

The crystal structure of $K_2Si^{VI}Si_3^{IV}O_9$

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Abstract

The crystal structure of $K_2Si^{VI}Si_3^{IV}O_9$ has been refined in space group $P6_3/m$ to an $R = 2.02\%$ and is confirmed to be isotypic with wadeite ($K_2ZrSi_3O_9$). The atomic charges of Si^{VI} , Si^{IV} , $O(1)_{br}$ and $O(2)_{nbr}$ are +3.3, +2.5, -1.4 and -1.4, respectively, and suggest that an increase in the coordination number of a Si atom from 4 to 6 significantly increases the ionic character of that atom. The mean octahedral Si-O distance, 1.778 Å, compares well with that predicted by an empirical equation, 1.781 Å.

Introduction

The phase $K_2Si^{VI}Si_3^{IV}O_9$ was first synthesized by Kinomura, Kume and Koizumi (1975) at high temperature and pressure. They concluded that this phase has the wadeite structure because: (1) its X-ray powder pattern is similar to that of $K_2TiSi_3O_9$ (Choisnet, Deschamps and Raveau, 1973) and (2) the a and c cell edges were found to agree with values predicted from a plot of the variations in the a and c cell edges with the radius of the octahedral cation for a variety of wadeite-type structures. Kinomura *et al.* (1975) discussed the geophysical significance of $K_2Si^{VI}Si_3^{IV}O_9$ in the Earth's mantle and suggested that this phase may be an intermediate step in the transition of feldspar to a hollandite-type phase.

The purpose of this study was to refine the crystal structure of $K_2Si^{VI}Si_3^{IV}O_9$ so that variations in the steric details and local bonding features between the $Si^{VI}-O$ and $Si^{IV}-O$ bond could be examined. In addition, because $K_2Si^{VI}Si_3^{IV}O_9$ contains both four and six-coordinated Si, it provides an excellent opportunity for studying the interactions present in an $Si^{VI}-O-Si^{IV}$ linkage.¹

Experimental details

Specimen preparation

Single crystals of $K_2Si^{VI}Si_3^{IV}O_9$ were synthesized by reacting crystalline potassium tetrasilicate ($K_2Si_4O_9$) at high temperature and pressure. The starting material, $K_2Si_4O_9$, was kindly provided to us by Professor David R. Wones who had synthesized the crystalline $K_2Si_4O_9$ in 1958 at the USGS laboratories according to the procedure described by Schairer and Bowen (1955). The potassium tetrasilicate was sealed in a Pt capsule and placed in a

¹ $Si_3O[PO_4]_6$ also contains four and six-coordinated Si (Mayer, 1974), but none of the oxygen atoms in this phase are common to both Si^{IV} and Si^{VI} .

piston-cylinder apparatus. The sample was held at 24 kbar and 900°C for one hour. The resulting run product consisted of a mixture of crystalline material and glass. After careful optical examination of the crystalline material a clear single crystal, with approximate dimensions 45 × 60 × 85 μm, was chosen for X-ray diffraction study. Precession photographs verified that the crystal is untwinned and that its Laue symmetry is consistent with the space group of wadeite, $P6_3/m$.

Data collection

Integrated intensities were collected up to $2\theta = 80^\circ$ in one quadrant of reciprocal space ($-h < 0 \leq +h$, $k \geq 0$, $l \geq 0$) using a Picker four-circle diffractometer with graphite-monochromatized $MoK\alpha$ radiation (0.7107 Å). The reflection data were measured using the $\omega - 2\theta$ scan mode with a scan width of $(2.0^\circ + 0.7^\circ \tan\theta)$ and $\sigma_I/I = 0.01$ for $0 < 2\theta \leq 65^\circ$ and with a scan width of $(1.3^\circ + 0.7^\circ \tan\theta)$ and $\sigma_I/I = 0.01$ for $65 < 2\theta \leq 80^\circ$. Cell parameters were determined by a least squares calculation on 23 reflections in the range $39^\circ < 2\theta < 65^\circ$ that were individually centered at eight equivalent positions on the diffractometer. Cell parameters and other crystallographic data are listed in Table 1.

Refinement procedure

All structure refinements were carried out using the full-matrix least-squares refinement program RADY (Sasaki, pers. comm.), a modified version of RADIEL (Coppens *et al.*, 1975). Reflections for which $I_{obs} < 3\sigma_I$ were considered unobservable and eliminated from the refinements. Based on this rejection criterion 432 of the 2419 observed data were excluded from the refinements. In addition, 109 reflections that had unequal backgrounds were also eliminated. Reflections were considered to have unequal backgrounds if

$$RB < BMIN \text{ or } RB > BMAX$$

Table 3. Observed and calculated structure factors for $K_2Si^{VI}Si_3^{IV}O_9$.

