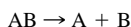


TABLE 4.11 Bond Dissociation Energies

The bond dissociation energy (enthalpy change) for a bond A—B which is broken through the reaction



is defined as the standard-state enthalpy change for the reaction at a specified temperature, here at 298 K. That is,

$$\Delta H_{f,298} = \Delta H_{f,298}(A) + \Delta H_{f,298}(B) - \Delta H_{f,298}(AB)$$

All values refer to the gaseous state and are given at 298 K. Values of 0 K are obtained by subtracting $\frac{3}{2}RT$ from the value at 298 K.

To convert the tabulated values to kcal/mol, divide by 4.184.

Bond	$\Delta H_{f,298}^{\circ}$, kJ/mol	Bond	$\Delta H_{f,298}^{\circ}$, kJ/mol
Aluminum		Antimony (<i>continued</i>)	
Al—Al	186(9)	Sb—O	372(84)
Al—As	180	Sb—P	357
Al—Au	326(6)	Sb—S	379
Al—Br	439(8)	Sb—Te	277.4(38)
Al—C	255	Arsenic	
Al—Cl	494(13)	As—As	382(11)
AlCl—Cl	402(8)	As—Cl	448
AlCl ₂ —Cl	372(8)	As—Ga	209.6(12)
AlO—Cl	515(84)	As—H	272(12)
Al—Cu	216(10)	As—N	582(126)
Al—D	291	As—O	481(8)
Al—F	664(6)	As—P	534(13)
AlF—F	546(42)	As—S	(478)
AlF ₂ —F	544(46)	As—Se	96
AlO—F	761(42)	As—Te	198(15)
Al—H	285(6)	Astatine	
Al—I	368(4)	At—At	(115.9)
Al—Li	176(15)	Barium	
Al—N	297(96)	Ba—Br	370(8)
Al—O	512(4)	Ba—Cl	444(13)
AlCl—O	540(41)	Ba—F	487(7)
AlF—O	582	Ba—I	>431(4)
Al—P	213(13)	Ba—O	563(42)
Al—Pd	259(12)	Ba—OH	477(42)
Al—S	374(8)	Ba—S	400(19)
Al—Se	334(10)	Beryllium	
Al—Si	251(3)	Be—Be	59
Al—Te	268(10)	Be—Br	381(84)
Al—U	326(29)	Be—Cl	388(9)
Antimony			
Sb—Sb	299(6)		
Sb—Br	314(59)		
Sb—Cl	360(50)		
Sb—F	439(96)		
Sb—N	301(50)		

TABLE 4.11 Bond Dissociation Energies (*Continued*)

Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Beryllium (<i>continued</i>)		Bromine	
Be—Cl	540(63)	Br—Br	193.870(4)
Be—F	577(42)	Br—C	280(21)
Be—H	226(21)	Br—CH ₃	284(8)
Be—O	448(21)	Br—CH ₂ Br	255(13)
Be—S	372(59)	Br—CHBr ₂	259(17)
Bismuth		Br—CBr ₃	209(13)
Bi—Bi	197(4)	Br—CCl ₃	218(13)
Bi—Br	267(4)	Br—CF ₃	285(13)
Bi—Cl	305(8)	Br—CF ₂ CF ₃	287.4(63)
Bi—D	284	Br—CF ₂ CF ₂ CF ₃	278.2(63)
Bi—F	259(29)	Br—CHF ₂	289
Bi—Ga	159(17)	Br—Cl	218.84(4)
Bi—H	279	Br—CN	381
Bi—O	343(6)	Br—CO—C ₆ H ₅	268
Bi—P	280(13)	Br—F	233.8(2)
Bi—Pb	142(15)	Br—N	276(21)
Bi—S	316(5)	Br—NF ₂	222
Bi—Sb	251(4)	Br—NO	120.1(63)
Bi—Se	280(6)	Br—O	235.1(4)
Bi—Te	232(11)	Cadmium	
Bi—Tl	121(13)	Cd—Cd	11.3(8)
Boron		Cd—Br	159(96)
B—B	297(21)	Cd—Cl	206.7(34)
H ₃ B—BH ₃	146	Cd—F	305(21)
OB—BO	506(84)	Cd—H	69.0(4)
B—Br	435(21)	Cd—I	138(21)
B—C	448(29)	Cd—In	138
B—Cl	536(29)	Cd—O	142(42)
BO—Cl	460(42)	Cd—S	196
B—D	341(6)	Cd—Se	310
B—F	766(13)	Calcium	
BF—F	523(63)	Ca—Ca	14.98(46)
BF ₂ —F	557(84)	Ca—Br	321(23)
B—H	330(4)	Ca—Cl	398(13)
B—I	384(21)	Ca—F	527(21)
B—N	389(21)	Ca—H	167.8
B—O	806(5)	Ca—I	285(63)
BCl—O	715(41)	Ca—O	464(84)
B—P	347(17)	Ca—S	314(19)
B—S	581(9)	Carbon	
B—Se	462(15)	C—C	607(21)
B—Si	289(29)	H ₃ C—CH ₃	368
B—Te	354(20)		

