

Table 43A-2-001. $\text{K}_2\text{Mg}_2(\text{SO}_4)_3$, $\text{Rb}_2\text{Cd}_2(\text{SO}_4)_3$, $(\text{NH}_4)_2\text{Cd}_2(\text{SO}_4)_3$, $\text{Tl}_2\text{Cd}_2(\text{SO}_4)_3$, $\text{K}_2\text{Mn}_2(\text{SO}_4)_3$, $\text{Tl}_2\text{Mg}_2(\text{SO}_4)_3$, $(\text{NH}_4)_2\text{Mg}_2(\text{SO}_4)_3$, $\text{Tl}_2\text{Mn}_2(\text{SO}_4)_3$, $(\text{NH}_4)_2\text{Mn}_2(\text{SO}_4)_3$. Phase transition temperatures, determined by thermal expansion [88Kah]. Consult each subsection for Θ by other papers.

Crystal	Θ [K] This work F: first order S: second order		Θ [K] Other papers	Reported space group below Θ	Ferro- electricity
$\text{K}_2\text{Mg}_2(\text{SO}_4)_3$			63.8 54.9 51.0		
$(\text{NH}_4)_2\text{Cd}_2(\text{SO}_4)_3$	93	(F)	89, 92	P2_1	Yes
$\text{Rb}_2\text{Cd}_2(\text{SO}_4)_3$	129	(S)	129	P2_1	Yes
	97	(F)	103	P1	Yes
	64.5	(F)	68	$\text{P2}_1\text{2}_1\text{2}_1$	No
$\text{Tl}_2\text{Cd}_2(\text{SO}_4)_3$	127.5	(F)	128	P2_1	Yes
	121	(F)	120	P1	Yes
	107	(F)	—	P1	Yes
	95.5	(F)	92	$\text{P2}_1\text{2}_1\text{2}_1$	No
$(\text{NH}_4)_2\text{Mn}_2(\text{SO}_4)_3$	—				
$\text{K}_2\text{Mn}_2(\text{SO}_4)_3$	190.5	(F)	193	$\text{P2}_1\text{2}_1\text{2}_1$	No
	178	(F)		?	
$\text{Tl}_2\text{Mn}_2(\text{SO}_4)_3$	—				
$(\text{NH}_4)_2\text{Mg}_2(\text{SO}_4)_3$	241	(F)			?
	220	(F)	221		?
$\text{Tl}_2\text{Mg}_2(\text{SO}_4)_3$	230.8	(S)?			?
	227.8	(S)?		?	

Table 43A-2-002. Langbeinite family, $\text{M}_2^{1+}\text{M}_2^{2+}(\text{SO}_4)_3$. Unit cell parameter [\AA] for the cubic crystals [65Wyk]. (a) indicates that the crystal is orthorhombic at RT.

$\text{M}^{1+} \backslash \text{M}^{2+}$	Ni	Mg	Zn	Co	Fe	Mn	Cd	Ca
Cs								10.724
Tl				10.033	10.108	10.229	10.385	
Rb	9.930	10.005		10.026	10.098	10.218	10.382	10.570
NH_4	9.904	9.979		9.997	10.068	10.192	10.350	10.536
K	9.838	9.920	9.925	9.929	10.007	10.114	(a)	(a)

Table 43A-2-003. K₂Mg₂(SO₄)₃, K₂Ca₂(SO₄)₃, K₂Co₂(SO₄)₃, K₂Zn₂(SO₄)₃. Fractional atomic coordinates of K₂M₂²⁺(SO₄)₃ [86Spe].

