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 $A_r = 24.305$ Magnesium (Mg)

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Magnesium (Mg)

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	0 to 923 K crystal 923 to 1366.104 K liquid above 1366.104 K ideal monatomic ga	Refer to the individual tables for details.
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Enthalpy Ke.	ference Te	Enthalpy Reference Temperature	- T, - 298.15 K		Standard State Pressure	H	p = 0.1 MPa
τÆ	ಟ	S -[G	-H^(T,)]/T	$H^{\bullet}-H^{\bullet}(T_{t})$	 VH•	Φ.	log Kr
088	0.	9.505	INFINITE 53.066	-4356	000	000	000
298.15	24.869	32.671	32.671	0.0	် ဝံ	် ဝံ	်ဝံ
98	24.897	32.825	32.671	0.046	oʻ	Ö	o o
38	27.171	46.113	35.578	5.268 5.268	ာ်ဝံ	ಶರ	ာ်ဝံ
88	28.184	51.156	37.764	8.035	ď	Ö	ď
388	30.507	59.569 63.241	42,200 44,336	13.895	် ဝ	ಶರರ	ಶರರ
923.000	32,238	64.050	44.818	17.751	CRYSTAL	1 2 2 2	CINON NO
1000	34,309	75.983	47.113	28.870	ó	0.	ó
2000	34309	79.253 82.238 84.984	49.888 52.462 54.859	32.301	ರರಂ	ರರಂ	ರರಂ
1366.104	34.309	86.686 180.286	\$6.358 \$6.359	41.431	. g.	ÇY GAGT	8
1400 1500	20.786	180.796	59.365 67.509	170.003	oo	00	ಠಠ
922	20.786	183.571	74.721	174.160	o o	ರರ	ರರ
1800 1800 2000	20.787 20.787 20.789	186.020 187.144 188.210	86.954 92.198 96.972	178.317 180.396 182.475	ರರರ	ರರರ	ರರರ
2200	20.791	189.224	101,341	184.554	ಠಠ	ರರ	ರರ
2400 2400 2400	20.802 20.812 20.812	191.116	109.067	188.713 190.794 192.875	ರ ರ ೦	ddd	ddc
2600	20.846	193.669	118.684	194.959	် ဝင	i de	်ဝင
7800 7800 7800 7800 7800 7800 7800 7800	20.956	195.216	124 096	201227	600	100	
3100	21.085	197.352	131.084	205.430	ာ် ဝ	ರ ರ	ာ် ဝံ
3300	21.172	198.022 198.675	133.165	207.543	o o	ರರ	ರರ
3200	21.3% 21.537	199.312 199.934	137.019	211.799	oo	ರರ	ರರ
3600 3700	21.697	200.543	140.514	216.107	66	ರರ	ರರ
3800	22.22	201.726	143.705	222.703	ರರ	ರರ	ರರ
4100	22.832	203.431	148.013	227.215	် ဝ	i ဝ	င် ဝ
4300	23.128	203.985	149.339	229.513	o	o d	o o
4400 4500	24.152	205.076	151.848	234,203	00	ಠಠ	
4600	24.537	206.149	154.185	239.034	6.0	ರಂ	0 0
84 6 0 0 0 0 0 0 0	25.37 25.820 28.20	207.211	156.373	244.023	iddd	idda	iddd
200	26.773	208.790	159.410	251.841	်ဝင်	ido	် ဝံင
\$300 \$400	28.329	209.839	161.293	257.296	600	00	
2200	28.878	210.888	163 077	262.962	င် ဇ	ರ ೧	ರ (
\$600 \$700 \$800	30.020	211.940	164.773	265.878 268.851 771 887	တ်ဝင	óóc	o o c
2800	31.213	212.9%	166.390	274 973	်ဝဝ	i ರ ರ	600
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Mg₁(cr)

CURRENT. September 1983

CRYSTAL
Magnesium (Mg)

 $A_r = 24.3057$ Magnesium (Mg)

 $\Delta_t H^{\circ}(298.15 \text{ K}) = 0 \text{ kJ} \cdot \text{mol}^{-1}$ $\Delta_{tus} H^{\circ}(923 \text{ K}) = 8.477 \pm 0.418 \text{ kJ} \cdot \text{mol}^{-1}$ $\Delta_t H^{\circ}(0 \text{ K}) = 0 \text{ kJ} \cdot \text{mol}^{-1}$ $S^{\circ}(298.15 \text{ K}) = 32.671 \pm 0.10 \text{ J·K}^{-1} \cdot \text{mol}^{-1}$ Pearson Notation, hP2 fea = 923 ± 1 K

Enthalpy of Formation Zero by definition

teat Capacity and Entropy

polynomials over selected overlapping temperature intervals. The temperature region of 1.14 K is described by the equation. $C_p^* = 0.3 \times 10^{-4}$ $T + 0.8 \times 10^{-6} T^3$ cal. K⁻¹ mol⁻¹. The $S^*(298.15 \text{ K})$ value calculated from the polynomials agrees with those of Hultgren *et al.*, Gurvich The adopted heat capacities are derived from heat capacity¹² and enthalpy data³ by fitting the experimental data with orthogonal et al., and CODATA to within 0.01 J·K -1-mol

on an incorrect relative atomic mass. Furnkawa et al. stated that the heat capacity values should be multiplied by 24,32/24.22 = 1.0041 to consistent with the atomic mass of 1954. The current value for the relative atomic mass of magnesium requires a multiplier of 24.305/24.22 - 1 0035. Our analysis of this smoothed data (with orthogonal polynomials) suggests that the reported values at 18 K and 200 K Craig et al. I measured the heat capacity in the region 12-320 K. Only smoothed values at 10 K intervals were reported and these were based

The heat capacity study of Saba et al.² consisted of 37 determinations covering the range 293-548 K. Again only smoothed values at 10 K intervals were given. Using the current relative atomic mass for magnesium, this data should be multiplied by 24.305/24.32 = 0.99938. The enthalpy data of McDonald, 6 values in the range 404 914 K, also need to be corrected by a factor of 24.305/24.312 = 0.99971. In the region 300-320 K, the corrected results of Craig et al. I lie 0.1% higher and Saba et al. 20.2% lower than the adopted values. The maximum deviation in the enthalpy data of McDonald' in comparison with our derived enthalpy values is 0 1%, except for the point at 403 K which is 0.7%. At may be in error.

fitting procedure. The heat capacity results of Mannchen and Bornkessel, 12-300 K, were presented only graphically and support the results of Craig et. al. The quantitative agreement is uncertain since it is not clear if the authors were aware of the correction required for the data of Craig et. al. Clusius and Vaughn8 made experimental heat capacity determinations in the range 11-228 K. These data scatter about the the melting point, the entropies of JANAF, Hultgren et. al., and Gurvich et al. 3 are 15.308, 15.34, and 15.313 cal·K⁻¹-mol⁻¹, respectively. Other studies⁴⁻¹³ are considered for comparison with and confirmation of the adopted values, but they are not included in the polynomial selected values within ±2-4%

Phase Data

According to Pearson, ¹⁵ magnesium has the hcp(A3) prototype structure. In the alkaline earth metal series, only α-Be has a similar structure.

Refer to the liquid table for details

Sublimation Data

The enthalpy of sublimation of magnesium is the enthalpy of formation of the gas. It is chosen to be that adopted by CODATA8 based on numerous experimental studies which are discussed in the ideal gas table. 14

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¹⁴JANAF Thermochemical Tables: Mg(g), 9-30-83.

¹⁵W. B. Pearson, "A Handbook of Lattice Spacings and Structures of Metals and Alloys," Pergamon Press, London, 1958, (1967).

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			L·K-'mol-'			KJ·mol-1		
	7.K	ប	S* -[G	$-[G^{\bullet}-H^{\bullet}(T_{\bullet})]T$	$H^{\bullet}-H^{\bullet}(T_{\epsilon})$	$\Delta_i H^{\bullet}$	Φ_{iG}	log K,
	0	oʻ	oʻ	INFINITE	-4.998	o	ó	oʻ
	8	15.762	9.505	\$3.066	-4.356	o'	Ö	o
_	200	22.724	23.143	34.888	-2349	o' (o' (oʻ (
	250	24.018	28.364	33.076	-1.178	o'	Ö	oʻ
	298.15	24.869	32.671	32.671	ö	o'	ó	ö
	300	24.897	32.825	32.671	0,046	Ö	Ö	0
	350	25.568	36.715	32.977	1308	ó	ó	ď
	\$	26.144	40.167	33.664	2.601	ó	Ö	ö
	450	26.668	43.277	34.562	3.922	ó	ó	ö
	800	171.72	46.113	35.578	5.268	o	Ó	o
_	9	28.184	51.156	37.764	8.035	ó	Ö	oʻ
	902	29.279	55.581	39.999	10.907	o	ó	ö
_	800	30.507	59.569	42.200	13.895	ö	o	ö
_	8	31.895	63.241	44.336	17.014	oʻ	o	oʻ
_	923.000	32.238	64.050	44.818	- 17.71	CRYSTAL	T <> LIQUID	an
_	000	33.460	66.681	46.401	20,280	-8.590	0.712	-0.037
	0011	35.214	69.951	48.394	23.712	-8.589	1.64	-0.078
_	1200	37.164	73.097	50.322	27,330	-8.402	2.567	-0.112
-	1300	39,316	76.155	52.192	31.152	-8.011	3.467	-0.139
_	1400	41.673	79.154	54.011	35,200	-134.803	7.4%	-0.280
	1500	44.238	82.115	55.786	39.493	-132.588	17.584	-0.612
_	0091	47.013	85.058	57.524	44.054	-130.106	27.516	-0.898
_	1700	20.000	87.996	59.230	48.903	-127.336	37.284	-1.146
	008	53.199	90.944	60.910	54.061	-124256	46.881	-1.360
_	<u>8</u>	56.613	93.911	62.568	59.550	-120.846	26.297	-1548
_	2000	60.241	96.906	64.210	65,391	-117084	65.524	-1.711
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Magnesium (Mg)

PREVIOUS September 1962

CURRENT September 1983

LIQUID

 $S^{(298.15 \text{ K})} = [34.464] \text{ J·K}^{-1} \cdot \text{mol}^{-1}$

 $\Delta_t H^{\circ}(298.15 \text{ K}) = [4.790] \text{ kJ·mol}^{-1}$ $\Delta_{tas} H^{\circ}(923 \text{ K}) = 8.477 \pm 0.418 \text{ kJ·mol}^{-1}$

4, = 24.305 Magnesium (Mg)

Mg₁(I)

The hear of formation is calculated from that of the crystal by addition of the heat of fusion, $\Delta_{tas}H^{*}(923 \text{ K})$, and the enthalpy differences, $H^{*}(923;298.15)$, for the crystal and the liquid. This value is dependent on the arbitrary choice of the liquid phase heat capacity values for temperatures less than 923 K. **Enthalpy of Formation**

Heat Capacity and Entropy

The enthalpy measurements of McDonald, five observations in the temperature range 954-1263 K, are used to derive a constant liquid phase heat capacity of 8.2 cal·K⁻¹·mol⁻¹. This constant value is adopted for the entire liquid region and the region between 298.15 and 923 K. Gurvich et al. 13 have adopted the same value. Kubaschewski² quoted an unpublished study by Reinartz which gave C,(1) = 8.1 ± 0.3 cal·K⁻¹·mol⁻¹. The enthalpies measured by McDonald deviate by -0.2 to +0.3% from the adopted values. The enthalpy study of Awbery and Griffiths' extended only 100 K into the liquid region (3 data points) and cannot be used to reliably predict the heat capacity; in addition, their reported enthalpies are 15% lower than the adopted values.

Fusion Data

The melting point is adopted as 923 ± 1 K. Charlesworth* and Geschneider* both adopted this value after critically reviewing the available data in 1964 and 1970, respectively. The primary studies are by Chadwick* (923 K), Jones* (920.5 K), and Haughton and Payne* ±05K)]

The adopted heat of melting, $\Delta_{tot}H^0 = 2.026$ kcal·mol⁻¹, is derived from the enthalpy study of McDonald.¹ Although McDonaldl reports an uncertainty of ± 50 cal·mol⁻¹, we feel a value of ± 100 cal·mol⁻¹ reflects better the scatter of the various studies. Kubaschewski² quoted values for $\Delta_{tot}H^0$ of 2.030 ± 0.080 and 1.830 ± 0.090 kcal·mol⁻¹ from the unpublished work of Reinartz and a thesis of Wittig, respectively. The calorimetric studies of Ginsberg and Wrigge⁹ and the DTA study of Chiotte et al. 10 led to values of 90.6 ± 2 cal/g (2.202 ± 0.049 kcal-mol⁻¹) and 1.970 ± 0.016 kcal-mol⁻¹, respectively. An enthalpy study of Succirctull and McDonald¹¹ led to a heat of melting of 2.14 kcal-mol⁻¹; however, this value was thought to be in error due to a container reaction. These reported values all support the adopted value. The enthalpy study of Awbery and Griffiths³ led to a muccircluch lower value of 1.130 kcal·mol⁻¹

Vaporization Data

 T_b is calculated as the temperature for which $\Delta_{vw}G^o = 0$ for the liquid vaporizing to the ideal monatomic gas. T_b -corresponds to a fugacity of one bar. The heat of vaporization is calculated from the heat of formation of the liquid and the gas at T_b . Vaporization studies are discussed in the Mg(g) single phase table.12

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 ¹JANAF Thermochemical Tables: Mg(g), 3–31–82.

¹L. V. Gurvich et al., "Thermodynamic Properties of Individual Substances," Volume III, Nauka, Moscow, (1981).

Standard State Pressure = $p^* = 0.1$ MPa -0.706 -0.945 -1.154 -1.339 -0.746 -0.740 -0.615 -0.513 -0.428 -0.238 -0.146 -0.072 -0.118 log Kr 0000 -> LIOUID FUGACITY - 1 bar 2.731 1.955 1.107 0.211 3.167 21.636 30.741 39.766 48.717 57.596 Ş. CRYSTAL -124.705 -123.352 -122.000 -120.648 -119.296 1.790 1.808 5.261 5.684 5.48 ki-moi 0 000 $H^{\bullet}-H^{\bullet}(T_{r})$ 37.803 41.234 44.665 48.096 51.527 54.958 10.356 13.787 17.218 20.649 21.438 24.080 27.511 30.941 36.640 Enthalpy Reference Temperature = T, = 298.15 K S -[G-H'(T,)]/T 34.465 34.882 35.810 37.010 41.197 44.050 46.805 49.425 50.008 51.903 55.454 58.544 60.525 59.865 J.K-'mol-' 89.894 58.457 63.746 63.27 72.368 73.234 75.983 79.253 84.238 86.686 34.309 34.309 34.309 34.309 34.309 34.309 34.309 26666 4,309 4,309 24,439 ů 250 250 28.15 888888 Ĕ

Magnesium (Mg)

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Mg (cr,I)

Standard State Pressure = p^* = 0.1 MPa

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Magnesium (Mg)

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- T 298.15 K	"H'(T,)]/T	INFINITE 53.066	34.888 33.076	32.671	32.671 32.977	33.664	34.562 35.578	37.764	39.999 47.700	44.336	44.818 44.818	47.113	49.888	54.859	56.358	57.103 59.211	61.19	63.079	66.558	68.175
Temperature		0. 9.505	23 143 28 364	32.671	32.825 36.715	40.167	45277	51 156	59 569	63.241	64.050	75.983	79.253	84.984	86.686	87.527 89.894	92.108	82.188	98.004	99.764
Reference To	ប	0. 15.762	22.724 24.018	24.869	24.897 25.568	26.144	27.171	28.184	30.507	31.895	32.238 34.309	34,309	34,309	34309	34,309	34309 34309	34,309	4 4 8 8	34309	34,309
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A_r = 24.305 Magnesium (Mg)

CRYSTAL-LIQUID

Refer to the individual tables for details.

0 to 923 K crystal we 923 K liquid

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Magnesium (Mg)

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CURRENT September 1983 (1 bar)

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PREVIOUS: September 1962 (1 atm)

Magnesium (Mg)	Enthalpy Reference Temperature = $T_{\rm c}$	TK C_r^* $S^* - [G^* - H^*(T_r)]I$	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	5 20.786 148.648	20.786 148.776 1	20.786 154.756 20.786 157.204	20.786 159.394		20.786 171.612	20.786 175.783	20.786 179.255 1	20.786 180.796	20.786 183.571	1700 20 786 184.832 10 1800 20.787 186.020 10	20.787 187.144	20.791 189.224 20.795 190.192	2300 20.802 191.116 F 2400 20.812 192.002 F 2500 20.826 192.851 F	20.846 193.669 20.874 194.456	2800 20,909 195,216 17 2900 20,956 195,950 17	21.085 197.352	3300 21.275 198.675 1 3400 21.396 199.312 1 3500 21.537 199.934 1	21.697 200.543 1 21.879 201.140	3800 22.083 201.726 1 3900 22.310 202.303 1 4000 22.559 202.871 1	22.832 203.431 1 23.128 203.985 1	4300 23.447 204.533 1 4400 23.789 205.076 1 4500 24.152 205.614 1	24.537 206.149 24.944 206.681	25.372 207.211 25.820 207.739 26.287 208.265	26.773 208.790 1 27.276 209.315	209.839	29.442 211.414	5700 30,020 211,940 1 5800 30,610 212,467 1 5900 31,213 212,996 1
	- 298.15 K	$H^{\bullet}(T_t)$	INFINITE –6.197 167.128 –4.119 150.549 –2.040			49.463 2.117 50.190 3.156		52.727 6.274 54.455 8.353 56.124 10.431	57.712 12.510 59.213 14.589					67.691 29 139 168.677 31.218			73.796 43.694 73.796 43.694 74.541 45.776		176.632 52.034 177.285 54.127 177.920 56.776		79.716 62.566 80.283 64.699 80.836 66.845		82.918 75.603 82.918 75.603 83.409 77.846		84.742 85.279 87.103 85.725 89.500		87.018 96.923 87.436 99.483 87.847 102.088		189.048 110.196 189.437 113.002		190,580 121,751 190,953 124,782 191 177 873
	Standard State Pressure	l _	145.901 147.337 147.409	_		146,616	_	145.339 144.546 143.636	142.596		-	000					ဝံဝဲဝ				ಪರಕ				ರರರ						
		δ,Ο,Φ	145.901 135.694 123.968	112.522	112.307	100.780 95.067	89.387	78.122 66.981 55.961	45.062 35.000	25.283 15.690	6.209 CITY = 1 bar		o .	00	ೆ ೦	ರ ರ	ರರರ	i ဝဝ	o o o	ರರ	ರರರ	o o	ರರರ	ರರ	ರರರ	ರರ:	ಶರರ	oʻoʻ	000	ာ် ဝံ	joo
Mg ₁ (g)	p* = 0.1 MPa	log Kr	- 70.879 - 32.377 - 34.880	-19.713	-19.554	-13.161 -11.035	-9.338	-6.801 -4.998 -1654	-2.615	-1.201	- 1	o c	0	ರ ರ ೧	ರರ	೦೦	ರರದ	ರರ	ರರಂ	ೆರೆ	ಂದರ	ರ ರ	o o o	o o	ಶರರ	o o	ರರರ	00	ರರ	ံ ဝံ	ತರದ

Magnesium (Mg)

IP(Mg, g) = $61671.02 \pm 0.10 \text{ cm}^{-1}$ S*(298.15 K) = $148.648 \pm 0.020 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$

IDEAL GAS

 $\Delta_t H^{\circ}(0 \text{ K}) = 145.90 \pm 0.80$ $\Delta_t H^{\circ}(298.15 \text{ K}) = 147.10 \pm 0.80$

-						
	Weights 8,	-	-	٣	2	6
	Electronic Levels and Quantum Weights State	00.0	21850.405	21870.464	21911.178	35051.264
	Electronic State	\s^	2	³P ₁	³ P ₂	<u>.</u> آي

Enthalpy of Formation

The adopted enthalpy of formation values for Mg(g), $\Delta_1 H^2(298.15 \text{ K}) = 147.10 \pm 0.80 \text{ kJ mol}^{-1}$, is that recommended by CODA value was calculated, according to CODATA, from the vapor pressure measurements by Priselkov (673–773 K), Gilbreath (495 McCreary and Thom (716–800 K), Pahlman and Smith (650–930 K), and others cited in Hultgren *et al.* ⁶

Heat Capacity and Entropy

and cutting off the summation in the partition function* has no effect on the thermodynamic functions to 4000 K. This is a result o energy of all levels other than the ground state and the levels listed above; the next excited state is approximately 41197 cm⁻¹ above the The information on electronic energy levels and quantum weights, given by Martin and Zulubas,7 is incomplete because many the predicted levels have not been observed. Our calculations indicate that any reasonable method of fitting in these missing levels (f state. Although we list only a few levels, all levels listed by Martin and Zulubas⁷ and estimated levels (for n < 60) are conside Extension of these calculations above 6000 K may require consideration of the additional states and use of different fill and cutoff pr calculation. The reported uncertainty in \$°(298.15 K) is due to uncertainties in the relative atomic mass and the fundamental

J-K-1-mol-1 because this table uses a reference pressure of 1 bar, whereas CODATA recommendations are based on 1 atm. Sec-The thermal functions at 298.15 K differ from the CODATA recommendations for two reasons. First, the entropy differs changes, ~0.002 J·K⁻¹-mol⁻¹, arise due to the use of slightly different values for the fundamental constants.

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Mg;(g)

Magnesium, Ion (Mg*)

(Mg ⁺)	
<u>o</u>	
nesium,	

IDEAL GAS

Magr

 $P(Mg^*, g) = 121267.61 \pm 0.05 \text{ cm}^{-1}$ S*(298 15 K) = 154.410 ± 0.02 J·K⁻¹·mol⁻¹

M_r = 24.30445 Magnesium, Ion (Mg⁺)

-lom

1001. V.f 70'0 = 014'4-01			Δ _t H*(298.15 K) = [891.047] kJ·moi ⁻
	Electronic State	Electronic Levels and Quantum Weights State &, cm -1 8,	reights 8.
	2S ₁₂	0.00	2
	² P ₃₂	35760.88	14
Formation g, 0 K) is calculated from $\Delta_f H^*(Mg, g, 0 K)^1$ using the spectroscopic value of IP(Mg) = 61671.02 \pm 0.10 an Martin and Zolubas. The ionization limit is converted from cm ⁻¹ to kJ mol ⁻¹ using the factor, 1 cm ⁻¹ and from the 1072 CONATA 6400	s, g, 0 K) using the	e spectroscopic value of I	Formation g, 0 K) is calculated from $\Delta_f H^*(Mg, g, 0 K)^1$ using the spectroscopic value of IP(Mg) = 61671.02 \pm 0.10 cm ⁻¹ (737.749 \pm 0.00) in Martin and Zolubas. The ionization limit is converted from cm ⁻¹ to k1 mol ⁻¹ using the factor, 1 cm ⁻¹ = 0.01196266 k1·mol ⁻¹ from the factor, 1 cm ⁻¹ = 0.01196266 k1·mol ⁻¹

Enthalpy of F

which is derived from the 1973 CODATA fundamental constants.3 Rosenstock et al.4 and Levin and Lias3 have summanzed additional ionization and appearance potential data Δ_tH°(Mg⁺, g, 0 kJ·mol⁻¹) from N

 $\Delta H^*(Mg^*g, 298.15 \text{ K})$ is calculated from $\Delta_H^*(Mg, g, 0 \text{ K})$ by using IP(Mg) with JANAF ¹ enthalpies, $H^*(0 \text{ K}) + H^*(298.15 \text{ K})$, for Mg(g), Mg*(g), and e ⁻(ref). $\Delta_H^*(Mg \to Mg^* + e^-, 298.15 \text{ K})$ differs from a room temperature threshold energy due to inclusion of these enthalpies and to threshold effects discussed by Rosenstock et al. $^4\Delta_H^{*}(298.15 \text{ K})$ should be changed by $-6.197 \text{ kJ} \cdot \text{mol}^{-1}$ if it is to be used in the ion convention that excludes the enthalpy of the electron

Heat Capacity and Entropy

off the summation in the partition function has no effect on the thermodynamic functions to 6000 K. This is a result of the high energy of all levels other than the ground state and the first two excited states, the next excited state is 69804.95 cm -1 above the ground state. Since inclusion of these higher excited states has no effect on the thermodynamic functions (to 6000 K), we list only the ground state and the first two excited states. The reported uncertainty in S°(298.15 K) is due to uncertainties in the relative ionic mass and the fundamental constants. Extension of these calculations above 6000 K may require consideration of the excited states and use of different fill and cutoff procedures. The information on electronic energy levels and quantum weights, given by Martin and Zolubas, 2 is incomplete because many theoretically predicted levels have not been observed. Our calculations indicate that any reasonable method of filling in these missing levels and cutting

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 R. D. Levin and S. G. Lias, U. S. Nat. Bur. Stand., NSRDS-NR-71, (1982).

Total Color	-	Enthalpy F	Reference To	Enthalpy Reference Temperature	- T 298.15	×	Standard State Pressure	"	n° = 0.1 MPa
T/K Cf. F(T) F − (G* − H(T)) I/T H − H(T) AH* 100 0.78 1.0 NFINUTE −6.197 83.560 250 1.78 1.56.11 155.21 −2.149 83.560 250 1.78 1.54.10 15.471 1.001 891.078 250 1.78 1.54.29 15.471 1.001 891.078 350 2.0.78 15.45.29 15.45.24 1.001 891.078 450 2.0.78 15.45.29 15.441 0.038 891.078 891.078 450 2.0.78 15.45.24 1.001 891.078 891.08 891.08 450 2.0.78 16.24.74 1.64.96 4.196 894.170 891.08 60 2.0.78 16.29.74 1.64.96 1.44.19 891.08 891.08 10 2.0.78 1.0.79 1.0.79 891.08 1.14.19 891.08 10 2.0.78 1.0.79 1.0.79 891.08 1.0.79 <th>-</th> <th>:</th> <th></th> <th>J·K-'mol-'</th> <th></th> <th></th> <th>kf.mol-'</th> <th></th> <th></th>	-	:		J·K-'mol-'			kf.mol-'		
100 0.0. 10. 1786 11.0. 155.21 -1.1001 220. 11.		7.K	ប		-H'(T,)]/T	$H^{\bullet}-H^{\bullet}(T_{i})$	$\Delta_{\rm r}H^{ullet}$	Φ_{G}	log K,
298.15 20.786 154.410 154.410 0. 891.078 300 20.786 154.253 154.411 0.038 891.078 400 20.786 154.253 151.75 151.75 151.75 891.078 400 20.786 162.517 155.253 3.115 893.684 500 20.786 162.457 155.253 3.115 893.684 600 20.786 162.457 162.497 18.40 62.416 893.64 700 20.786 17.245 16.497 11.250 893.64 19.256 1100 20.786 18.244 16.497 14.289 893.64 17.243 18.546 893.64 17.243 18.546 893.64 17.243 18.546 893.64 17.243 18.546 893.64 17.243 18.546 893.64 17.243 18.546 893.64 17.243 18.546 893.64 17.243 18.546 893.64 18.546 18.546 18.546 18.546 18.546		° 28 28 28	0. 20.786 20.786 20.786	0. 131.703 146.111 150.749	INFINITE 172.891 156.312 154.753	-6.197 -4.119 -2.040 -1.001	883.650		
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20786 160.519 155.225 21178 871.534 20.786 162.967 153.953 3.156 893.438 20.786 165.297 153.953 3.156 894.138 20.786 165.297 153.953 3.156 894.138 20.786 172.151 160.218 89.34.38 20.786 173.251 164.37 10.211 899.033 20.786 173.256 16.394 16.667 892.200 20.786 181.346 16.437 10.211 899.033 20.786 181.344 166.773 18.18.48 893.201 20.786 181.246 16.499 10.239 17.131 20.786 18.234 165.733 18.14 17.242 17.242 20.786 18.249 10.783 17.242 17.242 17.242 20.786 18.249 17.242 17.242 17.242 17.242 20.786 18.244 17.142 17.242 17.242 17.242		98	20.786	154539	154.411	0.038	891.078	848.231	-147.690
500 20.786 16.2567 15.956 41.55 893.438 500 20.786 165.157 156.766 41.56 893.43 893.438 600 20.786 163.471 165.766 41.58 893.438 893.438 800 20.786 17.4251 16.473 11.2310 893.64 893.43 1100 20.786 17.3451 16.473 11.2310 893.64 19.256 1100 20.786 18.5348 16.673 11.2310 893.64 19.280 19.280 1100 20.786 18.5348 16.673 11.2310 893.64 19.280		8	20.786	160.519	155.226	2.117	892.680	833.704	-108.871
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1100	٠-	<u>88</u>	20.786	17.375	163.475	12.510	899.053	756 784	-43 923
1200	-	001	20.786	181.546	166.394	16,667	892.080	726.633	-34.505
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20.800 208.895 189.619 79.030 821.048 20.804 209.396 100.084 81.110 821.748 20.815 20.0895 81.110 821.748 82.778 20.815 210.354 190.984 83.272 821.737 821.741 20.820 211.030 191.847 89.458 820.141 820.848 20.830 211.738 192.265 91.520 821.516 821.516 20.850 211.173 192.265 93.644 83.256 821.556 20.850 211.173 192.265 93.644 83.138 84.210 20.870 213.473 193.473 95.690 831.888 84.210 20.871 213.424 194.241 101.935 840.346 841.767 39.347 20.920 214.238 194.861 104.047 841.767 39.347 20.921 215.226 195.647 110.047 841.488 31.767 20.922 214.248 194.261 <td< th=""><th></th><th>4000 4000 4000</th><th>20.794</th><th>207.855</th><th>188.657 189.144</th><th>74.871</th><th>818.083 819.998</th><th>514.156 506.184 498.163</th><th>-7.068 -6.780 -6.780</th></td<>		4000 4000 4000	20.794	207.855	188.657 189.144	74.871	818.083 819.998	514.156 506.184 498.163	-7.068 -6.780 -6.780
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310.786 312.021 313.219 314.383 315.516

-45.545 -9.203 -9.206 -

188.914 181.337 173.823 169.682 171.702 171.725 175.751 177.779 181.843 181.84

141.340 141.296 141.248 141.197

285.400 287.702 289.877 291.938 293.897

271.282 274.543 277.552 280.346 282.954

CURRENT: March 1964 (1 bar)

Magnesium Nitride (MgN)

PREVIOUS March 1964 (1 atm)

M.= 38.3117 Magnesium N	
IDEAL GAS	
nesium Nitride (MaN)	

Mg₁N₁(g)

Standard State Pressure = $p^* = 0.1$ MPa

NFINITE -146.063 -70.399 -55.292

289.040 279.629 266.548 264.634 229.266 249.278 250.256 240.886 221.551 221.551 221.551 221.551 221.551 221.551 221.551 221.551 221.553 221.55

0. 210.1583 210.211 219.159 224.833 225.037 225.037 234.636 234.636 234.636 234.636 234.636 234.636 234.636 234.636 234.636 236.737 23

M,= 38.3117 Magnesium Nitride (MgN)	$\Delta_t H^9(0 \text{ K}) = [289.04 \pm 25.1] \text{ kJ·mol}^{-1}$ Enthalpy Reference Temperature = $T_t = 298.15 \text{ K}$ Sta $(298.15 \text{ K}) = [288.70 \pm 25.1] \text{ kJ·mol}^{-1}$ KJ·mol $^{-1}$ KJ·mol
M;=38.3117 P	$\Delta_t H^{\circ}(0 \text{ K}) = [289.04 \pm 25.1] \text{ kJ·mol}^{-1}$ $\Delta_t H^{\circ}(298.15 \text{ K}) = [288.70 \pm 25.1] \text{ kJ·mol}^{-1}$
IDEAL GAS	
Magnesium Nitride (MgN)	S°(298.15 K) = [224.835] J·K ⁻¹ ·mol ⁻¹

'-mol ⁻¹				$\Delta_t H^{-}(0 \text{ K}) = [289.04]$ $\Delta_t H^{-}(298.15 \text{ K}) = [288.70]$	[288.70
,	Electronic L State	Electronic Level and Quantum Weight State £., cm ⁻¹ 8,	Weight 8.		
	[1]	0	E		
$\omega_c = [700] \text{ cm}^{-1}$ $B_c = [0.5542] \text{ cm}^{-1}$	7	$\omega_{e} x_{e} = [4.8] \text{ cm}^{-1}$ $\alpha_{e} = [0.0052] \text{ cm}^{-1}$	7_	σ = 1 r _e = [1.85] Å	

Enthalpy of Formation

AHP(NgN, g. 298.15 K) was estimated from bond strengths using MgO and comparison with analogous pairs of compounds such as, PN and PO, and also the bond strengths of C-N and C-O in organic compounds.

