VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education
Year

CHEMISTRY

Written examination

Annotated 2019

DATA BOOK

by James Kennedy

Instructions

This data book is provided for your reference.
A question and answer book is provided with this data book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

Version 2 – June 2018

Table of contents

1. Periodic table of the elements

1 **H** 1.0 hydrogen																	2 **He** 4.0 helium
3 **Li** 6.9 lithium	4 **Be** 9.0 beryllium											5 **B** 10.8 boron	6 **C** 12.0 carbon	7 **N** 14.0 nitrogen	8 **O** 16.0 oxygen	9 **F** 19.0 fluorine	10 **Ne** 20.2 neon
11 **Na** 23.0 sodium	12 **Mg** 24.3 magnesium											13 **Al** 27.0 aluminium	14 **Si** 28.1 silicon	15 **P** 31.0 phosphorus	16 **S** 32.1 sulfur	17 **Cl** 35.5 chlorine	18 **Ar** 39.9 argon
19 **K** 39.1 potassium	20 **Ca** 40.1 calcium	21 **Sc** 45.0 scandium	22 **Ti** 47.9 titanium	23 **V** 50.9 vanadium	24 **Cr** 52.0 chromium	25 **Mn** 54.9 manganese	26 **Fe** 55.8 iron	27 **Co** 58.9 cobalt	28 **Ni** 58.7 nickel	29 **Cu** 63.5 copper	30 **Zn** 65.4 zinc	31 **Ga** 69.7 gallium	32 **Ge** 72.6 germanium	33 **As** 74.9 arsenic	34 **Se** 79.0 selenium	35 **Br** 79.9 bromine	36 **Kr** 83.8 krypton
37 **Rb** 85.5 rubidium	38 **Sr** 87.6 strontium	39 **Y** 88.9 yttrium	40 **Zr** 91.2 zirconium	41 **Nb** 92.9 niobium	42 **Mo** 96.0 molybdenum	43 **Tc** (98) technetium	44 **Ru** 101.1 ruthenium	45 **Rh** 102.9 rhodium	46 **Pd** 106.4 palladium	47 **Ag** 107.9 silver	48 **Cd** 112.4 cadmium	49 **In** 114.8 indium	50 **Sn** 118.7 tin	51 **Sb** 121.8 antimony	52 **Te** 127.6 tellurium	53 **I** 126.9 iodine	54 **Xe** 131.3 xenon
55 **Cs** 132.9 caesium	56 **Ba** 137.3 barium	57–71 lanthanoids	72 **Hf** 178.5 hafnium	73 **Ta** 180.9 tantalum	74 **W** 183.8 tungsten	75 **Re** 186.2 rhenium	76 **Os** 190.2 osmium	77 **Ir** 192.2 iridium	78 **Pt** 195.1 platinum	79 **Au** 197.0 gold	80 **Hg** 200.6 mercury	81 **Tl** 204.4 thallium	82 **Pb** 207.2 lead	83 **Bi** 209.0 bismuth	84 **Po** (210) polonium	85 **At** (210) astatine	86 **Rn** (222) radon
87 **Fr** (223) francium	88 **Ra** (226) radium	89–103 actinoids	104 **Rf** (261) rutherfordium	105 **Db** (262) dubnium	106 **Sg** (266) seaborgium	107 **Bh** (264) bohrium	108 **Hs** (267) hassium	109 **Mt** (268) meitnerium	110 **Ds** (271) darmstadtium	111 **Rg** (272) roentgenium	112 **Cn** (285) copernicium	113 **Nh** (280) nihonium	114 **Fl** (289) flerovium	115 **Mc** (289) moscovium	116 **Lv** (292) livermorium	117 **Ts** (294) tennessine	118 **Og** (294) oganesson

57 **La** 138.9 lanthanum	58 **Ce** 140.1 cerium	59 **Pr** 140.9 praseodymium	60 **Nd** 144.2 neodymium	61 **Pm** (145) promethium	62 **Sm** 150.4 samarium	63 **Eu** 152.0 europium	64 **Gd** 157.3 gadolinium	65 **Tb** 158.9 terbium	66 **Dy** 162.5 dysprosium	67 **Ho** 164.9 holmium	68 **Er** 167.3 erbium	69 **Tm** 168.9 thulium	70 **Yb** 173.1 ytterbium	71 **Lu** 175.0 lutetium

89 **Ac** (227) actinium	90 **Th** 232.0 thorium	91 **Pa** 231.0 protactinium	92 **U** 238.0 uranium	93 **Np** (237) neptunium	94 **Pu** (244) plutonium	95 **Am** (243) americium	96 **Cm** (247) curium	97 **Bk** (247) berkelium	98 **Cf** (251) californium	99 **Es** (252) einsteinium	100 **Fm** (257) fermium	101 **Md** (258) mendelevium	102 **No** (259) nobelium	103 **Lr** (262) lawrencium

atomic number **79** symbol of element **Au**
relative atomic mass **197.0** name of element **gold**

The value in brackets indicates the mass number of the longest-lived isotope.