Compound	Atom	x	y	z
K ₂ Mg ₂ (SO ₄) ₃ RT	K(1)	0.8166(1)	0.8166(1)	0.8166(1)
	K(2)	0.0482(1)	0.0482(1)	0.0482(1)
	Mg(1)	0.3353(2)	0.3353(2)	0.3353(2)
	Mg(2)	0.5992(2)	0.5992(2)	0.5992(2)
	S(1)	0.2161(1)	0.3757(1)	0.0179(1)
	O(1)	0.3042(4)	0.2731(2)	0.9579(5)
	O(2)	0.0755(4)	0.3291(4)	0.0092(4)
	O(3)	0.2344(4)	0.5012(4)	0.9407(5)
	O(4)	0.2533(4)	0.4024(5)	0.1582(4)
K ₂ Ca ₂ (SO ₄) ₃ <i>T</i> = 260 °C	K(1)	0.8158(1)	0.8158(1)	0.8158(1)
	K(2)	0.0520(1)	0.0520(1)	0.0520(1)
	Ca(1)	0.3301(1)	0.3301(1)	0.3301(1)
	Ca(2)	0.5885(1)	0.5885(1)	0.5885(1)
	S(1)	0.2281(1)	0.3746(1)	0.0095(1)
	O(1)	0.3159(3)	0.2805(3)	0.9584(4)
	O(2)	0.1008(3)	0.3224(4)	0.0088(4)
	O(3)	0.2334(5)	0.4844(4)	0.9273(4)
	O(4)	0.2652(4)	0.4156(4)	0.1352(3)
K ₂ Ca ₂ (SO ₄) ₃ RT	K(1)	0.8308(1)	0.8132(1)	0.8111(1)
	K(2)	0.0343(1)	0.0570(1)	0.0614(1)
	Ca(1)	0.3065(1)	0.3395(1)	0.3245(1)
	Ca(2)	0.5987(1)	0.5940(1)	0.5752(1)
	S(1)	0.2112(1)	0.3719(1)	0.0191(1)
	S(2)	0.3872(1)	0.0045(1)	0.2507(1)
	S(3)	0.0010(1)	0.2179(1)	0.3697(1)
	O(1)	0.3075(3)	0.2695(3)	0.0349(4)
	O(2)	0.0866(3)	0.3186(3)	0.9758(4)
	O(3)	0.2583(3)	0.4629(3)	0.9203(4)
	O(4)	0.1933(4)	0.4245(4)	0.1476(3)
	O(5)	0.3047(3)	0.9320(3)	0.3418(3)
	O(6)	0.3941(4)	0.1387(3)	0.2908(4)
	O(7)	0.5187(3)	0.9521(3)	0.2603(4)
	O(8)	0.3367(4)	0.9903(4)	0.1172(3)
	O(9)	0.0622(4)	0.1013(3)	0.3200(4)
	O(10)	0.9066(4)	0.1877(3)	0.4734(3)
	O(11)	0.9294(3)	0.2776(4)	0.2597(4)
	O(12)	0.0996(3)	0.3051(3)	0.4214(3)

(continued)

Table 43A-2-003 (continued)

Compound	Atom	x	y	z
K ₂ Co ₂ (SO ₄) ₃ RT	K(1)	0.8149(2)	0.8149(2)	0.8149(2)
	K(2)	0.0493(2)	0.0493(2)	0.0493(2)
	Co(1)	0.3352(1)	0.3352(1)	0.3352(1)
	Co(2)	0.5951(1)	0.5951(1)	0.5951(1)
	S(1)	0.2182(2)	0.3758(2)	0.0178(2)
	O(1)	0.3087(8)	0.2737(7)	0.9610(6)
	O(2)	0.0785(9)	0.3293(8)	0.0045(9)
	O(3)	0.2402(7)	0.4991(6)	0.9399(7)
	O(4)	0.2492(7)	0.4053(7)	0.1580(8)
K ₂ Zn ₂ (SO ₄) RT	K(1)	0.8143(2)	0.8143(2)	0.8143(2)
	K(2)	0.0493(2)	0.0493(2)	0.0493(2)
	Zn(1)	0.3346(1)	0.3346(1)	0.3346(1)
	Zn(2)	0.5934(1)	0.5934(1)	0.5934(1)
	S(1)	0.2187(2)	0.3759(2)	0.0179(2)
	O(1)	0.3017(8)	0.2744(8)	0.9610(8)
	O(2)	0.0796(7)	0.3282(7)	0.0037(8)
	O(3)	0.2405(9)	0.5024(8)	0.9410(9)
	O(4)	0.2523(8)	0.4058(9)	0.1601(7)

Table 43A-2-004. $\text{K}_2\text{Mg}_2(\text{SO}_4)_3$. C_p , S_m vs. T [89Rob]. S_m : molar entropy. C_p : molar heat capacity.

T [K]	C_p [J mol ⁻¹ K ⁻¹]	S_m [J mol ⁻¹ K ⁻¹]
5	0.22	0.07
10	1.69	0.56
15	5.46	1.87
20	11.55	4.21
25	19.99	7.65
30	30.33	12.18
35	42.15	17.73
40	54.96	24.19
45	68.14	31.42
50	80.47	39.25
60	100.2	55.76
70	116.3	72.44
80	131.5	88.97
90	145.7	105.3
100	158.9	121.3
110	171.2	137.1
120	182.7	152.5
130	193.7	167.5
140	204.1	182.3
150	213.8	196.7
160	223.0	210.8
170	231.8	224.6
180	240.4	238.1
190	248.5	251.3
200	256.3	264.2
210	263.7	276.9
220	270.8	289.3
230	277.6	301.5
240	284.1	313.5
250	290.2	325.2
260	296.2	336.7
270	302.2	348.0
280	308.3	359.1
290	314.3	370.0
300	320.0	380.8
310	325.5	391.4
320	330.7	401.8
330	335.8	412.0
340	340.6	422.1
350	345.1	432.1
360	349.3	441.8
370	353.4	451.5
273.15	304.2	351.5
298.15	319.0	378.8

Table 43A-2-005. K₂Mg₂(SO₄)₃. C_p vs. T [89Rob]. Series indicate that the data were obtained in different runs.