Heat Capacity and Entropy

The r_e value for MgN was estimated from MgO by comparison with similar pairs PO and PN, SiO and SiN, and AlO and AlN. Using Guggenbeimer. 1 to for MgO was found to lie between the single and multiple bonding cases. Magnesium nitride was assumed to be similar to MgO and ω_e , 700 cm⁻¹ was obtained. It was assumed that the $x_e\mu^{1/2}$ value for MgN was equal to that for MgO thus giving $\omega_e x_e = 4.8$ cm⁻¹. B_e was calculated from r_e . The α_e value was calculated from B_e , ω_e and $\omega_e x_e$

Reference

'Guggenheimer's Relation, Proc. Phys. Soc. (London) 58, 456 (1946).

Magnesium Oxide (MgO)

PREVIOUS December 1965

CURRENT December 1974

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H*(0 K)
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CRYSTAL

Δ_tH*(0 K) = -597.060 ± 0.63 kJ·mol Δ_tH*(298.15 K) = -601.241 ± 0.63 kJ·mol $\Delta_{\text{fus}}H^{\circ} = [77.822 \pm 16.7] \text{ kJ-mo}$ $S^{\circ}(298.15 \text{ K}) = 26.924 \pm 0.08 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$

Enthalpy of Formation

T_{lus} = 3105 ± 30 K

Δ_tH° is based on oxygen bomb calorimetry of Holley and Huber¹ and HCl-solution calorimetry of Shomate and Huffman. 2 The report values of -143.70 ± 0.12^1 and -143.84 ± 0.05^2 kcal-mol⁻¹ become Δ_H (298.15 K) = -143.61 ± 0.12 and -143.78 ± 0.08 kcal-mo when adjusted to 1969 atomic weights. We adopt the median value of -143.70 ± 0.15 kcal-mol⁻¹.

in MgO rather than from high surface area and small particle size. Since the excess energy is eliminated at 7>~1000°C, it is unlikely the NBS² adopted -143.81 kcal mol-1 for macrocrystalline periclase, based on the data of Shomate and Huffman² converted to 1961 atom weights. Parker preferred the data of Shornate and Huffman because of the inference that their sample corresponded more closely to t macrocrystalline standard state. New 🕰 Hata suggest that excess energy of up to ~1.1 kcal-mol⁻¹ arises mainly from disorder (defec

Other data for AH" were reviewed by Parker.³ New measurements exist for $\Delta_{ab}H^{\circ}$ of MgO⁴ and Mg, ³ but we have not attempted to deri this effect would bias the combustion data of Holley and Huber. Δ_tH° because of difference in the final states of the solutions.

Heat Capacity and Entropy

of Cpot and enthalpies (373-1173 K) of fused MgO measured in a Bunsen ice calorimeter by Victor & Douglas 7 S(298.15 K) is obtain om C, based on a negligible extrapolation to absolute zero.

Maximum deviatons of the C, data from the adopted curve are ±1.7% near 15 K, ±1 0% near 20 K, ±0.4% near 40 K, and ~0.2% below 270 K is based on data (3-270 K) for single crystals measured by Barron et al. 6 Values above 270 K are from a constrained

higher temperatures. Gmelin later reported smoothed C°, values (2–320 K) derived from data for MgO sintered at high temperature. The almost 7% at 90 K. Gmelin's values gave 5°(298.15 K) = 6.50, i.e., higher by ~0.06 cal·K⁻¹·mol⁻¹. Larger positive deviations in C_g exi at all temperatures (20-301 K) for the non standard state MgO used by Giauque and Archibald. Ther sample was prepared from hydroxia values are in good agreement with the adopted curve except from 70 to 140 K, where deviations are all positive and reach a maximum

in vacuo at ~350°C and was not annealed at high temperature. The microcrystalline product presumably was disordered, leading to exces C_p and S°(298 15 K) = 6.66 cal·K⁻¹·mol⁻¹. Limited data of Parks and Kelley¹⁰ for fused MgO tend to confirm the adopted curve.

Deviations of the enthalpy data from the adopted curve are ±0 15% (373–1173 K).⁷ –0.3 ± 0.3% (402–1799 K).¹¹ +0.8 ± 0.9% (370 1591 K).²² and –2.8 to +1.0% (equation for 1200–2500 K).¹³ Microcalorimetric C_p² data (305–455 K).¹⁴ agree with the adopted curve at the mid temperature but have a temperature derivative which is too small.

Fusion Data

Refer to the liquid table for details.

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Enthalpy Ref	erence Te	Enthalpy Reference Temperature = $T_r = 298.15$ $1 \cdot K^{-1} \text{mol}^{-1}$	• T, = 298.15	×	Standard State Pressure	e Pressure = 1	$= p^{\bullet} = 0.1 \text{ MPa}$
7.K	ະ	S -[C	-[G*-H*(T,)]T	H*-H*(T,)	\	Φ.G•	log Kr
0 00 00	7.802	0. 2.548	INFINITE 52.212 30.037	-5.159 -4966 -3.188	-597.060 -598.962	- 597 060	INFINITE 307.976
ν.	37.106		26.924	0	-601.241	-568.945	75.15
	37.244	27.154 38.678	26.925 28.460	0.069	-601.245	-568.745 -557.898	99.027
	45.544	48.523	31.513	8.505	-601.046	-547.078	57.153
	47.430	57.006 64.420	35.072 38.746	13.160	-600.738	-536.312	46.690 39.221
88 8	49.740 50.539	70.9% 76.902	42.374 45.888	22.898	-600 156	-514,930	33.621
	51.208	82.262	49.262	33.001	-608.462	-492.952	25.749
8 <u>8</u> 8	51.794 52.325	91.70	52.488 55.569	38.151	-608.496	-481.399	22.860
	52.810	95.908	58.512	48.615	-608.461	-458.291	18.414
	53.693	103.528	64.017	53.918 59.266	-735.804	-443.575	16.550
	54.107	107.007	965.99	64.656	-732.877	-402.026	13.125
	54 808 54 898	113.426	69.07.1 1.440	70.087	-731.371	-381.394	11.719
200	55.278	116.404	75.737	81.067	-728.277	-340.395	9.358
	100.00	119.249	15.942	86.613	-726.690	-320.021	8.358
	56.379	124.587	80.125	92.197	-725.079	727 927 -	7.455
	56.738	127.101	82.114	103.472	-721.781	-259368	5.890
7500 7500	57.094 57.445	129 <i>5</i> 24 131.862	84.039 85.905	109.164	-720.097	-239.300	5.208
	161.18	134,121	87.716	120.653	-716.659	-199.372	4.005
2800	58.145	136,309	89.476	126.450	-714.906	-179.509	3.473
	58.836	140.489	92.851	138.148	-711.338	-139 979	2521
	77.17	142.489	94.473	144.049	-709.524	-120.308	2.095
9	50.573	0.4.450	50.05	149.987	-707.689	=	1.697
	27.60	144532	20.131	150.284	CRYSTAL	•	
	60.201	46.331	97.595	155.955	-705.840	-81.147	1.325
3400	60.541	149.980	0.52001	167.995	-702.095	-42.218	0.649
	61.214	153 460	103.412	180 171	000	156.	100
	61.551	155.142	104.788	186.309	-696.387	15.763	-0.223
	61.888	156.787	106.135	192.481	-694.467	34.985	-0 481
	62.561	159.979	108.748	204.926	-692.542 -690 613	54.156 73.277	-0.725 -0.957

CURRENT: December 1974

M_r = 40.3044 Magnesium Oxide (MgO)

Mg101(1)

 $\Delta_t H^{\circ}(298.15 \text{ K}) = [-532.609] \text{ kJ} \cdot \text{mol}^{-1}$ Δ_{fus}H° = [77.822 ± 16.7] kJ·mol⁻¹

 $S^{\circ}(298.15 \text{ K}) = [48.366] \text{ J·K}^{-1} \cdot \text{mol}^{-1}$

Enthalpy of Formation

The = 3105 ± 30 K

 $\Delta_H^{*}(\text{MgO}, 1, 298.15 \text{ K})$ is calculated from that of the crystal by adding $\Delta_{\text{Lu}}H^{*}$ and the difference in enthalpy, $H^{*}(3105 \text{ K}) + H^{*}(298.15 \text{ K})$ between the crystal and liquid

 C_p^s is assumed to be 16 cal- K^{-1} mol⁻¹ except below the glass transition (2100 K) where $C_p^s(1)$ is taken equal to $C_p^s(cr)$. Enthalpy data yield $C_p^s \ge 19$ cal- K^{-1} mol⁻¹ for liquid BeO¹ but there may be a positive bias due to volatilization. $S^s(298.15 \text{ K})$ is calculated in a manner analogous to that used for the enthalpy of formation. Heat Capacity and Entropy

Fusion Data

Documented values for T_{im} (in °C, IPTS-48) include 2800 ± 20, 2827 ± 20³ and 2852.⁴⁵ We adopt the median value³ which becomes 2832°C = 3105 K on IPTS-68

Calorimetric data for $\Delta_{tus}H^o$ are not available. Kelley^a derived an apparent $\Delta_{tus}H^o = 18.5$ kcal·mol⁻¹ at $T_{tus} = 2915$ K from liquidus data CaO, Al₂O₃, Cr₂O₃, PuO₂ and UO₂. These values are so uncertain that we assume $\Delta_{tas}H^{o} = 18.6$ kcal-mol⁻¹ based on $\Delta_{tas} = 6$ cal k^{-1} mol⁻¹. $\Delta_{tas}H^{o} = 20$ kcal-mol⁻¹ was measured calorimetrically for BeO, but the crystal is hexagonal or tetragonal rather than cubic as in the case for the MgO-ZrO₂ binary. The old and new. 43 data for MgO-ZrO₂ imply gross non-ideality which makes the system unsutable for obtaining the enthalpy of fusion. Apparent Athe values ranging from 8 to 30 kcal mol are obtained from more suitable binary systems 9 to involving

Vaporization Data

Vaporization rates based on weight loss at $T_{\rm fea}$ were repoted by Noguchi² for MgO and six other refractory oxides. Vaporization of MgO near 2000 K has been studied by Langmuir-Aorsion. Langmuir-weight-loss, ^{12,13} Knudsen-mass-spectrometric, ¹⁴ Knudsen-effusion i⁵ and transpiration ^{15,16} methods. Vaporization near 2000 K is primarily to the elements, ¹⁴ Mg(g) and presumably O(g) and O₂(g), rather than to MgO(g). Quantitative interpretation of the vaporization species is uncertain. The adopted tables predict that MgO(g) is insignificant near 2000 K but should become one of the significant components of the vapor near $T_{\rm fea}$.

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L. Alman, J. Phys. Chem. 67, 366 (1963). A. Alexander, J. S. Ogden, and A. Levy, J. Chem. Phys. 39, 3057 (1963).

| Standard State Pressure = p = 0.1 MPa kJ·mol ⁻¹ | <u>۲</u> | | 88.773 | 197 | 103 | | 835 | 835
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| Φ'C. | | | -506.707 | - 506.546 | -489.167 | -480.5 | -463.4 | -454.955 | 775.754 | -426.9 | -417.5 | -386.284 | | | -312.503 | | GLASS <> LIQUID | | | | -187.062
 | | | 01 –
 | ٧ | -83.5 | -49.708
 | | | 33.615 |
 | | 115.395 | | 262 | 195.912
 | |
| $\Delta_i H^{ullet}$ | | | -532.609 | -532.614 | -532.414 | -532.106 | -531.525 | -531,331 | 370 053 | -539.864 | -539.829 | -665.724 | -664246 | -661.206 | -659.645 | -656.447 | <u> </u> | 736 | -651.037 | -648.350
-645.674 | -643.012
 | -637.725 | -635.103
-632.496 | -629.904
 | CRYSTAL | -624.772 | -622.235
-619.719
 | -617226 | -614.757 | -609.901
-607.518 | -605.167
 | -600.572 | -598.332 | -593.978 | -591.869 | -587.796
 | |
| $H^{\bullet}-H^{\bullet}T$ | | | 0 | 0.069 | 8.505 | 13.160 | 22.898 | 27.913 | 10.00 | 43.358 | 48.615 | 59.266 | 64.656 | 75.558 | 81.067 | 92.197 | 92.197 | 108.80 | 105.585 | 118.974 | 125.669
 | 139.057 | 145.752
152.446 | 159.140
 | 159.475 | 165.835 | 179.224
185.918
 | 192.612 | 199.307
206.001 | 212.6% 219.3% | 226.084
 | 239.473 | 246.168
252.862 | 259.556 | 266.251
272.945 | 279.640
 | |
| -[G*-H*(T.)]T | | | 48,366 | 48.367 | 52.956 | 56.514 | 63.816 | 67.330 | 73.03 | 77.012 | 79.955 | 85.459 | 88.039 | 90.513
92.891 | 95.180 | 99.512 | 99.512 | 575 101 | 103.599 | 105.571 | 109.379
 | 113.011 | 114.764 | 118.152
 | 118.235 | 119.790 | 122.959
 | 125.994 | 128.906 | 130,319 | 133.062
 | 135 701 | 136.984 | 139.482 | 140.698 | 143.067
 | |
| S[C. | | | 48,366 | 48.5%
5.5% | 996.69 | 78.448 | 92.439 | 98.344 | 103.703 | 113.143 | 117.351 | 124.970 | 128.449 | 134.868 | 137.846 | 143 415 | 143 415 | 146 530 | 149.505 | 155.087 | 157.713
 | 162.674 | 165.023
167.293 | 169.488
 | 169.595 | 171.613 | 175.671
 | 179.498 | 181.332 | 184.856
186.551 | 188.204
 | 191.393 | 192.932 | 195.907 | 197.347 | 200 137
 | |
| ٷ | \$ | | 37.106 | 37.244 | 45.544 | 47.430 | 49.740 | 50.539 | 207.15 | 52.325 | 52.810 | 53.693
53.693 | 54.107 | 5. 50
5. 89
8. 89 | 55.278 | 56.019 | 56.019 | | 46.99 | 8 8
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8 | 88 | 3 5 | 202 | 8 | 2005 | 0091 | 808 | 1800 | 2100 | 2100 001 | 2200 | 230 | 7
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80.8 | 4900
2005
 | |

PREVIOUS: December 1965

Refer to the individual tables for details.

0 to 3105 K crystal above 3105 K liquid

7.K C 100 100 200 2	rence Te	mperature	Enthalpy Reference Temperature = $T_r = 298.15 \text{ K}$ 1·K ⁻¹ mol ⁻¹		Standard State Pressure	•	p* = 0.1 MPa
	ະ	S -[C	-[G-H'(T,)]T	$H^{\bullet}-H^{\bullet}(T_{i})$	 ₽.H.4	₽ C•	log Kr
	9.0		INFINITE	-5.159	-597.060	-597 060	INFINITE
	26.681	14.0%	30.037	-3188	-600.646	-579.488	151347
	37.106	26.924	26.924	oʻ	-601.241	-568.945	719.66
88	37.244 40.561	27.154	26.925	0.069	-601.245	-568.745	720.62
	45.544	48.523	31.513	8.505	-601.046	-547.078	57.153
	47.430	57.006	35.072	13.160	-600.738	-536.312	46.690
	49.740	70.996	42.374	22.898	-600.156	-514,930	33.621
88	50,539	76.902	45.888	27.913	- 599.962	-504.289	29.268
	51.794	87.171	52.488	38.151	-608.496	-481.399	22.860
	52.325	91.701	55.569	43.358	-608 495	-469.844	20.452
84	53.262	99.839	61.325	53.918	-735.804	-443.575	16.550
	53 693	103.528	64.017	59.266	-734.355	-422.752	14.722
	\$4.107 \$4.509	107.007	66.5% 69.071	70.05 70.087	-732877	-402,026	13.125
	54.898	113.426	71.449	75.558	-729.837	-360.851	10.472
2000	55.278 55.651	116.404	75.737 75.942	81.067 86.613	-728.277	-340.395	9.358 3.58
	56.019	121.973	78.070	92.197	-725.079	-299.7ZT	7.455
	56.379	124.587	80.125	97.816	-723.442	-279.510	6.636
750	57.094	129.524	84,039	109.164	-720.097	-239.300	5208
	57.445	131.862	85.905	114.891	-718.389	-219,301	4.582
7800 7300	57.797	134.121	87.716	120.653	-716.659	- 199.372	3.473
	58.491	138.430	61.187	132.282	-713.132	-159.712	2.979
	58.836	140.489	92.851	138.148	-711.338	-139.979	2521
	59.516	144.436	96.053	149.987	-707.689	-100.697	1.697
25	59.523	144.532	96.131	150284	CRYSTAL	TAL <> LIQUID	dub
	80.74	565.61	90.131	778.107		IKANSIIION	
	86.94 44.24	173.673	100.594	241.161	-624.772	-83.338	5.0.
3,00	66.944	175.671	102.773	247.855	-622.235	-49 708	0.764
	66.944	179.498	106.930	261.244	-617.226	-16.174	0.235
3700	66.944	181.332	916'801	267.938	-614.757	0.487	-0.007
	86.94 4.44 4.44	184.856	112.721	281.327	-609.901	33.615	-0.450
	66.944	186.551	114.546	288.022	-607.518	50.084	-0.654
4100	66.944	188.204	116,322	294.716	-605.167	66.495	-0.847
	66.94	191393	119.740	308.105	-600.572	99.149	-1.204
	66.944	192.932	121.386	314.799	-598.332	115.395	-1.370
	86.94	194.436	122.993	321.494	-596.133	131.591	-1527
	86.54 44.54	195.907	124.562	328.188	-593.978	147.739	1.678
	66 944	198.756	127.595	341.577	-589.807	179.897	-1.958
\$000 \$000	86.94 66.944	200.137	130.496	354,966	-587.796	195.912	-2088

CURRENT December 1974 (1 bar)

Continued on page 1569

IDEAL GAS	
Magnesium Oxide (MgO)	

Mg,0,(g)

M_r = 40.3044 Magnesium Oxide (MgO)

C67708 15 K)	- 072 216	2008 15K1 = 213 260 + 3.1 1.K-1.mol-1	<u> </u>				HV	Δ _t H*(0 K)	$\Delta_t H^{\circ}(0 \text{ K}) = 58.59 \pm 25.1 \text{ kJ·mol}^{-1}$ $\Delta_t H^{\circ}(798.15 \text{ K}) = 58.16 \pm 25.1 \text{ kJ·mol}^{-1}$	Enthalpy R
(x) (21:0(2) c	- (07-01-		5				i			7,8
			Electr	Electronic States and Molecular Constants (σ=1	d Molecular (Constants (0=	÷		1	° <u>e</u>
	State	€, cm ^{−1}	8	es cm-1	ω _c κ _e cm ^{−1}	Be, cm-I	a, cm-	rs A	Source	285
	X'X	0.0	-	785.1	5.18	0.5743	0.0050	1.749	_	298.15
	Ë	[2300]	9	[664.4]	[3.9]	[0.5050]	[0.0040]	[1.864]	2-7	300
	Α'Π	3503.3	7	664.4	3.9	0.5050	0.0040	1.864	-	350
	Ķ	[14000]	3	[824.1]	[4.8]	[0.5822]	[0.0045]	[1.737]	5-2 -2	8.8
	B'Z*	20004.	-	824.1	4.76	0.5822	0.0045	1.737	-	800
	ņ	[28000]	3	[632.5]	[5.3]	[0.501]	[0.0048]	[1.872	3	009
	М	[29000]	9	[632.5]	[5.3]	[0.501]	[0.0048]	[1.872]	3 :	88
	D'Δ	29775.	7	632.5	5.3	0.5014	0.0048	1.872	641	38
	M	[30000]	3	[632.5]	[5.3]	[0.501]	[0.0048]	[1.872]	.	000
	C'\\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	30004	_	632.4	5.2	0.5008	0.0048	1.873	-	811
	ΕİΣ	37684.	_	[632.4]	[52]	0.5273	[0.0048]	1.825	10.14	1200
	Ë	[37000]	9	[017]	[5]	[0.5615]	[0.005]	[1.768]	5	969
	F'Π	37879.	7	710	[2.]	0.5615	[0.005]	1.768	10.3.4	1500
	щ	[39000]	9	[26]	[5.]	[0.5249]	[0.005]	[1.83]	3	0091
	ЦS	39868.	7	790	[5.]	0.5249	[0.005]	1.83	1034	829

Enthalpy of Formation

We adopt $D_0^* = 80 \pm 6 \text{ kcal·mol}^{-1}$ and $\Delta_f H^0$ (298.15 K) = 13.9 $\pm 6 \text{ kcal mol}^{-1}$ based on equilibria analyzed below. Greatest weight is to mass-spectrometric data¹¹ for reactions A and B. We give "<" or ">" for ΔH^0 and D^0_0 values which may have a systematic bias JANAF differences in A.H"(298.15 K) for WO₃-WO₂ may be biased by as much as -3.5 kcal·mol⁻¹, leading to a positive bias in D₀ reaction B. Mass spectrait and transpiration data11 yield an upper limit to D6, we neglect Mg(OH), and MgOH which probably are imp in. Dection and Jenkins 15 concluded that hydroxides were negligible in their H2-Oz-N3 flames; we doubt this conclusion and presum reaction Dyields an upper limit to D. Our adopted value is comparable with those of Richards et al. 71 and Brewer & Rosenblatt, 16 consi the difference in functions for MgO.

kcal-mol⁻¹, ¹⁹ furthermore, we cannot firm this D₀ from the published information. D₀° = 83 kcal-mol⁻¹ was derived²⁰ by fitting an electr aivity potential function to X.2. This state is predicted $^{14.11}$ to dissociate to excited state 0^4 D₁ at 45.4 kcal·mol⁻¹. Theoretical calculat support this prediction. Linear Birge-Sponer extrapolation yields a very low estimate for D_6 , just as it does for the alkali halides, ¹¹ unles by new evidence for importance of hydroxides (CaO, g). Inadequate allowance for hydroxides may bias a recent flame result of $D_0^a = 88$ Cuntecture, in turknows of Do are dismissed for reasons cited in critical reviews. 17 18 11 Schoffeld's criticism 7 of flame studies is supfails to dissociate to 01(D) as predicted.

				Data	SS.	∆,H°(298.15	K) kcal·mol-1	Δ _t H [*] (298	.15 K) D ₆
Source	Method	Reaction*	7/K	Points	Points cal·K ⁻¹ ·mol ⁻¹	2nd law	2nd law 3rd law kcal·mol ⁻¹	kcal	mol-1
=	Knudsen mass spec.	V	2026-2274 8	8	-13 ± 5	12 ± 11	39.5 ± 3	15.3	78.6 ± 3
	Knudsen mass spec.	æ	2106-2225	9	-18 + 8	23 ± 16	63.1 ± 3	>10.1	<83.8 ± 5
2	Knudsen mass spec.	Ų	1950	_	1	I	>148.7	>5.0	<86.9 ± 5
23	Transpiration	U	1780-2010	7	-8 ± 3	132 ± 5	$>148.3 \pm 2$	<u>7</u>	$< 89.2 \pm 2$
<u>.</u>	Transpiration	U	2033-2175	∞	-52 ± 32	53 ± 68	162.8 ± 8	19.1	74.7 ± 8
2	Flame spec.	Ω	1570-2370	4	-9±1	-11 ± 2	>5.7 ± 6	>-1.6	<95.4 ± 6
	*Reactions:	A) Mg(g) B) Mg(g)	A) Mg(g) + O ₂ (g) = MgO(g) + O(g) B) Mg(g) + WO ₃ (g) = MgO(g) + WO ₂ (g)	(3)O3)	O(g) + WO ₂ (g)	C) MgO(c D) Mg(g)	C) MgO(cr) = MgO(g) C) Mg(g) + OH(g) = MgO(g) + H(g)	(g) + H(g)	

Heat Capacity and Entropy

are also based on calculations. Vibrational-rotational constants are estimated in isoconfigurational groups by comparison with BeO, CaO, Sci. 242.00 and BaO. Low-lying levels and their vibrational-rotational constants cause marked changes in the thermodynamic functions, which are PREVIOUS: December 1974 (I atm) in the isoconfigurational order given by Schamps and Lefebvre-Brion. Designations of the new E, F and G states are based on theoreal calculations. Field² concluded that calculations $^{+6}$ of the isoconfigurational A/II- 3 II separation should be adequate for estimatif low-lying 3 II state. The other potentially low-lying state (3 2) is estimated similarly from isoconfigurational B/2. Higher estimated Electronic levels (T_0) and vibrational-rotational constants of observed states are from Rosen 1 and other recent sources. $^{-10}$ States are calculated using first-order anharmonic corrections to Q_i^2 and Q_i^2 in the partition function $Q = Q_u \Sigma Q_i^2 Q_i^2 g_i$, $\exp(-c_2 \epsilon_i T)$.

-lom-	Enthalpy R	eference Te	mperature	Enthalpy Reference Temperature = $T_r = 298.15 \text{ K}$ I·K ⁻¹ mol ⁻¹		Standard State Pressure k1-mol ⁻¹	Pressure = p	- = 0.1 MPa
2	7.¥	ះ	S - [G	-[G*-H*(T,)]/T	$H^{\bullet}-H^{\bullet}(T_{\bullet})$	Δ,Η*	$\Delta_i G^{\bullet}$	log K,
	0 8	0.		INFINITE	-8.909	58.588	58.588	INFINITE -26634
	285	30.117	200.873	216.143	-3.054	58.886	42.689	-11.149
	298.15	32.173		213.269	0	58.158	34.895	-6.113
	300	32.215	213.468	213.270	0.060	58.144	34.750	-6.051
	88	33.401 34.783	218.522	213.666 214.562	3.403	57,783	27.060	-3.534
	2 8	36.452 38.434	231.200	215.743	5.182 7.053	57.147 56.901	23.280 19.531	-2.702 -2.040
	88	43.078	238.608	220.068	11.124	56.624	12.088	-1.052
	§ §	51.783	252.250	226.439	20649	56.994	-2.783	0.182
	88	53.890	258.472 264.208	229.657 232.829	25.934 31.379	57.457 49.315	-10.282 -17.121	0.597 0.894
	8	54.608	269.429	235.923	36.857	49.607	-23.779	1.129
	200	53.729 52.496	274.147	238.915	42.278 47.591	49.823 49.914	-30.461	1.326
•	1400	51.139	282.241	244.546	52,773	-75.404	-40.685 -38.093	1.518
	0091	48.558	288.897	249.687	62.737	-75.399	-35.573	1.161
	88	47 439 46 454	291.807	252.080	67.27 72.229	-73 768	-33.111	0.891
	000	45.599	296.978	256.541	76.831	-73.114	-28.323	0.779 0.679
s given	2100	44.230	301.471	260.611	85.806	-72.070	-23.664	0.589
as. The	2300	43.231	303.516	262.515	94547	-71.538	-21,368	0.434
76 from	2400	42.841	307.279	266.091	98.850	-71.012	-16.827	0.366
me that	2600	42.229	310.682	269.392	107.354	-70.559	-12.331	0.248
idering	2800	41.993	312.272	270.951	111.565	-70.393 -70.262	-10.095	0.195 0.1 <i>4</i> 7
ported	2300	41 629	315.259	273.905	119.925	-70.163	-5.637	0.102
8 ± 23	3100	41.381	318.026	276.664	128.224	-70.053	-1 191	0.020
troneg-	3200	41.291	320.608	77.977 279.250	132.357	-70.040 -70.052	3,250	-0.017 -0.051
ations ss X'X	005	41.167	321.838	280.484	140.602	-70.090 -70.154	5.472 7.695	-0.084 -0.115
	3600	41.103	324.189	282.848	148.828	-70.243	9.921	-0.14 -0.14
ង	888	4 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6	326 411	285.082	157.047	-70.503	14.381	-0.198
,	4000	41 117	328.519	287.202	165.267	-70.874	18.858	-0.246
1+3	4100 4200	41.14	329.534 330.526	288.222 289.218	169.380	-71.105	23.356	0.789
+۱+ د د	84	4 222	331.496	290.190	177.616	-71.562	27.881	-0.331
1 + 1	4500	41.329	333.372	292.067	185.871	-72.358	30.154	-0.350
ı ∞ I +I	84 4	41.393	334.281 335.172	292.975 293.864	190.007	-72.761 -73.203	34.729	986
9 +	84 4 88 8 88 8	41.539	336.046 336.903	294.733 295.585	198.300	-73.686	37.030	-0.403
	2000	41.709	337 745	296.420	206.624	-74.781	41.665	-0 435
	2200	41.902	339.384	298.041	214,985	76.057	46.347	0.466
	\$400 2400 2400 2500 2500	45.03 42.113	340.970	299.602	223.386	27.575	21.83	0 494
re listed	000	377.07	341.745	201 107	183 184	-70 198	55.876	-0.521
oretical	5700	45.467	343.256	301.840	236.072	-80.115	58.296	-0534
d levels	2800	42.72	344 725	303.269	244.591	-82.116	63.186	689
o, C20,	9	42.860	345.444	303.900	748.870	-83.202	60.60	7/50-

25.849 23.490 21.358 19.421 17.655 16.038

-1717.128 -1715.327

174.712 172.091

181217 187,338 199,581 -858.649 -817.979 -777.388 -736.870 -696.421

-1713.561 -1711.829 -1710.131 -1708.467 -1706.838

224.068 224.068 236.311 248.554 260.798

34.633 31.409 28.473

-1060,837

-1549.254 -1676.053 -1674.175 -1672,377 -1720,835 -1718,964

226.850 235.923 244.370

252.271 259.694 266.692 270.046 273.311

> -370.20 -373.3

> > 23.72

 -8.7 ± 0.15

HF solution calorimeter (a) $MgO(cr) + SiO_7(cr) = MgSiO_3(cr)$ Aqueous solubility (b) $MgSiO_3(cr) + 3H_2O(1) - Mg^{++}(aq)$

+ H,SiO,(2q) + 2OH (2q)

113.879 126.122 138.365 150.609 162.852 175.095

Standard State Pressure = $p^* = 0.1$ MPa

kJ-mol-

 $\Delta_1 H$

 $H^{\bullet}-H^{\bullet}(T_{i})$

S -[C.-H'(T,)]/T

ž

NFINITE 792.950 389.255

-1539.788 -1544.271 -1547.531

256.140 254.467 187.036 146.578

-1461.484 -1432.276 -1403.073

-1548.930 -1549.184 -1548.910

-1462.023

-1548.917

67.768 68.276 93.738 115.590

81.927

0. 23.912 59.643

119.613 100.361 85.929 74.711

-1373,955 -1344,943 -1316.047 -1287,267

-1547.624 -1546.754 -1545.768

0.152 9.031 18.838 29.273 40.208 51.581 63.356 63.315 64.384

134.600 151.449 166.629 180.492 180.891

82.228 94.194 101.512 106.997 111.621 115.780

-1548.358

65.709 58.337 52.197

-1228.515 -1199.129

-1552.043 -1551.461

88.091 100.125 107.105

205,381

193.911

-1257.958

-1552.726

110.332 110.332 117.854 25.298 32.414 136.393 139.250 145.836 152.126 158.141 163.899 169.417

119.788 120.340 120.340 120.340 120.340 122.432 122.432 122.432 122.432 122.432 122.432 122.432 122.432

II <---> III TRANSITION -1169.845 -1137.516 -1099.115

I <--> II TRANSTTION

CRYSTAL(I-II-III)

Magnesium Silicate (MgSiO₃)

Enthalpy Reference Temperature = T, = 29&15 K

J.K-'mol-'

Magnesium Silicate (MgSiO₃)

PREVIOUS: September 1964

CURRENT December 1967

	$\Delta_i H^{\circ}(0 \text{ K}) = -1539 79 \pm 4.2 \text{ kJ mol}^{-1}$
$S^{*}(298.15 \text{ K}) = 67.77 \pm 0.8 \text{ J·K}^{-1} \cdot \text{mol}^{-1}$	$\Delta_0 H^0(298.15 \text{ K}) = -1548.92 \pm 4.2 \text{ kJ} \cdot \text{mol}^{-1}$
$T_{\rm tri} = 903 \text{K} = 0.67 \text{kJ} \cdot \text{mol}^{-1}$	$\Delta_{\rm ray}H^{\circ} = 0.67 \rm kJ \cdot mol^{-1}$
T _{tr.2} = 1258 K	$\Delta_{m2}H^{\circ} = 1632 \text{ kJ} \cdot \text{mol}^{-1}$
$T_{\text{lus}} = 1850 \pm 2 \text{K}$	$\Delta_{\rm bu}H^{\circ} = [75.312 \pm 20.9] \text{ kJ·mol}^{-1}$

Enthalpy of Formation

and measured the enthalpies of solution of each component. They appear to have made the water-absorption correction to the enthalpy of We derive $\Delta H^{*}(MgSiO_{s}, cr, 298.15 \text{ K}) = -370.20 \pm 1.0 \text{ kcal·mol}^{-1} \text{ using the } \Delta_{t}H^{*}(298.15 \text{ K}) \text{ of } MgO(cr) \text{ and } SiO_{t}(cr, low quarts) from$ Forgeson et al. report a $\Delta H^{*}(298.15 \text{ K}) = -8.69 \pm 0.15 \text{ kcal·mol}^{-1}$ for reaction (a) They used a hydrofluoric acid solution calorimeter solution of SiO₄(cr) in the wrong direction. We reverse the correction so that the new $\Delta_{\omega}H$ almost overlaps the range observed by King." the JANAF tables.

