STRENGTHS OF CHEMICAL BONDS*

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The strength of a chemical bond, $D°$(R-X), often known as the bond dissociation energy, is defined as the standard enthalpy change of the reaction in which the bond is broken: RX → R + X. It is given by the thermochemical equation, $D°(R\text{-}X) = \Delta_f H°(R) + \Delta_f H°(X) - \Delta_f H°(RX)$. Some authors list bond strengths at a temperature of absolute zero but here the values at 298 K are given because more thermodynamic data are available for this temperature. Bond strengths or bond dissociation energies are not equal to, and may differ considerably from, mean bond energies determined solely from thermochemical data on atoms and molecules.

Table 1
BOND STRENGTHS IN DIATOMIC MOLECULES

These have usually been measured spectroscopically or by mass spectrometric analysis of hot gases effusing a Knudsen cell. Excellent accounts of these and other methods are given in (i) *Dissociation Energies and Spectra of Diatomic Molecules*, by A. G. Gaydon, 3rd. ed., Chapman & Hall, London, 1968 and (ii) "Mass Spectrometric Determination of Bond Energies of High-Temperature Molecules", K. A. Gingerich, *Chimia*, 26, 619, 1972. The errors quoted in the table are those given in the original paper or review article. The references have been chosen primarily as a key to the literature. It should not be assumed that the author referred to was responsible for the value quoted, as the reference may be to a review article.

Bond strengths reported at a temperature of absolute zero, $D°_0$, have been converted to $D°_{298}$ by the use of enthalpy functions taken mainly from the JANAF Thermochemical Tables, Third Edition, *J. Phys. Chem. Ref. Data*, 14, Suppl. 1, 1985, wherever possible. For most bonds, however, this data is not available and the conversion has been made by the approximate relation:

$$D°_{298} = D°_0 + (3/2)RT$$

The list below does not include the increasing number of bond strengths of diatomic molecules now being calculated by *ab initio* methods.

The Table has been arranged in an alphabetical order of the atoms.

Molecule	$D°_{298}$/kJ mol^{-1}	Ref.	Molecule	$D°_{298}$/kJ mol^{-1}	Ref.	Molecule	$D°_{298}$/kJ mol^{-1}	Ref.
Ag-Ag	160.3 ± 3.4	314	Al-Cl	511.3 ± 0.8	312	As-Ga	209.6 ± 1.2	83
Ag-Al	183.7 ± 9.2	79	Al-Co	181.6 ± 0.2	22	As-H	274.0 ± 2.9	29
Ag-Au	202.9 ± 9.2	4	Al-Cr	223.6 ± 0.6	19	As-I	296.6 ± 28.0	325
Ag-Bi	193 ± 42	246	Al-Cu	227.1 ± 1.2	21	As-In	201	297
Ag-Br	293 ± 29	120	Al-D	290.8	246	As-N	489 ± 2	310
Ag-Cl	314.2	184	Al-F	663.6 ± 6.3	80	As-O	481 ± 8	262
Ag-Cu	174.1 ± 9.2	136	Al-H	284.9 ± 6.3	80	As-P	433.5 ± 12.6	137
Ag-D	226.8	205	Al-I	369.9 ± 2.1	267	As-S	379.5 ± 6.3	262
Ag-Dy	130 ± 19	203	Al-Kr	6.047 ± 0.001	180	As-Sb	330.5 ± 5.4	94
Ag-Eu	129.7 ± 12.6	66	Al-Li	76.5	39	As-Se	96	288
Ag-F	354.4 ± 16.3	120	Al-N	297 ± 96	120	As-Tl	198.3 ± 14.6	300
Ag-Ga	180 ± 15	44	Al-Ni	225 ± 5	20	At-At	~80	89
Ag-Ge	174.5 ± 20.9	135	Al-O	511 ± 3	56,74	Au-Au	226.2 ± 0.5	210
Ag-H	215.1 ± 8	217	Al-P	216.7 ± 12.6	80	Au-B	367.8 ± 10.5	145
Ag-Ho	123.4 ± 16.7	62	Al-Pd	254.4 ± 12.1	64	Au-Ba	254.8 ± 10.0	135
Ag-I	234 ± 29	120	Al-S	373.6 ± 7.9	376	Au-Be	285 ± 8	120
Ag-In	166.5 ± 4.9	13	Al-Sb	216.3 ± 5.9	293	Au-Bi	297 ± 8.4	135
Ag-Li	173.6 ± 6.3	276,303	Al-Se	337.6 ± 10.0	376	Au-Ca	243	135
Ag-Mn	100 ± 21	246	Al-Si	229.3 ± 30.1	51	Au-Ce	339 ± 21	135
Ag-Na	138.1 ± 8.4	291,298	Al-Te	267.8 ± 10.0	376	Au-Cl	343 ± 9.6	120
Ag-Nd	<209	221	Al-U	326 ± 29	123	Au-Co	222 ± 17	135
Ag-O	220.1 ± 20.9	287	Al-V	147.4 ± 1.0	22	Au-Cr	213 ± 17	135
Ag-S	217.1	349	Al-Xe	7.43 ± 0.69	43	Au-Cs	255 ± 3.3	41
Ag-Se	202.5	349	Ar-Ar	4.73 ± 0.04	181	Au-Cu	228.0 ± 5.0	34,135
Ag-Si	177.8 ± 10.0	320	Ar-He	3.89	246	Au-D	318.4	205
Ag-Sn	136.0 ± 20.9	3	Ar-Hg	6.15	246	Au-Dy	259 ± 21	203
Ag-Te	195.8	349	Ar-I	10.0	40	Au-Eu	241.0 ± 10.5	66
Al-Al	133 ± 6	118	Ar-K	4.2	205	Au-Fe	187.0 ± 16.7	220
Al-Ar	5.182 ± 0.005	180	As-As	382.0 ± 10.5	247	Au-Ga	234 ± 38	135
Al-As	202.9 ± 7.1	294,301	As-Cl	448	80	Au-Ge	274.1 ± 5.0	135
Al-Au	325.9 ± 6.3	124	As-D	270.3	205	Au-H	292.0 ± 8	217
Al-Br	429 ± 6	186	As-F	410	205	Au-Ho	267.4 ± 16.7	62,250

* Revised to November 1998.

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Table 1
BOND STRENGTHS IN DIATOMIC MOLECULES (continued)

Molecule	D°_{298}/kJ mol^{-1}	Ref.
Au-In	286.0 ± 5.7	13
Au-La	336.4 ± 20.9	127
Au-Li	284.5 ± 6.7	276
Au-Lu	332.2 ± 16.7	132
Au-Mg	243 ± 42	246
Au-Mn	185.4 ± 12.6	342
Au-Na	215.1 ± 12.6	298
Au-Nd	299.2 ± 20.9	127
Au-Ni	247 ± 16	352
Au-O	221.8 ± 20.9	287
Au-Pb	130 ± 42	246
Au-Pd	155 ± 21	135
Au-Pr	310 ± 21	135
Au-Rb	243 ± 2.9	41
Au-Rh	231.0 ± 29	66
Au-S	418 ± 25	131
Au-Sc	280.3 ± 16.7	128
Au-Se	243.1	349
Au-Si	305.4 ± 5.9	139
Au-Sn	254.8 ± 7.1	233
Au-Sr	264 ± 42	246
Au-Tb	289.5 ± 33.5	152,250
Au-Te	317.6	349
Au-U	318 ± 29	123
Au-V	240.6 ± 12.1	172
Au-Y	307.1 ± 8.4	177
B-B	297 ± 21	80
B-Br	396	32
B-C	448 ± 29	246
B-Ce	305 ± 21	246
B-Cl	511.3 ± 4	195
B-D	341.0 ± 6.3	246
B-F	757	257
B-H	340	302
B-I	220.5 ± 0.8	315
B-Ir	514.2 ± 17.2	381
B-La	339 ± 63	246
B-N	389 ± 21	80
B-O	808.8 ± 20.9	287
B-P	346.9 ± 16.7	147
B-Pd	329.3 ± 20.9	381
B-Pt	477.8 ± 16.7	268
B-Rh	475.7 ± 20.9	381
B-Ru	446.9 ± 20.9	381
B-S	580.7 ± 9.2	374
B-Sc	276 ± 63	246
B-Se	461.9 ± 14.6	374
B-Si	317 ± 7	390
B-Te	354.4 ± 20.1	374
B-Th	297	140
B-Ti	276 ± 63	246
B-U	322 ± 33	246
B-Y	293 ± 63	246
Ba-Br	362.8 ± 8.4	104,199,230
Ba-Cl	436.0 ± 8.4	197,199
Ba-D	≤193.7	205
Ba-F	587.0 ± 6.7	101,196
Ba-H	176 ± 14.6	120
Ba-I	320.8 ± 6.3	188
Ba-O	561.9 ± 13.4	287
Ba-Pd	221.8 ± 5.0	125
Ba-Rh	259.4 ± 25.1	125
Ba-S	400.0 ± 18.8	70
Be-Be	59	35,87
Be-Br	381 ± 84	246
Be-Cl	388.3 ± 9.2	108,191,382
Be-D	203.05	205
Be-F	577 ± 42	80,108
Be-H	200.0 ± 1.3	67
Be-O	434.7 ± 13.4	287
Be-S	372 ± 59	120
Bi-Bi	200.4 ± 7.5	307,324
Bi-Br	267.4 ± 4.2	76
Bi-Cl	301 ± 4	78
Bi-D	283.7	266
Bi-F	367 ± 13	400
Bi-Ga	159 ± 17	296
Bi-H	≤283.3	266
Bi-I	218.0 ± 4.6	77
Bi-In	153.6 ± 1.7	321
Bi-Li	154.0 ± 5.0	277,305
Bi-O	337.2 ± 12.6	287
Bi-P	280 ± 13	137
Bi-Pb	141.8 ± 14.6	324
Bi-S	315.5 ± 4.6	375
Bi-Sb	251 ± 4	244
Bi-Se	280.3 ± 5.9	375
Bi-Sn	210.0 ± 8.4	135
Bi-Te	232.2 ± 11.3	375
Bi-Tl	121 ± 13	84
Br-Br	192.807	1
Br-C	280 ± 21	120
Br-Ca	310.9 ± 9.2	319
Br-Cd	159 ± 96	120
Br-Cl	217.53 ± 0.29	59
Br-Co	331 ± 42	246
Br-Cr	328.0 ± 24.3	120
Br-Cs	389.1 ± 4	285,362
Br-Cu	331 ± 25	120
Br-D	370.74	205
Br-F	280 ± 12	211
Br-Fe	247 ± 96	120
Br-Ga	444 ± 17	80
Br-Ge	255 ± 29	120
Br-H	366.35	205
Br-Hg	72.8 ± 4	80
Br-I	179.1 ± 0.4	120,309
Br-In	414 ± 21	80
Br-K	379.9 ± 0.8	362,378
Br-Li	418.8 ± 4	362
Br-Mg	≤327.2	205
Br-Mn	314.2 ± 9.6	120
Br-N	276 ± 21	120
Br-Na	367.4 ± 0.8	362,378
Br-Ni	360 ± 13	120
Br-O	235.5 ± 2.4	46
Br-Pb	247 ± 38	120
Br-Rb	380.7 ± 4	362
Br-Sb	314 ± 59	120
Br-Sc	444 ± 63	246
Br-Se	297 ± 84	246
Br-Si	367.8 ± 10.0	106
Br-Sn	≥552	286
Br-Sr	333.0 ± 9.2	199
Br-Th	364	187
Br-Ti	439	246
Br-Tl	333.9 ± 1.7	28
Br-U	377.4 ± 6.3	260
Br-V	439 ± 42	246
Br-W	329.3	223
Br-Xe	5.94 ± 0.02	58
Br-Y	485 ± 84	246
Br-Zn	142 ± 29	246
C-C	610 ± 2.0	373
C-Ce	444 ± 13	236
C-Cl	397 ± 29	283
C-D	341.4	205
C-F	552	193
C-Ge	460 ± 21	120
C-H	338.4 ± 1.2	205
C-Hf	540 ± 25	357
C-I	209 ± 21	120
C-Ir	632 ± 4	171
C-La	462 ± 20	290
C-Mo	481 ± 15.9	167
C-N	748.0 ± 10	42
C-Nb	569 ± 13.0	167
C-O	1076.5 ± 0.4	80
C-Os	≥594	126
C-P	513.4 ± 8	350
C-Pt	598 ± 5.9	171,379
C-Rh	580.0 ± 3.8	332
C-Ru	616.2 ± 10.5	333
C-S	714.1 ± 1.2	71,354
C-Sc	≤444	148
C-Se	590.4 ± 5.9	343
C-Si	451.5	91,387
C-Tc	565 ± 29	322
C-Th	453 ± 17	166,357
C-Ti	423 ± 29	162,357
C-U	454.8 ± 15.1	165,169
C-V	427 ± 23.8	167
C-Y	418 ± 14	338
C-Zr	561 ± 25	357
Ca-Ca	~17	153
Ca-Cl	409 ± 9	269
Ca-D	≤169.9	205
Ca-F	527 ± 21	101,190
Ca-H	167.8	120
Ca-I	284.7 ± 8.4	188
Ca-Li	84.9 ± 8.4	397