T [K]	C_p [J mol ⁻¹ K ⁻¹]	T [K]	C_p [J mol ⁻¹ K ⁻¹]	T [K]	C_p [J mol ⁻¹ K ⁻¹]
Series 1		Series 3		Series 6	
338.9	339.9	567.5	412.2	806.0	450.2
348.8	344.2	577.5	413.0	816.0	451.1
358.8	348.3	587.4	413.9	825.9	451.7
368.7	353.0	597.3	416.0	835.9	453.1
378.7	355.6	607.3	417.6	845.7	453.6
388.6	358.4	617.2	418.0	855.4	454.4
398.6	361.6	627.2	419.8	865.1	456.2
408.5	365.3	637.1	421.5	874.8	459.3
418.4	365.4	647.0	423.1	883.5	463.8
428.4	372.7	657.0	425.2		
438.3	376.2	666.9	427.8	Series 7	
448.3	379.5	676.8	431.9	913.6	461.2
458.3	383.8	686.8	436.6	923.3	465.2
468.2	387.2	695.7	439.4	933.0	462.8
478.1	390.3			941.7	464.7
488.0	393.7	Series 4			
497.0	397.4	666.9	425.0	Series 8	
		676.8	428.5	962.0	460.1
		686.8	428.7	971.7	460.6
Series 2		696.7	432.1	981.4	465.5
468.1	386.2	706.7	434.3	990.0	468.4
478.1	388.2	716.6	434.8		
488.0	390.5	726.5	435.9	Series 9	
498.0	393.5	736.5	436.8	835.9	455.9
507.9	395.7	745.4	437.3	845.7	454.5
517.8	398.2			855.4	453.2
527.8	401.0			865.1	455.4
537.7	403.8	Series 5		874.8	459.5
547.6	406.2	736.5	439.9	884.5	455.8
557.6	408.6	746.4	441.8	894.2	460.4
567.5	410.8	756.3	442.0	903.9	458.8
577.5	413.5	766.3	444.1	912.6	460.1
587.4	416.5	776.2	445.7		
596.3	419.4	786.2	447.4		
		796.1	448.0		
		806.0	449.9		
		815.0	451.6		

Table 43A-2-006. K₂Mg₂(SO₄)₃, Tl₂Cd₂(SO₄)₃, (NH₄)₂Cd₂(SO₄)₃, (NH₄)₂Mn₂(SO₄)₃. Refractive indices and electrooptic constants [69Vas].

Langbeinite	n_o ($\lambda = 589$ nm)	r_{41} ($\lambda = 546$ nm)	Langbeinite	n_o ($\lambda = 589$ nm)	r_{41} ($\lambda = 546$ nm)
K ₂ Mg ₂ (SO ₄) ₃	1.535	$0.40 \cdot 10^{-12}$ mV ⁻¹	(NH ₄) ₂ Cd ₂ (SO ₄) ₃	1.606	$0.70 \cdot 10^{-12}$ mV ⁻¹
(NH ₄) ₂ Mn ₂ (SO ₄) ₃	1.57	0.53	Tl ₂ Cd ₂ (SO ₄) ₃	1.730	0.37

Table 43A-2-007. $\text{K}_2\text{Mg}_2(\text{SO}_4)_3$, $(\text{NH}_4)_2\text{Cd}_2(\text{SO}_4)_3$, $\text{Tl}_2\text{Cd}_2(\text{SO}_4)_3$, $\text{Rb}_2\text{Cd}_2(\text{SO}_4)_3$, $\text{K}_2\text{Co}_2(\text{SO}_4)_3$. n vs. λ [87Bat].

λ [μm]	$\text{Tl}_2\text{Cd}_2(\text{SO}_4)_3$	$(\text{NH}_4)_2\text{Cd}_2(\text{SO}_4)_3$	$\text{Rb}_2\text{Cd}_2(\text{SO}_4)_3$	$\text{K}_2\text{Mg}_2(\text{SO}_4)_3$	$\text{K}_2\text{Co}_2(\text{SO}_4)_3$
0.405	1.7623	1.6230	1.6103		
0.436	1.7533	1.6184	1.6056	1.5425	1.6212
0.492	1.7420	1.6124	1.6001		
0.496	1.7411	1.6120			
0.546	1.7342	1.6082	1.5960	1.5359	
0.578	1.7308	1.6063	1.5942	1.5346	
0.589	1.7297	1.6057	1.5936	1.5342	
0.633	1.7260	1.6036	1.5917	1.5327	1.6073
1.13	1.707	1.590	1.578	1.523	1.598