Ressman et al.? calculated a $\Delta G^{\circ}(298.15 \text{ K}) = 23.72 \text{ kcal mol}^{-1}$ for reaction (b) using aqueous solubility data. We use the $\Delta G^{\circ}(298.15 \text{ K})$ of H₂O(1) and OH⁻ (aq) from source 3, $\Delta G^{\circ}(298.15 \text{ K})$ of H₂SIO₄(aq) from source 4 and $\Delta G^{\circ}(298.15 \text{ K})$ of Mg**(aq) from source 5 and we obtain a $\Delta G^{\circ}(298.15 \text{ K}) = -352.534 \text{ kcal mol}^{-1}$. We derive $\Delta G^{\circ}(298.15 \text{ K}) = -373.293 \text{ kcal mol}^{-1}$ using the above $\Delta_i G^{\circ}(298.15 \text{ K})$ of MgSiO₃(cr) and the entropies of Mg(cr), Si(cr) and O₂(g) from the JANAF tables.

and less We choose the enthalpy of formation derived from the result of Torgeson et al. which is considered to be better since it relates directly to the

kcal mol-1	kcal·mol-1 kcal mol-1	kcal·mol-1	Reaction	Source Method
$\Delta_l H^{\circ}(298.15)$	λ,H°(298.15 K) Δ,G°(298.15 K) Δ,H°(298.15)	Δ,H°(298.15 K)		
		he value.	urate and involves uncertainties in the auxiliary data used to calculate the value.	urate and involves uncertaint
sman et al. is l	om the work of Ree	13, cr, 298.15 K) derived fi	O (in the SiO ₂ -MgO system) measured by Rein et al. The Δ_1 (MgSiO ₃ , cr, 298.15 K) derived from the work of Reesman et al. is $\log M_2$	O (in the SiOr-MgO system)
ivities of SiO ₂ a	lerived from the acti	good agreement with that o	he oxides. Also the $\Delta_i G^*(MgSiO_2, 1, 1873 K)$ thus calculated is in very good agreement with that derived from the activities of SiO $_2$ a	he oxides. Also the $\Delta_i G^{\circ}(Mg)$
			and the same with the same wit	or to Columnia on account of

Heat Capacity and Entropy

range 580–1570 K. Using his data we derive the high temperature heat capacities which are joined smoothly with the low temperature values by a constrained fitting technique. The C_p^* values at 903 = 1258 K and above 1258 K are derived as 28 762 and 29.262 cal·K⁻¹-mol⁻¹. respectively, by assuming that the data of Wagner pertain to the stable phase in these regions. The entropy is based on \$^(50 K) = 0.49 cal·K^{-1} mol^{-1}. Low temperature heat capacities are from the data (53-295 K) of Kelley. Wagner measured the average heat capacities in the temperature

Transition Data

 $T_{\rm tril} = 903$ K is obtained from Boyd *et al.*? The authors determined the phase diagram boundary at high pressures and extrapolated to one atmosphere. $T_{\rm tril} = 1258$ K is taken from Atlas. ¹⁰ Below 903 K the phase is known as clinoenstatite. Between 903 and 1258 K it is rhombic enstatite and above 1258 K it is proteenstatite. We calculate $\Delta_{\rm tril}H^{\circ}$ and $\Delta_{\rm tril}H^{\circ}$ (from dT/dP (slopes of the inversion) = 2.6Kbar and 84kbar

Fusion Data

¹⁰L. Atlas, J. Geol. 60, 125-47 (1952).
 ¹¹D. A. Stephenson, C. B. Sclar and J. V. Smith, Mineral. Mag. 35, 839-46 (1966).

reported by Boyd et al. 9¹³ and from the densities of clinoenstatite (3.210 gm/cc) and rhombic enstatite (3.208 gm/cc) reported by Stephenson et al. 11 and the density of protoenstatite (3.10 gm/cc) reported by Smith. 12 Refer to the liquid table for details

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F. R. Boyd and J. L. England, Ann. Rept. Director of the Geophysical Laboratory, No. 1455, 117-120 (1965).

¹²I. V. Smith, Acta Cryst. 12, 515 (1959).
¹³F. R. Boyd, J. L. England and B. T. C. Davis, J. Geophys. Res. 69, (10), 2101 (1964).

J. Phys. Chem. Ref. Data, Monograph 9

CURRENT: December 1967

PREVIOUS: September 1964

ignesium Silicate (MgSiO ₃)
M _r = 100.3887 Ma
רומחום
Magnesium Silicate (MgSiO ₃)

Mg,O₃Si₁(!)

1	$\Delta_t H^{\circ}(298.15 \text{ K}) = [-1494.862 \pm 20.9] \text{ kJ·mol}^{-1}$	$\Delta_{trs} H^{\circ} = 0.67 \text{ kJ} \cdot \text{mol}^{-1}$	$\Delta_{\text{trg}}H^{\circ} = 1.632 \text{ kJ} \cdot \text{mol}^{-1}$	$\Delta_{lus}H^{\circ} = [75.312 \pm 20.9] \text{ kJ·mol}^{-1}$
	$S^{\circ}(298.15 \text{ K}) = [92.515] \text{ J·K}^{-1} \cdot \text{mol}^{-1}$	$T_{\text{Ed}} = 903 \text{K}$	$T_{\text{tr},2} = 1258 \text{K}$	$T_{\text{tos}} = 1850 \pm 2 \text{K}$

Enthalpy of Formation

 $\Delta_h H^2(\dot{M}_SSiO_3, 1, 298.15 \, K)$ is calculated from $\Delta_h H^2(\dot{M}_SSiO_3, cr, 298.15 \, K)$ by adding $\Delta_{nu} H^2$ and the difference in enthalpy, $H^2(18SG)$ and $H^2(298.15 \, K)$, between the crystal and liquid.

Heat Capacity and Entropy

A glass transition is assumed at 900 K. Below 900 K the heat capacity is obtained from the heat capacity of the crystal. Above 900 heat capacity is assumed constant and estimated as 35 cal-K⁻¹-mol⁻¹ or 7 cal-K⁻¹ g-atom⁻¹. S'(1, 298.15 K) is calculated in a ma analogous to that used for the enthalpy of formation.

Transition Data

Refer to the crystal table for details.

Fusion Data

T_{ra} is taken from Bowen and Andersen.¹ MgSiO₁(cr) melts incongruently in the temperature range 1830–1850 K at atmospheric pres Δ_{tas}H° is estimated from the phase diagrams of the MgSiO₂-TiO₃ system reported by MacGregor.⁴ The phase diagrams were determin 10 and 20 kbars pressure where MgSiO₃(cr) melts congruently.

References ¹N. L. Bowen and O. Andersen, J. Amer. Chem. Sci. 37, 487 (1914).

²I. D. MacGregor, Ann. Rept. Director of the Geophysical Laboratory, No. 1455, 135–9, (1965).

									_
·mol-i	Enthalpy R	eference T	emperature	Enthalpy Reference Temperature = $T_r = 298.15 \text{ K}$ $1.\text{K}^{-1}\text{mol}^{-1}$	×	Standard Str k I-mol-1	Standard State Pressure = p = 0.1 MPa k1-mol ⁻¹	- 0.1 MPa	
-lom:	τÆ	ະ	S. –[G.	-[G*-H'(T,)]/T	$H^{\bullet}-H^{\bullet}(T_{i})$	l	$\Phi'G$	log Kr	
loш.	0 0 0 200 0								
50 K)	298.15	126.18	92.515	92.515	Ö	-1494.862	-1415.346	247.963	
	88	82.228	93.022	92.516	0.152	-1494.875	-1414.853	246.348	
	8	101.512	140.337	102.661	18.838	-1494.855	-1361.392	142.224	
K the	88	106.997	159.347	110.559	29.273	-1494,303	-1334.747	116.200	
nanner	888	115.780	205 239	126.899	51.581	-1492.699	-1281.789	83.692	
	900.000		205.239	134.844	63.356	GLASS	SS <> LIQUID	Q Q	
	200.000		2007.59	134.844	92,250	-1405 770	1KANSTI1ON - 1728 717	61.63	
	8 2	146.440	234.625	150.404	92.644	-1493.435	-1202.076	57.082	
	30.0	146.440 146.440	247.367 259.088	157.961	107.288	-1490244	-1175.731	51.178	
essure.	9 5	146.440	269.941	172.387	136.576	-1611545	-1120.632	41.811	
ned at	99	146.440	289.495	185.830	165,864	-1603.067	-1051.085	34.314	
	2 <u>8</u>	146.440 146.440	306.743	192.192	180.508	-1649.124	-1016.266	31.226	
	1850,000	146.440	310.756	201,310	202.474	III	~	- į	
	000	146.440	314.661	204.242	209.796	-1640.616	-942.295	25.906	
	2007	146 440	370.317	202.202	739.084	-1632 277	215 028-	500.62	_
	2200	146.440	336.129	220.799	253.728	-1628.114	-832.976	19.77	
	2300	146.440	342.639	225.956	268.372	-1624.015	-796.926	18.099	
	250	146.440	354.849	235.786	297.660	- 1615.921	- 725.349	15.155	
	2800	146,440	360.593	240.476	312,304	-1611.924	-689.805	13.858	
	2800	146 440	371.445	249.448	341.592	-1604.033	-619.169	11.551	
	280	146.440 146.440	376.584	253.744	356.236	-1500 138	- 584.065	10.520	
	3	40.44	20104	776767	210,000	9179661-	- 549.093	10C.K	_
									_
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Mg₁O₃Si₁(cr,l)

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sate (MgSiO
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= 100.388
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• IIII I:0 - A-	log Kr	192.950	256.140	254.467 187.036 146.578	119.613	85.929 74.711		65 709	52.197		42.441	34.633	İ	25.906	21.621	18.099	13.155	12.660	10.520 9.561	
	$\Delta_i G^{\bullet}$	- 1539.788 - 1518.053 - 1490.410	-1462.023	- 1461.484 - 1432.276 - 1403.073	-1373.955	-1344,943 -1316,047 -1287,267	I <>II	-1257.958	-1228.515	II <> III TRANSITION	-1169.845 -1137.516	-1060.837	<> LIQUID TRANSITION	-942.295 -905.650	-869.215 -832.976	-796.926 -761.053	-725.349	-654.414	-584.065 -549.093	
kJ·mol ⁻¹		-1539 788	-1548.917	-1548.930 -1549.184 -1548.910	-1548.358	-1546.754 -1546.754 -1545.768	- 1	-1552.726	-1552.043 -1551.461		- 1549.254 - 1676.053	-1672.377 -1720.835	=	- 1640.616 - 1636.414	-1632.247	-1624015 -1619.951	-1611.924	-1607 962 -1604.033	-1600 138 -1596.278	
	$H^{\circ}-H^{\bullet}(T_i)$	-12.113 -11.330 -7.037	0	0 152 9 031 18.838	29.273	\$1.581 63.356	63.715	76.057	88.091 100.125	107.105	113.879	150.609	181.217	263.851	293.139	322.427	366,359	381.003	424.935	
	-[G*-H*(T,)]/T	INFINITE 124.420 74.617	67.768	67 770 11.160 17.915	85.812	102.152	110.332	117.854	125.298 132.414	136.393 136.393	139.250	158.141	172.091	175.792	189.727	202 453	219.686	225 007 230 143	235.104	
J·K-'mol-	S -[G	0. 11.117 39.430	67 768	68.276 93.738 115.590	134.600	180.492	180.891	193.911	205.381	221.532 222.829	235.923	259.694 259.694	270.046	314.661	329.317	342.639	360,593	366.120 371.445	376.584 381.549	
	ប	0. 23.912 59.643	126.18	82.228 94.194 101.512	106.997	115.780	-		120.340	120.340 122.432	122.432	122.432	122.432	146.440 146.440	146.440 146.440	146.440 146.440	4 4 4 6 4 6 4 6 4 6 4 6 4 6 6 6 6 6 6 6	146.440 146.440	146 440 146 440	
J·K-'mol-'	ТЖ	0 00 0	298,15	888	88	888	903 000	0001	1200	1258.000	0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.0	888	1850,000	2000	2100	7300 7400 7400	7909 7800	2700	3000	

Magnesium Silicate (MgSiO₃)

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Refer to the individual tables for details.

0 to 903 H 903 to 1258 H 1258 to 1850 H above 1850 H

CURRENT: June 1967

PREVIOUS: June 1961

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M_r = 120.1832 Magnesium Titanium Oxide (MgTiO₃) CRYSTAL

Mg,O3Ti,(cr)

 $\Delta_t H^{\circ}(0 \text{ K}) = -1563.26 \pm 6.3 \text{ kJ·mc}$ $\Delta_t H^{\circ}(298.15 \text{ K}) = -1572.56 \pm 6.3 \text{ kJ·mc}$ $\Delta_{tot} H^{\circ} = [90.374] \text{ kJ·mc}$

The adopted enthalpy of formation is calculated from $\Delta_t H^{\circ}(298.15 \,\mathrm{K}) = -6.35 \pm 0.25 \,\mathrm{kcal \cdot mol}^{-1}$ for the reaction MgO(cr) TiO₂(utile \rightarrow MgTiO₃(cr) measured by Kelley et al., using a solution calorimetric method. For the same reaction a value $\Delta_t H^{\circ}(298.15 \,\mathrm{K}) = -5.5 \pm 0.1 \,\mathrm{kcal \cdot mol}^{-1}$ was obtained with a calorimetric bomb method by Ronfilov and Feodos'ev.² These authors u the oxidation of lampblack in order to initiate the formation of the titanate from the oxides. Unfortunately the desired enthalpy of react was only 1.2 to 1.5 percent of the total measured heat, and consequently this result appears to be more uncertain than that measured by $S^{(298.15 \text{ K})} = 74.56 \pm 0.4 \text{ J·K}^{-1} \cdot \text{mol}^{-1}$ **Enthalpy of Formation** $T_{\text{fus}} = 1953 \pm 20$

Heat Capacity and Entropy

solution calorimetric method.

Low temperature heat capacities are from the data (52-296 K) of Shomate.³ High temperature enthalpues have been measured (402-1720 by Naylor and Cook.⁴ High temperature heat capacities are derived from the enthalpies by a futting technique which constrains the curvious smoothly with the low temperature values. The entropy is based on $S'(52 \text{ K}) = 0.45 \text{ cal·K}^{-1} \text{ mol}^{-1}$.

Fusion Data

Refer to the liquid table for details.

References

1. K. K. Kelley, S. S. Todd and E. G. King, U. S. Bur. Mines RI 5059, (1954).

2. B. I. Ronfilov and N. Freodox'ev, Russ. J. Inorg. Chem. 9, 1452 (1964).

3. C. H. Shomate, J. Amer. Chem. Soc. 67, 964 (1946).

4. B. F. Naylor and O. A. Cook, J. Amer. Chem. Soc. 68, 1003 (1946).

0	Enthalpy Ro	eference Te	mperature	Enthalpy Reference Temperature = T, = 298.15 K	<u>.</u>	Standard Sta	Standard State Pressure = $p^* = 0.1 \text{ MPa}$	p = 0.1 MPa	_
-lou			J·K-'mol-'			E.mol-1			
lou_t_lou	τÆ	ះ	S -[G	$-[G^{\bullet}-H^{\circ}(T_{i})]T$	$H^{\bullet}-H^{\bullet}(T_{\epsilon})$	$\Delta_{c}H^{\bullet}$	Φ_iG^{ullet}	log K _r	
	0	oʻ	o	INFINITE	-13.556	-1563,260	-1563.260	INFINITE	
	8	25.510	10.857	138,595	-12.774	-1568.037	-1541,350	805,119	_
+ F:	200	67.873	42.539	82.308	-7.954	-1571,507	-1513.096	395.180	-
e of	298.15	91.881	74.559	74.559	ö	-1572.556	-1484.128	260.013	
nsed	300	92.203	75.128	74,561	0.170	-1572.560	-1483.579	258.314	_
2	9	105.244	103,609	78.355	10 102	-1572.255	-1453.939	189.865	_
4	200	113.123	128.001	85.906	21.047	-1571.304	-1424.461	148.812	-
y uz	9	118.453	149.124	94.722	32,641	-1570.043	-1395.208	121 464	_
	90	122,353	167.690	103.847	44.690	-1568.636	-1366.179	101.946	_
	800	125,382	184,233	112.880	57.082	-1567.162	-1337.357	87.320	_
	8	127.846	199.147	121.650	69.747	-1565.714	-1308.719	75.956	
(N) (C)	0001	129.938	212.728	130.089	82.639	-1572.993	-1279.523	66.835	-
2	1100	131.775	225.200	138.177	95.726	-1571.915	-1250.229	59.368	
01 24	1200	133.432	236.738	145.915	108.987	-1574.903	-1220.909	53,145	
	1300	134.972	247 480	153,319	122.408	-1573.268	-1191.476	47.874	
	1400	136.423	257.536	160.408	135.979	-1699.017	-1159.002	43.243	_
	1500	137.821	266.996	167.202	149 691	-1695.995	-1120.536	39.021	_
	1600	139.185	275.934	173.721	163.542	-1692.979	-1082.270	35,333	
	28	140,532	284.413	179.985	177.527	- 1689.982	-1044.193	32,084	
	008	141.879	292.483	186.012	191.648	-1687.017	-1006.291	29.202	-
	8	143.23	300.191	028.161	205.503	-1684.097	-968.553	26.627	
	1953,000	143 249	304 141	194.815	213,514	CRYST	CRYSTAL <> LIQUID	and	
	2000	144.595	307.572	197.425	220.294	-1695.921	-930.513	24,303	
	2100	145.980	314.660	202.840	234,823	-1693.874	-892.293	22.195	-
	2200	147.394	321.484	208.078	249.491	-1691.721	-854.172	20.281	-
	2300	148.833	328.067	213.153	264.302	-1689.459	-816.152	18.535	
	2400	150310	334.433	218.074	279.259	-1687.086	-778.233	16.938	
	2500	151.825	340.599	222.853	294,366	-1684.598	-740.415	15.470	_
	2600	183,381	346.584	227.497	309.626	-1681,989	-702.699	14.117	
	2700	154.975	352.402	232.016	325.043	-1679.257	-665.085	12.867	_
•	2800	156.615	358.068	236.417	340.622	-1676.398	-627.574	11.708	-
	2900	158,302	363.593	240.708	356.368	-1673.405	-590.170	10.630	_
	3000	160.038	368.989	244.894	372.284	-1670.277	-552.869	9.626	-

Mg,O₃Ti₁(I)

M_i = 120.1832 Magnesium Titanium Oxide (MgTiO₃)

Enthalpy Reference Temperature = T, = 298.15 K

J·K-'mol-'.

Standard State Pressure = p = 0.1 MPa

log Kr

δĀ

는 달 구 $\Delta_r H^{\bullet}$

 $H^{\bullet}-H^{\circ}(T_{r})$

S -[G-H'(T,)]T

ئ

ΤX

248.794 247 176 181.988 142.893 116.849 98.262 84.336 73.515 64.829

-1393.623 -1342.196 -1316.819 -1291.649 -1266.664 -1241.121

-1497.635 -1497.329 -1496.378

111.082 111.651 140.132 164.524

91.881 92.203 105.244 113.123

-1420.091

-1497.631

51.718 51.791 46.771

-1496.990 -1499.977

95.726 108.987 122.409

174.699 182.438 189.842

261.723 273.261 284.003

131 775 133 432 134 972

134972

-1498.342

-1495 117 -1493 710 -1492 236 -1490 789 -1498 067

32.641 44.690 57.082 69.747 82.639

131.245 140.370 149.403 158.173 166.612

185.647 204.213 220.756 235.670 249.251

18.453 122.353 125.382 127.846 129.938

GLASS <--> LIQUID TRANSITION -1215 479 -1189.811 -1164.030

-1135,313 -1100,794

-1621.344 -1610.233 -1604.905 -1599.743 -1594.761

122.409 122.409 138.726 155.044 171.361 187.679 203.997 2203.997

284 003 284 003 296 095 307 353 317 884 327 777 337 104 345 926

163 176 163 176 163 176 163 176 163 176 163 176

34.822 31.735 29.000 26.560

-1066.645 -1032.835 -99.334 -966.115

--- CRYSTAL <--> LIQUID ---

189.842 189.842 197.005 203.991 210.784 223.772 229.971 235.980 241.805 247.454 252.95

350.416 354.296 362.258 369.848 377.102 384.047

163.176 163.176

-932.699

-1604658

-899.195 -865.873 -832.724 -799.738 -766.907

-1600.822 -1597.019 -1593.251 -1589.518 -1585.818

163.176 163.176 163.176 163.176 163.176

228 963 236.632 252.949 269.267 285.585 301.902 318.220

24 360 22.366 22.366 22.366 22.366 22.366 22.4 11.402 11.402 11.403 11.4

-572.786 -540.857 -590.035 -477.315 -445 695 -414.170 -374.949 -332.352 -289.872

-1554.057 -1550.706

416.125 432.443 448.761 465.078 481.396

291.575 295.851 300.023 304.094 308.070

425.809 430.989 436.011 440.882

35.55.55 57.

-1547.392

-1953.217 -1948.749 -1944.379 -1940.107

311.955 315.752 319.466 323.099 326.655

450.209 454.680 459.031 463.270 467.401

-734.223 -701.679 -669.269 -636.988 -604.829

-1574,922 -1571,357 -1567,828

334.537 350.855 367.173 383.490 399.808

268.439 273.320 278.067 282.688 287.189

397 108 403.266 409.200 414.926 420.458

-1564.332

-1582.152

CURRENT June 1967

PREVIOUS

רוסחום
MgTiO ₃)
Oxide (
litanium
Magnesium 1

 $\Delta_{\rho}H^{\circ}(298.15 \text{ K}) = [-1497 631 \pm 6.3] \text{ kJ mol}^{-1}$ $\Delta_{lu}H^{\circ} = [90.374] \text{ kJ·mol}^{-1}$ $S^{\circ}(298.15 \text{ K}) = [111.082] \text{ J·K}^{-1} \cdot \text{mol}^{-1}$ $T_{\text{tis}} = 1953 \pm 20 \text{ K}$

Enthalpy of Formation

 $\Delta H'(MgTiO_3, 1, 298.15 \text{ K})$ is calculated from $\Delta H'(MgTiO_3, \text{cr. } 298.15 \text{ K})$ by adding $\Delta_{los}H'$ and the difference in enthalpy, H'(1953 K)–H'(298 15 K), between the crystal and liquid.

Heat Capacity and Entropy

A glass transition is assumed at 1300 K. The heat capacity below 1300 K is obtained from the heat capacity of the crystal Above 1300 K the heat capacity is assumed constant and estimated as 39 cal-K-1 mol-1 or 7.8 cal-K-1 g-atom-1 S7(1, 298.15 K) is calculated in a manner analogous to that used for the enthalpy of formation.

