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THEORETICAL ENERGY RELEASE OF THERMITES, INTERMETALLICS, AND COMBUSTIBLE METALS[†]

S. H. Fischer and M. C. Grubelich
Sandia National Laboratories
Albuquerque, NM 87185-1453

ABSTRACT

Thermite mixtures, intermetallic reactants, and metal fuels have long been used in pyrotechnic applications. Advantages of these systems typically include high energy density, impact insensitivity, high combustion temperature, and a wide range of gas production. They generally exhibit high temperature stability, and possess insensitive ignition properties. In this paper, we review the applications, benefits, and characteristics of thermite mixtures, intermetallic reactants, and metal fuels. Calculated values for reactant density, heat of reaction (per unit mass and per unit volume), and reaction temperature (without and with consideration of phase changes and the variation of specific heat values) are tabulated. These data are ranked in several ways, according to density, heat of reaction, reaction temperature, and gas production.

INTRODUCTION

Exothermic reactions between a metal and a metal oxide (thermite) and between metallic elements (intermetallic), as well as the combustion of metals (metal oxidation reactions), are extremely useful sources of energy production and material synthesis for numerous applications. For example, the thermite welding process was first demonstrated in 1898 and continues to be the most frequently used method for the field welding of railroad track.[1, 2]

Other applications for thermite reactions include: thermite torches for underwater and atmospheric cutting and perforation; electronic hardware destruct devices; additives to propellants and explosives for increased performance; pyrotechnic switches; airbag gas generator materials; reactive fragments; high-temperature-stable igniters; free-standing insertable heat sources; devices to breach ordnance cases to relieve pressure during fuel fires; and methods of producing alumina liners *in situ* for pipes.

Applications for intermetallic reactions include: consumable port covers for ramjet engine inlets; tracer compositions for munitions; ramjet fuels; self-ejecting combustible plumes for large-area heating; ignition aids for thermites; thermal battery heat sources; incendiary projectiles; delay fuzes; additives to propellants to increase burn rate without significant decrease of specific impulse; and shaped-charge liners.

Metal fuels have been used as: additives to increase shock sensitivity of explosives; additives to increase explosive blast effects; fuel-air explosives; additives to both solid and liquid propellants to increase density impulse; methods of controlling combustion instability in solid propellant rockets; additives to solid and liquid fuels for ramjets to increase range; and fuels in numerous pyrotechnic devices.[2-22]

Thermite, intermetallic, and metal fuels (with an oxidizer) can be ignited via a thermal impulse from a hot-wire, exploding bridgewire (EBW), or semiconductor bridge (SCB) igniter as well as by laser impingement, mechanical methods, or shock initiation.[12, 23-29] Many of these formulations are stable at high temperatures and are insensitive to the effects of moisture, corrosion, friction, spark, shock, contaminants, and variations in composition[15]. Clearly, these types of exothermic reaction mixtures provide the output for a wide variety of engineering applications with a large choice of ignition methods.

CALCULATIONS

The "traditional" thermite reaction is taken as the reaction of a stoichiometric mix of aluminum and magnetite (Fe_3O_4) reacting exothermically to completion with the products being alumina (Al_2O_3) and iron. Many other thermite mixtures exist; many of these, as well as intermetallic and metal-oxidation reactions, are surveyed in this

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paper. Some of these reactions produce little or no gas. Others produce significant amounts of gaseous products. The reactant composition can be chosen to produce solid, liquid, and/or gaseous products as required for the particular application.[6, 30, 31]

Tables 1a through 1f list the theoretical maximum density (TMD) of the reactants, the adiabatic reaction temperature without and with taking into account the heats of phase changes, the state of the products, the amount of gas produced referenced to the total mass of the reactants (or products), and the heat of reaction based on the mass and volume of the reactants for a selection of exothermic thermite reactions. The same information for intermetallic reactions is listed in Tables 2a through 2f. In the field of intermetallic reactions, boron, carbon, and silicon are usually considered metallic.[15] In the present study, sulfur is also included. In these tables the reactions are first listed alphabetically and then ranked in descending order according to reactant density, heat of reaction (per unit mass and per unit volume of the reactants), reaction temperature, and moles of gas produced per unit mass. Analogous values (metal density and heat of reaction with respect to the mass and volume of the metal) for metal-oxidation reactions are listed in Tables 3a through 3d. Physical, thermochemical, and reaction data are taken from references 13, 14, 17, 18, 28, and 32 through 47.

The heat of reaction is calculated assuming complete adiabatic reaction of the reactants starting at 298K. The increase in temperature is calculated using the average specific heat over the temperature range from 298K to the adiabatic reaction temperature. If phase transitions (solid-solid, solid-liquid, or liquid-gas) occur over that temperature range, the adiabatic reaction temperature is calculated taking into account the heats of those transitions and using the average specific heats for each temperature range between transitions. This calculated temperature is an upper limit for the ideal case of complete reaction and no energy losses.

In most of the calculations reported in the open literature, the adiabatic reaction temperature is calculated without taking into account the heats of the phase transitions. This leads to erroneously high temperatures. For instance, for "traditional" thermite ($8Al + 3Fe_3O_4$) the adiabatic reaction temperature with no phase transitions taken into account is calculated as 4057K. In contrast, with the solid-solid, solid-liquid, and liquid-gas heats of transition included, the adiabatic reaction temperature is more accurately calculated as 3135K. Similarly, for Ti + 2B, the calculated adiabatic reaction temperature drops from 3710K to 3498K. Measured reaction temperatures are in reasonable agreement with the calculated values. Temperatures ranging from 2800K to 3000K have been measured for $8Al + 3Fe_3O_4$, while that for Ti + 2B has been measured in the range of 3150K to 3300K.[15, 47, 50]

An accurate calculation of the adiabatic reaction temperature is important for determining whether the reaction is likely to be self-propagating. A strong indication that the reaction is self-propagating is if at least one of the product species is brought to its melt temperature.[43] Another indication that a reaction is self-propagating is an adiabatic reaction temperature greater than 2000K.[17] (Reactions which are not self-propagating under normal conditions may become so when initiated by a high-power stimulus, such as a high-energy shock. Self-propagation can also be promoted by preheating the reactants to a high temperature.[43]) It should be noted that, because the effect of phase changes on the product temperature takes a finite time, the initial temperature rise may control the diffusion and reaction rates before the temperature drops due to the phase changes.[28]

The reaction temperature is also a guide as to which materials are suitable for a given application. For some applications, such as cutting through metal, high temperatures are required. For others, such as air-bag inflation, low-temperature products are desirable.

DISCUSSION

For engineering applications, the "optimal" exothermic mixture is dependent on several factors which include: energy per unit mass (or volume depending on the requirements of the application); chemical stability of the reactants and products at normal operating temperatures; chemical compatibility of the reactants and products with other materials present in the application; toxicity of the reactants and products; reaction rate; ease of processing; availability of the reactants; reaction temperature; state of the products; and cost.

From Tables 1 and 2, thermite and intermetallic compositions can be selected to produce solid, liquid, or gaseous reaction products as required for a particular application. In situations where gas production is undesirable, such as obturated systems, applications for which it is desirable to control the reaction rate by conduction rather than

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convection, or systems which may be adversely affected by pressure variations, solid and liquid products are more suitable. However, in order to perform mechanical work, rapidly convey the product (as in a torch-type output), or inflate items such as airbags, the production of gases is required.

Similar compromises apply for the selection of metal fuels. Desirable properties for metal fuels are a high heat of combustion per unit mass of metal (or of the metal and the oxidizer for some applications), a high density, and low melt and vaporization temperatures. Table 3 contains several properties of importance. Ideally one would select boron or beryllium based on their high energy content. Unfortunately, low combustion efficiency and toxicity, respectively, limit the application of these metals. In general, the wide use of aluminum in propellant, pyrotechnic, and explosive formulations is because of its many desirable properties. Most other metals have applications in systems requiring very specific properties. For example, zirconium is used where ignition sensitivity and high reaction rates are required, while copper is used when a good heat conductor is necessary.

SUMMARY

Numerous thermite and intermetallic energetic compositions exist that can be used for a wide variety of engineering applications. Metal combustion reactions are also of great utility. A comprehensive list of these materials and their energetic properties is presented here. Comparison to experimentally measured reaction temperatures shows reasonable agreement with the calculated adiabatic reaction temperatures when phase changes are taken into account. The properties tabulated in this report provide a useful guide for choosing exothermic formulations for engineering applications.

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Table 1a - Thermite Reactions (in Alphabetical Order)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2Al + 3AgO	6.085	7503	3253	l-g	gas	0.7519	0.8083	896.7	5457
2Al + 3Ag_2O	6.386	4941	2436	liquid	l-g	0.4298	0.4636	504.8	3224
2Al + B_2O_3	2.524	2621	2327	s-l	solid	0.0000	0.0000	780.7	1971
2Al + Bi_2O_3	7.188	3995	3253	l-g	gas	0.4731	0.8941	506.1	3638
2Al + 3CoO	5.077	3392	3201	liquid	l-g	0.0430	0.0254	824.7	4187
8Al +3Co_3O_4	4.716	3938	3201	liquid	l-g	0.2196	0.1294	1012	4772
2Al + Cr_2O_3	4.190	2789	2327	s-l	liquid	0.0000	0.0000	622.0	2606
2Al + 3CuO	5.109	5718	2843	liquid	l-g	0.5400	0.3431	974.1	4976
2Al + 3Cu_2O	5.280	4132	2843	liquid	l-g	0.1221	0.0776	575.5	3039
2Al + Fe_2O_3	4.175	4382	3135	liquid	l-g	0.1404	0.0784	945.4	3947
8Al + 3Fe_3O_4	4.264	4057	3135	liquid	l-g	0.0549	0.0307	878.8	3747
2Al + 3HgO	8.986	7169	3253	l-g	gas	0.5598	0.9913	476.6	4282
10Al + 3I_2O_5	4.119	8680	>3253	gas	gas	0.6293	1.0000	1486	6122
4Al + 3MnO_2	4.014	4829	2918	liquid	gas	0.8136	0.4470	1159	4651
2Al + MoO_3	3.808	5574	3253	l-g	liquid	0.2425	0.2473	1124	4279
10Al + 3Nb_2O_5	4.089	3240	2705	liquid	solid	0.0000	0.0000	600.2	2454
2Al +3NiO	5.214	3968	3187	liquid	l-g	0.0108	0.0063	822.3	4288
2Al + Ni_2O_3	4.045	5031	3187	liquid	l-g	0.4650	0.2729	1292	5229
2Al + 3PbO	8.018	3968	2327	s-l	gas	0.4146	0.8591	337.4	2705
4Al + 3PbO_2	7.085	6937	3253	l-g	gas	0.5366	0.9296	731.9	5185
8Al + 3Pb_3O_4	7.428	5427	3253	l-g	gas	0.4215	0.8466	478.1	3551
2Al + 3PdO	7.281	5022	3237	liquid	l-g	0.6577	0.6998	754.3	5493
4Al + 3SiO_2	2.668	2010	1889	solid	liquid	0.0000	0.0000	513.3	1370
2Al + 3SnO	5.540	3558	2876	liquid	l-g	0.1070	0.1270	427.0	2366
4Al + 3SnO_2	5.356	5019	2876	liquid	l-g	0.2928	0.3476	686.8	3678
10Al + 3Ta_2O_5	6.339	3055	2452	liquid	solid	0.0000	0.0000	335.6	2128
4Al + 3TiO_2	3.590	1955	1752	solid	liquid	0.0000	0.0000	365.1	1311
16Al + 3U_3O_8	4.957	1406	1406	solid	solid	0.0000	0.0000	487.6	2417
10Al + 3V_2O_5	3.107	3953	3273	l-g	liquid	0.0699	0.0356	1092	3394
4Al + 3WO_2	8.085	4176	3253	l-g	solid	0.0662	0.0675	500.6	4047
2Al + WO_3	5.458	5544	3253	l-g	liquid	0.1434	0.1463	696.4	3801
2B + Cr_2O_3	4.590	977	917	liquid	solid	0.0000	0.0000	182.0	835.3
2B + 3CuO	5.665	4748	2843	gas	l-g	0.4463	0.2430	738.1	4182
2B + Fe_2O_3	4.661	2646	2065	liquid	liquid	0.0000	0.0000	590.1	2751
8B + 3Fe_3O_4	4.644	2338	1903	liquid	liquid	0.0000	0.0000	530.1	2462
4B + 3MnO_2	4.394	3000	2133	l-g	liquid	0.3198	0.1715	773.1	3397
8B + 3Pb_3O_4	8.223	4217	2019	liquid	l-g	0.4126	0.8559	326.9	2688
3Be + B_2O_3	1.850	3278	2573	liquid	s-l	0.0000	0.0000	1639	3033
3Be + Cr_2O_3	4.089	3107	2820	s-l	liquid	0.0000	0.0000	915.0	3741
Be + CuO	5.119	3761	2820	s-l	liquid	0.0000	0.0000	1221	6249
3Be + Fe_2O_3	4.163	4244	3135	liquid	l-g	0.1029	0.0563	1281	5332

Table 1a - Thermite Reactions (in Alphabetical Order) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$4Be + Fe_3O_4$	4.180	4482	3135	liquid	l-g	0.0336	0.0188	1175	4910
$2Be + MnO_2$	3.882	6078	2969	liquid	gas	0.9527	0.5234	1586	6158
$2Be + PbO_2$	7.296	8622	4123	l-g	gas	0.4665	0.8250	875.5	6387
$4Be + Pb_3O_4$	7.610	5673	3559	liquid	gas	0.4157	0.8614	567.8	4322
$2Be + SiO_2$	2.410	2580	2482	solid	liquid	0.0000	0.0000	936.0	2256
$3Hf + 2B_2O_3$	6.125	2656	2575	solid	liquid	0.0000	0.0000	296.5	1816
$3Hf + 2Cr_2O_3$	7.971	2721	2572	solid	liquid	0.0000	0.0000	302.3	2410
$Hf + 2CuO$	8.332	5974	2843	solid	l-g	0.3881	0.2466	567.6	4730
$3Hf + 2Fe_2O_3$	7.955	5031	2843	solid	l-g	0.2117	0.1183	473.3	3765
$2Hf + Fe_3O_4$	7.760	4802	2843	solid	l-g	0.1835	0.1025	450.4	3496
$Hf + MnO_2$	8.054	5644	3083	s-l	gas	0.3263	0.3131	534.6	4305
$2Hf + Pb_3O_4$	9.775	9382	4410	liquid	gas	0.2877	0.5962	345.9	3381
$Hf + SiO_2$	6.224	2117	1828	solid	liquid	0.0000	0.0000	203.3	1265
$2La + 3AgO$	6.827	8177	4173	liquid	gas	0.4619	0.4983	646.7	4416
$2La + 3CuO$	6.263	6007	2843	liquid	l-g	0.3737	0.2374	606.4	3798
$2La + Fe_2O_3$	5.729	4590	3135	liquid	l-g	0.1234	0.0689	529.6	3034
$2La + 3HgO$	8.962	7140	>4472	l-g	gas	.32 - .43	.65 - 1	392.0	3513
$10La + 3I_2O_5$	5.501	9107	>4472	gas	gas	0.3347	1.0000	849.2	4672
$4La + 3MnO_2$	5.740	5270	3120	liquid	gas	0.3674	0.2019	593.4	3406
$2La + 3PbO$	8.207	4598	2609	liquid	gas	0.3166	0.6561	287.4	2359
$4La + 3PbO_2$	7.629	7065	>4472	gas	gas	0.3927	1.0000	518.8	3958
$8La + 3Pb_3O_4$	7.789	5628	4049	liquid	gas	0.2841	0.5886	378.6	2949
$2La + 3PdO$	7.769	5635	3237	liquid	l-g	0.2450	0.2606	536.2	4166
$4La + 3WO_2$	8.366	3826	3218	liquid	solid	0.0000	0.0000	361.2	3022
$2La + WO_3$	6.572	5808	4367	liquid	liquid	0.0000	0.0000	445.8	2930
$6Li + B_2O_3$	0.891	2254	1843	s-l	solid	0.0000	0.0000	1293	1152
$6Li + Cr_2O_3$	1.807	2151	1843	s-l	solid	0.0000	0.0000	799.5	1445
$2Li + CuO$	2.432	4152	2843	liquid	l-g	0.2248	0.1428	1125	2736
$6Li + Fe_2O_3$	1.863	3193	2510	liquid	liquid	0.0000	0.0000	1143	2130
$8Li + Fe_3O_4$	0.517	3076	2412	liquid	liquid	0.0000	0.0000	1053	2036
$4Li + MnO_2$	1.656	3336	2334	liquid	l-g	0.4098	0.2251	1399	2317
$6Li + MoO_3$	1.688	4035	2873	l-g	solid	0.2155	0.0644	1342	2265
$8Li + Pb_3O_4$	4.133	4186	2873	l-g	liquid	0.1655	0.0496	536.7	2218
$4Li + SiO_2$	1.177	1712	1687	solid	s-l	0.0000	0.0000	763.9	898.7
$6Li + WO_3$	2.478	3700	2873	l-g	solid	0.0113	0.0034	825.4	2046
$3Mg + B_2O_3$	1.785	6389	3873	l-g	liquid	0.4981	0.2007	2134	1195
$3Mg + Cr_2O_3$	3.164	3788	2945	solid	l-g	0.1023	0.0532	813.1	2573
$Mg + CuO$	3.934	6502	2843	solid	l-g	0.8186	0.5201	1102	4336
$3Mg + Fe_2O_3$	3.224	4703	3135	liquid	l-g	0.2021	0.1129	1110	3579
$4Mg + Fe_3O_4$	3.274	4446	3135	liquid	l-g	0.1369	0.0764	1033	3383
$2Mg + MnO_2$	2.996	5209	3271	liquid	gas	0.7378	0.4053	1322	3961

Table 1a - Thermite Reactions (in Alphabetical Order) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$4Mg + Pb_3O_4$	5.965	5883	3873	l-g	gas	0.4216	0.8095	556.0	3316
$2Mg + SiO_2$	2.148	3401	2628	solid	l-g	0 – .92	0 - .26	789.6	1695
2Nd + 3AgO	7.244	7628	3602	liquid	gas	0.4544	0.4902	625.9	4534
2Nd + 3CuO	6.719	5921	2843	liquid	l-g	0.3699	0.2350	603.4	4054
2Nd + 3HgO	9.430	7020	<5374	gas	gas	0.4263	1.0000	392.7	3703
$10Nd + 3I_2O_5$	5.896	10067	<7580	gas	gas	0.3273	1.0000	840.6	4956
$4Nd + 3MnO_2$	6.241	5194	3287	liquid	gas	0.3580	0.1967	589.9	3682
$4Nd + 3PbO_2$	8.148	6938	<5284	gas	gas	0.3862	1.0000	517.8	4219
$8Nd + 3Pb_3O_4$	8.218	5553	3958	liquid	gas	0.2803	0.5808	379.6	3120
2Nd + 3PdO	8.297	6197	3237	liquid	l-g	0.2394	0.2547	532.7	4420
$4Nd + 3WO_2$	9.016	4792	3778	liquid	liquid	0.0000	0.0000	362.9	3272
$2Nd + WO_3$	7.074	5438	4245	liquid	liquid	0.0000	0.0000	446.1	3156
2Ta + 5AgO	9.341	6110	2436	liquid	l-g	0.4229	0.4562	466.2	4355
2Ta + 5CuO	9.049	4044	2843	liquid	l-g	0.0776	0.0493	390.3	3532
$6Ta + 5Fe_2O_3$	9.185	2383	2138	solid	liquid	0.0000	0.0000	235.0	2558
2Ta + 5HgO	12.140	5285	<4200	liquid	gas	0.3460	0.6942	263.3	3120
$2Ta + I_2O_5$	7.615	8462	7240	gas	gas	0.2875	1.0000	648.6	4939
2Ta + 5PbO	10.640	2752	2019	solid	l-g	0.1475	0.3056	154.5	1644
$4Ta + 5PbO_2$	11.215	4935	3472	liquid	gas	0.2604	0.5397	338.6	3797
$8Ta + 5Pb_3O_4$	10.510	3601	2019	solid	l-g	0.2990	0.6196	225.0	2365
2Ta + 5PdO	11.472	4344	3237	liquid	l-g	0.0575	0.0612	360.4	4135
$4Ta + 5WO_2$	13.515	2556	2196	liquid	solid	0.0000	0.0000	145.1	1962
$6Ta + 5WO_3$	9.876	2883	2633	liquid	solid	0.0000	0.0000	206.2	2036
$3Th + 2B_2O_3$	6.688	3959	3135	solid	liquid	0.0000	0.0000	337.8	2259
$3Th + 2Cr_2O_3$	8.300	4051	2945	solid	l-g	0.0590	0.0307	334.5	2776
Th + 2CuO	8.582	7743	2843	solid	l-g	0.4301	0.3421	558.7	4795
$3Th + 2Fe_2O_3$	8.280	6287	3135	solid	l-g	0.2619	0.1463	477.9	3957
$2Th + Fe_3O_4$	8.092	5912	3135	solid	l-g	0.2257	0.1261	458.5	3710
$Th + MnO_2$	8.391	7151	3910	liquid	gas	0.3135	0.1722	529.2	4440
$Th + PbO_2$	10.19	10612	4673	l-g	gas	0.2817	0.6231	482.8	4922
$2Th + Pb_3O_4$	9.845	8532	4673	l-g	gas	0.2695	0.5633	360.5	3549
$Th + SiO_2$	6.732	3813	2628	solid	l-g	0 - .34	0 - .10	258.2	1738
$3Ti + 2B_2O_3$	2.791	1498	1498	solid	solid	0.0000	0.0000	276.6	772.0
$3Ti + 2Cr_2O_3$	4.959	1814	1814	solid	solid	0.0000	0.0000	296.2	1469
Ti + 2CuO	5.830	5569	2843	liquid	l-g	0.3242	0.2060	730.5	4259
$3Ti + 2Fe_2O_3$	5.010	3358	2614	liquid	liquid	0.0000	0.0000	612.0	3066
$Ti + Fe_3O_4$	4.974	3113	2334	liquid	liquid	0.0000	0.0000	563.0	2800
$Ti + MnO_2$	4.826	3993	2334	liquid	l-g	0.3783	0.2078	752.7	3633
$2Ti + Pb_3O_4$	8.087	5508	2498	liquid	gas	0.3839	0.7955	358.1	2896
$Ti + SiO_2$	3.241	715	715	solid	solid	0.0000	0.0000	75.0	243.1
2Y + 3CuO	5.404	7668	3124	liquid	l-g	0.7204	0.4577	926.7	5008

Table 1a - Thermite Reactions (in Alphabetical Order) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$8Y + 3Fe_3O_4$	4.803	5791	3135	liquid	l-g	0.3812	0.2129	856.3	4113
$10Y + 3I_2O_5$	4.638	12416	>4573	gas	gas	0.4231	1.0000	1144	5308
$4Y + 3MnO_2$	4.690	7405	<5731	gas	gas	0.8110	1.0000	1022	4792
$2Y + MoO_3$	4.567	8778	>4572	gas	liquid	0.6215	1.0000	1005	4589
$2Y + Ni_2O_3$	4.636	7614	3955	liquid	gas	0.5827	0.3420	1120	5194
$4Y + 3PbO_2$	6.875	9166	>4572	gas	gas	0.4659	1.0000	751.0	5163
$2Y + 3PdO$	7.020	8097	3237	liquid	l-g	0.4183	0.4451	768.1	5371
$4Y + 3SnO_2$	5.604	7022	4573	l-g	gas	.37 - .62	.44 - 1	726.1	4068
$10Y + 3Ta_2O_5$	6.316	5564	>4572	l-g	liquid	0 - 0.23	0 - 0.51	469.7	2966
$10Y + 3V_2O_5$	3.970	7243	>3652	l-g	gas	0.2130	0.4181	972.5	3861
$2Y + WO_3$	5.677	8296	>4572	gas	liquid	0.2441	0.5512	732.2	4157
$3Zr + 2B_2O_3$	3.782	2730	2573	solid	s-l	0.2930	0.0317	437.4	1654
$3Zr + 2Cr_2O_3$	5.713	2915	2650	solid	liquid	0.0000	0.0000	423.0	2417
$Zr + 2CuO$	6.400	6103	2843	solid	l-g	0.5553	0.3529	752.9	4818
$3Zr + 2Fe_2O_3$	5.744	4626	3135	liquid	l-g	0.0820	0.0458	666.2	3827
$2Zr + Fe_3O_4$	5.668	4103	3135	liquid	l-g	0.0277	0.0155	625.1	3543
$Zr + MnO_2$	5.647	5385	2983	s-l	gas	0.5613	0.3084	778.7	4398
$2Zr + Pb_3O_4$	8.359	6595	3300	l-g	gas	0.3683	0.7440	408.1	3412
$Zr + SiO_2$	4.098	2233	1687	solid	s-l	0.0000	0.0000	299.7	1228