TABLE 4.11 Bond Dissociation Energies (*Continued*)

Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Carbon (<i>continued</i>)		Carbon (<i>continued</i>)	
(CH ₃) ₂ C—CH ₃	335	CF ₃ —(N=NCF ₃)	231.0
(CH ₃) ₂ C—C(CH ₃) ₂	282.4	H ₂ C=NH	644(21)
CH ₃ —C ₆ H ₅	389	HC≡N	937
CH ₃ —CH ₂ C ₆ H ₅	301	CH ₃ —NO	174.9(38)
(CH ₃) ₃ C—C(C ₆ H ₅) ₃	63	C ₂ H ₅ —NO	175.7(54)
CH ₃ —allyl	301	C ₃ H ₇ —NO	167.8(75)
CH ₃ —vinyl	121	(CH ₃) ₂ CH—NO	171.5(54)
CH ₃ —C≡CH	490	<i>n</i> -C ₄ H ₉ —NO	215.5(42)
CH ₂ =CH—CH=CH ₂	418	C ₆ H ₅ —NO	215.5(42)
HC≡C—C≡CH	628	Cl ₃ C—NO	134
H ₂ C=CH ₂	682	F ₃ C—NO	130
HC≡CH	962	C ₆ F ₅ —NO	211.3(42)
CH ₃ —CN	506(21)	NC—NO	121(13)
CH ₃ —CH ₂ CN	305(8)	CH ₃ —NO ₂	247(13)
CH ₃ —CH(CH ₃)CN	331(8)	C ₂ H ₅ —NO ₂	259
CH ₃ —C(C ₆ H ₅)CN(CH ₃)	251	C—O	1076.5(4)
CH ₃ CH ₂ —CH ₂ CN	321.8(71)	CH ₃ —OCH ₃	335
NC—CN	603(21)	CH ₃ —OC ₆ H ₅	381
C ₆ H ₅ —C ₆ H ₅	418	CH ₃ —OCH ₂ C ₆ H ₅	280
CH ₃ —CF ₃	423.4(46)	C ₂ H ₅ —OC ₆ H ₅	213
CH ₂ F—CH ₂ F	368(8)	C ₆ H ₅ CH ₂ —OCOCH ₃	285
CF ₃ —CF ₃	406(13)	C ₆ H ₅ CH ₂ —OCOC ₆ H ₅	289
CF ₂ =CF ₂	318(13)	CH ₃ CO—OCH ₃	406
CF ₃ —CN	501	CH ₃ —OSOCH ₃	280
CH ₃ —CHO	314	CH ₂ =CHCH ₂ —OSOCH ₃	209
CH ₃ —CO	342.7	C ₆ H ₅ CH ₂ —OSOCH ₃	222
CH ₃ CO—CF ₃	308.8	C=O	749
CH ₃ CO—COCH ₃	280(8)	H ₂ C=O	732
C ₆ H ₅ CO—COC ₆ H ₅	277.8	OC=O	532.2(4)
Aryl—CH ₂ COCH ₂ —aryl	273.6	SC=O	628
C ₆ H ₅ CH ₂ —COOH	284.9	C≡O	1075
(C ₆ H ₅ CH ₂) ₂ CH—COOH	248.5	C—P	513(8)
C—Cl	397(29)	C—S	699(8)
C—F	536(21)	CH ₃ —SH	305(13)
C—H	337.2(8)	CH ₃ —SC ₆ H ₅	285(8)
C—I	209(21)	CH ₃ —SCH ₂ C ₆ H ₅	247(8)
C—N	770(4)	OC—S	310.4
CF ₃ —NF ₂	272(13)	C—Se	582(96)
CH ₃ —NH ₂	331(13)		
C ₆ H ₅ CH ₂ —NH ₂	301(4)	Cerium	
CH ₃ —NHC ₆ H ₅	285	Ce—Ce	243(21)
CH ₃ —N(CH ₃)C ₆ H ₅	272	Ce—F	582(42)
C ₆ H ₅ CH ₂ —NHCH ₃	289(4)	Ce—N	519(21)
C ₆ H ₅ CH ₂ —N(CH ₃) ₂	255(4)	Ce—O	795(13)
CH ₃ —(N=NCH ₃)	219.7	Ce—S	573(13)
C ₂ H ₅ —(N=NC ₂ H ₅)	209.2	Ce—Se	495(15)
(CH ₃) ₃ C—N=NC(CH ₃) ₃	182.0	Ce—Te	389(42)
Aryl—CH ₂ N=NCH ₂ —aryl	157		