TURN OVER

2. Electrochemical series

ALL OF THESE HALF EQUATIONS SHOW REDUCTIONS

Reaction OXIDANTS + e^- ⇌ REDUCTANTS	Standard electrode potential (E^0) in volts at 25 °C
STRONGEST OXIDANT → $F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	+2.87
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$	+1.77
$Au^+(aq) + e^- \rightleftharpoons Au(s)$	+1.68
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$	+1.23
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	+1.09
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77
$O_2(g) + 2H^+(aq) + 2e^- \rightleftharpoons H_2O_2(aq)$	+0.68
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(g)$	+0.14
* $2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	−0.13
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	−0.14
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	−0.25
$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$	−0.28
$Cd^{2+}(aq) + 2e^- \rightleftharpoons Cd(s)$	−0.40
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	−0.44
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	−0.76
$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$	−0.83
$Mn^{2+}(aq) + 2e^- \rightleftharpoons Mn(s)$	−1.18
$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$	−1.66
$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$	−2.37
$Na^+(aq) + e^- \rightleftharpoons Na(s)$	−2.71
$Ca^{2+}(aq) + 2e^- \rightleftharpoons Ca(s)$	−2.87
$K^+(aq) + e^- \rightleftharpoons K(s)$	−2.93
$Li^+(aq) + e^- \rightleftharpoons Li(s)$	−3.04

THESE TWO HALF-EQNS SWAP AT >2 M

E^0 ← STANDARD CONDITIONS
- 1 atm
- 1 M
- 25 °C

THESE VOLTAGES ALL CHANGE AT NON-STANDARD CONDITIONS

MnO_4^-

$Cr_2O_7^{2-}$

↑ CAN BE EXTRACTED IN AQUEOUS SOLUTIONS ↑

MUST BE EXTRACTED MOLTEN (l) WITHOUT H_2O

* STANDARD HYDROGEN ELECTRODE

FOR A SPONTANEOUS REACTION TO OCCUR:

REDUCTION → CATHODE

OXIDATION → ANODE

STRONGEST REDUCTANT = MOST REACTIVE METAL ON THIS LIST

* RECENTLY CHANGED

3. Chemical relationships

Name	Formula
number of moles of a substance	$n = \frac{m}{M}; \quad n = cV; \quad n = \frac{V}{V_m}$
universal gas equation	$pV = nRT$
calibration factor (CF) for bomb calorimetry	$CF = \frac{VIt}{\Delta T}$
heat energy released in the combustion of a fuel	$q = mc\Delta T$
enthalpy of combustion	$\Delta H = \frac{q}{n}$
electric charge	$Q = It$
number of moles of electrons	$n(e^-) = \frac{Q}{F}$
% atom economy	$\frac{\text{molar mass of desired product}}{\text{molar mass of all reactants}} \times \frac{100}{1}$
% yield	$\frac{\text{actual yield}}{\text{theoretical yield}} \times \frac{100}{1}$

one term not 2

DON'T ADD 273 TO ΔT!

J

kJ

CONVERT J TO kJ HERE BY ÷1000 W CALCULATIONS

4. Physical constants and standard values

Name	Symbol	Value
Avogadro constant	N_A or L	6.02×10^{23} mol^{-1}
charge on one electron (elementary charge)	e	-1.60×10^{-19} C
Faraday constant	F	96 500 C mol^{-1}
molar gas constant	R	8.31 J mol^{-1} K^{-1}
molar volume of an ideal gas at SLC (25 °C and 100 kPa)	V_m	24.8 L mol^{-1}
specific heat capacity of water	c	~~4.18 kJ kg^{-1} K^{-1}~~ or 4.18 J g^{-1} K^{-1}
density of water at 25 °C	d	997 kg m^{-3} or 0.997 g mL^{-1} *

$n = \frac{N}{N_A}$

$C_1V_1 = C_2V_2$

$C_1V_1 + C_2V_2 = C_3V_3$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$d = \frac{M}{V}$

* RECENTLY CHANGED

5. Unit conversions

Measured value	Conversion
0 °C	273 K
100 kPa	750 mm Hg or 0.987 atm
1 litre (L)	1 dm^3 or 1×10^{-3} m^3 or 1×10^3 cm^3 or 1×10^3 mL

