

The Periodic Table of the Elements

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* 58 – 71 Lanthanides

† 90 – 103 Actinides

140.1 Ce cerium 58	140.9 Pr praseodymium 59	144.2 Nd neodymium 60	[145] Pm promethium 61	150.4 Sm samarium 62	152.0 Eu europium 63	157.3 Gd gadolinium 64	158.9 Tb terbium 65	162.5 Dy dysprosium 66	164.9 Ho holmium 67	167.3 Er erbium 68	168.9 Tm thulium 69	173.0 Yb ytterbium 70	175.0 Lu lutetium 71
232.0 Th thorium 90	231.0 Pa protactinium 91	238.0 U uranium 92	[237] Np neptunium 93	[244] Pu plutonium 94	[243] Am americium 95	[247] Cm curium 96	[247] Bk berkelium 97	[251] Cf californium 98	[252] Es einsteinium 99	[257] Fm fermium 100	[258] Md mendelevium 101	[259] No nobelium 102	[262] Lr lawrencium 103

Chemistry Data Sheet

Table A

Infrared absorption data

Bond	Wavenumber /cm ⁻¹
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 B

¹H NMR chemical shift data

Type of proton	δ/ppm
ROH	0.5–5.0
RCH ₃	0.7–1.2
RNH ₂	1.0–4.5
R ₂ CH ₂	1.2–1.4
R ₃ 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 ₂ 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 C

¹³C NMR 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
$\begin{array}{c} \\ \text{R}-\text{C}-\text{C}- \\ \quad \\ \text{O} \end{array}$	20–50
$\begin{array}{c} \quad \\ \text{R}-\text{C}-\text{N} \\ \quad \end{array}$	25–60
$\begin{array}{c} \\ -\text{C}-\text{O}- \\ \end{array}$ alcohols, ethers or esters	50–90
$\begin{array}{c} \diagup \quad \diagdown \\ \text{C}=\text{C} \\ \diagdown \quad \diagup \end{array}$	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