Table 1b - Thermite Reactions (in Descending Order of Reactant Mixture Density)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$4Ta + 5WO_2$	13.515	2556	2196	liquid	solid	0.0000	0.0000	145.1	1962
$2Ta + 5HgO$	12.140	5285	<4200	liquid	gas	0.3460	0.6942	263.3	3120
$2Ta + 5PdO$	11.472	4344	3237	liquid	l-g	0.0575	0.0612	360.4	4135
$4Ta + 5PbO_2$	11.215	4935	3472	liquid	gas	0.2604	0.5397	338.6	3797
$2Ta + 5PbO$	10.640	2752	2019	solid	l-g	0.1475	0.3056	154.5	1644
$8Ta + 5Pb_3O_4$	10.510	3601	2019	solid	l-g	0.2990	0.6196	225.0	2365
$Th + PbO_2$	10.190	10612	4673	l-g	gas	0.2817	0.6231	482.8	4922
$6Ta + 5WO_3$	9.876	2883	2633	liquid	solid	0.0000	0.0000	206.2	2036
$2Th + Pb_3O_4$	9.845	8532	4673	l-g	gas	0.2695	0.5633	360.5	3549
$2Hf + Pb_3O_4$	9.775	9382	4410	liquid	gas	0.2877	0.5962	345.9	3381
$2Nd + 3HgO$	9.430	7020	<5374	gas	gas	0.4263	1.0000	392.7	3703
$2Ta + 5AgO$	9.341	6110	2436	liquid	l-g	0.4229	0.4562	466.2	4355
$6Ta + 5Fe_2O_3$	9.185	2383	2138	solid	liquid	0.0000	0.0000	235.0	2558
$2Ta + 5CuO$	9.049	4044	2843	liquid	l-g	0.0776	0.0493	390.3	3532
$4Nd + 3WO_2$	9.016	4792	3778	liquid	liquid	0.0000	0.0000	362.9	3272
$2Al + 3HgO$	8.986	7169	3253	l-g	gas	0.5598	0.9913	476.6	4282
$2La + 3HgO$	8.962	7140	>4472	l-g	gas	.32 - .43	.65 - 1	392.0	3513
$Th + 2CuO$	8.582	7743	2843	solid	l-g	0.4301	0.3421	558.7	4795
$Th + MnO_2$	8.391	7151	3910	liquid	gas	0.3135	0.1722	529.2	4440
$4La + 3WO_2$	8.366	3826	3218	liquid	solid	0.0000	0.0000	361.2	3022
$2Zr + Pb_3O_4$	8.359	6595	3300	l-g	gas	0.3683	0.7440	408.1	3412
$Hf + 2CuO$	8.332	5974	2843	solid	l-g	0.3881	0.2466	567.6	4730
$3Th + 2Cr_2O_3$	8.300	4051	2945	solid	l-g	0.0590	0.0307	334.5	2776
$2Nd + 3PdO$	8.297	6197	3237	liquid	l-g	0.2394	0.2547	532.7	4420
$3Th + 2Fe_2O_3$	8.280	6287	3135	solid	l-g	0.2619	0.1463	477.9	3957
$8B + 3Pb_3O_4$	8.223	4217	2019	liquid	l-g	0.4126	0.8550	326.9	2688
$8Nd + 3Pb_3O_4$	8.218	5553	3958	liquid	gas	0.2803	0.5808	379.6	3120
$2La + 3PbO$	8.207	4598	2609	liquid	gas	0.3166	0.6561	287.4	2359
$4Nd + 3PbO_2$	8.148	6938	<5284	gas	gas	0.3862	1.0000	517.8	4219
$2Th + Fe_3O_4$	8.092	5912	3135	solid	l-g	0.2257	0.1261	458.5	3710
$2Ti + Pb_3O_4$	8.087	5508	2498	liquid	gas	0.3839	0.7955	358.1	2896
$4Al + 3WO_2$	8.085	4176	3253	l-g	solid	0.0662	0.0675	500.6	4047
$Hf + MnO_2$	8.054	5644	3083	s-l	gas	0.3263	0.3131	534.6	4305
$2Al + 3PbO$	8.018	3968	2327	s-l	gas	0.4146	0.8591	337.4	2705
$3Hf + 2Cr_2O_3$	7.971	2721	2572	solid	liquid	0.0000	0.0000	302.3	2410
$3Hf + 2Fe_2O_3$	7.955	5031	2843	solid	l-g	0.2117	0.1183	473.3	3765
$8La + 3Pb_3O_4$	7.789	5628	4049	liquid	gas	0.2841	0.5886	378.6	2949
$2La + 3PdO$	7.769	5635	3237	liquid	l-g	0.2450	0.2606	536.2	4166
$2Hf + Fe_3O_4$	7.760	4802	2843	solid	l-g	0.1835	0.1025	450.4	3496
$4La + 3PbO_2$	7.629	7065	>4472	gas	gas	0.3927	1.0000	518.8	3958
$2Ta + I_2O_5$	7.615	8462	7240	gas	gas	0.2875	1.0000	648.6	4939

Table 1b - Thermite Reactions (in Descending Order of Reactant Mixture Density) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$4Be + Pb_3O_4$	7.610	5673	3559	liquid	gas	0.4157	0.8614	567.8	4322
$8Al + 3Pb_3O_4$	7.428	5427	3253	l-g	gas	0.4215	0.8466	478.1	3551
$2Be + PbO_2$	7.296	8622	4123	l-g	gas	0.4665	0.8250	875.5	6387
$2Al + 3PdO$	7.281	5022	3237	liquid	l-g	0.6577	0.6998	754.3	5493
$2Nd + 3AgO$	7.244	7628	3602	liquid	gas	0.4544	0.4902	625.9	4534
$2Al + Bi_2O_3$	7.188	3995	3253	l-g	gas	0.4731	0.8941	506.1	3638
$4Al + 3PbO_2$	7.085	6937	3253	l-g	gas	0.5366	0.9296	731.9	5185
$2Nd + WO_3$	7.074	5438	4245	liquid	liquid	0.0000	0.0000	446.1	3156
$2Y + 3PdO$	7.020	8097	3237	liquid	l-g	0.4183	0.4451	768.1	5371
$4Y + 3PbO_2$	6.875	9166	>4572	gas	gas	0.4659	1.0000	751.0	5163
$2La + 3AgO$	6.827	8177	4173	liquid	gas	0.4619	0.4983	646.7	4416
$Th + SiO_2$	6.732	3813	2628	solid	l-g	0 - .34	0 - .10	258.2	1738
$2Nd + 3CuO$	6.719	5921	2843	liquid	l-g	0.3699	0.2350	603.4	4054
$3Th + 2B_2O_3$	6.688	3959	3135	solid	liquid	0.0000	0.0000	337.8	2259
$2La + WO_3$	6.572	5808	4367	liquid	liquid	0.0000	0.0000	445.8	2930
$Zr + 2CuO$	6.400	6103	2843	solid	l-g	0.5553	0.3529	752.9	4818
$2Al + 3Ag_2O$	6.386	4941	2436	liquid	l-g	0.4298	0.4636	504.8	3224
$10Al + 3Ta_2O_5$	6.339	3055	2452	liquid	solid	0.0000	0.0000	335.6	2128
$10Y + 3Ta_2O_5$	6.316	5564	>4572	l-g	liquid	0 - .23	0 - .51	469.7	2966
$2La + 3CuO$	6.263	6007	2843	liquid	l-g	0.3737	0.2374	606.4	3798
$4Nd + 3MnO_2$	6.241	5194	3287	liquid	gas	0.3580	0.1967	589.9	3682
$Hf + SiO_2$	6.224	2117	1828	solid	liquid	0.0000	0.0000	203.3	1265
$3Hf + 2B_2O_3$	6.125	2656	2575	solid	liquid	0.0000	0.0000	296.5	1816
$2Al + 3AgO$	6.085	7503	3253	l-g	gas	0.7519	0.8083	896.7	5457
$4Mg + Pb_3O_4$	5.965	5883	3873	l-g	gas	0.4216	0.8095	556.0	3316
$10Nd + 3I_2O_5$	5.896	10067	<7580	gas	gas	0.3273	1.0000	840.6	4956
$Ti + 2CuO$	5.830	5569	2843	liquid	l-g	0.3242	0.2060	730.5	4259
$3Zr + 2Fe_2O_3$	5.744	4626	3135	liquid	l-g	0.0820	0.0458	666.2	3827
$4La + 3MnO_2$	5.740	5270	3120	liquid	gas	0.3674	0.2019	593.4	3406
$2La + Fe_2O_3$	5.729	4590	3135	liquid	l-g	0.1234	0.0689	529.6	3034
$3Zr + 2Cr_2O_3$	5.713	2915	2650	solid	liquid	0.0000	0.0000	423.0	2417
$2Y + WO_3$	5.677	8296	>4572	gas	liquid	0.2441	0.5512	732.2	4157
$2Zr + Fe_3O_4$	5.668	4103	3135	liquid	l-g	0.0277	0.0155	625.1	3543
$2B + 3CuO$	5.665	4748	2843	gas	l-g	0.4463	0.2430	738.1	4182
$Zr + MnO_2$	5.647	5385	2983	s-l	gas	0.5613	0.3084	778.7	4398
$4Y + 3SnO_2$	5.604	7022	4573	l-g	gas	.37 - .62	.44 - 1	726.1	4068
$2Al + 3SnO$	5.540	3558	2876	liquid	l-g	0.1070	0.1270	427.0	2366
$10La + 3I_2O_5$	5.501	9107	>4472	gas	gas	0.3347	1.0000	849.2	4672
$2Al + WO_3$	5.458	5544	3253	l-g	liquid	0.1434	0.1463	696.4	3801
$2Y + 3CuO$	5.404	7668	3124	liquid	l-g	0.7204	0.4577	926.7	5008
$4Al + 3SnO_2$	5.356	5019	2876	liquid	l-g	0.2928	0.3476	686.8	3678

Table 1b - Thermite Reactions (in Descending Order of Reactant Mixture Density) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2Al + 3Cu_2O	5.280	4132	2843	liquid	l-g	0.1221	0.0776	575.5	3039
2Al +3NiO	5.214	3968	3187	liquid	l-g	0.0108	0.0063	822.3	4288
Be + CuO	5.119	3761	2820	s-l	liquid	0.0000	0.0000	1221	6249
2Al + 3CuO	5.109	5718	2843	liquid	l-g	0.5400	0.3431	974.1	4976
2Al + 3CoO	5.077	3392	3201	liquid	l-g	0.0430	0.0254	824.7	4187
3Ti + 2Fe_2O_3	5.010	3358	2614	liquid	liquid	0.0000	0.0000	612.0	3066
Ti + Fe_3O_4	4.974	3113	2334	liquid	liquid	0.0000	0.0000	563.0	2800
3Ti + 2Cr_2O_3	4.959	1814	1814	solid	solid	0.0000	0.0000	296.2	1469
16Al + 3U_3O_8	4.957	1406	1406	solid	solid	0.0000	0.0000	487.6	2417
Ti + MnO_2	4.826	3993	2334	liquid	l-g	0.3783	0.2078	752.7	3633
8Y + 3Fe_3O_4	4.803	5791	3135	liquid	l-g	0.3812	0.2129	856.3	4113
8Al +3Co_3O_4	4.716	3938	3201	liquid	l-g	0.2196	0.1294	1012	4772
4Y + 3MnO_2	4.690	7405	<5731	gas	gas	0.8110	1.0000	1022	4792
2B + Fe_2O_3	4.661	2646	2065	liquid	liquid	0.0000	0.0000	590.1	2751
8B + 3Fe_3O_4	4.644	2338	1903	liquid	liquid	0.0000	0.0000	530.1	2462
10Y + 3I_2O_5	4.638	12416	>4573	gas	gas	0.4231	1.0000	1144	5308
2Y + Ni_2O_3	4.636	7614	3955	liquid	gas	0.5827	0.3420	1120	5194
2B + Cr_2O_3	4.590	977	917	liquid	solid	0.0000	0.0000	182.0	835.3
2Y + MoO_3	4.567	8778	>4572	gas	liquid	0.6215	1.0000	1005	4589
4B + 3MnO_2	4.394	3000	2133	l-g	liquid	0.3198	0.1715	773.1	3397
8Al + 3Fe_3O_4	4.264	4057	3135	liquid	l-g	0.0549	0.0307	878.8	3747
2Al + Cr_2O_3	4.190	2789	2327	s-l	liquid	0.0000	0.0000	622.0	2606
4Be + Fe_3O_4	4.180	4482	3135	liquid	l-g	0.0336	0.0188	1175	4910
2Al + Fe_2O_3	4.175	4382	3135	liquid	l-g	0.1404	0.0784	945.4	3947
3Be + Fe_2O_3	4.163	4244	3135	liquid	l-g	0.1029	0.0568	1281	5332
8Li + Pb_3O_4	4.133	4186	2873	l-g	liquid	0.1655	0.0496	536.7	2218
10Al + 3I_2O_5	4.119	8680	>3253	gas	gas	0.6293	1.0000	1486	6122
Zr + SiO_2	4.098	2233	1687	solid	s-l	0.0000	0.0000	299.7	1228
10Al + 3Nb_2O_5	4.089	3240	2705	liquid	solid	0.0000	0.0000	600.2	2454
3Be + Cr_2O_3	4.089	3107	2820	s-l	liquid	0.0000	0.0000	915.0	3741
2Al + Ni_2O_3	4.045	5031	3187	liquid	l-g	0.4650	0.2729	1292	5229
4Al + 3MnO_2	4.014	4829	2918	liquid	gas	0.8136	0.4470	1159	4651
10Y + 3V_2O_5	3.970	7243	>3652	l-g	gas	0.2130	0.4181	972.5	3861
Mg + CuO	3.934	6502	2843	solid	l-g	0.8186	0.5201	1102	4336
2Be + MnO_2	3.882	6078	2969	liquid	gas	0.9527	0.5234	1586	6158
2Al + MoO_3	3.808	5574	3253	l-g	liquid	0.2425	0.2473	1124	4279
3Zr + 2B_2O_3	3.782	2730	2573	solid	s-l	0.2930	0.0317	437.4	1654
4Al + 3TiO_2	3.590	1955	1752	solid	liquid	0.0000	0.0000	365.1	1311
4Mg + Fe_3O_4	3.274	4446	3135	liquid	l-g	0.1369	0.0764	1033	3383
Ti + SiO_2	3.241	715	715	solid	solid	0.0000	0.0000	75.0	243.1
3Mg + Fe_2O_3	3.224	4703	3135	liquid	l-g	0.2021	0.1129	1110	3579

Table 1b - Thermite Reactions (in Descending Order of Reactant Mixture Density) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$3Mg + Cr_2O_3$	3.164	3788	2945	solid	l-g	0.1023	0.0532	813.1	2573
$10Al + 3V_2O_5$	3.107	3953	3273	l-g	liquid	0.0699	0.0356	1092	3394
$2Mg + MnO_2$	2.996	5209	3271	liquid	gas	0.7378	0.4053	1322	3961
$3Ti + 2B_2O_3$	2.791	1498	1498	solid	solid	0.0000	0.0000	276.6	772.0
$4Al + 3SiO_2$	2.668	2010	1889	solid	liquid	0.0000	0.0000	513.3	1370
$2Al + B_2O_3$	2.524	2621	2327	s-l	solid	0.0000	0.0000	780.7	1971
$6Li + WO_3$	2.478	3700	2873	l-g	solid	0.0113	0.0034	825.4	2046
$2Li + CuO$	2.432	4152	2843	liquid	l-g	0.2248	0.1428	1125	2736
$2Be + SiO_2$	2.410	2580	2482	solid	liquid	0.0000	0.0000	936.0	2256
$2Mg + SiO_2$	2.148	3401	2628	solid	l-g	0 - .92	0 - .26	789.6	1695
$6Li + Fe_2O_3$	1.863	3193	2510	liquid	liquid	0.0000	0.0000	1143	2130
$3Be + B_2O_3$	1.850	3278	2573	liquid	s-l	0.0000	0.0000	1639	3033
$6Li + Cr_2O_3$	1.807	2151	1843	s-l	solid	0.0000	0.0000	799.5	1445
$3Mg + B_2O_3$	1.785	6389	3873	l-g	liquid	0.4981	0.2007	2134	1195
$6Li + MoO_3$	1.688	4035	2873	l-g	solid	0.2155	0.0644	1342	2265
$4Li + MnO_2$	1.656	3336	2334	liquid	l-g	0.4098	0.2251	1399	2317
$4Li + SiO_2$	1.177	1712	1687	solid	s-l	0.0000	0.0000	763.9	898.7
$6Li + B_2O_3$	0.891	2254	1843	s-l	solid	0.0000	0.0000	1293	1152
$8Li + Fe_3O_4$	0.517	3076	2412	liquid	liquid	0.0000	0.0000	1053	2036

Table 1c - Thermite Reactions (in Descending Order of Heat of Reaction per Unit Mass)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$3Mg + B_2O_3$	1.785	6389	3873	l-g	liquid	0.4981	0.2007	2134	1195
$3Be + B_2O_3$	1.850	3278	2573	liquid	s-l	0.0000	0.0000	1639	3033
$2Be + MnO_2$	3.882	6078	2969	liquid	gas	0.9527	0.5234	1586	6158
$10Al + 3I_2O_5$	4.119	8680	>3253	gas	gas	0.6293	1.0000	1486	6122
$4Li + MnO_2$	1.656	3336	2334	liquid	l-g	0.4098	0.2251	1399	2317
$6Li + MoO_3$	1.688	4035	2873	l-g	solid	0.2155	0.0644	1342	2265
$2Mg + MnO_2$	2.996	5209	3271	liquid	gas	0.7378	0.4053	1322	3961
$6Li + B_2O_3$	0.891	2254	1843	s-l	solid	0.0000	0.0000	1293	1152
$2Al + Ni_2O_3$	4.045	5031	3187	liquid	l-g	0.4650	0.2729	1292	5229
$3Be + Fe_2O_3$	4.163	4244	3135	liquid	l-g	0.1029	0.0568	1281	5332
$Be + CuO$	5.119	3761	2820	s-l	liquid	0.0000	0.0000	1221	6249
$4Be + Fe_3O_4$	4.180	4482	3135	liquid	l-g	0.0336	0.0188	1175	4910
$4Al + 3MnO_2$	4.014	4829	2918	liquid	gas	0.8136	0.4470	1159	4651
$10Y + 3I_2O_5$	4.638	12416	>4573	gas	gas	0.4231	1.0000	1144	5308
$6Li + Fe_2O_3$	1.863	3193	2510	liquid	liquid	0.0000	0.0000	1143	2130
$2Li + CuO$	2.432	4152	2843	liquid	l-g	0.2248	0.1428	1125	2736
$2Al + MoO_3$	3.808	5574	3253	l-g	liquid	0.2425	0.2473	1124	4279
$2Y + Ni_2O_3$	4.636	7614	3955	liquid	gas	0.5827	0.3420	1120	5194
$3Mg + Fe_2O_3$	3.224	4703	3135	liquid	l-g	0.2021	0.1129	1110	3579
$Mg + CuO$	3.934	6502	2843	solid	l-g	0.8186	0.5201	1102	4336
$10Al + 3V_2O_5$	3.107	3953	3273	l-g	liquid	0.0699	0.0356	1092	3394
$8Li + Fe_3O_4$	0.517	3076	2412	liquid	liquid	0.0000	0.0000	1053	2036
$4Mg + Fe_3O_4$	3.274	4446	3135	liquid	l-g	0.1369	0.0764	1033	3383
$4Y + 3MnO_2$	4.690	7405	<5731	gas	gas	0.8110	1.0000	1022	4792
$8Al + 3Co_3O_4$	4.716	3938	3201	liquid	l-g	0.2196	0.1294	1012	4772
$2Y + MoO_3$	4.567	8778	>4572	gas	liquid	0.6215	1.0000	1005	4589
$2Al + 3CuO$	5.109	5718	2843	liquid	l-g	0.5400	0.3431	974.1	4976
$10Y + 3V_2O_5$	3.970	7243	>3652	l-g	gas	0.2130	0.4181	972.5	3861
$2Al + Fe_2O_3$	4.175	4382	3135	liquid	l-g	0.1404	0.0784	945.4	3947
$2Be + SiO_2$	2.410	2580	2482	solid	liquid	0.0000	0.0000	936.0	2256
$2Y + 3CuO$	5.404	7668	3124	liquid	l-g	0.7204	0.4577	926.7	5008
$3Be + Cr_2O_3$	4.089	3107	2820	s-l	liquid	0.0000	0.0000	915.0	3741
$2Al + 3AgO$	6.085	7503	3253	l-g	gas	0.7519	0.8083	896.7	5457
$8Al + 3Fe_3O_4$	4.264	4057	3135	liquid	l-g	0.0549	0.0307	878.8	3747
$2Be + PbO_2$	7.296	8622	4123	l-g	gas	0.4665	0.8250	875.5	6387
$8Y + 3Fe_3O_4$	4.803	5791	3135	liquid	l-g	0.3812	0.2129	856.3	4113
$10La + 3I_2O_5$	5.501	9107	>4472	gas	gas	0.3347	1.0000	849.2	4672
$10Nd + 3I_2O_5$	5.896	10067	<7580	gas	gas	0.3273	1.0000	840.6	4956
$6Li + WO_3$	2.478	3700	2873	l-g	solid	0.0113	0.0034	825.4	2046
$2Al + 3CoO$	5.077	3392	3201	liquid	l-g	0.0430	0.0254	824.7	4187
$2Al + 3NiO$	5.214	3968	3187	liquid	l-g	0.0108	0.0063	822.3	4288

Table 1c- Thermite Reactions (in Descending Order of Heat of Reaction per Unit Mass) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$3Mg + Cr_2O_3$	3.164	3788	2945	solid	l-g	0.1023	0.0532	813.1	2573
$6Li + Cr_2O_3$	1.807	2151	1843	s-l	solid	0.0000	0.0000	799.5	1445
$2Mg + SiO_2$	2.148	3401	2628	solid	l-g	0 - .92	0 - .26	789.6	1695
$2Al + B_2O_3$	2.524	2621	2327	s-l	solid	0.0000	0.0000	780.7	1971
$Zr + MnO_2$	5.647	5385	2983	s-l	gas	0.5613	0.3084	778.7	4398
$4B + 3MnO_2$	4.394	3000	2133	l-g	liquid	0.3198	0.1715	773.1	3397
$2Y + 3PdO$	7.020	8097	3237	liquid	l-g	0.4183	0.4451	768.1	5371
$4Li + SiO_2$	1.177	1712	1687	solid	s-l	0.0000	0.0000	763.9	898.7
$2Al + 3PdO$	7.281	5022	3237	liquid	l-g	0.6577	0.6998	754.3	5493
$Zr + 2CuO$	6.400	6103	2843	solid	l-g	0.5553	0.3529	752.9	4818
$Ti + MnO_2$	4.826	3993	2334	liquid	l-g	0.3783	0.2078	752.7	3633
$4Y + 3PbO_2$	6.875	9166	>4572	gas	gas	0.4659	1.0000	751.0	5163
$2B + 3CuO$	5.665	4748	2843	gas	l-g	0.4463	0.2430	738.1	4182
$2Y + WO_3$	5.677	8296	>4572	gas	liquid	0.2441	0.5512	732.2	4157
$4Al + 3PbO_2$	7.085	6937	3253	l-g	gas	0.5366	0.9296	731.9	5185
$Ti + 2CuO$	5.830	5569	2843	liquid	l-g	0.3242	0.2060	730.5	4259
$4Y + 3SnO_2$	5.604	7022	4573	l-g	gas	.37 - .62	.44 - 1	726.1	4068
$2Al + WO_3$	5.458	5544	3253	l-g	liquid	0.1434	0.1463	696.4	3801
$4Al + 3SnO_2$	5.356	5019	2876	liquid	l-g	0.2928	0.3476	686.8	3678
$3Zr + 2Fe_2O_3$	5.744	4626	3135	liquid	l-g	0.0820	0.0458	666.2	3827
$2Ta + I_2O_5$	7.615	8462	7240	gas	gas	0.2875	1.0000	648.6	4939
$2La + 3AgO$	6.827	8177	4173	liquid	gas	0.4619	0.4983	646.7	4416
$2Nd + 3AgO$	7.244	7628	3602	liquid	gas	0.4544	0.4902	625.9	4534
$2Zr + Fe_3O_4$	5.668	4103	3135	liquid	l-g	0.0277	0.0155	625.1	3543
$2Al + Cr_2O_3$	4.190	2789	2327	s-l	liquid	0.0000	0.0000	622.0	2606
$3Ti + 2Fe_2O_3$	5.010	3358	2614	liquid	liquid	0.0000	0.0000	612.0	3066
$2La + 3CuO$	6.263	6007	2843	liquid	l-g	0.3737	0.2374	606.4	3798
$2Nd + 3CuO$	6.719	5921	2843	liquid	l-g	0.3699	0.2350	603.4	4054
$10Al + 3Nb_2O_5$	4.089	3240	2705	liquid	solid	0.0000	0.0000	600.2	2454
$4La + 3MnO_2$	5.740	5270	3120	liquid	gas	0.3674	0.2019	593.4	3406
$2B + Fe_2O_3$	4.661	2646	2065	liquid	liquid	0.0000	0.0000	590.1	2751
$4Nd + 3MnO_2$	6.241	5194	3287	liquid	gas	0.3580	0.1967	589.9	3682
$2Al + 3Cu_2O$	5.280	4132	2843	liquid	l-g	0.1221	0.0776	575.5	3039
$4Be + Pb_3O_4$	7.610	5673	3559	liquid	gas	0.4157	0.8614	567.8	4322
$Hf + 2CuO$	8.332	5974	2843	solid	l-g	0.3881	0.2466	567.6	4730
$Ti + Fe_3O_4$	4.974	3113	2334	liquid	liquid	0.0000	0.0000	563.0	2800
$Th + 2CuO$	8.582	7743	2843	solid	l-g	0.4301	0.3421	558.7	4795
$4Mg + Pb_3O_4$	5.965	5883	3873	l-g	gas	0.4216	0.8095	556.0	3316
$8Li + Pb_3O_4$	4.133	4186	2873	l-g	liquid	0.1655	0.0496	536.7	2218
$2La + 3PdO$	7.769	5635	3237	liquid	l-g	0.2450	0.2606	536.2	4166
$Hf + MnO_2$	8.054	5644	3083	s-l	gas	0.3263	0.3131	534.6	4305