= 997 g H_2O @ 25°C

6. Metric (including SI) prefixes

Metric (including SI) prefixes	Scientific notation	Multiplying factor
giga (G)	10^9	1 000 000 000
mega (M)	10^6	1 000 000
kilo (k)	10^3	1000
deci (d)	10^{-1}	0.1
centi (c)	10^{-2}	0.01
milli (m)	10^{-3}	0.001
micro (μ)	10^{-6}	0.000001
nano (n)	10^{-9}	0.000000001
pico (p)	10^{-12}	0.000000000001

IN CALCULATIONS, REPLACE PREFIXES WITH VALUES

pH FORMULAE

$pH = -\log_{10}[H^+]$

$[H^+] = 10^{-pH}$

$[H^+] = \frac{10^{-14}}{[OH^-]}$

$[OH^-] = \frac{10^{-14}}{[H^+]}$

ONLY TRUE IN AQUEOUS SOLUTIONS AT 25°C

$[H^+] = [H_3O^+]$ IN AQUEOUS SOLUTION

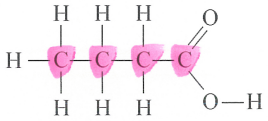
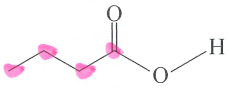
7. Acid-base indicators

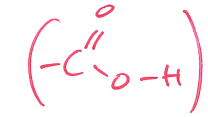
Name	pH range	Colour change from lower pH to higher pH in range
thymol blue (1st change)	1.2–2.8	red → yellow
methyl orange	3.1–4.4	red → yellow
bromophenol blue	3.0–4.6	yellow → blue
methyl red	4.4–6.2	red → yellow
bromothymol blue	6.0–7.6	yellow → blue
phenol red	6.8–8.4	yellow → red
thymol blue (2nd change)	8.0–9.6	yellow → blue
phenolphthalein	8.3–10.0	colourless → pink *

IN PURE WATER, $[H^+] = [OH^-]$ EVEN IF THE pH ISN'T 7

8. Representations of organic molecules

The following table shows different representations of organic molecules, using butanoic acid as an example.

Formula	Representation
molecular formula	$C_4H_8O_2$
structural formula	 YOU MUST DRAW ALL ATOMS & ALL BONDS.
semi-structural (condensed) formula	$CH_3CH_2CH_2COOH$ or $CH_3(CH_2)_2COOH$
skeletal structure	 CORNERS & ENDS WITHOUT A LETTER ARE CARBON ATOMS.

ALL CONTAIN CARBOXYL GROUP 

9. Formulas of some fatty acids → ALL ARE SOLID AT 25°C

YOU MUST ADD THE WORD "ACID" TO THESE!

Name	Formula	N(C=C)	Semi-structural formula
lauric acid	$C_{11}H_{23}COOH$	0	$CH_3(CH_2)_{10}COOH$
myristic acid	$C_{13}H_{27}COOH$	0	$CH_3(CH_2)_{12}COOH$
palmitic acid	$C_{15}H_{31}COOH$	0	$CH_3(CH_2)_{14}COOH$
palmitoleic acid	$C_{15}H_{29}COOH$	1	$CH_3(CH_2)_4CH_2CH{=}CHCH_2(CH_2)_5CH_2COOH$
stearic acid	$C_{17}H_{35}COOH$	0	$CH_3(CH_2)_{16}COOH$
oleic acid	$C_{17}H_{33}COOH$	1	$CH_3(CH_2)_7CH{=}CH(CH_2)_7COOH$
linoleic acid	$C_{17}H_{31}COOH$	2	$CH_3(CH_2)_4(CH{=}CHCH_2)_2(CH_2)_6COOH$
linolenic acid	$C_{17}H_{29}COOH$	3	$CH_3CH_2(CH{=}CHCH_2)_3(CH_2)_6COOH$
arachidic acid	$C_{19}H_{39}COOH$	0	$CH_3(CH_2)_{17}CH_2COOH$
arachidonic acid	$C_{19}H_{31}COOH$	4	$CH_3(CH_2)_4(CH{=}CHCH_2)_3CH{=}CH(CH_2)_3COOH$

TO FIND N(C=C) IN A FATTY ACID TAIL, USE:

$$N(C{=}C) = C - \frac{H-1}{2}$$

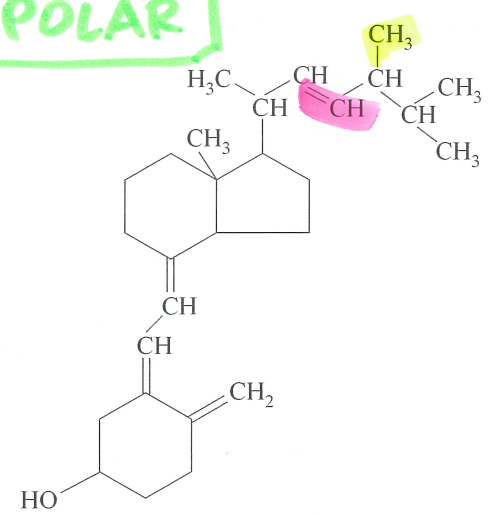
(eg) ARACHIDONIC ACID $C_{19}H_{31}COOH$