H	K	L	F _{obs}	F _{calc}	A _{calc}	B _{calc}	σ_F
-8	0	0	20.36555	20.17610	20.17576	.11681	.22016
-7	0	0	17.57616	17.29284	-17.29005	-.31082	.19020
-6	0	0	27.08810	26.99280	26.98012	.82724	.24921
-5	0	0	21.02526	21.87272	21.87161	-.22105	.19516
-4	0	0	11.65230	12.28118	12.27338	-.43762	.12542
-3	0	0	46.63274	47.15018	47.13935	1.01087	.38582
-2	0	0	27.69529	28.05159	-28.04743	-.48301	.22236
-1	0	0	19.49720	18.71997	18.71672	-.34885	.15387
7	1	0	8.02375	7.81310	7.78847	.61980	.19391
6	1	0	3.49270	3.51869	-3.50978	-.25024	.30622
5	1	0	27.70750	27.85407	27.85382	.11933	.28861
4	1	0	73.21147	73.54941	73.54134	1.08926	.72135
3	1	0	33.67427	33.38478	-33.38109	-.49607	.32430
2	1	0	36.53734	36.36297	-36.36122	-.35665	.34392
1	1	0	35.20162	34.39019	34.37670	.96293	.32841
-3	1	0	4.58608	3.93585	-3.93554	-.04896	.10805
-4	1	0	44.96466	44.97862	44.97855	-.07916	.43186
-5	1	0	45.70239	45.04988	45.04354	.75599	.44420
-6	1	0	7.09103	7.29362	7.28551	-.34380	.15308
-7	1	0	22.60193	22.36255	-22.35906	-.39481	.25427
-8	1	0	34.12429	34.34736	34.33798	.80279	.37076
-9	1	0	21.58965	21.56485	21.56485	.01047	.27021
-9	2	0	9.69855	9.89021	-9.88482	-.32665	.20329
-8	2	0	18.69935	18.60207	-18.59949	-.30989	.23002
-7	2	0	47.59164	46.90578	46.89283	1.10229	.48411
-5	2	0	5.10266	4.58896	-4.57425	-.36708	.14434
-4	2	0	72.58967	73.41055	73.39966	1.26433	.69076
3	2	0	39.63149	38.76166	-38.75897	-.45678	.38578
4	2	0	10.90120	10.61060	-10.60835	-.21878	.15758
5	2	0	22.40408	21.83453	21.81973	.80359	.24959
6	2	0	12.97426	12.56794	-12.56372	-.32586	.19296
7	2	0	5.65342	6.28883	-6.28533	-.20996	.25174
6	3	0	58.51367	58.44492	58.43555	1.04655	.61851
4	3	0	10.26375	10.00378	-9.99714	-.36451	.16417
3	3	0	17.17528	16.91851	16.90034	.78389	.19541
-7	3	0	12.70891	12.75864	12.75861	.02677	.17441
-8	3	0	7.18325	7.11250	7.11220	-.06519	.18533
-9	3	0	13.59125	13.35203	13.33847	.60164	.20692
-9	4	0	5.93542	6.56374	-6.55401	-.35741	.23046
-8	4	0	24.65977	24.39825	24.38823	.69921	.27628
5	4	0	17.61023	17.63748	17.63679	-.15614	.22961
5	5	0	16.61400	16.52810	16.51931	.53882	.27137
-1	9	1	16.22443	15.96944	15.96593	.33493	.23161
-4	9	1	3.81493	3.63550	-3.63489	.06662	.29691

-5	9	1	28.19096	28.18864	-28.18419	-.50110	.31880
-6	9	1	5.21601	5.09628	5.09467	.12792	.25270
-7	9	1	11.85216	12.01543	12.00895	.39432	.20607
-8	9	1	4.97987	4.83040	-4.82627	-.19971	.27200
-8	8	1	10.44291	10.20305	10.20102	.20312	.17308
-6	8	1	4.91498	4.95170	4.95169	-.00973	.23493
-5	8	1	5.05756	5.17854	-5.17590	.16520	.21679
-4	8	1	8.69192	8.80687	8.80677	.04204	.17981
-3	8	1	7.65385	7.83209	7.83208	.01483	.18524
-2	8	1	8.81932	8.64728	-8.64723	.02842	.18520
-1	8	1	25.71590	25.87168	-25.87045	-.25144	.29423
0	7	1	10.36885	10.31956	10.31458	.32039	.15813
-1	7	1	29.38828	29.23272	-29.23015	-.38755	.38669
-2	7	1	6.53265	6.30762	6.30673	.10583	.17121
-3	7	1	33.41544	33.11905	33.11595	.45365	.34758
-4	7	1	12.05177	11.94798	-11.94581	-.22786	.17250
-5	7	1	12.61255	12.40507	-12.40503	-.03278	.17709
-6	7	1	22.08552	22.26354	-22.26339	-.08177	.25026
-9	6	1	3.34958	.24945	-.24945	-.00036	.53550
-6	6	1	7.32580	7.34331	-7.34142	-.16645	.14421
-4	6	1	23.57800	23.82395	23.82171	.32661	.25005
-3	6	1	11.19618	10.80021	-10.79719	-.25553	.15510
-1	6	1	9.53285	9.24727	9.24414	.24043	.15538
1	5	1	3.59680	3.65175	3.64794	.16674	.26243
0	5	1	25.66614	25.87526	-25.87249	-.37877	.22961
-1	5	1	14.28449	14.14073	14.14047	.08484	.16909
-2	5	1	15.28415	15.92911	-15.92908	.03038	.17354
-3	5	1	12.20288	12.35368	-12.34850	-.35803	.15210
-4	5	1	22.37201	22.24118	22.23905	.30763	.23256
-4	4	1	19.92488	20.17369	-20.17022	-.37378	.17895
-3	4	1	14.57955	14.83562	14.83229	.31426	.16043
-2	4	1	6.75460	6.72390	-6.72389	.01193	.11867
-1	4	1	27.67868	28.74698	28.74692	.06208	.27156
0	3	1	8.44019	7.78379	-7.78308	.10491	.10068
-1	3	1	18.07983	17.86114	-17.85949	.24288	.17921
-2	3	1	58.70724	58.66540	-58.66462	-.30341	.55460
-2	2	1	68.71405	68.94699	68.94434	.60462	.55765
-1	2	1	37.49955	36.77748	-36.77715	-.15669	.34936
0	1	1	18.32849	17.59269	-17.59201	.15431	.14668
-8	0	2	15.31153	15.52739	-15.52214	-.40391	.18977
-7	0	2	9.89181	10.03265	10.03263	-.02341	.15811
-6	0	2	32.69066	32.72242	32.71482	.70524	.29462
-5	0	2	5.00773	5.27386	5.26957	-.21256	.14279
-4	0	2	21.71105	22.70552	22.70547	-.04492	.19297
-3	0	2	59.56960	59.71557	59.70928	.86639	.49483
-2	0	2	7.34111	7.79498	-7.79462	-.07517	.08708
-1	0	2	18.43848	17.58311	17.58160	-.23029	.14979
0	0	2	21.28027	20.13321	-20.12880	.42160	.33706
7	1	2	30.78261	30.78562	30.77727	.71719	.34094
6	1	2	5.66799	5.55331	-5.55232	-.10446	.19485
5	1	2	28.09629	28.32100	-28.31617	-.52283	.29352
4	1	2	15.18381	14.99753	14.98472	.61974	.17646