Table 1c- Thermite Reactions (in Descending Order of Heat of Reaction per Unit Mass) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2Nd + 3PdO	8.297	6197	3237	liquid	l-g	0.2394	0.2547	532.7	4420
8B + 3Fe_3O_4	4.644	2338	1903	liquid	liquid	0.0000	0.0000	530.1	2462
2La + Fe_2O_3	5.729	4590	3135	liquid	l-g	0.1234	0.0689	529.6	3034
Th + MnO_2	8.391	7151	3910	liquid	gas	0.3135	0.1722	529.2	4440
4La + 3PbO_2	7.629	7065	>4472	gas	gas	0.3927	1.0000	518.8	3958
4Nd + 3PbO_2	8.148	6938	<5284	gas	gas	0.3862	1.0000	517.8	4219
4Al + 3SiO_2	2.668	2010	1889	solid	liquid	0.0000	0.0000	513.3	1370
2Al + Bi_2O_3	7.188	3995	3253	l-g	gas	0.4731	0.8941	506.1	3638
2Al + 3Ag_2O	6.386	4941	2436	liquid	l-g	0.4298	0.4636	504.8	3224
4Al + 3WO_2	8.085	4176	3253	l-g	solid	0.0662	0.0675	500.6	4047
16Al + 3U_3O_8	4.957	1406	1406	solid	solid	0.0000	0.0000	487.6	2417
Th + PbO_2	10.190	10612	4673	l-g	gas	0.2817	0.6231	482.8	4922
8Al + 3Pb_3O_4	7.428	5427	3253	l-g	gas	0.4215	0.8466	478.1	3551
3Th + 2Fe_2O_3	8.280	6287	3135	solid	l-g	0.2619	0.1463	477.9	3957
2Al + 3HgO	8.986	7169	3253	l-g	gas	0.5598	0.9913	476.6	4282
3Hf + 2Fe_2O_3	7.955	5031	2843	solid	l-g	0.2117	0.1183	473.3	3765
10Y + 3Ta_2O_5	6.316	5564	>4572	l-g	liquid	0 - .23	0 - .51	469.7	2966
2Ta + 5AgO	9.341	6110	2436	liquid	l-g	0.4229	0.4562	466.2	4355
2Th + Fe_3O_4	8.092	5912	3135	solid	l-g	0.2257	0.1261	458.5	3710
2Hf + Fe_3O_4	7.760	4802	2843	solid	l-g	0.1835	0.1025	450.4	3496
2Nd + WO_3	7.074	5438	4245	liquid	liquid	0.0000	0.0000	446.1	3156
2La + WO_3	6.572	5808	4367	liquid	liquid	0.0000	0.0000	445.8	2930
3Zr + 2B_2O_3	3.782	2730	2573	solid	s-l	0.2930	0.0317	437.4	1654
2Al + 3SnO	5.540	3558	2876	liquid	l-g	0.1070	0.1270	427.0	2366
3Zr + 2Cr_2O_3	5.713	2915	2650	solid	liquid	0.0000	0.0000	423.0	2417
2Zr + Pb_3O_4	8.359	6595	3300	l-g	gas	0.3683	0.7440	408.1	3412
2Nd + 3HgO	9.430	7020	<5374	gas	gas	0.4263	1.0000	392.7	3703
2La + 3HgO	8.962	7140	>4472	l-g	gas	.32 - .43	.65 - 1	392.0	3513
2Ta + 5CuO	9.049	4044	2843	liquid	l-g	0.0776	0.0493	390.3	3532
8Nd + 3Pb_3O_4	8.218	5553	3958	liquid	gas	0.2803	0.5808	379.6	3120
8La + 3Pb_3O_4	7.789	5628	4049	liquid	gas	0.2841	0.5886	378.6	2949
4Al + 3TiO_2	3.590	1955	1752	solid	liquid	0.0000	0.0000	365.1	1311
4Nd + 3WO_2	9.016	4792	3778	liquid	liquid	0.0000	0.0000	362.9	3272
4La + 3WO_2	8.366	3826	3218	liquid	solid	0.0000	0.0000	361.2	3022
2Th + Pb_3O_4	9.845	8532	4673	l-g	gas	0.2695	0.5633	360.5	3549
2Ta + 5PdO	11.472	4344	3237	liquid	l-g	0.0575	0.0612	360.4	4135
2Ti + Pb_3O_4	8.087	5508	2498	liquid	gas	0.3839	0.7955	358.1	2896
2Hf + Pb_3O_4	9.775	9382	4410	liquid	gas	0.2877	0.5962	345.9	3381
4Ta + 5PbO_2	11.215	4935	3472	liquid	gas	0.2604	0.5397	338.6	3797
3Th + 2B_2O_3	6.688	3959	3135	solid	liquid	0.0000	0.0000	337.8	2259
2Al + 3PbO	8.018	3968	2327	s-l	gas	0.4146	0.8591	337.4	2705

Table 1c- Thermite Reactions (in Descending Order of Heat of Reaction per Unit Mass) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$10Al + 3Ta_2O_5$	6.339	3055	2452	liquid	solid	0.0000	0.0000	335.6	2128
$3Th + 2Cr_2O_3$	8.300	4051	2945	solid	l-g	0.0590	0.0307	334.5	2776
$8B + 3Pb_3O_4$	8.223	4217	2019	liquid	l-g	0.4126	0.8550	326.9	2688
$3Hf + 2Cr_2O_3$	7.971	2721	2572	solid	liquid	0.0000	0.0000	302.3	2410
$Zr + SiO_2$	4.098	2233	1687	solid	s-l	0.0000	0.0000	299.7	1228
$3Hf + 2B_2O_3$	6.125	2656	2575	solid	liquid	0.0000	0.0000	296.5	1816
$3Ti + 2Cr_2O_3$	4.959	1814	1814	solid	solid	0.0000	0.0000	296.2	1469
$2La + 3PbO$	8.207	4598	2609	liquid	gas	0.3166	0.6561	287.4	2359
$3Ti + 2B_2O_3$	2.791	1498	1498	solid	solid	0.0000	0.0000	276.6	772.0
$2Ta + 5HgO$	12.140	5285	<4200	liquid	gas	0.3460	0.6942	263.3	3120
$Th + SiO_2$	6.732	3813	2628	solid	l-g	0 - .34	0 -.10	258.2	1738
$6Ta + 5Fe_2O_3$	9.185	2383	2138	solid	liquid	0.0000	0.0000	235.0	2558
$8Ta + 5Pb_3O_4$	10.510	3601	2019	solid	l-g	0.2990	0.6196	225.0	2365
$6Ta + 5WO_3$	9.876	2883	2633	liquid	solid	0.0000	0.0000	206.2	2036
$Hf + SiO_2$	6.224	2117	1828	solid	liquid	0.0000	0.0000	203.3	1265
$2B + Cr_2O_3$	4.590	977	917	liquid	solid	0.0000	0.0000	182.0	835.3
$2Ta + 5PbO$	10.640	2752	2019	solid	l-g	0.1475	0.3056	154.5	1644
$4Ta + 5WO_2$	13.515	2556	2196	liquid	solid	0.0000	0.0000	145.1	1962
$Ti + SiO_2$	3.241	715	715	solid	solid	0.0000	0.0000	75.0	243.1

Table 1d - Thermite Reactions (in Descending Order of Heat of Reaction per Unit Volume)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$2Be + PbO_2$	7.296	8622	4123	l-g	gas	0.4665	0.8250	875.5	6387
$Be + CuO$	5.119	3761	2820	s-l	liquid	0.0000	0.0000	1221	6249
$2Be + MnO_2$	3.882	6078	2969	liquid	gas	0.9527	0.5234	1586	6158
$10Al + 3I_2O_5$	4.119	8680	>3253	gas	gas	0.6293	1.0000	1486	6122
$2Al + 3PdO$	7.281	5022	3237	liquid	l-g	0.6577	0.6998	754.3	5493
$2Al + 3AgO$	6.085	7503	3253	l-g	gas	0.7519	0.8083	896.7	5457
$2Y + 3PdO$	7.020	8097	3237	liquid	l-g	0.4183	0.4451	768.1	5371
$3Be + Fe_2O_3$	4.163	4244	3135	liquid	l-g	0.1029	0.0568	1281	5332
$10Y + 3I_2O_5$	4.638	12416	>4573	gas	gas	0.4231	1.0000	1144	5308
$2Al + Ni_2O_3$	4.045	5031	3187	liquid	l-g	0.4650	0.2729	1292	5229
$2Y + Ni_2O_3$	4.636	7614	3955	liquid	gas	0.5827	0.3420	1120	5194
$4Al + 3PbO_2$	7.085	6937	3253	l-g	gas	0.5366	0.9296	731.9	5185
$4Y + 3PbO_2$	6.875	9166	>4572	gas	gas	0.4659	1.0000	751.0	5163
$2Y + 3CuO$	5.404	7668	3124	liquid	l-g	0.7204	0.4577	926.7	5008
$2Al + 3CuO$	5.109	5718	2843	liquid	l-g	0.5400	0.3431	974.1	4976
$10Nd + 3I_2O_5$	5.896	10067	<7580	gas	gas	0.3273	1.0000	840.6	4956
$2Ta + I_2O_5$	7.615	8462	7240	gas	gas	0.2875	1.0000	648.6	4939
$Th + PbO_2$	10.190	10612	4673	l-g	gas	0.2817	0.6231	482.8	4922
$4Be + Fe_3O_4$	4.180	4482	3135	liquid	l-g	0.0336	0.0188	1175	4910
$Zr + 2CuO$	6.400	6103	2843	solid	l-g	0.5553	0.3529	752.9	4818
$Th + 2CuO$	8.582	7743	2843	solid	l-g	0.4301	0.3421	558.7	4795
$4Y + 3MnO_2$	4.690	7405	<5731	gas	gas	0.8110	1.0000	1022	4792
$8Al + 3Co_3O_4$	4.716	3938	3201	liquid	l-g	0.2196	0.1294	1012	4772
$Hf + 2CuO$	8.332	5974	2843	solid	l-g	0.3881	0.2466	567.6	4730
$10La + 3I_2O_5$	5.501	9107	>4472	gas	gas	0.3347	1.0000	849.2	4672
$4Al + 3MnO_2$	4.014	4829	2918	liquid	gas	0.8136	0.4470	1159	4651
$2Y + MoO_3$	4.567	8778	>4572	gas	liquid	0.6215	1.0000	1005	4589
$2Nd + 3AgO$	7.244	7628	3602	liquid	gas	0.4544	0.4902	625.9	4534
$Th + MnO_2$	8.391	7151	3910	liquid	gas	0.3135	0.1722	529.2	4440
$2Nd + 3PdO$	8.297	6197	3237	liquid	l-g	0.2394	0.2547	532.7	4420
$2La + 3AgO$	6.827	8177	4173	liquid	gas	0.4619	0.4983	646.7	4416
$Zr + MnO_2$	5.647	5385	2983	s-l	gas	0.5613	0.3084	778.7	4398
$2Ta + 5AgO$	9.341	6110	2436	liquid	l-g	0.4229	0.4562	466.2	4355
$Mg + CuO$	3.934	6502	2843	solid	l-g	0.8186	0.5201	1102	4336
$4Be + Pb_3O_4$	7.610	5673	3559	liquid	gas	0.4157	0.8614	567.8	4322
$Hf + MnO_2$	8.054	5644	3083	s-l	gas	0.3263	0.3131	534.6	4305
$2Al + 3NiO$	5.214	3968	3187	liquid	l-g	0.0108	0.0063	822.3	4288
$2Al + 3HgO$	8.986	7169	3253	l-g	gas	0.5598	0.9913	476.6	4282
$2Al + MoO_3$	3.808	5574	3253	l-g	liquid	0.2425	0.2473	1124	4279
$Ti + 2CuO$	5.830	5569	2843	liquid	l-g	0.3242	0.2060	730.5	4259
$4Nd + 3PbO_2$	8.148	6938	<5284	gas	gas	0.3862	1.0000	517.8	4219

Table 1d- Thermite Reactions (in Descending Order of Heat of Reaction per Unit Volume) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2Al + 3CoO	5.077	3392	3201	liquid	l-g	0.0430	0.0254	824.7	4187
2B + 3CuO	5.665	4748	2843	gas	l-g	0.4463	0.2430	738.1	4182
2La + 3PdO	7.769	5635	3237	liquid	l-g	0.2450	0.2606	536.2	4166
2Y + WO_3	5.677	8296	>4572	gas	liquid	0.2441	0.5512	732.2	4157
2Ta + 5PdO	11.472	4344	3237	liquid	l-g	0.0575	0.0612	360.4	4135
8Y + 3Fe_3O_4	4.803	5791	3135	liquid	l-g	0.3812	0.2129	856.3	4113
4Y + 3SnO_2	5.604	7022	4573	l-g	gas	.37 - .62	.44 - 1	726.1	4068
2Nd + 3CuO	6.719	5921	2843	liquid	l-g	0.3699	0.2350	603.4	4054
4Al + 3WO_2	8.085	4176	3253	l-g	solid	0.0662	0.0675	500.6	4047
2Mg + MnO_2	2.996	5209	3271	liquid	gas	0.7378	0.4053	1322	3961
4La + 3PbO_2	7.629	7065	>4472	gas	gas	0.3927	1.0000	518.8	3958
3Th + 2Fe_2O_3	8.280	6287	3135	solid	l-g	0.2619	0.1463	477.9	3957
2Al + Fe_2O_3	4.175	4382	3135	liquid	l-g	0.1404	0.0784	945.4	3947
10Y + 3V_2O_5	3.970	7243	>3652	l-g	gas	0.2130	0.4181	972.5	3861
3Zr + 2Fe_2O_3	5.744	4626	3135	liquid	l-g	0.0820	0.0458	666.2	3827
2Al + WO_3	5.458	5544	3253	l-g	liquid	0.1434	0.1463	696.4	3801
2La + 3CuO	6.263	6007	2843	liquid	l-g	0.3737	0.2374	606.4	3798
4Ta + 5PbO_2	11.215	4935	3472	liquid	gas	0.2604	0.5397	338.6	3797
3Hf + 2Fe_2O_3	7.955	5031	2843	solid	l-g	0.2117	0.1183	473.3	3765
8Al + 3Fe_3O_4	4.264	4057	3135	liquid	l-g	0.0549	0.0307	878.8	3747
3Be + Cr_2O_3	4.089	3107	2820	s-l	liquid	0.0000	0.0000	915.0	3741
2Th + Fe_3O_4	8.092	5912	3135	solid	l-g	0.2257	0.1261	458.5	3710
2Nd + 3HgO	9.430	7020	<5374	gas	gas	0.4263	1.0000	392.7	3703
4Nd + 3MnO_2	6.241	5194	3287	liquid	gas	0.3580	0.1967	589.9	3682
4Al + 3SnO_2	5.356	5019	2876	liquid	l-g	0.2928	0.3476	686.8	3678
2Al + Bi_2O_3	7.188	3995	3253	l-g	gas	0.4731	0.8941	506.1	3638
Ti + MnO_2	4.826	3993	2334	liquid	l-g	0.3783	0.2078	752.7	3633
3Mg + Fe_2O_3	3.224	4703	3135	liquid	l-g	0.2021	0.1129	1110	3579
8Al + 3Pb_3O_4	7.428	5427	3253	l-g	gas	0.4215	0.8466	478.1	3551
2Th + Pb_3O_4	9.845	8532	4673	l-g	gas	0.2695	0.5633	360.5	3549
2Zr + Fe_3O_4	5.668	4103	3135	liquid	l-g	0.0277	0.0155	625.1	3543
2Ta + 5CuO	9.049	4044	2843	liquid	l-g	0.0776	0.0493	390.3	3532
2La + 3HgO	8.962	7140	>4472	l-g	gas	.32 - .43	.65 - 1	392.0	3513
2Hf + Fe_3O_4	7.760	4802	2843	solid	l-g	0.1835	0.1025	450.4	3496
2Zr + Pb_3O_4	8.359	6595	3300	l-g	gas	0.3683	0.7440	408.1	3412
4La + 3MnO_2	5.740	5270	3120	liquid	gas	0.3674	0.2019	593.4	3406
4B + 3MnO_2	4.394	3000	2133	l-g	liquid	0.3198	0.1715	773.1	3397
10Al + 3V_2O_5	3.107	3953	3273	l-g	liquid	0.0699	0.0356	1092	3394
4Mg + Fe_3O_4	3.274	4446	3135	liquid	l-g	0.1369	0.0764	1033	3383
2Hf + Pb_3O_4	9.775	9382	4410	liquid	gas	0.2877	0.5962	345.9	3381
4Mg + Pb_3O_4	5.965	5883	3873	l-g	gas	0.4216	0.8095	556.0	3316

Table 1d- Thermite Reactions (in Descending Order of Heat of Reaction per Unit Volume) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$4Nd + 3WO_2$	9.016	4792	3778	liquid	liquid	0.0000	0.0000	362.9	3272
$2Al + 3Ag_2O$	6.386	4941	2436	liquid	l-g	0.4298	0.4636	504.8	3224
$2Nd + WO_3$	7.074	5438	4245	liquid	liquid	0.0000	0.0000	446.1	3156
$8Nd + 3Pb_3O_4$	8.218	5553	3958	liquid	gas	0.2803	0.5808	379.6	3120
$2Ta + 5HgO$	12.140	5285	<4200	liquid	gas	0.3460	0.6942	263.3	3120
$3Ti + 2Fe_2O_3$	5.010	3358	2614	liquid	liquid	0.0000	0.0000	612.0	3066
$2Al + 3Cu_2O$	5.280	4132	2843	liquid	l-g	0.1221	0.0776	575.5	3039
$2La + Fe_2O_3$	5.729	4590	3135	liquid	l-g	0.1234	0.0689	529.6	3034
$3Be + B_2O_3$	1.850	3278	2573	liquid	s-l	0.0000	0.0000	1639	3033
$4La + 3WO_2$	8.366	3826	3218	liquid	solid	0.0000	0.0000	361.2	3022
$10Y + 3Ta_2O_5$	6.316	5564	>4572	l-g	liquid	0 - .23	0 - .51	469.7	2966
$8La + 3Pb_3O_4$	7.789	5628	4049	liquid	gas	0.2841	0.5886	378.6	2949
$2La + WO_3$	6.572	5808	4367	liquid	liquid	0.0000	0.0000	445.8	2930
$2Ti + Pb_3O_4$	8.087	5508	2498	liquid	gas	0.3839	0.7955	358.1	2896
$Ti + Fe_3O_4$	4.974	3113	2334	liquid	liquid	0.0000	0.0000	563.0	2800
$3Th + 2Cr_2O_3$	8.300	4051	2945	solid	l-g	0.0590	0.0307	334.5	2776
$2B + Fe_2O_3$	4.661	2646	2065	liquid	liquid	0.0000	0.0000	590.1	2751
$2Li + CuO$	2.432	4152	2843	liquid	l-g	0.2248	0.1428	1125	2736
$2Al + 3PbO$	8.018	3968	2327	s-l	gas	0.4146	0.8591	337.4	2705
$8B + 3Pb_3O_4$	8.223	4217	2019	liquid	l-g	0.4126	0.8550	326.9	2688
$2Al + Cr_2O_3$	4.190	2789	2327	s-l	liquid	0.0000	0.0000	622.0	2606
$3Mg + Cr_2O_3$	3.164	3788	2945	solid	l-g	0.1023	0.0532	813.1	2573
$6Ta + 5Fe_2O_3$	9.185	2383	2138	solid	liquid	0.0000	0.0000	235.0	2558
$8B + 3Fe_3O_4$	4.644	2338	1903	liquid	liquid	0.0000	0.0000	530.1	2462
$10Al + 3Nb_2O_5$	4.089	3240	2705	liquid	solid	0.0000	0.0000	600.2	2454
$16Al + 3U_3O_8$	4.957	1406	1406	solid	solid	0.0000	0.0000	487.6	2417
$3Zr + 2Cr_2O_3$	5.713	2915	2650	solid	liquid	0.0000	0.0000	423.0	2417
$3Hf + 2Cr_2O_3$	7.971	2721	2572	solid	liquid	0.0000	0.0000	302.3	2410
$2Al + 3SnO$	5.540	3558	2876	liquid	l-g	0.1070	0.1270	427.0	2366
$8Ta + 5Pb_3O_4$	10.510	3601	2019	solid	l-g	0.2990	0.6196	225.0	2365
$2La + 3PbO$	8.207	4598	2609	liquid	gas	0.3166	0.6561	287.4	2359
$4Li + MnO_2$	1.656	3336	2334	liquid	l-g	0.4098	0.2251	1399	2317
$6Li + MoO_3$	1.688	4035	2873	l-g	solid	0.2155	0.0644	1342	2265
$3Th + 2B_2O_3$	6.688	3959	3135	solid	liquid	0.0000	0.0000	337.8	2259
$2Be + SiO_2$	2.410	2580	2482	solid	liquid	0.0000	0.0000	936.0	2256
$8Li + Pb_3O_4$	4.133	4186	2873	l-g	liquid	0.1655	0.0496	536.7	2218
$6Li + Fe_2O_3$	1.863	3193	2510	liquid	liquid	0.0000	0.0000	1143	2130
$10Al + 3Ta_2O_5$	6.339	3055	2452	liquid	solid	0.0000	0.0000	335.6	2128
$6Li + WO_3$	2.478	3700	2873	l-g	solid	0.0113	0.0034	825.4	2046
$8Li + Fe_3O_4$	0.517	3076	2412	liquid	liquid	0.0000	0.0000	1053	2036
$6Ta + 5WO_3$	9.876	2883	2633	liquid	solid	0.0000	0.0000	206.2	2036

Table 1d- Thermite Reactions (in Descending Order of Heat of Reaction per Unit Volume) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$2Al + B_2O_3$	2.524	2621	2327	s-l	solid	0.0000	0.0000	780.7	1971
$4Ta + 5WO_2$	13.515	2556	2196	liquid	solid	0.0000	0.0000	145.1	1962
$3Hf + 2B_2O_3$	6.125	2656	2575	solid	liquid	0.0000	0.0000	296.5	1816
$Th + SiO_2$	6.732	3813	2628	solid	l-g	0 - .34	0 -.10	258.2	1738
$2Mg + SiO_2$	2.148	3401	2628	solid	l-g	0 - .92	0 - .26	789.6	1695
$3Zr + 2B_2O_3$	3.782	2730	2573	solid	s-l	0.2930	0.0317	437.4	1654
$2Ta + 5PbO$	10.640	2752	2019	solid	l-g	0.1475	0.3056	154.5	1644
$3Ti + 2Cr_2O_3$	4.959	1814	1814	solid	solid	0.0000	0.0000	296.2	1469
$6Li + Cr_2O_3$	1.807	2151	1843	s-l	solid	0.0000	0.0000	799.5	1445
$4Al + 3SiO_2$	2.668	2010	1889	solid	liquid	0.0000	0.0000	513.3	1370
$4Al + 3TiO_2$	3.590	1955	1752	solid	liquid	0.0000	0.0000	365.1	1311
$Hf + SiO_2$	6.224	2117	1828	solid	liquid	0.0000	0.0000	203.3	1265
$Zr + SiO_2$	4.098	2233	1687	solid	s-l	0.0000	0.0000	299.7	1228
$3Mg + B_2O_3$	1.785	6389	3873	l-g	liquid	0.4981	0.2007	2134	1195
$6Li + B_2O_3$	0.891	2254	1843	s-l	solid	0.0000	0.0000	1293	1152
$4Li + SiO_2$	1.177	1712	1687	solid	s-l	0.0000	0.0000	763.9	898.7
$2B + Cr_2O_3$	4.590	977	917	liquid	solid	0.0000	0.0000	182.0	835.3
$3Ti + 2B_2O_3$	2.791	1498	1498	solid	solid	0.0000	0.0000	276.6	772.0
$Ti + SiO_2$	3.241	715	715	solid	solid	0.0000	0.0000	75.0	243.1