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Table 1
BOND STRENGTHS IN DIATOMIC MOLECULES (continued)

Molecule	D°_{298}/kJ mol^{-1}	Ref.
Ca-O	402.1 ± 16.7	287,326
Ca-S	337.6 ± 18.8	70,205
Cd-Cd	7.36	251
Cd-Cl	208.4	205
Cd-F	305 ± 21	31
Cd-H	69.0 ± 0.4	120
Cd-I	97.23	215
Cd-In	138	246
Cd-O	235.6 ± 83.7	158,287
Cd-S	208.4 ± 20.9	158
Cd-Se	127.6 ± 25.1	158
Cd-Te	100.0 ± 15.1	158
Ce-Ce	245.2	127
Ce-F	582 ± 42	246
Ce-Ir	586	149
Ce-N	519 ± 21	146
Ce-O	795 ± 8	95
Ce-Os	506 ± 33	126
Ce-Pd	322.2	63
Ce-Pt	556	149
Ce-Rh	548	149
Ce-Ru	531 ± 25	126
Ce-S	569	24
Ce-Se	494.5 ± 14.6	271
Ce-Te	189.4 ± 12.8	252
Cl-Cl	242.580 ± 0.004	205
Cl-Co	337.6 ± 6.7	194
Cl-Cr	377.8 ± 6.7	194
Cl-Cs	448 ± 8	285,363
Cl-Cu	377.8 ± 7.5	184
Cl-D	436.47	205
Cl-Eu	~326	113
Cl-F	256.23	205,279
Cl-Fe	329.7 ± 6.7	194
Cl-Ga	481 ± 13	80
Cl-Ge	~431	205
Cl-H	431.62	205
Cl-Hg	100 ± 8	120
Cl-I	211.3 ± 0.4	120
Cl-In	439 ± 8	80
Cl-K	433.0 ± 8	363
Cl-Li	469 ± 13	80
Cl-Mg	327.6 ± 2.1	105,197,382
Cl-Mn	338.5 ± 6.7	194
Cl-N	333.9 ± 9.6	54
Cl-Na	412.1 ± 8	363
Cl-Ni	377.0 ± 6.7	194
Cl-O	268.85 ± 0.10	2
Cl-P	289 ± 42	246
Cl-Pb	301 ± 29	120
Cl-Ra	343 ± 75	120
Cl-Rb	427.6 ± 8	363
Cl-S	277.0	224
Cl-Sb	360 ± 50	120
Cl-Sc	331	386
Cl-Se	322	246
Cl-Si	406	308,385
Cl-Sm	≥423	399
Cl-Sn	414 ± 17	246
Cl-Sr	406 ± 13	197,199
Cl-Ta	544	23
Cl-Th	489	261
Cl-Ti	405.4 ± 10.5	192
Cl-Tl	372.8 ± 2.1	28
Cl-U	452 ± 8	259
Cl-V	477 ± 63	246
Cl-W	423 ± 42	246
Cl-Xe	6.7	205
Cl-Y	527 ± 84	246
Cl-Yb	~322	113
Cl-Zn	228.9 ± 19.7	73
Cm-O	736	341
Co-Co	167 ± 25	218
Co-Cu	167 ± 17	135
Co-F	435 ± 63	246
Co-Ge	234 ± 21	135
Co-H	226 ± 42	369
Co-I	285 ± 21	246
Co-Nb	267.0 ± 0.1	8
Co-O	384.5 ± 13.4	287
Co-S	331	349
Co-Si	276 ± 17	380
Co-Ti	235.4 ± 0.1	353
Co-Y	253.7 ± 0.1	8
Co-Zr	306.4 ± 0.1	8
Cr-Cr	142.9 ± 5.4	201
Cr-Cu	155 ± 21	222
Cr-F	444.8 ± 19.7	227
Cr-Ge	154 ± 7	202
Cr-H	190.3 ± 7.0	53
Cr-I	287.0 ± 24.3	120
Cr-N	377.8 ± 18.8	152,355
Cr-O	461 ± 9	179
Cr-Pb	105 ± 2	202
Cr-S	331	93
Cr-Sn	141 ± 3	202
Cs-Cs	43.919 ± 0.010	394
Cs-F	519 ± 8	285
Cs-H	175.364	401
Cs-Hg	8	205
Cs-I	337.2 ± 2.1	285,361
Cs-Na	63.2 ± 1.3	86
Cs-O	295.8 ± 62.8	287
Cs-Rb	49.57 ± 0.01	174
Cu-Cu	176.52 ± 2.38	135,323
Cu-D	270.3	205
Cu-Dy	142 ± 21	203
Cu-F	413.4 ± 13	99
Cu-Ga	215.9 ± 15.1	44
Cu-Ge	208.8 ± 21	273
Cu-H	277.8	217,318
Cu-Ho	142 ± 21	203
Cu-I	197 ± 21	120
Cu-In	187.4 ± 7.9	13
Cu-Li	192.9 ± 8.8	276
Cu-Mn	158.6 ± 17	222
Cu-Na	176.1 ± 16.7	299
Cu-Ni	202 ± 10	117
Cu-O	269.0 ± 20.9	287
Cu-S	276	349
Cu-Se	251	349
Cu-Si	221.3 ± 6.3	320
Cu-Sn	169.5 ± 6.7	3,237
Cu-Tb	193 ± 19	203
Cu-Te	278.7	1
D-D	443.533	205
D-F	576.6	205
D-Ga	<272.8	253
D-Ge	≤322	205
D-H	439.433	205
D-Hg	42.05	205
D-In	246.0	205
D-Li	240.1892 ± 0.0046	207,360
D-Lu	302	308
D-Mg	135.1	205
D-Ni	≤302.9	205
D-Pt	≤350.2	205
D-S	351	205
D-Si	302.5	205
D-Sr	≥275.7	205
D-Zn	88.7	205
Dy-F	531	406
Dy-O	607 ± 17	95
Dy-S	414 ± 42	246
Dy-Se	322 ± 42	246
Dy-Te	234 ± 42	246
Er-F	565 ± 17	406
Er-O	615 ± 13	95
Er-S	418 ± 42	246
Er-Se	326 ± 42	246
Er-Te	238 ± 42	246
Eu-Eu	33.5 ± 17	66
Eu-F	544	242
Eu-Li	66.9 ± 2.9	275
Eu-O	479 ± 10	95
Eu-Rh	233.9 ± 33	66
Eu-S	362.3 ± 13.0	271,347
Eu-Se	301 ± 14.6	25,178,271
Eu-Te	243 ± 14.6	25,271
F-F	158.78	205
F-Ga	577 ± 14.6	270
F-Gd	590.4 ± 27.2	405
F-Ge	485 ± 21	98
F-H	569.87 ± 0.06	402
F-Hf	650 ± 15	16
F-Hg	~180	205
F-Ho	540	406
F-I	≤271.5	7,33,60,75

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Table 1
BOND STRENGTHS IN DIATOMIC MOLECULES (continued)

