

Physical constants

Avogadro constant (L)	$6.02 \times 10^{23} \text{ mol}^{-1}$
Elementary charge (e)	$1.60 \times 10^{-19} \text{ C}$
Gas constant (R)	$8.31 \text{ J mol}^{-1} \text{ K}^{-1}$
Molar volume of a gas at room temperature and pressure (r.t.p.):	$24 \text{ dm}^3 \text{ mol}^{-1}$
Ionic product of water (K_w)	$1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}$

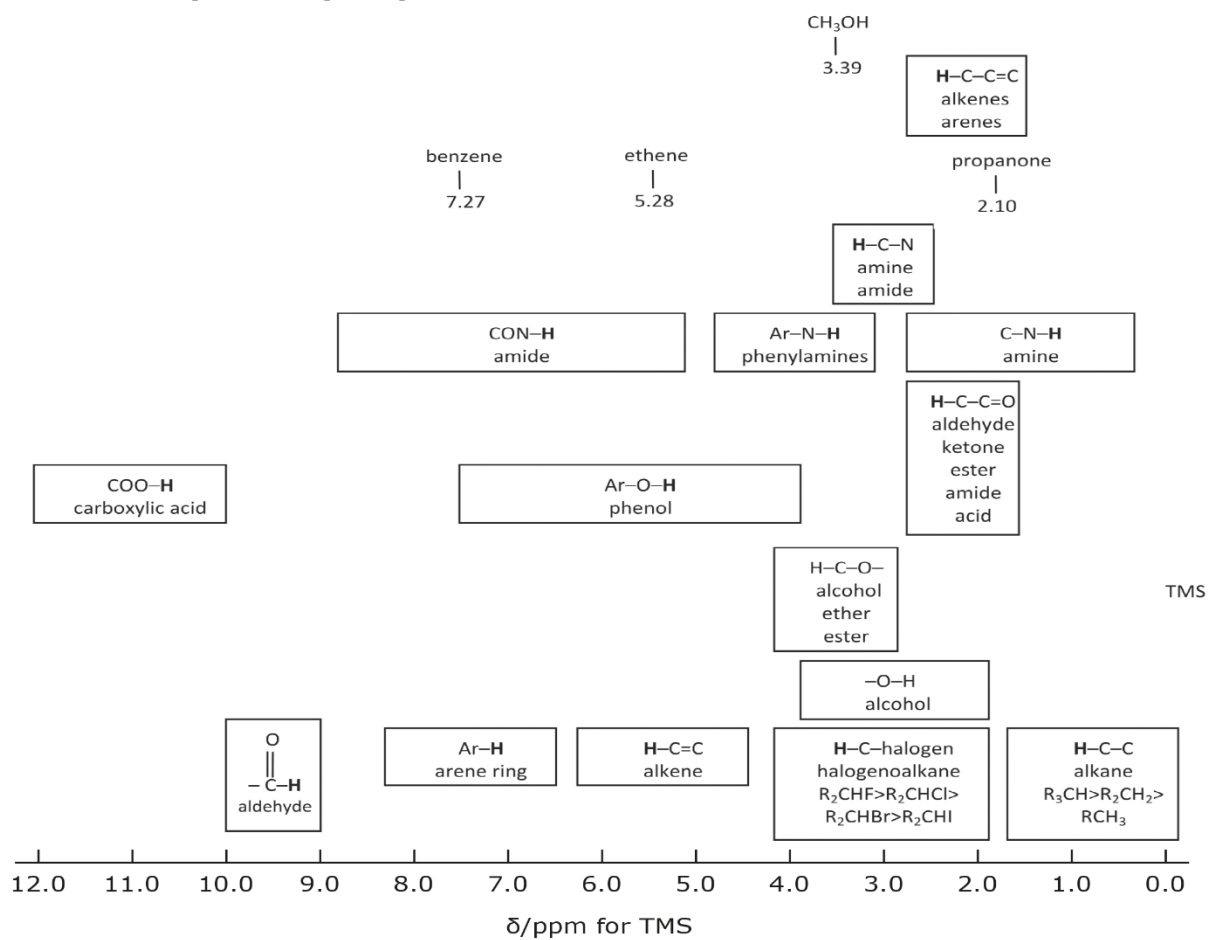
$$1 \text{ dm}^3 = 1000 \text{ cm}^3 = 0.001 \text{ m}^3$$