Table 1e - Thermite Reactions (in Descending Order of Reaction Temperature)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$10Nd + 3I_2O_5$	5.896	10067	<7580	gas	gas	0.3273	1.0000	840.6	4956
$2Ta + I_2O_5$	7.615	8462	7240	gas	gas	0.2875	1.0000	648.6	4939
$4Y + 3MnO_2$	4.690	7405	<5731	gas	gas	0.8110	1.0000	1022	4792
$2Nd + 3HgO$	9.430	7020	<5374	gas	gas	0.4263	1.0000	392.7	3703
$4Nd + 3PbO_2$	8.148	6938	<5284	gas	gas	0.3862	1.0000	517.8	4219
$Th + PbO_2$	10.190	10612	4673	l-g	gas	0.2817	0.6231	482.8	4922
$2Th + Pb_3O_4$	9.845	8532	4673	l-g	gas	0.2695	0.5633	360.5	3549
$10Y + 3I_2O_5$	4.638	12416	>4573	gas	gas	0.4231	1.0000	1144	5308
$4Y + 3SnO_2$	5.604	7022	4573	l-g	gas	.37 - .62	.44 - 1	726.1	4068
$2Y + MoO_3$	4.567	8778	>4572	gas	liquid	0.6215	1.0000	1005	4589
$4Y + 3PbO_2$	6.875	9166	>4572	gas	gas	0.4659	1.0000	751.0	5163
$10Y + 3Ta_2O_5$	6.316	5564	>4572	l-g	liquid	0 - 0.23	0 - 0.51	469.7	2966
$2Y + WO_3$	5.677	8296	>4572	gas	liquid	0.2441	0.5512	732.2	4157
$2La + 3HgO$	8.962	7140	>4472	l-g	gas	.32 - .43	0.65 - 1	392.0	3513
$10La + 3I_2O_5$	5.501	9107	>4472	gas	gas	0.3347	1.0000	849.2	4672
$4La + 3PbO_2$	7.629	7065	>4472	gas	gas	0.3927	1.0000	518.8	3958
$2Hf + Pb_3O_4$	9.775	9382	4410	liquid	gas	0.2877	0.5962	345.9	3381
$2La + WO_3$	6.572	5808	4367	liquid	liquid	0.0000	0.0000	445.8	2930
$2Nd + WO_3$	7.074	5438	4245	liquid	liquid	0.0000	0.0000	446.1	3156
$2Ta + 5HgO$	12.140	5285	<4200	liquid	gas	0.3460	0.6942	263.3	3120
$2La + 3AgO$	6.827	8177	4173	liquid	gas	0.4619	0.4983	646.7	4416
$2Be + PbO_2$	7.296	8622	4123	l-g	gas	0.4665	0.8250	875.5	6387
$8La + 3Pb_3O_4$	7.789	5628	4049	liquid	gas	0.2841	0.5886	378.6	2949
$8Nd + 3Pb_3O_4$	8.218	5553	3958	liquid	gas	0.2803	0.5808	379.6	3120
$2Y + Ni_2O_3$	4.636	7614	3955	liquid	gas	0.5827	0.3420	1120	5194
$Th + MnO_2$	8.391	7151	3910	liquid	gas	0.3135	0.1722	529.2	4440
$3Mg + B_2O_3$	1.785	6389	3873	l-g	liquid	0.4981	0.2007	2134	1195
$4Mg + Pb_3O_4$	5.965	5883	3873	l-g	gas	0.4216	0.8095	556.0	3316
$4Nd + 3WO_2$	9.016	4792	3778	liquid	liquid	0.0000	0.0000	362.9	3272
$10Y + 3V_2O_5$	3.970	7243	>3652	l-g	gas	0.2130	0.4181	972.5	3861
$2Nd + 3AgO$	7.244	7628	3602	liquid	gas	0.4544	0.4902	625.9	4534
$4Be + Pb_3O_4$	7.610	5673	3559	liquid	gas	0.4157	0.8614	567.8	4322
$4Ta + 5PbO_2$	11.215	4935	3472	liquid	gas	0.2604	0.5397	338.6	3797
$2Zr + Pb_3O_4$	8.359	6595	3300	l-g	gas	0.3683	0.7440	408.1	3412
$4Nd + 3MnO_2$	6.241	5194	3287	liquid	gas	0.3580	0.1967	589.9	3682
$10Al + 3V_2O_5$	3.107	3953	3273	l-g	liquid	0.0699	0.0356	1092	3394
$2Mg + MnO_2$	2.996	5209	3271	liquid	gas	0.7378	0.4053	1322	3961
$2Al + 3AgO$	6.085	7503	3253	l-g	gas	0.7519	0.8083	896.7	5457
$2Al + Bi_2O_3$	7.188	3995	3253	l-g	gas	0.4731	0.8941	506.1	3638
$2Al + 3HgO$	8.986	7169	3253	l-g	gas	0.5598	0.9913	476.6	4282
$10Al + 3I_2O_5$	4.119	8680	>3253	gas	gas	0.6293	1.0000	1486	6122

Table 1e- Thermite Reactions (in Descending Order of Reaction Temperature) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2Al + MoO_3	3.808	5574	3253	l-g	liquid	0.2425	0.2473	1124	4279
4Al + 3PbO_2	7.085	6937	3253	l-g	gas	0.5366	0.9296	731.9	5185
8Al + 3Pb_3O_4	7.428	5427	3253	l-g	gas	0.4215	0.8466	478.1	3551
4Al + 3WO_2	8.085	4176	3253	l-g	solid	0.0662	0.0675	500.6	4047
2Al + WO_3	5.458	5544	3253	l-g	liquid	0.1434	0.1463	696.4	3801
2Al + 3PdO	7.281	5022	3237	liquid	l-g	0.6577	0.6998	754.3	5493
2La + 3PdO	7.769	5635	3237	liquid	l-g	0.2450	0.2606	536.2	4166
2Nd + 3PdO	8.297	6197	3237	liquid	l-g	0.2394	0.2547	532.7	4420
2Ta + 5PdO	11.472	4344	3237	liquid	l-g	0.0575	0.0612	360.4	4135
2Y + 3PdO	7.020	8097	3237	liquid	l-g	0.4183	0.4451	768.1	5371
4La + 3WO_2	8.366	3826	3218	liquid	solid	0.0000	0.0000	361.2	3022
2Al + 3CoO	5.077	3392	3201	liquid	l-g	0.0430	0.0254	824.7	4187
8Al +3Co_3O_4	4.716	3938	3201	liquid	l-g	0.2196	0.1294	1012	4772
2Al +3NiO	5.214	3968	3187	liquid	l-g	0.0108	0.0063	822.3	4288
2Al + Ni_2O_3	4.045	5031	3187	liquid	l-g	0.4650	0.2729	1292	5229
2Al + Fe_2O_3	4.175	4382	3135	liquid	l-g	0.1404	0.0784	945.4	3947
8Al + 3Fe_3O_4	4.264	4057	3135	liquid	l-g	0.0549	0.0307	878.8	3747
3Be + Fe_2O_3	4.163	4244	3135	liquid	l-g	0.1029	0.0568	1281	5332
4Be + Fe_3O_4	4.180	4482	3135	liquid	l-g	0.0336	0.0188	1175	4910
2La + Fe_2O_3	5.729	4590	3135	liquid	l-g	0.1234	0.0689	529.6	3034
3Mg + Fe_2O_3	3.224	4703	3135	liquid	l-g	0.2021	0.1129	1110	3579
4Mg + Fe_3O_4	3.274	4446	3135	liquid	l-g	0.1369	0.0764	1033	3383
3Th + 2B_2O_3	6.688	3959	3135	solid	liquid	0.0000	0.0000	337.8	2259
3Th + 2Fe_2O_3	8.280	6287	3135	solid	l-g	0.2619	0.1463	477.9	3957
2Th + Fe_3O_4	8.092	5912	3135	solid	l-g	0.2257	0.1261	458.5	3710
8Y + 3Fe_3O_4	4.803	5791	3135	liquid	l-g	0.3812	0.2129	856.3	4113
3Zr + 2Fe_2O_3	5.744	4626	3135	liquid	l-g	0.0820	0.0458	666.2	3827
2Zr + Fe_3O_4	5.668	4103	3135	liquid	l-g	0.0277	0.0155	625.1	3543
2Y + 3CuO	5.404	7668	3124	liquid	l-g	0.7204	0.4577	926.7	5008
4La + 3MnO_2	5.740	5270	3120	liquid	gas	0.3674	0.2019	593.4	3406
Hf + MnO_2	8.054	5644	3083	s-l	gas	0.3263	0.3131	534.6	4305
Zr + MnO_2	5.647	5385	2983	s-l	gas	0.5613	0.3084	778.7	4398
2Be + MnO_2	3.882	6078	2969	liquid	gas	0.9527	0.5234	1586	6158
3Mg + Cr_2O_3	3.164	3788	2945	solid	l-g	0.1023	0.0532	813.1	2573
3Th + 2Cr_2O_3	8.300	4051	2945	solid	l-g	0.0590	0.0307	334.5	2776
4Al + 3MnO_2	4.014	4829	2918	liquid	gas	0.8136	0.4470	1159	4651
2Al + 3SnO	5.540	3558	2876	liquid	l-g	0.1070	0.1270	427.0	2366
4Al + 3SnO_2	5.356	5019	2876	liquid	l-g	0.2928	0.3476	686.8	3678
6Li + MoO_3	1.688	4035	2873	l-g	solid	0.2155	0.0644	1342	2265
8Li + Pb_3O_4	4.133	4186	2873	l-g	liquid	0.1655	0.0496	536.7	2218
6Li + WO_3	2.478	3700	2873	l-g	solid	0.0113	0.0034	825.4	2046

Table 1e- Thermite Reactions (in Descending Order of Reaction Temperature) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2Al + 3CuO	5.109	5718	2843	liquid	l-g	0.5400	0.3431	974.1	4976
2Al + 3Cu_2O	5.280	4132	2843	liquid	l-g	0.1221	0.0776	575.5	3039
2B + 3CuO	5.665	4748	2843	gas	l-g	0.4463	0.2430	738.1	4182
Hf + 2CuO	8.332	5974	2843	solid	l-g	0.3881	0.2466	567.6	4730
3Hf + 2Fe_2O_3	7.955	5031	2843	solid	l-g	0.2117	0.1183	473.3	3765
2Hf + Fe_3O_4	7.760	4802	2843	solid	l-g	0.1835	0.1025	450.4	3496
2La + 3CuO	6.263	6007	2843	liquid	l-g	0.3737	0.2374	606.4	3798
2Li + CuO	2.432	4152	2843	liquid	l-g	0.2248	0.1428	1125	2736
Mg + CuO	3.934	6502	2843	solid	l-g	0.8186	0.5201	1102	4336
2Nd + 3CuO	6.719	5921	2843	liquid	l-g	0.3699	0.2350	603.4	4054
2Ta + 5CuO	9.049	4044	2843	liquid	l-g	0.0776	0.0493	390.3	3532
Th + 2CuO	8.582	7743	2843	solid	l-g	0.4301	0.3421	558.7	4795
Ti + 2CuO	5.830	5569	2843	liquid	l-g	0.3242	0.2060	730.5	4259
Zr + 2CuO	6.400	6103	2843	solid	l-g	0.5553	0.3529	752.9	4818
3Be + Cr_2O_3	4.089	3107	2820	s-l	liquid	0.0000	0.0000	915.0	3741
Be + CuO	5.119	3761	2820	s-l	liquid	0.0000	0.0000	1221	6249
10Al + 3Nb_2O_5	4.089	3240	2705	liquid	solid	0.0000	0.0000	600.2	2454
3Zr + 2Cr_2O_3	5.713	2915	2650	solid	liquid	0.0000	0.0000	423.0	2417
6Ta + 5WO_3	9.876	2883	2633	liquid	solid	0.0000	0.0000	206.2	2036
2Mg + SiO_2	2.148	3401	2628	solid	l-g	0 - .92	0 - .26	789.6	1695
Th + SiO_2	6.732	3813	2628	solid	l-g	0 - .34	0 -.10	258.2	1738
3Ti + 2Fe_2O_3	5.010	3358	2614	liquid	liquid	0.0000	0.0000	612.0	3066
2La + 3PbO	8.207	4598	2609	liquid	gas	0.3166	0.6561	287.4	2359
3Hf + 2B_2O_3	6.125	2656	2575	solid	liquid	0.0000	0.0000	296.5	1816
3Be + B_2O_3	1.850	3278	2573	liquid	s-l	0.0000	0.0000	1639	3033
3Zr + 2B_2O_3	3.782	2730	2573	solid	s-l	0.2930	0.0317	437.4	1654
3Hf + 2Cr_2O_3	7.971	2721	2572	solid	liquid	0.0000	0.0000	302.3	2410
6Li + Fe_2O_3	1.863	3193	2510	liquid	liquid	0.0000	0.0000	1143	2130
2Ti + Pb_3O_4	8.087	5508	2498	liquid	gas	0.3839	0.7955	358.1	2896
2Be + SiO_2	2.410	2580	2482	solid	liquid	0.0000	0.0000	936.0	2256
10Al + 3Ta_2O_5	6.339	3055	2452	liquid	solid	0.0000	0.0000	335.6	2128
2Al + 3Ag_2O	6.386	4941	2436	liquid	l-g	0.4298	0.4636	504.8	3224
2Ta + 5AgO	9.341	6110	2436	liquid	l-g	0.4229	0.4562	466.2	4355
8Li + Fe_3O_4	0.517	3076	2412	liquid	liquid	0.0000	0.0000	1053	2036
4Li + MnO_2	1.656	3336	2334	liquid	l-g	0.4098	0.2251	1399	2317
Ti + Fe_3O_4	4.974	3113	2334	liquid	liquid	0.0000	0.0000	563.0	2800
Ti + MnO_2	4.826	3993	2334	liquid	l-g	0.3783	0.2078	752.7	3633
2Al + B_2O_3	2.524	2621	2327	s-l	solid	0.0000	0.0000	780.7	1971
2Al + Cr_2O_3	4.190	2789	2327	s-l	liquid	0.0000	0.0000	622.0	2606
2Al + 3PbO	8.018	3968	2327	s-l	gas	0.4146	0.8591	337.4	2705
4Ta + 5WO_2	13.515	2556	2196	liquid	solid	0.0000	0.0000	145.1	1962

Table 1e- Thermite Reactions (in Descending Order of Reaction Temperature) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$6Ta + 5Fe_2O_3$	9.185	2383	2138	solid	liquid	0.0000	0.0000	235.0	2558
$4B + 3MnO_2$	4.394	3000	2133	l-g	liquid	0.3198	0.1715	773.1	3397
$2B + Fe_2O_3$	4.661	2646	2065	liquid	liquid	0.0000	0.0000	590.1	2751
$8B + 3Pb_3O_4$	8.223	4217	2019	liquid	l-g	0.4126	0.8550	326.9	2688
$2Ta + 5PbO$	10.640	2752	2019	solid	l-g	0.1475	0.3056	154.5	1644
$8Ta + 5Pb_3O_4$	10.510	3601	2019	solid	l-g	0.2990	0.6196	225.0	2365
$8B + 3Fe_3O_4$	4.644	2338	1903	liquid	liquid	0.0000	0.0000	530.1	2462
$4Al + 3SiO_2$	2.668	2010	1889	solid	liquid	0.0000	0.0000	513.3	1370
$6Li + B_2O_3$	0.891	2254	1843	s-l	solid	0.0000	0.0000	1293	1152
$6Li + Cr_2O_3$	1.807	2151	1843	s-l	solid	0.0000	0.0000	799.5	1445
$Hf + SiO_2$	6.224	2117	1828	solid	liquid	0.0000	0.0000	203.3	1265
$3Ti + 2Cr_2O_3$	4.959	1814	1814	solid	solid	0.0000	0.0000	296.2	1469
$4Al + 3TiO_2$	3.590	1955	1752	solid	liquid	0.0000	0.0000	365.1	1311
$4Li + SiO_2$	1.177	1712	1687	solid	s-l	0.0000	0.0000	763.9	898.7
$Zr + SiO_2$	4.098	2233	1687	solid	s-l	0.0000	0.0000	299.7	1228
$3Ti + 2B_2O_3$	2.791	1498	1498	solid	solid	0.0000	0.0000	276.6	772.0
$16Al + 3U_3O_8$	4.957	1406	1406	solid	solid	0.0000	0.0000	487.6	2417
$2B + Cr_2O_3$	4.590	977	917	liquid	solid	0.0000	0.0000	182.0	835.3
$Ti + SiO_2$	3.241	715	715	solid	solid	0.0000	0.0000	75.0	243.1

Table 1f - Thermite Reactions (in Descending Order of Moles of Gas Produced)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$2Be + MnO_2$	3.882	6078	2969	liquid	gas	0.9527	0.5234	1586	6158
$Mg + CuO$	3.934	6502	2843	solid	l-g	0.8186	0.5201	1102	4336
$4Al + 3MnO_2$	4.014	4829	2918	liquid	gas	0.8136	0.4470	1159	4651
$4Y + 3MnO_2$	4.690	7405	<5731	gas	gas	0.8110	1.0000	1022	4792
$2Al + 3AgO$	6.085	7503	3253	l-g	gas	0.7519	0.8083	896.7	5457
$2Mg + MnO_2$	2.996	5209	3271	liquid	gas	0.7378	0.4053	1322	3961
$2Y + 3CuO$	5.404	7668	3124	liquid	l-g	0.7204	0.4577	926.7	5008
$2Al + 3PdO$	7.281	5022	3237	liquid	l-g	0.6577	0.6998	754.3	5493
$10Al + 3I_2O_5$	4.119	8680	>3253	gas	gas	0.6293	1.0000	1486	6122
$2Y + MoO_3$	4.567	8778	>4572	gas	liquid	0.6215	1.0000	1005	4589
$2Y + Ni_2O_3$	4.636	7614	3955	liquid	gas	0.5827	0.3420	1120	5194
$Zr + MnO_2$	5.647	5385	2983	s-l	gas	0.5613	0.3084	778.7	4398
$2Al + 3HgO$	8.986	7169	3253	l-g	gas	0.5598	0.9913	476.6	4282
$Zr + 2CuO$	6.400	6103	2843	solid	l-g	0.5553	0.3529	752.9	4818
$2Al + 3CuO$	5.109	5718	2843	liquid	l-g	0.5400	0.3431	974.1	4976
$4Al + 3PbO_2$	7.085	6937	3253	l-g	gas	0.5366	0.9296	731.9	5185
$3Mg + B_2O_3$	1.785	6389	3873	l-g	liquid	0.4981	0.2007	2134	1195
$2Al + Bi_2O_3$	7.188	3995	3253	l-g	gas	0.4731	0.8941	506.1	3638
$2Be + PbO_2$	7.296	8622	4123	l-g	gas	0.4665	0.8250	875.5	6387
$4Y + 3PbO_2$	6.875	9166	>4572	gas	gas	0.4659	1.0000	751.0	5163
$2Al + Ni_2O_3$	4.045	5031	3187	liquid	l-g	0.4650	0.2729	1292	5229
$2La + 3AgO$	6.827	8177	4173	liquid	gas	0.4619	0.4983	646.7	4416
$2Nd + 3AgO$	7.244	7628	3602	liquid	gas	0.4544	0.4902	625.9	4534
$2B + 3CuO$	5.665	4748	2843	gas	l-g	0.4463	0.2430	738.1	4182
$Th + 2CuO$	8.582	7743	2843	solid	l-g	0.4301	0.3421	558.7	4795
$2Al + 3Ag_2O$	6.386	4941	2436	liquid	l-g	0.4298	0.4636	504.8	3224
$2Nd + 3HgO$	9.430	7020	<5374	gas	gas	0.4263	1.0000	392.7	3703
$10Y + 3I_2O_5$	4.638	12416	>4573	gas	gas	0.4231	1.0000	1144	5308
$2Ta + 5AgO$	9.341	6110	2436	liquid	l-g	0.4229	0.4562	466.2	4355
$4Mg + Pb_3O_4$	5.965	5883	3873	l-g	gas	0.4216	0.8095	556.0	3316
$8Al + 3Pb_3O_4$	7.428	5427	3253	l-g	gas	0.4215	0.8466	478.1	3551
$2Y + 3PdO$	7.020	8097	3237	liquid	l-g	0.4183	0.4451	768.1	5371
$4Be + Pb_3O_4$	7.610	5673	3559	liquid	gas	0.4157	0.8614	567.8	4322
$2Al + 3PbO$	8.018	3968	2327	s-l	gas	0.4146	0.8591	337.4	2705
$8B + 3Pb_3O_4$	8.223	4217	2019	liquid	l-g	0.4126	0.8550	326.9	2688
$4Li + MnO_2$	1.656	3336	2334	liquid	l-g	0.4098	0.2251	1399	2317
$4La + 3PbO_2$	7.629	7065	>4472	gas	gas	0.3927	1.0000	518.8	3958
$Hf + 2CuO$	8.332	5974	2843	solid	l-g	0.3881	0.2466	567.6	4730
$4Nd + 3PbO_2$	8.148	6938	<5284	gas	gas	0.3862	1.0000	517.8	4219
$2Ti + Pb_3O_4$	8.087	5508	2498	liquid	gas	0.3839	0.7955	358.1	2896
$8Y + 3Fe_3O_4$	4.803	5791	3135	liquid	l-g	0.3812	0.2129	856.3	4113

Table 1f- Thermite Reactions (in Descending Order of Moles of Gas Produced) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$Ti + MnO_2$	4.826	3993	2334	liquid	l-g	0.3783	0.2078	752.7	3633
$2La + 3CuO$	6.263	6007	2843	liquid	l-g	0.3737	0.2374	606.4	3798
$4Y + 3SnO_2$	5.604	7022	4573	l-g	gas	.37 - .62	.44 - 1	726.1	4068
$2Nd + 3CuO$	6.719	5921	2843	liquid	l-g	0.3699	0.2350	603.4	4054
$2Zr + Pb_3O_4$	8.359	6595	3300	l-g	gas	0.3683	0.7440	408.1	3412
$4La + 3MnO_2$	5.740	5270	3120	liquid	gas	0.3674	0.2019	593.4	3406
$4Nd + 3MnO_2$	6.241	5194	3287	liquid	gas	0.3580	0.1967	589.9	3682
$2Ta + 5HgO$	12.140	5285	<4200	liquid	gas	0.3460	0.6942	263.3	3120
$10La + 3I_2O_5$	5.501	9107	>4472	gas	gas	0.3347	1.0000	849.2	4672
$10Nd + 3I_2O_5$	5.896	10067	<7580	gas	gas	0.3273	1.0000	840.6	4956
$Hf + MnO_2$	8.054	5644	3083	s-l	gas	0.3263	0.3131	534.6	4305
$Ti + 2CuO$	5.830	5569	2843	liquid	l-g	0.3242	0.2060	730.5	4259
$2La + 3HgO$	8.962	7140	>4472	l-g	gas	.32 - .43	.65 - 1	392.0	3513
$4B + 3MnO_2$	4.394	3000	2133	l-g	liquid	0.3198	0.1715	773.1	3397
$2La + 3PbO$	8.207	4598	2609	liquid	gas	0.3166	0.6561	287.4	2359
$Th + MnO_2$	8.391	7151	3910	liquid	gas	0.3135	0.1722	529.2	4440
$8Ta + 5Pb_3O_4$	10.510	3601	2019	solid	l-g	0.2990	0.6196	225.0	2365
$3Zr + 2B_2O_3$	3.782	2730	2573	solid	s-l	0.2930	0.0317	437.4	1654
$4Al + 3SnO_2$	5.356	5019	2876	liquid	l-g	0.2928	0.3476	686.8	3678
$2Hf + Pb_3O_4$	9.775	9382	4410	liquid	gas	0.2877	0.5962	345.9	3381
$2Ta + I_2O_5$	7.615	8462	7240	gas	gas	0.2875	1.0000	648.6	4939
$8La + 3Pb_3O_4$	7.789	5628	4049	liquid	gas	0.2841	0.5886	378.6	2949
$Th + PbO_2$	10.190	10612	4673	l-g	gas	0.2817	0.6231	482.8	4922
$8Nd + 3Pb_3O_4$	8.218	5553	3958	liquid	gas	0.2803	0.5808	379.6	3120
$2Th + Pb_3O_4$	9.845	8532	4673	l-g	gas	0.2695	0.5633	360.5	3549
$3Th + 2Fe_2O_3$	8.280	6287	3135	solid	l-g	0.2619	0.1463	477.9	3957
$4Ta + 5PbO_2$	11.215	4935	3472	liquid	gas	0.2604	0.5397	338.6	3797
$2La + 3PdO$	7.769	5635	3237	liquid	l-g	0.2450	0.2606	536.2	4166
$2Y + WO_3$	5.677	8296	>4572	gas	liquid	0.2441	0.5512	732.2	4157
$2Al + MoO_3$	3.808	5574	3253	l-g	liquid	0.2425	0.2473	1124	4279
$2Nd + 3PdO$	8.297	6197	3237	liquid	l-g	0.2394	0.2547	532.7	4420
$2Th + Fe_3O_4$	8.092	5912	3135	solid	l-g	0.2257	0.1261	458.5	3710
$2Li + CuO$	2.432	4152	2843	liquid	l-g	0.2248	0.1428	1125	2736
$8Al + 3Co_3O_4$	4.716	3938	3201	liquid	l-g	0.2196	0.1294	1012	4772
$6Li + MoO_3$	1.688	4035	2873	l-g	solid	0.2155	0.0644	1342	2265
$10Y + 3V_2O_5$	3.970	7243	>3652	l-g	gas	0.2130	0.4181	972.5	3861
$3Hf + 2Fe_2O_3$	7.955	5031	2843	solid	l-g	0.2117	0.1183	473.3	3765
$3Mg + Fe_2O_3$	3.224	4703	3135	liquid	l-g	0.2021	0.1129	1110	3579
$2Hf + Fe_3O_4$	7.760	4802	2843	solid	l-g	0.1835	0.1025	450.4	3496
$8Li + Pb_3O_4$	4.133	4186	2873	l-g	liquid	0.1655	0.0496	536.7	2218
$2Ta + 5PbO$	10.640	2752	2019	solid	l-g	0.1475	0.3056	154.5	1644

