

SCH4U: Chemistry, Grade 12, University Preparation

Periodic Table

1 IA																	18 VIIIA
1 H 1.01	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.1	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.6	53 I 126.9	54 Xe 131.29
55 Cs 132.9	56 Ba 137.3	57 La* 138.9	58 Hf 178.5	59 Ta 180.9	60 W 183.9	61 Re 186.2	62 Os 190.2	63 Ir 192.2	64 Pt 195.1	65 Au 197.0	66 Hg 200.6	67 Tl 204.4	68 Pb 207.2	69 Bi 209	70 Po (209)	71 At (210)	72 Rn (222)
87 Fr (223)	88 Ra (226)	89 Ac^ (227)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Ds (271)	111 Rg (272)							

* 58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
^ 90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

Ions

Ion formula	Ion name	Ion formula	Ion name
NH_4^+	Ammonium		
CH_3CO_2^-	Acetate	PO_4^{3-}	Phosphate
CN^-	Cyanide	HPO_4^{2-}	Hydrogen phosphate
NO_2^-	Nitrite	H_2PO_4^-	Dihydrogen phosphate
NO_3^-	Nitrate	ClO^-	Hypochlorite
CO_3^{2-}	Carbonate	ClO_2^-	Chlorite
HCO_3^-	Hydrogen carbonate (or bicarbonate)	ClO_3^-	Chlorate
SO_3^{2-}	Sulfite	ClO_4^-	Perchlorate
SO_4^{2-}	Sulfate	CrO_4^{2-}	Chromate
HSO_4^-	Hydrogen sulfate (or bisulfate)	$\text{Cr}_2\text{O}_7^{2-}$	Dichromate
MnO_4^-	Permanganate	O_2^{2-}	Peroxide

Energy Changes and Rates of Reaction References

Standard Enthalpies of Formation (kJ)