Molecule	D°_{298}/kJ mol^{-1}	Ref.
F-In	506 ± 14.6	270
F-K	497.5 ± 2.5	17
F-La	598 ± 42	246
F-Li	577 ± 21	80
F-Lu	333.5	208
F-Mg	461.9 ± 5.0	101,196
F-Mn	423.4 ± 14.6	228
F-Mo	464.8	198
F-N	343	205
F-Na	519	205
F-Nd	545.2 ± 12.6	403
F-Ni	430 ± 20	85
F-O	219.54 ± 10	48
F-P	439 ± 96	120
F-Pb	356 ± 8	408
F-Pm	540 ± 42	246
F-Pr	582 ± 46	246
F-Pu	538.5 ± 29	229
F-Rb	494 ± 21	80
F-Ru	402	185
F-S	342.7 ± 5.0	30,200,231
F-Sb	439 ± 96	120
F-Sc	589.1 ± 13	404
F-Se	339 ± 42	246
F-Si	552.7 ± 2.1	109
F-Sm	565	242
F-Sn	466.5 ± 13	408
F-Sr	541.8 ± 6.7	101,196
F-Ta	573 ± 13	256
F-Tb	561 ± 42	246
F-Th	652	263
F-Ti	569 ± 33	407
F-Tl	445.2 ± 19.2	28
F-Tm	510	242
F-U	659.0 ± 10.5	157,258
F-V	590 ± 63	246
F-W	548 ± 63	246
F-Xe	15.77	317,368
F-Y	605.0 ± 20.9	404
F-Yb	≥521.3	18,113,399
F-Zn	368 ± 63	246
F-Zr	616 ± 15	16
Fe-Fe	75 ± 17	330
Fe-Ge	210.9 ± 29	219
Fe-H	180 ± 25	369
Fe-O	390.4 ± 17.2	287
Fe-S	322	93
Fe-Si	297 ± 25	380
Ga-Ga	112.1 ± 7	337
Ga-H	<274.1	253
Ga-I	339 ± 9.6	120
Ga-Li	133.1 ± 14.6	160
Ga-O	353.5 ± 41.8	287
Ga-P	229.7 ± 12.6	130
Ga-Sb	192.0 ± 12.6	295
Ga-Te	251 ± 25	377
Gd-O	719 ± 10	95
Gd-S	526.8 ± 10.5	116,345
Gd-Se	431 ± 14.6	25
Gd-Te	343 ± 14.6	25
Ge-Ge	263.6 ± 7.1	238
Ge-H	≤321.7	243
Ge-Ni	290.3 ± 10.9	335
Ge-O	659.4 ± 12.6	226,287
Ge-Pd	254.7 ± 10.5	334
Ge-S	534 ± 3	280
Ge-Sc	271.0 ± 11	234
Ge-Se	484.7 ± 1.7	282
Ge-Si	296.4 ± 8.6	391
Ge-Te	397 ± 3	282
Ge-Y	279.8 ± 11.4	235
H-H	435.990	205
H-Hg	39.844	205
H-I	298.407	205
H-In	243.1	205
H-K	174.576	206,401
H-Li	238.049 ± 0.004	393
H-Mg	126.4 ± 2.9	14,15,100
H-Mn	234 ± 29	120
H-N	≤339	205
H-Na	185.69 ± 0.25	274,316
H-Ni	252.3 ± 8	217
H-O	427.6	205
H-P	297	205
H-Pb	≤157	205
H-Pd	234 ± 25	369
H-Pt	≤335	205
H-Rb	167 ± 21	120
H-Rh	247 ± 21	369
H-Ru	234 ± 21	369
H-S	344.3 ± 12.1	212
H-Sc	~180	329
H-Se	314.47 ± 0.96	122
H-Si	≤299.2	205
H-Sn	264 ± 17	120
H-Sr	163 ± 8	120
H-Te	268 ± 2.1	119
H-Ti	204.6 ± 8.8	52
H-Tl	188 ± 8	120
H-V	208.7 ± 7.0	53
H-Yb	159 ± 38	120
H-Zn	85.8 ± 2.1	120
He-He	3.8	205
He-Hg	6.61	246
Hf-C	548 ± 63	246
Hf-N	536 ± 29	152,245
Hf-O	801.7 ± 13.4	287
Hg-Hg	8 ± 2	204
Hg-I	34.69 ± 0.96	388
Hg-K	8.24 ± 0.21	246
Hg-Li	13.8	205
Hg-Na	9.2	205,411
Hg-O	220.9 ± 33.1	158
Hg-Rb	8.4	205
Hg-S	217.1 ± 22.2	158
Hg-Se	144.3 ± 30.1	158
Hg-Te	≤142	246
Hg-Tl	4	183
Ho-Ho	84 ± 17	62
Ho-O	611 ± 17	95
Ho-S	428.4 ± 14.6	345
Ho-Se	335 ± 17	25
Ho-Te	259 ± 17	25
I-I	151.088	205,371
I-In	331	384
I-K	325.1 ± 0.8	361,378
I-Li	345.2 ± 4.2	361
I-Mg	~285	26
I-Mn	282.8 ± 9.6	120
I-N	159 ± 17	246
I-Na	304.2 ± 2.1	361,378
I-Ni	293 ± 21	120
I-O	230	47
I-Pb	193 ± 4	340
I-Rb	318.8 ± 2.1	361
I-Si	293	205
I-Sn	234 ± 42	246
I-Sr	269.9 ± 5.9	239
I-Te	192 ± 42	246
I-Ti	310 ± 42	246
I-Tl	272 ± 8	26
I-Zn	108.29	215
I-Zr	305	241
In-In	100 ± 8	246
In-Li	92.5 ± 14.6	160
In-O	<320.1	287
In-P	197.9 ± 8.4	291
In-S	289 ± 17	69
In-Sb	151.9 ± 10.5	81
In-Se	247 ± 17	69
In-Te	218 ± 17	69
Ir-La	577 ± 13	176
Ir-O	414.6 ± 42.3	287
Ir-Si	462.8 ± 20.9	381
Ir-Th	573	133
Ir-Ti	422 ± 13	289
Ir-Y	456.1 ± 16.7	177
K-K	54.63 ± 0.02	6,265
K-Kr	4.6	205
K-Li	82.0 ± 4.2	103,410
K-Na	65.994 ± 0.008	36,410
K-O	277.8 ± 20.9	287
K-Xe	5.0	205
Kr-Kr	5.23	50,205
Kr-O	<8	246
Kr-Xe	5.505 ± 0.002	9
La-La	247 ± 21	386
La-N	519 ± 42	246
La-O	799 ± 4	95
La-Pt	502 ± 21	272
La-Rh	527 ± 17	65

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Table 1
BOND STRENGTHS IN DIATOMIC MOLECULES (continued)

Molecule	D°_{298}/kJ mol^{-1}	Ref.
La-S	573.2 ± 1.7	214,359
La-Se	477 ± 17	25,271
La-Te	381 ± 17	25,154
La-Y	202.1	386
Li-Li	110.21 ± 4	383,398
Li-Mg	67.4 ± 6.3	396
Li-Na	87.181 ± 0.001	102,111
Li-O	333.5 ± 8.4	287
Li-Pb	78.7 ± 7.9	277
Li-S	312.5 ± 7.5	232
Li-Sb	172.8 ± 10.0	278
Li-Sm	49.0 ± 4.2	275
Li-Tm	69.0 ± 3.3	275
Li-Yb	37.2 ± 2.9	275
Lu-Lu	142 ± 33	246
Lu-O	678 ± 8	95
Lu-Pt	402 ± 33	141
Lu-S	507.1 ± 14.6	114,345
Lu-Se	418 ± 17	25
Lu-Te	326 ± 17	25
Mg-Mg	8.552 ± 0.004	264,397
Mg-O	363.2 ± 12.6	287
Mg-S	234	70
Mn-Mn	25.9	221
Mn-O	402.9 ± 41.8	225,287
Mn-S	301 ± 17	395
Mn-Se	239.3 ± 9.2	351
Mo-Mo	406 ± 21	168
Mo-Nb	456 ± 25	163
Mo-O	560.2 ± 20.9	287
N-N	945.33 ± 0.59	205
N-O	630.57 ± 0.13	205
N-P	617.1 ± 20.9	72,151
N-Pu	473 ± 63	246
N-S	464 ± 21	246
N-Sb	301 ± 50	120
N-Sc	469 ± 84	246
N-Se	370 ± 11	254
N-Si	470 ± 15	311
N-Ta	611 ± 84	246
N-Th	577.4 ± 33.1	144,152
N-Ti	476.1 ± 33.1	152,356
N-U	531.4 ± 2.1	142
N-V	477.4 ± 17.2	107,152
N-Xe	23.0	182
N-Y	481 ± 63	246
N-Zr	564.8 ± 25.1	143,152
Na-Na	73.0813 ± 0.0001	213
Na-O	256.1 ± 16.7	287
Na-Rb	63.25	392
Nb-Nb	510 ± 10.0	164
Nb-Ni	271.9 ± 0.1	8
Nb-O	771.5 ± 25.1	287
Nb-Ti	302.0 ± 0.1	254
Nd-Nd	<163	246
Nd-O	703 ± 13	95
Nd-S	471.5	25
Nd-Se	385 ± 17	25,156,271
Nd-Te	305 ± 17	25
Ne-Ne	3.93	365
Ni-Ni	200.7 ± 0.2	304
Ni-O	382.0 ± 16.7	287
Ni-Pt	273.7 ± 0.3	367
Ni-S	344.3	93
Ni-Si	318 ± 17	380
Ni-V	206.3 ± 0.1	353
Ni-Y	283.9 ± 0.1	8
Ni-Zr	279.7 ± 0.1	8
Np-O	718.4 ± 41.8	287
O-O	498.36 ± 0.17	38,205
O-Os	575	189
O-P	599.1 ± 12.6	287
O-Pa	788.3 ± 17.2	240
O-Pb	382.0 ± 12.6	287
O-Pd	380.7 ± 83.7	287
O-Pm	674 ± 63	246
O-Pr	753 ± 13	95
O-Pt	391.6 ± 41.8	287
O-Pu	715.9 ± 33.9	287
O-Rb	255 ± 84	37
O-Re	626.8 ± 83.7	287
O-Rh	405.0 ± 41.8	287
O-Ru	528.4 ± 41.8	287
O-S	517.90 ± 0.05	57
O-Sb	434.3 ± 41.8	287
O-Sc	681.6 ± 11.3	287
O-Se	464.8 ± 21.3	287,344
O-Si	799.6 ± 13.4	287
O-Sm	565 ± 13	95
O-Sn	531.8 ± 12.6	287
O-Sr	426.3 ± 6.3	327
O-Ta	799.1 ± 12.6	287
O-Tb	711 ± 13	95
O-Te	376.1 ± 20.9	287
O-Th	878.6 ± 12.1	287
O-Ti	672.4 ± 9.2	287
O-Tm	502 ± 13	95
O-U	759.4 ± 13.4	287
O-V	626.8 ± 18.8	12,287
O-W	672.0 ± 41.8	287
O-Xe	36.4	246
O-Y	719.6 ± 11.3	209,287
O-Yb	397 ± 17	95
O-Zn	159 ± 4	55
O-Zr	776.1 ± 13.4	287
P-P	489.5 ± 10.5	151
P-Pt	≤416.7	348
P-Rh	353.1 ± 17	348
P-S	444 ± 8	92
P-Sb	356.9	249
P-Se	363.6 ± 10.0	92
P-Si	363.6	346
P-Te	297.9 ± 10.0	92
P-Th	550.2 ± 42	135
P-Tl	209 ± 13	293
P-U	297 ± 21	246
P-W	305 ± 4	150
Pb-Pb	86.6 ± 0.8	138,305
Pb-S	346.0 ± 1.7	375
Pb-Sb	161.5 ± 10.5	409
Pb-Se	302.9 ± 4	375
Pb-Te	251 ± 13	375
Pd-Pd	100 ± 15	331
Pd-Si	261 ± 12	336
Pd-Y	238 ± 17	313
Pm-S	423 ± 63	246
Pm-Se	339 ± 63	246
Pm-Te	255 ± 63	246
Po-Po	187.0	205
Pr-S	492.5 ± 4.6	112
Pr-Se	446.4 ± 23.0	155,271
Pr-Te	326 ± 42	246
Pt-Pt	307 ± 2	366
Pt-Si	501.2 ± 18.0	381
Pt-Th	552	133
Pt-Ti	397 ± 13	173
Pt-Y	474.0 ± 12.1	170
Rb-Rb	48.898 ± 0.005	5
Rh-Rh	285.3 ± 0.05	255
Rh-Sc	443.9 ± 10.5	175
Rh-Si	395.0 ± 18.0	381
Rh-Th	515 ± 21	129
Rh-Ti	390.8 ± 14.6	61
Rh-U	519 ± 17	129
Rh-V	364 ± 29	135
Rh-Y	445.2 ± 10.5	175
Ru-Si	397.1 ± 20.9	381
Ru-Th	591.6 ± 42	134
Ru-V	414 ± 29	135
S-S	425.30	205
S-Sb	378.7	110
S-Sc	477 ± 13	359,372
S-Se	371.1 ± 6.7	90
S-Si	623	205
S-Sm	389	112
S-Sn	464 ± 3.3	88
S-Sr	339	45
S-Tb	515 ± 42	246
S-Te	339 ± 21	88
S-Ti	418 ± 3	96,292
S-Tm	368 ± 42	246
S-U	522.6 ± 9.6	359
S-V	450	97,205
S-Y	528.4 ± 10.5	358
S-Yb	167	246
S-Zn	205 ± 13	82,158
S-Zr	575.3 ± 16.7	359
Sb-Sb	299.2 ± 6.3	81,248
Sb-Te	277.4 ± 3.8	306,364
Sb-Tl	126.8 ± 10.5	11,293
Sc-Sc	162.8 ± 21	136