Table 1f- Thermite Reactions (in Descending Order of Moles of Gas Produced) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$2Al + WO_3$	5.458	5544	3253	l-g	liquid	0.1434	0.1463	696.4	3801
$2Al + Fe_2O_3$	4.175	4382	3135	liquid	l-g	0.1404	0.0784	945.4	3947
$4Mg + Fe_3O_4$	3.274	4446	3135	liquid	l-g	0.1369	0.0764	1033	3383
$2La + Fe_2O_3$	5.729	4590	3135	liquid	l-g	0.1234	0.0689	529.6	3034
$2Al + 3Cu_2O$	5.280	4132	2843	liquid	l-g	0.1221	0.0776	575.5	3039
$2Al + 3SnO$	5.540	3558	2876	liquid	l-g	0.1070	0.1270	427.0	2366
$3Be + Fe_2O_3$	4.163	4244	3135	liquid	l-g	0.1029	0.0568	1281	5332
$3Mg + Cr_2O_3$	3.164	3788	2945	solid	l-g	0.1023	0.0532	813.1	2573
$3Zr + 2Fe_2O_3$	5.744	4626	3135	liquid	l-g	0.0820	0.0458	666.2	3827
$2Ta + 5CuO$	9.049	4044	2843	liquid	l-g	0.0776	0.0493	390.3	3532
$10Al + 3V_2O_5$	3.107	3953	3273	l-g	liquid	0.0699	0.0356	1092	3394
$4Al + 3WO_2$	8.085	4176	3253	l-g	solid	0.0662	0.0675	500.6	4047
$3Th + 2Cr_2O_3$	8.300	4051	2945	solid	l-g	0.0590	0.0307	334.5	2776
$2Ta + 5PdO$	11.472	4344	3237	liquid	l-g	0.0575	0.0612	360.4	4135
$8Al + 3Fe_3O_4$	4.264	4057	3135	liquid	l-g	0.0549	0.0307	878.8	3747
$2Al + 3CoO$	5.077	3392	3201	liquid	l-g	0.0430	0.0254	824.7	4187
$4Be + Fe_3O_4$	4.180	4482	3135	liquid	l-g	0.0336	0.0188	1175	4910
$2Zr + Fe_3O_4$	5.668	4103	3135	liquid	l-g	0.0277	0.0155	625.1	3543
$6Li + WO_3$	2.478	3700	2873	l-g	solid	0.0113	0.0034	825.4	2046
$2Al + 3NiO$	5.214	3968	3187	liquid	l-g	0.0108	0.0063	822.3	4288
$2Mg + SiO_2$	2.148	3401	2628	solid	l-g	0 - .92	0 - .26	789.6	1695
$Th + SiO_2$	6.732	3813	2628	solid	l-g	0 - .34	0 - .10	258.2	1738
$10Y + 3Ta_2O_5$	6.316	5564	>4572	l-g	liquid	0 - .23	0 - .51	469.7	2966
$2Al + B_2O_3$	2.524	2621	2327	s-l	solid	0.0000	0.0000	780.7	1971
$2Al + Cr_2O_3$	4.190	2789	2327	s-l	liquid	0.0000	0.0000	622.0	2606
$10Al + 3Nb_2O_5$	4.089	3240	2705	liquid	solid	0.0000	0.0000	600.2	2454
$4Al + 3SiO_2$	2.668	2010	1889	solid	liquid	0.0000	0.0000	513.3	1370
$10Al + 3Ta_2O_5$	6.339	3055	2452	liquid	solid	0.0000	0.0000	335.6	2128
$4Al + 3TiO_2$	3.590	1955	1752	solid	liquid	0.0000	0.0000	365.1	1311
$16Al + 3U_3O_8$	4.957	1406	1406	solid	solid	0.0000	0.0000	487.6	2417
$2B + Cr_2O_3$	4.590	977	917	liquid	solid	0.0000	0.0000	182.0	835.3
$2B + Fe_2O_3$	4.661	2646	2065	liquid	liquid	0.0000	0.0000	590.1	2751
$8B + 3Fe_3O_4$	4.644	2338	1903	liquid	liquid	0.0000	0.0000	530.1	2462
$3Be + B_2O_3$	1.850	3278	2573	liquid	s-l	0.0000	0.0000	1639	3033
$3Be + Cr_2O_3$	4.089	3107	2820	s-l	liquid	0.0000	0.0000	915.0	3741
$Be + CuO$	5.119	3761	2820	s-l	liquid	0.0000	0.0000	1221	6249
$2Be + SiO_2$	2.410	2580	2482	solid	liquid	0.0000	0.0000	936.0	2256
$3Hf + 2B_2O_3$	6.125	2656	2575	solid	liquid	0.0000	0.0000	296.5	1816
$3Hf + 2Cr_2O_3$	7.971	2721	2572	solid	liquid	0.0000	0.0000	302.3	2410
$Hf + SiO_2$	6.224	2117	1828	solid	liquid	0.0000	0.0000	203.3	1265
$4La + 3WO_2$	8.366	3826	3218	liquid	solid	0.0000	0.0000	361.2	3022

Table 1f- Thermite Reactions (in Descending Order of Moles of Gas Produced) (cont.)

reactants		adiabatic reaction temperature (K)		state of products		gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes	state of oxide	state of metal	moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
$2La + WO_3$	6.572	5808	4367	liquid	liquid	0.0000	0.0000	445.8	2930
$6Li + B_2O_3$	0.891	2254	1843	s-l	solid	0.0000	0.0000	1293	1152
$6Li + Cr_2O_3$	1.807	2151	1843	s-l	solid	0.0000	0.0000	799.5	1445
$6Li + Fe_2O_3$	1.863	3193	2510	liquid	liquid	0.0000	0.0000	1143	2130
$8Li + Fe_3O_4$	0.517	3076	2412	liquid	liquid	0.0000	0.0000	1053	2036
$4Li + SiO_2$	1.177	1712	1687	solid	s-l	0.0000	0.0000	763.9	898.7
$4Nd + 3WO_2$	9.016	4792	3778	liquid	liquid	0.0000	0.0000	362.9	3272
$2Nd + WO_3$	7.074	5438	4245	liquid	liquid	0.0000	0.0000	446.1	3156
$6Ta + 5Fe_2O_3$	9.185	2383	2138	solid	liquid	0.0000	0.0000	235.0	2558
$4Ta + 5WO_2$	13.515	2556	2196	liquid	solid	0.0000	0.0000	145.1	1962
$6Ta + 5WO_3$	9.876	2883	2633	liquid	solid	0.0000	0.0000	206.2	2036
$3Th + 2B_2O_3$	6.688	3959	3135	solid	liquid	0.0000	0.0000	337.8	2259
$3Ti + 2B_2O_3$	2.791	1498	1498	solid	solid	0.0000	0.0000	276.6	772.0
$3Ti + 2Cr_2O_3$	4.959	1814	1814	solid	solid	0.0000	0.0000	296.2	1469
$3Ti + 2Fe_2O_3$	5.010	3358	2614	liquid	liquid	0.0000	0.0000	612.0	3066
$Ti + Fe_3O_4$	4.974	3113	2334	liquid	liquid	0.0000	0.0000	563.0	2800
$Ti + SiO_2$	3.241	715	715	solid	solid	0.0000	0.0000	75.0	243.1
$3Zr + 2Cr_2O_3$	5.713	2915	2650	solid	liquid	0.0000	0.0000	423.0	2417
$Zr + SiO_2$	4.098	2233	1687	solid	s-l	0.0000	0.0000	299.7	1228

Table 2a - Intermetallic Reactions (in Alphabetical Order)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Al + 2B	2.607	2251	>1252	l-g	0 - 2.1	0 - 1	742	1940
4Al + 3C	2.574	1673	1673	solid	0.0	0.0	371	965
2Al + Ca	2.051	2836	1738	liquid	0.0	0.0	558	1140
4Al + Ca	2.248	1880	>972	s-l	0.0	0.0	348	782
4Al + Ce	4.095	1173	1173	solid	0.0	0.0	126	458
Al + Co	5.171	2195	>1912	s-l	0.0	0.0	307	1590
4Al + Co	3.581	*	*	*	*	*	231	637
5Al + 2Co	3.999	1755	>1452	s-l	0.0	0.0	277	1110
3Al + Cr	3.568	793	793	solid	0.0	0.0	120	430
Al + Cu	5.294	935	935	solid	0.0	0.0	108	573
Al + Fe	4.844	1423	1423	solid	0.0	0.0	211	1020
3Al + Fe	3.688	1407	1407	solid	0.0	0.0	278	1020
4Al + La	3.946	1495	*	s-l	0.0	0.0	166	780
Al + Li	1.476	1160	>972	s-l	0.0	0.0	345	509
Al + Mn	4.676	803	803	solid	0.0	0.0	124	586
Al + Ni	5.165	2362	>1910	s-l	0.0	0.0	330	1710
Al + 3Ni	6.820	1524	1524	solid	0.0	0.0	180	1230
Al + Pd	7.072	2725	2653	liquid	0.0	0.0	327	2890
4Al + Pr	4.094	1703	*	s-l	0.0	0.0	216	800
Al + Pt	11.63	3379	3073	liquid	0.0	0.0	216	2510
4Al + Pu	6.708	1403	1403	solid	0.0	0.0	123	820
2Al + 3S	2.102	*	*	*	0.0	0.0	800	1680
Al + Ta	9.952	1011	1011	solid	0.0	0.0	56.7	564
3Al + Ta	6.407	665	665	solid	0.0	0.0	35.9	230
Al + Ti	3.628	1597	1597	solid	0.0	0.0	240	872
Al + 3Ti	4.071	*	*	*	*	*	138	560
2Al + Ti	3.326	1643	*	l-s	*	*	314	1100
3Al + Ti	3.172	1591	1591	solid	0.0	0.0	272	862
3Al + 2Ti	3.448	*	*	*	*	*	158	544
4Al + U	6.582	1205	*	liquid	0.0	0.0	89.8	591
3Al + V	3.412	1023	1023	solid	0.0	0.0	198	792
2Al + Zr	4.240	1923	*	l-s	*	*	267	1130
4B + C	2.444	1202	1202	solid	0.0	0.0	308	751
6B + Ce	4.374	2388	2388	solid	0.0	0.0	395	1730
2B + Cr	4.622	1571	1571	solid	0.0	0.0	306	1410
2B + Hf	8.232	3945	3653	liquid	0.0	0.0	401	3300
6B + La	4.198	2503	*	l-s	0.0	0.0	560	2350
2B + Mg	2.031	1706	1706	dec	0.0	0.0	479	972
6B + Mg	2.234	918	918	solid	0.0	0.0	251	600
2B + Mn	4.732	1386	1386	solid	0.0	0.0	294	1390
2B + Mo	6.091	1533	1533	solid	0.0	0.0	196	1280

* More data needed for this calculation.

Table 2a - Intermetallic Reactions (in Alphabetical Order) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2B + Nb	5.875	2793	2793	solid	0.0	0.0	524	3080
6B + Sm	4.684	1233	1233	solid	0.0	0.0	232	1050
6B + Si	2.497	503	503	solid	0.0	0.0	76.4	177
2B + Ta	10.36	2766	2766	solid	0.0	0.0	247	2560
4B + Th	7.240	1823	1823	solid	0.0	0.0	189	1360
B + Ti	3.922	3559	>2452	l or g	0 - 1.7	0 - 1	652	2560
2B + Ti	3.603	3710	3498	liquid	0.0	0.0	1320	5170
2B + U	12.22	1335	1335	solid	0.0	0.0	149	1820
4B + U	9.407	2124	2124	solid	0.0	0.0	209	1960
B + V	4.749	2574	2574	solid	0.0	0.0	536	2540
2B + V	4.187	2960	2960	s-l	0.0	0.0	671	2810
5B + 2W	10.37	1233	1233	solid	0.0	0.0	83.0	1350
6B + Y	3.354	973	973	solid	0.0	0.0	156	503
2B + Zr	4.926	3783	3673	liquid	0.0	0.0	683	3360
3Ba + 2Bi	5.185	1673	*	liquid	0.0	0.0	87.3	169
Ba + 2C	3.236	1466	1466	solid	0.0	0.0	111	359
2Ba + Pb	4.025	1913	>1200	l-g	0 - .21	0 - 1	143	576
3Ba + 2Sb	4.252	1833	*	liquid	*	*	133	563
2Ba + Sn	4.153	2398	*	l-g	0 - .25	0 - 1	240	1000
Be + 2C	2.131	3043	*	l-g	0 - .33	0 - 1	1750	3720
2Be + C	1.995	1932	1932	solid	0.0	0.0	931	1860
5Be + Nb	3.920	1663	1663	solid	0.0	0.0	336	1300
13Be + Pu	4.756	723	723	solid	0.0	0.0	100	476
13Be + U	4.679	773	773	solid	0.0	0.0	110	513
Bi + K	3.723	1253	*	liquid	0.0	0.0	55	204
Bi + 3K	2.071	1791	*	liquid?	*	*	127	263
Bi + Li	6.319	1273	>689	liquid	0.0	0.0	85.5	535
2C + Ca	1.757	1113	1113	solid	0.0	0.0	223	392
2C + Ce	5.201	1779	1779	solid	0.0	0.0	170	884
3C + 7Cr	5.978	1175	1175	solid	0.0	0.0	136	813
C +Hf	9.084	4441	>4222	s-l	0.0	0.0	315	2860
2C + La	4.905	1973	1973	solid	0.0	0.0	178	870
3C + 7Mn	6.130	742	742	solid	0.0	0.0	62.1	380
C + 2Mo	7.662	1077	1077	solid	0.0	0.0	62.3	477
2C + 2Na	1.206	733	733	solid	0.0	0.0	137	165
0.98C + Nb	6.522	3182	3182	solid	0.0	0.0	317	2070
C + Nb	9.678	3003	3003	solid	0.0	0.0	321	2060
C + 2Nb	7.328	2634	2634	solid	0.0	0.0	230	1680
C + Si	2.416	1914	1914	solid	0.0	0.0	436	1050
2C + Sr	2.518	1242	1242	solid	0.0	0.0	160	404
C + Ta	11.90	2678	2678	solid	0.0	0.0	179	2120

* More data needed for this calculation.

Table 2a - Intermetallic Reactions (in Alphabetical Order) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
1.94C + Th	8.230	2211	2211	solid	0.0	0.0	138	1140
2C + Th	8.169	3073	3073	solid	0.0	0.0	179	1280
C + Ti	3.754	3644	3523	liquid	0.0	0.0	736	2760
C + U	13.96	1871	1871	solid	0.0	0.0	93.6	1310
2C + U	11.29	1573	1573	solid	0.0	0.0	95.5	1080
C + V	4.499	2121	2121	solid	0.0	0.0	383	1720
C + W	13.20	1259	1259	solid	0.0	0.0	49.0	647
C + Zr	5.276	3800	3800	solid	0.0	0.0	455	2400
Ca + 2Mg	1.649	801	801	solid	0.0	0.0	108	178
2Ca + Pb	4.105	1713	>1475	liquid	0.0	0.0	172	705
Ca + Si	2.490	2504	2504	liquid	0.0	0.0	529	1320
Ca + Sn	3.772	3622	>1272	l or g	0 - 1.5	0 - 1	239	903
2Ca + Sn	2.927	2994	>1407	l or g	0 - .50	0 - 1	377	1100
11Cd + Pu	1.056	843	843	solid	0.0	0.0	31.0	293
Ce + Mg	4.713	1552	*	s-l	0.0	0.0	111	523
2Ce + Pb	8.194	1653	>1652	s-l	0.0	0.0	81.5	665
Ce + 2Si	4.547	2083	*	liquid	0.0	0.0	255	1100
Ce + Zn	6.904	1413	>1098	liquid	0.0	0.0	78.0	535
Co + Si	4.862	1733	>1732	s-l	0.0	0.0	299	1450
Cr + Si	4.316	1231	1231	solid	0.0	0.0	159	684
Cr + 2Si	3.625	1530	1530	solid	0.0	0.0	222	804
3Cr + Si	5.558	1493	1493	solid	0.0	0.0	179	996
5Cr + 3Si	4.900	1671	1671	solid	0.0	0.0	226	1110
Cu + 2Mg	3.199	665	665	solid	0.0	0.0	61.0	195
2Cu + Mg	5.368	721	721	solid	0.0	0.0	52.9	284
Cu + Pd	10.64	873	873	solid	0.0	0.0	44.5	472
Fe + Si	4.564	1659	1659	solid	0.0	0.0	225	1020
Ge + 2Mg	4.123	1678	1391	s-l	0.0	0.0	207	853
2Ge + Nb	6.269	1443	1443	solid	0.0	0.0	84.4	524
Li + Pb	6.848	1258	>754	liquid	0.0	0.0	67.2	460
Li + Sb	4.123	1333	*	liquid	0.0	0.0	170	700
Li + Sn	4.298	1516	*	s-l	0.0	0.0	134	576
Mg + S	2.037	7039	*	*	*	*	1500	3060
3Mg + 2Sb	4.039	1433	1433	solid	0.0	0.0	121	484
Mg + Se	3.398	4817	*	*	*	*	678	2300
2Mg + Si	1.956	1286	1286	solid	0.0	0.0	247	483
2Mg + Sn	3.787	1163	1163	solid	0.0	0.0	113	450
Mg + Te	4.311	4676	*	*	*	*	329	1420
2Mg + Th	5.767	1067	1067	solid	0.0	0.0	54.0	311
Mg + U	9.874	2213	*	liquid	0.0	0.0	157	1570
Mg+ Y	3.343	1943	*	liquid	0.0	0.0	274	912

* More data needed for this calculation.

Table 2a - Intermetallic Reactions (in Alphabetical Order) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Mn + S	2.370	1394	1394	solid	0.0	0.0	164	390
Mn + Si	4.415	1615	>1542	s-l	0.0	0.0	224	989
Mn + 1.7Si	3.846	1433	*	s-l	0.0	0.0	226	847
Mo + 2Si	4.581	1854	1854	solid	0.0	0.0	187	855
Mo + 7Si	3.265	1823	1823	solid	0.0	0.0	206	940
3Mo + Si	7.308	1278	1278	solid	0.0	0.0	76.9	562
5Mo + 3Si	6.476	788	788	solid	0.0	0.0	43.1	279
Na + Sb	3.453	1090	*	liquid	0.0	0.0	110	380
Na + Sn	3.548	1073	1073	solid	0.0	0.0	71.4	254
Nb + Ni	8.695	1083	1083	solid	0.0	0.0	71.0	610
Nb + 2Si	4.463	1897	1897	solid	0.0	0.0	201	898
5Nb + 3Si	6.233	2518	2518	solid	0.0	0.0	222	1390
Ni + Si	4.855	1838	>1265	s-l	0.0	0.0	235	1140
Pd + Sn	8.966	1599	*	s-l	0.0	0.0	112	1000
Pu + 12Zn	8.409	973	973	solid	0.0	0.0	71.3	600
S + Zn	2.419	4144	*	l-g*	0.0	0.0	500	1210
Si + 2Ta	11.79	1836	1836	solid	0.0	0.0	76.9	907
2Si + Ta	7.086	1781	1781	solid	0.0	0.0	120	8510
3Si + 5Ta	11.19	920	920	solid	0.0	0.0	80.9	906
2Si + Th	6.659	2323	2323	solid	0.0	0.0	144	961
2Si + Ti	3.134	1913	>1772	s-l	0.0	0.0	308	967
3Si + 5Ti	3.719	2548	>2402	s-l	0.0	0.0	428	1590
2Si + U	8.369	1663	1663	solid	0.0	0.0	106	940
2Si + V	3.429	3341	2023	s-l	0.0	0.0	700	2400
2Si + W	7.480	1549	1549	solid	0.0	0.0	92.6	693
Si + Y	3.754	2108	*	s-l	0.0	0.0	275	1000
Si + 2Zr	5.291	2787	>2197	liquid	0.0	0.0	236	1250
2Si + Zr	4.004	1988	1893	liquid	0.0	0.0	258	1040
3Si + 5Zr	5.141	1132	1132	solid	0.0	0.0	255	1310
2U + 17Zn	8.778	973	973	solid	0.0	0.0	60.0	530
2Zn + Zr	6.816	1723	*	l-s	0.0	0.0	170	1160

* More data needed for this calculation.

Table 2b - Intermetallic Reactions (in Descending Order of Reactant Mixture Density)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
C + U	13.96	1871	1871	solid	0.0	0.0	93.6	1310
C + W	13.20	1259	1259	solid	0.0	0.0	49.0	647
2B + U	12.22	1335	1335	solid	0.0	0.0	149	1820
C + Ta	11.90	2678	2678	solid	0.0	0.0	179	2120
Si + 2Ta	11.79	1836	1836	solid	0.0	0.0	76.9	907
Al + Pt	11.63	3379	3073	liquid	0.0	0.0	216	2510
2C + U	11.29	1573	1573	solid	0.0	0.0	95.5	1080
3Si + 5Ta	11.19	920	920	solid	0.0	0.0	80.9	906
Cu + Pd	10.64	873	873	solid	0.0	0.0	44.5	472
5B + 2W	10.37	1233	1233	solid	0.0	0.0	83.0	1350
2B + Ta	10.36	2766	2766	solid	0.0	0.0	247	2560
Al + Ta	9.952	1011	1011	solid	0.0	0.0	56.7	564
Mg + U	9.874	2213	*	liquid	0.0	0.0	157	1570
C + Nb	9.678	3003	3003	solid	0.0	0.0	321	2060
4B + U	9.407	2124	2124	solid	0.0	0.0	209	1960
C +Hf	9.084	4441	>4222	s-l	0.0	0.0	315	2860
Pd + Sn	8.966	1599	*	s-l	0.0	0.0	112	1000
2U + 17Zn	8.778	973	973	solid	0.0	0.0	60.0	530
Nb + Ni	8.695	1083	1083	solid	0.0	0.0	71.0	610
Pu + 12Zn	8.409	973	973	solid	0.0	0.0	71.3	600
2Si + U	8.369	1663	1663	solid	0.0	0.0	106	940
2B + Hf	8.232	3945	3653	liquid	0.0	0.0	401	3300
1.94C + Th	8.230	2211	2211	solid	0.0	0.0	138	1140
2Ce + Pb	8.194	1653	>1652	s-l	0.0	0.0	81.5	665
2C + Th	8.169	3073	3073	solid	0.0	0.0	179	1280
C + 2Mo	7.662	1077	1077	solid	0.0	0.0	62.3	477
2Si + W	7.480	1549	1549	solid	0.0	0.0	92.6	693
C + 2Nb	7.328	2634	2634	solid	0.0	0.0	230	1680
3Mo + Si	7.308	1278	1278	solid	0.0	0.0	76.9	562
4B + Th	7.240	1823	1823	solid	0.0	0.0	189	1360
2Si + Ta	7.086	1781	1781	solid	0.0	0.0	120	8510
Al + Pd	7.072	2725	2653	liquid	0.0	0.0	327	2890
Ce + Zn	6.904	1413	>1098	liquid	0.0	0.0	78.0	535
Li + Pb	6.848	1258	>754	liquid	0.0	0.0	67.2	460
Al + 3Ni	6.820	1524	1524	solid	0.0	0.0	180	1230
2Zn + Zr	6.816	1723	*	l-s	0.0	0.0	170	1160
4Al + Pu	6.708	1403	1403	solid	0.0	0.0	123	820
2Si + Th	6.659	2323	2323	solid	0.0	0.0	144	961
4Al + U	6.582	1205	*	liquid	0.0	0.0	89.8	591
0.98C + Nb	6.522	3182	3182	solid	0.0	0.0	317	2070
5Mo + 3Si	6.476	788	788	solid	0.0	0.0	43.1	279

* More data needed for this calculation.