Infrared spectroscopy

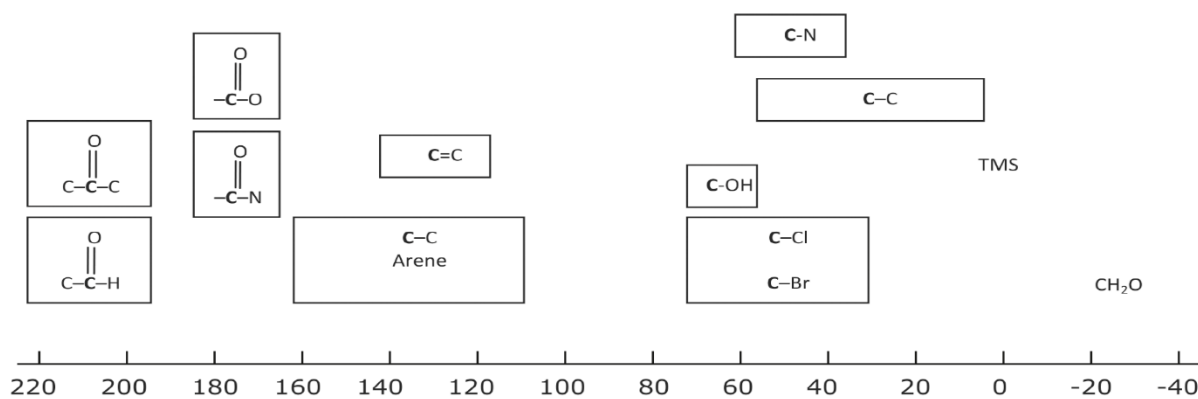
Correlation of infrared absorption wavenumbers with molecular structure

Group	Wavenumber range/cm ⁻¹
C-H stretching vibrations	
Alkane	2962-2853
Alkene	3095-3010
Alkyne	3300
Arene	3030
Aldehyde	2900-2820 and 2775-2700
C-H bending vibrations	
Alkane	1485-1365
Arene 5 adjacent hydrogen atoms	750 and 700
4 adjacent hydrogen atoms	750
3 adjacent hydrogen atoms	780
2 adjacent hydrogen atoms	830
1 isolated hydrogen atom	880
N-H stretching vibrations	
Amine	3500-3300
Amide	3500-3140
O-H stretching vibrations	
Alcohols and phenols	3750-3200
Carboxylic acids	3300-2500
C=C stretching vibrations	
Isolated alkene	1669-1645
Arene	1600, 1580, 1500, 1450
C=O stretching vibrations	
Aldehydes, saturated alkyl	1740-1720
Ketones, alkyl	1720-1700
Ketones, aryl	1700-1680
Carboxylic acids, alkyl	1725-1700
Carboxylic acids, aryl	1700-1680
Carboxylic acid, anhydrides	1850-1800 and 1790-1740
Acyl halides, chlorides	1795
Acyl halides, bromides	1810
Esters, saturated	1750-1735
Amides	1700-1630
Triple bond stretching vibrations	
C≡N	2260-2215
C≡C	2260-2100

¹H nuclear magnetic resonance chemical shifts relative to tetramethylsilane (TMS)



¹³C nuclear magnetic resonance chemical shifts relative to tetramethylsilane (TMS)



Pauling electronegativities

Pauling electronegativity index

								H										He
								2.1										
Li	Be											B	C	N	O	F		Ne
1.0	1.5											2.0	2.5	3.0	3.5	4.0		
Na	Mg											Al	Si	P	S	Cl		Ar
0.9	1.2											1.5	1.9	2.1	2.5	3.0		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br		Kr
0.8	1.0	1.3	1.5	1.6	1.6	1.5	1.8	1.8	1.8	1.9	1.6	1.6	2.0	2.0	2.4	2.8		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I		Xe
0.8	1.0	1.2	1.3	1.6	2.1	1.9	2.2	2.2	2.2	1.9	1.6	1.7	1.9	1.9	2.1	2.5		
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At		Rn
0.7	0.9	1.1	1.3	1.5	2.3	1.9	2.2	2.2	2.2	2.5	2.0	1.6	1.8	1.9	2.0	2.2		

Indicators

		pK_{in} (at 298 K)	acid	pH range	alkaline
1	Thymol blue (acid)	1.7	red	1.2–2.8	yellow
2	Screened methyl orange	3.7	purple	3.2–4.2	green
3	Methyl orange	3.7	red	3.2–4.4	yellow
4	Bromophenol blue	4.0	yellow	2.8–4.6	blue
5	Bromocresol green	4.7	yellow	3.8–5.4	blue
6	Methyl red	5.1	red	4.2–6.3	yellow
7	Litmus		red	5.0–8.0	blue
8	Bromothymol blue	7.0	yellow	6.0–7.6	blue
9	Phenol red	7.9	yellow	6.8–8.4	red
10	Phenolphthalein (in ethanol)	9.3	colourless	8.2–10.0	red

Standard electrode potentials

E^\ominus Standard electrode potential of aqueous system at 298 K, that is, standard emf of electrochemical cell in the hydrogen half-cell forms the left-hand side electrode system.