3	1	2	25.43777	25.96978	25.96978	-.00434	.25251
2	1	2	5.52146	5.24921	-5.24609	-.18096	.10920
1	1	2	84.92543	84.44460	84.43857	1.00933	.78429
-3	1	2	28.22783	28.49910	-28.49493	-.48765	.26862
-4	1	2	26.42868	25.58195	-25.57851	-.41954	.26096
-5	1	2	67.02836	68.36968	68.36306	.95146	.65890
-6	1	2	4.59875	4.77521	4.77482	-.06117	.19222
-7	1	2	15.50725	15.83056	15.83051	.03927	.20141
-8	1	2	12.62025	12.85025	12.83910	.53515	.19919
-9	1	2	6.26469	6.41361	-6.40773	-.27449	.23968
-9	2	2	13.19367	13.23081	13.23071	.04917	.21050
-8	2	2	10.89925	10.78746	10.78746	-.01205	.18877
-7	2	2	3.16062	3.28729	3.26317	.39745	.33127
-6	2	2	3.98997	3.28528	3.28015	-.18344	.19087
-5	2	2	7.91793	8.21476	8.21418	-.09804	.13769
-4	2	2	10.30514	10.15006	10.13410	.56908	.13207
3	2	2	22.56608	23.13848	23.13848	-.00885	.23307
5	2	2	31.23927	30.86296	30.85514	.69496	.32952
6	2	2	13.01796	12.82025	12.82025	.00388	.19449
7	2	2	3.78306	3.57523	3.57461	-.06704	.40219
6	3	2	3.53417	3.17897	-3.17022	.23567	.39081
5	3	2	14.13457	14.04168	14.04167	-.01226	.19891
4	3	2	5.86850	6.72208	6.72207	-.01280	.18948
3	3	2	40.32115	40.08544	40.07647	.84771	.40307
-7	3	2	18.88821	19.14762	-19.14338	-.40283	.22002
-8	3	2	12.05849	12.03203	-12.02912	-.26425	.18780
-9	3	2	23.51201	23.80887	23.79919	.67883	.24429
-9	4	2	12.54381	12.50231	12.50213	.06786	.20282
-8	4	2	35.57022	35.16827	35.16116	.70707	.37838
-2	6	2	3.01776	1.22023	-1.20381	-.19948	.36163
-2	9	3	13.39795	13.67058	-13.66210	-.48141	.20866
-4	9	3	20.44633	20.61689	20.60893	.57261	.24976
-5	9	3	8.79433	8.94890	8.94778	-.14158	.19135
-6	9	3	9.41235	9.37239	-9.37153	-.12703	.19211
-8	8	3	12.29531	12.52235	12.51482	.43423	.17158
-6	8	3	43.05113	43.32038	-43.31511	-.67544	.45577
-5	8	3	8.16927	8.20215	8.18473	.53428	.17881
-4	8	3	9.90075	9.58243	-9.58234	-.04135	.17395
-3	8	3	26.50221	26.67781	-26.66828	-.71321	.29353
-2	8	3	16.16242	16.49553	16.48243	.65740	.20940
-1	8	3	10.96587	10.50761	10.50465	.24939	.18618
0	7	3	5.39481	5.31800	-5.30407	.38504	.17283
-1	7	3	15.25284	15.19371	-15.18971	-.34878	.19545
-2	7	3	5.89463	6.16745	-6.16655	-.10517	.17413
-3	7	3	8.49487	8.12441	8.11829	.31512	.15909
-4	7	3	11.77677	11.64792	-11.63542	-.53951	.16826
-5	7	3	7.55460	7.75106	-7.75100	.03244	.16330
-6	7	3	34.59133	34.89845	34.88895	.81446	.36416
-6	6	3	18.62773	19.20004	19.19933	.16530	.18588
-5	6	3	27.92275	27.49699	-27.48956	-.63892	.29171
-4	6	3	7.72148	7.20133	7.18398	.49965	.14579
-3	6	3	38.62689	39.10877	39.10795	.25366	.38810