Table 2b - Intermetallic Reactions (in Descending Order of Reactant Mixture Density) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
3Al + Ta	6.407	665	665	solid	0.0	0.0	35.9	230
Bi + Li	6.319	1273	>689	liquid	0.0	0.0	85.5	535
2Ge + Nb	6.269	1443	1443	solid	0.0	0.0	84.4	524
5Nb + 3Si	6.233	2518	2518	solid	0.0	0.0	222	1390
3C + 7Mn	6.130	742	742	solid	0.0	0.0	62.1	380
2B + Mo	6.091	1533	1533	solid	0.0	0.0	196	1280
3C + 7Cr	5.978	1175	1175	solid	0.0	0.0	136	813
2B + Nb	5.875	2793	2793	solid	0.0	0.0	524	3080
2Mg + Th	5.767	1067	1067	solid	0.0	0.0	54.0	311
3Cr + Si	5.558	1493	1493	solid	0.0	0.0	179	996
2Cu + Mg	5.368	721	721	solid	0.0	0.0	52.9	284
Al + Cu	5.294	935	935	solid	0.0	0.0	108	573
Si + 2Zr	5.291	2787	>2197	liquid	0.0	0.0	236	1250
C + Zr	5.276	3800	3800	solid	0.0	0.0	455	2400
2C + Ce	5.201	1779	1779	solid	0.0	0.0	170	884
3Ba + 2Bi	5.185	1673	*	liquid	0.0	0.0	87.3	169
Al + Co	5.171	2195	>1912	s-l	0.0	0.0	307	1590
Al + Ni	5.165	2362	>1910	s-l	0.0	0.0	330	1710
3Si + 5Zr	5.141	1132	1132	solid	0.0	0.0	255	1310
2B + Zr	4.926	3783	3673	liquid	0.0	0.0	683	3360
2C + La	4.905	1973	1973	solid	0.0	0.0	178	870
5Cr + 3Si	4.900	1671	1671	solid	0.0	0.0	226	1110
Co + Si	4.862	1733	>1732	s-l	0.0	0.0	299	1450
Ni + Si	4.855	1838	>1265	s-l	0.0	0.0	235	1140
Al + Fe	4.844	1423	1423	solid	0.0	0.0	211	1020
13Be + Pu	4.756	723	723	solid	0.0	0.0	100	476
B + V	4.749	2574	2574	solid	0.0	0.0	536	2540
2B + Mn	4.732	1386	1386	solid	0.0	0.0	294	1390
Ce + Mg	4.713	1552	*	s-l	0.0	0.0	111	523
6B + Sm	4.684	1233	1233	solid	0.0	0.0	232	1050
13Be + U	4.679	773	773	solid	0.0	0.0	110	513
Al + Mn	4.676	803	803	solid	0.0	0.0	124	586
2B + Cr	4.622	1571	1571	solid	0.0	0.0	306	1410
Mo + 2Si	4.581	1854	1854	solid	0.0	0.0	187	855
Fe + Si	4.564	1659	1659	solid	0.0	0.0	225	1020
Ce + 2Si	4.547	2083	*	liquid	0.0	0.0	255	1100
C + V	4.499	2121	2121	solid	0.0	0.0	383	1720
Nb + 2Si	4.463	1897	1897	solid	0.0	0.0	201	898
Mn + Si	4.415	1615	>1542	s-l	0.0	0.0	224	989
6B + Ce	4.374	2388	2388	solid	0.0	0.0	395	1730
Cr + Si	4.316	1231	1231	solid	0.0	0.0	159	684

* More data needed for this calculation.

Table 2b - Intermetallic Reactions (in Descending Order of Reactant Mixture Density) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Mg + Te	4.311	4676	*	*	*	*	329	1420
Li + Sn	4.298	1516	*	s-l	0.0	0.0	134	576
3Ba + 2Sb	4.252	1833	*	liquid	*	*	133	563
2Al + Zr	4.240	1923	*	l-s	*	*	267	1130
6B + La	4.198	2503	*	l-s	0.0	0.0	560	2350
2B + V	4.187	2960	2960	s-l	0.0	0.0	671	2810
2Ba + Sn	4.153	2398	*	l-g	0 - .25	0 - 1	240	1000
Ge + 2Mg	4.123	1678	1391	s-l	0.0	0.0	207	853
Li + Sb	4.123	1333	*	liquid	0.0	0.0	170	700
2Ca + Pb	4.105	1713	>1475	liquid	0.0	0.0	172	705
4Al + Ce	4.095	1173	1173	solid	0.0	0.0	126	458
4Al + Pr	4.094	1703	*	s-l	0.0	0.0	216	800
Al + 3Ti	4.071	*	*	*	*	*	138	560
3Mg + 2Sb	4.039	1433	1433	solid	0.0	0.0	121	484
2Ba + Pb	4.025	1913	>1200	l-g	0 - .21	0 - 1	143	576
2Si + Zr	4.004	1988	1893	liquid	0.0	0.0	258	1040
5Al + 2Co	3.999	1755	>1452	s-l	0.0	0.0	277	1110
4Al + La	3.946	1495	*	s-l	0.0	0.0	166	780
B + Ti	3.922	3559	>2452	l or g	0 - 1.7	0 - 1	652	2560
5Be + Nb	3.920	1663	1663	solid	0.0	0.0	336	1300
Mn + 1.7Si	3.846	1433	*	s-l	0.0	0.0	226	847
2Mg + Sn	3.787	1163	1163	solid	0.0	0.0	113	450
Ca + Sn	3.772	3622	>1272	l or g	0 - 1.5	0 - 1	239	903
C + Ti	3.754	3644	3523	liquid	0.0	0.0	736	2760
Si + Y	3.754	2108	*	s-l	0.0	0.0	275	1000
Bi + K	3.723	1253	*	liquid	0.0	0.0	55	204
3Si + 5Ti	3.719	2548	>2402	s-l	0.0	0.0	428	1590
3Al + Fe	3.688	1407	1407	solid	0.0	0.0	278	1020
Al + Ti	3.628	1597	1597	solid	0.0	0.0	240	872
Cr + 2Si	3.625	1530	1530	solid	0.0	0.0	222	804
2B + Ti	3.603	3710	3498	liquid	0.0	0.0	1320	5170
4Al + Co	3.581	*	*	*	*	*	231	637
3Al + Cr	3.568	793	793	solid	0.0	0.0	120	430
Na + Sn	3.548	1073	1073	solid	0.0	0.0	71.4	254
Na + Sb	3.453	1090	*	liquid	0.0	0.0	110	380
3Al + 2Ti	3.448	*	*	*	*	*	158	544
2Si + V	3.429	3341	2023	s-l	0.0	0.0	700	2400
3Al + V	3.412	1023	1023	solid	0.0	0.0	198	792
Mg + Se	3.398	4817	*	*	*	*	678	2300
6B + Y	3.354	973	973	solid	0.0	0.0	156	503
Mg+ Y	3.343	1943	*	liquid	0.0	0.0	274	912

* More data needed for this calculation.

Table 2b - Intermetallic Reactions (in Descending Order of Reactant Mixture Density) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2Al + Ti	3.326	1643	*	l-s	*	*	314	1100
Mo + 7Si	3.265	1823	1823	solid	0.0	0.0	206	940
Ba + 2C	3.236	1466	1466	solid	0.0	0.0	111	359
Cu + 2Mg	3.199	665	665	solid	0.0	0.0	61.0	195
3Al + Ti	3.172	1591	1591	solid	0.0	0.0	272	862
2Si + Ti	3.134	1913	>1772	s-l	0.0	0.0	308	967
2Ca + Sn	2.927	2994	>1407	l or g	0 - .50	0 - 1	377	1100
Al + 2B	2.607	2251	>1252	l-g	0 - 2.1	0 - 1	742	1940
4Al + 3C	2.574	1673	1673	solid	0.0	0.0	371	965
2C + Sr	2.518	1242	1242	solid	0.0	0.0	160	404
6B + Si	2.497	503	503	solid	0.0	0.0	76.4	177
Ca + Si	2.490	2504	2504	liquid	0.0	0.0	529	1320
4B + C	2.444	1202	1202	solid	0.0	0.0	308	751
S + Zn	2.419	4144	*	l-g*	0.0	0.0	500	1210
C + Si	2.416	1914	1914	solid	0.0	0.0	436	1050
Mn + S	2.370	1394	1394	solid	0.0	0.0	164	390
4Al + Ca	2.248	1880	>972	s-l	0.0	0.0	348	782
6B + Mg	2.234	918	918	solid	0.0	0.0	251	600
Be + 2C	2.131	3043	*	l-g	0 - .33	0 - 1	1750	3720
2Al + 3S	2.102	*	*	*	0.0	0.0	800	1680
Bi + 3K	2.071	1791	*	liquid?	*	*	127	263
2Al + Ca	2.051	2836	1738	liquid	0.0	0.0	558	1140
Mg + S	2.037	7039	*	*	*	*	1500	3060
2B + Mg	2.031	1706	1706	dec	0.0	0.0	479	972
2Be + C	1.995	1932	1932	solid	0.0	0.0	931	1860
2Mg + Si	1.956	1286	1286	solid	0.0	0.0	247	483
2C + Ca	1.757	1113	1113	solid	0.0	0.0	223	392
Ca + 2Mg	1.649	801	801	solid	0.0	0.0	108	178
Al + Li	1.476	1160	>972	s-l	0.0	0.0	345	509
2C + 2Na	1.206	733	733	solid	0.0	0.0	137	165
11Cd + Pu	1.056	843	843	solid	0.0	0.0	31.0	293

* More data needed for this calculation.

Table 2c - Intermetallic Reactions (in Descending Order of Heat of Reaction per Unit Mass)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Be + 2C	2.131	3043	*	l-g	0 - .33	0 - 1	1750	3720
Mg + S	2.037	7039	*	*	*	*	1500	3060
2B + Ti	3.603	3710	3498	liquid	0.0	0.0	1320	5170
2Be + C	1.995	1932	1932	solid	0.0	0.0	931	1860
2Al + 3S	2.102	*	*	*	0.0	0.0	800	1680
Al + 2B	2.607	2251	>1252	l-g	0 - 2.1	0 - 1	742	1940
C + Ti	3.754	3644	3523	liquid	0.0	0.0	736	2760
2Si + V	3.429	3341	2023	s-l	0.0	0.0	700	2400
2B + Zr	4.926	3783	3673	liquid	0.0	0.0	683	3360
Mg + Se	3.398	4817	*	*	*	*	678	2300
2B + V	4.187	2960	2960	s-l	0.0	0.0	671	2810
B + Ti	3.922	3559	>2452	l or g	0 - 1.7	0 - 1	652	2560
6B + La	4.198	2503	*	l-s	0.0	0.0	560	2350
2Al + Ca	2.051	2836	1738	liquid	0.0	0.0	558	1140
B + V	4.749	2574	2574	solid	0.0	0.0	536	2540
Ca + Si	2.490	2504	2504	liquid	0.0	0.0	529	1320
2B + Nb	5.875	2793	2793	solid	0.0	0.0	524	3080
S + Zn	2.419	4144	*	l-g*	0.0	0.0	500	1210
2B + Mg	2.031	1706	1706	dec	0.0	0.0	479	972
C + Zr	5.276	3800	3800	solid	0.0	0.0	455	2400
C + Si	2.416	1914	1914	solid	0.0	0.0	436	1050
3Si + 5Ti	3.719	2548	>2402	s-l	0.0	0.0	428	1590
2B + Hf	8.232	3945	3653	liquid	0.0	0.0	401	3300
6B + Ce	4.374	2388	2388	solid	0.0	0.0	395	1730
C + V	4.499	2121	2121	solid	0.0	0.0	383	1720
2Ca + Sn	2.927	2994	>1407	l or g	0 - .50	0 - 1	377	1100
4Al + 3C	2.574	1673	1673	solid	0.0	0.0	371	965
4Al + Ca	2.248	1880	>972	s-l	0.0	0.0	348	782
Al + Li	1.476	1160	>972	s-l	0.0	0.0	345	509
5Be + Nb	3.920	1663	1663	solid	0.0	0.0	336	1300
Al + Ni	5.165	2362	>1910	s-l	0.0	0.0	330	1710
Mg + Te	4.311	4676	*	*	*	*	329	1420
Al + Pd	7.072	2725	2653	liquid	0.0	0.0	327	2890
C + Nb	9.678	3003	3003	solid	0.0	0.0	321	2060
0.98C + Nb	6.522	3182	3182	solid	0.0	0.0	317	2070
C +Hf	9.084	4441	>4222	s-l	0.0	0.0	315	2860
2Al + Ti	3.326	1643	*	l-s	*	*	314	1100
4B + C	2.444	1202	1202	solid	0.0	0.0	308	751
2Si + Ti	3.134	1913	>1772	s-l	0.0	0.0	308	967
Al + Co	5.171	2195	>1912	s-l	0.0	0.0	307	1590
2B + Cr	4.622	1571	1571	solid	0.0	0.0	306	1410

* More data needed for this calculation.

Table 2c - Intermetallic Reactions (in Descending Order of Heat of Reaction per Unit Mass) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Co + Si	4.862	1733	>1732	s-l	0.0	0.0	299	1450
2B + Mn	4.732	1386	1386	solid	0.0	0.0	294	1390
3Al + Fe	3.688	1407	1407	solid	0.0	0.0	278	1020
5Al + 2Co	3.999	1755	>1452	s-l	0.0	0.0	277	1110
Si + Y	3.754	2108	*	s-l	0.0	0.0	275	1000
Mg+ Y	3.343	1943	*	liquid	0.0	0.0	274	912
3Al + Ti	3.172	1591	1591	solid	0.0	0.0	272	862
2Al + Zr	4.240	1923	*	l-s	*	*	267	1130
2Si + Zr	4.004	1988	1893	liquid	0.0	0.0	258	1040
Ce + 2Si	4.547	2083	*	liquid	0.0	0.0	255	1100
3Si + 5Zr	5.141	1132	1132	solid	0.0	0.0	255	1310
6B + Mg	2.234	918	918	solid	0.0	0.0	251	600
2B + Ta	10.36	2766	2766	solid	0.0	0.0	247	2560
2Mg + Si	1.956	1286	1286	solid	0.0	0.0	247	483
Al + Ti	3.628	1597	1597	solid	0.0	0.0	240	872
2Ba + Sn	4.153	2398	*	l-g	0 - .25	0 - 1	240	1000
Ca + Sn	3.772	3622	>1272	l or g	0 - 1.5	0 - 1	239	903
Si + 2Zr	5.291	2787	>2197	liquid	0.0	0.0	236	1250
Ni + Si	4.855	1838	>1265	s-l	0.0	0.0	235	1140
6B + Sm	4.684	1233	1233	solid	0.0	0.0	232	1050
4Al + Co	3.581	*	*	*	*	*	231	637
C + 2Nb	7.328	2634	2634	solid	0.0	0.0	230	1680
5Cr + 3Si	4.900	1671	1671	solid	0.0	0.0	226	1110
Mn + 1.7Si	3.846	1433	*	s-l	0.0	0.0	226	847
Fe + Si	4.564	1659	1659	solid	0.0	0.0	225	1020
Mn + Si	4.415	1615	>1542	s-l	0.0	0.0	224	989
2C + Ca	1.757	1113	1113	solid	0.0	0.0	223	392
Cr + 2Si	3.625	1530	1530	solid	0.0	0.0	222	804
5Nb + 3Si	6.233	2518	2518	solid	0.0	0.0	222	1390
4Al + Pr	4.094	1703	*	s-l	0.0	0.0	216	800
Al + Pt	11.63	3379	3073	liquid	0.0	0.0	216	2510
Al + Fe	4.844	1423	1423	solid	0.0	0.0	211	1020
4B + U	9.407	2124	2124	solid	0.0	0.0	209	1960
Ge + 2Mg	4.123	1678	1391	s-l	0.0	0.0	207	853
Mo + 7Si	3.265	1823	1823	solid	0.0	0.0	206	940
Nb + 2Si	4.463	1897	1897	solid	0.0	0.0	201	898
3Al + V	3.412	1023	1023	solid	0.0	0.0	198	792
2B + Mo	6.091	1533	1533	solid	0.0	0.0	196	1280
4B + Th	7.240	1823	1823	solid	0.0	0.0	189	1360
Mo + 2Si	4.581	1854	1854	solid	0.0	0.0	187	855
Al + 3Ni	6.820	1524	1524	solid	0.0	0.0	180	1230

* More data needed for this calculation.

Table 2c - Intermetallic Reactions (in Descending Order of Heat of Reaction per Unit Mass) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
C + Ta	11.90	2678	2678	solid	0.0	0.0	179	2120
2C + Th	8.169	3073	3073	solid	0.0	0.0	179	1280
3Cr + Si	5.558	1493	1493	solid	0.0	0.0	179	996
2C + La	4.905	1973	1973	solid	0.0	0.0	178	870
2Ca + Pb	4.105	1713	>1475	liquid	0.0	0.0	172	705
2C + Ce	5.201	1779	1779	solid	0.0	0.0	170	884
Li + Sb	4.123	1333	*	liquid	0.0	0.0	170	700
2Zn + Zr	6.816	1723	*	l-s	0.0	0.0	170	1160
4Al + La	3.946	1495	*	s-l	0.0	0.0	166	780
Mn + S	2.370	1394	1394	solid	0.0	0.0	164	390
2C + Sr	2.518	1242	1242	solid	0.0	0.0	160	404
Cr + Si	4.316	1231	1231	solid	0.0	0.0	159	684
3Al + 2Ti	3.448	*	*	*	*	*	158	544
Mg + U	9.874	2213	*	liquid	0.0	0.0	157	1570
6B + Y	3.354	973	973	solid	0.0	0.0	156	503
2B + U	12.22	1335	1335	solid	0.0	0.0	149	1820
2Si + Th	6.659	2323	2323	solid	0.0	0.0	144	961
2Ba + Pb	4.025	1913	>1200	l-g	0 - .21	0 - 1	143	576
Al + 3Ti	4.071	*	*	*	*	*	138	560
1.94C + Th	8.230	2211	2211	solid	0.0	0.0	138	1140
2C + 2Na	1.206	733	733	solid	0.0	0.0	137	165
3C + 7Cr	5.978	1175	1175	solid	0.0	0.0	136	813
Li + Sn	4.298	1516	*	s-l	0.0	0.0	134	576
3Ba + 2Sb	4.252	1833	*	liquid	*	*	133	563
Bi + 3K	2.071	1791	*	liquid?	*	*	127	263
4Al + Ce	4.095	1173	1173	solid	0.0	0.0	126	458
Al + Mn	4.676	803	803	solid	0.0	0.0	124	586
4Al + Pu	6.708	1403	1403	solid	0.0	0.0	123	820
3Mg + 2Sb	4.039	1433	1433	solid	0.0	0.0	121	484
3Al + Cr	3.568	793	793	solid	0.0	0.0	120	430
2Si + Ta	7.086	1781	1781	solid	0.0	0.0	120	8510
2Mg + Sn	3.787	1163	1163	solid	0.0	0.0	113	450
Pd + Sn	8.966	1599	*	s-l	0.0	0.0	112	1000
Ba + 2C	3.236	1466	1466	solid	0.0	0.0	111	359
Ce + Mg	4.713	1552	*	s-l	0.0	0.0	111	523
13Be + U	4.679	773	773	solid	0.0	0.0	110	513
Na + Sb	3.453	1090	*	liquid	0.0	0.0	110	380
Al + Cu	5.294	935	935	solid	0.0	0.0	108	573
Ca + 2Mg	1.649	801	801	solid	0.0	0.0	108	178
2Si + U	8.369	1663	1663	solid	0.0	0.0	106	940
13Be + Pu	4.756	723	723	solid	0.0	0.0	100	476

* More data needed for this calculation.

Table 2c - Intermetallic Reactions (in Descending Order of Heat of Reaction per Unit Mass) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2C + U	11.29	1573	1573	solid	0.0	0.0	95.5	1080
C + U	13.96	1871	1871	solid	0.0	0.0	93.6	1310
2Si + W	7.480	1549	1549	solid	0.0	0.0	92.6	693
4Al + U	6.582	1205	*	liquid	0.0	0.0	89.8	591
3Ba + 2Bi	5.185	1673	*	liquid	0.0	0.0	87.3	169
Bi + Li	6.319	1273	>689	liquid	0.0	0.0	85.5	535
2Ge + Nb	6.269	1443	1443	solid	0.0	0.0	84.4	524
5B + 2W	10.37	1233	1233	solid	0.0	0.0	83.0	1350
2Ce + Pb	8.194	1653	>1652	s-l	0.0	0.0	81.5	665
3Si + 5Ta	11.19	920	920	solid	0.0	0.0	80.9	906
Ce + Zn	6.904	1413	>1098	liquid	0.0	0.0	78.0	535
3Mo + Si	7.308	1278	1278	solid	0.0	0.0	76.9	562
Si + 2Ta	11.79	1836	1836	solid	0.0	0.0	76.9	907
6B + Si	2.497	503	503	solid	0.0	0.0	76.4	177
Na + Sn	3.548	1073	1073	solid	0.0	0.0	71.4	254
Pu + 12Zn	8.409	973	973	solid	0.0	0.0	71.3	600
Nb + Ni	8.695	1083	1083	solid	0.0	0.0	71.0	610
Li + Pb	6.848	1258	>754	liquid	0.0	0.0	67.2	460
C + 2Mo	7.662	1077	1077	solid	0.0	0.0	62.3	477
3C + 7Mn	6.130	742	742	solid	0.0	0.0	62.1	380
Cu + 2Mg	3.199	665	665	solid	0.0	0.0	61.0	195
2U + 17Zn	8.778	973	973	solid	0.0	0.0	60.0	530
Al + Ta	9.952	1011	1011	solid	0.0	0.0	56.7	564
Bi + K	3.723	1253	*	liquid	0.0	0.0	55.0	204
2Mg + Th	5.767	1067	1067	solid	0.0	0.0	54.0	311
2Cu + Mg	5.368	721	721	solid	0.0	0.0	52.9	284
C + W	13.20	1259	1259	solid	0.0	0.0	49.0	647
Cu + Pd	10.64	873	873	solid	0.0	0.0	44.5	472
5Mo + 3Si	6.476	788	788	solid	0.0	0.0	43.1	279
3Al + Ta	6.407	665	665	solid	0.0	0.0	35.9	230
11Cd + Pu	1.056	843	843	solid	0.0	0.0	31.0	293

* More data needed for this calculation.

Table 2d - Intermetallic Reactions (in Descending Order of Heat of Reaction per Unit Volume)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2Si + Ta	7.086	1781	1781	solid	0.0	0.0	120	8510
2B + Ti	3.603	3710	3498	liquid	0.0	0.0	1320	5170
Be + 2C	2.131	3043	*	l-g	0 - .33	0 - 1	1750	3720
2B + Zr	4.926	3783	3673	liquid	0.0	0.0	683	3360
2B + Hf	8.232	3945	3653	liquid	0.0	0.0	401	3300
2B + Nb	5.875	2793	2793	solid	0.0	0.0	524	3080
Mg + S	2.037	7039	*	*	*	*	1500	3060
Al + Pd	7.072	2725	2653	liquid	0.0	0.0	327	2890
C +Hf	9.084	4441	>4222	s-l	0.0	0.0	315	2860
2B + V	4.187	2960	2960	s-l	0.0	0.0	671	2810
C + Ti	3.754	3644	3523	liquid	0.0	0.0	736	2760
2B + Ta	10.36	2766	2766	solid	0.0	0.0	247	2560
B + Ti	3.922	3559	>2452	l or g	0 - 1.7	0 - 1	652	2560
B + V	4.749	2574	2574	solid	0.0	0.0	536	2540
Al + Pt	11.63	3379	3073	liquid	0.0	0.0	216	2510
C + Zr	5.276	3800	3800	solid	0.0	0.0	455	2400
2Si + V	3.429	3341	2023	s-l	0.0	0.0	700	2400
6B + La	4.198	2503	*	l-s	0.0	0.0	560	2350
Mg + Se	3.398	4817	*	*	*	*	678	2300
C + Ta	11.90	2678	2678	solid	0.0	0.0	179	2120
0.98C + Nb	6.522	3182	3182	solid	0.0	0.0	317	2070
C + Nb	9.678	3003	3003	solid	0.0	0.0	321	2060
4B + U	9.407	2124	2124	solid	0.0	0.0	209	1960
Al + 2B	2.607	2251	>1252	l-g	0 - 2.1	0 - 1	742	1940
2Be + C	1.995	1932	1932	solid	0.0	0.0	931	1860
2B + U	12.22	1335	1335	solid	0.0	0.0	149	1820
6B + Ce	4.374	2388	2388	solid	0.0	0.0	395	1730
C + V	4.499	2121	2121	solid	0.0	0.0	383	1720
Al + Ni	5.165	2362	>1910	s-l	0.0	0.0	330	1710
2Al + 3S	2.102	*	*	*	0.0	0.0	800	1680
C + 2Nb	7.328	2634	2634	solid	0.0	0.0	230	1680
Al + Co	5.171	2195	>1912	s-l	0.0	0.0	307	1590
3Si + 5Ti	3.719	2548	>2402	s-l	0.0	0.0	428	1590
Mg + U	9.874	2213	*	liquid	0.0	0.0	157	1570
Co + Si	4.862	1733	>1732	s-l	0.0	0.0	299	1450
Mg + Te	4.311	4676	*	*	*	*	329	1420
2B + Cr	4.622	1571	1571	solid	0.0	0.0	306	1410
2B + Mn	4.732	1386	1386	solid	0.0	0.0	294	1390
5Nb + 3Si	6.233	2518	2518	solid	0.0	0.0	222	1390
4B + Th	7.240	1823	1823	solid	0.0	0.0	189	1360
5B + 2W	10.37	1233	1233	solid	0.0	0.0	83.0	1350

* More data needed for this calculation.