TABLE 4.11 Bond Dissociation Energies (*Continued*)

Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Cesium		Chromium (<i>continued</i>)	
Cs—Cs	41.75(93)	Cr—Cu	155(21)
Cs—Br	397.5(42)	Cr—F	437(20)
Cs—Cl	439(21)	Cr—Ge	170(29)
Cs—F	514(8)	Cr—H	280(50)
Cs—H	178.1(38)	Cr—I	287(24)
Cs—I	339(4)	Cr—N	378(19)
Cs—O	297(25)	Cr—O	427(29)
Cs—OH	385(13)	OCr—O	531(63)
		O ₂ Cr—O	477(84)
		Cr—S	339(21)
Chlorine		Cobalt	
Cl—Cl	242.580(16)	Co—Co	167(25)
Cl—C	338(42)	Co—Br	331(42)
Cl—CH ₃	339(21)	Co—Cl	398(8)
Cl—CH ₃ ⁺	213	Co—Cu	162(17)
Cl—C(CH ₃) ₃	328.4	Co—F	435(63)
Cl—CH ₂ Cl	310(13)	Co—Ge	239(25)
Cl—CCl ₃	293(21)	Co—I	235(81)
Cl—CF ₃	360(33)	Co—O	368(21)
Cl—CCl ₂ F	305(8)	Co—S	343(21)
Cl—CClF ₂	318(8)		
Cl—CF ₂ CF ₂	346.0(71)	Copper	
Cl—CH=CH ₂	351	Cu—Cu	202(4)
Cl—CN	439	Cu—Br	331(25)
Cl—COCl	328	Cu—Cl	383(21)
Cl—COCH ₃	349.4	Cu—F	431(13)
Cl—COC ₆ H ₅	310(13)	Cu—Ga	216(15)
Cl—Cl ⁺	393	Cu—Ge	209(21)
Cl—ClO	143.3(42)	Cu—H	280(8)
O ₃ Cl—ClO ₄	243	Cu—I	197(21)
Cl—F	250.54(8)	Cu—Ni	206(17)
O ₃ Cl—F	255	Cu—O	343(63)
Cl—N	389(50)	Cu—S	285(17)
Cl—NCl	280	Cu—Se	293(38)
Cl—NCl ₂	381	Cu—Sn	177(17)
Cl—NF ₂	<i>ca.</i> 134	Cu—Te	176(38)
Cl—NH ₂	251(25)		
Cl—NO	159(6)	Curium	
Cl—NO ₂	142(4)	Cm—O	736
Cl—O	272(4)		
OCl—O	243(13)	Dysprosium	
O ₂ Cl—O	201(4)	Dy—F	527(21)
Cl—P	289(42)	Dy—O	611(42)
Cl—SiCl ₃	464	Dy—Se	322(42)
		Dy—Te	234(42)
Chromium			
Cr—Cr	155(21)		
Cr—Br	328(24)		
Cr—Cl	366(24)		

TABLE 4.11 Bond Dissociation Energies (*Continued*)

Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Erbium		Gallium (<i>continued</i>)	
Er—F	565(17)	Ga—O	285(63)
Er—O	611(13)	Ga—P	230(13)
Er—S	418(42)	Ga—Sb	209(13)
Er—Se	326(42)	Ga—Te	251(25)
Er—Te	239(42)	Germanium	
Europium		Ge—Ge	274(21)
Eu—Eu	33.5(165)	Ge—Br	255(29)
Eu—Cl	<i>ca.</i> 326	Ge—Cl	431.8(4)
Eu—F	528(18)	Ge—F	485(21)
Eu—O	557(13)	Ge—H	321.3(8)
Eu—S	364(15)	Ge—O	662(13)
Eu—Se	301(15)	Ge—S	551.0(25)
Eu—Te	243(15)	Ge—Se	490(21)
Fluorine		Ge—Si	301(21)
F—F	156.9(96)	Ge—Te	402(8)
F—F ⁺	>251	Gold	
F—CH ₃	452(21)	Au—Au	221.3(21)
F—C(CH ₃) ₃	439	Au—B	368(11)
F—C ₆ H ₅	485	Au—Be	285(8)
F—CCl ₃	444(21)	Au—Bi	293(84)
F—CCl ₂ F	460(25)	Au—Cl	343(10)
F—CClF ₂	490(25)	Au—Co	215(13)
F—CF ₃	523(17)	Au—Cr	215(6)
F—COCH ₃	498	Au—Cu	232(9)
F—FO	272(13)	Au—Fe	187(17)
F—FO ₂	81.0	Au—Ga	294(15)
F—N	301(42)	Au—Ge	277(15)
F—NF	318(25)	Au—H	314(10)
F—NF ₂	243(8)	Au—La	80(5)
F—NO	235.6(42)	Au—Li	68.0(16)
F—NO ₂	197(25)	Au—Mg	243(42)
Gadolinium		Au—Mn	185(13)
Gd—F	590(27)	Au—Ni	274(21)
Gd—O	716(17)	Au—Pb	130(42)
Gd—S	525(15)	Au—Pd	143(21)
Gd—Se	431(15)	Au—Rh	231(29)
Gallium		Au—S	418(25)
Ga—Ga	138(21)	Au—Si	312(12)
Ga—Br	444(17)	Au—Sn	244(17)
(CH ₃) ₃ Ga—CH ₃	253	Au—Te	247(67)
Ga—Cl	481(13)	Au—U	318(29)
Ga—F	577(15)	Hafnium	
Ga—H	<274	Hf—C	548(63)
Ga—I	339(10)	Hf—N	534(29)
		Hf—O	791(8)

TABLE 4.11 Bond Dissociation Energies (Continued)

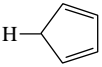
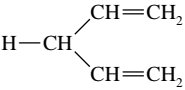
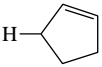
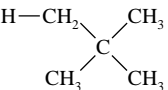
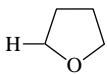
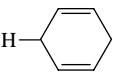
Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Hydrogen		Hydrogen (continued)	
H—H	436.002(4)	H—CHCl ₂	414.2
H— ² H or H—D	439.446(4)	H—CCl ₃	377(8)
² H— ² H or D—D	443.546(4)	H—CBr ₃	377(8)
H—Br	365.7(21)	H—CCl ₂ CHCl ₂	393(8)
H—C	337.2(8)	H—CH ₂ F	423(8)
H—CH	452(33)	H—CHF ₂	423(8)
H—CH ₂	473(4)	H—CF ₃	444(13)
H—CH ₃	431(8)	H—CF ₂ Cl	435(4)
² H—C ² H ₃ or D—CD ₃	442.75(25)	H—CH ₂ CF ₃	446(45)
H—C≡CH	523(4)	H—CF ₂ CH ₃	416(4)
H—CH=CH ₂	427	H—CF ₂ CF ₃	431(63)
H—CH ₂ CH ₃	410(4)	H—CHI	431(8)
H—CH ₂ C≡CH	392.9(50)	H—CHI ₂	431(8)
H—CH ₂ CH=CH ₂	356	H—CN	540(25)
H—cyclopropyl	423(13)	H—CH ₂ CN	ca. 389
H—CH ₂ CH ₂ CH ₃	410(8)	H—CH(CH ₃)CN	377(8)
H—CH(CH ₃) ₂	395.4	H—C(CH ₃) ₂ CN	364(8)
H—cyclobutyl	397(13)	H—CH ₂ NH ₂	397(8)
H—CH ₂ CH(CH ₃) ₂	360	H—CH ₂ Si(CH ₃) ₃	414(4)
H—CH(CH ₃)CH ₂ CH ₃	397(4)	H—CH ₂ COCH ₃	393(75)
H—C(CH ₃) ₃	381	H—Cl	431.8(4)
	339(4)	H—CO	126(8)
	335(4)	H—CHO	364(4)
	343(4)	H—COOH	377
	414(4)	H—COCH ₃	364(4)
H—C(CH ₃) ₂ CH=CH ₂	331	H—COCH ₂ CH ₃	364(4)
H—cyclopentyl	395(42)		385
H—CH ₂ C(CH ₃) ₃	418(4)	H—COC ₆ H ₅	364(4)
H—C ₆ H ₅	431	H—COCF ₃	381(8)
H—CH ₂ C ₆ H ₅	356(4)	H—F	568.6(13)
H—C(C ₆ H ₅) ₃	314	H—I	298.7(8)
	310	H—N	314(17)
H—cyclohexyl	399.6(42)	H—NH	377(8)
H—cycloheptyl	387.0(42)	H—NH ₂	435(8)
H—norbornyl	406(13)	H—NHCH ₃	431(8)
H—CH ₂ Br	410(25)	H—N(CH ₃) ₂	397(8)
H—CHBr ₂	435	H—NHC ₆ H ₅	335(13)
H—CH ₂ Cl	423	H—N(CH ₃)C ₆ H ₅	310(13)
		HNF ₂	318(13)
		H—N ₃	356
		H—NO	<205
		H—O	428.0(21)
		H—OH	498.7(8)
		H—OCH ₃	436.8(42)
		H—OCH ₂ CH ₃	436.0
		H—OC(CH ₃) ₃	439(4)
		H—OC ₆ H ₅	368(25)
		H—ONO	327.6(25)