-2	6	3	3.35774	1.83677	-1.76059	-.52349	.22900
-1	6	3	14.00410	14.13811	14.12678	.56589	.17598
0	5	3	5.63186	5.18812	-5.16687	-.46914	.12911
-2	5	3	67.67698	68.54163	68.53626	.85766	.66609
-3	5	3	9.72781	8.57771	-8.56115	-.53277	.13675
-4	5	3	21.09815	21.07486	-21.07264	-.30575	.22232
-4	4	3	13.88569	13.36271	-13.35176	-.54084	.13773
-3	4	3	13.23044	12.69904	12.68369	.62429	.15037
-2	4	3	21.49111	21.09589	-21.09589	-.01172	.21587
-1	4	3	82.08063	82.09461	-82.08855	-.99742	.78733
0	3	3	9.51230	9.69514	-9.69458	-.10444	.10476
-1	3	3	3.78657	3.27407	-3.18773	.74693	.11989
-2	3	3	41.26396	41.12011	-41.11436	-.68719	.39135
-2	2	3	8.23167	7.44471	7.43311	.41542	.08994
-1	2	3	19.48749	19.02773	-19.02709	.15569	.18797
0	1	3	70.86327	70.69614	70.69053	.89097	.56906
-8	0	4	20.92181	21.01479	21.01138	.37849	.22335
-7	0	4	4.41484	4.11380	4.11377	-.01478	.20166
-6	0	4	7.91545	8.04203	8.04011	.17587	.13847
-5	0	4	4.68118	4.46825	-4.46629	.13234	.14022
-4	0	4	22.27681	22.04288	-22.04281	-.05363	.19855
-3	0	4	11.34419	11.71708	11.71546	.19441	.11718
-2	0	4	26.66545	26.01631	26.01625	-.05614	.22127
-1	0	4	18.85294	18.07153	-18.07131	.08900	.15879
0	0	4	53.14060	53.98210	53.97746	.70789	.86206
7	1	4	3.94606	4.44889	4.44845	.06202	.27252
6	1	4	20.35697	20.31604	20.31596	.05629	.23661
5	1	4	38.55495	39.22521	39.22262	.45094	.39339
4	1	4	29.99730	30.62832	30.62632	.35057	.30513
3	1	4	7.25119	7.35365	-7.35296	-.10088	.12577
2	1	4	32.13824	31.60880	31.60875	.05754	.30844
1	1	4	9.14796	8.63129	8.63069	.10184	.11130
-3	1	4	51.69607	51.79589	51.79463	.36123	.49591
-4	1	4	29.67669	30.04141	30.03982	.30924	.29420
-5	1	4	29.13422	29.29901	-29.29900	.02347	.29640
-8	1	4	17.63155	17.84329	17.84166	.24128	.22635
-9	2	4	5.83951	5.91502	-5.91467	-.06488	.22810
-8	2	4	3.63928	3.49814	3.49808	-.02100	.27537
-7	2	4	37.77663	38.07981	38.07700	.46237	.39430
-6	2	4	8.36016	8.12245	8.12171	.10988	.14842
-5	2	4	4.48055	4.55083	4.55083	.00593	.15346
-4	2	4	56.75357	57.00029	56.99839	.46487	.55188
4	2	4	19.50856	19.67514	19.67473	.12573	.21679
5	2	4	11.42083	11.43612	11.43488	.16843	.17135
7	2	4	5.79026	5.69592	5.69571	.04991	.23657
6	3	4	24.37299	24.52533	24.52006	.50792	.28724
5	3	4	9.05231	9.06854	-9.06851	-.02410	.17931
4	3	4	7.71492	7.52321	7.52309	-.04274	.16069
3	3	4	13.27570	13.20880	13.20852	.08624	.16845
-7	3	4	33.22524	33.26411	33.26234	.34352	.34868
-8	3	4	23.58591	23.92692	23.92586	.22468	.26900
-9	3	4	7.28489	7.77208	7.77176	.06996	.20313

-9	4	4	6.74666	6.77216	-6.77160	-.08765	.20781
-8	4	4	4.04845	3.78718	-3.78562	.10871	.29372
5	4	4	3.81435	3.13358	-3.13163	.11057	.33032
-4	9	5	4.30079	4.66708	4.65313	.36059	.26817
-5	9	5	32.19996	32.14806	-32.13848	-.78480	.36081
-6	9	5	8.04910	7.76543	7.76441	.12527	.20348
-8	8	5	13.58316	13.73335	13.72453	.49211	.18094
-6	8	5	5.26894	5.51627	5.50655	-.32735	.22629
-5	8	5	12.42180	12.58836	12.57903	.48455	.18954
-4	8	5	8.30726	7.84101	7.84091	.04000	.17839
-2	8	5	6.54313	6.94634	6.93781	.34414	.20438
-1	8	5	14.93094	15.24674	-15.24476	-.24532	.21074
0	7	5	25.23162	25.70042	25.69250	.63773	.24771
-1	7	5	25.53614	25.52904	-25.51895	-.71791	.28387
-2	7	5	5.30799	5.35657	5.35556	.10387	.19180
-3	7	5	31.32551	31.22482	31.21463	.79738	.33264
-4	7	5	22.22747	22.20699	-22.19953	-.57578	.24976
-6	7	5	5.64865	5.69540	-5.68949	.25942	.19514
-6	6	5	11.93711	11.90464	-11.90352	-.16303	.15034
-5	6	5	12.47553	12.34676	-12.33517	-.53489	.17179
-4	6	5	29.90267	30.30439	30.29653	.69913	.31332
-3	6	5	23.86978	23.89266	-23.89135	-.24996	.25590
-2	6	5	23.96111	23.88326	-23.87368	-.67660	.25761
-1	6	5	20.46420	20.34970	20.34066	.60661	.22982
0	5	5	34.41753	34.47177	-34.46338	-.76037	.30499
-1	5	5	6.73799	6.95337	6.95287	.08291	.14393
-2	5	5	8.22951	7.94702	-7.93474	.44145	.13901
-3	5	5	30.65218	30.25503	-30.24546	-.76092	.31143
-4	5	5	20.28013	20.38026	20.37802	.30190	.21987
-4	4	5	33.38188	33.49683	-33.48759	-.78707	.28888
-3	4	5	33.80607	33.43900	33.43082	.73965	.33385
-2	4	5	7.17385	7.71146	7.71146	.01130	.12868
-1	4	5	16.00229	16.91793	16.91382	-.37285	.17708
0	3	5	4.11586	3.84191	3.84051	.10350	.12406
-1	3	5	34.17616	33.29046	33.28323	.69388	.33097
-2	3	5	39.24609	38.79909	-38.79180	-.75208	.37651
-2	2	5	66.08404	66.77194	66.76352	1.06050	.54816
-1	2	5	7.08267	7.76190	-7.76038	-.15370	.10966
0	1	5	12.83672	12.91846	12.90239	.63404	.11977
-7	0	6	24.56160	24.62300	24.61991	.39032	.24510
-6	0	6	4.17109	4.26069	4.25481	-.22383	.22020
-5	0	6	5.73591	5.52672	5.51909	.29030	.14013
-4	0	6	19.02673	18.66449	18.65798	.49296	.18028
-3	0	6	4.56226	4.72390	4.71450	-.29790	.12564
-2	0	6	36.63647	37.23575	37.23204	.52576	.30719
-1	0	6	19.33375	19.10685	19.10286	.39005	.16964
0	0	6	104.91225	104.38303	-104.37977	-.82543	1.72919
7	1	6	11.63161	11.83120	11.83090	-.08383	.19769
6	1	6	14.12335	14.00618	14.00225	.33197	.19627
5	1	6	8.14019	8.34677	-8.34670	-.03462	.16211
4	1	6	22.14406	21.91502	-21.91096	-.42173	.23919
3	1	6	42.44140	42.38323	42.37971	.54597	.41805