Fusion Data

The incongruent melting point is obtained from Massazza. Previous work by Coughanour? indicates congruent melting point at 1903 K. The A_{lm}H* is estimated from those of Na₂O 2TiO₂ and Na₂O TiO₂ observed by Naylor³ and CaO-TiO₂-SiO₂ observed by King.*

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 B. F. Naylor, J. Amer. Chem. Soc. 67, 2120 (1945).
 G. King, R. L. Orr and K. Bonnickson, J. Amer. Chem. Soc. 76, 4320 (19

Refer to the individual tables for details.

gTiO ₃)
n Oxide (M
n Titaniun
Magnesiur

AH*		H*-H*(T); -13.556 -12.774 -7.954 -7.9	Control Cont	S - [G" 0 INI 10.857 42.539 74.539 74.539 74.128 110.16569 110.16569 110.1659 110.16769 110.1	C5 0. 25510 67873 92.203 105.244 113.123 112.358 112.382 113.433 113.433 113.433 114.471 114.471 114.471 114.471 114.471	77K 0 100 100 200 200 200 400 400 400 700 700 1100 1100 1100 11
- 1563.260 - 1588.037 - 1571.507 - 1572.556 - 1572.556 - 1570.043 - 1570.043		-13.55 -12.74 -1.74 0. 0. 10.102 21.047 44.650 57.082 67.082 67.082 67.083 67.0	HNITE 138.595 13.308 14.539 17.4561 17.4561 17.355 11.200 11.200 11.200 11.200 11.300 160.400 167.200		0. 25510 61873 91.881 92.203 105.244 113.123 125.385 125.385 125.385 127.384 131.773 134.573 1	28.15 28.15 300 300 500 500 500 500 500 500 500 50
- 1572.556 - 1572.550 - 1572.553 - 1572.554 - 1570.043 - 1586.556 - 1567.162 - 1573.193 - 1574.993 - 1574.993 - 1574.993 - 1574.993 - 1574.993 - 1574.993 - 1574.993 - 1574.993 - 1574.993 - 1659.993		0. 0.170 10.102 21.0102 21.044 44.690 57.082 69.747 82.639 92.639 98.563 112.408 112.408 149.691 163.542 115.521	74.559 74.561 74.561 74.561 74.562 75.762 76		91.881 92.203 115.244 115.244 115.234 112.335 122.338 122.338 122.338 131.775	298.15 300 400 500 500 600 600 600 600 1200 1200 1200 1200 1
- 1572.560 - 1577.255 - 1570.043 - 1580.043 - 1580.162 - 1565.714 - 1572.093 - 1572.093 - 1573.015 - 1673.015 - 1673.015		0.170 10.102 21.002 32.641 44.680 57.082 57.082 66.747 82.639 92.639 112.408 113.408 163.542 163.542 115.537	78.561 85.906 10.2847 112.889 121.650 121.650 138.17 145.915 145.915 167.202 179.721 179.721 179.721 179.721 179.721 179.721 179.721 179.721 179.721 179.721 179.721		92.203 192.244 113.123 118.453 122.382 127.846 131.775 131.475 134.472 137.821 139.185	250 250 250 250 250 250 250 250 250 250
- 1570,043 - 1588,636 - 1587,162 - 1587,162 - 1572,933 - 1572,933 - 1573,268 - 1699,017 - 1689,593		2.25 4.664 4.660 57.082 69.747 82.639 98.539 135.979 145.691 191.648	94,770 103,847 111,288 121,688 138,177 145,918 165,720 173,721		118.453 125.383 125.384 125.384 129.38 131.775 134.972 136.423 137.821 139.185 141.879	8 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9 9
- 1588.636 - 1567.142 - 1572.993 - 1572.993 - 1574.903 - 1574.903 - 1695.995 - 1695.995		44.690 57.082 69.747 82.639 95.726 108.987 122.408 149.691 163.542 115.527 191.648	103.847 111.2880 130.689 130.689 130.315 153.315 153.315 157.202 173.721 179.985 186.601 194.815		122.353 127.382 127.384 127.384 131.775 131.472 136.23 130.285 140.532 141.879	200 200 200 200 200 200 200 200 200 200
- 1565.714 - 1572.993 - 1571.915 - 1573.268 - 1699.017 - 1695.995 - 1689.995		69.747 82.639 95.726 108.987 122.408 135.979 149.691 175.57 175.57	121.650 130.089 130.089 133.17 145.915 153.319 167.202 173.721 179.985 191.820 191.820		127.846 129.938 131.775 133.432 134.972 136.423 137.821 140.538 141.879	900 1200 1300 1300 1300 1300 1300 1300 13
-1571,915 -1574,903 -1573,268 -1699,017 -1692,995 -1692,979		95.726 108.987 122.408 135.979 149.691 175.27 175.27	138.17 145.915 153.319 160.408 167.202 173.721 179.985 186.012 191.820		131.775 133 432 134 972 136 423 137.821 140.532	1200 1200 1500 1500
-1574,903 -1573,268 -1699,017 -1692,995 -1692,979		122.408 135.979 149.691 163.542 177.527	153.319 160.408 160.408 167.202 173.721 179.985 191.820 191.820		133 432 134 972 136,423 137.821 140,532 141.879	8645 8665 8665 8665 8665 8665 8665 8665
- 1699 017 - 1695,995 - 1692,979 - 1689,982		135.979 149.691 163.542 177.527 191.648	160.408 167.202 173.721 179.985 186.012 191.820		136.423 137.821 139.185 140.532	8 5 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
-1692.979 -1689.982		163.542 177.527 191.648	173.721 179.985 186.012 191.820		139.185 140.532 141.879	009
-1089.987		191.648	179.985 186.012 191.820 194.815		141.879	
-1687.017		200	191.820		1 42 238	888
CRYS	1	213.514		304.141	143.949	1953.000
TR/		303.888	194.815		163 176	1953.000
-1604,658		311.57	198517	354.296	63.176	3100
-1597.019		344.193	213.397		163.176	7200
0.510 -1593.251 -832.724 6.828 -1589.518 -799.739		360.510 376.828	220.358 227.035	377.102	163 176 163.176	7 7 7 7 7 7 7
-1585.818		393.145	233.450		163 176	2500
-1582.152	Tī	409.463	239.622		163.176	700 700 700
-1574.922	ī	442.098	251.308		163.176	2800
-1571.357 -1567.828	77	458.416	256.852 262.214	414.926	163.176	3000
-1564,332	Ŧ	491.051	267.405		163.176	3100
-1560.871 -1557.446	1 1	507,369 523,686	272.437		183.176 163.176	3300
0.004 -1554.057 -477.315	1	540.004	282.057		163 176	3400
-1567 397	'	175055	291 147		163.176	360
-1953.217		588.957	295.502		163.176	3700
20101		605.274	299.749 303.887		163.176 163.176	886
		76777			721 176	3
		17 CM2	303.887	453.270	163.176 163.176	300

Mg,04S,(cr)

M_r = 120.3626 Magnesium Sulfate (MgSO₄)

CURRENT March 1966

 $\Delta_l H^o(0 \text{ K}) = -1250.40 \pm 20.9 \text{ kJ mol}^{-1}$ $\Delta_l H^o(298.15 \text{ K}) = -1261.79 \pm 20.9 \text{ kJ·mol}^{-1}$ $\Delta_{lm} H^o = 14644 \text{ kJ·mol}^{-1}$ CRYSTAL $S^{(298.15 \text{ K})} = 91.40 \pm 0.8 \text{ J·K}^{-1} \cdot \text{mol}^{-1}$ r_{rs} = 1400 K

Enthalpy of Formation

 $MgO(cr) + SO_J(g) = MgSO_J(cr)$. The value of $\Delta_J H^o(298$ 15 K) was calculated by the 3rd law method using the equilibrium data obtained from a transpiration study by Knopf and Staude. In addition Marchal* measured the total pressure of $SO_J(g)$, $SO_J(g)$ and $O_J(g)$ above $MgSO_J(cr)$ and partial pressures were obtained by application of the SO_J - SO_J equilibrium data. Another value of $\Delta_J H^o(MgSO_L, cr, 298$ 15 K) may be derived from the measured enthalpy of solution of $MgSO_J(cr)$ by Thomsen³ and the measured enthalpies of mixing of $MgCI_J(aq, 200 H_JO)$ with H_J - $MgSO_J(aq, 200 H_JO)$ and $MgSO_J(aq, 200 H_JO)$ with $2HCI_J(100 H_JO)$ by Thomsen⁴ The adopted $\Delta_1H^*(298\ 15\ K) = -301.6 \pm 5\ kcal·mol^{-1}$ was calculated from the $\Delta_1H^*(298.15\ K) = 63.3 \pm 5\ kcal·mol^{-1}$ for the reaction

Drift Δ.H°(298.15 K) Δ.H°(298.15 K)	kcal·mol ⁻¹	1144-1313 0.514	1223-1428 0.525 72.394	, (Q	SO ₆ (aq, 200 H ₂ O) 2HCl(aq, 100H ₂ O) 298.15 -3.52 -305.1*
	Source Reaction	No Marca + (a) OS + (a) Marca	2 M•O(cr) + SO ₁ (g) = MgSO ₂ (cr)	MgSO ₄ (cr) = MgSO ₄ (aq, 200 H ₂ O)	 MgCl₂(aq, 200 H₂O) + H₂SO₄(aq, 200 H₂O) MgSO₄(aq, 200 H₂O) + 2HCl(aq, 100H₂O)

H₂SO₄(aq, 200 H₂O) = -212.387, HCl(aq, 100 H₂O) = -39.74 and MgCl₂(aq, 200 H₂O) = -189.5 kcal·mol⁻¹. *Combination of the reactions 3 and 4 with the following $\Delta_f H^o(298.15 \ K)$:

Heat Capacity and Entropy

MgO(cr) was calculated from the correlation of the low temperature heat capacities. The values from the two sources join smoothly at 298.15 K. Above the melting point (1400 K) the heat capacity was graphically extrapolated. The entropy was calculated at 50.12 K using the Debye and Einstein function D(242/T) + 2E(378/T) + 2E(866/T) + E(1683/T) given by Moore and Kelley. The value of 5°(50 12 K) = 1.08 cal·K⁻¹-mol⁻¹. The low temperature heat capacities 53.3–295.4 K were measured by Moore and Kelley. The heat capacities in the temperature range 298-1400 K were estimated from the equation $MgSO_4(cr) = CaSO_4(cr) + MgO(cr) - CaO(cr)$ CaSO_4(cr) and CaO(cr) G_p^* were calculated using the equation $G_p^* = 16.78 + 23.60 \times 10^{-3} T$ and $G_p^* = 11.67 + 1.08 \times 10^{-3} T - 1.56 \times 10^{3} T$ respectively, Kelley. The heat capacity of

Fusion Data

T_{fus} and ∆_{fus}H° from Kelley.⁶

References

H. J. Knopf and H. Staude, Z. Physik. Chem. (Leipzig) 204, 265 275 (1955).
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K. K. Kelley, U. S. Bur. Mines Bull 584, (1960).
K. K. Kelley, U. S. Bur. Mines Bull. 393, (1936).

Enthalpy R	eference Te	mperature	Enthalpy Reference Temperature = T, = 298.15 K		Standard Sta	Standard State Pressure = p = 0.1 MPa	, = 0.1 MPa
:		J-K-'mol-			Lt.mol-'		
7/K	ಚ	S -{G	-{G*-H*(T,)]/T	$H^{\bullet}-H^{\bullet}(T_{i})$	$\Delta_{\rm r}H^{ullet}$	₽.	log Kr
c	ď	ď	INFINITE	-15.390	-1250.399	-1250.399	INFINITE
ξ	36.313	62661	160 297	-14.032	-1256.182	-1221.316	637.950
8	73,309	57.532	99.534	-8.400	-1260.022	-1184.778	309.432
298 15	96.232	91396	91.396	ó	-1261.786	-1147 408	201.021
Ę	96 441	91,992	91398	0.178	-1261.804	-1146698	199.658
9	109 997	121.692	95.355	10.535	-1264.542	-1108.138	144.708
8	119.411	147.271	103.240	22.015	-1265 774	-1068 894	111.667
\$	127.612	062 691	112.492	34.379	-1266.082	-1029.474	89.624
8	34.306	189.970	122.143	47 479	-1265.710	-990.061	73.879
8	40 499	208 314	131.785	61.223	-1264.839	-950.737	62 077
Ş	146 231	225 196	141.238	75.562	-1316.686	-910467	52.842
8	151.670	240.888	150.428	90.461	-1322.424	-864.769	45.171
2	156.691	255.582	159.326	105.881	-1319.324	-819 150	38.898
2	161 419	269 424	167.930	121.793	-1315.827	-773.831	33.684
5	165 352	282 504	176.245	138 137	-1311.983	-728.819	29.284
600	168.619	294.881	184,281	154,840	-1435.265	-680.946	25.406
1400000		294.882	184.281	154.841	CRYSI	CRYSTAL <> LIQUID	and
905		306 611	192.049	171.843	-1429.556	-627.265	21.843
0091	173 787	117 750	095 661	189 105	-1423.656	-573.970	18.738
25	175 895	328.350	206.826	206.591	-1417.595	-521 049	16.010
88	17 TX	338.458	213.861	224.276	-1411.397	-468.490	13.595
	14	348 117	220 675	242.140	- 1405.080	-416.278	= 44
2000	181,033	357,363	227.279	260 166	-1398.658	-364.401	9.517
2.0	187 468	366,230	233.686	278.342	- 1392.145	-312.848	7.782
32	183.807	374.750	239 906	296.657	-1385.549	-261.606	6.211
250	185 067	382 949	245 948	315.101	-1378.878	-210.668	4.784
2,00	186.259	390.850	251.822	333.668	-1372.138	-160.021	3 483
255	187 393	398.477	257.537	352,351	-1365,335	- 109.656	2.291

Magnesium Sulfate (MgSO₄)

PREVIOUS: December 1960

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m Sulfate (MgSO ₄) Mg ₁ O ₄ S ₁ (I)	initialpy Reference Temperature = T_r = 298.15 K Standard State Pressure = p^{\bullet} = 0.1 MPa J·K ⁻¹ mol ⁻¹
M,= 120.3626 Magnesium Sulfate (MgSO4)	$\Delta_l H^0(298.15 \text{ K}) = [-1246.587] \text{ kJ·mol}^{-1}$ Enthalpy Reference Temperature = $T_r = 298.15 \text{ K}$ $\Delta_{lu} H^0 = 14.644 \text{ kJ·mol}^{-1}$
TIONID (*)	ī
Magnesium Sulfate (MgSO4)	$S^{\circ}(298.15 \text{ K}) = [102.125] \text{ J·K}^{-1} \cdot \text{mol}^{-1}$ $T_{\text{tas}} = 1400 \text{ K}$

·K ⁻¹ ·mol ⁻¹	Δ _t H°(298.15 K) = [- 1246. Δ _{tus} H° = 14
Enthatpy of Formation $\Delta_H^{*}(M_SSO_4, cr, 298.15 \text{ K})$ by adding $\Delta_{los}H^{*}$ and the difference in enthalpy $\Delta_{los}H^{*}(M_SSO_4, cr, 298.15 \text{ K})$ by adding $\Delta_{los}H^{*}$ and the difference in enthalpy	difference in enthalpy

y, H°(14 A glass transition was assumed at 1000 K. The heat capacity below 1000 K was obtained from the heat capacity of the crystal. Above the heat capacity was assumed constant and estimated as 38.0 cal·K⁻¹·mol⁻¹ by comparison with those for MgCl₂(l), KCl(l) and K₂ S^o(l, 298.15 K) is calculated in a manner analogous to that used for the enthalpy of formation. Δ_tH°(MgSO₄, I, 298.15 K) is calculated fror H°(298.15 K), between the crystal and liquid. Heat Capacity and Entropy

Fusion Data
Refer to the crystal table for details.

-								
KJ-mol-1	Enthalpy K	elerence I(J·K-'mol-'.	Enthalpy Reference Temperature = I; = 29&15 R		ן מ	ite Pressure = 1	= p = 0.1 Mra
	7.K	ប	s, -[C,	$-[G^{\bullet}-H^{\bullet}(T_{\bullet})]T$	$H^{\bullet}-H^{\bullet}(T_t)$		Φ'C•	log Kr
1400 K)-	000							· ·
	298.15	96.232	102.125	102.125	ď	-1246,587	-1135.408	198.919
ve 100 K	888	109.997	132.421	106.084	0.178	- 1246.605 - 1249.343	-1134.718 -1097.231	197.572
K ₂ SO ₄ (I).	<u> </u>	119.411	180.519	123.221	34.379	-1250.573	-1020.713	88.861
	88	134,306	200.700	132.873	47 479	-1250.511	-982.373	73,306
	888	146231	235.858	151.964	75.505 90.690	-1301.545	-904.921	\$2.520 44.937
	1000,000		251.845	161.156	90.690			
	0011		266.999	170.100	106.589		-815.802	
	0021	158.992	280.833	178.760	122.488	-1299.933	-771.628	33.588
	1400	158.992	305.342	195 137	154.286	-1420.620	-680.946	25.406
	1400.000	_	305.342	195.137	154,286	CRYSTAL	'AL <> LIQUID	QID
	1500	158.992	316,311	202.854	170.186	-1416.015	-628.274	21.878
	885	158.992	326.572	210.269	186.085	-1411.477	-575.906	16.095
	008	158.992	345.299	224.253	217.883	-1402.590	-471.996	13.697
	882	158.992	362.050	237.209	249.682	-1393.944	-440.415	9.639
	2100	158.992	369.808	243.340	265.581	-1389.707	-317.923	7.908
	882	158.992	384271	254.976	297.379	-1381.400	-216.233	4.911
	7 4 00 7200	158.992	391.038 397.528	260.505 265.857	313.278	-1377,328 -1373,310	-165.662	3.606 2.408
	PREVIOUS, December 1960	December .	0961				CURRE	CURRENT: March 1966
		i						

Mg₁O₄S₁(cr,I)

CURRENT: March 1966

(MgSO ₄)
Sulfate
Magnesium
$M_r = 120.3626$

CRYSTAL-LIQUID

0 to 1400 K crystal
above 1400 K liquid
Refer to the individual tables for detaals.

Magnesium Sulfate (MgSO₄)

J. Phys. Chem. Ref. Data, Monograph 9

Mg,0,W,(cr)

CURRENT March 1967

PREVIOUS: June 1963

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M_r = 272.1526 Magnesium Tungsten Oxide (MgWO4) CRYSTAL

Mg,O,W,(cr)

 $\Delta_t H^{\circ}(0 \text{ K}) = -1505.74 \pm 33.5 \text{ kJ·n}$ $\Delta_t H^{\circ}(298.15 \text{ k}) = -1515.86 \pm 33.5 \text{ kJ·n}$ $S^{\circ}(298.15 \text{ K}) = 101.19 \pm 0.8 \text{ J} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$ T_{fus} = Unknown

Enthalpy of Formation

A.G° = −224,370 + 65.677 (cal·K⁻¹·mol⁻¹) for MgO(cr) + W(cr) + 3/20₂(g) → MgWO₄(cr). 3rd law analysis of the Δ₁G° equation is Δ₄H²(298.15 K) = −218.6 kcal·mol⁻¹, from which the adopted Δ₄H²(MgWO₄, cr, 298.15 K), −362.3 kcal·mol⁻¹, is calculated. The 2nd analysis gives Δ₄H²(MgWO₄, cr, 298.15 K) = −372.7 kcal mol⁻¹. The drift is 8.0 cal·K⁻¹·mol⁻¹. Rezubtina, et a.d.² determined the Gibbs energy changes Δ₁G° = 51.300-2.7677 (cal·K⁻¹·mol⁻¹) for the reaction MgWO₄(cr) + 3H₄ξg MgO(cr) + W(cr) + 3H₂Q(g) in the temperature range 1073 K-1273 K by a circulation method. This leads to hears of formation of 3 kcal·mol⁻¹ by the 3rd law method and 377.2 kcal·mol⁻¹ by the 2nd law method. Both determinations were performed by Rezukthina am cell reaction MgO(cr) + W(cr) + 3Fe₀95 = MgWO4(cr) + 2.85 Fe(cr), in the temperature range 1220-1370 K. Incorporating the results with auxiliary thermal data, the authors obt Rezukhina and Levitskii measured the emf, E = 0.2433-0.0001264T, for the

co workers, but they considered the data obtained by the emf method to be more reliable than that derived from heterogeneous equi

Heat Capacity and Entropy

are estimated by comparison with those of CaWO₄(cr), *CaO(cr)* and MgO(cr). * These two sets of data are joined smoothly at 298.15 Low temperature heat capacities, 52.92-296.09 K, were measured calorimetrically by King and Weller. The heat capacities above a graphical method.

The entropy, S'(298.15 K) = 21.184 cal·K⁻¹ mol⁻¹, is taken from King and Weller, based on an extrapolation of S'(51 K) = cal·K⁻¹·mol⁻¹. No spin magnetic entropy is predicted below 51 K based on the diamagnetism observed by Gerasimov.⁷

References
T. N. Rezukhina and V. A. Levitskii, Russ. J Phys. Chem. 37, 1277 (1963).

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T. A. Yakovleva and T. N. Rezukhina, Russ. J. Phys. Chem. 34, 390 (1960).

Y. K. A. Kelley, U.S. Bur. Mines Bull. 584, (1960).

Ya. K. Kelley, U.S. Bur. Mines Bull. 584, (1960).

S. Manochemical Tables: MgO, 12–31–65.

Ya. I. Gerasimov, Papers Presented to Section on Inorganic Chemistry, 16th Intern. Congress Pure and Applied Chem. Paris (1957), pp.

I -lom-	Enthalpy R	eference Te	mperature	Enthalpy Reference Temperature = T, = 298.15 K		Standard Sta	Standard State Pressure = p*	p* = 0.1 MPa
-lom-	i		J·K ⁻¹ mol ⁻¹			٦		:
known	7.¥	ಟ	S - [G	$-[G^*-H^*(T_*)]T$	$H_{\bullet}-H_{\bullet}(T_{\bullet})$. Δ _. H.•	δ'C	log K _r
ò	001	38.221	21 150	INFINITE 179.146	-17.218 -15.800	-1505.744 -1511 429	-1505 744 -1476 970	INFINITE 771.490
sC(ct)	298.15	027.53		101.186	-9.542	-1515.863	-1404274	246.014
n gives	300	109.621	101.862	101.188	0.202	-1515.861	-1403.532	244.377
nd law	§ 8	123.428	135.424	105.670	11.902 24.675	-1515 122 -1513.648	-1366171 -1329.093	178.404
1	9	137.026	188.377	124.856	38 112	-1511.854	-1292,348	112.509
↑ (S) ↑	88	141.670	209.851	135.496	52.049	- 1509.900	-1255.916	93.718
200.1	35	150.415	246 577	156 273	81.268	-1505 606	-1183 900	68 712
ind nis	200	154.808	262.595	196.067	96.528	-1511,860	-1147,567	59 943
IIIOTIA.	001	159 410	277.566	175.530	112,239	-1509.378	-1111.254	52.769
	1200	164.013	291.633	184.625	128.410	-1506.559	-1075.183	46.801
	1300	168.615	304.945	193,373	145.043	-1503.393	-1039.361	41.762
300 K	1400	173.008	317.600	201 798	162.122	-1627.297	-1000.628	37 334
SK hy	1500	177.611	329.694	209.924	179.655	- 1622.088	-956.046	33.292
64	1600	182 004	341.296	217.775	197.634	-1616532	-911.823	29.768
	1700	186.606	352.469	225.371	216.066	-1610.619	-867.958	26.669
/7:1=	08	000161	363.259	232 734	234.945	-1604.355	-824 451	23.925
	88	100.001	383.885	246.826	774058	- 1590.756	115 857-	19.288
75. ZZ7								
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Mg,OsTi₂(cr)

CURRENT. June 1967

(MgTi ₂ O ₅)
Oxide
Titanium
Magnesium

PREVIOUS June 1961

M _r = 200.0620 Magnesium Titanium Oxide (MgTi ₂ O ₅)	$\Delta_0 H^0(0 \text{ K}) = -2495.43 \pm 10.5 \text{ kJ} \cdot \text{mol}^{-1}$ $(298.15 \text{ K}) = -2509 35 \pm 10.5 \text{ kJ} \cdot \text{mol}^{-1}$ $\Delta_{los} H^0 = [146.440] \text{ kJ} \cdot \text{mol}^{-1}$ $TK C_s^+ S_s^ [C_s^- H^*(T_s)] T H^{-1}$
CRYSTAL M, = 200.0620	$\Delta H^{9}(0 \text{ K}) = -2495.43 \pm 10.5 \text{ kJ·mol}^{-1}$ $\Delta_{t}H^{9}(298.15 \text{ K}) = -2509.35 \pm 10.5 \text{ kJ·mol}^{-1}$ $\Delta_{tos}H^{9} = 1146.4401 \text{ kJ·mol}^{-1}$
Magnesium Titanium Oxide (MgTi ₂ O ₅) CRY?	$S^{\circ}(298.15 \text{ K}) = 135 60 \pm 6.3 \text{ J·K}^{-1} \cdot \text{mol}^{-1}$ $T_{\text{tos}} = 1963 \pm 20$

Δ_{fus}H° = [146 440] kJ·mc

Enthalpy of Formation

 $\Delta_t H^2(298\ 15\ K)$ is calculated from $\Delta_t H^2(298.15\ K) = -4.45\pm0.45$ kcal mol⁻¹ for the reaction MgO(cr) + 2T1O_X(rutile) = MgTi₂O₃(measured by Kelley et al., using a solution calorimetric method. The uncertainty of \pm 2.5 kcal mol⁻¹ assigned to the enthalpy of format is due primarily to TiO2(ruttle).

Heat Capacity and Entropy

Low temperature heat capacities are from the data (52-296 K) of Todd. High temperature enthalpies have been measured (397-1812 by Orr and Coughlin ³ High temperature heat capacities are derived from the enthalpies by a fitting technique which constrains the curve join smoothly with the low temperature values. The entropy is based on $S^{o}(51 \text{ K}) = 1.11 \text{ cal} \cdot \text{K}^{-1} \cdot \text{mol}^{-1}$.

(b) all the Mg and one-half of the Ti ions are randomly distributed giving 2.75 cal·K¹¹-mol¹¹. These assumptions were proposed in one make MgTi₂O₂ stable relative to MgTiO₃ at high temperatures. Phase data of Massazza and Surcha,⁴ indicate that MgTi₂O₃ me congruently at 1963 ± 20 K and that there is a temperature range. To make A₂G'(1800 K) < 0 would require that S'(0 K) ≥ 0. congruently We adopt a compromuse zero-point entropy of 2 cal·K¹¹-mol¹¹ between the upper (3.79 cal K¹¹-mol¹¹) and the lower (0.cal·K¹¹-mol¹¹) lunits. Kelley et al., suggested that there may be a zero-point entropy due to randomness of the cations. The authors estimated S"(0 K) from following alternative assumptions (a) all the Mg and Ti ions are randomly distributed among the latice sites giving 3 79 cal K-1 mol-1

Fusion Data

Refer to the liquid table for details

References

¹K. K. Kelley, S. S. Todd and E. G. King, U. S. Bur Mines RI 5059, (1954)

²S. S. Todd, J. Amer. Chem. Soc. 74, 4669 (1952).

³R. L. Orr and J. P. Coughlin, J. Amer. Chem. Soc. 74, 3186 (1952).

⁴F. Massazza and E. Sirchia, 16th Int. Congress of Pure and Appl. Chem., Inorg. Sect., Paris, 1975, pp. 161–168, Butterworths Scienti publications, London, (1958).

1	Totholny Defendent Temperature T	of manner To		T - 100 15 V		3	1	
, ₋	Emiliar py R	בוכו בוועב זו	J·K-'mol-'	C1.067 = 11 =	4	KI-mol-	Standard State Pressure = $p = 0.1$ NiPa $k \cdot 1 \cdot mot^{-1}$	p = 0.1 MPa
1-10	7.K	ับ	S -[0	$-[G^{\bullet}-H^{\circ}(T_{i})]T$	$H^{\circ}-H^{\circ}(T_{*})$	$\Delta_{r}H^{\bullet}$	Δ _G •	log K,
s(cr)	2000	0. 46.129 110.533	0 22.217 75.638	INFINITE 231 124 139.695	-22.439 -20.891 -12.811	-2495.477 -2502 903 -2507 943	-2495 427 -2459 195 -2413.208	INFINITE 1284.552 630.265
	298.15	146.858	135.603	135,603		-2509.354	-2368.790	415.002
	300	147.335	136.513	135.606	0.272	-2509.357	-2367 918	412.291
-	\$ \$	176,665	219.925	153,575	33,175	-2508 821 -2507.459	-2320.819	237.559
2 K)	9	184 498	252.858	167.441		-2505 701	- 2227 426	193 915
3	28	190.807	307.628	195.899		-2503.712	-2181,202	162.763
the c	85	201,238	331.036	209.634	109.262	-2499.268	-2089 630	121.279
gud	8 2	210 284	104.755	735 557		900 CDC7-	175'5507-	100 /43
rder	1200	214.539	390.791	247.732	171.671	-2509 739	-1951.222	84 934
nelts	000	218.681	408.127	259.410		-2506.427	- 1904.812	76.536
0.35	88	226,731	439.986	281.401		-2625 354	- 1800.324	62.693
cr.0	0091	230 672	454 745	777.162		-2620.240	-1745 488	56 984
	008	238,438	482.364	311 441	307 662	-2609.756	- 1636 771	47.498
	0061	242.279	495.359	320.781	331.698	-2604.443	-1582.861	43.516
	1963.000	244.685	503,301	326,512	347.037	CRYSTAL	TAL <> LIQUID	ani
	2000	246.099	507.883	329.825	356.116	-2628 493	-1528.324	39.916
	2100	249 902	519.982	338.593	_	-2624.683	-1473,408	36.649
	2300	257.000	\$41.055	355 380		-2616108	-1418,079	33,084
	2400	261.220	554.092	363.431	457.588	- 2611.324	-1309.817	28.507
	200	216.50	204.032	270.070		167.0007-	169 6671 -	067.07
ntific	2700	272,450	585.508	386,383	537.640	-2595.087	-1201776 -1148.073	22.211
	2800	276.177	595.484	393.673	565.071	-2589 036	-1094.589	20 420
	9,00 3,00 3,00 3,00 3,00 3,00 3,00 3,00	279.901 283.621	605.241 614.792	400.801	592.875 621.051	-2582.667 -2575.979	-1041.330	18.756
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CURRENT: June 1967

PREVIOUS June 1961

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LIQUID

Mg₁O₅Ti₂(I)

M_r = 200.0620 Magnesium Titanium Oxide (MgTi₂O₅)

 $\Delta_t H^{\circ}(298.15 \text{ K}) = [-2382 \ 31 \pm 8.4] \text{ kJ} \cdot \Delta_{tu} H^{\circ} = [146.440] \text{ kJ} \cdot$

S°(298.15 K) = [197.783] J·K⁻¹·mol⁻¹ Flus = 1963 ± 20 K

Enthalpy of Formation

ΔH°(MgTi₂O₅, 1, 298.15 K) is calculated from ΔH°(MgTi₂O₅, cr, 298.15 K) by adding Δ_{fts}H° and the difference in enthalpy, H°(196 H°(298.15 K), between the crystal and liquid.

Heat Capacity and Entropy
A glass transition is assumed at 1300 K. Below 1300 K the heat capacity is obtained from the heat capacity of the crystal. Above 13 the heat capacity is assumed constant and estimated as 62.4 cal·K⁻¹·mol⁻¹ or 7.8 cal·K⁻¹g-atom⁻¹. S°(1, 298. 15 K) is calculated in a manalogous to that used for the enthalpy of formation.

Fusion Data

The congruent melting point is obtained from Massazza.¹ Previous work by Coughanour² indicates congruent melting at 1925 K. The L is estimated from those of Na₂O 2TiO₂ and Na₂O-TiO₂ observed by Na₂O-TiO₂ and Na₂O-TiO₂ observed by Na₂O-TiO₃ and Na₂O-TiO₃ observed by Na₂O-TiO₃ and Na₂O-TiO₃ and Na₂O-TiO₃ observed by Na₂O-TiO₃ and Na₂O-TiO₃ an

References

1. Massazza and E. Sirchia, 16th Int. Congress of Pure and Appl. Chem., Inorg. Sect., Paris (1957), pp 161-8, Butterworths Scientiations, London, (1958).

²L. W. Coughanour and V. A. DeProsse, J. Res. Nat. Bur. Stand. 51, 87 (1953). ³B. V. Naylor, J. Amer. Chem. Soc. 67, 2120 (1945). ⁴E. G. King, R. L. Ort and K. R. Bonnickson, J. Amer. Chem. Soc. 76, 4320 (1954).

