OCR
RECOGNISING ACHIEVEMENT

# SPECIMEN

**Advanced (Subsidiary) GCE**

**CHEMISTRY A**

Data Sheet

**Specimen**

The information in this Sheet is for the use of candidates following Chemistry A H034 and H434.

A copy of this sheet will be included as an insert with each unit paper.

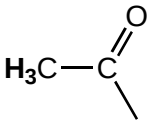
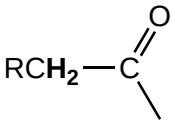
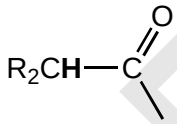
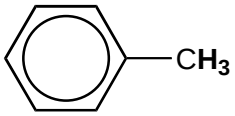
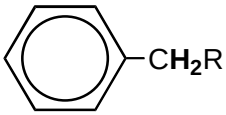
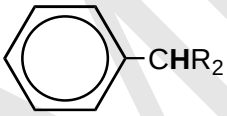
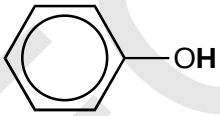
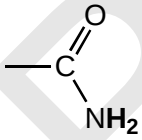
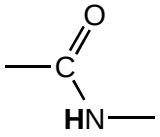
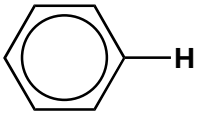
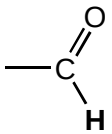
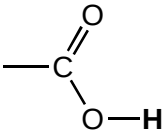
Copies of this sheet may be used for teaching.

**General information**

- 1 mol of gas molecules occupies 24.0 $dm^3$ at room temperature and pressure, RTP.
- Avogadro constant, $N_A = 6.02 \times 10^{23}$ $mol^{-1}$.
- Ionic product of water, $K_w = 1.00 \times 10^{-14}$ $mol^2$ $dm^{-6}$.

## $^1$H NMR chemical shifts relative to TMS

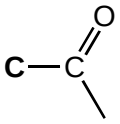
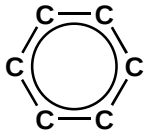
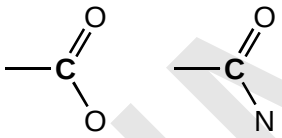
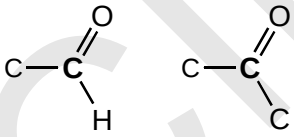
Chemical shifts are typical values and can vary slightly depending on the solvent, concentration and substituents.

| type of proton | | | chemical shift, $\delta$ / ppm |
|---|---|---|---|
| R–C**H$_3$** | | | 0.7–1.6 |
| N–**H** | R–O**H** | | 1.0–5.5* |
| R–C**H$_2$**–R | | | 1.2–1.4 |
| R$_3$C**H** | | | 1.6–2.0 |
|  |  |  | 2.0–2.9 |
|  |  |  | 2.3–2.7 |
| N–C**H$_3$** | N–C**H$_2$**R | N–C**H**R$_2$ | 2.3–2.9 |
| O–C**H$_3$** | O–C**H$_2$**R | O–C**H**R$_2$ | 3.3–4.3 |
| Br or Cl–C**H$_3$** | Br or Cl–C**H$_2$**R | Br or Cl–C**H**R$_2$ | 3.0–4.2 |
| |  | | 4.5–10.0* |
| | –C**H**=C**H**– | | 4.5–6.0 |
|  |  | | 5.0–12.0* |
| |  | | 6.5–8.0 |
| |  | | 9.0–10 |
| |  | | 11.0–12.0* |

* OH and NH chemical shifts are very variable (sometimes outside these limits) and are often broad. Signals are not usually seen as split peaks.

**$^{13}$C NMR chemical shifts relative to TMS**

Chemical shifts are typical values and can vary slightly depending on the solvent, concentration and substituents.

| type of carbon | chemical shift, $\delta$ / ppm |
|---|---|
| **C**–**C** (alkanes) | 10–35 |
|  | 20–30 |
| **C**–Cl or **C**–Br | 30–70 |
| **C**–N (amines) | 35–60 |
| **C**–OH | 50–65 |
| **C**=**C** (alkenes) | 115–140 |
| aromatic  | 125–150 |
| carbonyl (ester, carboxylic acid, amide)  | 160–185 |
| carbonyl (aldehyde, ketone)  | 190–220 |