2	1	6	34.81034	35.18848	35.18614	.40569	.34083
1	1	6	18.67116	19.26291	19.26162	-.22337	.19243
-3	1	6	8.43065	8.41340	8.41272	.10696	.12822
-4	1	6	10.24840	11.06686	-11.06592	.14417	.14435
-5	1	6	5.58170	5.82079	5.81989	-.10214	.15784
-6	1	6	13.39496	13.29883	13.29234	.41537	.18031
-7	1	6	30.23506	30.20273	30.19908	.46921	.33065
-8	1	6	9.52787	9.40852	-9.40496	-.25857	.19533
-8	2	6	25.14300	25.04693	25.04388	.39093	.29094
-7	2	6	15.63573	15.60992	-15.60194	-.49924	.24808
-6	2	6	16.27825	15.95685	15.95391	.30598	.19708
-5	2	6	22.82685	22.45507	22.45099	.42782	.24354
-4	2	6	22.15096	21.93497	-21.92794	-.55504	.23121
3	2	6	43.54207	43.60497	43.60195	.51302	.43700
4	2	6	20.82369	20.89661	20.89460	.29045	.23408
5	2	6	5.14800	5.27556	5.27134	-.21113	.20113
6	2	6	21.33937	21.56390	21.56007	.40655	.25758
5	3	6	14.88471	14.58999	14.58454	.39866	.20603
4	3	6	21.12287	21.05767	21.05309	.43911	.24332
3	3	6	13.17730	13.11991	13.11904	-.15064	.17460
-7	3	6	2.95878	1.10151	1.09992	.05907	.45683
-8	3	6	4.42108	4.63208	4.62948	.15509	.24990
-9	4	6	16.97722	17.47490	17.46931	.44209	.23032
-4	8	6	3.48431	3.25863	3.25567	-.13879	.47659
-6	8	7	11.17626	11.20936	-11.19995	-.45930	.19237
-5	8	7	19.84412	20.22858	20.22603	.32097	.24529
-4	8	7	6.21497	6.51543	-6.51532	-.03807	.20587
-3	8	7	18.79119	18.79505	-18.78855	-.49446	.23685
-2	8	7	21.63192	21.51211	21.50753	.44427	.26287
-1	8	7	23.90191	24.39741	24.39623	.23936	.28620
0	7	7	7.47877	7.67328	7.67124	.17702	.16611
-1	7	7	14.70988	14.86907	14.86848	-.13300	.20314
-2	7	7	4.70503	5.13681	-5.13580	-.10193	.27616
-3	7	7	15.15875	15.36202	-15.36175	.09163	.20078
-4	7	7	4.84689	5.17404	-5.16480	-.30909	.20637
-5	7	7	14.03550	13.89785	13.89782	.03084	.19373
-6	7	7	32.76478	32.64904	32.64387	.58093	.35803
-6	6	7	3.89364	3.52111	3.51748	.15965	.19303
-5	6	7	12.00096	11.62083	-11.61419	-.39273	.17505
-3	6	7	3.63191	3.82350	3.81567	.24451	.22112
-2	6	7	21.60170	21.67090	-21.66915	-.27540	.24387
-1	6	7	8.91469	8.98162	8.97581	.32292	.16489
0	5	7	3.08417	2.75020	2.74148	-.21885	.26943
-1	5	7	12.27400	12.54500	-12.54474	-.08102	.16717
-2	5	7	26.31021	26.12131	26.11490	.57840	.27808
-3	5	7	10.71647	10.26791	-10.26444	-.26688	.15748
-4	5	7	19.17136	19.11803	-19.11574	-.29618	.21749
-4	4	7	4.98625	4.48698	-4.47894	-.26839	.13333
-3	4	7	12.29063	11.94719	11.94227	.34273	.15857
-2	4	7	8.21656	8.20400	8.20400	-.01071	.13973
-1	4	7	39.31346	39.06819	-39.06191	-.70028	.39462
0	3	7	2.60500	2.33793	2.33570	-.10205	.25015

