.1	21.6	1.295	11
	1310.5	22.1	1.262	
53	1288.4	22.4	1.228	8
	1266.0	22.9	1.194	
54	1243.1	23.2	1.159	4
	1219.9	23.6	1.124	
55	1196.3	24.0	1.089	+ 1
	1172.3	24.3	1.054	
56	1148.0	24.6	1.018	- 2
	1123.4	24.9	0.982	
57	1098.5	25.3	0.946	5
	1073.2	25.5	0.910	
58	1046.7	25.8	0.874	8
	1021.9	26.1	0.838	
59	995.8	26.4	0.801	11
	969.4	26.6	0.765	
60	942.8	26.8	0.728	14
	916.0	27.0	0.691	
61	889.0	27.2	0.654	17
	861.8	27.5	0.617	
62	834.3	27.6	0.581	20
	806.7	27.8	0.544	
63	778.9	27.9	0.508	23
	751.0	28.1	0.471	
64	722.9	28.2	0.434	25
	694.7	-28.3	0.397	
65	+ 666.4		+0.361	-28

Arg.	c	Diff.	$\frac{\Delta c}{\Delta e}$	$\frac{\Delta c}{\Delta e^2}$
65 ⁰	+666''4	-28''4	+0''361	-28
	638.0	28.6	0.325	
66	609.4	28.7	0.289	30
	581.7	28.7	0.253	
67	552.0	28.8	0.217	32
	523.2	28.8	0.181	
68	494.4	28.9	0.145	34
	465.5	28.9	0.109	
69	436.6	28.9	0.074	36
	407.7	28.9	0.039	
70	378.8	29.0	+0.004	38
	349.8	28.9	-0.030	
71	320.9	29.0	0.065	40
	291.9	28.9	0.099	
72	263.0	28.8	0.133	41
	234.2	28.8	0.166	
73	204.4	28.8	0.200	43
	176.6	28.7	0.233	
74	147.9	28.6	0.266	44
	119.3	28.5	0.299	
75	90.8	28.5	0.331	46
	62.3	28.3	0.363	
76	34.0	28.3	0.395	47
	+ 5.7	28.1	0.426	
77	- 22.4	28.0	0.457	48
	50.4	27.9	0.488	
78	78.3	27.7	0.518	49
	106.0	27.6	0.548	
79	133.6	27.4	0.577	50
	161.0	27.3	0.607	
80	188.3	27.1	0.636	51
	215.4	27.0	0.664	
81	242.4	26.7	0.692	52
	269.1	26.5	0.720	
82	295.6	26.3	0.747	52
	321.9	26.2	0.774	
83	348.1	26.0	0.801	53
	374.1	25.8	0.827	
84	399.9	25.5	0.853	54
	425.4	25.3	0.878	
85	450.7	25.0	0.903	54
	475.7	24.8	0.928	
86	500.5	24.6	0.952	54
	525.1	24.3	0.976	
87	549.4	24.1	0.999	55
	573.5	-23.8	1.022	
88	-597.3		-1.045	-55

Arg.	c	Diff.	$\frac{\Delta c}{\Delta e}$	$\frac{\Delta c}{\Delta e^2}$
88°	- 597''3	-23''6	-1''045	-55
	620.9	23.3	1.067	
89	644.2	23.0	1.089	55
	667.2	22.7	1.110	
90	689.9	22.5	1.131	55
	712.4	22.2	1.151	
91	734.6	21.9	1.171	55
	756.5	21.6	1.191	
92	778.1	21.3	1.210	55
	799.4	21.0	1.229	
93	820.4	20.7	1.247	55
	841.4	20.4	1.265	
94	861.5	20.1	1.283	55
	881.6	19.8	1.300	
95	901.4	19.5	1.316	55
	920.9	19.2	1.332	
96	940.1	18.8	1.348	54
	958.9	18.5	1.364	
97	977.4	18.2	1.379	54
	995.6	17.8	1.393	
98	1013.4	17.5	1.407	54
	1030.9	17.2	1.421	
99	1048.1	16.9	1.434	54
	1065.0	16.5	1.447	
100	1081.5	16.2	1.460	53
	1097.7	15.8	1.472	
101	1113.5	15.5	1.483	53
	1129.0	15.2	1.494	
102	1144.2	14.8	1.505	52
	1159.0	14.5	1.516	
103	1173.5	14.2	1.526	52
	1187.7	13.8	1.536	
104	1201.5	13.4	1.545	51
	1214.9	13.1	1.554	
105	1228.0	12.7	1.562	51
	1240.7	12.4	1.570	
106	1253.1	12.0	1.578	50
	1265.1	11.7	1.585	
107	1276.8	11.4	1.592	50
	1288.2	11.0	1.599	
108	1299.2	10.6	1.605	49
	1309.8	10.3	1.610	
109	1320.1	9.9	1.615	48
	1330.0	9.6	1.620	
110	1339.6	9.2	1.625	48
	1348.8	- 8.9	1.630	
111	-1357.7		-1.634	-47