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Table 1
BOND STRENGTHS IN DIATOMIC MOLECULES (continued)

Molecule	D°_{298}/kJ mol^{-1}	Ref.	Molecule	D°_{298}/kJ mol^{-1}	Ref.	Molecule	D°_{298}/kJ mol^{-1}	Ref.
Sc-Se	385 ± 17	246	Se-Zn	170.7 ± 25.9	82,158	Te-Zn	117.6 ± 18.0	158
Sc-Si	228.7 ± 14	234	Si-Si	325 ± 7	328	Th-Th	≤289	140
Sc-Te	289 ± 17	246	Si-Te	452 ± 8	205,281	Ti-Ti	141.4 ± 21	216
Se-Se	332.6 ± 0.4	90,375	Si-Y	258.8 ± 17.3	235	Ti-V	203.2 ± 0.1	353
Se-Si	538 ± 13	370	Sm-Te	272.4 ± 14.6	271	Ti-Zr	214.3 ± 0.1	254
Se-Sm	331.0 ± 14.6	271	Sn-Sn	187.1 ± 0.3	284	Tl-Tl	64.4 ± 17	10
Se-Sn	401.2 ± 5.9	68	Sn-Te	359.8	205	U-U	222 ± 21	246
Se-Sr	~285	27	Sr-Sr	15.5 ± 0.4	121	V-V	269.3 ± 0.1	353
Se-Tb	423 ± 42	246	Tb-Tb	131.4 ± 25.1	250	V-Zr	260.6 ± 0.3	254
Se-Te	291.6 ± 4	88,90,159	Tb-Te	339 ± 42	246	Xe-Xe	6.138 ± 0.001	49,115
Se-Ti	381 ± 42	246	Te-Te	257.6 ± 4.1	389	Y-Y	159 ± 21	246
Se-Tm	276 ± 42	246	Te-Ti	289 ± 17	246	Yb-Yb	20.5 ± 17	161
Se-V	347 ± 21	246	Te-Tm	276 ± 42	246	Zn-Zn	29	339
Se-Y	435 ± 13	246	Te-Y	339 ± 13	246	Zr-Zr	298.2 ± 0.1	8

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Table 1
BOND STRENGTHS IN DIATOMIC MOLECULES (continued)

42. Calculated from $\Delta_f H°(CN) = 441.4 \pm 4.6$ kJ mol^{-1} (Table 4), but see also Costes, M., Naulin, C., and Dorthe, G., *Astron. Astronphys.*, 232, 270, 1990.
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Table 1
BOND STRENGTHS IN DIATOMIC MOLECULES (continued)

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Table 1
BOND STRENGTHS IN DIATOMIC MOLECULES (continued)

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Table 2
ENTHALPY OF FORMATION OF GASEOUS ATOMS FROM ELEMENTS IN THEIR STANDARD STATES

For elements that are diatomic gases in their standard states these are readily obtained from the bond strength. For elements that are crystalline in their standard states they are derived from vapor pressure data.

Atom	$\Delta_f H^\circ_{298}$/kJ mol^{-1}	Ref.	Atom	$\Delta_f H^\circ_{298}$/kJ mol^{-1}	Ref.	Atom	$\Delta_f H^\circ_{298}$/kJ mol^{-1}	Ref.
			Hf	619 ± 4	1	Re	774 ± 6.3	1
Ag	284.9 ± 0.8	2	Hg	61.38 ± 0.04	2	Rh	556 ± 4	1
Al	330.0 ± 4.0	2	I	106.76 ± 0.04	2	Ru	650.6 ± 6.3	1
As	302.5 ± 13	1	In	243 ± 4	1	S	277.17 ± 0.15	2
Au	368.2 ± 2.1	1	Ir	669 ± 4	1	Sb	264.4 ± 2.5	1
B	565 ± 5	2	K	89.0 ± 0.8	2	Sc	377.8 ± 4	1
Ba	177.8 ± 4	1	Li	159.3 ± 1.0	2	Se	227.2 ± 4	1
Be	324 ± 5	2	Mg	147.1 ± 0.8	2	Si	450 ± 8	2
Bi	209.6 ± 2.1	1	Mn	283.3 ± 4	1	Sn	301.2 ± 1.5	2
Br	111.87 ± 0.12	2	Mo	658.1 ± 2.1	1	Sr	163.6 ± 2.1	1
C	716.68 ± 0.45	2	N	472.68 ± 0.40	2	Ta	782.0 ± 2.5	1
Ca	177.8 ± 0.8	2	Na	107.5 ± 0.7	2	Te	196.6 ± 2.1	1
Cd	111.80 ± 0.20	2	Nb	721.3 ± 4	1	Th	602 ± 6	2
Ce	423 ± 13	1	Ni	430.1 ± 2.1	1	Ti	473 ± 3	2
Cl	121.301 ± 0.008	2	O	249.18 ± 0.10	2	Tl	182.21 ± 0.4	1
Co	428.4 ± 4	1	Os	787 ± 6.3	1	U	533 ± 8	2
Cr	397 ± 4	1	P	316.5 ± 1.0	2	V	514.2 ± 1.3	1
Cs	76.5 ± 1.0	2	Pb	195.2 ± 0.8	2	W	849.8 ± 4	1
Cu	337.4 ± 1.2	2	Pd	376.6 ± 2.1	1	Y	424.7 ± 2.1	1
Er	317.1 ± 4	1	Pt	565.7 ± 1.3	1	Yb	152.09 ± 0.8	1
F	79.38 ± 0.30	2	Pu	364.4 ± 17	1	Zn	130.40 ± 0.40	2
Ge	372 ± 3	2	Rb	80.9 ± 0.8	2	Zr	608.8 ± 4	1
H	217.998 ± 0.006	2						

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Table 3
BOND STRENGTHS IN POLYATOMIC MOLECULES

The values below refer to a temperature of 298 K and have mostly been determined by kinetic methods (see (i) S. W. Benson, *J. Chem. Educ.*, 42, 502, 1965, (ii) J. A. Kerr, *Chem. Rev.*, 66, 465, 1966 and (iii) D. F. McMillen and D. M. Golden, *Ann. Rev. Phys. Chem.*, 33, 493, 1982, for a full description of the methods). An increasing number of bond strengths are being determined from gas-phase acidity cycles and from photoionization mass spectrometry (see J. Berkowitz, G. B. Ellison and D. Gutman, *J. Phys. Chem.*, 98, 2744, 1994).

Bond strengths in polyatomic molecules are notoriously difficult to measure accurately since the mechanisms of the kinetic systems involved in many of the measurements are seldom straightforward. Thus much controversy has taken place in the literature over the past 15 years concerning C-H bond strengths in simple alkanes, for which we recommend data based largely on kinetic studies involving time-resolved flow tube experiments with mass spectrometric determination of reactant radical concentrations (see Berkowitz, J., Ellison, G. B., and Gutman, D., *J. Phys. Chem.*, 98, 2744, 1994.). These alkane bond strengths and the enthalpies of formation of the corresponding radicals are significantly larger than values derived from experiments in very low pressure reactors (see Dobis, O. and Benson, S. W., *J. Phys. Chem.*, 101, 6030, 1997; and Benson, S. W. and Dobis, O., *J. Phys. Chem.*, 102, 5175, 1998). Other examples illustrating the difficulties involved are concerned with the C-H bond strengths in ethene and methanol or the corresponding enthalpies of formation of the vinyl and hydroxymethyl radicals and changes to the recommendations could well arise.

Some of the bond strengths have been calculated from the enthalpies of formation of the species involved according to the equations:

$$D^\circ(\text{R–X}) = \Delta_f H^\circ(\text{R}) + \Delta_f H^\circ(\text{X}) - \Delta_f H^\circ(\text{RX})$$
$$D^\circ(\text{R–R}) = 2\,\Delta_f H^\circ(\text{R}) - \Delta_f H^\circ(\text{RR})$$

The enthalpies of formation of the atoms and radicals are taken from Tables 2 and 4 and for the molecules from the appropriate References following Table 3.