-1	3	7	40.67205	40.90744	40.90500	.44640	.40071
-2	3	7	12.81940	12.54822	12.54215	-.39041	.15576
-6	2	7	3.09240	2.08581	2.07020	-.25472	.41213
-2	2	7	20.88510	21.01837	-21.01803	.11919	.18770
-1	2	7	28.80658	28.72173	28.72133	.15074	.28687
0	1	7	37.05797	36.69340	36.68899	.56842	.31272
-7	0	8	3.79421	3.39237	3.37922	.29846	.27241
-6	0	8	12.07434	12.11054	-12.09967	-.51293	.16193
-5	0	8	29.55105	29.48722	29.48295	.50170	.31729
-4	0	8	20.56913	20.22238	20.21930	.35271	.19886
-3	0	8	20.46438	20.15416	-20.14307	-.66854	.19304
-2	0	8	15.99898	15.75624	15.75130	.39433	.15689
-1	0	8	32.87538	33.10220	33.09765	.54874	.28400
0	0	8	56.22286	56.30535	56.30477	-.25554	.96571
6	1	8	15.11227	15.10712	15.10243	.37658	.20975
5	1	8	40.08334	40.07605	40.06829	.78852	.42523
4	1	8	6.83196	6.77578	6.76169	-.43668	.15675
3	1	8	4.70148	4.49323	4.48188	.31909	.16615
2	1	8	16.77067	16.49880	16.49145	.49250	.19046
1	1	8	33.51164	32.96747	-32.95763	-.80555	.33523
-3	1	8	40.23956	39.59954	39.59177	.78438	.40278
-4	1	8	47.75386	47.35602	47.35070	.70957	.48029
-5	1	8	19.29223	18.70628	-18.69149	-.74613	.22301
-6	1	8	20.48443	20.50067	20.49771	.34860	.24085
-8	2	8	3.30598	1.73180	1.70818	.28505	.51375
-7	2	8	4.57541	5.16300	5.15818	-.22303	.23855
-6	2	8	19.42941	19.26502	19.25926	.47088	.23008
-5	2	8	16.70489	16.89319	16.88848	.39878	.20089
-4	2	8	4.71104	4.30362	4.28603	-.38872	.16071
4	2	8	15.36040	15.31395	15.30623	.48598	.19798
5	2	8	14.95102	14.75332	-14.74474	-.50319	.20431
6	2	8	4.48897	4.20292	4.19425	.26969	.21175
5	3	8	9.75045	10.11518	10.11110	.28725	.19342
4	3	8	9.59647	9.33734	9.33262	.29689	.17847
3	3	8	22.27417	22.15779	-22.14827	-.64946	.25320
-7	3	8	28.37936	28.19066	28.18274	.66832	.31561
-8	3	8	21.06629	21.18059	21.17411	.52372	.25963
-8	4	8	12.50357	12.57209	-12.56158	-.51396	.19841
-1	7	9	4.45949	4.51467	-4.51356	-.10021	.26041
-2	7	9	4.79151	4.97195	4.97096	.09937	.23607
-3	7	9	9.93373	9.94275	9.94161	.15043	.18537
-6	7	9	18.27317	18.21745	-18.21438	-.33402	.23803
-6	6	9	10.91750	10.98066	-10.97956	-.15524	.16339
-5	6	9	7.04638	6.98533	6.98413	.12958	.18762
-4	6	9	7.22439	7.38737	7.38737	.00929	.18234
-3	6	9	18.75715	18.93962	-18.93813	-.23742	.22844
-2	6	9	3.30859	3.02249	-3.02247	.00912	.31354
0	5	9	7.99483	8.22856	-8.22840	-.05119	.15075
-1	5	9	3.63583	4.04424	4.04348	.07858	.24409
-2	5	9	26.37343	26.20313	-26.20161	-.28224	.35204
-3	5	9	5.37663	5.19708	-5.19704	-.01906	.17949
-4	5	9	16.31956	16.34541	16.34286	.28864	.20470

-4	4	9	4.71420	4.97758	-4.97751	-.02478	.16274
-3	4	9	2.90163	2.62753	2.62722	-.04027	.29559
-2	4	9	3.95748	4.15642	4.15640	.00998	.20030
0	3	9	5.40288	5.24942	5.24846	.10009	.14020
-2	2	9	21.27396	21.11141	21.11045	.20176	.19957
-1	2	9	6.59781	6.54325	-6.54161	-.14684	.14253
3	1	9	31.54052	31.65893	-31.65658	-.38592	.57308
0	1	9	17.89846	17.65313	-17.65170	-.22458	.17236
-6	0	10	3.84502	3.66777	-3.65105	-.34981	.27174
-5	0	10	24.66116	24.68848	24.68598	.35089	.24486
-4	0	10	38.76081	38.66083	38.65693	.54891	.41038
-3	0	10	4.40835	4.03014	-4.00439	-.45485	.15894
-2	0	10	20.58311	20.64624	20.63777	.59143	.22999
-1	0	10	32.83903	32.76710	32.76383	.46267	.29510
0	0	10	31.99270	31.81132	-31.79676	-.96216	.57358
5	1	10	6.47230	6.54320	-6.54307	.04111	.19859
4	1	10	16.04568	16.12369	-16.11428	-.55064	.20751
2	1	10	12.19171	12.12221	12.11295	.47379	.16952
-3	1	10	4.10347	3.99398	-3.98943	.19055	.19264
-4	1	10	7.43422	7.44930	7.44595	.22356	.16615
-5	1	10	21.49820	21.55757	21.55607	-.25365	.25164
-6	1	10	20.28842	20.08997	20.08451	.46828	.24854
-7	2	10	24.34876	24.19571	-24.18816	-.60453	.27522
-6	2	10	15.88738	15.68971	15.68550	.36364	.21256
-5	2	10	21.99161	21.77025	21.76482	.48591	.25418
-4	2	10	30.89569	30.66776	-30.65999	-.69051	.32994
3	2	10	23.93699	24.13970	24.13311	.56384	.27122
4	2	10	7.50875	7.74646	7.73859	.34908	.18319
5	2	10	5.47219	5.29255	-5.28198	-.33423	.18953
4	3	10	14.68681	14.74143	14.73340	.48663	.21246
3	3	10	6.09587	5.77614	-5.76888	-.28946	.19336
-4	3	10	30.84754	30.60659	30.60070	.60001	.40352
3	4	10	4.21074	3.82133	-3.81925	.12608	.41731
-5	6	11	4.01878	3.91175	3.90002	.30269	.31515
-4	6	11	15.74101	15.46929	-15.46287	-.44544	.21672
-3	5	11	22.72193	22.88259	22.88145	.22883	.27249
-2	6	11	19.90731	20.00042	19.99580	.42956	.24854
-1	6	11	11.07347	11.08483	-11.07875	-.36714	.19360
0	5	11	18.73799	18.57578	18.56912	.49761	.20550
-2	5	11	11.52357	11.81446	11.81274	-.20166	.18555
-3	5	11	18.78306	18.61178	18.60531	.49071	.23286
-4	5	11	13.56248	13.52782	-13.52493	-.27937	.19723
-4	4	11	17.66622	17.87921	17.87198	.50856	.19201
-3	4	11	18.48823	18.28378	-18.27803	-.45824	.22554
-2	4	11	9.12707	9.04552	-9.04551	-.00915	.17150
-1	4	11	16.36232	16.34584	-16.34535	.12682	.20948
0	3	11	6.49140	6.65559	-6.65487	-.09759	.14793
-1	3	11	23.64377	23.73442	-23.73097	-.40464	.26479
-2	3	11	8.62454	8.72798	8.71613	.45463	.16344
0	2	11	31.37003	31.26831	31.25970	.73387	.33375
1	0	11	3.16720	2.52174	2.49882	.33920	.37167
-2	0	12	7.35938	7.37669	7.37582	.11326	.14757