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-mol-	Enthalpy R	eference Te	mperature	Enthalpy Reference Temperature = T, = 298.15	×	Standard Str	Standard State Pressure = p k1-mol ⁻¹	= p = 0.1 MPa
	TK	ະ	S -[G	-[G*-H*(T,)]/T	H*-H*(T,)	ŧ	δ.G.	log Kr
63 K)-	° 200							
	298.15	146.858	197.783	197.783	o	-2382.307	-2260.282	395.992
40061	88	147.335	198.692	203.819	0.272	-2382.310	-2259.525	393.418
1300 h	8	176.665	282 105	215.754	33 175	-2380.411	-2178.007	227.535
	88	184.498	315.037	229.620 243.931	51.250 70.024	-2378.654 -2376.665	-2137.686 -2097.680	186.102 156.531
	88	196.276 201.238	369.807 393.215	258.078 271.813	89.383 109.262	-2374 486	-2057.972 -2018.544	134,372
$\Delta_{\rm fus}H^{\circ}$	8 5	205.870	414 660	285.040	129.620	-2378.616	- 1978.653	103.354
	300	214.539 218.681	434 490 452.970 470.307	297.735 309.911 321.589	171.671 171.671 193.333	-2382.691 -2382.691 -2379.379	- 1938.752 - 1898.789 - 1858.597	92.084 82.652 74.679
ientific	1300.000	218.681 261.082	470.307	321.589 321.589	193,333	CLASS	SS <> LIQUID TRANSTTION	
	1400	261.082 261.082	489 655 507.668	332.911 343.968	219.441 245.549	-2499.262 -2490.636	-1815.654 -1767.128	67.743 61.537
	895	261.082	524.518	354.732	7271.657	-2482.284	-1719.168	56.125
	0 0 0 0 0 0 0 0 0 0 0 0 0	261.082	555.268 569.384	385.184	323.873	-2466 497 -2459.112	-1624.740 -1578.179	47 149
	1963.00		577.901	391.233	366.430	CRYSTAL	(AL <> LIQUID	QIN
	2000	261.082	582.776	394.731	376.090	-2481.473	-1531.089	39.988
	2100	261.082	595.514	403.992	402.198	-2476.355	- 1483.696	36.905
	200	261.082	619.265	421.694	454.414	-2466.290	-1389.624	31.559
	2500	261.082	641.035	438.383	480.522 506.631	-2461.342 -2456.451	-1342.919 -1296.419	29.228 27.087
	2600	261.082	651.275	446.375	532.739	-2451.614	-120.113	25.115
	2800	261.082	670.623	461.710	584.955	-2442.105	-1158.047	21.604
	3000	261.082 261.082	679.785 688.636	469.073	611.063	-2437.431 -2432.812	-1112,272 -1066,655	20.034
	3100	261.082	697.196	483.235	663.280	-2428.245	-1021.190	17.207
	330	261.082	713.519	496.702	715.496	-2419.271	-930,700	14.732
	3200	261.082 261.082	721.313	503.195 509.535	741.604	-2414.863 -2410.508	-885.656 -840.744	13.606
	3600	261.082	736.236	515.731	793.820	-2406.207	-795.954	11.549
	3800	261.082	750.352	527.711	846.037	-3213.497	-668.648	9.191
	3900 4000	261.082 261.082	757.134 763.744	533.507 539.181	872.145 898.253	-3207.003 -3200.675	-601.763 -535.044	8.060 6.987

	STAI	!
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(°C
(MgTi ₂ (
Oxide
Titanium
Magnesium

$M_r = 200.0620$	Magnesiu	ım Titan	ium Oxic	Magnesium Titanium Oxide (MgTi ₂ O ₅)	Ç.		Mg	Mg,O ₅ Ti ₂ (cr,l)	
	Enthalpy R	Reference To	Enthalpy Reference Temperature * T.	. T. = 298.15 K		Standard State Pressure	1 1	p° = 0.1 MPa	
	τÆ	ະ	S -[C	-[G*-H*(T,)]/T	$H^{\bullet}-H^{\bullet}(T_{\epsilon})$)	₽ 'Q•	log Kr	
	0 8 8 0	0. 46.129 110.533	0 22.217 75.638	139 695	-22 439 -20.891 -12.811	-2495.427 -2502.903 -2507.943	-2495 427 -2459 195 -2413 208	1284.552 630.265	
	298.15	146.858	135.603	135,603	6	-2509.354	-2368.790	415.002	
	888	147,335	136.513	135.606 141.640 25.506	0.272 16.019	-2509.357 -2508.821	-2367.918 -2320.819	412.291 303.068	
	88	184.498	252.858	167.441	51.250	-2505.701	-2227.426	193.915	
	88	196.276	307.628	195.899	89.383	-2503.712	-2181.202	162.763	
	88	205.870	331.036 352.481	209.634 222.861	109.262 129.620	-2499.268 -2505.664	-2089.630 -2043.521	121.279	
	1200	210.284	390 791	235.557	150.429	-2503.688	-1997.403	94.849	
	98	218.681 222.739	424.482	259.410 270.622	215.404	-2506.427	- 1904.812 - 1855.496	76.536 69.229	
	991	230.672	454.745	291.777	260 748	-2620.334	-1745.488	56.984	
	808	238.438	482,364	301.781	307.662	-2615.031 -2609.756	-1690.975	51.957	
	1963,000		503.301	326.512	347.037	- 2604.443	08780	43518	
	1963.000		577.901	326,512	493.477		NSTITIO	 }	
	2000	261,082	582.776	331,208	503.137	-2481 473	-1531.089	39.988	
	2200	261.082 261.082	595.514 607.660	343 493 355 227	529.245 555.353	-2476355	-1483.696	36,905	
	7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7	261.082 261.082	619.265 630.377	366.456 377.223	581.462 607.570	-2466.290	-1389.624	31.559	
	2500	261.082	641,035	387.564	633.678	-2456.451	-1296.419	27.087	
	2700	261.082	651.275	407.093	659.786 685.894	-2451.614 -2446.832	-1250.113 -1203.992	25.115	
	888	261.082	670.623	475.264	712,002	-2442.105 -2437.431	-1158.047	20.034	
	300	261.082	088.636	433,896	764.219	-2432.812	-1066.655	18.572	
	3200	261.082	705.485	450.350	816.435	-2428.245	-1021.190 -975.875	15.930	
	000	261.082	721.313	465.828	868.651	-2419 <i>27</i> 1 -2414 <i>8</i> 63	-885.656	13.606	
	360	261.082	736.236	480 440	920.868	-2406.207	-795 954	1 549	
	3700	261.082	743.390	487.450	946.976	-3220.157	-735.708	10.386	
	386	261.082	757.134	500.931	999.192	-3207.003	-601.763	8.060	
	4000	780.102	163.744	507.419	1025.300	-3200.675	-535.044	6.987	
	_								
	PREVIOUS						CURRE	CURRENT, June 1967	

Refer to the individual tables for details.

0 to 1963 K crystal above 1963 K liquid

CURRENT: September 1977

CRYSTAL	
(dS)	
esium Sulfide (MqS	•
Magnesi)

L		
	$\Delta_t H^0(0 \text{ K}) = -34465 \pm 4.2 \text{ kJ} \cdot \text{mol}^{-1}$	$\Delta H^{\circ}(298.15 \text{ K}) = -345.72 \pm 4.2 \text{ kJ} \cdot \text{mol}^{-1}$
		33 ± 0.4 J·K ⁻¹ ·mol ⁻¹

Mg₁S₁(cr)

M_r = 56.365 Magnesium Sulfide (MgS)

kcal-mol^{1,4} The uncertainty reflects the correction to 298.15 K and the ambiguity of the exact solution composition. Von Wartenberg* measured $\Delta_1 H^o(293 \text{ K}) = -33.95 \pm 0.79 \text{ kcal-mol}^{-1}$ for $MgS(cr) + 2 \text{ HCI}(30 \text{ H}_2O, \text{ aq}) \rightarrow MgCl_3(30 \text{ H}_2O, \text{ aq}) + H_2S(g)$. We derive Δ_H^2 (MgS, cr. 293.15 K) = 82.8 ± 2.0 kcai mol⁻¹ respectively based on the following auxiliary data: Δ_H^2 (HCI-100 H₂O, aq. 298.15 K) = -9.5 kcai mol⁻¹; and Δ_H^2 (MgCl₂-100 H₂O, aq. 298.15 K) = -190.59 $MgS(cr) + 2 \text{ HCI(aq, 100 H₂O)} \rightarrow MgCL_{2}(aq, 100 H₂O) + H₂S(aq). We derive <math>\Delta_{l}H^{2}(MgS, cr, 298 15 \text{ K}) = -83.0 \pm 2.0 \text{ kcal·mol}^{-1} \text{ and}$ Sabatier¹ determined △H°(286 K) = -37.8 ± 1.0 kcal·mol⁻¹ while Moutlor² determined △H°(291 K) = -38.0 ± 1.0 kcal·mol⁻¹ Enthalpy of Formation S°(298.15 K) = 50.3

Δμ'(MgS, cr. 298.15 K) = -82.0 ± 1.0 kcal·mol⁻¹ based on the following auxiliary datz. Δμ'(HCl·30 H,O. aq. 298.15 K) = 39.357 kcal·mol⁻¹ 3 and Δμ'(MgCl₂ 30 H₂O, aq. 298.15 K) = 189 78 kcal·mol⁻¹ 4. Kapustinskii and Korshunov⁶ performed calorimetric measurements of the enthalpy of formation of MgS(cr) from the pure elements. They

determined AHP(298.15 K) = -84.33 ± 0.27 kcal·mol⁻¹ for Mg(cr) + S(cr, rhombic) = MgS(cr).

Our analyses of equilibrium studies of Curlock and Pidgeon¹ and of Dewing and Richardson¹ are given below. The two studies are m reasonable agreement. The 3rd law AH²(298.15 K) may be in error by as much as 0.5 kcal mol⁻¹ since the Gibbs energy functions employed in the calculations are partially based on estimated high temperature C²_p values.

		Data			SS	ΔH°(298.15 K), kcal·mol ⁻¹	1 A _t H°(298.15 K)
Source	Method	Points	Reaction*	T/K	cal·K ⁻¹ ·mol ⁻¹	2nd law 3rd law	
Curlock7	Equilibrium	9	٧	1180-1483	-0.60 ± 0.45	$-8.49 \pm 0.59 - 9.19 \pm 0.24$	4 -81.59 ± 0.4
Dewing*	Equilibrium	9	∢	1267-1768	-2.23 ± 0.22	$-5.53 \pm 0.38 - 873 \pm 1.01$	

*Reaction: A) $MgS(cr) + H_2O(g) = MgO(cr) + H_2S(g)$ Our adopted value is based on a weighted average of all the data

Heat Capacity and Entropy

Stull *et al.*, measured the low temperature heat capacities in an adiabatic calorimeter from 15–320 K. Their smooth values are adopted in the tabulation. The entropy $5^{\circ}(298.15 \text{ K}) = 12.03 \pm 0.1 \text{ cal-K}^{-1} \text{mol}^{-1}$ is based on $5^{\circ} = 0.010 \text{ cal-K}^{-1} \text{mol}^{-1}$ at 15 K. The C_{ρ}^{ρ} values above 320 K are estimated by graphical extrapolation combined with method B of Kubaschewski *et. al.*¹⁰

Fusion Data

MgS melts above 2300 K "and no other literature melting data are available.

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Kubaschewski, E. L. Evans, and C. B. Alcock, "Metallurgical Thermochemistry," 4th ed., Pergamon Press, Oxford, (1967). ¹⁰O. Kubaschewski, E. L. Evans, and C. B. Alcock, "Metallurgical Thermochemistry," 4th
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 ¹²IANAF Thermochemical Tables: MgO(cr) 12–13–74; H₂O(g) 3–31–61, H₂S(g) 6–30–77.

Standard State Pressure = p = 0.1 MPa 99.444 44.579 150.921.150 150.921.150 160.921 NFINITE 59.818 -341.406 -339.840 -337.556 -334.934 -332.097 -329.094 -324.871 -314.931 -304,770 -294,602 -284,431 -271,091 -251,639 -232.279 -213.008 -193.822 -174.718 -80.328 -61.662 -43.064 -24.532 -6.064 12.341 30.683 -136.742 -341.433 529.112 -351.381 -352.575 -353.697 -407.949 -416.494 -416.585 -416.645 -416.676 -544.087 -542.712 -525.756 -524.029 -522.270 -520.479 -518.656 345.728 348.212 349.975 -536.947 -535.444 345.724 -541311 533.91 14530 19555 24652 24652 24653 34923 34923 34923 36044 61.429 66.836 77.837 83.385 88.968 88.968 100.561 0.084 4.753 9.584 Enthalpy Reference Temperature = T, = 298.15 K $S^{\bullet} - [G^{\bullet} - H^{\bullet}(T_{\bullet})]T$ 86.467 84.342 50.334 52.150 55.639 59.606 63.631 67.556 71.318 78.305 81.538 84.613 87.542 90.335 93.005 95.562 98.014 100.369 104.820 106.927 108.964 110.935 50,334 114.697 116.496 118.244 119.944 121.600 J·K-'mol-' 50.616 64.032 74.807 57 488 14,790 127.571 47.120 49.864 52.501 55.039 50,334 83.823 09.823 162.141 34.79 49.915 50.543 51.003 52.347 52.802 53.252 53.681 54.073 45.564 51.463 51.882 45,647 47.614 54.476 54.910 55.312 55.647 56.024 56.468 57.326 57.739 58.131 58.534 58.953 59.371 59.789 ئ 98.15 ΤÃ

PREVIOUS: December 1971

Mg₁S₁(g)

M_r = 56.365 Magnesium Sulfide (MgS)

Mg₁S₁(g)

CURRENT September 1977 (1 bar)

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de
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S
siu
gne
Mai

S°(298.15 K)

IDEAL GAS

) = 225.48	= 225.483 ± 4.2 J·K ⁻¹ ·mol ⁻¹	·mol-				$\Delta_i H^o(2S)$	H*(0 K) = [14 18 I5 K) = [14	$\Delta_t H^{\circ}(0 \text{ K}) = [145.39 \pm 66.9] \text{ kJ mo}$ $\Delta_t H^{\circ}(298 \text{ 15 K}) = [145.23 \pm 66.9] \text{ kJ·mo}$	K E
			Electro	nic States and	Electronic States and Molecular Constants	nstants	•		
State	€, cm	š	we, cm	ω _c τ _e , cm	ρ _c , cm	ae, cm	رۍ ۸	Source	
XIX.	0.0		526.47	2.681	0.26570	0.00174	2.1425	-	
Ę	[2000]	9	[430]	[2.2]	[0.237]	[0.0015]	[2.27]	7	
ᄪ	[3000]	7	[430]	[2.2]	[0.237]	[0 0015]	[2.27]	m	
į,	[17000]	3	[493.20]	[2.313]	[0.2530]	[0 00153]	[2.1956]	ij	
Α'Σ.	23036.98	_	495.20	2.313	0.2530	0.00153	2.1956	-	

Enthalpy of Formation

Colin et al.1 searched unsuccessfully for gaseous MgS in a Knudsen effusion mass-spectrometric experiment. They set the upper limi inherent in linear-Birge-Sponer extrapolations (LBX) on the oxides and sulfides of the alkaline earths. The normal LBX yield $D\hat{G}(MgS,g) = 73$ kcal·mol⁻¹. When adjusted for ionic character with the Hildenbrand correction, $^3D\hat{G}(MgS,g) = 65$ kcal·mol⁻¹. The groun reliable method of esturation is that of Hauge and Margrave* based on the observation that the ratio D_{MS}K_{MO}D_{Mo}K_{MS} is very similar fo clements within a given group. Based on data involving known bond energies and force constants of the gaseous diatomic oxides and sulfides oxides and sulfides⁶ suggest lower values of $D_0^0(MgS, g)$ than the Hauge and Margrave method leads to. We adopt $D_0^0(MgS, g) \approx 16 \text{ kcal·mol-}^1$. Using auxiliary JANAF data, we calculate $\Delta_1 H^0(MgS, g, 298 15 \text{ K}) = 34.71 \pm 16 \text{ kcal·mol-}^1$. De(MgS, g) = 55 kcal-mol-1 There are no other equilibrium or positive mass spectrometric data involving MgS(g); consequently De(MgS, g state of MgS cannot dissociate into ground state atoms. After correcting for the excited atomic products, D2(MgS, g) = 42 kcal-mol-1. A mor we calculate DolMgS, g) = 78 ± 10 kcal·mol-1. Dissociation energies of the alkaline earth monoxides were taken from Srivastava, dissoc ation energies for the alkaline earth sulfides were taken the JANAF Thermochemical Tables⁶ and force constants were calculated fror must be estimated. The Birge-Sponer extrapolation is of little utility in this case. Gaydon, has gone into great detail concerning the problem spectroscopic data of Barrow and Cousins 7 Further comparisons of vapor pressures and enthalpies of sublimation for the other alkaline ear

Heat Capacity and Entropy

account for the natural abundances of the elements. Other low-lying electronic states and their vibrational-rotational constants are estimated in isoconfigurational groups by analogy with MgO^o and from trends observed in the known states of the other alkaline-earth oxides and sulfides. Uncertainty in the energy and molecular constants for the estimated states may contribute significantly, perhaps as much as 1.C cal·K⁻¹ mol⁻¹ to the entropy at 298.15 K. The spectroscopic constants of the observed states, taken from Marcano and Barrow^{*} for the 1sotopic species M_2^{23} , are corrected to

splitting of the isoconfigurational Σ states are used to place the $^3\Sigma$ state 6000 cm⁻¹ below the experimentally observed 4 A¹ Σ * state. B analogy with MgO° we do not feel that a '\Delta state exists below 25000 cm-1. The thermodynamic functions are calculated using first-ord The ground state of gazerous MgS is taken as 'Y. There should be low-lying triplet states. A 'II state is predicted for MgS at 3000 cm based on experimentally observed 'II states for MgO,' BeO,' and BeS. ¹⁰ The corresponding triplet, ³II, is assumed to lie 1000 cm - lowe in energy based on trends in the triplet-singlet splitting observed by Field" for the alkaline-earth oxides Smilar trends in the triplet-single anharmonic corrections to Q'_i and Q'_i in the partition function $Q = Q_i \sum Q_i Q_i g_i$, $\exp(-c_2 \epsilon_i / T)$.

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39 34,648 212,647 224,648 10064 145,200 9,000 40 37,972 26,602 226,873 1,622 141,668 9,100 45 47,977 26,602 226,873 1,623 141,668 9,101 45 47,977 26,602 226,873 1,234 1,134 1,134 1,134 60 42,972 26,602 226,873 1,134 1,134 1,134 1,134 100 52,741 261,88 28,292 27,403 1,134 1,134 1,134 100 53,877 26,402 27,403 1,134 1,134 1,135 1100 53,877 26,402 27,403 1,134 1,135 1,135 1,135 1100 53,877 26,402 27,403 1,135 1,135 1,135 1,135 1100 54,877 27,403 1,135 1,134 2,134 1,135 1100 54,877 27,403 1,134	298.15		225.483	225.483	o	145.227	79 297	-17 046
400 77977 276.687 275.878 1567 1717 400 77977 276.687 275.878 1567 1711 500 42972 255.684 278.979 1718 1910 65.39 600 42972 255.694 278.979 1718 1910 66.39 700 257.41 261.686 239.592 12.384 193.17 50.31 700 25.41 261.88 236.24 239.592 12.384 193.17 66.39 1100 35.81 26.62 239.592 12.384 193.17 50.486 1100 35.81 26.62 24.531 18.395 13.13 13.395 13.13 1100 35.81 26.62 24.531 18.395 13.13 13.395 13.394 1100 45.82 26.62 26.63 26.44 27.31 13.24 27.31 1100 45.83 26.63 27.24 27.31 27.31 27.31	88	34.648	225.697	225.484	0064	145.203	97.000	-16.889
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800 \$5700 188.00 \$100 800 \$5700 188.00 \$100 \$1133 \$1238 \$1341 \$1133 1000 \$4510 \$1490 \$14540 \$14540 \$1453 \$1454 \$1453 \$1454	98	48.397	253.377	232.903	12.284	137.324	52.038	-4.530
900 55.544 749.40 24.4481 18.313 18.159 11.11 1100 53.380 28.576 246.24 33.831 18.159 11.137 13.956 1100 53.380 28.576 250.24 34.21 13.424 -2.948 1200 51.717 29.247 25.421 44.510 73.44 -2.948 1300 48.385 29.247 25.421 45.351 -2.948 1400 48.385 29.247 25.441 -2.547 -2.547 1500 46.161 304.531 26.930 73.244 -1.547 -1.558 1500 45.17 307.230 26.930 73.244 -1.586 -1.586 1800 45.17 307.230 30.330 -1.532 73.244 -1.586 -1.586 1800 45.17 30.246 27.559 60.590 -1.532 -1.1192 1800 45.17 47.24 27.544 1.547 -1.1192 -1.1192		55 100	268.406	239.950	22.765	135.386	23.941	-1.563
1100 53380 285 926 200.240 39.255 71.465 -2.948 1200 50.777 294.274 256.421 45.597 71.474 -2.948 1200 50.777 294.274 256.421 45.597 71.474 -2.948 1200 50.777 294.274 256.421 45.597 71.474 -2.948 1200 42.717 301.256 201.298 59.323 -23.246 -2.05.277 -2.05.274 1200 42.717 301.256 201.298 59.323 -23.247 -1.18.16 1200 42.717 301.256 201.298 59.323 -23.247 -1.18.16 1200 42.717 31.246 27.127 26.259 201.298 29.227 -2.2568 -1.14.16 -2.207 20.000 42.717 31.445 26.233 77.440 -2.2277 -1.11.19 20.000 42.727 31.445 26.233 31.445 26.233 31.445 26.233 31.445 20.233 31.445 20.233 31.445 20.233 31.445 20.233 22.761 20.232 21.475 21.243 22.000 41.725 31.445 20.277 21.102 21		55.594	274 940	243.481	28.313	81.559	1.133	9,00
1200 51771 25050 253408 44510 73434 -9886 1400 45385 258230 256421 45530 7343 -9886 1500 45177 30154 256421 4531 -5467 -6839 1500 45217 30458 268230 68350 -51268 -13468 1700 45217 30458 268330 73042 -51268 -13486 1800 4476 31226 27152 4740 -52274 -1186 200 4776 31226 271539 73042 -51267 -1119 200 4776 31226 271539 86.08 -51467 -118 200 4776 31048 27934 86.08 -51409 -448 200 4717 31044 27934 94.77 -51109 -448 200 4178 312225 31248 27934 -1196 -51109 -448 200 4178		53,380	285.926	250.240	39.255	73.486	-2.948	0.140
1500 45.287 25.274 25.274 25.274 25.274 25.277 25.		51.717	290.500	253.408	44.510	73.424	-9.896	0.431
1500 47.278 201.556 264.555 561.588 59.323 -53.867 -18.166 1500 47.278 204.551 264.555 563.950 -53.224 -18.166 1500 43.765 312.262 265.950 68.560 -22.698 -11.192 -11.192 1500 43.765 312.262 271.520 -25.931 -8.2920 -25.067 -21.931 -8.2920 -25.067 -21.673 -26.653 -21.673 -26.653 -22.00 43.765 312.262 271.525 86.066 -21.673 -21.673 -6.6653 -22.00 43.765 312.262 271.525 -21.00 -21.673		48.585	298.230	259.279	54.531	-54.64	- 20.572	0.768
1500 46, 161 304,551 264,555 65,993 - 15,808		47.278	301.536	261.988	59.323	-53.867	-18.166	0.633
1800 4476 509.88 269.303 71502 715		46.161	304.551	264.555	63.993	-53.224	-15.808	0.516
1900 43.765 312.265 271.539 67.789 -51.931 -8.900 2000 42.176 316.525 2715.394 -51.647 -4.663 2100 42.786 318.572 277.594 -51.677 -4.613 2200 42.786 318.572 277.539 86.096 -51.167 -4.183 2300 41.539 322.539 28.2761 107.079 -51.100 4.488 2500 41.375 325.539 28.2761 107.079 -51.100 4.488 2600 41.375 33.00.35 28.2761 107.079 -51.100 8.945 2700 41.375 33.00.35 28.874 119.456 -51.031 11.169 2800 41.002 33.00.35 28.874 119.456 -51.631 13.365 290 41.002 33.00.35 28.874 119.456 -51.631 11.169 390 40.002 33.348 29.270 121.523 -51.439 10.024 3		44 426	309.881	269.303	73 042	-52.272	-11.192	0.325
2100 42,752 315,329 315,329 41,329 41,329 41,329 42,48		43.765	312,265	271.502	77.450	-51931	-8.920	0.245
2200 42,362 318,572 27,573 30,500 -51,657 -448 2300 42,568 310,488 279,330 94,772 -51,155 0.048 2400 41,781 322,223 284,76 -51,105 -51,105 0.048 2400 41,785 322,532 284,376 107,06 -51,105 448 2500 41,735 332,532 284,376 107,06 -51,106 448 2700 41,022 330,055 284,376 111,205 -51,101 111,69 2800 41,002 330,055 288,474 119,406 -51,409 119,605 300 40,702 334,681 290,204 119,406 -51,499 100,002 300 40,702 334,681 296,411 139,406 -51,499 20,002 300 40,702 334,681 296,411 139,406 -51,489 20,002 300 40,702 334,682 297,711 48,002 20,134 40,486<		C14.C4	316 603	045.512	61.190	50.15-	-0.003	0.1/4
2300 42,048 372,048 279,330 44,572 51195 0.048 2500 41,789 372,212 381,081 98 763 -51106 4498 2500 41,375 373,539 282,376 10706 -51102 4498 2700 41,275 377,118 285,931 111,205 -51101 8945 2700 41,072 336,615 287,438 119,422 -511,101 111,69 290 41,002 330,035 387,439 115,321 -51,141 111,69 300 40,925 334,681 290,270 121,203 1336 310 40,825 334,681 290,270 121,512 -51,339 310 40,826 334,681 290,491 133,746 -51,339 1738 310 40,826 334,681 290,491 13,331 -51,414 29,077 310 40,762 334,682 297,771 148,098 -51,344 40,436 310 <t< td=""><td></td><td>42.75</td><td>318.572</td><td>24.55 24.503</td><td>90.351</td><td>-51.30</td><td>-4.419 -2 183</td><td>0.052</td></t<>		42.75	318.572	24.55 24.503	90.351	-51.30	-4.419 -2 183	0.052
2500 41,375 322,222 26,100 4,088 2500 41,375 323,932 282,376 107,076 -51,002 4,488 2500 41,375 323,535 284,376 107,076 -51,002 4,488 2500 41,122 332,935 284,376 1107,076 -51,103 13,365 2800 41,102 336,235 288,374 119,456 -51,233 13,355 300 40,265 332,785 291,620 127,612 -51,233 17,857 310 40,865 332,335 291,620 127,612 -51,439 20,022 310 40,786 334,081 292,941 13,984 -51,633 20,331 340 40,776 340,002 28,889 297,771 148,008 -52,144 24,575 350 40,776 340,002 28,889 29,944 15,616 -53,444 40,436 400 40,774 34,1408 290,004 15,616 -53,444 40	_	42.048	320.448	279.330	94.572	-51 195	0.048	-0.001
260 41,375 332,559 284,376 107,076 -51,082 6,721 2700 41,225 377,118 285,931 111,235 -51,101 8,945 2800 40,1023 330,045 288,874 119,426 -51,203 11,595 3000 40,923 331,442 202,720 121,623 -51,203 13,595 3100 40,826 332,785 291,620 127,612 -51,439 20,022 3300 40,776 334,681 292,926 13,146 -51,439 20,022 3400 40,776 336,534 296,613 13,146 -51,439 20,077 3500 40,776 340,022 296,421 13,934 -51,935 20,077 360 40,776 340,022 298,888 15,043 -51,935 20,077 3700 40,776 340,022 298,888 15,043 -51,935 20,077 3800 40,776 340,022 298,888 15,043 -51,935	2500	41.559	323 933	282.761	102.929	-51.126	4.498	-0.049
2500 41,125 247,118 25.931 111,120 25.1101 8.945 2500 41,102 330,055 288.874 119.426 -51,101 18.945 3000 40,925 331.44 200,270 17.612 -51,101 13.96 3100 40,825 332,785 291,620 17.612 -51,333 17.857 3300 40,780 334,818 292,926 13,146 -51,439 20,002 3300 40,776 334,618 292,924 13,848 24,713 24,573 3500 40,776 34,002 296,613 13,746 -51,335 20,771 3500 40,776 34,002 298,898 15,005 -52,144 24,773 3600 40,776 34,002 298,898 15,005 -52,144 24,773 3800 40,776 34,002 298,898 15,003 -52,344 40,436 3800 40,776 34,002 298,898 15,003 -52,344 40,436		41.375	325.559	284.376	107.076	-51.082	6.721	-0.135
200 41 003 330,055 288.874 119.426 -51,203 13.365 300 40.925 314.44 290,770 123.53 -51,234 156.55 3100 40.855 334.785 291,620 127.612 -51,384 156.55 3300 40.796 334.785 294,193 137.66 -51,499 20.002 3300 40.776 334.736 296.613 143.31 -51,734 24.775 3400 40.776 340.025 296.613 143.31 -51,344 29.077 3500 40.766 340.025 298.898 152.087 -52.14 29.077 3700 40.776 340.025 298.898 152.087 -52.347 313.53 380 40.776 341.089 299.944 156.163 -52.344 313.53 380 40.817 341.089 299.944 156.163 -53.44 40.34 4100 40.817 341.183 300.116 164.327 -53.14		41.102	328.615	287.428	115.321	-51.101	11.169	-0.173
3100 40.865 33.735 291.620 17.612 -51.83 17.52 3200 40.850 334.081 292.956 131.666 -51.499 20.092 3300 40.776 335.347 294.193 133.76 -51.439 20.092 3300 40.776 335.347 294.191 139.854 -51.774 24.575 3500 40.766 338.882 297.771 148.008 -51.1935 26.823 3600 40.766 338.883 297.771 148.008 -52.144 29.771 3700 40.776 340.002 298.898 152.063 -52.344 35.077 3800 40.776 340.002 298.898 152.063 -52.347 36.00 3800 40.00 434.108 299.944 156.163 -52.347 36.00 400 40.877 34.1183 302.101 164.377 -53.124 45.01 400 40.877 34.1183 302.101 164.377 -53.124 <		41 003	330.055	288.874	119 426	-51.203	13.3%	-0.241
320 40.820 334.188 222.976 131 666 -51.499 20.092 330 40.776 33.41.88 229.781 135.76 -51.499 20.092 3400 40.776 33.45.54 295.411 133.76 -51.633 22.31 3500 40.776 3340.02 299.24 15.163 -51.63 22.53 3600 40.776 340.02 299.94 15.163 -51.34 29.07 360 40.776 340.02 299.94 15.163 -52.34 3135 400 40.776 341.089 299.94 15.163 -52.34 40.436 400 40.877 341.183 301.061 164.377 -53.112 38.150 400 40.877 341.183 302.101 164.377 -53.143 40.436 400 40.882 344.182 302.101 164.377 -53.143 41.30 400 40.882 344.182 30.4105 175.597 -53.43 47.34 <		40.865	337 785	201.002	127.617	181 15-	7871	-0.301
3400 40.790 335.34 294.193 135.76 -51.633 22.31 3400 40.776 337.55 296.613 113.87 -51.633 22.31 3500 40.76 337.75 296.613 143.931 -51.955 26.823 3500 40.76 337.75 296.83 122.08 -22.14 20.77 3700 40.77 341.089 299.94 156.163 -52.37 315.00 390 40.817 342.189 300.100 166.437 -53.37 315.00 400 40.817 34.183 300.101 164.37 -53.43 40.45 400 40.82 344.182 300.101 164.37 -53.43 40.45 400 40.82 344.182 300.101 164.37 -53.43 40.45 400 40.921 345.183 304.102 175.39 -53.43 40.45 400 40.921 345.03 306.016 180.96 -53.43 40.45		40.820	334.081	292.926	131 696	-51.499	20.092	-0.328
3500 40.764 337.736 296.613 14.931 -51.955 26.823 3500 40.766 338.885 29.7771 148.08 -52.14 29.077 3700 40.776 340.002 298.892 155.163 -52.14 29.077 3800 40.776 341.089 299.94 155.163 -52.87 313.60 3900 40.877 34.183 392.101 160.243 -51.347 315.00 400 40.887 34.183 392.101 166.437 -53.143 315.00 4200 40.882 344.183 392.101 166.437 -53.143 40.45 4200 40.921 345.183 392.101 166.437 -53.143 40.45 4200 40.921 345.183 390.110 166.327 -53.143 40.45 4200 40.921 345.183 306.016 180.96 -53.773 40.36 4500 41.002 348.005 306.395 184.800 -54.58 46		6.75 6.77 7.72	335,337	295.421	139.854	-51.633	22.331	-0.353
3500 40.766 33.88.5 29.7711 148.008 -52.144 29.077 3700 40.776 340,002 298.893 152.065 -52.34 31.315 3800 40.779 341,029 299.994 156.163 -52.847 31.560 400 40.847 343,183 302.101 166.437 -53.43 31.50 400 40.847 343,183 392.101 166.437 -53.43 40.436 410 40.887 346.143 302.101 166.437 -53.43 40.436 420 40.964 346.143 305.116 166.437 -53.43 40.436 430 41.062 346.143 305.01 175.30 -53.43 40.436 450 41.062 346.143 305.07 176.597 -54.487 40.346 450 41.062 347.083 306.016 180.966 -53.48 40.341 450 41.062 347.083 306.399 184.800 -53.48 47.331<		40.764	337 736	296.613	143.931	-51.955	26.823	-0.400
3500 40,770 340,002 258,98 15,100 -22,54 31,530 3800 40,773 341,089 156,163 -22,54 31,530 3900 40,817 341,189 301,061 166,437 -52,43 3580 4100 40,847 343,183 302,101 164,377 -53,43 40,436 4100 40,921 345,118 302,101 172,303 -53,473 40,436 4300 40,921 345,118 304,105 175,307 -54,43 40,436 4300 40,921 345,118 305,017 175,307 -54,43 40,436 4500 40,023 346,103 105,077 176,597 -54,437 40,331 4500 41,002 347,733 366,105 188,809 -55,486 51,393 4500 41,117 349,733 368,712 19,302 -55,844 56,688 4500 41,118 315,11 310,466 210,126 -51,304 50,533		40.766	338.885	177.762	148.008	-52.144	75.077	-0.422
3900 40,847 342,149 301,061 160,243 -52,843 35,872 4000 40,847 34,1183 302,101 164,277 -53,143 38,150 4100 40,921 344,128 304,105 175,303 -53,773 40,73 4200 40,921 344,128 304,105 175,303 -53,773 40,73 4200 40,926 344,103 306,016 175,303 -53,773 40,73 4200 41,012 347,033 306,016 188,09 -54,488 47,342 4500 41,115 348,005 306,616 188,09 -54,887 47,342 4500 41,115 349,733 308,725 193,023 -55,466 51,343 400 41,117 349,733 308,725 193,023 -55,46 51,343 400 41,117 349,733 308,725 193,023 -55,46 51,343 400 41,118 331,511 310,266 201,249 -55,46 <t< td=""><td></td><td>40.793</td><td>341.089</td><td>299,994</td><td>156.163</td><td>-52.587</td><td>33,600</td><td>-0.442</td></t<>		40.793	341.089	299,994	156.163	-52.587	33,600	-0.442
4100 40.882 344.182 303.116 168.413 -53.444 40.436 4200 40.921 345.178 304.116 175.491 -53.473 42.702 4200 40.921 345.178 304.105 175.403 -53.773 42.702 4200 40.922 345.178 304.105 175.403 -53.473 42.702 4200 40.922 345.178 305.075 175.403 -53.473 42.703 420.00 41.002 346.003 305.003 168.005 -54.438 47.342 4500 41.002 348.003 307.841 188.009 -53.466 51.933 4700 41.110 349.779 307.841 188.009 -55.546 51.933 4800 41.287 315.161 310.436 201.269 -57.516 59.053 5000 41.287 315.161 310.436 201.269 -57.801 61.431 51.000 41.473 315.300 312.009 209.538 -58.500 65.229 5200 41.473 315.300 312.803 209.538 -60.050 65.229 5200 41.577 315.183 20.500 61.833 5500 41.577 315.183 20.500 61.833 5500 41.577 315.183 20.500 61.833 5500 41.577 315.183 20.500 61.833 5500 41.577 315.183 20.500 61.833 5500 41.737 315.183 20.500 61.833 5500 41.737 315.183 20.223 61.833 61.645 5500 41.737 315.183 20.500 61.833 5500 41.737 315.183 20.500 61.833 5500 41.737 315.183 20.500 61.833 5500 41.737 315.183 20.523 61.833		40.817	342.149	301.061	160.243	-52.843	35.872	-0.480
4200 40,211 345,178 304,105 172,503 -53,773 42,729 4300 40,965 346,143 306,016 175,507 -53,773 42,729 4500 41,012 347,083 306,016 180,696 -54,388 45,531 4500 41,002 348,005 306,393 184,800 -53,897 49,663 4500 41,115 348,903 306,715 183,300 -53,846 41,342 4700 41,116 349,793 308,725 193,023 -55,846 54,335 4800 41,278 306,61 309,589 197,143 -56,545 56,638 4900 41,378 315,151 311,266 201,269 -57,150 61,311 500 41,348 333,166 312,080 209,338 -58,500 63,823 510 41,473 333,166 313,660 217,833 -60,305 66,239 5200 41,473 337,033 315,944 226,133 -60,305	4100	40.882	344.192	303.116	168.413	-53.434	40,436	-0.515
4500 41,012 347,033 306,016 180,656 -54,548 47,342 4500 41,012 347,033 306,016 180,656 -54,548 47,342 4500 41,115 348,003 306,319 184,800 -54,548 47,342 4700 41,115 348,093 306,312 -55,846 51,933 4700 41,115 348,093 308,723 193,023 -55,846 54,335 4800 41,228 330,661 309,589 197,143 -56,545 56,688 4800 41,287 331,511 31,314 311,266 203,400 -57,801 61,431 5100 41,410 333,46 311,266 203,400 -57,801 61,431 5200 41,473 333,476 313,660 217,833 -60,505 66,229 5300 41,573 334,761 313,660 217,833 -60,505 66,229 5500 41,734 337,033 315,944 230,323 -62,779 76,077 5600 41,734 337,033 315,944 -66,029 81,001 5800 41,888 339,256 318,071 24,2874 -66,029 81,001	2500	40.921	345.178	304.105	172.503	-53.773	42.729	-0.531
4500 41.062 348.005 306.979 184.800 -54.987 49.665 4600 41.115 348.909 307.329 184.800 -54.887 49.665 4700 41.115 348.909 307.324 188.999 -55.846 51.993 4700 41.278 350.661 309.589 197.143 -55.846 51.395 4900 41.287 3315.11 316.50 201.269 -77.150 61.315 5100 41.410 331.346 311.266 205.400 -77.801 61.431 5200 41.473 333.946 312.890 209.238 -58.500 65.823 5200 41.473 333.970 31.2878 213.882 -59.250 65.823 5300 41.573 334.761 313.660 217.833 -60.050 66.229 5500 41.743 335.263 314.429 22.64.133 -60.050 66.229 5500 41.743 337.033 315.944 22.64.133 -62.779 76.077 5500 41.744 337.033 315.944 230.323 -62.779 76.077 5500 41.748 337.033 315.944 -66.059 81.201 5900 41.985 339.256 318.071 24.2874 -66.029 81.201	4400	41.012	347.083	306.016	180.696	- 54.548	47.342	-0.562
400 41.115 348 90 307.841 188.390 -55.466 51.931 4700 41.170 348 90 308.732 188.390 -55.466 51.931 480 41.28 350.661 309.589 197.143 -55.546 54.335 5000 41.287 351.246 311.266 201.249 -571.50 61.431 5100 41.410 353.166 311.268 205.400 -571.801 61.431 5200 41.473 353.276 311.287 21.362 -58.500 65.229 5300 41.473 353.776 313.878 21.362 -58.250 65.229 5300 41.573 353.78 315.87 -60.050 66.229 5500 41.78 35.528 314.429 21.930 -60.905 71.085 5500 41.78 35.528 314.429 22.61.59 -60.905 71.085 5500 41.78 35.528 315.924 23.03.23 -62.779 76.007 5600 41.78 35.525 317.583 -24.550 -65.803 78.495 5800 41.88 355.25 317.583 -24.850 -63.803 81.505 5900 41.98 359.256 318.071 24.2874 -66.029 83.256	_	41.062	348.005	306.939	184 800	-54.987	49.663	-0.576
4800 41,228 350,661 309,589 197,143 -56,545 56,688 4900 41,287 315,151 310,246 201,249 -77,150 59,033 5000 41,347 335,346 311,266 205,338 -78,500 63,233 5200 41,473 353,761 313,660 217,833 -60,505 63,239 5300 41,573 354,761 313,660 217,833 -60,905 63,239 5400 41,672 355,38 314,429 211,590 -60,905 71,085 5500 41,734 357,032 315,518 226,153 -62,779 76,007 5700 41,734 370,032 315,518 23,450 -62,779 76,007 5700 41,88 357,032 317,548 234,530 -62,779 76,007 5800 41,88 359,256 318,071 24,2874 -66,029 81,501 5900 41,935 318,071 24,2874 -66,029 83,256		41.15 41.170	348 909	308.725	188.909	-55.466	51.993 54.335	-0.590 -0.604
5000 41.348 357.346 311.266 205.400 -57.801 61.431 5100 41.410 353.166 311.266 205.400 -57.801 61.431 5200 41.473 353.734 311.268 211.682 -99.250 65.229 5300 41.577 354.761 313.660 217.833 -60.050 66.229 5400 41.662 355.38 314.429 211.990 -60.905 71.085 5500 41.682 355.38 314.429 226.159 -60.905 71.085 5600 41.734 337.033 315.924 230.323 -62.779 76.007 5700 41.804 357.792 316.652 224.550 -63.803 78.455 5800 41.868 359.256 318.071 24.2874 -66.029 81.501 5900 41.935 359.256 318.071 24.2874 -66.029 81.506		41.228	350.661	309.589	197.143	-56.545	56.688	-0.617
41.410 335.166 312.080 209.538 -58.500 63.823 41.537 353.700 312.878 213.682 -99.250 66.229 41.637 345.761 313.660 217.833 -60.050 66.279 41.662 335.538 314.429 221.990 -60.905 71.085 41.683 335.532 315.924 220.323 -61.814 73.538 41.801 337.792 315.652 23.450 -63.803 78.455 41.803 335.236 318.071 242.874 -66.029 83.506		41348	352,346	311.266	205.400	-57.801	61.431	-0.642
41.537 354.761 313.660 217.833 -60.050 68.649 41.662 355.538 314.429 221.990 -60.905 71.085 41.668 355.532 315.942 226.333 -61.814 73.538 41.734 357.053 315.924 220.332 -62.779 76.007 41.801 357.792 316.652 224.550 -65.803 78.495 41.803 339.236 318.071 242.874 -66.029 83.256	2100	41.410	353.166	312.080	209.538	-58.500	63.823	-0.654
41.662 335.538 314.429 221.190 -60.905 71.085 41.668 335.532 315.183 226.133 -61.814 73.338 41.734 337.035 315.924 220.332 -62.779 76.007 41.801 337.792 316.652 224.500 -65.873 78.495 41.803 339.236 318.071 242.874 -66.029 83.526	2300	41.537	354.761	313.660	217.833	-60.050	68 649	-0.677
41 734 357 053 315,924 220,332 -6,779 76,007 41,861 357,725 316,525 234,550 -63,833 78,495 41,862 338,520 317,368 238,633 -64,886 81,001 41,935 339,236 318,071 242,874 -66,029 83,536	2800	4.602 4.602 5.602	355.538	314.429	221.990	-61.814	73.538	-0.688 -0.698
41.801 357.792 316.652 234.500 -6.5873 78.495 41.868 338.502 317.368 238.633 -6.4386 81.001 41.935 359.236 318.071 242.874 -66.029 83.256	2600	41 734	357 053	315.924	230.323	-62.779	76 007	-0.709
41.935 359.236 318.071 242.874 -66.029 83.526	\$700	41.801	357.792	316.652	234.500	-63.803	78.495	-0.719
	2006	41.935	359.236	318.071	242.874	04.880	81.001	671.0