An attempt has been made to list all the important values obtained by methods that are considered to be valid. The references are intended to serve as a guide to the literature.

Bond	D°_{298}/kJ mol^{-1}	Ref.	Bond	D°_{298}/kJ mol^{-1}	Ref.
H-CH	424.0 ± 4.2	1	H-C_6H_5	473.1 ± 3.0	46
H-CH_2	462.0 ± 4.0	1	H-Cyclohexa-1,3-dien-5-yl	305 ± 21	63
H-CH_3	438.9 ± 0.4	16	H-Cyclohexa-1,4-dien-3-yl	305.4 ± 8.4	45
H-CCH	556.1 ± 2.9	4,37	H-Cyclohexyl	399.6 ± 4	63
H-$CHCH_2$	465.3 ± 3.4	37,81	H-$C(CH_3)_2CCCH_3$	344.3 ± 11.3	63
H-C_2H_5	423.0 ± 1.6	16	H-$CH_2C(CH_3)C(CH_3)_2$	326.4 ± 4.6	63
H-Cycloprop-2-en-1-yl	379.1 ± 17	63	H-$C(CH_3)_2C(CH_3)CH_2$	319.2 ± 4.6	63
H-CH_2CCH	374.0 ± 8	63	H-$CH_2C_6H_5$	375.7 ± 1.7	35
H-CH_2CHCH_2	361.9 ± 8.8	16,35	H-Cyclohepta-1,3,5-trien-7-yl	305.4 ± 8	63
H-Cyclopropyl	444.8 ± 1.3	63	H-Norbornyl	404.6 ± 10.5	63
H-n-C_3H_7	423.3 ± 2.1	82	H-Cycloheptyl	387.0 ± 4	63
H-i-C_3H_7	409.1 ± 2.0	82	H-$CH(CH_3)C_6H_5$	357.3 ± 6.3	63
H-CH_2CCCH_3	364.8 ± 8	63	H-Inden-1-yl	351 ± 13	63
H-$CH(CH_3)CCH$	347.7 ± 9.2	63	H-$C(CH_3)_2C_6H_5$	353.1 ± 6.3	63
H-Cyclobutyl	403.8 ± 4	63	H-1-Naphthylmethyl	356.1 ± 6.3	63
H-Cyclopropylmethyl	407.5 ± 6.7	63	H-$CH(C_6H_5)_2$	340.6	80
H-$CH(CH_3)CHCH_2$	345.2 ± 5.4	63	H-9,10-Dihydroanthracen-9-yl	315.1 ± 6.3	63
H-$CH_2CHCHCH_3$	358.2 ± 6.3	63	H-$C(CH_3)(C_6H_5)_2$	339 ± 8	63
H-$CH_2C(CH_3)CH_2$	358.2 ± 4	91,95	H-9-Anthracenylmethyl	342.3 ± 6.3	63
H-n-C_4H_9	425.4 ± 2.1	82	H-9-Phenanthrenylmethyl	356.1 ± 6.3	63
H-i-C_4H_9	425.2 ± 2.1	82	H-CN	527.6 ± 1.7	16
H-s-C_4H_9	411.2 ± 2.0	82	H-CH_2CN	392.9 ± 8.4	16
H-t-C_4H_9	404.3 ± 1.3	82	H-CH_2NC	380.7 ± 8.8	16
H-Cyclopenta-1,3-dien-5-yl	346.7	1,12	H-$CH(CH_3)CN$	376.1 ± 9.6	63
H-Spiropentyl	413.4 ± 4	63	H-$C(CH_3)_2CN$	361.9 ± 8.4	63
H-Cyclopent-1-en-3-yl	344.3 ± 4	63	H-CH_2NH_2	390.4 ± 8.4	63
H-$CH_2CHCHCHCH_2$	347 ± 13	63	H-CH_2NHCH_3	364 ± 8	63
H-$CH(C_2H_3)_2$	319.7	63,92	H-$CH_2N(CH_3)_2$	351 ± 8	63
H-$CH(CH_3)CCCH_3$	365.3 ± 11.3	63	H-CHO	368.5 ± 1.0	23
H-$C(CH_3)_2CCH$	338.9 ± 9.6	63	H-CHCO	440.6 ± 8.8	16
H-$C(CH_3)_2CHCH_2$	323.0 ± 6.3	63	H-$COCH_3$	373.8 ± 1.5	67
H-Cyclopentyl	403.5 ± 2.5	22,74	H-$COCHCH_2$	364.4 ± 4.2	63
H-$CH_2C(CH_3)_3$	418 ± 8	63	H-COC_2H_5	371.3	1,12
H-$C(CH_3)_2C_2H_5$	404.0 ± 6.3	1,74,89	H-COC_6H_5	363.6 ± 4	63

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Table 3
BOND STRENGTHS IN POLYATOMIC MOLECULES (continued)

Bond	D°_{298}/kJ mol^{-1}	Ref.
H-$COCF_3$	380.7 ± 8	63
H-CH_2CHO	394.6 ± 9.2	16
H-CH_2COCH_3	411.3 ± 7.5	63
H-$CH(CH_3)COCH_3$	386.2 ± 5.9	63
H-CH_2OCH_3	402.2	1,12
H-$CH(CH_3)OC_2H_5$	383.7 ± 1.7	55
H-Tetrahydrofuran-2-yl	385 ± 4	63
H-2-Furylmethyl	361.9 ± 8	63
H-CH_2OH	401.8 ± 1.5	50
H-$CH(CH_3)OH$	401.4	1,12
H-$CH(OH)CHCH_2$	341.4 ± 7.5	63
H-$C(CH_3)_2OH$	381 ± 4	63
H-$CH_2OCOC_6H_5$	419.2 ± 5.4	63
H-$COOCH_3$	387.9 ± 4	63
H-CH_2F	423.8 ± 4	77
H-CHF_2	431.8 ± 4	77
H-CF_3	449.5	3,61
H-CHFCl	421.7 ± 5.4	97
H-CF_2Cl	421.3 ± 8.3	64
H-$CHFCl_2$	413.8 ± 5.0	97
H-CH_2Cl	419.0 ± 2.3	84
H-$CHCl_2$	402.5 ± 2.7	84
H-CH_2CH_2Cl	423.1 ± 2.4	85
H-$CH(CH_3)Cl$	406.6 ± 1.5	84
H-$C(CH_3)Cl_2$	390.6 ± 1.5	84
H-CCl_3	392.5 ± 2.5	48
H-CH_2Br	425.1 ± 4.2	97
H-$CHBr_2$	417.2 ± 7.5	97
H-CBr_3	401.7 ± 6.7	63
H-CH_2I	431 ± 8	63
H-CHI_2	431 ± 8	63
H-$CHCF_2$	448 ± 8	90
H-CFCHF	448 ± 8	90
H-$CFCF_2$	452 ± 8	90
H-CH_2CF_3	446.4 ± 4.6	63
H-CF_2CH_3	416.3 ± 10.5	63
H-C_2F_5	429.7 ± 2.1	63
H-CFCFCl	444 ± 8	90
H-$CHClCF_3$	425.9 ± 6.3	63
H-CClCFCl	439 ± 8	90
H-$CClCH_2$	>433.5	81
H-CClCHCl	435 ± 8	90
H-CCl_2CHCl_2	393 ± 8	63
H-C_2Cl_5	393.5 ± 6.0	66
H-$CClBrCF_3$	404.2 ± 6.3	63
H-n-C_3F_7	435 ± 8	63
H-i-C_3F_7	433.5 ± 2.5	38
H-$CHClCHCH_2$	370.7 ± 5.9	63
H-C_6F_5	476.6	63
H-$CH_2Si(CH_3)_3$	415.1 ± 4	99
H-CSH	399.6 ± 5.0	16
H-CH_2SH	392.9 ± 8.4	16
H-CH_2SCH_3	384.9 ± 5.9	49
H-NH_2	452.7 ± 1.3	16
H-$NHCH_3$	418.4 ± 10.5	63
H-$N(CH_3)_2$	382.8 ± 8	63
H-NHC_6H_5	368.2 ± 8	63
H-$N(CH_3)C_6H_5$	366.1 ± 8	63
H-NO	195.35 ± 0.25	32
H-NO_2	327.6 ± 2.1	63
H-NF_2	316.7 ± 10.5	63
H-$NHNH_2$	366.1	44
H-NH_3	385 ± 21	63
H-OH	498 ± 4	63
H-OCH_3	436.0 ± 3.8	16
H-OC_2H_5	437.7 ± 3.4	16
H-$OC(CH_3)_3$	439.7 ± 4	63
H-$OCH_2C(CH_3)_3$	428.0 ± 6.3	63
H-OC_6H_5	361.9 ± 8	63
H-O_2H	369.0 ± 4.2	88
H-O_2CH_3	370.3 ± 2.1	56
H-$O_2C(CH_3)_3$	374.0 ± 0.8	47
H-$OCOCH_3$	442.7 ± 8	63
H-$OCOC_2H_5$	445.2 ± 8	63
H-OCO-n-C_3H_7	443.1 ± 8	63
H-ONO	327.6 ± 2.1	15
H-ONO_2	423.4 ± 2.1	15
H-SiH	351	63
H-SiH_2	268	63
H-SiH_3	384.1 ± 2.0	83
H-SiH_2CH_3	374.9	99
H-$SiH(CH_3)_2$	374.0	99
H-$Si(CH_3)_3$	377.8	63,99
D-$Si(CH_3)_3$	389 ± 7.1	36
H-$SiH_2C_6H_5$	369.0	63,99
H-SiF_3	418.8	63,99
H-$SiCl_3$	382.0	63,99
H-Si_2H_5	361.1	63
H-$Si(CH_3)_2Si(CH_3)_3$	356.9 ± 8.4	45
H-$Si(Si(CH_3)_3)_3$	330.5 ± 8.4	45
H-PH_2	351.0 ± 2.1	16
H-SH	381.6 ± 2.9	65
H-SCH_3	365.3 ± 2.5	65
H-SC_6H_5	348.5 ± 8	63
H-SO	172.8	100
H-GeH_3	349.0 ± 8	16
H-GeH_2I	331 ± 8	68
H-$Ge(CH_3)_3$	339 ± 8	34
H-AsH_2	319.2 ± 0.8	16
H-SeH	334.93 ± 0.75	16
H-$Sn(n\text{-}C_4H_9)_3$	308.4 ± 8.4	19
H-SbH_2	288.3 ± 2.1	16
H-TeH	277.0 ± 5.0	16
HC$\int$CH	965 ± 8	1,24,74
$H_2C{=}CH_2$	728.3 ± 6	1,74
CH_3-CH_3	376.0 ± 2.1	1,74,86
CH_3-CH_2CCH	318.0 ± 8	63
CH_3-CH_2CCCH_3	308.4 ± 6.3	63
CH_3-$CH(CH_3)CCH$	305.4	63
CH_3-$C(CH_3)CCH_2$	320.1 ± 9.2	63
CH_3-$CH_2CHCHCH_3$	305.0 ± 3.3	63
CH_3-$CH_2C(CH_3)CH_2$	301.2 ± 3.3	91
CH_3-$CH(CH_3)CCCH_3$	320.9 ± 6.3	63
CH_3-$C(CH_3)_2CCH$	295.8 ± 6.3	63