$2\text{Ag}_{(s)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{Ag}_2\text{O}_{(s)}$	-30.66
$\text{C}_{(s)} + 2\text{H}_{2(g)} \longrightarrow \text{CH}_{4(g)}$	-75.18
$2\text{C}_{(s)} + 3\text{H}_{2(g)} \longrightarrow \text{C}_2\text{H}_{6(g)}$	-84.84
$3\text{C}_{(s)} + 4\text{H}_{2(g)} \longrightarrow \text{C}_3\text{H}_{8(g)}$	-104.16
$6\text{C}_{(s)} + 3\text{H}_{2(g)} \longrightarrow \text{C}_6\text{H}_{6(g)}$	83.24
$6\text{C}_{(s)} + 3\text{H}_{2(g)} \longrightarrow \text{C}_6\text{H}_{6(l)}$	48.85
$\text{Ca}_{(s)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{CaO}_{(s)}$	-637.98
$\text{Ca}_{(s)} + \text{O}_{2(g)} + \text{H}_{2(g)} \longrightarrow \text{Ca(OH)}_{2(s)}$	-990.36
$\text{C}_{(s)} + 2\text{H}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{CH}_3\text{OH}_{(g)}$	-202.02
$\text{C}_{(s)} + \text{H}_2\text{O}_{(g)} \longrightarrow \text{CO}_{(g)} + \text{H}_{2(g)}$	131.40
$\text{C}_{(s)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{CO}_{(g)}$	-110.94
$\text{C}_{(s)} + \text{O}_{2(g)} \longrightarrow \text{CO}_{2(g)}$	-394.90
$\text{CO}_{(g)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{CO}_{2(g)}$	-283.92
$\text{Cu}_{(s)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{CuO}_{(s)}$	-155.82
$2\text{Cu}_{(s)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{Cu}_2\text{O}_{(s)}$	-167.16
$2\text{Fe}_{(s)} + 3/2\text{O}_{2(g)} \longrightarrow \text{Fe}_2\text{O}_{3(s)}$	-825.30
$\frac{1}{2}\text{H}_{2(g)} + \frac{1}{2}\text{Br}_{2(l)} \longrightarrow \text{HBr}_{(g)}$	-36.37
$\frac{1}{2}\text{H}_{2(g)} + \frac{1}{2}\text{Cl}_{2(g)} \longrightarrow \text{HCl}_{(g)}$	-92.65
$\frac{1}{2}\text{H}_{2(g)} + \frac{1}{2}\text{F}_{2(g)} \longrightarrow \text{HF}_{(g)}$	-541.80
$\frac{1}{2}\text{H}_{2(g)} + \frac{1}{2}\text{I}_{2(s)} \longrightarrow \text{HI}_{(g)}$	26.04
$\frac{1}{2}\text{H}_{2(g)} + \frac{1}{2}\text{I}_{2(g)} \longrightarrow \text{HI}_{(g)}$	-5.04
$\text{H}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{H}_2\text{O}_{(g)}$	-242.76
$\text{H}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{H}_2\text{O}_{(l)}$	-283.46
$\text{H}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{H}_2\text{O}_{(s)}$	-289.47
$\text{H}_{2(g)} + \text{S}_{(s)} \longrightarrow \text{H}_2\text{S}_{(g)}$	-20.24
$\text{Hg}_{(l)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{HgO}_{(s)}$	-91.14
$\text{Mg}_{(s)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{MgO}_{(s)}$	-603.96
$\text{Na}_{(s)} + \frac{1}{2}\text{Cl}_{2(g)} \longrightarrow \text{NaCl}_{(s)}$	-412.44
$\text{Na}_{(s)} + \frac{1}{2}\text{Cl}_{2(g)} + 3/2\text{O}_{2(g)} \longrightarrow \text{NaClO}_{3(s)}$	-359.94
$\frac{1}{2}\text{N}_{2(g)} + 3/2\text{H}_{2(g)} \longrightarrow \text{NH}_{3(g)}$	-46.29
$\frac{1}{2}\text{N}_{2(g)} + 2\text{H}_{2(g)} + \frac{1}{2}\text{Cl}_{2(g)} \longrightarrow \text{NH}_4\text{Cl}_{(s)}$	-316.60
$\frac{1}{2}\text{N}_{2(g)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{NO}_{(g)}$	90.72
$\frac{1}{2}\text{N}_{2(g)} + \text{O}_{2(g)} \longrightarrow \text{NO}_{2(g)}$	34.00
$\text{S}_{(s)} + \text{O}_{2(g)} \longrightarrow \text{SO}_{2(g)}$	-297.19
$\text{S}_{(s)} + 3/2\text{O}_{2(g)} \longrightarrow \text{SO}_{3(g)}$	-396.69
$\frac{1}{8}\text{S}_{8(s)} + \text{O}_{2(g)} \longrightarrow \text{SO}_{2(g)}$	-298.20
$\frac{1}{8}\text{S}_{8(s)} + \text{H}_{2(g)} + 2\text{O}_{2(g)} \longrightarrow \text{H}_2\text{SO}_{4(l)}$	-814.80