TABLE 4.11 Bond Dissociation Energies (Continued)

Bond	ΔH_{298}° , kJ/mol	Bond	ΔH_{298}° , kJ/mol
Hydrogen (<i>continued</i>)		Iridium	
H—ONO ₂	423.4(25)	Ir—O	352(21)
H—OOH	374(8)	Ir—Si	463(21)
H—OOCCH ₃	469(17)	Iron	
H—OOCCH ₂ CH ₃	460(17)	Fe—Fe	100(21)
H—OOCCH ₂ H ₇	431(17)	Fe—Br	247(96)
H—P	343(29)	Fe—Cl	<i>ca.</i> 352
H—S	344(12)	Fe—O	409(13)
H—SH	381(4)	Fe—S	339(21)
H—SCH ₃	<i>ca.</i> 368	Fe—Si	297(25)
H—Se	305(2)	Krypton	
H—Si	298.49(46)	Kr—Kr	5.4(8)
H—SiH ₃	393(13)	Kr—F	54
H—Si(CH ₃) ₃	377(13)	Lanthanum	
H—Te	268(2)	La—La	247(21)
Indium		La—C	506(63)
In—In	100(8)	La—F	598(42)
In—Br	418(21)	La—N	519(42)
In—Cl	439(8)	La—O	799(13)
In—F	506(15)	La—S	577(25)
In—O	360(21)	Lead	
In—P	197.9(85)	Pb—Pb	339(25)
In—S	289(17)	Pb—Br	247(38)
In—Sb	152(11)	Pb(CH ₃) ₃ —CH ₃	207(42)
In—Se	247(17)	Pb—Cl	301(29)
In—Te	218(17)	Pb—F	356(8)
Iodine		Pb—H	176(21)
I—I	152.549(8)	Pb—I	197(38)
I—Br	179.1(4)	Pb—O	378(4)
I—CH ₃	232(13)	Pb—S	346.0(17)
I—C ₂ H ₅	223.8	Pb—Se	303(4)
I—CH(CH ₃) ₂	222	Pb—Te	251(13)
I—C(CH ₃) ₃	207.1	Lithium	
I—CH ₂ CF ₃	234(4)	Li—Li	106(4)
I—CF ₂ CH ₃	216(4)	Li—Br	423(21)
I—C ₃ F ₇	209(4)	Li—Cl	469(13)
I—CH=CHCH ₃	172	Li—F	577(21)
I—C ₆ H ₅	268(4)	Li—H	247
I—C ₆ F ₅	276	Li—I	352(13)
I—Cl	213.3(4)	Li—Na	88
I—COCH ₃	219.7	Li—O	341(6)
I—CN	305(4)	Li—OH	427(21)
I—F	280(4)		
I—N	159(17)		
I—NO	71(4)		
I—NO ₂	75(4)		
I—O	184(21)		