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Table 3
BOND STRENGTHS IN POLYATOMIC MOLECULES (continued)

Bond	D°_{298}/kJ mol^{-1}	Ref.	Bond	D°_{298}/kJ mol^{-1}	Ref.
n-C_3H_7-CH_2CCH	306.3 ± 6.3	63	s-C_4H_9-N_2s-C_4H_9	195.4	13
CH_3-C(CH_3)$_2$$CHCH_2$	284.9 ± 6.3	63	t-C_4H_9-N_2t-C_4H_9	182.0	13
n-C_3H_7-CH_2CHCH_2	295.8	96	$C_6H_5CH_2$-$N_2CH_2C_6H_5$	157.3	13
CH_3-C(CH_3)$_2$$CCCH_3$	303.3 ± 6.3	63	CF_3-N_2CF_3	231.0	13
$CHCCH_2$-s-C_4H_9	300.0 ± 6.3	63	CH_3-NO	167.4 ± 3.3	63
CH_3-$CH_2C_6H_5$	332.2 ± 4	63	i-C_3H_7-NO	152.7 ± 13	63
CH_3-CH(CH_3)C_6H_5	312.1 ± 6.3	63	t-C_4H_9-NO	165.3 ± 6.3	63
C_2H_5-$CH_2C_6H_5$	294.1 ± 4	63	C_6H_5-NO	212.5 ± 4	63
CH_3-1-Naphthylmethyl	305.0 ± 6.3	63	NC-NO	120.5 ± 10.5	43
CH_3-C(CH_3)$_2$$C_6H_5$	308.4 ± 6.3	63	CF_3-NO	179.1 ± 8	63
$CHCCH_2$-$CH_2C_6H_5$	256.9 ± 8	63	C_6F_5-NO	208.4 ± 4	63
n-C_3H_7-$CH_2C_6H_5$	292.9 ± 4	63	CCl_3-NO	134 ± 13	63
CH_3-9-Anthracenylmethyl	282.8 ± 6.3	63	t-C_4H_9-NOt-C_4H_9	121	21
CH_3-9-Phenanthrenylmethyl	305.0 ± 6.3	63	CH_3-NO_2	254.4	63
CH_3-CH(C_6H_5)$_2$	301 ± 8	63	$CH_2C(CH_3)$-NO_2	245.2	63
CH_3-C(CH_3)(C_6H_5)$_2$	289 ± 8	63	i-C_3H_7-NO_2	246.9	63
CH_3-CN	509.6 ± 8	63	t-C_4H_9-NO_2	244.8	63
C_2H-CN	602 ± 4	70	C_6H_5-NO_2	298.3 ± 4	63
C_2H_5-CH_2NH_2	332.2 ± 8	63	C(NO_2)$_3$-NO_2	169.5 ± 4	63
CH_3-CH_2CN	336.4 ± 4	93	CH_3-OC(CH_3)CH_2	277.4	101
C_2H_5-CH_2CN	321.7 ± 7.1	63	CH_3-OC_6H_5	238 ± 8	73
CH_3-CH(CH_3)CN	329.7 ± 8	63	CH_3-$OCH_2C_6H_5$	280.3	26
C_2H_5-CH_2CN	321.7 ± 7.1	63	C_2H_5-OC_6H_5	264 ± 6.3	63
CH_3-C(CH_3)$_2$CN	312.5 ± 6.7	63	CH_2CHCH_2-OC_6H_5	208.4 ± 8	63
CH_3-C(CH_3)(CN)C_6H_5	250.6	63	O=CO	532.2 ± 0.4	29
$C_6H_5CH_2$-CH_2NH_2	284.5 ± 8	63	CH_3-O_2	137.0 ± 3.8	53
$C_6H_5CH_2$-C_5H_4N	362.8	80	C_2H_5-O_2	148.4 ± 8.4	53
CN-CN	536 ± 4	30	CH_2CHCH_2-O_2	76.2 ± 2.1	62
CH_3-2-Furylmethyl	314 ± 8	63	i-C_3H_7-O_2	155.4 ± 9.6	53
CH_3-COC_6H_5	355.6 ± 9.2	102	t-C_4H_9-O_2	152.8 ± 7.4	53
$C_6H_5CH_2$-$COCH_2C_6H_5$	273.6 ± 8	63	$C_6H_5CH_2$-O_2CCH_3	280 ± 8	63
CH_3CO-$COCH_3$	282.0 ± 9.6	63	$C_6H_5CH_2$-$O_2CC_6H_5$	289	13
$C_6H_5CH_2$-COOH	280	63	CH_3-O_2SCH_3	279.5	63
C_6H_5CO-COC_6H_5	277.8	63	CH_2CHCH_2-O_2SCH_3	207.5	63
(C_6H_5)$_2$CH-COOH	248.5 ± 13	63	$C_6H_5CH_2$-O_2SCH_3	221.3	63
CF_3-COC_6H_5	308.8 ± 8	63	CF_3-O_2CF_3	361.5	10
CF_2=CF_2	319.2 ± 13	103	CH_2Cl-O_2	122.4 ± 10.5	53
CH_2F-CH_2F	368 ± 8	51	$CHCl_2$-O_2	108.2 ± 8.2	53
CH_3-CF_3	423.4 ± 4.6	79	CCl_3-O_2	92.0 ± 6.4	53
CF_3-CF_3	413.0 ± 10.5	63	CH_3CHCl-O_2	131.2 ± 1.8	53
C_6F_5-C_6F_5	487.9 ± 24.7	78	CH_3CCl_2-O_2	112.2 ± 2.2	53
CH_3-BF_2	~473	63	(CH_3)$_2$CCl-O_2	136.0 ± 3.8	53
C_6H_5-BCl_2	~510	63	CH_3-SH	312.5 ± 4.2	65
CH_2CHCH_2-Si(CH_3)$_3$	293	63	t-C_4H_9-SH	286.2 ± 6.3	63
s-C_4H_9-Si(CH_3)$_3$	414	63	C_6H_5-SH	361.9 ± 8	63
CH_3-NHC_6H_5	298.7 ± 8	63	CH_3-SCH_3	307.9 ± 3.3	65
$C_6H_5CH_2$-NH_2	297.5 ± 4	63	CH_3-SC_6H_5	290.4 ± 8	63
CH_3-N(CH_3)C_6H_5	296.2 ± 8	63	$C_6H_5CH_2$-SCH_3	256.9 ± 8	63
$C_6H_5CH_2$-$NHCH_3$	287.4 ± 8	63	S-CS	430.5 ± 13	63
$C_6H_5CH_2$-N(CH_3)$_2$	259.8 ± 8	63	F-CH_3	472	1,61
CH_2=N_2	<175	58	F-CN	469.9 ± 5.0	63
CH_3-N_2CH_3	219.7	13	F-COF	535 ± 12	18
C_2H_5-$N_2C_2H_5$	209.2	13	F-CHFCl	465.3 ± 9.6	97
i-C_3H_7-N_2i-C_3H_7	198.7	13	F-CF_2Cl	490 ± 25	41
n-C_4H_9-N_2n-C_4H_9	209.2	13	F-$CFCl_2$	462.3 ± 10.0	97
i-C_4H_9-N_2i-C_4H_9	205.0	13	F-CF_2CH_3	522.2 ± 8	63

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Table 3
BOND STRENGTHS IN POLYATOMIC MOLECULES (continued)

