

## GCE Chemistry Data Sheet


**Table 1**  
Infrared absorption data

Bond	Wavenumber /cm <sup>-1</sup>
N—H (amines)	3300–3500
O—H (alcohols)	3230–3550
C—H	2850–3300
O—H (acids)	2500–3000
C≡N	2220–2260
C=O	1680–1750
C=C	1620–1680
C—O	1000–1300
C—C	750–1100

**Table 2**  
<sup>1</sup>H n.m.r. chemical shift data

Type of proton	δ/ppm
ROH	0.5–5.0
RCH <sub>3</sub>	0.7–1.2
RNH <sub>2</sub>	1.0–4.5
R <sub>2</sub> CH <sub>2</sub>	1.2–1.4
R <sub>3</sub> CH	1.4–1.6
$\begin{array}{c}   \\ \text{R}-\text{C}-\text{C}- \\    \quad   \\ \text{O} \quad \text{H} \end{array}$	2.1–2.6
$\begin{array}{c}   \\ \text{R}-\text{O}-\text{C}- \\   \\ \text{H} \end{array}$	3.1–3.9
RCH <sub>2</sub> Cl or Br	3.1–4.2
$\begin{array}{c}   \\ \text{R}-\text{C}-\text{O}-\text{C}- \\    \quad   \\ \text{O} \quad \text{H} \end{array}$	3.7–4.1
$\begin{array}{c} \text{R} \quad \text{H} \\ \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \end{array}$	4.5–6.0
$\begin{array}{c} \text{O} \\ // \\ \text{R}-\text{C} \\   \\ \text{H} \end{array}$	9.0–10.0
$\begin{array}{c} \text{O} \\ // \\ \text{R}-\text{C} \\   \\ \text{O}-\text{H} \end{array}$	10.0–12.0

**Table 3**  
<sup>13</sup>C n.m.r. chemical shift data

Type of carbon	δ/ppm
$\begin{array}{c}   \quad   \\ -\text{C}-\text{C}- \\   \quad   \end{array}$	5–40
$\begin{array}{c}   \\ \text{R}-\text{C}-\text{Cl or Br} \\   \end{array}$	10–70
$\begin{array}{c}   \\ \text{R}-\text{C}-\text{C}- \\    \quad   \\ \text{O} \quad   \end{array}$	20–50
$\begin{array}{c}   \\ \text{R}-\text{C}-\text{N} \\   \quad \diagdown \end{array}$	25–60
$\begin{array}{c}   \\ -\text{C}-\text{O}- \\   \end{array}$ alcohols, ethers or esters	50–90
$\begin{array}{c} \diagdown \quad / \\ \text{C}=\text{C} \\ / \quad \diagdown \end{array}$	90–150
R—C≡N	110–125
	110–160
$\begin{array}{c}   \\ \text{R}-\text{C}- \\    \\ \text{O} \end{array}$ esters or acids	160–185
$\begin{array}{c}   \\ \text{R}-\text{C}- \\    \\ \text{O} \end{array}$ aldehydes or ketones	190–220