TABLE 4.11 Bond Dissociation Energies (*Continued*)

Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Lutetium		Molybdenum	
Lu—Lu	142(34)	Mo—I	372
Lu—F	569(42)	Mo—O	607(34)
Lu—O	695(13)	MoO—O	678(84)
Lu—S	507(15)	MoO ₂ —O	565(84)
Lu—Te	326(17)	Neodymium	
Magnesium		Nd—F	545(13)
Mg—Mg	8.522(4)	Nd—O	703(34)
Mg—Br	297(63)	Nd—S	474(15)
Mg—Cl	318(13)	Nd—Se	385(17)
Mg—F	462(21)	Nd—Te	305(17)
MgF—F	569(42)	Neon	
Mg—H	197(50)	Ne—Ne	3.93
Mg—I	<i>ca.</i> 285	Neptunium	
Mg—O	394(35)	Np—O	720(29)
Mg—OH	238(21)	Nickel	
Mg—S	310(75)	Ni—Ni	261.9(25)
Manganese		Ni—Br	360(13)
Mn—Mn	42(29)	Ni—Cl	372(21)
Mn—Br	314(10)	Ni—F	435
Mn—Cl	361(10)	Ni—H	289(13)
Mn—F	423(15)	Ni—I	293(21)
Mn—I	283(10)	Ni—O	391.6(38)
Mn—Cu	159(17)	Ni—S	360(21)
Mn—O	402(34)	Ni—Si	318(17)
Mn—S	301(17)	Niobium	
Mn—Se	201(13)	Nb—O	753(13)
Mercury		Nitrogen	
Hg—Hg	17.2(21)	N—N	945.33(59)
Hg—Br	72.8(42)	N—Br	276(21)
CH ₃ —HgCH ₃	240.6	ON—Br	28.7(15)
C ₂ H ₅ —HgC ₂ H ₅	182.8(42)	N—Cl	389(50)
C ₃ H ₇ —HgC ₃ H ₇	197.1	ON—Cl	159(6)
Isopropyl—Hgisopropyl	170.3	O ₂ N—Cl	142(4)
C ₆ H ₅ —HgC ₆ H ₅	285	N—F	301(42)
Hg—Cl	100(8)	FN—F	318(21)
Hg—F	130(38)	F ₂ F—N	243(8)
Hg—H	39.8	ON—F	236(4)
Hg—I	38	O ₂ N—F	188(21)
Hg—K	8.24(21)		
Hg—Na	>6.7		
Hg—S	213		
Hg—Se	(167)		
Hg—Te	(142)		

TABLE 4.11 Bond Dissociation Energies (Continued)

Bond	ΔH_{298}° , kJ/mol	Bond	ΔH_{298}° , kJ/mol
Nitrogen (continued)		Oxygen (continued)	
N—I	159(17)	C ₂ H ₅ O—OC ₂ H ₅	159
F ₂ N—NF ₂	88(4)	C ₃ H ₇ O—OC ₃ H ₇	155
H ₂ N—NH ₂	297(8)	Palladium	
H ₂ N—NHCH ₃	271		
H ₂ N—N(CH ₃) ₂	264		
H ₂ N—NHC ₆ H ₅	213	Pd—O	234(29)
HN—N ₂	38	Phosphorus	
ON—N	480.7(42)		
ON—NO ₂	39.8(8)		
O ₂ N—NO ₂	57.3(21)	P—P	490(11)
HN=NH	456(42)	P—Br	266.5
N≡N	946	P—C	513(8)
N—O	630.57(13)	P—Cl	289(42)
HN=O	481	P—F	439(96)
NN—O	167	P—H	343(29)
ON—O	305	P—N	617(21)
N—P	617(21)	P—O	596.6
N—S	464(21)	Br ₃ P=O	498(21)
Osmium		Cl ₃ P=O	510(21)
		F ₃ P=O	544(21)
O ₃ Os—O	301(21)	P—S	346.0(17)
Oxygen		P=S	347
		P—Se	363(10)
		P—Te	298(10)
O—O	498.34(20)	Platinum	
O—Br	235.1(4)		
HO—CH ₃	377(13)	Pt—B	478(17)
HO—CH=CH ₂	364	Pt—H	352(38)
HO—CH ₂ CH=CH ₂	456	Pt—O	347(34)
HO—C ₆ H ₅	431	Pt—P	417(17)
HO—CH ₂ C ₆ H ₅	322	Pt—Si	501(18)
HO—CHO	402(13)	Potassium	
HO—COCH ₃	452(21)		
HO—COC ₂ H ₅	180		
O—Cl	272(4)	K—K	57.3(42)
HO—Cl	251(13)	K—Br	383(8)
O—F	222(17)	K—Cl	427(8)
O—FO	467	K—F	497.5(25)
FO—OF	261(84)	K—H	183(15)
O—I	184(21)	K—I	331(13)
HO—I	234(13)	K—Na	63.6(29)
O—N	630.57(13)	K—O	239(34)
HO—NCH ₃	209	K—OH	343(8)
HO—OC(CH ₃) ₃	192(8)	Praseodymium	
HO—OH	213.8(21)		
O—OH	268(4)		
CF ₃ O—OCF ₃	192	Pr—F	582(46)
CH ₃ O—OCH ₃	157.3(8)	Pr—O	753(17)
		Pr—S	492.5(46)