Arg.	c	Diff.	$\frac{\Delta c}{\Delta e}$	$\frac{\Delta c}{\Delta e^2}$
111°	-1357''7	- 8''5	-1''634	-47
	1366.2	8.2	1.637	
112	1374.4	7.8	1.640	46
	1382.2	7.5	1.642	
113	1389.7	7.1	1.646	46
	1396.8	6.8	1.648	
114	1403.6	6.4	1.650	45
	1410.0	6.0	1.652	
115	1416.0	5.7	1.653	44
	1421.7	5.4	1.654	
116	1427.1	5.0	1.654	43
	1432.1	4.7	1.654	
117	1436.8	4.4	1.654	43
	1441.2	4.0	1.653	
118	1445.2	3.6	1.652	42
	1448.8	3.3	1.651	
119	1452.1	3.0	1.649	41
	1455.1	2.7	1.648	
120	1457.8	2.3	1.646	41
	1460.1	1.9	1.644	
121	1462.0	1.7	1.641	40
	1463.7	1.3	1.638	
122	1465.0	0.9	1.634	39
	1465.9	0.7	1.631	
123	1466.6	- 0.3	1.627	38
	1466.9	0.0	1.623	
124	1466.9	+ 0.4	1.618	38
	1466.5	0.6	1.614	
125	1465.9	1.0	1.609	37
	1464.9	1.3	1.604	
126	1463.6	1.6	1.598	36
	1462.0	1.9	1.592	
127	1460.1	2.3	1.586	35
	1457.8	2.6	1.580	
128	1455.2	2.9	1.573	35
	1452.3	3.2	1.566	
129	1449.1	3.4	1.559	34
	1445.7	3.8	1.551	
130	1441.9	4.1	1.543	33
	1437.8	4.4	1.535	
131	1433.4	4.7	1.527	32
	1428.7	4.9	1.519	
132	1423.8	5.3	1.510	31
	1418.5	5.6	1.501	
133	1412.9	5.8	1.492	31
	1407.1	+ 6.1	1.483	
134	-1401.0		-1.474	-30

Arg.	c	Diff.	$\frac{\Delta c}{\Delta e}$	$\frac{\Delta c}{\Delta e^2}$
134 ⁰	-1401''0		-1''474	-30
	1394.6	+ 6''4	1.464	
135	1387.9	6.7	1.454	29
	1380.9	7.0	1.444	
136	1373.7	7.2	1.433	28
	1366.2	7.5	1.423	
137	1358.4	7.8	1.412	28
	1350.3	8.1	1.401	
138	1342.0	8.3	1.390	27
	1333.4	8.6	1.379	
139	1324.6	8.8	1.367	26
	1315.5	9.1	1.355	
140	1306.1	9.4	1.343	25
	1296.6	9.5	1.331	
141	1286.7	9.9	1.318	25
	1276.6	10.1	1.306	
142	1266.3	10.3	1.293	24
	1255.7	10.6	1.280	
143	1244.9	10.8	1.267	23
	1233.9	11.0	1.254	
144	1222.6	11.3	1.240	22
	1211.1	11.5	1.227	
145	1199.4	11.7	1.213	22
	1187.4	12.0	1.199	
146	1175.2	12.2	1.185	21
	1162.8	12.4	1.171	
147	1150.2	12.6	1.157	20
	1137.4	12.8	1.143	
148	1124.4	13.0	1.128	19
	1111.1	13.3	1.113	
149	1097.7	13.4	1.098	19
	1084.1	13.6	1.083	
150	1070.2	13.9	1.068	18
	1056.2	14.0	1.053	
151	1042.0	14.2	1.037	17
	1027.6	14.4	1.022	
152	1013.0	14.6	1.006	16
	998.2	14.8	0.990	
153	983.3	14.9	0.974	16
	968.2	15.1	0.958	
154	952.9	15.3	0.942	15
	937.4	15.5	0.926	
155	921.8	15.6	0.909	14
	906.0	15.8	0.893	
156	890.1	15.9	0.876	14
	874.0	16.1	0.860	
157	- 857.7	+16.3	-0.843	-13

Arg.	c	Diff.	$\frac{\Delta c}{\Delta e}$	$\frac{\Delta c}{\Delta e^2}$
157 ⁰	- 857''7		-0''843	-13
	841.3	+16''4	0.826	
158	824.8	16.5	0.809	12
	808.1	16.7	0.792	
159	791.2	16.9	0.775	12
	774.3	16.9	0.758	
160	757.2	17.1	0.740	11
	739.9	17.3	0.723	
161	722.5	17.4	0.705	10
	705.0	17.5	0.688	
162	687.4	17.6	0.670	10
	669.7	17.7	0.653	
163	651.9	17.8	0.635	9
	633.9	18.0	0.617	
164	615.8	18.1	0.599	8
	597.7	18.1	0.581	
165	579.4	18.3	0.563	8
	561.0	18.4	0.545	
166	542.6	18.4	0.526	7
	524.0	18.6	0.508	
167	505.4	18.6	0.490	7
	486.6	18.8	0.472	
168	467.8	18.8	0.453	6
	448.9	18.9	0.435	
169	429.9	19.0	0.416	6
	410.9	19.0	0.398	
170	391.8	19.1	0.379	5
	372.6	19.2	0.360	
171	353.4	19.2	0.341	5
	334.1	19.3	0.323	
172	314.7	19.4	0.304	4
	295.3	19.4	0.285	
173	275.8	19.5	0.266	3
	256.3	19.5	0.247	
174	236.8	19.6	0.228	3
	217.2	19.7	0.209	
175	197.5	19.7	0.190	2
	177.9	19.6	0.171	
176	158.2	19.7	0.152	2
	138.5	19.7	0.133	
177	118.7	19.8	0.114	1
	99.0	19.7	0.095	
178	79.2	19.8	0.076	- 1
	59.4	19.8	0.057	
179	39.6	19.8	0.038	0
	19.8	19.8	-0.019	
180	0.0	+19.8	0.000	0

$$\cotg \frac{1}{2} v' = \frac{1-e}{1+e} \cotg \frac{1}{2} M; \quad v = v' + c; \quad r = \frac{p}{1+e \cos v}; \quad \cos E = \frac{\cos v + e}{1+e \cos v}.$$