Table 2d - Intermetallic Reactions (in Descending Order of Heat of Reaction per Unit Volume) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Ca + Si	2.490	2504	2504	liquid	0.0	0.0	529	1320
C + U	13.96	1871	1871	solid	0.0	0.0	93.6	1310
3Si + 5Zr	5.141	1132	1132	solid	0.0	0.0	255	1310
5Be + Nb	3.920	1663	1663	solid	0.0	0.0	336	1300
2B + Mo	6.091	1533	1533	solid	0.0	0.0	196	1280
2C + Th	8.169	3073	3073	solid	0.0	0.0	179	1280
Si + 2Zr	5.291	2787	>2197	liquid	0.0	0.0	236	1250
Al + 3Ni	6.820	1524	1524	solid	0.0	0.0	180	1230
S + Zn	2.419	4144	*	l-g*	0.0	0.0	500	1210
2Zn + Zr	6.816	1723	*	l-s	0.0	0.0	170	1160
2Al + Ca	2.051	2836	1738	liquid	0.0	0.0	558	1140
1.94C + Th	8.230	2211	2211	solid	0.0	0.0	138	1140
Ni + Si	4.855	1838	>1265	s-l	0.0	0.0	235	1140
2Al + Zr	4.240	1923	*	l-s	*	*	267	1130
5Al + 2Co	3.999	1755	>1452	s-l	0.0	0.0	277	1110
5Cr + 3Si	4.900	1671	1671	solid	0.0	0.0	226	1110
2Al + Ti	3.326	1643	*	l-s	*	*	314	1100
2Ca + Sn	2.927	2994	>1407	l or g	0 - .50	0 - 1	377	1100
Ce + 2Si	4.547	2083	*	liquid	0.0	0.0	255	1100
2C + U	11.29	1573	1573	solid	0.0	0.0	95.5	1080
6B + Sm	4.684	1233	1233	solid	0.0	0.0	232	1050
C + Si	2.416	1914	1914	solid	0.0	0.0	436	1050
2Si + Zr	4.004	1988	1893	liquid	0.0	0.0	258	1040
Al + Fe	4.844	1423	1423	solid	0.0	0.0	211	1020
3Al + Fe	3.688	1407	1407	solid	0.0	0.0	278	1020
Fe + Si	4.564	1659	1659	solid	0.0	0.0	225	1020
2Ba + Sn	4.153	2398	*	l-g	0 - .25	0 - 1	240	1000
Pd + Sn	8.966	1599	*	s-l	0.0	0.0	112	1000
Si + Y	3.754	2108	*	s-l	0.0	0.0	275	1000
3Cr + Si	5.558	1493	1493	solid	0.0	0.0	179	996
Mn + Si	4.415	1615	>1542	s-l	0.0	0.0	224	989
2B + Mg	2.031	1706	1706	dec	0.0	0.0	479	972
2Si + Ti	3.134	1913	>1772	s-l	0.0	0.0	308	967
4Al + 3C	2.574	1673	1673	solid	0.0	0.0	371	965
2Si + Th	6.659	2323	2323	solid	0.0	0.0	144	961
Mo + 7Si	3.265	1823	1823	solid	0.0	0.0	206	940
2Si + U	8.369	1663	1663	solid	0.0	0.0	106	940
Mg+ Y	3.343	1943	*	liquid	0.0	0.0	274	912
Si + 2Ta	11.79	1836	1836	solid	0.0	0.0	76.9	907
3Si + 5Ta	11.19	920	920	solid	0.0	0.0	80.9	906
Ca + Sn	3.772	3622	>1272	l or g	0 - 1.5	0 - 1	239	903

* More data needed for this calculation.

Table 2d - Intermetallic Reactions (in Descending Order of Heat of Reaction per Unit Volume) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Nb + 2Si	4.463	1897	1897	solid	0.0	0.0	201	898
2C + Ce	5.201	1779	1779	solid	0.0	0.0	170	884
Al + Ti	3.628	1597	1597	solid	0.0	0.0	240	872
2C + La	4.905	1973	1973	solid	0.0	0.0	178	870
3Al + Ti	3.172	1591	1591	solid	0.0	0.0	272	862
Mo + 2Si	4.581	1854	1854	solid	0.0	0.0	187	855
Ge + 2Mg	4.123	1678	1391	s-l	0.0	0.0	207	853
Mn + 1.7Si	3.846	1433	*	s-l	0.0	0.0	226	847
4Al + Pu	6.708	1403	1403	solid	0.0	0.0	123	820
3C + 7Cr	5.978	1175	1175	solid	0.0	0.0	136	813
Cr + 2Si	3.625	1530	1530	solid	0.0	0.0	222	804
4Al + Pr	4.094	1703	*	s-l	0.0	0.0	216	800
3Al + V	3.412	1023	1023	solid	0.0	0.0	198	792
4Al + Ca	2.248	1880	>972	s-l	0.0	0.0	348	782
4Al + La	3.946	1495	*	s-l	0.0	0.0	166	780
4B + C	2.444	1202	1202	solid	0.0	0.0	308	751
2Ca + Pb	4.105	1713	>1475	liquid	0.0	0.0	172	705
Li + Sb	4.123	1333	*	liquid	0.0	0.0	170	700
2Si + W	7.480	1549	1549	solid	0.0	0.0	92.6	693
Cr + Si	4.316	1231	1231	solid	0.0	0.0	159	684
2Ce + Pb	8.194	1653	>1652	s-l	0.0	0.0	81.5	665
C + W	13.20	1259	1259	solid	0.0	0.0	49.0	647
4Al + Co	3.581	*	*	*	*	*	231	637
Nb + Ni	8.695	1083	1083	solid	0.0	0.0	71.0	610
6B + Mg	2.234	918	918	solid	0.0	0.0	251	600
Pu + 12Zn	8.409	973	973	solid	0.0	0.0	71.3	600
4Al + U	6.582	1205	*	liquid	0.0	0.0	89.8	591
Al + Mn	4.676	803	803	solid	0.0	0.0	124	586
2Ba + Pb	4.025	1913	>1200	l-g	0 - .21	0 - 1	143	576
Li + Sn	4.298	1516	*	s-l	0.0	0.0	134	576
Al + Cu	5.294	935	935	solid	0.0	0.0	108	573
Al + Ta	9.952	1011	1011	solid	0.0	0.0	56.7	564
3Ba + 2Sb	4.252	1833	*	liquid	*	*	133	563
3Mo + Si	7.308	1278	1278	solid	0.0	0.0	76.9	562
Al + 3Ti	4.071	*	*	*	*	*	138	560
3Al + 2Ti	3.448	*	*	*	*	*	158	544
Bi + Li	6.319	1273	>689	liquid	0.0	0.0	85.5	535
Ce + Zn	6.904	1413	>1098	liquid	0.0	0.0	78.0	535
2U + 17Zn	8.778	973	973	solid	0.0	0.0	60.0	530
2Ge + Nb	6.269	1443	1443	solid	0.0	0.0	84.4	524
Ce + Mg	4.713	1552	*	s-l	0.0	0.0	111	523

* More data needed for this calculation.

Table 2d - Intermetallic Reactions (in Descending Order of Heat of Reaction per Unit Volume) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
13Be + U	4.679	773	773	solid	0.0	0.0	110	513
Al + Li	1.476	1160	>972	s-l	0.0	0.0	345	509
6B + Y	3.354	973	973	solid	0.0	0.0	156	503
3Mg + 2Sb	4.039	1433	1433	solid	0.0	0.0	121	484
2Mg + Si	1.956	1286	1286	solid	0.0	0.0	247	483
C + 2Mo	7.662	1077	1077	solid	0.0	0.0	62.3	477
13Be + Pu	4.756	723	723	solid	0.0	0.0	100	476
Cu + Pd	10.64	873	873	solid	0.0	0.0	44.5	472
Li + Pb	6.848	1258	>754	liquid	0.0	0.0	67.2	460
4Al + Ce	4.095	1173	1173	solid	0.0	0.0	126	458
2Mg + Sn	3.787	1163	1163	solid	0.0	0.0	113	450
3Al + Cr	3.568	793	793	solid	0.0	0.0	120	430
2C + Sr	2.518	1242	1242	solid	0.0	0.0	160	404
2C + Ca	1.757	1113	1113	solid	0.0	0.0	223	392
Mn + S	2.370	1394	1394	solid	0.0	0.0	164	390
3C + 7Mn	6.130	742	742	solid	0.0	0.0	62.1	380
Na + Sb	3.453	1090	*	liquid	0.0	0.0	110	380
Ba + 2C	3.236	1466	1466	solid	0.0	0.0	111	359
2Mg + Th	5.767	1067	1067	solid	0.0	0.0	54.0	311
11Cd + Pu	1.056	843	843	solid	0.0	0.0	31.0	293
2Cu + Mg	5.368	721	721	solid	0.0	0.0	52.9	284
5Mo + 3Si	6.476	788	788	solid	0.0	0.0	43.1	279
Bi + 3K	2.071	1791	*	liquid?	*	*	127	263
Na + Sn	3.548	1073	1073	solid	0.0	0.0	71.4	254
3Al + Ta	6.407	665	665	solid	0.0	0.0	35.9	230
Bi + K	3.723	1253	*	liquid	0.0	0.0	55.0	204
Cu + 2Mg	3.199	665	665	solid	0.0	0.0	61.0	195
Ca + 2Mg	1.649	801	801	solid	0.0	0.0	108	178
6B + Si	2.497	503	503	solid	0.0	0.0	76.4	177
3Ba + 2Bi	5.185	1673	*	liquid	0.0	0.0	87.3	169
2C + 2Na	1.206	733	733	solid	0.0	0.0	137	165

* More data needed for this calculation.

Table 2e - Intermetallic Reactions (in Descending Order of Reaction Temperature)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
C +Hf	9.084	4441	>4222	s-l	0.0	0.0	315	2860
C + Zr	5.276	3800	3800	solid	0.0	0.0	455	2400
2B + Zr	4.926	3783	3673	liquid	0.0	0.0	683	3360
2B + Hf	8.232	3945	3653	liquid	0.0	0.0	401	3300
C + Ti	3.754	3644	3523	liquid	0.0	0.0	736	2760
2B + Ti	3.603	3710	3498	liquid	0.0	0.0	1320	5170
0.98C + Nb	6.522	3182	3182	solid	0.0	0.0	317	2070
Al + Pt	11.63	3379	3073	liquid	0.0	0.0	216	2510
2C + Th	8.169	3073	3073	solid	0.0	0.0	179	1280
C + Nb	9.678	3003	3003	solid	0.0	0.0	321	2060
2B + V	4.187	2960	2960	s-l	0.0	0.0	671	2810
2B + Nb	5.875	2793	2793	solid	0.0	0.0	524	3080
2B + Ta	10.36	2766	2766	solid	0.0	0.0	247	2560
C + Ta	11.90	2678	2678	solid	0.0	0.0	179	2120
Al + Pd	7.072	2725	2653	liquid	0.0	0.0	327	2890
C + 2Nb	7.328	2634	2634	solid	0.0	0.0	230	1680
B + V	4.749	2574	2574	solid	0.0	0.0	536	2540
5Nb + 3Si	6.233	2518	2518	solid	0.0	0.0	222	1390
Ca + Si	2.490	2504	2504	liquid	0.0	0.0	529	1320
B + Ti	3.922	3559	>2452	l or g	0 - 1.7	0 - 1	652	2560
3Si + 5Ti	3.719	2548	>2402	s-l	0.0	0.0	428	1590
6B + Ce	4.374	2388	2388	solid	0.0	0.0	395	1730
2Si + Th	6.659	2323	2323	solid	0.0	0.0	144	961
1.94C + Th	8.230	2211	2211	solid	0.0	0.0	138	1140
Si + 2Zr	5.291	2787	>2197	liquid	0.0	0.0	236	1250
4B + U	9.407	2124	2124	solid	0.0	0.0	209	1960
C + V	4.499	2121	2121	solid	0.0	0.0	383	1720
2Si + V	3.429	3341	2023	s-l	0.0	0.0	700	2400
2C + La	4.905	1973	1973	solid	0.0	0.0	178	870
2Be + C	1.995	1932	1932	solid	0.0	0.0	931	1860
C + Si	2.416	1914	1914	solid	0.0	0.0	436	1050
Al + Co	5.171	2195	>1912	s-l	0.0	0.0	307	1590
Al + Ni	5.165	2362	>1910	s-l	0.0	0.0	330	1710
Nb + 2Si	4.463	1897	1897	solid	0.0	0.0	201	898
2Si + Zr	4.004	1988	1893	liquid	0.0	0.0	258	1040
C + U	13.96	1871	1871	solid	0.0	0.0	93.6	1310
Mo + 2Si	4.581	1854	1854	solid	0.0	0.0	187	855
Si + 2Ta	11.79	1836	1836	solid	0.0	0.0	76.9	907
4B + Th	7.240	1823	1823	solid	0.0	0.0	189	1360
Mo + 7Si	3.265	1823	1823	solid	0.0	0.0	206	940
2Si + Ta	7.086	1781	1781	solid	0.0	0.0	120	8510

* More data needed for this calculation.

Table 2e - Intermetallic Reactions (in Descending Order of Reaction Temperature) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2C + Ce	5.201	1779	1779	solid	0.0	0.0	170	884
2Si + Ti	3.134	1913	>1772	s-l	0.0	0.0	308	967
2Al + Ca	2.051	2836	1738	liquid	0.0	0.0	558	1140
Co + Si	4.862	1733	>1732	s-l	0.0	0.0	299	1450
2B + Mg	2.031	1706	1706	dec	0.0	0.0	479	972
4Al + 3C	2.574	1673	1673	solid	0.0	0.0	371	965
5Cr + 3Si	4.900	1671	1671	solid	0.0	0.0	226	1110
5Be + Nb	3.920	1663	1663	solid	0.0	0.0	336	1300
2Si + U	8.369	1663	1663	solid	0.0	0.0	106	940
Fe + Si	4.564	1659	1659	solid	0.0	0.0	225	1020
2Ce + Pb	8.194	1653	>1652	s-l	0.0	0.0	81.5	665
Al + Ti	3.628	1597	1597	solid	0.0	0.0	240	872
3Al + Ti	3.172	1591	1591	solid	0.0	0.0	272	862
2C + U	11.29	1573	1573	solid	0.0	0.0	95.5	1080
2B + Cr	4.622	1571	1571	solid	0.0	0.0	306	1410
2Si + W	7.480	1549	1549	solid	0.0	0.0	92.6	693
Mn + Si	4.415	1615	>1542	s-l	0.0	0.0	224	989
2B + Mo	6.091	1533	1533	solid	0.0	0.0	196	1280
Cr + 2Si	3.625	1530	1530	solid	0.0	0.0	222	804
Al + 3Ni	6.820	1524	1524	solid	0.0	0.0	180	1230
3Cr + Si	5.558	1493	1493	solid	0.0	0.0	179	996
2Ca + Pb	4.105	1713	>1475	liquid	0.0	0.0	172	705
Ba + 2C	3.236	1466	1466	solid	0.0	0.0	111	359
5Al + 2Co	3.999	1755	>1452	s-l	0.0	0.0	277	1110
2Ge + Nb	6.269	1443	1443	solid	0.0	0.0	84.4	524
3Mg + 2Sb	4.039	1433	1433	solid	0.0	0.0	121	484
Al + Fe	4.844	1423	1423	solid	0.0	0.0	211	1020
3Al + Fe	3.688	1407	1407	solid	0.0	0.0	278	1020
2Ca + Sn	2.927	2994	>1407	l or g	0 - .50	0 - 1	377	1100
4Al + Pu	6.708	1403	1403	solid	0.0	0.0	123	820
Mn + S	2.370	1394	1394	solid	0.0	0.0	164	390
Ge + 2Mg	4.123	1678	1391	s-l	0.0	0.0	207	853
2B + Mn	4.732	1386	1386	solid	0.0	0.0	294	1390
2B + U	12.22	1335	1335	solid	0.0	0.0	149	1820
2Mg + Si	1.956	1286	1286	solid	0.0	0.0	247	483
3Mo + Si	7.308	1278	1278	solid	0.0	0.0	76.9	562
Ca + Sn	3.772	3622	>1272	l or g	0 - 1.5	0 - 1	239	903
Ni + Si	4.855	1838	>1265	s-l	0.0	0.0	235	1140
C + W	13.20	1259	1259	solid	0.0	0.0	49.0	647
Al + 2B	2.607	2251	>1252	l-g	0 - 2.1	0 - 1	742	1940
2C + Sr	2.518	1242	1242	solid	0.0	0.0	160	404

* More data needed for this calculation.

Table 2e - Intermetallic Reactions (in Descending Order of Reaction Temperature) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
6B + Sm	4.684	1233	1233	solid	0.0	0.0	232	1050
5B + 2W	10.37	1233	1233	solid	0.0	0.0	83.0	1350
Cr + Si	4.316	1231	1231	solid	0.0	0.0	159	684
4B + C	2.444	1202	1202	solid	0.0	0.0	308	751
2Ba + Pb	4.025	1913	>1200	l-g	0 - .21	0 - 1	143	576
3C + 7Cr	5.978	1175	1175	solid	0.0	0.0	136	813
4Al + Ce	4.095	1173	1173	solid	0.0	0.0	126	458
2Mg + Sn	3.787	1163	1163	solid	0.0	0.0	113	450
3Si + 5Zr	5.141	1132	1132	solid	0.0	0.0	255	1310
2C + Ca	1.757	1113	1113	solid	0.0	0.0	223	392
Ce + Zn	6.904	1413	>1098	liquid	0.0	0.0	78.0	535
Nb + Ni	8.695	1083	1083	solid	0.0	0.0	71.0	610
C + 2Mo	7.662	1077	1077	solid	0.0	0.0	62.3	477
Na + Sn	3.548	1073	1073	solid	0.0	0.0	71.4	254
2Mg + Th	5.767	1067	1067	solid	0.0	0.0	54.0	311
3Al + V	3.412	1023	1023	solid	0.0	0.0	198	792
Al + Ta	9.952	1011	1011	solid	0.0	0.0	56.7	564
6B + Y	3.354	973	973	solid	0.0	0.0	156	503
Pu + 12Zn	8.409	973	973	solid	0.0	0.0	71.3	600
2U + 17Zn	8.778	973	973	solid	0.0	0.0	60.0	530
4Al + Ca	2.248	1880	>972	s-l	0.0	0.0	348	782
Al + Li	1.476	1160	>972	s-l	0.0	0.0	345	509
Al + Cu	5.294	935	935	solid	0.0	0.0	108	573
3Si + 5Ta	11.19	920	920	solid	0.0	0.0	80.9	906
6B + Mg	2.234	918	918	solid	0.0	0.0	251	600
Cu + Pd	10.64	873	873	solid	0.0	0.0	44.5	472
11Cd + Pu	1.056	843	843	solid	0.0	0.0	31.0	293
Al + Mn	4.676	803	803	solid	0.0	0.0	124	586
Ca + 2Mg	1.649	801	801	solid	0.0	0.0	108	178
3Al + Cr	3.568	793	793	solid	0.0	0.0	120	430
5Mo + 3Si	6.476	788	788	solid	0.0	0.0	43.1	279
13Be + U	4.679	773	773	solid	0.0	0.0	110	513
Li + Pb	6.848	1258	>754	liquid	0.0	0.0	67.2	460
3C + 7Mn	6.130	742	742	solid	0.0	0.0	62.1	380
2C + 2Na	1.206	733	733	solid	0.0	0.0	137	165
13Be + Pu	4.756	723	723	solid	0.0	0.0	100	476
2Cu + Mg	5.368	721	721	solid	0.0	0.0	52.9	284
Bi + Li	6.319	1273	>689	liquid	0.0	0.0	85.5	535
3Al + Ta	6.407	665	665	solid	0.0	0.0	35.9	230
Cu + 2Mg	3.199	665	665	solid	0.0	0.0	61.0	195
6B + Si	2.497	503	503	solid	0.0	0.0	76.4	177

* More data needed for this calculation.

Table 2e - Intermetallic Reactions (in Descending Order of Reaction Temperature) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Mg + S	2.037	7039	*	*	*	*	1500	3060
Mg + Se	3.398	4817	*	*	*	*	678	2300
Mg + Te	4.311	4676	*	*	*	*	329	1420
S + Zn	2.419	4144	*	l-g*	0.0	0.0	500	1210
Be + 2C	2.131	3043	*	l-g	0 - .33	0 - 1	1750	3720
6B + La	4.198	2503	*	l-s	0.0	0.0	560	2350
2Ba + Sn	4.153	2398	*	l-g	0 - .25	0 - 1	240	1000
Mg + U	9.874	2213	*	liquid	0.0	0.0	157	1570
Si + Y	3.754	2108	*	s-l	0.0	0.0	275	1000
Ce + 2Si	4.547	2083	*	liquid	0.0	0.0	255	1100
Mg+ Y	3.343	1943	*	liquid	0.0	0.0	274	912
2Al + Zr	4.240	1923	*	l-s	*	*	267	1130
3Ba + 2Sb	4.252	1833	*	liquid	*	*	133	563
Bi + 3K	2.071	1791	*	liquid?	*	*	127	263
2Zn + Zr	6.816	1723	*	l-s	0.0	0.0	170	1160
4Al + Pr	4.094	1703	*	s-l	0.0	0.0	216	800
3Ba + 2Bi	5.185	1673	*	liquid	0.0	0.0	87.3	169
2Al + Ti	3.326	1643	*	l-s	*	*	314	1100
Pd + Sn	8.966	1599	*	s-l	0.0	0.0	112	1000
Ce + Mg	4.713	1552	*	s-l	0.0	0.0	111	523
Li + Sn	4.298	1516	*	s-l	0.0	0.0	134	576
4Al + La	3.946	1495	*	s-l	0.0	0.0	166	780
Mn + 1.7Si	3.846	1433	*	s-l	0.0	0.0	226	847
Li + Sb	4.123	1333	*	liquid	0.0	0.0	170	700
Bi + K	3.723	1253	*	liquid	0.0	0.0	55.0	204
4Al + U	6.582	1205	*	liquid	0.0	0.0	89.8	591
Na + Sb	3.453	1090	*	liquid	0.0	0.0	110	380
4Al + Co	3.581	*	*	*	*	*	231	637
2Al + 3S	2.102	*	*	*	0.0	0.0	800	1680
Al + 3Ti	4.071	*	*	*	*	*	138	560
3Al + 2Ti	3.448	*	*	*	*	*	158	544

* More data needed for this calculation.

Table 2f - Intermetallic Reactions (in Descending Order of Moles of Gas Produced)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Al + 2B	2.607	2251	>1252	l-g	0 - 2.1	0 - 1	742	1940
B + Ti	3.922	3559	>2452	l or g	0 - 1.7	0 - 1	652	2560
Ca + Sn	3.772	3622	>1272	l or g	0 - 1.5	0 - 1	239	903
2Ca + Sn	2.927	2994	>1407	l or g	0 - .50	0 - 1	377	1100
Be + 2C	2.131	3043	*	l-g	0 - .33	0 - 1	1750	3720
2Ba + Sn	4.153	2398	*	l-g	0 - .25	0 - 1	240	1000
2Ba + Pb	4.025	1913	>1200	l-g	0 - .21	0 - 1	143	576
4Al + 3C	2.574	1673	1673	solid	0.0	0.0	371	965
2Al + Ca	2.051	2836	1738	liquid	0.0	0.0	558	1140
4Al + Ca	2.248	1880	>972	s-l	0.0	0.0	348	782
4Al + Ce	4.095	1173	1173	solid	0.0	0.0	126	458
Al + Co	5.171	2195	>1912	s-l	0.0	0.0	307	1590
5Al + 2Co	3.999	1755	>1452	s-l	0.0	0.0	277	1110
3Al + Cr	3.568	793	793	solid	0.0	0.0	120	430
Al + Cu	5.294	935	935	solid	0.0	0.0	108	573
Al + Fe	4.844	1423	1423	solid	0.0	0.0	211	1020
3Al + Fe	3.688	1407	1407	solid	0.0	0.0	278	1020
4Al + La	3.946	1495	*	s-l	0.0	0.0	166	780
Al + Li	1.476	1160	>972	s-l	0.0	0.0	345	509
Al + Mn	4.676	803	803	solid	0.0	0.0	124	586
Al + Ni	5.165	2362	>1910	s-l	0.0	0.0	330	1710
Al + 3Ni	6.820	1524	1524	solid	0.0	0.0	180	1230
Al + Pd	7.072	2725	2653	liquid	0.0	0.0	327	2890
4Al + Pr	4.094	1703	*	s-l	0.0	0.0	216	800
Al + Pt	11.63	3379	3073	liquid	0.0	0.0	216	2510
4Al + Pu	6.708	1403	1403	solid	0.0	0.0	123	820
2Al + 3S	2.102	*	*	*	0.0	0.0	800	1680
Al + Ta	9.952	1011	1011	solid	0.0	0.0	56.7	564
3Al + Ta	6.407	665	665	solid	0.0	0.0	35.9	230
Al + Ti	3.628	1597	1597	solid	0.0	0.0	240	872
3Al + Ti	3.172	1591	1591	solid	0.0	0.0	272	862
4Al + U	6.582	1205	*	liquid	0.0	0.0	89.8	591
3Al + V	3.412	1023	1023	solid	0.0	0.0	198	792
4B + C	2.444	1202	1202	solid	0.0	0.0	308	751
6B + Ce	4.374	2388	2388	solid	0.0	0.0	395	1730
2B + Cr	4.622	1571	1571	solid	0.0	0.0	306	1410
2B + Hf	8.232	3945	3653	liquid	0.0	0.0	401	3300
6B + La	4.198	2503	*	l-s	0.0	0.0	560	2350
2B + Mg	2.031	1706	1706	dec	0.0	0.0	479	972
6B + Mg	2.234	918	918	solid	0.0	0.0	251	600
2B + Mn	4.732	1386	1386	solid	0.0	0.0	294	1390

* More data needed for this calculation.