Magnesium Sulfide (MgS)

PREVIOUS. September 1977 (1 atm)

CURRENT: September 1983 (1 bar)

(Mg ₂)
sium (
fagne
~

1974 (1 atm)

PREVIOUS December

Spectroscopic Constants for ² Mg ₂ in cm ⁻¹ 10 ² α _e 10 ⁶ D _e r _e , Å References ω _e ω _e τ B _e 10 ² α _e 10 ⁶ D _e r _e , Å References .121 1.6448* 0.092866 3.7758* 1.2166° 3.8905 1 .13 [1.95] [0.171] [1.89] [0.413] [2.91] 4 ⁴ .2 [1.67] [0.145] [1.64] [0.389] [3.18] 4 ⁴ .1 [1.17] [0.181] [1.15] [0.343] [2.91] 4 ⁴	0 ³ a _e 10 ⁵ D _e r _e , Å 7758 ^b 1.2166 ^e 3.8905 89] [0.413] [2.91] 64] [0.359] [3.18] 15] [0.343] [2.91]	
1.6448* 0.092866 3.7758* 1.2166* [1.95] [0.171] [1.89] [0.413] [1.67] [0.145] [1.64] [0.359] [1.17] [0.181] [1.15] [0.343]	866 3.7758* 1.2166*] [1.89] [0.413]] [1.64] [0.359]] [1.15] [0.343]	ζ, g
[1.95] [0.171] [1.89] [0.413] [1.67] [0.145] [1.64] [0.359] [1.17] [0.181] [1.15] [0.343]	[1.89] [0.413] [1.64] [0.359] [1.15] [0.343]	404 51.12
[1.67] [0.145] [1.64] [0.359] [1.17] [0.181] [1.15] [0.343]] [1.64] [0.359]] [1.15] [0.343]	
[1.17] [0.181] [1.15] [0.343]] [1.15] [0.343]	
	$10^{-4} (v + 1/2)^4$ $(v + 1/2)^2$ $10^{-8} (v + 1/2)^2$.	[34941] [263.1]

Enthalpy of Formation

from CODATA,¹³ we calculate the adopted value of $\Delta_t H^*(Mg_2, g_1, 0) = 288 16 \text{ kJ·mol}^{-1}$. Our adopted D° is in essential agreement with the value adopted by Brewer¹² and by Wagman *et al.*³ It should be noted that a value of $D_0^\circ = 11.3 \pm 4.1 \text{ kJ·mol}^{-1}$ was determined by a mass spectrometric study of Wu, Ihle and Gingerich.⁷ In light of the spectroscopic evidence, this value appears to be too large. The ground state dissociation energy for ²⁴Mg, was determined by Li and Stwalley² to be 404.1 ± 0.5 cm⁻¹. This value was corrected to natural abundance M₂, with the result $D_0^a = 404.3$ cm⁻¹. Using this value and the recommended value for $\Delta_f H^o(Mg, g, 0) = 146.499$ kJ·mol⁻¹

Heat Capacity and Entropy

which are more realistic at temperatures greater than 1000 K. The large maximum in the heat capacity at 5000 K, for example, would not be present if the excited states were not included. Also, it should be noted that Mg.(g) is an example of a molecule where the traditional integration methods of calculating the thermal functions fail due to the shallow ground state.

The rotational levels are extrapolated to high J values according to the method of Khachkuruzov* who proposed a simpler form of Wooley's experimental study from Balfour and Douglas. No known spectroscopic data exists for the three lowest excited electronic states of Mg2(g). In order to generate the spectroscopic constants of these states, a Morse potential was least squares fit to the calculated potential curves of Stevens and Krause, an ab initio investigation which included configuration interaction. Although this procedure for estimating the The thermal functions are calculated using a direct summation technique analogous to the alkali dimers and diatomic halogens. Included in the calculation are the ground state and the three lowest excited states. Spectrocopic constants for the 12, ground state are taken from an spectroscopic data results in substantial uncertainty in the generated constants, the inclusion of the excited states results in thermal functions

method.⁶ For the ground state only, we included the so-called quasi-bound rotational levels above the dissociation limit.⁹ The values used for J_{lum} and v_{num} are 93 and 17, respectively, as determined by.⁶ Separate calculations were performed for each of the six isotopic dimeric species (made up from the three atomic isotopes.²⁴Mg, ²⁵Mg, by adjusting the spectroscopic constants of ²⁴Mg using a standard reduced mass scaling routine.¹⁰ The results were combined according to the natural abundance of the atoms, ²⁴Mg, 78.99%, ²²Mg, 10.00%, ²⁵Mg, 11.01%, ¹¹ Splitting of the rotational levels in the ³T₆ and ³², states was taken into account only insofar as the degeneracy of these states were increased accordingly. The adopted value of S⁵(298.15 K) is 0.64 J·K ¹ mol⁻¹ smaller than that adopted by.⁶

References

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Magnesium Silicate (Mg₂SiO₄)

PREVIOUS: September 1964

CURRENT December 1967

 $\Delta_t H^{\circ}(0 \text{ K}) = -2163.63 \pm 4.2 \text{ kJ} \cdot \text{mol}^{-1}$ $\Delta_p H^{\circ}(298.15 \text{ K}) = -2176.94 \pm 4.2 \text{ kJ} \cdot \text{mol}^{-1}$ $\Delta_{fun} H^{\circ} = [71.128 \pm 20.9] \text{ kJ} \cdot \text{mol}^{-1}$ $S^{\circ}(298.15 \text{ K}) = 95.14 \pm 0.8 \text{ J·K}^{-1} \cdot \text{mol}^{-1}$

CRYSTAL

Magnesium Silicate (Mg₂SiO₄)

Enthalpy of Formation Ttus = 2171 ± 11 K

Togeson et al. have reported a $\Delta_H^2(298.15 \, \text{K}) = -15.1 \pm 0.2 \, \text{kral mol}^{-1}$ for reaction (a). They used an HF solution calorimeter and measured the enthalpies of solution of each component. We derive $\Delta_H^{4}(Mg_sSiO_4$, ct, 298.15 K) = -520.30 \pm 10 kcal·mol⁻¹ using the Kapusinskii et al. 2 used the same method but measured only ΔH^q (298.15 K) = 95 00 \pm 0.47 kcal mol⁻¹ for reaction (b). We calculate ΔH^q (Mg₂SiO₄, α , 298.15 K) = -572.27 kcal mol⁻¹ using the ΔH^q (298.15 K) of H₂SiF₆(α) from source 3 and the ΔH^q (298.15 K) of H₂O(1) $\Delta_t H^{\circ}(298.15 \text{ K})$ of MgO(cr) and SiO₂(cr, low quartz) from JANAF tables.

Ressman et al. salculated a $\Delta G^{*}(298.15 \text{ K}) = 42.46 \text{ kcal·mol}^{-1}$ for reaction (c) using aqueous solubility data. We use the $\Delta G^{*}(298.15 \text{ K})$ of H₂O(t) and OH (aq) from source 4. $\Delta_1G^2(298.15 \text{ K})$ of H₂SiO₄(aq) from source 3 and $\Delta_1G^2(298.15 \text{ K})$ of Mg⁺⁺(aq) from source 6 and we obtain a $\Delta_2G^2(Mg_2SiO_4$, cr. 298.15 K) = -524.848 kcal mol⁻¹ using the and HF(aq) from source 4.

The adopted value is from the work of Torgeson et al.! which is considered to be the most reliable since it relates directly to the oxides. The other reported values are less accurate and involve uncertainties in the auxiliary data used to derive the heat of formation. above A.G. (298.15 K) of Mg.SiO.(cr) and the entropies of Mg(cr), Si(cr) and O.(g) from the JANAF tables.

			Δ,H°(298.15 K)	$\Delta_i G^*(298.15 \text{ K}) \Delta_i H^*(298.15 \text{ K})$	Δ _r H°(298.15 K)
Source	Source Method	Reaction	kcal-mol .	kcal-mol .	kcal-mol .
_	hydrofluoric acid solution calorimeter	(a) 2 MgO(cr) + SiO ₂ (cr) = Mg ₂ SiO ₄ (cr)	-15.10 ± 0.2		-520.3
~	hydrofluoric acid	(b) Mg ₂ SiO ₄ (cr) + 10 HF(aq, 4.44 H ₂ O) =	95.0 ± 0.47	-522.27	
	solution calorimeter	2 MgF ₂ (cr) + H ₂ SiF ₆ (714 HF(aq) + 322 OH ₂ O) + 4 H ₂ O(l)			
•	aqueous solubility	(c) $Mg_2SiO_4(cr) + 4 H_2O() = 2 Mg^{++}(aq)$	42.46	-524.848	
		+ H, NO, (20) + 4 OH (20)			

Heat Capacity and Entropy

Low temperature heat capacities are from the data (53-295 K) of Kelley. High temperature enthalpies have been measured (398-1808 K) by Oπ.* High temperature heat capacities are derived from the enthalpies by a fitting technique which constrains the curve to join smoothly with the low temperature values. The entropy is based on S°(50 K) = 0.60 cal·K⁻¹ mol⁻¹.

Fusion Data

Tres is obtained from Davis et al. 9 Are H° is estimated from MacGregor's 10 phase diagrams of the Mg2S1O4-TiO25ystem. The phase diagrams were determined at 10 and 20 kbars pressure.

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D. MacGregor, Ann. Rept. Director of the Geophysical Laboratory, No. 1455, 135 9 (1965).

Standard State Pressure = p° = 0.1 MPa 360.532 358.180 263.410 206.554 168.664 141 615 121 339 105.579 92.904 82.519 73.868 66.554 60.052 53.995 48.706 44.034 36.049 32.667 29.614 26.845 24.322 22.015 19.899 17.950 16.150 14.483 11.935 -- CRYSTAL <---> LIQUID - 1737.746 - 1697.000 - 1656.367 - 1609.516 - 1550.560 - 1491.904 - 1433.933 - 1311.273 - 1250.787 -1937.382 -1897.786 -1858.375 -1819.128 -1778.598 -2057.141 -2017.131 -1977.171 -1190.575 2057.879 -1130.631 -2185.281 -2185.281 -2183.847 -2437.073 -2432.626 -2175.539 -2174.292 -2172.975 -2171.673 -2187.632 2463.154 2463.154 2457.742 -2428.390 -2415.638 -2409.054 -2402.334 -2395.483 -2176.953 -2177.207 -2176.585 -2428.036 -2452.175 2446.445 -2176.935 -2163.63 Ç Ā 331.600 337.487 357.900 378.506 399.303 -17.280 -16.280 -10.180 0. 0.220 13.141 27.491 42.767 58.715 75.191 92.104 109.392 127.013 144.936 163.139 181.602 200.314 219.261 238.434 257.828 277.434 297.248 317.264 Enthalpy Reference Temperature = T, = 293.15 K S -[G'-H'(T,)]T 272.430 279.298 285.965 292.445 121.447 133 419 145.302 156.869 168.026 208.338 226.152 234.558 242.660 250.480 258.036 270.399 298.747 304.883 310.861 316.692 322.382 178.744 189.024 198.881 265.348 INFINITE L·K-'mol-' 294.210 309.804 425.833 434.907 443.676 452.166 460.396 468.386 476.153 483.712 491.076 95.876 132.920 164.894 259.206 277.418 324,372 338,054 350,962 363.190 374.813 385.897 396.497 406.660 416.426 423.139 95.140 192.724 217.297 239.291 88.380 88.380 88.399 190.619 192.845 195.008 197.108 199 163 203.154 205.100 207.020 208.915 210.790 212.648 214.490 216.315 218.124 119.148 137.557 148.695 201.175 18.688 156 431 162.310 167.063 177.770 171.088 202.673 ئ 2171.000 298.15 °28 7.8

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LIQUID

Magnesium Silicate (Mg₂SiO₄)

Mg₂O₄Si₁(I)

 $\Delta_t H^{\circ}(298.15 \text{ K}) = [-2113.88 \pm 20.9] \text{ kJ·mol}^{-1}$ $\Delta_{tus} H^{\circ} = [71.128 \pm 20.9] \text{ kJ·mol}^{-1}$

Enthalpy of Formation $\Delta_H^a(Mg_2SiO_a, cr, 298.15 K)$ by adding $\Delta_{las}H^a$ and the difference in enthalpy, $H^a(2171 K)$ $H^a(298.15 K)$, between the crystal and liquid. $S^{\circ}(298.15 \text{ K}) = [123.044] \text{ J·K}^{-1} \cdot \text{mol}^{-1}$ $T_{\text{tss}} = 2171 \pm 11 \text{ K}$

Heat Capacity and Entropy

A glass transition is assumed at 1400 K. Below 1400 K the heat capacity is obtained from the heat capacity of the crystal. Above 1400 K the heat capacity is assumed constant and estimated as 49 cal·K⁻¹·mol⁻¹ or 7 cal·K⁻¹ g-atom⁻¹. S°(1, 298.15 K) is calculated in a manne analogous to that used for the enthalpy of formation.

Fusion Data Refer to the crystal table for details.

T/K C* S* -[G*-If(T _i)]IT H*-If(T _i) 200 298.15 118.688 123.044 123.046 0.220 290.11 119.688 123.044 123.046 0.220 300 119.148 123.780 123.046 0.220 400 137.557 123.780 123.046 0.220 500 18.6431 220.628 149.351 24.501 600 156.431 220.628 149.351 42.761 800 16.5431 220.628 149.351 42.761 100 177.70 325.114 206.648 17.191 900 177.70 325.114 206.648 17.191 100 177.70 325.114 206.648 17.191 1100 177.70 325.114 206.648 17.191 1200 183.565 337.708 216.528 14.205 140.000 185.895 365.938 236.242 181.603 140.000 185.895 <	T.T	Enthalpy Re	ference Te	mperature	Enthalpy Reference Temperature = $T_t = 298.15 \text{ K}$ 1.8^{-1}	×	Standard St.	Standard State Pressure = $p^* = 0.1 \text{ MPa}$ t. 1o1-1	p° = 0.1 MPa
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205.016 449.083 294.229 335.114 -2381.266 -1188.252 205.016 453.022 299.444 339.00			205.016	439.082	286.776	304.612	-2387.319	-1245.209	32.522
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205.016 47.87.25 305.12.25 34.51.0 2.15.22.9 175.15.23 205.016 47.84.1 315.370 386.619 -236.334 -1019.047 205.016 48.28.1 315.370 386.619 -236.334 -1019.047 205.016 48.28.1 315.370 386.619 -236.334 -1019.047 205.016 500.69 314.617 48.124 -236.334 -907.485 205.016 500.69 314.617 48.124 -236.316 -907.485 205.016 515.299 314.637 48.124 -234.917 -907.485 205.016 515.299 346.595 489.127 -2134.18 -796.814 205.016 515.299 313.333 599.638 -2134.58 -741.816 205.016 517.49 368.679 571.131 -2132.29 -577.866 205.016 541.79 368.679 571.786 -573.861 -573.861 205.016 541.80 373.818 363.368 230.637 -230.817			205.016	455.902	299.444	339.670	CRYSI	AL <> LIQ	ani
205.016 476.46i 315.370 386.619 -2553.334 -1019.047 205.016 48.4830 313.370 386.619 -2553.334 -1019.047 205.016 49.2871 313.403 477.622 -235.163 -907.485 205.016 500.605 314.637 448.124 -235.91 -907.485 205.016 500.605 314.637 448.124 -234.91 -825.058 205.016 517.239 314.535 489.127 -234.189 -796.834 205.016 517.239 315.333 590.638 -2134.587 -741.816 205.016 535.441 363.368 550.632 -2137.296 -577.866 205.016 541.789 368.679 571.131 -2132.296 -577.866 205.016 541.789 368.679 571.131 -213.229 -577.866 205.016 541.780 373.886 591.635 -230.687 -415.277 205.016 553.811 378.917 612.136 -2301.510 -415.277 </td <td></td> <td></td> <td>205.016</td> <td>458.025</td> <td>308.555</td> <td>366.117</td> <td>-2369298</td> <td>-1075.186</td> <td>24.418</td>			205.016	458.025	308.555	366.117	-2369298	-1075.186	24.418
205.016 492.871 338.401 477.622 -2351.693 -907.495 205.016 500.699 334.637 448.124 -234.917 -832.08 205.016 515.259 346.595 488.124 -234.917 -796.384 205.016 515.259 346.595 489.127 -234.186 -796.384 205.016 532.401 363.333 599.628 -234.186 -741.816 205.016 535.413 363.368 550.638 -233.887 -517.386 205.016 541.749 386.79 571.13 -2131.296 -577.896 205.016 541.780 373.867 571.786 -577.896 205.016 547.870 373.867 571.786 -577.896 205.016 553.813 378.917 612.136 -230.610 -415.577 205.016 553.813 378.451 612.136 -236.137 -415.577 205.016 555.205 381.389 631.441 -2669.130 -232.167 205.016 <t< td=""><td></td><td></td><td>205.016</td><td>476.461</td><td>321.982</td><td>386.619</td><td>-2363.384</td><td>-1019.047</td><td>22.179 20.124</td></t<>			205.016	476.461	321.982	386.619	-2363.384	-1019.047	22.179 20.124
205.016 500.059 343.631 448.622 -234.031 -755.203 205.016 500.059 343.639 448.622 -234.0189 -796.834 205.016 515.229 346.595 469.127 -234.0189 -796.834 205.016 515.229 346.595 469.127 -2334.589 -741.816 205.016 515.441 363.368 510.042 -2334.059 -7313.232 205.016 541.749 368.679 571.13 -2317.761 -577.896 205.016 541.749 368.679 571.13 -2317.291 -523.610 205.016 553.813 378.917 612.136 -2301.510 -415.277 205.016 553.813 378.917 612.136 -2301.510 -415.277 205.016 550.205 378.888 631.409 -2674.711 -286.637 205.016 570.673 399.399 673.641 -2669.130 -272.167 205.016 570.673 399.399 673.641 -2669.130 -272.167 205.016 570.673 399.399 673.641 -2669.130 -275.458 205.016 570.673 399.399 673.641 -2669.130 -275.458 205.016 570.673 399.399 673.641 -2669.130 -275.458 205.016 570.673 399.399 673.641 -2669.130 -275.458 205.016 570.673 399.399 673.641 -2669.130 -275.458 205.016 570.673 399.399 673.644 -2669.130 -275.458 205.016 570.673 399.399 673.644 -2669.130 -275.458 205.016 570.673 399.399 673.644 -2669.130 -2669.130 -275.678 205.016 570.673 399.399 673.644 -2669.130 -2669.130 -275.678 205.016 570.673 399.399 673.644 -2669.130 -2669.130 -275.678 205.016 570.673 399.399 673.644 -2669.130 -2669.130 -275.678 205.016 570.673 399.399 673.644 -2669.130 -2669.130 -275.678 205.016 570.673 399.399 673.644 -2669.130 -2669.130 -275.678 205.016 570.679 399.259 396.016 570.679 300.016 570.679 399.259 396.016 570.679 300.016 570.679 300.016 570.679 300.016 570.016 5			205.016	492.871	328.401	427.622	-2351.693	-907.495	18.232
205.016 515.229 346.595 489.127 -2.334.508 -741.816 205.016 572.249 352.333 599.628 -2.233.877 -686.991 205.016 535.441 363.368 530.109 -2.233.298 -577.393 205.016 547.870 366.799 571.133 -2317.291 -577.896 205.016 547.870 377.886 591.635 -230.617 -469.488 205.016 553.813 378.917 612.136 -230.617 -469.488 205.016 553.813 378.917 612.136 -230.617 -469.488 205.016 555.813 378.917 612.136 -230.1510 -415.277 205.016 555.813 378.917 612.136 -251.137 -235.657 205.016 555.205 383.33 653.400 -267.4711 -286.637 205.016 570.657 393.399 673.641 -2669.130 -222.167 205.016 570.581 494.43 -2669.130 -93.665			205.016	508.065	340.699	468.625	-2340.189	-832.038	14.865
205.016 538,932 357,922 530,130 -2323.26 -632,353 205.016 535,441 363,368 550,622 -2317.761 -577.886 205.016 547,870 373,8679 571,133 -2312.291 -573,861 205.016 547,870 373,8679 591,635 -2306,872 -469,488 205.016 553,813 378,917 612,136 -2301,510 -415,277 205.016 555,205 388,681 631,40 -264,711 -286,637 205.016 570,673 393,399 673,641 -266,310 -232,167 205.016 570,673 393,399 673,641 -266,310 -272,167 205.016 570,673 394,399 674,41 -266,312 -157,845 205.016 570,673 394,325 14,644 -2663,180 -93,665			205.016	515.259 522.209	346.595 352.333	489.127 509.628	-2334.508 -2328.877	-741.816 -686.991	13.362
205.016 535.441 365.368 550.52 -2317.767 -257.886 205.016 547.879 386.679 571.133 -2312.291 -523.610 205.016 553.813 378.917 612.135 -2301.510 -449.488 205.016 553.813 378.917 612.135 -2301.510 -415.277 205.016 556.205 388.681 631.40 -264.711 -286.657 205.016 570.673 393.399 673.641 -2665.130 -272.167 205.016 570.673 393.399 73.641 -2665.130 -1272.167 205.016 570.673 393.399 74.644 -2665.130 -157.845 205.016 570.673 393.399 74.644 -2665.130 -157.845			205.016	528.932	357.922	530.130	-2323.296	-632,353	10.655
205.016 547.870 373.860 591.635 -2306.87 -469.488 205.016 553.813 378.917 612.136 -2301.510 -415.277 205.016 555.205 388.681 631.40 -567.4711 -286.637 205.016 570.673 393.399 673.641 -266.410 -226.617 205.016 570.673 393.399 673.641 -2669.130 -222.167 205.016 570.673 393.399 673.641 -2669.130 -232.167 205.016 570.673 393.499 1444 -2669.130 -157.845 205.016 570.673 394.252 714.644 -2663.120 -157.845			205.016	535.441	363.368	550.632	797 7157	-577.896 577.896	9.433 8.788
205016 555,813 518,511 012,130 -2,015,10 -413,521 205,016 556,230 388,681 653,140 -2,674,711 -286,637 205,016 570,673 393,399 673,641 -2669,130 -222,167 205,016 570,673 393,399 673,641 -2669,130 -222,167 205,016 571,673 694,143 -2,663,630 -157,845 205,016 581,189 402,528 714,644 -2,658,186 -93,665			205.016	547.870	373.860	591.635	-2306.872	-469.488	7213
205.016 570.673 595.359 505.250 2.240.05 2.00.202.02 2.51.42.3 205.016 570.673 593.399 673.641 2.666.319 -222.167 205.016 570.673 593.399 673.641 2.666.310 -222.167 205.016 571.079 396.396.310 694.413 2.665.320 -1573.45 205.016 581.189 402.528 714.644 -2268.186 -93.665			910.502	555.813	3/8.91/	017.130	0151052-	175,517	1070
205.016 570.673 393.399 673.641 -2669.130 -222.167 205.016 575.598 398.013 694.143 -2663.620 -1573.845 205.016 381.189 402.528 714.644 -2658.186 -93.665		3,960	205.016	565.205	388.681	653,140	-2680.362	-286.637	4.047
205,016 581,189 402,528 714,644 - 2658,186 - 93,665		988	205.016	570.673	393,399	673.641	-2669.130	-222.167	3.054
		900	205.016	581.189	402.528	714,644	-2658.186	-93.665	1.223
		PREVIOUS: September 1964	September	1964				CURRENT	CURRENT December 1967

Mg₂O₄Si₁(cr,l)

Magnesium Silicate (Mg ₂ SiO ₄)	
$M_{\rm r} = 140.6931$	

CRYSTAL-LIQUID

Refer to the individual tables for details.