-1	0	12	9.61802	9.61117	9.60783	.25337	.14456
4	0	12	3.08957	1.87697	1.87415	.10277	.47894
4	1	12	10.44188	10.56417	10.56413	.02867	.19198
2	1	12	11.41791	11.58082	11.57885	.21346	.18047
1	1	12	7.91332	7.73975	-7.73620	-.23450	.16998
-3	1	12	26.82979	26.84305	26.83864	.48637	.30032
-4	1	12	24.84089	24.87915	24.87549	.42681	.28735
-5	1	12	11.68511	12.26827	-12.26564	-.25394	.19606
-5	2	12	7.02984	6.84303	6.84136	.15079	.19581
-4	2	12	17.25557	17.21382	17.21346	.11022	.22143
-3	4	13	11.25948	11.33227	-11.32291	-.46055	.19424
-1	4	13	29.05291	29.13412	29.12379	.77579	.40713
-1	3	13	24.05447	24.18534	-24.17883	-.56141	.28136
-2	3	13	3.85271	3.72897	3.69324	.51496	.26276
-4	2	13	3.29094	2.19290	2.19289	-.00826	.47282
-2	2	13	5.16699	4.60567	4.59757	-.27293	.18089
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0	1	13	24.65976	25.00697	-24.99780	-.67710	.24471
-2	0	14	13.01263	12.78330	12.78251	.14238	.20312
0	0	14	28.89619	28.72182	-28.72180	-.03356	.56916
1	1	14	23.19560	23.36872	23.36425	.45691	.27854
-9	0	0	30.24479	30.34802	30.33861	.75577	.24729
9	1	0	10.58171	10.72563	-10.72220	-.27117	.21422
-10	1	0	5.11890	5.48170	5.47626	-.24407	.29176
-11	2	0	5.24770	5.93635	-5.93222	-.22126	.30190
-10	2	0	16.50664	16.73157	16.72426	.49470	.21355
8	2	0	4.83797	5.78345	5.76247	.49216	.29560
8	3	0	9.42270	9.25029	-9.24680	-.25385	.22133
-10	3	0	4.28542	3.76155	3.76140	-.03403	.28907
-11	4	0	25.10028	25.03900	25.02281	.90016	.26374
6	4	0	14.09691	13.43051	13.43051	-.00476	.20161
7	4	0	10.78331	10.99526	10.98391	.49965	.21582
6	5	0	11.25732	10.70708	-10.70285	-.30104	.20988
-10	10	0	4.27914	3.85360	-3.84217	-.29663	.40462
-2	11	1	11.89034	11.77787	11.77625	.19490	.22070
-3	11	1	7.67513	7.42834	-7.42088	-.33299	.23728
-4	11	1	7.99074	7.95097	-7.94983	-.13425	.23152
-5	11	1	15.36811	15.33607	15.32996	.43280	.21782
-6	11	1	5.35766	5.35485	5.35480	-.02443	.28120
-9	11	1	18.23348	17.90496	-17.90183	-.33489	.23563
-10	10	1	12.78329	12.65998	12.65919	.14196	.19161
-8	10	1	7.78018	7.84693	-7.84381	-.22127	.23106
-6	10	1	11.47194	11.03261	11.03188	.12677	.19523
-2	10	1	21.71833	21.15815	21.15652	.26252	.23837
-9	9	1	3.54601	3.01010	-3.00985	.03859	.40226
-11	3	1	4.34653	3.69070	-3.68911	-.10812	.56449
-10	0	2	6.69918	6.21190	6.21138	.08035	.25204
-9	0	2	14.26976	15.03985	15.03400	.41958	.17971
9	1	2	8.69409	8.28094	8.28084	.04218	.28012
-10	1	2	7.12378	6.54637	6.54636	.01530	.24518
-11	2	2	7.32758	7.28640	7.28638	.01567	.30315
-10	2	2	24.89653	25.61062	25.60230	.65273	.25712