	Right-hand electrode system	E^\ominus / V
1	$\text{Na}^+ + \text{e}^- \rightleftharpoons \text{Na}$	-2.71
2	$\text{Mg}^{2+} + 2\text{e}^- \rightleftharpoons \text{Mg}$	-2.37
3	$\text{Al}^{3+} + 3\text{e}^- \rightleftharpoons \text{Al}$	-1.66
4	$\text{V}^{2+} + 2\text{e}^- \rightleftharpoons \text{V}$	-1.18
5	$\text{Zn}^{2+} + 2\text{e}^- \rightleftharpoons \text{Zn}$	-0.76
6	$\text{Cr}^{3+} + 3\text{e}^- \rightleftharpoons \text{Cr}$	-0.74
7	$\text{Fe}^{2+} + 2\text{e}^- \rightleftharpoons \text{Fe}$	-0.44
8	$\text{Cr}^{3+} + \text{e}^- \rightleftharpoons \text{Cr}^{2+}$	-0.41
9	$\text{V}^{3+} + \text{e}^- \rightleftharpoons \text{V}^{2+}$	-0.26
10	$\text{Ni}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ni}$	-0.25
11	$\text{H}^+ + \text{e}^- \rightleftharpoons \frac{1}{2}\text{H}_2$	0.00
12	$\text{S}_4\text{O}_6^{2-} + 2\text{e}^- \rightleftharpoons 2\text{S}_2\text{O}_3^{2-}$	+0.09
13	$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+0.15
14	$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0.34
15	$\text{VO}^{2+} + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{V}^{3+} + \text{H}_2\text{O}$	+0.34
16	$\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$	+0.40
17	$\text{S}_2\text{O}_3^{2-} + 6\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{S} + 3\text{H}_2\text{O}$	+0.47
18	$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+0.52
19	$\text{I}_2 + 2\text{e}^- \rightleftharpoons 2\text{I}^-$	+0.54
20	$\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2$	+0.68
21	$\text{Fe}^{3+} + \text{e}^- \rightleftharpoons \text{Fe}^{2+}$	+0.77
22	$\text{Ag}^+ + \text{e}^- \rightleftharpoons \text{Ag}$	+0.80
23	$\text{NO}_3^- + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{NO}_2 + \text{H}_2\text{O}$	+0.80
24	$\text{ClO}^- + \text{H}_2\text{O} + 2\text{e}^- \rightleftharpoons \text{Cl}^- + 2\text{OH}^-$	+0.89
25	$\text{VO}_2^+ + 2\text{H}^+ + \text{e}^- \rightleftharpoons \text{VO}^{2+} + \text{H}_2\text{O}$	+1.00
26	$\text{Br}_2 + 2\text{e}^- \rightleftharpoons 2\text{Br}^-$	+1.09
27	$\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1.23
28	$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1.33
29	$\text{Cl}_2 + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-$	+1.36
30	$\text{MnO}_4^- + 8\text{H}^+ + 5\text{e}^- \rightleftharpoons \text{Mn}^{2+} + 4\text{H}_2\text{O}$	+1.51
31	$\text{H}_2\text{O}_2 + 2\text{H}^+ + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}$	+1.77

The Periodic Table of Elements

1	2	3	4	5	6	7	0 (8)
6.9 Li lithium 3	9.0 Be beryllium 4	10.8 B boron 5	12.0 C carbon 6	14.0 N nitrogen 7	16.0 O oxygen 8	19.0 F fluorine 9	20.2 Ne neon 10
23.0 Na sodium 11	24.3 Mg magnesium 12	27.0 Al aluminium 13	28.1 Si silicon 14	31.0 P phosphorus 15	32.1 S sulfur 16	35.5 Cl chlorine 17	39.9 Ar argon 18
39.1 K potassium 19	40.1 Ca calcium 20	47.9 Ti titanium 22	54.9 Mn manganese 25	58.9 Co cobalt 27	65.4 Zn zinc 30	79.9 Br bromine 35	83.8 Kr krypton 36
85.5 Rb rubidium 37	87.6 Sr strontium 38	91.2 Zr zirconium 40	98 Tc technetium 43	102.9 Rh rhodium 45	112.4 Cd cadmium 48	126.9 I iodine 53	131.3 Xe xenon 54
132.9 Cs caesium 55	137.3 Ba barium 56	178.5 Hf hafnium 72	186.2 Re rhenium 75	192.2 Ir iridium 77	200.6 Hg mercury 80	209.0 Po polonium 84	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	138.9 La* lanthanum 57	183.8 W tungsten 74	180.9 Ta tantalum 73	197.0 Au gold 79	[210] At astatine 85	
		45.0 Sc scandium 21	52.0 Cr chromium 24	58.9 Co cobalt 27	63.5 Cu copper 29	[209] Pb lead 82	
		88.9 Y yttrium 39	95.9 Mo molybdenum 42	102.9 Rh rhodium 45	106.4 Pd palladium 46	204.4 Tl thallium 81	
		138.9 La* lanthanum 57	183.8 W tungsten 74	180.9 Ta tantalum 73	197.0 Au gold 79	204.4 Tl thallium 81	
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