Magnesium Silicate (Mg_zSiO₄)

Tr. C; F. Theory Line Enthalpy Reference Temperature	eference To	emperature	- T, - 298.15 K	<u></u>	Standard St.	Standard State Pressure = 1	p* = 0.1 MPa	
0. 0. 0. DNFINTE -17280 -2165.64 - 18.68 - 18.68 - 18.68 - 18.68 - 18.69 - 18.69 - 18.69 - 18.69 - 18.69 - 18.69 - 18.69 - 18.68 - 18.69 - 18.	7.K	l to		*-H*(T,)]/T	H*H*(T,	٦	δ.	log Kr
86.14 54.162 105.060 -10.180 -2174.508 -118.688 95.140 0. 02176.533 -119.18 68.95 14.00 0. 02176.533 -119.18 68.95 14.00 0. 02176.533 -13.257 13.297 100.068 13.141 -2177.207 -1276.537 13.297 100.068 13.141 -2177.207 -1276.537 13.297 100.068 13.141 -2177.207 -1276.537 13.297 100.068 13.141 -2177.207 -1276.537 13.297 100.068 13.141 -2177.207 -1276.537 13.297 145.307 145.307 145.307 15.191 -2177.207 -1276.537 13.297 145.307 145.307 15.191 -2177.207 -1276.537 13.297 145.307 145.307 15.191 -2177.207 17.101 -2176.207 145.307 17.101 -2176.207 145.307 17.101 -2176.207 145.307 17.101 -2176.207 145.307 17.101 -2176.207 145.307 17.101 -2176.207 1	° <u>8</u>	0.	0. 14.050	INFINITE 176.849	-17.280 -16.280	-2163.634	-2163.634	INFINITE 1114.924
19.18 688 9.51.40 0.	200	86.144		105,060	-10.180	-2174.908	-2096.757	547.617
19,148 39,2876 90,913 11,141 11,1535	298.15	118.688	95.140	95.140	0.	-2176.935	-2057.879	360.532
156.431 192.724 121.447 42.767 -2175.539 167.053 153.103 153	\$ \$ \$	137.557	95.876 132.920 164.894	95.142 100.068 109.913	13.141	-2176953 -2177207 -2176585	-2017.131 -1977.171	263.410 206.554
167,063 172.97 133.419 15.114.273 15.111.088 15.29.201 145.302 15.119 -2117.473 17.110.88 259.206 156.869 92.104 -2117.673 17.110.88 259.206 156.869 92.104 -2117.673 17.110.8 259.206 156.869 92.104 -2117.673 17.110.8 259.206 156.869 92.104 -2117.673 182.665 12.417.7 182.44 177.013 -2185.281 182.663 13.417.8 182.84 163.139 -2185.281 182.84 163.139 -2185.281 182.84	8	156.431	192.724	121.447	42.767	-2175.539	-1937.382	168 664
17,000 25,241 17,252 17,152 1	88	162.310	217.297	133.419	58 715	-2174.292	-1897 786	141 615
174.667 177.418 188.026 1103.32 -2187.52 -2187.52 -2187.52 -2187.52 -2187.52 -2287.52 -2	38	171.088	259.206	156.869	92.104	-2171.673	- 1819.128	105.579
183.65 3.99.210 177.770 29.2410 177.770 29.2410 177.770 29.2410 177.770 29.2410 177.770 29.2410 177.770 29.2410 177.770 29.2410 177.770 29.2410 177.770 29.2410 177.270 29.2410 177.2711 183.95 33.05.95 217.421 243.231 181.622 243.231 243.241 243.231 243.241 243.2	000	174.607	277.418	168.026	109.392	-2187.632	-1778.598	92.904
18.346 13.477 19.881 18.139 -218.387 -218.3	82	177.770	309,804	178.744	127.013	-2185.281	-1737.746	82.519 73.868
18.595 338.024 203.38 181.627 2431.013 182.895 338.024 2345.28 2431.013 2431.013 2431.014 2431.626 2431.03 2431.013 2431.014 2431.626 2431.014 2431.626 2431.016 2431.014 2431.626 2431.016 2431.014 2431.026 2431.014 2431.026 2431.014 2431.026	1300	183.360	324.372	188.881	163.139	-2183.847	-1656.367	66.554
190,619 363,190 226,152 219,261 -2428,036 197,108 396,479 220,480 277,434 2475,488 197,108 396,477 220,480 277,434 -2475,174 201,175 406,660 258,036 277,434 -245,174 201,175 416,476 265,348 317,264 -242,177 201,175 416,476 265,348 317,264 -242,177 202,016 423,592 270,399 431,600 -242,175 202,016 428,623 277,282 426,277 277,882 426,277 277,882 426,277 277,882 426,277 277,882 426,277 277,882 426,277 277,882 426,277 277,882 426,277 277,882 277,882 426,277 277,882 277,882 277,882 277,882 277,882 277,882 277,882 277,882 277,882 277,872 277,8	<u>8</u> 8	185.895	338.054	208,338	200.314	-2437.073	-1550,516	53 995
195.084 374.811 314.538 248.404 195.008 385.897 242.660 279.848 2468.404 197.108 396.497 240.460 279.248 2463.154 201.175 416.476 250.480 277.434 2457.175 201.175 416.476 250.399 311.600 277.248 2457.175	0091	190.619	363.190	226.152	19761	-2428.036	-1491.904	48.706
197,108 366,477 250,450 277,434 -245,154 -245,174 -2	6 8 8	192.845	374.813	234.558	238.434	-2473.488	-1433.093	10 816
199,163 406.660 255.348 317.264 -245.175 -202.673 423.19 270.399 314.600 —— CRYSTAA 205.0516 455.902 270.399 314.600 —— CRYSTAA 205.0516 455.902 270.399 314.600 —— CRYSTAA 205.0516 467.736 281.138 429.175 -2396.238 -2395.0516 467.736 281.138 429.175 -2396.238 -2395.0516 467.736 281.138 429.175 -2396.238 -2395.0516 492.871 205.016 492.871 204.148 490.680 -2351.693 205.016 512.299 470.178 -2354.584 -2395.016 512.299 311.282 311.282 311.282 31.283 31.249 31.282 31.284 -2345.030 205.016 512.299 313.14 572.686 -2334.689 205.016 513.899 205.018 205.016 513.899 205.019 613.689 -2317.707 205.016 553.88 366.339 695.699 -266.9130 205.016 575.98 381.844 777.200 -266.45.20 205.016 575.98 381.844 777.700 -266.35.20 205.016 575.98 386.763 777.702 -265.81.86	<u>8</u>	197.108	396.497	250.480	277.434	-2463.154	-1311.273	36.049
201115 414450 52348 311,000 4234113 423139 4	2000	199.163	406.660	258,036	297.248	-2457.742	-1250.787	32.667
202.653 4.51.199 770.359 402.720 — CAYSTAN 205.016 455.902 770.359 402.720 = 2256.228 — CAYSTAN 205.016 455.902 770.359 402.721 = 2256.228 — CAYSTAN 205.016 47.461 289.056 449.676 -2256.328 — CAYSTAN 205.016 47.451 289.056 449.676 -2256.328 — CAYSTAN 205.016 47.451 289.056 449.676 -2256.328 — CAYSTAN 205.016 502.000 311.222 511.231 -2246.329 205.016 512.259 311.242 511.241 -2246.329 205.016 512.259 311.242 511.241 -2246.328 705.016 512.259 311.242 511.241 -2246.328 705.016 512.259 311.242 511.241 -2246.328 705.016 513.243 311.243 65.449 77.05 613.629 -2212.295 705.016 513.243 310.340 673.4191 -2312.291 705.016 513.243 310.340 673.4191 -2312.291 705.016 513.243 310.340 673.4191 -2312.291 705.016 513.243 310.340 673.4191 -2312.291 705.016 513.243 310.340 673.419 -2312.291 705.016 513.243 310.340 772.00 -2266.320 773.010 575.010	2100		416.426	265.348	317.204	-2452.175	:: - ::-	29.014
205.016 4.38.623 272.862 408.673 -2235.259 -205.016 47.756 281.138 429.175 -2236.238 -205.016 47.756 281.138 429.175 -2236.238 -205.016 47.45 281.138 429.05 -2236.384 -2235.016 47.45 281.138 -2237.131 -2377.131 -2377	2171,000		423.139	270.399 270.399	331.600 402.728	(R)	STAL <> LI TRANSITION	- and
205.016 47.150 281.138 422.175 2259.258 - 205.016 476.461 289.056 449.676 -2259.384 - 205.016 476.461 289.056 449.676 -2259.384 - 205.016 500.609 311.232 511.831 -2249.317 - 205.016 500.609 311.232 511.831 -2249.317 - 205.016 500.609 311.232 511.831 -2249.318 - 205.016 500.609 311.232 511.831 -2249.318 - 205.016 500.609 311.234 500.609 511.831 -2249.318 - 205.016 500.609 311.234 500.609 511.831 -2249.318 - 205.016 500.609 311.234 500.609 674.191 -2206.317 - 205.016 500.609 311.234 500.200 674.191 -2206.317 - 205.016 500.609 311.609 675.609 -2669.32 205.016 500.609 311.609 716.809 -2669.130 205.016 500.609 311.89 386.763 777.200 -2665.620 205.016 500.609 386.763 777.200 -2665.620 205.016 500.609 386.763 777.700 -2665.8186	2200		458.623	272.862	408.673	-2375.259	-1131.582	26.867
205.016 484.839 296.739 470.178 -2251.535 205.016 484.839 296.479 470.178 -2251.535 205.016 500.609 311.232 511.818 -2240.189 205.016 500.609 311.232 511.818 -2240.189 205.016 512.299 313.44 572.866 -2238.877 205.016 513.299 313.48 572.866 -2238.877 205.016 513.240 349.570 613.639 -2310.239 205.016 513.241 343.663 613.689 -2310.239 205.016 513.241 349.570 643.191 -2312.231 205.016 513.243 360.900 675.194 -2204.371 205.016 513.813 360.900 675.194 -2204.371 205.016 515.298 31.844 777.200 -2265.520 205.016 515.298 31.844 777.200 -2265.520 205.016 515.298 386.763 775.699 -2265.520 205.016 515.298 386.763 775.699 -2265.520	2300	202.016	476.451	281.138	429.175	-2363.238	-10/5.186	22.179
205.016 450.4281 30.4148 490.689 - 1251.693 205.016 500.609 311.222 311.818 - 1234.518 205.016 512.299 331.344 512.299 513.181 - 1234.518 205.016 512.299 331.344 517.286 - 1232.299 205.016 517.299 331.344 517.286 - 1232.299 205.016 517.299 331.349 517.818 - 1232.299 205.016 517.299 335.313 60.909 613.699 - 1230.299 205.016 517.299 613.639 613.639 - 1230.299 205.016 517.299 517.639 716.197 - 1230.299 205.016 517.598 318.84 777.200 - 1265.020 318.94 777.200 - 1265.020 318.94 777.200 - 1265.020 318.94 777.200 - 1265.020 318.94 777.200 - 1265.020 318.94 777.200 - 1265.020 318.94 777.200 - 1265.020 318.94 777.200 - 1265.020 318.94 777.200 - 1265.020 318.94	2200	205.016	484.830	296.759	470.178	-2357.515	-963.154	20.124
205.016 508.065 318.178 511.03 1.245.171 205.016 512.295 318.178 511.03 1.245.018 205.016 512.295 313.14 572.686 -2234.508 205.016 512.295 313.14 572.686 -2235.237 205.016 513.04 1.345.651 613.689 -2217.767 205.016 513.04 1.345.651 613.089 1.217.291 205.016 513.04 1.345.651 613.069 205.016 513.04 1.345.651 613.069 205.016 513.04 1.345.651 613.069 205.016 513.04 1.345.04 205.016 513.04 1.345.04 205.016 513.04 1.345.04 205.016 513.04 1.345.04 205.016 513.04 1.345.04 205.016 513.04 1.345.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016 513.04 205.016	200	205.016	492.871	304.148	490.680	-2351.693	-907.495	18.232
205.016 512.259 313.14 572.686 2234.508 205.016 522.209 331.314 572.686 2232.857 205.016 528.923 337.581 593.188 -2322.286 205.016 541.749 349.570 634.191 -2312.291 205.016 553.3813 360.900 675.194 -2306.872 205.016 553.3813 360.900 675.194 -2306.872 205.016 553.203 371.659 716.597 -2206.320 205.016 570.673 376.893 776.893 -2664.320 205.016 570.673 376.893 386.763 777.702 -2663.220 205.016 571.899 386.763 777.702 -2663.220	7 7 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8 7 8	205.016	508.065	318,178	531.683	-2340.189	-832.038	14.865
205.016 528.923 337.581 593.188 -2323.286 505.016 535.411 443.663 613.689 -2317.767 505.016 535.412 443.663 613.689 -2317.767 505.016 547.870 335.313 654.897 -2302.871 505.016 535.313 360.390 6575.194 -2301.510 505.016 535.313 360.390 6575.194 -2301.510 505.016 535.313 360.390 6575.194 -2301.510 505.016 575.988 366.330 716.679 -2663.130 505.016 575.988 386.763 777.702 -2658.186 575.016 575.988 386.763 777.702 -2658.186	2800	205.016	515.259	324.850	552.184	-2334.508	-741.816	13.362
205.016 513.41 343.66 613.689 -2317.757 205.016 513.41 343.66 613.689 -2317.757 205.016 547.870 345.31 654.892 -230.6872 205.016 553.813 560.900 6575.194 -230.511 654.892 205.016 553.813 560.900 6575.194 -230.511 655.205 205.016 555.205 311.639 716.519 716.519 716.529 205.016 575.998 381.844 777.200 -256.81.86 205.016 581.189 386.763 777.702 -265.81.86	900	205.010	578 037	337 581	503 188	-2373 706	155 659-	10.55
205.016 54.7749 49.570 634.991 2312.291 205.016 547.870 355.313 654.692 -236.872 205.016 5573.813 360.900 675.194 -2201.510 205.016 555.205 771.639 716.197 -266.130 205.016 570.673 776.893 776.893 776.893 776.893 776.893 776.893 776.893 776.893 776.893 776.893 776.893 776.893 777.702 -2865.620 205.016 581.189 386.763 777.702 -2865.8186	3200	205.016	535.441	343.663	613.689	-2317.767	-577.896	9.433
205.016 533.813 360.900 675.194 -2.206.21.205.016 535.813 360.900 675.194 -2.206.21.510 505.016 535.813 360.900 675.194 -2.206.21.510 505.016 575.298 376.803 716.197 -2.604.131 205.016 5715.998 386.765 777.702 -2.663.186 205.016 581.189 386.765 777.702 -2.663.186	3300	205.016	541.749	349.570	634.191	-2312.291	-523.610	8.288
205.016 559.588 3-66.339 695.696 -2.680.362 205.016 570.673 376.803 776.899 -2.669.130 205.016 571.599 386.763 777.702 -2.665.130 205.016 581.189 386.763 777.702 -2.665.8186	3500	205.016	553.813	360.900	675.194	-2301510	-409.465	6207
205.016 55.205 371.659 716.197 716.107 205.016 570.673 376.803 736.899 -2664.731 205.016 575.998 386.763 777.702 -2655.8186 205.016 581.189 386.763 777.702 -2653.186	3600	205.016	559.588	366.339	695.696	-2680,362	-351.255	5.097
205.016 5715,998 381,844 757,200 -2265,620 205.016 581,189 386,763 777,702 -2658,186 381,849 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 386,763 777,702 -2658,186 381,899 3	3700	205.016	565.205	371.639	716.197	-2674.711	-286.637	4.047
205.016 581.189 386.763 777.702 -2658.186	3800	205.016	570.673	376.805	736.699	-2669.130	- 222.167	3.054
	600	205.016	581.189	386.763	207.177	-2658.186	-93.665	1223
	PDEMOTIC						CHERENT	. December 19

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 $\Delta_t H^0(0 \text{ K}) = -2151.03 \pm 6.3 \text{ kJ-mol}$ $\Delta_t H^0(298.15 \text{ K}) = -2164.38 \pm 6.3 \text{ kJ-mol}$ Δ_{fus}H° = [129.704] kJ·mo

 $S^{(298.15 \text{ K})} = 115.10 \pm 6.3 \text{ J·K}^{-1} \cdot \text{mol}^{-1}$

Mg2TiO₄(cr) measured by Kelley, using a solution calorimetric method. The uncertainty of ±1.5 kcal·mol⁻¹ assigned to the enthalpy formation is due primarily to TiO₂(rutile) The enthalpy of formation is calculated from $\Delta H^{*}(298.15 \, \mathrm{K}) = -4.1 \pm 0.25 \, \mathrm{kcal \cdot mol^{-1}}$ for the reaction 2 MgO(cr) + TiO₂(tutile) Enthalpy of Formation

Heat Capacity and Entropy

Low temperature heat capacities are from the data (52-296 K) of Todd.2

High temperature entialpies have been measured (392-1817 K) by Orr. High temperature heat capacities are derived from the entialpi by a fitting technique which constrains the curve to join smoothly with the low temperature values.

a zero-point entropy of 2RIn2 corresponding to random distribution of Tr and Mg on the extahedral sites of the spinel lattice. The adopti The entropy is based on $S^{\circ}(51 \text{ K}) = 0.66 + 2.75 = 3.41 \text{ cal-K}^{-1} \cdot \text{mol}^{-1}$, where the first term is a lattice contribution and the second term value is 5°(298.15 K) = 27.51 ± 1.5 cal·K-1 mol-1 instead of 24.76 ± 0.15 cal·K-1 mol-1 as given by Todd

ions occupy the tetrahedral interstices in the oxygen lattice, while the remaining Mg ions and the Ti ions are (presumably) randomly locat Barth* showed from intensities of the x-ray diffraction lines that Mg3TiO₄ is a spinel of the inverse (or variate) class. Thus, half of the N

thus, they recommended an intermediate value of RIn2 for the zero-point entropy. In a previous review, however, Kelley used the theoretic value of 2RIn2 in order to make Mg.7TiQ, stable relative to Mg.TiQ, at high temperatures. We choose to adopt 2RIn2, although the evident is not conclusive. Recent studies of solid state reactions by Bautsch and Werner? indicate that A.G. is negative for M. King and Kelley® suggested that the degree of structural randomness is not established and that it may vary with the sample of Mg.TTC FIO₃(cr) + MgO(cr) → Mg₂FIO₄(cr) at temperatures of 1673 K and above Both RIn2 and 2RIn2 are consistent with this evidence. in the octahedral interstices This conclusion was confirmed by Romeijn.5

Fusion Data
Refer to the Inquid table for details.

¹K. K. Kelley, S S. Todd and E. G. King, U. S. Bur. Mines RI 5059, (1954).

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 H. J. Bautsch and I. Werner, Silikat Tech. 14, 203 (1963).

M,= 160.4876 Magnesium Titanium Oxide (Mg ₂ TiO ₄)	Magnesiu	m Titan	ium Oxi	de (Mg ₂ TiO	3		Ĭ	Mg₂O₄Ti₁(cr)	
.03 ± 6.3 kJ·mol ⁻¹	Enthalpy R	eference Te	mperature	Enthalpy Reference Temperature = $T_r = 298.15 \text{ K}$ $1.\text{K}^{-1}\text{mol}^{-1}$		Standard Stal	Standard State Pressure = $p^* = 0.1 \text{ MPa}$ k1:mol ⁻¹	° = 0.1 MPa	
[129.704] kJ·mol ⁻¹	ΤÆ	:	S -[G	$-[G^{\bullet}-H^{\bullet}(T_{i})]T$	$H^{\bullet}-H^{\bullet}(T_{\epsilon})$		Δ_{iG}	log K,	
	0	ó	o'	INFINITE	-18.836	-2151.027	-2151.027	INFINITE	
r) + TiO ₂ (rutile) →	88	34.639 94.320	26.740 70.337	204.267 125.901	-17 753	-2157.597 -2162.710	-2122.882	1108.880 544.776	_
to the enthalpy of	298.15	128.574	115.102	115.102	0	-2164383	-2047.719	358.752	_
	300	129.026	115.899	115.104	0.238	-2164.393	-2046.995	356 414	_
	\$ \$	146.285	155.637	120.405	14.093	-2164.204	-2007.859	262.199	_
	8	163.686	218.628	143.161	45.280	-2161.887	-1930.126	168,032	_
	902	169.582	244.316	155.813	61.952	-2160.357	-1891.618	141.154	
from the enthalpies	000	174.707	267.301	168,337	171.67	-2158.713	-1853,339	121.011	_
	88	09761	288.151	180.509	76.877	-2157.045	-1815.267	105.355	
the second term is	881	000.001	201700	267.241	250.511	0707177	- 1173,933	92.700	_
attice. The adopted	200	8/7/8	341 483	203.515	133.60/	-21/1269	-1730,349	82.452	
	1300	195.456	356.976	224.714	171 940	-2171.398	-1657,101	66.583	_
hus, half of the Mo	1400	160:661	371.594	234.689	191.668	-2423.636	-1611300	80.118	-
or andomly located	1500	202.614	385.451	244.282	211.754	-2418.140	-1553,467	54.097	_
) tanconiny located	0091	206.041	398.637	253.520	232.188	-2412.452	-1496.007	48.840	_
	1700	209.367	411,229	262.429	252.959	-2406.595	-1438.908	44.212	_
ample of Mg ₂ TiO ₄ ;	008	212,610	423.288	271.033	274 058	-2400.588	-1382.158	8 6 5 6 5	_
used the theoretical	2000	218.840	446.014	287.410	317.209	-2402.896	-1269.205	33 148	_
Š,	2013 000		447.433	288.438	320 056	CRYST	CRYSTAL <> LIQUID	QID	_
negative tor Mg-	2100	221.831	456 764	295.220	339.243	-2397.315	-1212.657	30.163	_
s evidence.	2200	224.752	467.151	302,800	361.573	-2391.484	-1156,379	27.456	_
	2300	227.593	477.205	310.165	384.191	-2385.411	-1100,373	24.990	
	8 8 2 2 3	233.049	486.930 496.408	324.304	430,260	-2372.570	-1044.637	20.668	
	2600	235.668	505.600	331.101	453.696	-2365.816	-933.964	18.764	-
	2700	238.212	514.542	337.730	477.391	-2358.852	-879.024	17.006	_
	2800	240.685	\$23.250	344.201	501.336	-2351,684	-824,346	15.378	_
	800	245.417	540.018	356.701	549.951	-234,320	- 75.329 - 715.767	12.463	
									_

Mg2O4Ti₁(I)

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CURRENT: June 1967

Magnesium Titanium Oxide (Mg₂TiO₄)

PREVIOUS June 1961

sium Titanium Oxide (Mg ₂ TiO ₄)
Magne
M _r = 160.4876
Mr
LIQUID

$M_{\rm r}$ = 160.4876 Magnesium Titanium Oxi	$\Delta_t H^0$ (298.15 K) = [-2046.33 ± 6.3] kJ mol ⁻¹ Enthalpy Reference Temperature $\Delta_{tin} H^0$ = [129 704] kJ·mol ⁻¹
	Δ _t H°(298.15 K) = 1
magnesium mamum Oxide (mg21104)	$S^{0}(298.15 \text{ K}) = [172.412] \text{ J·K}^{-1} \cdot \text{mol}^{-1}$ $T_{\text{Lin}} = 2013 \pm 20 \text{ K}$

Enthalpy of Formation

 $\Delta_H^{*}(Mg_2TiO_a, 1, 298.15 \, K)$ is calculated from $\Delta_H^{*}(Mg_2TiO_a, cr. 298.15 \, K)$ by adding $\Delta_{tas}H^{*}$ and the difference in enthalpy, $H^{*}(2013 \, K)$ H°(298.15 K), between the crystal and liquid.

A glass transition is assumed at 1400 K. Below 1400 K the heat capacity is obtained from the heat capacity of the crystal. Above 1400 K the heat capacity is assumed constant and estimated as 54.6 cal K⁻¹ mol⁻¹ or 7.8 cal·K⁻¹g-atom⁻¹, S'(1, 298 15 K) is calculated in a manner. analogous to that used for the enthalpy of formation. Heat Capacity and Entropy

Fusion Data

The incongruent melting point is obtained from Massazza¹ Previous work by Coughanour² suggested congruent melting at 2005 K. A_{lus}H^o is estimated from those of Na₂O-2TiO₂ and Na₂O-TiO₂ observed by Naylor³ and CaO-TiO₂ SiO₂ observed by King.⁴

References 'F Massazza and E. Surchia, 16th Int Congress of Pure and Appl. Chem., Inorg. Sect., Paris (1957), pp 161-8, Butterworths Scientific Publications, London, (1958).

W. Coughanour and V. A. DeProsse, J. Res. Nat. Bur. Stand. 51, 87 (1953).
 B. F. Naylor, J. Amer. Chem. Soc. 67, 2120 (1945).
 G. King, R. L. Ort and K. R. Bonnickson, J. Amer. Chem. Soc. 76, 4320 (1954).

Mg₂O₄Ti₁(cr,l)

0 to 2013 K crystal above 2013 K liquid	Refer to the individual tables for details.

Enthalpy R	eference To	emperature	Enthalpy Reference Temperature = $T_r = 298.15 \text{ K}$	×	Standard Sta	Standard State Pressure	$p^{\circ} = 0.1 \text{ MPa}$
ΤÆ	ដ		-[G*-If*(T,)]/T	$H^{\bullet}-H^{\bullet}(T_i)$	A'H'A (Δ_{iG}	log K ₁
088	0. 34.639 94.320	0. 26.740 70.337	104.267 204.267 125.901	-18.836 -17.753 -11.113	-2151.027 -2157.597 -2162.710	-2151.027 -2122.882 -2085.881	INFINITE 1108.880 544.776
298.15	128.574		115.102	ď	-2164,383	-2047.719	358.752
88	129.026 146.285	115.899	115.104	0.238	-2164.393	-2046.995 -2007.859	356.414 262.199
8	156.410	189.441	130.920	29.260	-2163.228	-1968.875	205.687
88	169.582	244.316	155.813	61.952	-2160.357	-1891.618	141.154
88	174.707	267.301 288.151	168.337	17.07 75.877	-2158.713 -2157.045	-1853,339 -1815,267	121.011 105.355
8 .	183.686	307.275	192.243	115.032	-2172.648	-1775.953	92.766
88	191.690	341.483	214.332	152.581	-2171.269	-1736,349	73.858
<u>5</u>	195.456	356.976	224.714	171.940	-2171.398	-1657.101	66.583
1200	202.614	385.451	244.282	211.754	-2418.140	-1553.467	54.097
96	206.041	398.637	253.520	232.188	-2412.452	-1496.007	48.840
88	212,610	423.288	271.033	274.058	-2400.588	-1382.158	40.109
2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	215.765	434.868	287.410	317.209	-2394.453	-1325.745	36.447
2013.000		447 433	288.438	320.056		STAL <> LIQUID	ding
2015.000		008.110	288.438	449.760		IKANSIIION 1018 278	101.01
2200	228.446	532.159	308,305	492.480	-2260.577	-1218.278	27.743
2300	228.446	542.314	318.260	515.324	-2254277	-1118.992	25.413
88	228.446	561.362	336.957	561.013	-2241.816	-1020.800	21.328
2600	228.446	570.322	345.761	583.858	-2235.654	-972.081	19.529
2800	228.446 228.446	587.252 587.252	362.414	629.547	-2223.473	-923598	1,300
280	228,446	595.268	370.306	652.392	-2217.453	-827.300	14.901
8	370 446	10.00	305 316	100 000	505.11.77	121.010	165 61
3500	228.446	617.757	392.467	720.926	-2199.695	-684.383] [] []
3300	228.446	624.786	399.401	743.771	-2193.881	-637.120	10.085
350	28.446	638 228	412.668	789.460	-2182.422	-543.113	8.58 186
3600	228.446	644.664	419.024	812,305	-2176.783	-496.355	7,202
3700	228.446	650.923	425.207	835.149	-2580.306	-441.966	6239
2800	728.440	CI0.733	431.227	857.994	-2573.563	-384.261	5.282
400	228.446	668.733	442.812	903.683	-2560.458	-269.377	3.518
PREVIOUS-						CURR	CURRENT. June 1967

M.=76.6955	Magnesium Silicide (Mg _z Si)	ım Silici	de (Mg ₂ S	(f)				Mg ₂ SI ₁ (cr)
$\Delta_t H^{\circ}(298.15 \text{ K}) = [-77.822] \text{ kJ·mol}^{-1}$ $\Delta_{tot} H^{\circ} = [85.772] \text{ kJ·mol}^{-1}$	Enthalpy F	teference T	J·K ⁻¹ mol ⁻¹ S° -{G	Enthalpy Reference Temperature = T, = 298.15 K J.K ⁻¹ mol ⁻¹ T.K C; S* -[G*-H'(T _i)]T	K H*-H*(T,)	Standard State Pressure kJ·mol ⁻¹ Δ_{cH}° Δ_{cG}°		p = 0.1 MPz log K,
Lid., New York, (1958).	28.15 28.15 30.05		81.588 82.008 102.413 119.248 146.056 17.1137	81.588 84.332 84.332 85.833 95.833 100.3140 110.3140 110.315 1	0. 0.126 7232 14793 39.745 39.745 39.745 39.745 39.745 63.134 90.08 111.139 11		· · · · · · · · · · · · · · · · · · ·	113.00 113.00 110.005 1
	PREVIOUS		:				CURRENT: D	CURRENT: December 1960

Magnesium Silicide (Mg₂Si)

CRYSTAL

Enthalpy of Formation $\Delta_t H^o(298.15 \text{ K})$ and T_{tas} from NBS.¹

Heat Capacity and Entropy C_p^* and $\Delta_{\rm LM} H^*$ from Kubaschewski and Evans. 2 S^* (298.15 K) estimated.