8	2	2	21.06266	21.34639	21.33633	.65531	.41026
9	2	2	5.20422	5.84296	-5.83869	-.22342	.37514
8	3	2	5.47918	4.82898	4.82876	.04508	.33909
7	3	2	3.57801	2.25364	-2.24526	-.19415	.52007
-10	3	2	6.68118	6.82383	-6.82062	-.20934	.23064
-10	4	2	3.85356	3.53332	-3.52758	-.20129	.37168
6	4	2	3.80789	4.34100	-4.33425	-.24202	.37310
7	4	2	15.21495	15.82984	15.81934	.57638	.27086
6	5	2	8.91281	8.40007	8.39959	.08998	.27118
5	5	2	25.96719	26.12814	26.12016	.64571	.31142
-11	5	2	5.07122	5.55480	-5.55388	-.10082	.36684
1	8	3	9.90062	10.87790	10.87046	.40210	.24477
2	8	3	9.53158	9.81582	-9.81336	-.21982	.25879
3	8	3	12.14149	12.78984	-12.78334	-.40777	.37863
4	7	3	10.91006	11.30271	-11.30270	-.01454	.36983
3	7	3	5.57298	5.71460	5.69771	.43908	.31076
4	6	3	15.46259	15.36882	-15.36219	-.45141	.35593
5	6	3	11.02672	11.05097	11.03977	.49723	.37500
6	5	3	10.47997	10.16542	10.16500	-.09196	.37395
5	5	3	5.49502	6.00139	-6.00134	-.02339	.32993
6	4	3	19.00080	18.21201	18.20587	.47309	.38181
8	3	3	4.21636	2.93793	-2.93214	.18446	.55364
7	3	3	21.24521	20.63354	-20.62889	-.43789	.40251
8	2	3	5.69872	5.36923	5.36290	.26047	.45088
8	1	3	4.59862	4.70986	-4.70222	-.26801	.46482
-10	0	3	20.07108	20.73779	20.72719	.66311	.42211
9	0	4	4.66890	3.25751	3.24631	.26988	.36594
8	1	4	9.94715	9.69903	9.69889	.05262	.20656
-9	1	4	6.55131	6.13039	6.12491	.25898	.24388
-10	1	4	7.43054	7.24602	-7.24601	-.01540	.25475
-10	2	4	6.37549	6.51251	-6.51246	.02509	.27107
8	2	4	5.40476	5.16478	5.16473	.02237	.28418
7	3	4	8.77688	8.84253	8.84053	.18810	.22502
-10	3	4	15.18442	15.01389	15.01252	.20275	.21370
-11	3	4	10.70927	10.41804	10.41767	.08841	.22907
-10	4	4	12.17488	12.07403	12.07246	.19434	.20995
6	4	4	5.98448	5.96524	5.96063	.23452	.26749
7	4	4	6.68018	6.42544	6.42513	.06273	.26104
5	5	4	4.84229	4.58858	-4.58827	.05272	.29447
-11	5	4	13.47035	13.34182	13.34139	.10765	.22271
4	7	4	24.07913	23.86004	23.85565	.45781	.32618
-3	11	5	16.30193	16.66113	-16.65158	-.56400	.28986
-4	11	5	5.20190	5.24786	-5.24621	-.13145	.37880
-5	11	5	23.11044	22.99262	22.98303	.66406	.31856
-6	11	5	4.20043	3.91196	-3.90298	-.26492	.60909
-7	11	5	4.99780	4.76620	-4.76618	-.01398	.31325
-8	11	5	5.08770	5.64093	5.63045	.34376	.33229
-9	10	5	6.99826	7.65912	7.65124	.34732	.25831
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-6	10	5	11.56238	11.58772	11.58117	.38970	.21147
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-9	0	6	7.68824	8.11581	-8.11139	-.26776	.21513
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9	1	6	16.33173	16.59341	16.58949	.36047	.28599
8	1	6	8.59405	9.04936	9.04471	.29025	.23176
-9	1	6	6.61039	7.03007	-7.02953	.08710	.25164
-10	1	6	5.79520	5.78051	5.77078	.33526	.29611
7	2	6	14.02703	14.30855	14.30541	.29940	.20624
8	2	6	9.14344	8.95567	8.95564	-.02020	.23823
7	3	6	6.60864	6.90486	6.90330	.14673	.26403
6	3	6	29.04620	28.55754	-28.55295	-.51185	.33639
-9	3	6	6.20112	6.34099	6.34046	-.08242	.24072
-10	3	6	4.39373	4.23828	4.23620	.13292	.31607
-11	4	6	9.00835	9.50936	-9.49929	-.43753	.24918
-10	4	6	8.99250	8.44779	8.44657	.14356	.21894
7	4	6	4.13776	3.94122	3.94092	-.04918	.65401
6	5	6	16.94040	16.85468	16.85007	.39436	.28486
5	5	6	4.54339	4.46412	4.46381	-.05273	.38231
-11	5	6	4.96020	5.31326	5.30909	.21042	.33145
2	7	6	18.20167	18.09190	18.08721	.41186	.27194
-8	10	7	6.16575	6.02505	6.02130	.21272	.27499
-7	10	7	12.58432	12.81520	-12.81246	-.26505	.22455
-4	10	7	11.21171	10.52006	-10.51593	-.29486	.26653
-3	10	7	6.46337	6.40583	6.40046	.26231	.26417
-2	10	7	21.65115	21.51911	-21.51765	-.25054	.30987
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4	6	7	4.05806	2.93822	2.92517	-.27659	.42247
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8	1	8	11.58127	11.58964	11.58535	.31521	.22506
7	1	8	18.52882	18.54756	-18.54012	-.52513	.27066
7	2	8	7.86772	7.93458	7.92800	.32294	.23616
7	3	8	12.75085	12.65430	12.64686	.43413	.27634
6	3	8	18.58614	17.73088	17.73073	-.07311	.27471
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6	4	8	20.26065	20.16469	20.15895	.48089	.29800
5	5	8	8.95690	8.74618	-8.73413	-.45900	.28574
4	6	8	12.25376	12.09670	12.08859	.44281	.27301
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-3	8	9	11.28806	11.12361	11.12053	.26206	.25157
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7	2	10	9.22373	9.51036	9.50431	.33933	.29405
6	3	10	14.17916	14.25214	-14.23981	-.59270	.27621
5	3	10	24.62209	24.66118	24.65726	.43971	.31340
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5	4	10	18.78028	18.41824	18.41590	.29334	.28746
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2	7	10	18.90082	18.96742	18.96220	.44470	.29671
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-5	9	11	19.93015	19.50482	19.49655	.56797	.30281
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-2	8	11	5.79364	6.12725	-6.12530	-.15425	.29705
-1	8	11	5.15645	5.38497	5.38037	.22249	.32087
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-4	7	11	12.42934	12.14837	12.14343	.34640	.20623
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6	1	12	11.22061	10.74071	10.73943	.16592	.26783
5	1	12	24.41734	23.89060	23.88461	.53495	.31042
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4	3	12	5.67731	6.24844	6.24786	.08524	.29218
3	3	12	4.21921	3.10174	-3.09602	-.18819	.51976
3	4	12	19.91346	19.66266	19.65789	.43278	.28783
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1	6	13	22.53243	23.12131	23.11251	.63777	.44630
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-7	5	13	4.06198	2.79643	-2.79490	-.09252	.54014
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5	1	14	8.49973	9.05213	-9.04778	-.28075	.24282
3	1	14	14.10530	14.41997	14.41887	.17794	.35631
2	1	14	11.65012	11.81058	11.81050	.04340	.20038
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