Bond	D°_{298}/kJ mol^{-1}	Ref.	Bond	D°_{298}/kJ mol^{-1}	Ref.
F-C_2F_5	530.5 ± 7.5	63	CH_3-In$(CH_3)_2$	205 ± 17	63
Cl-CN	421.7 ± 5.0	63	CH_3-Sn$(CH_3)_3$	297 ± 17	63
Cl-COC_6H_5	310 ± 13	63	C_2H_5-Sn$(C_2H_5)_3$	264 ± 17	63
Cl-CSCl	265.3 ± 2.1	71	CH_3-Sb$(CH_3)_2$	255 ± 17	63
Cl-CF_3	360.2 ± 3.3	27	C_2H_5-Sb$(C_2H_5)_2$	243 ± 17	63
Cl-CHFCl	354.4 ± 11.7	97	CH_3-$HgCH_3$	255 ± 17	63
Cl-CF_2Cl	346.0 ± 13.4	97	C_2H_5-HgC_2H_5	205 ± 17	63
Cl-$CFCl_2$	305 ± 8	40	CH_3-Tl$(CH_3)_2$	167 ± 17	63
Cl-CH_2Cl	350.2 ± 0.8	97	CH_3-Pb$(CH_3)_3$	238 ± 17	63
Cl-$CHCl_2$	338.5 ± 4.2	97	C_2H_5-Pb$(C_2H_5)_3$	230 ± 17	63
Cl-CCl_3	305.9 ± 7.5	63	CH_3-Bi$(CH_3)_2$	218 ± 17	63
Cl-C_2F_5	346.0 ± 7.1	27	CO-Cr$(CO)_5$	155 ± 8	60
Cl-CF_2CF_2Cl	326 ± 8	63	CO-Fe$(CO)_4$	172 ± 8	60
Cl-$SiCl_3$	464	99	CO-Mo$(CO)_5$	167 ± 8	60
Br-CH_3	292.9 ± 5.0	39	CO-W$(CO)_5$	192 ± 8	60
Br-C_6H_5	336.8 ± 8	63	BH_3-BH_3	146	13
Br-CN	367.4 ± 5.0	63	NH_2-NH_2	275.3	63
Br-CH_2COCH_3	261.5	101	NH_2-$NHCH_3$	268.2 ± 8	63
Br-COC_6H_5	268.6	13	NH_2-$N(CH_3)_2$	246.9 ± 8	63
Br-CHF_2	289 ± 8	63	NH_2-NHC_6H_5	218.8 ± 8	63
Br-CF_3	296.2 ± 1.3	3	ON-NO_2	40.6 ± 2.1	63
Br-CF_2CH_3	287.0 ± 5.4	76	O_2N-NO_2	56.9	63
Br-C_2F_5	287.4 ± 6.3	63	NF_2-NF_2	88 ± 4	63
Br-n-C_3F_7	278.2 ± 10.5	63	O-N_2	167	1,14
Br-i-C_3F_7	274.1 ± 4.6	63	O-NO	305	1,14
Br-$CH_2C_6F_5$	225 ± 6	54	O-NO_2	208.7 ± 1.1	31
Br-$CHClCF_3$	274.9 ± 6.3	63	HO-NO	206.3	63
Br-CCl_3	231.4 ± 4	63	HO-NO_2	206.7	63
Br-$CClBrCF_3$	251.0 ± 6.3	63	HO_2-NO_2	96 ± 8	63
Br-CH_2Br	296.7 ± 1.3	97	CH_3O-NO	174.9 ± 3.8	9,11
Br-$CHBr_2$	292.0 ± 8	97	C_2H_5O-NO	175.7 ± 5.4	8,11
Br-CBr_3	235.1 ± 7.5	63	CH_3COO_2-NO_2	118.8 ± 3.0	17
Br-NO_2	82.0 ± 7.1	57	n-C_3H_7O-NO	167.8 ± 7.5	11
Br-NF_2	≤222	25	i-C_3H_7O-NO	171.5 ± 5.4	7,11
I-$CHCH_2$	259.0 ± 4.2	20	n-C_4H_9O-NO	177.8 ± 6.3	11
I-n-C_4H_9	205.0 ± 4	63	i-C_4H_9O-NO	175.7 ± 6.3	11
I-Norbornyl	261.5 ± 10.5	69	s-C_4H_9O-NO	173.6 ± 3.3	5,11
I-CN	305 ± 4	30	t-C_4H_9O-NO	171.1 ± 3.3	6,11
I-CF_3	227.2 ± 1.3	3	HO-$NCHCH_3$	207.9	13
I-CF_2CH_3	218.0 ± 4.2	63	Cl-NF_2	~134	1,75
I-CH_2CF_3	235.6 ± 4	63	I-NO	77.8 ± 0.4	42
I-C_2F_5	218.8 ± 2.9	2	I-NO_2	76.6 ± 4	98
I-n-C_3F_7	208.4 ± 4.2	63	HO-OH	213 ± 4	63
I-i-C_3F_7	215.1 ± 2.9	2	HO-$OCH_2C(CH_3)_3$	193.7 ± 7.9	63
I-n-C_4F_9	205.0 ± 4.2	72	CH_3O-OCH_3	157.3 ± 8	63
I-$C(CF_3)_3$	206	33	C_2H_5O-OC_2H_5	158.6 ± 4	63
I-C_6H_5	273.6 ± 8	63	n-C_3H_7O-On-C_3H_7	155.2 ± 4	63
I-C_6F_5	277.0	63	i-C_3H_7O-Oi-C_3H_7	157.7 ± 4	63
C_5H_5-FeC_5H_5	381 ± 13	59	s-C_4H_9O-Os-C_4H_9	152.3 ± 4	63
CH_3-$ZnCH_3$	285 ± 17	63	t-C_4H_9O-Ot-C_4H_9	159.0 ± 4	63
C_2H_5-ZnC_2H_5	238 ± 17	63	$C_2H_5C(CH_3)_2O$-$OC(CH_3)_2C_2H_5$	164.4 ± 4	63
CH_3-Ga$(CH_3)_2$	264 ± 17	63	$(CH_3)_3CCH_2O$-$OCH_2C(CH_3)_3$	152.3 ± 4	63
C_2H_5-Ga$(C_2H_5)_2$	209 ± 17	63	CF_3O-OCF_3	193.3	63
CH_3-Ge$(CH_3)_3$	347 ± 17	63	$(CF_3)_3CO$-$OC(CF_3)_3$	148.5 ± 4.6	63
CH_3-As$(CH_3)_2$	280 ± 17	63	t-C_4H_9O-OSi$(CH_3)_3$	197	63
CH_3-$CdCH_3$	251 ± 17	63	SF_5O-OSF_5	155.6	63

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Table 3
BOND STRENGTHS IN POLYATOMIC MOLECULES (continued)

Bond	D°_{298}/kJ mol^{-1}	Ref.	Bond	D°_{298}/kJ mol^{-1}	Ref.
t-C_4H_9O-OGe$(C_2H_5)_3$	192	63	O=PF_3	544 ± 21	52
t-C_4H_9O-OSn$(C_2H_5)_3$	192	63	O=PCl_3	510 ± 21	52
$FClO_2$-O	244.3	13	O=PBr_3	498 ± 21	52
CF_3O-O_2CF_3	126.8 ± 8	63	HO-Si$(CH_3)_3$	536	63
SF_5O-O_2SF_5	126.8	63	HS-SH	276 ± 8	63
CH_3CO_2-O_2CCH_3	127.2 ± 8	63	CH_3S-SCH_3	272.8 ± 3.8	65
$C_2H_5CO_2$-$O_2CC_2H_5$	127.2 ± 8	63	F-SF_5	420 ± 10	94
n-$C_3H_7CO_2$-O_2Cn-C_3H_7	127.2 ± 8	63	I-SH	206.7 ± 8	63
O-SO	552 ± 8	29	I-SO	180	63
F-OCF_3	182.0 ± 2.1	28	I-SCH_3	206.3 ± 7.1	87
HO-Cl	251 ± 13	52	I-Si$(CH_3)_3$	322	99
O-ClO	247 ± 13	29	H_3Si-SiH_3	310	63,99
HO-Br	234 ± 13	52	$(CH_3)_3Si$-Si$(CH_3)_3$	336.8	63,99
HO-I	234 ± 13	52	$(C_6H_5)_3Si$-Si$(C_6H_5)_3$	368 ± 29	63,99

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Table 3
BOND STRENGTHS IN POLYATOMIC MOLECULES (continued)

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Table 3
BOND STRENGTHS IN POLYATOMIC MOLECULES (continued)

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Table 4
ENTHALPIES OF FORMATION OF FREE RADICALS

The enthalpies of formation of the free radicals are related to the corresponding bond strengths by the equations

$$D°(\text{R-X}) = \Delta_f H°(\text{R}) + \Delta_f H°(\text{X}) - \Delta_f H°(\text{RX})$$

or

$$D°(\text{R-R}) = 2\Delta_f H°(\text{R}) - \Delta_f H°(\text{RR})$$

For an excellent review of the methods of determining the enthalpies of formation of free radicals the reader is referred to “Thermochemistry of Free Radicals” by H. E. O’Neal and S. W. Benson in *Free Radicals*, Kochi, J. K., Ed., John Wiley & Sons, New York, 1973, 275 and the article by J. Berkowitz, G. B. Ellison, and D. Gutman, *J. Phys. Chem.*, 98, 2744, 1994.

Radical	$\Delta_f H°_{298}$/kJ mol^{-1}	Ref.	Radical	$\Delta_f H°_{298}$/kJ mol^{-1}	Ref.
CH	596.4 ± 1.2	6	Spiropentyl	380.7 ± 4	48
CH_2(triplet)	390.4 ± 4	15,34	Cyclopent-1-en-3-yl	160.7 ± 4	48
CH_2(singlet)	428.3 ± 4	15	CH_2=CHCH=$CHCH_2$	205 ± 13	48
CH_3	146.4 ± 0.4	10	$(C_2H_3)_2CH$	205 ± 13	48
CH≡C	566.1 ± 2.9	5,27	CH_3C≡$CCHCH_3$	272.8 ± 9.6	48
CH_2=CH	300.0 ± 3.4	27,64	CH≡$CC(CH_3)_2$	257.3 ± 8.4	48
C_2H_5	120.9 ± 1.6	10	CH_2=$CHC(CH_3)_2$	77.4 ± 6.3	48
Cycloprop-2-en-1-yl	439.7 ± 17.2	48	Cyclopentyl	107.1 ± 2.5	17
CH≡CCH_2	340.6 ± 8.4	48	$(CH_3)_3CCH_2$	36.4 ± 8	48
CH_2=$CHCH_2$	170.7 ± 8.8	10,26	$C_2H_5C(CH_3)_2$	32.2 ± 6.3	71
CH_3CH=CH	262.7	77	C_6H_5	338 ± 3	35
Cyclopropyl	279.9 ± 1.1	48	Cyclohexa-1,3-dien-5-yl	197 ± 21	48
n-C_3H_7	100.8 ± 2.1	65	Cyclohexyl	58.2 ± 4	48
i-C_3H_7	86.6 ± 2.0	65	CH_3C≡$CC(CH_3)_2$	221.8 ± 9.6	48
CH_3C≡CCH_2	293.7	48	$(CH_3)_2C$=$C(CH_3)CH_2$	39.8 ± 6.3	48
CH_2=$CHCHCH_3$	125.5 ± 6.3	48	CH_2=$C(CH_3)C(CH_3)_2$	37.7 ± 6.3	48
CH≡$CCHCH_3$	295.0 ± 9.2	48	$C_6H_5CH_2$	208.0 ± 2.5	26
Cyclobutyl	214.2 ± 4.2	48	Cyclohepta-1,3,5-trien-7-yl	271.1 ± 8	48
Cyclopropylmethyl	213.8 ± 6.7	48	$CH_3CH_2CH_2C(CH_3)_2$	3.4 ± 8.4	69
CH_2=$C(CH_3)CH_2$	127.2 ± 5.4	48	Norbornyl	136.4 ± 10.5	48
CH_3CH=$CHCH_2$	125.5 ± 6.3	48	Cycloheptyl	51.1 ± 4	48
n-C_4H_9	80.9 ± 2.2	65	$C_6H_5CHCH_3$	169.0	48
i-C_4H_9	72.7 ± 2.2	65	$C_6H_5C(CH_3)_2$	134.7	48
s-C_4H_9	66.7 ± 2.1	65	1-Naphthylmethyl	252.7	48
t-C_4H_9	51.8 ± 1.3	65	$(C_6H_5)_2CH$	289	63
Cyclopenta-1,3-dien-5-yl	263.0	8	9,10-Dihydroanthracen-9-yl	256.9 ± 6.3	48

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Table 4
ENTHALPIES OF FORMATION OF FREE RADICALS (continued)