References ¹U. S. Nat. Bur. Stand., Circ. 500, (1952). ²O. Kubaschewski and E. L. Evans, "Metallurgical Thermochemistry," 3rd ed., Pergamon Press Ltd., New York, (1958).

CURRENT: December 1960

									14	131	-074	INA	Г	INCI	TIVIO		I I I V	1107	ν	IAC	/ La La		
Mg ₂ Sl ₁ (l)	- 0.1 MPa	log K,		2.636	5252 2522 2522	22,23	2658 2658 2614	253 253 250 250 250 250 250 250 250 250 250 250		2.1%	0.959	-0.084 -0.553 -0.971	-1346	-1.9% -2.268	-2.754 -2.967 -3.163	-3344	-3.667	-3.945 -4.070 -4.188	-4.449	-4.941 -5.167 -5.180			
	Standard State Pressure = $p^* = 0.1 \text{ MPa}$ k I-moi ⁻¹	Φ'		- 15.048	-15.121 -19.408 -24.201	-29.377	-45.804 -50.039	-53.844 -57.638 -61.418			-29.383 -14.432	20.104 37.168	54.105	87.622 104.212 120.697	137.081	185.665	217.617 233.471	249.249 264.952 280.585	306.610	385.756			
	Standard State	ν. - Η.Δ		-3.327	-3.282 -1.100 0.703	3.428	4.537 4.971 -11.938	-12.041 -12.188 -12.376	CRYSTAL	-267.425 -264.992	-262.602 -310.430	-307,893 -305,356 -302,819	-300.282	-295.212 -292.679 -290.148	-287.621 -285.098 -287.587	-280.074 -277.576	-275.091 -272.623	-270.173 -267.745 -265.344	-647.124	-641.662 -638.996 -636.378			
		$H^{\bullet}-H^{\bullet}(T_i)$		ö	0.174 9.588 19.002	28.416 37.830	56.658 56.072	75.486 84.900 94.314	101.375	103.728	122.556 131.970	141.384 150.798 160.212	169.626	197.868 207.282	216.696 226.110 235.524	244,938	263.766 273.180	282.594 292.008 301.472	310.836	329.664			
€	Enthalpy Reference Temperature = T. = 298.15 K	-[G*-H*(T,)]T		123.472	123.474 127.166 134.139	141.947	164.524	177.745 183.810 189.546	193.648	194.980 200.138	205.045	214.184 218.453 222.543	226.468	233.870 237.368 240.743	244.003 247.156 250.209	253.167	258.820 261.526	264.157 266.718 269.211	271.640	276.319 278.575 270.770			
side (Mg₂S	Temperature	S -[G			124.054 151.136 172.143							292.730 297.820 302.649		319.813				349.792 352.602 355.331		365.518			
m Silic	eference	 		94.140	94.149 94.140 94.140	94.140	24.14	94.140 94.140 94.140	94.140	94.140 94.140	94.140	24.45 24.45 24.45 34.45	94.140	2.7.2 3.1.2.3 3.1.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.3 3.3.	94.140 94.140	94.140	94.140 94.140	24.48 44.48 44.48	94.140	94.140			
Magnesiu	Enthalpy R	7.K	000	298.15	888	858	38 <u>8</u>	888 - 22	1375,000	1500 1500	9 <u>1</u> 2	8888 8888	2100	17.7.1 80.85 80.85	2500 2700 2800	3000	3100 3200	3300 3400 3500	3600	3800	}		
LIQUID M _r = 76.6955 Magnesium Silicide (Mg ₂ Si)	$\Delta_h H^0(298.15 \text{ k}) - [-3.327] \text{ kJ·mol}^{-1}$	10111.5% [271:50] = 13 ⁶³ [5	nthalpy of Formation A _f H°(Mg _S S), 1, 298.15 K) is calculated from A _f H°(Mg _S Si, cr, 298.15 K) by adding A _{fw} H° and the difference in enthalpy, H°(1375 K)- °(298.15 K), between the crystal and liquid.		ata estimated.		emistry", 3rd ed., Pergamon Press. Ltd., New York, (1958).																
Magnesium Silicide (Mg₂Si)	$S^{*}(298.15 \text{ K}) = [123.472] \text{ J·K}^{-1} \cdot \text{mol}^{-1}$	1 has = 1515 IN	Enthalpy of Formation $\Delta_H^2(Mg_S)$, 1, 298.15 K) is calculated from $\Delta_H^2(Mg_S)$; cr $H^2(298.15 \text{ K})$, between the crystal and liquid.	•	Fusion Data T _{in} from. \(^1\) \(^1\) And \(^2\) from Kubaschewski and Evans.\(^2\) Other data estimated.	References	 Nat. But. Stand., Cutc. 300, (1924). Kubaschewski and E. L. Evans, "Metallurgical Thermochemistry", 3rd ed., Pergamon Press. Ltd., New York, (1958). 																

Mg₂Si₁(cr,l)

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M_r = 76.6955 Magnesium Silicide (Mg₂Si)

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Magnesium Silicide (Mg₂Si)

0 to 1375 K crystal above 1375 K liquid	Refer to the individual tables for details.
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- p - 0.1 MPa	log Kr		13.500	13.416	6.630	5.659	3,827	3.368 2.983 2.656	QD.	2.196	0.959	-0.084 -0.553	-1.346	-1.990	-2522	-2.754	-3.344 -3.517	-3.667	-3.945 -4.070	-4.188	-4.449 -4.702	-4.941 -5.167 -5.380	CURRENT: December 1960
	₽'0		-77.055	-76.770 -76.770	-76.157	-75.833	-75.117	-70.933 -68.536 -66.095	TAL <> LIQUID TRANSITION	-58.848 -44.035	-29.383 -14.432	20.104 17.168	\$4.105	87.622	120.697	153.368	185.665	217.617	249.249	280,585	336.610	385.756 411.998	CURRENT: I
Standard State Pressure	l		-71.822	-77.826 -77.951	-78.054	-78.152	-78.661 -96.329	-97.022 -97.5% -98.052	N.	-267.425 -264.992	-262.602 -310.430	-307.893 -305.356 -307.819	-300.282	-295.212 -292.679	-290.148	-287.621	-280.074	-275.091	-270.173 -267.745	-265.344	-641.124	-636.378 -636.378	
<u>~</u>	$H^{\bullet}-H^{\bullet}(T_i)$		o	0.126 7.232	22.651	39.745	47.520 56.175	65,000 73,987 83,134	90.098	178.223 187.637	197.051 206.465	215.879 225.293	244.121	262.949 272.363	281.77	300.605	319.433	338.261	357.089	375.917	394.745	413.573	
Enthalpy Reference Temperature = T_t = 298.15 K $1 \cdot \text{K}^{-1} \text{mol}^{-1}$	-[G*-H*(T,)]/T		81.588	81.589 84.332 80.683	95.837	102.140	114.321	125.558 130.812 135.839	139.470 139.470	141.769	158.485	172.797 179.245 185.295	190.994	201.480	210.945	219.566	227.479	234.790	241.583 244.807	247.926	253.875	259.474 262.155	
emperature	S -[G		81.588	82,008 102,413	133.589	146.062	167.122 176.239	184.649 192.468 199.788	204.996 267.375	269.072 275.567	281.642 287.349	292.730 297.820 302.649	307.242	315.806	323.656	330.901	340.819	343.906	349.792	355,331	360.563	365.518 367.902	
ference T	ប		67.864	61.98 13.764 14.764	79.831	82,006 83,889	85.688 87.404	89.077 90.667 72.257	93.450 94.140	94.140 94.140	94.140 94.140	94.140 94.140 14.140	94.140	94.140 94.140	94.140	94.140	2.4 6.14 6.14	94.140	94.140	94.140	2.4.5 2.4.5 3.4.5	24.4 8.4 8.4	
Enthalpy Re	τÆ	°88	298.15	888	8	5 5 5	88	888 <u>8</u>	1375,000	1.40 1.50 1.50 1.50 1.50 1.50 1.50 1.50 1.5	99 <u>7</u>	888 848 848 848 848 848 848 848 848 848	2200	2300	2500	2700	3000	3100	3300	3200	3700	868 888	PREVIOUS:

Add **(290.15.5) =6(1.05 ± 4.2 J.) mm. T.	$\Delta_i H^{\circ}(298.15 \text{ K}) = -461.08 \pm 4.2 \text{ kJ} \cdot \text{mol}^{-1}$								
7.		<u></u>	eference Te	mperature	- T, = 298.15	*	Standard S	tate Pressure =	p° = 0.1 MPa
200 10 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		7.K		S -[G	-H'(T,)]/T	H*-H*(T,		A,G	log Kr
28.10 (10.70) (10.70) (10.71) (10.70)		100	3	2010	2,0	•			9
400 110764 11371 12020 110805 -46,1045 700 116.817 181.52 118031 21724 144.77 146.128 800 110.709 116.817 181.52 118031 21.2948 -46,1178 800 113.846 21.299 12.2001 55.311 -46,1.288 800 10.3846 21.299 135.739 69.327 1174 -46,1.288 800 10.3846 21.299 13.573 19.006 59.997 180.006 180		300	104.516	87.804 88.511	87.864	0. 0.193	-461.077 -461.075	-400.923	70.240
1,000 1,00		\$ 8	107.654	119.021	92.005 99.922	10.806 21.724	-461.046 -461.067	-380.381	49.673
119.872 197.390 127.001 56.311 -461.498 120.574 200.797 121.846 201.916 139.016 59.006 121.846 201.916 129.016 59.007 121.846 201.916 129.016 59.007 121.846 201.916 129.016 59.007 121.846 201.916 129.016 59.007 121.846 201.916 129.016 59.007 121.846 201.916 129.016 59.007 121.846 201.916 121.918 121.852 244.939 149.046 90.560 487.232 121.853 224.612 121.853 224.612 121.853 224.612 121.853 224.612 121.853 224.612 121.853 224.612 221.853 224.612 221.853 224.612 221.853 224.612 221.853 224.626 221.853 224.626 221.853 224.626 221.853 224.626 221.853 224.626 221.853 224.626 221.853 224.626 224.626 224.626 221.853 224.626 22	ndix B, (1960).	98	113.763	163.826	108.913	32.948	-461.128	-340.037	29.603
123.846 201.975 123.846 123.		800		197,390	127,001	56.311	-461.498	-299.630	19.564
123.846 123.933 144.123 169.133 -460.808 123.846 123.846 123.939 149.046 89.457 113.846 123.939 123.939 149.046 89.457 123.835 124.339 149.046 90.560 173.835 124.339 123.835 124.339 123.835 123.83		823.000		201.916	129.016	59.997		TRANSITION	
123.586 233.374 149.046 89.472 173.595 173.5		88		212,993 226,041	135.733	69.533 81.918	-460,808 -487,232	-279.470 -257.154	16.220
123.595 238.66 152.152 95.380 -487.339 123.595 259.618 157.152 107.740 -488.64 123.595 259.508 167.124 120.109 -489.968 123.595 258.668 174.054 144.819 -488.64 123.595 258.171 186.933 157.178 -862.233 157.178 -862.233 157.178 -862.233 157.178 -862.233 157.178 -862.233 157.2395 259.779 198.675 186.575 -862.256 123.595 306.411 204.171 194.257 -862.256 -862.256 123.595 312.731 204.43 206.616 -853.604 -853.		1061.000		233.374	149.046	89.472		_ II <> III	
12.555 259.501 101.100 -489.501 123.555 259.508 157.154 101.100 -489.508 123.555 259.508 157.157 124.59 124.59 124.59 124.59 124.59 124.59 124.59 124.59 124.59 124.59 124.59 124.59 124.59 125.50		200		238.861	152.152	95.380	-487,359	-234.128	11.118
123.555 286.658 171.195 180.649 171.2459 171.2550 171.155 180.649 171.2550 171.155 180.649 171.2550 171.155 180.649 171.2550 171.		38	23.595	259.508	159,832	120.100	-488.541	-211.050	7.548
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123.595 292.204 182.595 1818.397 -863.110 123.595 295.729 186.675 1818.397 -863.110 123.595 312.751 209.443 206.616 -855.504 123.595 312.751 209.443 206.616 -855.504 123.595 312.751 214.507 218.976 -855.504 123.595 330.025 224.071 243.695 -850.516 123.595 340.330 232.965 256.054 -845.586 123.595 340.330 232.965 268.414 -845.586		99	123.595	285.171	186.935	157.178	-868.283		1.724
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123.595 318.781 214.507 218.976 -855.504 123.595 39.0025 224.071 243.695 -85.001 123.595 340.330 228.596 256.054 -848.041 123.595 340.330 232.965 268.414 -845.586		200 200 200 200 200 200 200 200 200 200	123.595 123.595	306.411	204.171	194.257 206.616	-860.556 -858.022		-2.733 -3.915
123.595 345.31 213.35 -85.302 123.595 330.025 224.071 243.695 -85.0516 123.595 340.330 232.955 256.054 -845.586 123.595 340.330 232.965 268.414 -845.586		2100	123.595	318.781	214.507	218.976	-855.504		-4.980
123.595 335.285 228.596 256.054 -848.043 123.595 340.330 232.965 268.414 -845.586		888	123.595 123.595	324.531 330.025	219.378	243.695	-853.002		-5.946
		2400 2500	123.595 123.595	335285	228.5%	256.054	-848.043 -845.586		-7.629
		DDEATORIS.							7501

CRYSTAL Magnesium Nitride (Mg₃N₂)

 $S^{(298.15 \text{ K})} = [87.864 \pm 8.4] \text{ J·K}^{-1} \cdot \text{mol}^{-1}$

Enthalpy of Formation Data from Douglas et al.

Heat Capacity and Entropy Data from Douglas et al.

Reference ¹F. B. Douglas, A. C. Victor, and A. R. Beaudoin, U. S. Nat. Bur. Stand., Report 6928, Appendix B. (1960).

68.001 60.848 60.848 48.745 43.583 34.647 30.756 23.904 20.872 18.067 13.037

-1752.196 -1638.604 -1525.600 -1413.152 -1301.231

-4143.953 -4131.036 -4118.215 -4105.489 -4092.858

616.210 654.368 692.526 730.685

799.149 816.900 833.862 850.102 865.679

381.581 381.581 381.581 381.581 381.581

-4080321

807.001

570.260 582.024 593.452 604.563 615.371

880.644 895.045 908.923 922.313

381.581 381.581 381.581 381.581

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-4209.957 -4196.587

429.496 432,973 445.824 461.585 476.804 491.505

380.744 380.920 381.581 381.581 381.581 381.581

700.373

-2844.671 -2760.346 -2668.032 -2566.904 -2448.098 -2330.185

-3751.645 -3872.275 -3863.611 -423.344

274.920 311.925 349.525 387.425 425.458 433.455

555.683 587.236 616.851 644.714 670.862 695.407

360.075 365.682 373.757 377.899

-2213.109 -2096.819 -1981.265 -1866.404

-4183.281 -4170.074 -4156.965

718.517 740.328 760.959 780.531

609,640 446,528 348,620 283,353 236,754 201832 117,2912 115,082 115,082 110,115 95,772 85,250 76,073

-3254.772 -3172.761 -3091.163 -3010.075

-3747.814 -3745.544 -3741.994 -3737.409

75.488 104.658 135.785 168.613 203.048 238.653

360,377 405,305 446,840 485,488 521,754

282.211 301.248 320.620 335.975 351.540

234,563 255,793 277,109 298,140 318,706 338,726 358,136 376,909 395,053

3419.399 -3502.859

-3745.148 -3748.487 -3748.843

23.110

-3745.098

Standard State Pressure = p = 0.1 MPa

kJ-mod-

 $H^{\bullet}-H^{\bullet}(T_{i})$ $\Delta_{i}H^{\bullet}$

S -[G*-H*(T,)]/T

| ც

00 200 298.15

J.K-'mol-'

log K

₽G.

CURRENT: March 1963

CRYSTAL

Magnesium Phosphate (Mg₃P₂O₈)

5°(298.15 K) = [188.280] J·K⁻¹·mol⁻¹

Ten = 1621 K

Enthalpy Reference Temperature = T, = 298.15 K 7,8 $\Delta_t H^0(298.15 \text{ K}) = -3745.10 \pm 10.5 \text{ kJ} \cdot \text{mol}^{-1}$ $\Delta_{tm} H^0 = [121.35 \pm 41.8] \text{ kJ} \cdot \text{mol}^{-1}$

1. The enthalpy of reaction for the reaction 3MgO(cr) + P₂O₃(orthorohombic) → Mg₃P₂O₄(cr) had been evaluated at 348 K. A small temperature correction to 298.15 K was made with thermal data not available to Stevens and Turkdogan¹ on MgO (Giauque (2)), P₂O₃ JANAF 2. A new AH'(298.15 K) for P2Os(hexagonal) as reported by Holmes was combined with the enthalpy of reaction, -6.85 ± 1.0 The selected A.H" (298.15 K) is a weighted average of a revised calorimetric determination and a 3rd law calculation using equilibrium data. A calorimetric determination of the enthalpy of formation reported by Stevens and Turkdogan' was revised three ways: Table, December 31, 1962) and Mg₃P₂O₈ (this table). Enthalpy of Formation

is +8.35 kcal·mol¹ of Mg.P₂O₃ or +4.173 kcal·mol⁻¹ of P.)

This revised Δ_iH²(298.15 K), 897 60 ± 2.0 kcal·mol⁻¹, would appear to be more reliable than the original value reported by Stevens and 3. A correction of +8.35 kcal mol⁻¹ was made for the change in phosphorus reference state from white $(\alpha) \rightarrow red$ (V). (The correction ccal·mol⁻¹, for the reaction. P₂O₃(hexagonal) → P₂O₃(orthorhombic) as reported by Hill et. al.

Turkdogan¹

For the reaction $Mg_3P_3O_4(cr) + 5 H_2(g) \rightarrow 3 MgO(cr) + P_2(g) + 5 H_2O(g)$, the 3rd law treatment of the equilibrium data of Bookey² and the JANAF table free energy functions gave a Δ_4H^4 (298.15 K) = -893.11 kcal-mol⁻¹. The quantity, -895.10 ± 2.50 kcal-mol⁻¹, is taken as the most probable value for the enthalpy of formation of magnesium orthophosphate.

Heat Capacity and Entropy

The entropy at 298 15 was estimated by considering the additive entropy constants of Kelley⁶ and Evans and Kubaschewski.⁷ The heat capacity was estimated in a similar manner by considering the heat capacities of the constituent elements and related compounds such as Mg. O₂, MgO, P, P₂O₃, Ca₂P₂O₃, and Ca₃P₂O₃

Fusion Data

The melting point, 1621 K, as reported by Stevens and Turkdogan¹ was selected. There is disagreement on the melting point in the literature. From the work of Winter, *Kelley² has quoted a melting point of 1457 K and has calculated a ''rather uncertain value'' of 11.300 kcal·mol⁻for the heat of fusion. Bookey² has found a melting point of 1703 K. Berak¹0 gives 1630 K as the melting point.

References

1C. G. Stevens and E. T. Turkdogan, Trans. Faraday Soc. 50, 370 (1954).

2W. F. Giauque, J. Amer. Chem. Soc. 71, 3192 (1949).

3W. S. Holmes, Trans. Faraday Soc. 58, 1916 (1962).

4W. L. Hill, G. T. Faust, and S. B. Hendricks, J. Amer. Chem. Soc. 65, 794 (1943).

5 B. Bookey, J. Iron Steel Insitiute (London) 172, 66 (1952).

6 K. K. Kelley, U. S. Bur. Mines, personal communication, (June 1960).

7 E. L. Evans and O. Kubaschewski, Metallurgical Thermochemistry, (1958).

8 H. Winter, Diss. Universitats zu Leipzig, (1913).

9 K. K. Kelley, U. S. Bur. Mines Bull. 393, (1956).

10 Berak, Roczniki Chim. 32, 17 (1958).

Magnesium Phosphate (Mg₃P₂O₈)

PREVIOUS: December 1960

Mg₃O₈P₂(cr)

				NIST-JANAF THERMOCHEMICAL TABLES	
= p* = 0.1 MPa log K _r		601.782 597.824 438.777 342.508	278.668 233.088 198.930 172.392 151.080 133.638 119.035	D 106.369 84.921 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.369 84.920 106.320 84.920 106.32	
e Pressure = p		-3434.910 -3433.494 -3356.219 -3278.557	-3200.957 -3123.628 -3046.712 -2970.306 -2892.324 -2814.266 -2734.626	GLASS <> LIQUID -3773.316 -264.288 1 -413.486 -2541.863 1 -4113.480 -2451.863 1 -405.685 -2451.863 1 -405.685 -2251.863 1 -405.687 -219.200 1 -405.187 -219.200 1 -405.187 -219.200 1 -405.187 -219.200 1 -405.187 -219.200 1 -405.187 -219.200 1 -3077.702 -1794.118 1 -3077.702 -1794.118 1 -3077.702 -186.169 1 -3077.702 -186.169 1 -3077.703 -186.169 1 -3077.703 -186.169 1 -3077.704 -197.309 1 -307.304 -307.304 1 -307.304 -307.304 1 -307.305 -307.304 1 -307.305 -307.304 1 -307.305 -307.304 1 -307.305 -307.304 1 -307.305 -307.305 1 -307.305 -307.305 1 -307.305 -307.305 1 -307.305 -307.305 1 -307.305 -307.305 1 -307.305 -307.305 1 -307.305 -307.305 1 -307.305 -307.305 1 -307.305 -307.305 1 -307.307 -307.305 1 -307.305 -3	
Standard State Pressure kJ·mol ⁻¹ A _t H° A _t G°		-3663.190 -3663.240 -3666.578 -3666.934	-3665.905 -3663.635 -3660.086 -3655.500 -3675.747 -3669.736 -3790.321	GLAS -1773.116 -1773.116 -113.406 -4000.605 -4005.605 -4005.825 -4	
K H*-H*(T;)		0. 0.394 23.110 48.254	75.488 104.658 135.785 168.613 203.048 238.653 274.965	282.287 282.287 320.311 462.901 462.901 472.883 510.452 551.962 603.492 603.492 603.492 603.492 613.96	
Enthalpy Reference Temperature = T_s = 298.15 K $J.K^{-1}mol^{-1}$ $J.K$ C_s^{*} S^{*} $-[G^{*}-H^{*}(T_s)]JT$		235.102 235.106 243.810 261.092	281.385 302.615 323.931 344.962 365.529 385.548 404.960	408.766 423.944 421.394 473.715 479.715 479.715 479.715 483.503 538.035 538.03	
remperature		235.102 236.420 301.584 357.600		640,148 640,148 670,336 778,556 778,556 777,226 777,841 825,011 825,011 825,011 825,012 836,779 875,089 876,08	
eference		212.756 213.384 240.162 262.337	282.211 301.248 320.620 335.975 351.540 360.075	3,66,451 475,302 475,3	
Enthalpy R	°88	28.15 300 400 500	860 860 860 860 860 860 860 860 860 860	1220,000 120,000 150,0	
$\Delta_{H^0}(298.15 \text{ K}) = [-3663.190] \text{ kJ·mol}^{-1}$ $\Delta_{los}H^0 = [121.336 \pm 41.8] \text{ kJ·mol}^{-1}$	ng $\Delta_{ ext{in}}H^{\circ}$ and the difference in enthalpy, H° (1621 K)–	20, as given in Kelley, ¹ S°(1, 298.15 K) is calculated	given in Kelley.¹		

Enthalpy of Formation $\Delta_t H^{\circ}(Mg_3P_2O_4, cr, 298.15 \, K)$ by adding $H^{\circ}(Mg_3P_2O_4, cr, 298.15 \, K)$ by adding $H^{\circ}(298.15 \, K)$, between the crystal and liquid. $S^{\circ}(298.15 \text{ K}) = [235.102] \text{ J-K}^{-1} \cdot \text{mol}^{-1}$ $T_{\text{tat}} = 1621 \text{ K}$

Heat Capacity and Entropy

The heat capacity was estimated as 13/11 of the corresponding heat capacity of Ca₂P₂C in a manner similar to that used for the enthalpy of formation.

Reference IK. K. Kelley, U. S. Bur. Mines Bull. 5841, (1960).

Mg₃O₈P₂(cr,I)

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S* -[G*-H*T;])IT 188.280 188.280 189.284 188.284 189.598 188.284 310.777 214.270 356.377 224.563 446.840 777.109 485.348 258.149 485.348 218.740	H'(T.))/T 188.230 18.234 196.988 214.270 234.563	H*-H*(T,) 0. 0. 0.334 23.110	-3745.098 -3745.148 -3745.148	Δ,G* -3502.859 -3501.356	log K _r 613.686 609.640
	88.280 88.284 86.988 14.270 14.563	0. 0.394 23.110	-3745.098 -3745.148 -3748.487	-3502.859	613.686
	82.280 82.284 26.988 14.270	0. 0.394 23.110	-3745.098 -3745.148 -3748.487	-3502.859	613.686
	88.280 88.284 96.988 14.270	0.394 23.110	-3745.098 -3745.148 -3748.487	-3502.859	609.640
	8284 26988 14270 24563	23.110	-3745.148	-3501.356	609.640
	14.270 14.563	10.75		2410 300	
	14.563	47.5	-3748.843	-3337.054	348.620
	100	75.488	-3747.814	-3254.772	283.353
	25.75	135.785	-3745.544	-3172.761	236.754
	298.140	168.613	-3737.409	-3010.075	174.700
	18.706	203.048	-3757.656	-2927.411	152.912
	38.726 58.136	238.653	-3751.645	-2844.671	135.082
	606.90	311.925	-3863.611	-2668.032	107.203
644.714 39 670.862 41	395.053 412.578	349.525	-4223.344	-2566.904 -2448.098	95.772
	429.496	425.458	-4209.957	-2330.185	76.073
700.373 43	432.973	433.455	CRYSTAL	V>	anon
	19.408	592.340		-2219.200	68.188
	59.527	639.870	-4045.147	-2111.114	61.263
	7.623	734.931	-4000,086	- 2004.284	55.102 49.587
	829.52	782.461	-3977.702	-1794.118	44.626
	12.121	877.522	-3933.220	-1588.214	36.069
	76.308	925.052	-3911.122	- 1486.733	32.358
	77.440	1020.112	-3867.209	-1286.483	25.846
	22,306	1067.643	-3845.394	-1187,638	22.976
	50.762	1162.703	-3802.047	-992.339	17.874
	6 55	257.0121	-3780.518	875.818	865.51
	0.578	1305.294	-3737.751	-704.902	1.506
	3.162	1352.824	-3716.518	-610.456	9.663
	7.394	1447.885	-3674.363	-423.464	6320
	39.072 50.476	1495.415	-3653.448	-330.876	1.801
	51.617	1590.475	-3611.963	-147.421	2026
	3.159	1638,006	-3591.401	-56.516 33.860	0.757
	793.581	1733.066	-3550.666	123.729	-1.576
	77.77	1828.126	-3510.485	302.002	-3669
			- 3490 617	390.433	-4.635
238.917 81 249.844 82	23.559	1875.657	10.00		
			49.408 48.910 501.623 53.5121 53.5121 53.5128 576.208 576.208 56.7139 66.7139 66.7139 66.7139 66.7139 771.508 771.308 771.308	499.408 592.340 489.919 687.401 505.623 70.4031 505.634 70.4031 505.637 76.302 505.76.302 505.776.302	49.344 88 592.340 - 40451825 - 2 488.917 65.9870 - 40451825 - 2 488.917 65.9870 - 40451826 - 1 55.678 782.461 - 3977.702 - 1 55.987 872.461 - 3977.702 - 1 55.308 925.052 - 3913.220 - 1 576.208 925.052 - 3913.220 - 1 576.208 925.052 - 3913.220 - 1 576.208 925.052 - 3913.220 - 1 576.208 925.052 - 3913.220 - 1 576.208 925.052 - 3913.202 - 1 576.208 925.052 - 3913.202 - 1 576.208 925.052 - 3913.202 - 1 576.208 925.052 - 3913.202 - 1 576.208 925.052 - 3913.202 - 1 576.208 925.052 - 3913.202 - 1 576.208 925.052 - 3913.203 - 1 576.208 925.052 - 3913.203 - 1 576.208 925.052 - 3713.703 - 3713.053 - 1 577.208 165.208 - 3501.461 - 1 772.508 165.208 - 3501.666 - 3530.666

CRYSTAL-LIQUID

M_r = 262.85772 Magnesium Phosphate (Mg₃P₂O₈)

Refer to the individual tables for details.

0 to 1621 K crystal above 1621 K liquid

Magnesium Phosphate (Mg₃P₂O₈)

Continued from page 1539

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<sup>1</sup>B. Rosen, "Spectroscopic Data Relative to Diatomic Molecules," Pergamon Press, New York, p. 255. (1970).
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JANAF Thermochemical Tables: MgO(g), BeO(g), CaO(g), 12-31-74; SrO(g), BaO(g), 6-30-74; WO₂(g), WO₃(g).

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