# The Periodic Table of the Elements

1	2											3	4	5	6	7	0
(1)	(2)	<b>Key</b> relative atomic mass <b>symbol</b> name atomic (proton) number										(13)	(14)	(15)	(16)	(17)	(18)
6.9 <b>Li</b> lithium 3	9.0 <b>Be</b> beryllium 4											10.8 <b>B</b> boron 5	12.0 <b>C</b> carbon 6	14.0 <b>N</b> nitrogen 7	16.0 <b>O</b> oxygen 8	19.0 <b>F</b> fluorine 9	4.0 <b>He</b> helium 2
23.0 <b>Na</b> sodium 11	24.3 <b>Mg</b> magnesium 12	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	27.0 <b>Al</b> aluminium 13	28.1 <b>Si</b> silicon 14	31.0 <b>P</b> phosphorus 15	32.1 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17	39.9 <b>Ar</b> argon 18
39.1 <b>K</b> potassium 19	40.1 <b>Ca</b> calcium 20	45.0 <b>Sc</b> scandium 21	47.9 <b>Ti</b> titanium 22	50.9 <b>V</b> vanadium 23	52.0 <b>Cr</b> chromium 24	54.9 <b>Mn</b> manganese 25	55.8 <b>Fe</b> iron 26	58.9 <b>Co</b> cobalt 27	58.7 <b>Ni</b> nickel 28	63.5 <b>Cu</b> copper 29	65.4 <b>Zn</b> zinc 30	69.7 <b>Ga</b> gallium 31	72.6 <b>Ge</b> germanium 32	74.9 <b>As</b> arsenic 33	79.0 <b>Se</b> selenium 34	79.9 <b>Br</b> bromine 35	83.8 <b>Kr</b> krypton 36
85.5 <b>Rb</b> rubidium 37	87.6 <b>Sr</b> strontium 38	88.9 <b>Y</b> yttrium 39	91.2 <b>Zr</b> zirconium 40	92.9 <b>Nb</b> niobium 41	96.0 <b>Mo</b> molybdenum 42	[98] <b>Tc</b> technetium 43	101.1 <b>Ru</b> ruthenium 44	102.9 <b>Rh</b> rhodium 45	106.4 <b>Pd</b> palladium 46	107.9 <b>Ag</b> silver 47	112.4 <b>Cd</b> cadmium 48	114.8 <b>In</b> indium 49	118.7 <b>Sn</b> tin 50	121.8 <b>Sb</b> antimony 51	127.6 <b>Te</b> tellurium 52	126.9 <b>I</b> iodine 53	131.3 <b>Xe</b> xenon 54
132.9 <b>Cs</b> caesium 55	137.3 <b>Ba</b> barium 56	138.9 <b>La</b> * lanthanum 57	178.5 <b>Hf</b> hafnium 72	180.9 <b>Ta</b> tantalum 73	183.8 <b>W</b> tungsten 74	186.2 <b>Re</b> rhenium 75	190.2 <b>Os</b> osmium 76	192.2 <b>Ir</b> iridium 77	195.1 <b>Pt</b> platinum 78	197.0 <b>Au</b> gold 79	200.6 <b>Hg</b> mercury 80	204.4 <b>Tl</b> thallium 81	207.2 <b>Pb</b> lead 82	209.0 <b>Bi</b> bismuth 83	[209] <b>Po</b> polonium 84	[210] <b>At</b> astatine 85	[222] <b>Rn</b> radon 86
[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac</b> † actinium 89	[267] <b>Rf</b> rutherfordium 104	[268] <b>Db</b> dubnium 105	[271] <b>Sg</b> seaborgium 106	[272] <b>Bh</b> bohrium 107	[270] <b>Hs</b> hassium 108	[276] <b>Mt</b> meitnerium 109	[281] <b>Ds</b> darmstadtium 110	[280] <b>Rg</b> roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

\* 58 – 71 Lanthanides

140.1 <b>Ce</b> cerium 58	140.9 <b>Pr</b> praseodymium 59	144.2 <b>Nd</b> neodymium 60	[145] <b>Pm</b> promethium 61	150.4 <b>Sm</b> samarium 62	152.0 <b>Eu</b> europium 63	157.3 <b>Gd</b> gadolinium 64	158.9 <b>Tb</b> terbium 65	162.5 <b>Dy</b> dysprosium 66	164.9 <b>Ho</b> holmium 67	167.3 <b>Er</b> erbium 68	168.9 <b>Tm</b> thulium 69	173.1 <b>Yb</b> ytterbium 70	175.0 <b>Lu</b> lutetium 71
232.0 <b>Th</b> thorium 90	231.0 <b>Pa</b> protactinium 91	238.0 <b>U</b> uranium 92	[237] <b>Np</b> neptunium 93	[244] <b>Pu</b> plutonium 94	[243] <b>Am</b> americium 95	[247] <b>Cm</b> curium 96	[247] <b>Bk</b> berkelium 97	[251] <b>Cf</b> californium 98	[252] <b>Es</b> einsteinium 99	[257] <b>Fm</b> fermium 100	[258] <b>Md</b> mendelevium 101	[259] <b>No</b> nobelium 102	[262] <b>Lr</b> lawrencium 103

† 90 – 103 Actinides