Table 2f - Intermetallic Reactions (in Descending Order of Moles of Gas Produced) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
2B + Mo	6.091	1533	1533	solid	0.0	0.0	196	1280
2B + Nb	5.875	2793	2793	solid	0.0	0.0	524	3080
6B + Sm	4.684	1233	1233	solid	0.0	0.0	232	1050
6B + Si	2.497	503	503	solid	0.0	0.0	76.4	177
2B + Ta	10.36	2766	2766	solid	0.0	0.0	247	2560
4B + Th	7.240	1823	1823	solid	0.0	0.0	189	1360
2B + Ti	3.603	3710	3498	liquid	0.0	0.0	1320	5170
2B + U	12.22	1335	1335	solid	0.0	0.0	149	1820
4B + U	9.407	2124	2124	solid	0.0	0.0	209	1960
B + V	4.749	2574	2574	solid	0.0	0.0	536	2540
2B + V	4.187	2960	2960	s-l	0.0	0.0	671	2810
5B + 2W	10.37	1233	1233	solid	0.0	0.0	83.0	1350
6B + Y	3.354	973	973	solid	0.0	0.0	156	503
2B + Zr	4.926	3783	3673	liquid	0.0	0.0	683	3360
3Ba + 2Bi	5.185	1673	*	liquid	0.0	0.0	87.3	169
Ba + 2C	3.236	1466	1466	solid	0.0	0.0	111	359
2Be + C	1.995	1932	1932	solid	0.0	0.0	931	1860
5Be + Nb	3.920	1663	1663	solid	0.0	0.0	336	1300
13Be + Pu	4.756	723	723	solid	0.0	0.0	100	476
13Be + U	4.679	773	773	solid	0.0	0.0	110	513
Bi + K	3.723	1253	*	liquid	0.0	0.0	55.0	204
Bi + Li	6.319	1273	>689	liquid	0.0	0.0	85.5	535
2C + Ca	1.757	1113	1113	solid	0.0	0.0	223	392
2C + Ce	5.201	1779	1779	solid	0.0	0.0	170	884
3C + 7Cr	5.978	1175	1175	solid	0.0	0.0	136	813
C +Hf	9.084	4441	>4222	s-l	0.0	0.0	315	2860
2C + La	4.905	1973	1973	solid	0.0	0.0	178	870
3C + 7Mn	6.130	742	742	solid	0.0	0.0	62.1	380
C + 2Mo	7.662	1077	1077	solid	0.0	0.0	62.3	477
2C + 2Na	1.206	733	733	solid	0.0	0.0	137	165
0.98C + Nb	6.522	3182	3182	solid	0.0	0.0	317	2070
C + Nb	9.678	3003	3003	solid	0.0	0.0	321	2060
C + 2Nb	7.328	2634	2634	solid	0.0	0.0	230	1680
C + Si	2.416	1914	1914	solid	0.0	0.0	436	1050
2C + Sr	2.518	1242	1242	solid	0.0	0.0	160	404
C + Ta	11.90	2678	2678	solid	0.0	0.0	179	2120
1.94C + Th	8.230	2211	2211	solid	0.0	0.0	138	1140
2C + Th	8.169	3073	3073	solid	0.0	0.0	179	1280
C + Ti	3.754	3644	3523	liquid	0.0	0.0	736	2760
C + U	13.96	1871	1871	solid	0.0	0.0	93.6	1310
2C + U	11.29	1573	1573	solid	0.0	0.0	95.5	1080

* More data needed for this calculation.

Table 2f - Intermetallic Reactions (in Descending Order of Moles of Gas Produced) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
C + V	4.499	2121	2121	solid	0.0	0.0	383	1720
C + W	13.20	1259	1259	solid	0.0	0.0	49.0	647
C + Zr	5.276	3800	3800	solid	0.0	0.0	455	2400
Ca + 2Mg	1.649	801	801	solid	0.0	0.0	108	178
2Ca + Pb	4.105	1713	>1475	liquid	0.0	0.0	172	705
Ca + Si	2.490	2504	2504	liquid	0.0	0.0	529	1320
11Cd + Pu	1.056	843	843	solid	0.0	0.0	31.0	293
Ce + Mg	4.713	1552	*	s-l	0.0	0.0	111	523
2Ce + Pb	8.194	1653	>1652	s-l	0.0	0.0	81.5	665
Ce + 2Si	4.547	2083	*	liquid	0.0	0.0	255	1100
Ce + Zn	6.904	1413	>1098	liquid	0.0	0.0	78.0	535
Co + Si	4.862	1733	>1732	s-l	0.0	0.0	299	1450
Cr + Si	4.316	1231	1231	solid	0.0	0.0	159	684
Cr + 2Si	3.625	1530	1530	solid	0.0	0.0	222	804
3Cr + Si	5.558	1493	1493	solid	0.0	0.0	179	996
5Cr + 3Si	4.900	1671	1671	solid	0.0	0.0	226	1110
Cu + 2Mg	3.199	665	665	solid	0.0	0.0	61.0	195
2Cu + Mg	5.368	721	721	solid	0.0	0.0	52.9	284
Cu + Pd	10.64	873	873	solid	0.0	0.0	44.5	472
Fe + Si	4.564	1659	1659	solid	0.0	0.0	225	1020
Ge + 2Mg	4.123	1678	1391	s-l	0.0	0.0	207	853
2Ge + Nb	6.269	1443	1443	solid	0.0	0.0	84.4	524
Li + Pb	6.848	1258	>754	liquid	0.0	0.0	67.2	460
Li + Sb	4.123	1333	*	liquid	0.0	0.0	170	700
Li + Sn	4.298	1516	*	s-l	0.0	0.0	134	576
3Mg + 2Sb	4.039	1433	1433	solid	0.0	0.0	121	484
2Mg + Si	1.956	1286	1286	solid	0.0	0.0	247	483
2Mg + Sn	3.787	1163	1163	solid	0.0	0.0	113	450
2Mg + Th	5.767	1067	1067	solid	0.0	0.0	54.0	311
Mg + U	9.874	2213	*	liquid	0.0	0.0	157	1570
Mg+ Y	3.343	1943	*	liquid	0.0	0.0	274	912
Mn + S	2.370	1394	1394	solid	0.0	0.0	164	390
Mn + Si	4.415	1615	>1542	s-l	0.0	0.0	224	989
Mn + 1.7Si	3.846	1433	*	s-l	0.0	0.0	226	847
Mo + 2Si	4.581	1854	1854	solid	0.0	0.0	187	855
Mo + 7Si	3.265	1823	1823	solid	0.0	0.0	206	940
3Mo + Si	7.308	1278	1278	solid	0.0	0.0	76.9	562
5Mo + 3Si	6.476	788	788	solid	0.0	0.0	43.1	279
Na + Sb	3.453	1090	*	liquid	0.0	0.0	110	380
Na + Sn	3.548	1073	1073	solid	0.0	0.0	71.4	254
Nb + Ni	8.695	1083	1083	solid	0.0	0.0	71.0	610

* More data needed for this calculation.

Table 2f - Intermetallic Reactions (in Descending Order of Moles of Gas Produced) (cont.)

reactants		adiabatic reaction temperature (K)		state of intermetallic product	gas production		heat of reaction	
constituents	ρ_{TMD}, g/cm^3	w/o phase changes	w/ phase changes		moles gas per 100 g	g of gas per g	-Q, cal/g	-Q, cal/cm^3
Nb + 2Si	4.463	1897	1897	solid	0.0	0.0	201	898
5Nb + 3Si	6.233	2518	2518	solid	0.0	0.0	222	1390
Ni + Si	4.855	1838	>1265	s-l	0.0	0.0	235	1140
Pd + Sn	8.966	1599	*	s-l	0.0	0.0	112	1000
Pu + 12Zn	8.409	973	973	solid	0.0	0.0	71.3	600
S + Zn	2.419	4144	*	l-g*	0.0	0.0	500	1210
Si + 2Ta	11.79	1836	1836	solid	0.0	0.0	76.9	907
2Si + Ta	7.086	1781	1781	solid	0.0	0.0	120	8510
3Si + 5Ta	11.19	920	920	solid	0.0	0.0	80.9	906
2Si + Th	6.659	2323	2323	solid	0.0	0.0	144	961
2Si + Ti	3.134	1913	>1772	s-l	0.0	0.0	308	967
3Si + 5Ti	3.719	2548	>2402	s-l	0.0	0.0	428	1590
2Si + U	8.369	1663	1663	solid	0.0	0.0	106	940
2Si + V	3.429	3341	2023	s-l	0.0	0.0	700	2400
2Si + W	7.480	1549	1549	solid	0.0	0.0	92.6	693
Si + Y	3.754	2108	*	s-l	0.0	0.0	275	1000
Si + 2Zr	5.291	2787	>2197	liquid	0.0	0.0	236	1250
2Si + Zr	4.004	1988	1893	liquid	0.0	0.0	258	1040
3Si + 5Zr	5.141	1132	1132	solid	0.0	0.0	255	1310
2U + 17Zn	8.778	973	973	solid	0.0	0.0	60.0	530
2Zn + Zr	6.816	1723	*	l-s	0.0	0.0	170	1160
4Al + Co	3.581	*	*	*	*	*	231	637
Al + 3Ti	4.071	*	*	*	*	*	138	560
2Al + Ti	3.326	1643	*	l-s	*	*	314	1100
3Al + 2Ti	3.448	*	*	*	*	*	158	544
2Al + Zr	4.240	1923	*	l-s	*	*	267	1130
3Ba + 2Sb	4.252	1833	*	liquid	*	*	133	563
Bi + 3K	2.071	1791	*	liquid?	*	*	127	263
Mg + S	2.037	7039	*	*	*	*	1500	3060
Mg + Se	3.398	4817	*	*	*	*	678	2300
Mg + Te	4.311	4676	*	*	*	*	329	1420

* More data needed for this calculation.

Table 3a - Metal Combustion Reactions (in Alphabetical Order)

metal	oxide	MW, g/mol (metal)	ρ_{TMD}, g/cm^3 (metal)	$\Delta H_f°$, kcal/mol	T_{fus}, K, of metal	T_{vap}, K, of metal	Q, cal/g of metal	Q, cal/cm^3 of metal
Ag	Ag_2O	107.88	10.5	7.42	1234	2436	34.39	361.1
Al	Al_2O_3	26.98	2.70	400.5	933	2740	7422	20040
B	B_2O_3	10.82	2.50	304.0	2573	4139	14050	35120
Be	BeO	9.01	1.85	143.2	1553	3243	15890	29400
Bi	Bi_2O_3	209.00	9.87	137.2	544	1837	328.2	3240
Ce	Ce_2O_3	140.13	6.80	435.2	1048	3699	1553	10560
Co	CoO	58.93	8.90	56.87	1701	3201	965.0	8589
Cr	Cr_2O_3	52.01	7.14	272.4	2180	2945	2619	18700
Cs	Cs_2O	132.91	1.90	75.95	301	951	571.4	1086
Cs	Cs_2O_3	132.91	1.90	111.3	301	951	837.3	1591
Cs	CsO_2	131.91	1.90	62.04	301	951	466.8	886.9
Cu	CuO	63.54	8.93	37.30	1356	2843	587.0	5244
Cu	Cu_2O	63.54	8.93	40.80	1356	2843	321.1	2868
Fe	Fe_2O_3	55.85	7.86	197.0	1811	3135	1764	13860
Fe	Fe_3O_4	55.85	7.86	267.3	1811	3135	1595	12540
Hf	HfO_2	178.50	11.4	266.2	2495	4964	1491	17000
La	La_2O_3	138.92	6.15	428.7	1193	3730	1543	9489
Li	Li_2O	6.94	0.534	152.1	454	1620	10960	5852
Mg	MgO	24.32	1.74	151.8	923	1363	6241	10860
Mn	Mn_3O_4	54.94	7.30	331.7	1519	2334	2012	14690
Mo	MoO_3	95.95	9.01	178.1	2896	4952	1856	16720
Nb	Nb_2O_5	92.91	8.57	454.0	2750	5015	2443	20940
Nd	Nd_2O_3	144.27	7.01	433.6	1292	3341	1503	10530
Ni	NiO	58.69	8.90	57.29	1728	3187	976.1	8688
Pb	Pb_3O_4	207.20	11.3	171.8	601	2019	276.4	3133
Pd	PdO	106.40	12.0	27.60	1828	3237	259.4	3113
Pt	Pt_3O_4	195.09	21.4	64.05	2042	4100	109.4	2347
Si	SiO_2	28.09	2.49	217.7	1687	2628	7750	19298
Sn	SnO_2	118.70	7.31	138.8	505	2876	1169	8548
Sr	SrO_2	87.62	2.60	153.3	1042	1657	1750	4549
Ta	Ta_2O_5	180.95	16.6	489.0	3290	5698	1351	22430
Th	ThO_2	232.04	11.2	293.5	2023	5063	1265	14170
Ti	TiO_2	47.90	4.50	225.8	1693	3560	4714	21210
U	U_3O_8	238.07	18.9	854.4	1408	4091	1196	22610
V	V_2O_5	50.95	5.87	370.6	2183	3653	3634	21350
W	WO_2	183.86	19.3	140.9	3695	5936	766.6	14790
W	WO_3	183.86	19.3	201.5	3695	5936	1096	21150
Y	Y_2O_3	88.92	4.47	501.4	1799	3611	2819	12600
Zn	ZnO	65.38	7.14	83.76	692	1180	1281	9147
Zr	ZrO_2	91.22	5.68	263.0	2125	4650	2135	12130

Table 3b - Metal Combustion Reactions (in Descending Order of Metal Density)

metal	oxide	MW, g/mol (metal)	ρ_{TMD}, g/cm^3 (metal)	$\Delta H_f°$, kcal/mol	T_{fus}, K, of metal	T_{vap}, K, of metal	Q, cal/g of metal	Q, cal/cm^3 of metal
Pt	Pt_3O_4	195.09	21.4	64.05	2042	4100	109	2347
W	WO_2	183.86	19.3	140.9	3695	5936	767	14790
W	WO_3	183.86	19.3	201.5	3695	5936	1100	21150
U	U_3O_8	238.07	18.9	854.4	1408	4091	1200	22610
Ta	Ta_2O_5	180.95	16.6	489.0	3290	5698	1350	22430
Pd	PdO	106.40	12.0	27.60	1828	3237	259	3113
Hf	HfO_2	178.50	11.4	266.2	2495	4964	1490	17000
Pb	Pb_3O_4	207.20	11.3	171.8	601	2019	276	3133
Th	ThO_2	232.04	11.2	293.5	2023	5063	1260	14170
Ag	Ag_2O	107.88	10.5	7.42	1234	2436	34.4	361.1
Bi	Bi_2O_3	209.00	9.87	137.2	544	1837	328	3240
Mo	MoO_3	95.95	9.01	178.1	2896	4952	1860	16720
Cu	CuO	63.54	8.93	37.30	1356	2843	587	5244
Cu	Cu_2O	63.54	8.93	40.80	1356	2843	321	2868
Co	CoO	58.93	8.90	56.87	1701	3201	965	8589
Ni	NiO	58.69	8.90	57.29	1728	3187	976	8688
Nb	Nb_2O_5	92.91	8.57	454.0	2750	5015	2440	20940
Fe	Fe_2O_3	55.85	7.86	197.0	1811	3135	1760	13860
Fe	Fe_3O_4	55.85	7.86	267.3	1811	3135	1600	12540
Sn	SnO_2	118.70	7.31	138.8	505	2876	1170	8548
Mn	Mn_3O_4	54.94	7.30	331.7	1519	2334	2010	14690
Cr	Cr_2O_3	52.01	7.14	272.4	2180	2945	2620	18700
Zn	ZnO	65.38	7.14	83.76	692	1180	1280	9147
Nd	Nd_2O_3	144.27	7.01	433.6	1292	3341	1500	10530
Ce	Ce_2O_3	140.13	6.80	435.2	1048	3699	1550	10560
La	La_2O_3	138.92	6.15	428.7	1193	3730	1540	9489
V	V_2O_5	50.95	5.87	370.6	2183	3653	3630	21350
Zr	ZrO_2	91.22	5.68	263.0	2125	4650	2140	12130
Ti	TiO_2	47.90	4.50	225.8	1693	3560	4710	21210
Y	Y_2O_3	88.92	4.47	501.4	1799	3611	2820	12600
Al	Al_2O_3	26.98	2.70	400.5	933	2740	7420	20040
Sr	SrO_2	87.62	2.60	153.3	1042	1657	1750	4549
B	B_2O_3	10.82	2.50	304.0	2573	4139	14000	35120
Si	SiO_2	28.09	2.49	217.7	1687	2628	7750	19298
Cs	Cs_2O	132.91	1.90	75.95	301	951	571	1086
Cs	Cs_2O_3	132.91	1.90	111.3	301	951	837	1591
Cs	CsO_2	131.91	1.90	62.04	301	951	467	886.9
Be	BeO	9.01	1.85	143.2	1553	3243	15900	29400
Mg	MgO	24.32	1.74	151.8	923	1363	6240	10860
Li	Li_2O	6.94	0.534	152.1	454	1620	11000	5852

Table 3c - Metal Combustion Reactions (in Descending Order of Heat of Combustion per Unit Mass)

metal	oxide	MW, g/mol (metal)	ρ_{TMD}, g/cm^3 (metal)	$\Delta H_f°$, kcal/mol	T_{fus}, K, of metal	T_{vap}, K, of metal	Q, cal/g of metal	Q, cal/ cm^3 of metal
Be	BeO	9.01	1.85	143.2	1553	3243	15890	29400
B	B_2O_3	10.82	2.50	304.0	2573	4139	14050	35120
Li	Li_2O	6.94	0.534	152.1	454	1620	10960	5852
Si	SiO_2	28.09	2.49	217.7	1687	2628	7750	19298
Al	Al_2O_3	26.98	2.70	400.5	933	2740	7422	20040
Mg	MgO	24.32	1.74	151.8	923	1363	6241	10860
Ti	TiO_2	47.90	4.50	225.8	1693	3560	4714	21210
V	V_2O_5	50.95	5.87	370.6	2183	3653	3634	21350
Y	Y_2O_3	88.92	4.47	501.4	1799	3611	2819	12600
Cr	Cr_2O_3	52.01	7.14	272.4	2180	2945	2619	18700
Nb	Nb_2O_5	92.91	8.57	454.0	2750	5015	2443	20940
Zr	ZrO_2	91.22	5.68	263.0	2125	4650	2135	12130
Mn	Mn_3O_4	54.94	7.30	331.7	1519	2334	2012	14690
Mo	MoO_3	95.95	9.01	178.1	2896	4952	1856	16720
Fe	Fe_2O_3	55.85	7.86	197.0	1811	3135	1764	13860
Sr	SrO_2	87.62	2.60	153.3	1042	1657	1750	4549
Fe	Fe_3O_4	55.85	7.86	267.3	1811	3135	1595	12540
Ce	Ce_2O_3	140.13	6.80	435.2	1048	3699	1553	10560
La	La_2O_3	138.92	6.15	428.7	1193	3730	1543	9489
Nd	Nd_2O_3	144.27	7.01	433.6	1292	3341	1503	10530
Hf	HfO_2	178.50	11.4	266.2	2495	4964	1491	17000
Ta	Ta_2O_5	180.95	16.6	489.0	3290	5698	1351	22430
Zn	ZnO	65.38	7.14	83.76	692	1180	1281	9147
Th	ThO_2	232.04	11.2	293.5	2023	5063	1265	14170
U	U_3O_8	238.07	18.9	854.4	1408	4091	1196	22610
Sn	SnO_2	118.70	7.31	138.8	505	2876	1169	8548
W	WO_3	183.86	19.3	201.5	3695	5936	1096	21150
Ni	NiO	58.69	8.90	57.29	1728	3187	976.1	8688
Co	CoO	58.93	8.90	56.87	1701	3201	965.0	8589
Cs	Cs_2O_3	132.91	1.90	111.3	301	951	837.3	1591
W	WO_2	183.86	19.3	140.9	3695	5936	766.6	14790
Cu	CuO	63.54	8.93	37.30	1356	2843	587.0	5244
Cs	Cs_2O	132.91	1.90	75.95	301	951	571.4	1086
Cs	CsO_2	131.91	1.90	62.04	301	951	466.8	886.9
Bi	Bi_2O_3	209.0	9.87	137.2	544	1837	328.2	3240
Cu	Cu_2O	63.54	8.93	40.80	1356	2843	321.1	2868
Pb	Pb_3O_4	207.20	11.3	171.8	601	2019	276.4	3133
Pd	PdO	106.40	12.0	27.60	1828	3237	259.4	3113
Pt	Pt_3O_4	195.09	21.4	64.05	2042	4100	109.4	2347
Ag	Ag_2O	107.88	10.5	7.42	1234	2436	34.39	361.1

Table 3d - Metal Combustion Reactions (in Descending Order of Heat of Combustion per Unit Volume)

metal	oxide	MW, g/mol (metal)	ρ_{TMD}, g/cm^3 (metal)	$\Delta H_f°$, kcal/mol	T_{fus}, K, of metal	T_{vap}, K, of metal	Q, cal/g of metal	Q, cal/ cm^3 of metal
B	B_2O_3	10.82	2.50	304.0	2573	4139	14050	35120
Be	BeO	9.01	1.85	143.2	1553	3243	15890	29400
U	U_3O_8	238.07	18.9	854.4	1408	4091	1196	22610
Ta	Ta_2O_5	180.95	16.6	489.0	3290	5698	1351	22430
V	V_2O_5	50.95	5.87	370.6	2183	3653	3634	21350
Ti	TiO_2	47.90	4.50	225.8	1693	3560	4714	21210
W	WO_3	183.86	19.3	201.5	3695	5936	1096	21150
Nb	Nb_2O_5	92.91	8.57	454.0	2750	5015	2443	20940
Al	Al_2O_3	26.98	2.70	400.5	933	2740	7422	20040
Si	SiO_2	28.09	2.49	217.7	1687	2628	7750	19298
Cr	Cr_2O_3	52.01	7.14	272.4	2180	2945	2619	18700
Hf	HfO_2	178.50	11.4	266.2	2495	4964	1491	17000
Mo	MoO_3	95.95	9.01	178.1	2896	4952	1856	16720
W	WO_2	183.86	19.3	140.9	3695	5936	766.6	14790
Mn	Mn_3O_4	54.94	7.30	331.7	1519	2334	2012	14690
Th	ThO_2	232.04	11.2	293.5	2023	5063	1265	14170
Fe	Fe_2O_3	55.85	7.86	197.0	1811	3135	1764	13860
Y	Y_2O_3	88.92	4.47	501.4	1799	3611	2819	12600
Fe	Fe_3O_4	55.85	7.86	267.3	1811	3135	1595	12540
Zr	ZrO_2	91.22	5.68	263.0	2125	4650	2135	12130
Mg	MgO	24.32	1.74	151.8	923	1363	6241	10860
Ce	Ce_2O_3	140.13	6.80	435.2	1048	3699	1553	10560
Nd	Nd_2O_3	144.27	7.01	433.6	1292	3341	1503	10530
La	La_2O_3	138.92	6.15	428.7	1193	3730	1543	9489
Zn	ZnO	65.38	7.14	83.76	692	1180	1281	9147
Ni	NiO	58.69	8.90	57.29	1728	3187	976.1	8688
Co	CoO	58.93	8.90	56.87	1701	3201	965.0	8589
Sn	SnO_2	118.70	7.31	138.8	505	2876	1169	8548
Li	Li_2O	6.94	0.534	152.1	454	1620	10960	5852
Cu	CuO	63.54	8.93	37.30	1356	2843	587.0	5244
Sr	SrO_2	87.62	2.60	153.3	1042	1657	1750	4549
Bi	Bi_2O_3	209.0	9.87	137.2	544	1837	328.2	3240
Pb	Pb_3O_4	207.20	11.3	171.8	601	2019	276.4	3133
Pd	PdO	106.40	12.0	27.60	1828	3237	259.4	3113
Cu	Cu_2O	63.54	8.93	40.80	1356	2843	321.1	2868
Pt	Pt_3O_4	195.09	21.4	64.05	2042	4100	109.4	2347
Cs	Cs_2O_3	132.91	1.90	111.3	301	951	837.3	1591
Cs	Cs_2O	132.91	1.90	75.95	301	951	571.4	1086
Cs	CsO_2	131.91	1.90	62.04	301	951	466.8	886.9
Ag	Ag_2O	107.88	10.5	7.42	1234	2436	34.39	361.1