**Characteristic infrared absorptions in organic molecules**

| bond | location | wavenumber/cm$^{-1}$ |
|---|---|---|
| C–O | alcohols, esters, carboxylic acids | 1000–1300 |
| C=O | aldehydes, ketones, carboxylic acids, esters, amides | 1640–1750 |
| C–H | organic compound with a C–H bond | 2850–3100 |
| O–H | carboxylic acids | 2500–3300 (very broad) |
| N–H | amines, amides | 3200–3500 |
| O–H | alcohols, phenols | 3200–3550 (broad) |

# The Periodic Table of the Elements

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1.0 **H** hydrogen 1 | | | | | | | | | | 4.0 **He** helium 2 |
| 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 | 45.0 **Sc** scandium 21 | 47.9 **Ti** titanium 22 | 50.9 **V** vanadium 23 | 52.0 **Cr** chromium 24 | 54.9 **Mn** manganese 25 | 55.8 **Fe** iron 26 | 58.9 **Co** cobalt 27 | 58.7 **Ni** nickel 28 | 63.5 **Cu** copper 29 | 65.4 **Zn** zinc 30 | 69.7 **Ga** gallium 31 | 72.6 **Ge** germanium 32 | 74.9 **As** arsenic 33 | 79.0 **Se** selenium 34 | 79.9 **Br** bromine 35 | 83.8 **Kr** krypton 36 |
| 85.5 **Rb** rubidium 37 | 87.6 **Sr** strontium 38 | 88.9 **Y** yttrium 39 | 91.2 **Zr** zirconium 40 | 92.9 **Nb** niobium 41 | 95.9 **Mo** molybdenum 42 | [98] **Tc** technetium 43 | 101.1 **Ru** ruthenium 44 | 102.9 **Rh** rhodium 45 | 106.4 **Pd** palladium 46 | 107.9 **Ag** silver 47 | 112.4 **Cd** cadmium 48 | 114.8 **In** indium 49 | 118.7 **Sn** tin 50 | 121.8 **Sb** antimony 51 | 127.6 **Te** tellurium 52 | 126.9 **I** iodine 53 | 131.3 **Xe** xenon 54 |
| 132.9 **Cs** caesium 55 | 137.3 **Ba** barium 56 | 138.9 **La*** lanthanum 57 | 178.5 **Hf** hafnium 72 | 180.9 **Ta** tantalum 73 | 183.8 **W** tungsten 74 | 186.2 **Re** rhenium 75 | 190.2 **Os** osmium 76 | 192.2 **Ir** iridium 77 | 195.1 **Pt** platinum 78 | 197.0 **Au** gold 79 | 200.6 **Hg** mercury 80 | 204.4 **Tl** thallium 81 | 207.2 **Pb** lead 82 | 209.0 **Bi** bismuth 83 | [209] **Po** polonium 84 | [210] **At** astatine 85 | [222] **Rn** radon 86 |
| [223] **Fr** francium 87 | [226] **Ra** radius 88 | [227] **Ac*** actinium 89 | [261] **Rf** rutherfordium 104 | [262] **Db** dubnium 105 | [266] **Sg** seaborgium 106 | [264] **Bh** bohrium 107 | [277] **Hs** hassium 108 | [268] **Mt** meitnerium 109 | [271] **Ds** darmstadtium 110 | [272] **Rg** roentgenium 111 | Elements with atomic numbers 112–116 have been reported but not fully authenticated | | | | | | |

**Key**

relative atomic mass
**atomic symbol**
name
atomic (proton) number

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 140.1 **Ce** cerium 58 | 140.9 **Pr** praseodymium 59 | 144.2 **Nd** neodymium 60 | 144.9 **Pm** promethium 61 | 150.4 **Sm** samarium 62 | 152.0 **Eu** europium 63 | 157.2 **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] **Pa** protactinium 91 | 238.1 **U** uranium 92 | [237] **Np** neptunium 93 | [242] **Pu** plutonium 94 | [243] **Am** americium 95 | [247] **Cm** curium 96 | [245] **Bk** berkelium 97 | [251] **Cf** californium 98 | [254] **Es** einsteinium 99 | [253] **Fm** fermium 100 | [256] **Md** mendelevium 101 | [254] **No** nobelium 102 | [257] **Lr** lawrencium 103 |