C6 Standard Molar Entropies and Enthalpies of Formation

Chemical Name	Formula	ΔH_f° (kJ/mol)	S° (J/(mol·K))	Chemical Name	Formula	ΔH_f° (kJ/mol)	S° (J/(mol·K))
acetone	$(\text{CH}_3)_2\text{CO}_{(l)}$	-248.1	198.8	carbon disulfide	$\text{CS}_{2(l)}$	+89.0	—
aluminum oxide	$\text{Al}_2\text{O}_{3(s)}$	-1675.7	50.92	carbon monoxide	$\text{CO}_{(g)}$	-110.5	197.66
ammonia	$\text{NH}_{3(g)}$	-45.9	192.78	chloroethene	$\text{C}_2\text{H}_3\text{Cl}_{(g)}$	+37.3	263.9
ammonium chloride	$\text{NH}_4\text{Cl}_{(s)}$	-314.4	94.6	chromium(III) oxide	$\text{Cr}_2\text{O}_{3(s)}$	-1139.7	81.2
ammonium chloride	$\text{NH}_4\text{Cl}_{(aq)}$	-299.7	169.9	copper(I) oxide	$\text{Cu}_2\text{O}_{(s)}$	-168.6	93.1
ammonium nitrate	$\text{NH}_4\text{NO}_{3(s)}$	-365.6	151.08	copper(II) oxide	$\text{CuO}_{(s)}$	-157.3	42.6
barium carbonate	$\text{BaCO}_{3(s)}$	-1216.3	112.1	copper(I) sulfide	$\text{Cu}_2\text{S}_{(s)}$	-79.5	120.9
barium hydroxide	$\text{Ba}(\text{OH})_{2(s)}$	-944.7	107	copper(II) sulfide	$\text{CuS}_{(s)}$	-53.1	66.5
barium oxide	$\text{BaO}_{(s)}$	-553.5	72.07	cyclopropane	$\text{C}_3\text{H}_{6(g)}$	+17.8	—
barium sulfate	$\text{BaSO}_{4(s)}$	-1473.2	132.2	1,2-dichloroethane	$\text{C}_2\text{H}_4\text{Cl}_{2(l)}$	-126.9	—
benzene	$\text{C}_6\text{H}_{6(l)}$	+49.0	173.4	ethane	$\text{C}_2\text{H}_{6(g)}$	-83.8	229.1
bromine (vapour)	$\text{Br}_{2(g)}$	+30.9	245.47	1,2-ethanediol	$\text{C}_2\text{H}_4(\text{OH})_{2(l)}$	-454.8	163.2
butane	$\text{C}_4\text{H}_{10(g)}$	-125.6	310.1	ethanoic (acetic) acid	$\text{CH}_3\text{COOH}_{(l)}$	-432.8	159.9
calcium carbonate	$\text{CaCO}_{3(s)}$	-1206.9	91.7	ethanol	$\text{C}_2\text{H}_5\text{OH}_{(l)}$	-235.2	161.0
calcium chloride	$\text{CaCl}_{2(s)}$	-795.8	104.6	ethanol	$\text{C}_2\text{H}_5\text{OH}_{(g)}$	-235.2	282.70
calcium hydroxide	$\text{Ca}(\text{OH})_{2(s)}$	-986.1	83.4	ethene (ethylene)	$\text{C}_2\text{H}_{4(g)}$	+52.5	219.3
calcium oxide	$\text{CaO}_{(s)}$	-634.9	38.1	ethyne (acetylene)	$\text{C}_2\text{H}_{2(g)}$	+228.2	201.0
calcium sulphate	$\text{CaSO}_{4(s)}$	-1434.1	108.4	glucose	$\text{C}_6\text{H}_{12}\text{O}_{6(s)}$	-1273.1	212.1
carbon dioxide	$\text{CO}_{2(g)}$	-393.5	213.78				