Radical	$\Delta_f H°_{298}$/kJ mol^{-1}	Ref.	Radical	$\Delta_f H°_{298}$/kJ mol^{-1}	Ref.
9-Anthracenylmethyl	337.6	48	CF_3CH_2	-517.1 ± 5.0	48
9-Phenanthrenylmethyl	311.3	48	C_2F_5	-892.9 ± 4	48
CH_2CN	243.1 ± 11.3	10	$CCl=CH_2$	>251	64
CH_2NC	326.4 ± 11.3	10	CH_3CHCl	76.5 ± 1.6	67
CH_3CHCN	209.2 ± 9.6	48	CH_3CCl_2	48.4 ± 7.6	40,67
$(CH_3)_2CCN$	166.5 ± 8.4	48	CH_2CH_2Cl	93.0 ± 3.4	68
$C_6H_5C(CH_3)CN$	248.5	48	$CHCl_2CCl_2$	23.4 ± 8	48
CH_2NH_2	149.4 ± 8	48	CF_2ClCF_2	-686 ± 17	48
CH_3NHCH_2	126 ± 8	48	C_2Cl_5	33.5 ± 5.4	54
$(CH_3)_2NCH_2$	109 ± 8	48	C_6F_5	-547.7 ± 8	48
CN	441.4 ± 4.6	10	$(CH_3)_3SiCH_2$	-34.7	48
CHN_2	494.42	30	CS	278.5 ± 3.8	62
CHO	43.1	9,22	HCS	300.4 ± 8.4	10
CHCO	175.3 ± 8.4	10	CH_2SH	151.9 ± 8.4	10
CH_3CO	-10.0 ± 1.2	56	CH_3SCH_2	136.8 ± 5.9	38
$CH_2=CHCO$	72.4	48	NH	352.3 ± 9.6	60
C_2H_5CO	-32.3	8	NH_2	188.7 ± 1.3	10
C_6H_5CO	123.0 ± 9.6	78	HNO	112.9	25
CH_2CHO	10.5 ± 9.2	10	NF_2	34 ± 4	48
CH_3COCH_2	-23.9 ± 10.9	48	N_2H_3	243.5	33
$CH_3COCHCH_3$	-70.3 ± 7.1	48	N_3	469 ± 21	48
CH_3OCH_2	-0.1	8	CH_2NH	104.6 ± 13	33
$C_2H_5OCHCH_3$	-84.5	42	CH_3NH	177.4 ± 8	48
Tetrahydrofuran-2-yl	-18.0 ± 6.3	48	$(CH_3)_3N$	145.2 ± 8	48
CH_2OH	-17.8 ± 1.3	39	C_6H_5NH	237.2 ± 8	48
CH_2CH_2OH	-36.0	31	$C_6H_5NCH_3$	233.5 ± 8	48
CH=CHOH	113.0	31	NCO	127.0	13,79
CH_3CHOH	-51.6	8	CNO	407.01	41
$CH_2=CHCHOH$	0.0	48	CH_3N_2	215.5 ± 7.5	2
$(CH_3)_2COH$	-111.3 ± 4.6	48	$C_2H_5N_2$	187.4 ± 10.5	2
COOH	-217 ± 10	32	i-$C_3H_7N_2$	158.6 ± 9.2	2
$COOCH_3$	-169.0 ± 4	48	OH	39.3	48
$C_6H_5COOCH_2$	-69.9 ± 8.4	48	CH_3O	17.2 ± 3.8	10
CF	261.5 ± 4.6	3	C_2H_5O	-15.5 ± 3.4	10
CHF	143.1 ± 12.6	61	n-C_3H_7O	-41.4	48
CH_2F	-31.8 ± 8.4	59	i-C_3H_7O	-52.3	48
FCO	-152.1 ± 12	14	n-C_4H_9O	-62.8	48
CHF_2	-238.9 ± 4	59	s-C_4H_9O	-69.5 ± 3.3	48
CF_2	-184.1 ± 8.4	61	t-C_4H_9O	-90.8	48
CF_3	-466.1 ± 3.8	3	C_6H_5O	47.7	48
CHCl	336.4 ± 11.7	61	CF_3O	-655.6	7
CH_2Cl	117.3 ± 3.1	67	FO	109 ± 10	21
CFCl	31.0 ± 13.4	61	ClO	101.63 ± 0.1	1
CHFCl	-60.7 ± 10.0	73	BrO	125.8 ± 2.4	19
CF_2Cl	-279.1 ± 8.3	49	IO	126 ± 18	20
ClCO	-21.8	55	HO_2	14.6	70
$CHCl_2$	89.0 ± 3.0	67	CH_3O_2	9.0 ± 5.1	40
$CFCl_2$	-89.1 ± 10.0	73	$C_2H_5O_2$	-27.4 ± 9.9	40
CCl_2	230.1 ± 8.4	61	$CH_2=CHCH_2O_2$	87.9 ± 5.5	43
CCl_3	71.1 ± 2.5	37	i-$C_3H_7O_2$	-68.8 ± 11.3	16,40
CH_2Br	169.0 ± 4.2	73	t-$C_4H_9O_2$	-101.0 ± 9.2	40
$CHBr_2$	188.3 ± 9.2	73	$HOCH_2O_2$	-162.1 ± 2.1	43
CBr_3	207.1 ± 8	73	CF_3O_2	-614.0	43
CH_2I	230.1 ± 6.7	48	CF_2ClO_2	-406.5	43
CHI_2	333.9 ± 9.2	48	$CFCl_2O_2$	-213.7	43
CH_3CF_2	-302.5 ± 8	48	CH_2ClO_2	-5.1 ± 13.6	40

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Table 4
ENTHALPIES OF FORMATION OF FREE RADICALS (continued)

Radical	$\Delta_f H°_{298}$/kJ mol^{-1}	Ref.	Radical	$\Delta_f H°_{298}$/kJ mol^{-1}	Ref.
$CHCl_2O_2$	-19.2 ± 11.2	40	SiF_3	-1025	48,76
CCl_3O_2	-20.9 ± 8.9	40	SiCl	195.8	48,76
CH_3CHClO_2	-54.7 ± 3.4	40	$SiCl_2$	-163.6	48,76
$CH_3CCl_2O_2$	-63.8 ± 9.8	40	$SiCl_3$	-318	48,76
CH_3CO_2	-207.5 ± 4	48	SiH_3SiH	269.9 ± 14.6	74
CH_3COO_2	-172 ± 20	12	Si_2H_5	223.0	48,76
$C_2H_5CO_2$	-228.5 ± 4	48	PH_2	138.5 ± 2.5	10
n-$C_3H_7CO_2$	-249.4 ± 4	48	HS	143.0 ± 2.8	53
FO_2	26.1	45,58	CH_3S	124.6 ± 1.8	53
ClO_2	97.5	4,52	C_6H_5S	229.7 ± 8	48
OClO	95.6	28,51	SO	5.0	18
NO_3	73.7 ± 1.4	24	HSO	-4	44
sym-ClO_3	232.6	23	HSO_2	-222	11
SiH	377	48,76	CH_3SO_2	-239.3	57
SiH_2	269.0 ± 1.3	29,47	$HOSO_2$	-385	46
SiH_3	200.5 ± 2.5	66	SO_3	-395.7	75
CH_3Si	310	76	SF_4	-746 ± 12	72
CH_3SiH	213.0 ± 14.6	74	SF_5	-879.9 ± 20	72
CH_3SiH_2	152.7	48,76	CH_3S_2	68.6 ± 8	36
$(CH_3)_2Si$	109	76	$C_2H_5S_2$	43.5 ± 8	36
$(CH_3)_2SiH$	59.8	48,76	i-$C_3H_7S_2$	13.8 ± 8	36
$(CH_3)_3Si$	-3.3	48,76	t-$C_4H_9S_2$	-19.3 ± 8	36
$C_6H_5Si(CH_3)_2$	163	57	$HOCS_2$	110.5	50
$(C_6H_5)_2SiCH_3$	326	57	GeH_3	222 ± 8	10
$(C_6H_5)_3Si$	486.2	57	AsH_2	167.8 ± 1.3	10
SiF	-19.3	48,76	HSe	144.8 ± 2.1	10
SiF_2	-587.9	48,76	SbH_2	215.5 ± 2.5	10
			HTe	158.6 ± 5.0	10

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Table 4
ENTHALPIES OF FORMATION OF FREE RADICALS (continued)

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Table 5
BOND STRENGTHS OF SOME ORGANIC MOLECULES

Bond strengths at 298 K expressed in kJ/mol^{-1} for some organic molecules of the general formula R-X are presented below. Some are experimental values taken from the preceding tables; the remainder are calculated from the enthalpies of formation of atoms (Table 2) and of radicals (Table 4), and the enthalpies of formation of the parent compounds from sources indicated by the references below. The table also includes bond strengths for the inorganic molecules, hydrogen, the hydrogen halides, water and ammonia.

	H	F	Cl	Br	I	OH	NH_2	CH_3O	CH_3	CH_3CO	NO	CF_3	CCl_3
H	435.990	569.87	431.62	366.35	298.407	498	453	436	439	374	195	450	393
CH_3	439	472	350[e]	293	239[e]	387[e]	358[e]	348[e]	377[e]	354[e]	167	423	362[e]
C_2H_5	423	463[d]	354[e]	295[e]	236[e]	395[e]	357[e]	355[e]	371[e]	349[e]	—	—	—
i-C_3H_7	409	460[e]	353[e]	298[e]	234[e]	399[e]	359[e]	356[e]	367[e]	339[e]	153	—	—
t-C_4H_9	404	—	355[e]	296[e]	231[e]	404[e]	362[e]	353[e]	366[e]	332[e]	165	—	—
C_6H_5	473	533[e]	407[e]	346[f]	280[e]	474[e]	439[e]	423[e]	434[e]	415[e]	213	—	—
$C_6H_5CH_2$	376	—	310[e]	256[f]	215[f]	348[e]	302[e]	—	332	297[e]	—	—	—
CCl_3	393	419[e]	288[e]	224[e]	167[e]	—	—	—	362[e]	—	134	335[b]	286[e]
CF_3	450	547[e]	362[e]	294[e]	227	—	—	—	423	—	179	413	335[b]
C_2F_5	430	531[e]	347[e]	283[e]	219	—	—	—	—	—	—	—	—
CH_3CO	374	512[e]	354[f]	292[e]	223[e]	462[e]	417[e]	421[e]	354[e]	282	—	—	—
CN	528	470	422	367	305	—	—	—	514[e]	—	121	—	—
C_6F_5	473	487[e]	383[e]	—	277[a]	499[e]	—	—	441[e]	—	208[a]	—	—

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