TABLE 4.11 Bond Dissociation Energies (*Continued*)

Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Praseodymium (<i>continued</i>)		Scandium	
Pr—Se	446(23)	Sc—Sc	163(21)
Pr—Te	326(42)	Sc—Br	444(63)
Promethium		Sc—C	393(63)
Pm—F	540(42)	Sc—Cl	318
Pm—O	674(63)	Sc—F	589(13)
Pm—S	423(63)	Sc—N	469(84)
Pm—Se	339(63)	Sc—O	674(13)
Pm—Te	255(63)	Sc—S	478(13)
Radium		Sc—Se	385(17)
Ra—Cl	343(75)	Sc—Te	289(17)
Rhodium		Selenium	
Rh—Rh	285(21)	Se—Se	332.6(4)
Rh—B	476(21)	Se—Br	297(84)
Rh—C	583.7(63)	Se—C	582(96)
Rh—O	377(63)	Se—Cl	322
Rh—Si	395(18)	Se—F	339(42)
Rh—Ti	391(15)	Se—H	305(2)
Rubidium		Se—N	381(63)
Rb—Rb	45.6(21)	Se—O	423(13)
Rb—Br	389(13)	Se—P	364(10)
Rb—Cl	448(21)	Se—S	381(21)
Rb—F	494(21)	Se—Si	531(25)
Rb—H	167(21)	Se—Te	268(8)
Rb—I	335(13)	Silicon	
Rb—O	255(84)	Si—Si	327(10)
Rb—OH	351(8)	Si—Br	343(50)
Ruthenium		Si—C	435(21)
Ru—O	481(63)	Si—Cl	456(42)
O ₃ Ru—O	439	Si—F	540(13)
Ru—Si	397(21)	Si—H	298.49(46)
Ru—Th	592(42)	Si—I	339(84)
Samarium		Si—N	439(38)
Sm—Cl	423(13)	Si—O	798(8)
Sm—F	531(18)	Si—S	619(13)
Sm—O	619(13)	Si—Se	531(25)
Sm—S	389	H ₃ Si—SiH ₃	339(17)
Sm—Se	331(15)	(CH ₃) ₃ Si—Si(CH ₃) ₃	339
Sm—Te	272(15)	(Aryl) ₃ Si—Si(aryl) ₃	368(31)
		Si—Te	506(38)
		Silver	
		Ag—Ag	163(8)
		Ag—Au	203(9)
		Ag—Bi	193(42)

TABLE 4.11 Bond Dissociation Energies (Continued)

Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Silver (continued)		Tantalum	
Ag—Br	293(29)	Ta—N	611(84)
Ag—Cl	341.4	Ta—O	805(13)
Ag—Cu	176(8)	Tellurium	
Ag—F	354(16)	Te—B	354(20)
Ag—Ga	180(15)	Te—H	268(2)
Ag—Ge	175(21)	Te—I	193(42)
Ag—H	226(8)	Te—O	391(8)
Ag—I	234(29)	Te—P	298(10)
Ag—In	176(17)	Te—S	339(21)
Ag—O	213(84)	Te—Se	268(8)
Ag—Sn	136(21)	Terbium	
Ag—Te	293(96)	Tb—F	561(42)
Sodium		Tb—O	707(13)
Na—Na	77.0	Tb—S	515(42)
Na—Br	370(13)	Tb—Te	339(42)
Na—Cl	410(8)	Thallium	
Na—F	481(8)	Tl—Tl	63
Na—H	201(21)	Tl—Br	333.9(17)
Na—I	301(8)	Tl—Cl	372.8(21)
Na—K	63.6(29)	Tl—F	445(19)
Na—O	257(17)	Tl—H	188(8)
Na—OH	381(13)	Tl—I	272(8)
Na—Rb	59(4)	Thorium	
Strontium		Th—Th	289
Sr—Br	332(19)	Th—C	484(25)
Sr—Cl	406(13)	Th—N	577.4(21)
Sr—F	542(7)	Th—O	854(13)
Sr—H	163(8)	Th—P	377
Sr—I	263(42)	Thullium	
Sr—O	454(15)	Tm—F	569(42)
Sr—OH	381(42)	Tm—O	557(13)
Sr—S	314(21)	Tm—S	368(42)
Sulfur		Tm—Se	276(42)
S—S	429(6)	Tm—Te	276(42)
S—Cl	255	Tin	
S—F	343(5)	Sn—Sn	195(17)
O ₂ S—F	71	Sn—Br	339(4)
S—N	464(21)		
S—O	521.70(13)		
OS—O	551.4(84)		
O ₂ S—O	348.1(42)		
HS—SH	272(21)		

TABLE 4.11 Bond Dissociation Energies (Continued)

Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Tin (<i>continued</i>)		Vanadium (<i>continued</i>)	
BrSn—Br	326	V—Cl	477(63)
Br ₃ Sn—Br	272	V—F	590(63)
(C ₂ H ₅) ₃ Sn—C ₂ H ₅	<i>ca.</i> 238	V—N	477(8)
Sn—Cl	406(13)	V—O	644(21)
Sn—F	467(13)	V—S	490(16)
Sn—H	267(17)	V—Se	347(21)
Sn—I	234(42)	Xenon	
Sn—O	548(21)	Xe—Xe	6.53(30)
Sn—S	464(3)	Xe—F	13.0(4)
Sn—Se	401.3(59)	Xe—O	36.4
Sn—Te	319.2(8)	Ytterbium	
Titanium		Yb—Cl	322
Ti—Ti	141(21)	Yb—F	521(10)
Ti—Br	439	Yb—H	159(38)
Ti—C	435(25)	Yb—O	397.9(63)
Ti—Cl	494	Yb—S	167
Ti—F	569(34)	Yttrium	
Ti—H	<i>ca.</i> 159	Y—Y	159(21)
Ti—I	310(42)	Y—Br	485(84)
Ti—N	464	Y—C	418(63)
Ti—O	662(16)	Y—Cl	527(42)
Ti—S	426(8)	Y—F	605(21)
Ti—Se	381(42)	Y—N	481(63)
Ti—Te	289(17)	Y—O	715.1(30)
Tungsten		Y—S	528(11)
W—Cl	423(42)	Y—Se	435(13)
W—F	548(63)	Y—Te	339(13)
W—O	653(25)	Zinc	
OW—O	632(84)	Zn—Zn	29
O ₂ W—O	598(42)	Zn—Br	142(29)
W—P	305(4)	C ₂ H ₅ C—C ₂ H ₅	<i>ca.</i> 201
Uranium		Zn—Cl	229(20)
U—O	761(17)	Zn—F	368(63)
OU—O	678(59)	Zn—H	85.8(21)
O ₂ U—O	644(88)	Zn—I	138(29)
U—S	523(10)	Zn—O	284.1
Vanadium		Zn—S	205(13)
V—V	242(21)	Zn—Se	136(13)
V—Br	439(42)	Zn—Te	205
V—C	469(63)		

TABLE 4.11 Bond Dissociation Energies (*Continued*)

Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol	Bond	$\Delta H_f^{\circ}_{298}$, kJ/mol
Zirconium		Zirconium (<i>continued</i>)	
Zr—C	561(25)	Zr—O	760(8)
Zr—F	623(63)	Zr—S	575(17)
Zr—N	565(25)		

Source: T. L. Cottrell, *The Strengths of Chemical Bonds*, 2d ed., Butterworth, London, 1958; B. deB. Darwent, *National Standard Reference Data Series*, National Bureau of Standards, no. 31, Washington, 1970; S. W. Benson, *J. Chem. Educ.* **42**:502 (1965); and J. A. Kerr, *Chem. Rev.* **66**:465 (1966).