Chemical Name	Formula	ΔH_f° (kJ/mol)	S° (J/(mol·K))	Chemical Name	Formula	ΔH_f° (kJ/mol)	S° (J/(mol·K))
hexane	C ₆ H _{14(l)}	−198.7	296.1	pentane	C ₅ H _{12(l)}	−173.5	262.7
hydrazine	N ₂ H _{4(g)}	+95.4	237.11	phenylethene (styrene)	C ₆ H ₅ CHCH _{2(l)}	+103.8	237.6
hydrazine	N ₂ H _{4(l)}	50.6	121.2	phosphorus pentachloride	PCl _{5(g)}	−443.5	364.6
hydrogen bromide	HBr _(g)	−36.3	198.70	phosphorus trichloride	PCl _{3(l)}	−319.7	217.2
hydrogen chloride	HCl _(g)	−92.3	186.90	phosphorus trichloride	PCl _{3(g)}	−287.0	311.8
hydrogen cyanide	HCN _(g)	+135.1	201.81	potassium	K _(s)	0.0	75.90
hydrogen iodide	HI _(g)	+26.5	206.59	potassium	K _(l)	2.3	71.46
hydrogen peroxide	H ₂ O _{2(l)}	−187.8	109.6	potassium chlorate	KClO _{3(s)}	−397.7	143.1
hydrogen sulfide	H ₂ S _(g)	−20.6	205.81	potassium chloride	KCl _(s)	−436.7	82.55
iodine (vapour)	I _{2(g)}	+62.4	180.79	potassium hydroxide	KOH _(s)	−424.8	78.9
iron(III) oxide	Fe ₂ O _{3(s)}	−824.2	87.40	propane	C ₃ H _{8(g)}	−104.7	270.2
iron(II, III) oxide	Fe ₃ O _{4(s)}	−1118.4	145.27	silicon dioxide	SiO _{2(s)}	−910.7	41.46
lead(II) oxide	PbO _(s)	−219.0	66.5	silver bromide	AgBr _(s)	−100.4	107.11
lead(IV) oxide	PbO _{2(s)}	−277.4	68.60	silver chloride	AgCl _(s)	−127.0	96.25
magnesium carbonate	MgCO _{3(s)}	−1095.8	65.7	silver iodide	AgI _(s)	−61.8	115.5
magnesium chloride	MgCl _{2(s)}	−641.3	89.63	sodium bromide	NaBr _(s)	−361.1	86.82
magnesium hydroxide	Mg(OH) _{2(s)}	−924.5	63.24	sodium chloride	NaCl _(s)	−411.2	115.5
magnesium oxide	MgO _(s)	−601.6	26.95	sodium hydroxide	NaOH _(s)	−425.6	64.4
manganese(II) oxide	MnO _(s)	−385.2	59.8	sodium iodide	NaI _(s)	−287.8	98.50
manganese(IV) oxide	MnO _{2(s)}	−520.0	53.1	sucrose	C ₁₂ H ₂₂ O _{11(s)}	−2225.5	360.2
mercury	Hg _(l)	0.0	75.90	sulfur dioxide	SO _{2(g)}	−296.8	248.22
mercury	Hg _(g)	61.4	174.97	sulfur trioxide (liquid)	SO _{3(l)}	−441.0	—
mercury(II) oxide	HgO _(s)	−90.8	70.25	sulfur trioxide (vapour)	SO _{3(g)}	−395.7	256.77
mercury(II) sulfide	HgS _(s)	−58.2	82.4	sulfuric acid	H ₂ SO _{4(l)}	−814.0	156.90
methanal (formaldehyde)	CH ₂ O _(g)	−108.6	218.8	tin(II) oxide	SnO _(s)	−280.7	57.17
methane	CH _{4(g)}	−74.4	186.3	tin(IV) oxide	SnO _{2(s)}	−577.6	49.04
methanoic (formic) acid	HCOOH _(l)	−425.1	129.0	2,2,4-trimethylpentane	C ₈ H _{18(l)}	−259.2	328.0
methanol	CH ₃ OH _(l)	−239.1	126.8	urea	CO(NH ₂) _{2(s)}	−333.5	104.6
methylpropane	C ₄ H _{10(g)}	−134.2	294.6	water (liquid)	H ₂ O _(l)	−285.8	69.95
nickel(II) oxide	NiO _(s)	−239.7	38.00	water (vapour)	H ₂ O _(g)	−241.8	188.84
nitric acid	HNO _{3(l)}	−174.1	155.60	zinc oxide	ZnO _(s)	−350.5	43.65
nitrogen dioxide	NO _{2(g)}	+33.2	240.1	zinc sulfide	ZnS _(s)	−206.0	57.7
nitrogen monoxide	NO _(g)	+90.2	210.76	- Standard molar enthalpies (heats) of formation are measured at SATP (25°C and 100 kPa). The values were obtained from <i>The CRC Handbook of Chemistry and Physics</i>, 71st Edition. - The standard molar enthalpies of elements in their standard states are defined as zero.			
nitromethane	CH ₃ NO _{2(l)}	−113.1	171.8				
octane	C ₈ H _{18(l)}	−250.1	—				
ozone	O _{3(g)}	+142.7	163.2				