$N(C{=}C) = 19 - \frac{31-1}{2} = 4$

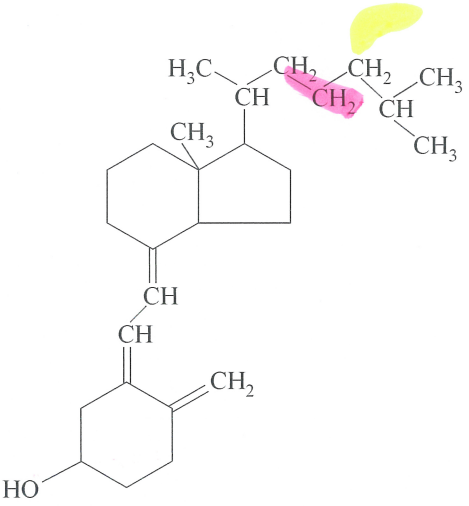
THERE ARE NO BENZENE RINGS ON THIS PAGE

10. Formulas of some biomolecules

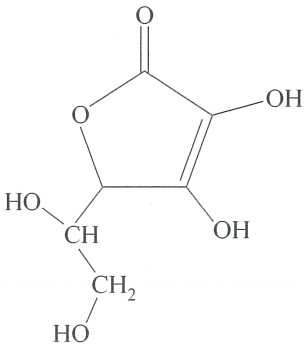
NON-POLAR



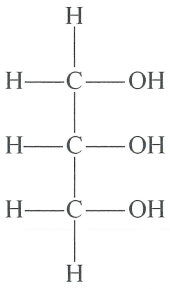
vitamin D_2 (ergocalciferol) ← NOT STRUCTURAL ISOMERS → vitamin D_3 (cholecalciferol)



POLAR

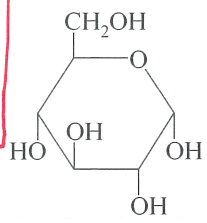


vitamin C (ascorbic acid)

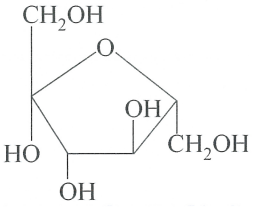


glycerol

MONOSACCHARIDES
$C_6H_{12}O_6$
$M_r = 180$



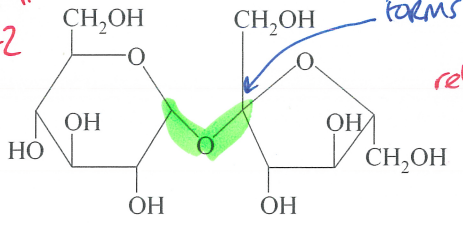
α-glucose



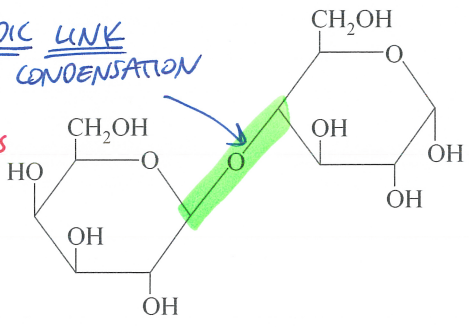
β-fructose (HAS FIVE SIDES)

DISACCHARIDES
$C_{12}H_{22}O_{11}$
$M_r = 342$

ETHER / GLYCOSIDIC LINK FORMS DURING A CONDENSATION REACTION releasing H_2O as a product



sucrose

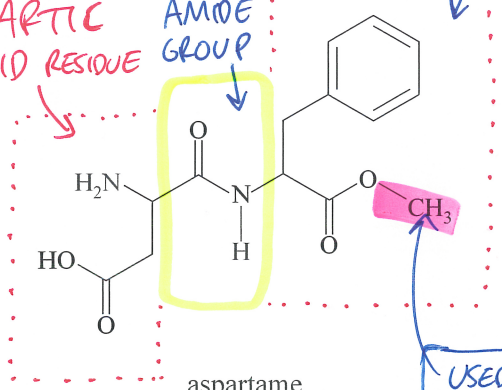


α-lactose

PHENYLALANINE RESIDUE

ASPARTIC ACID RESIDUE

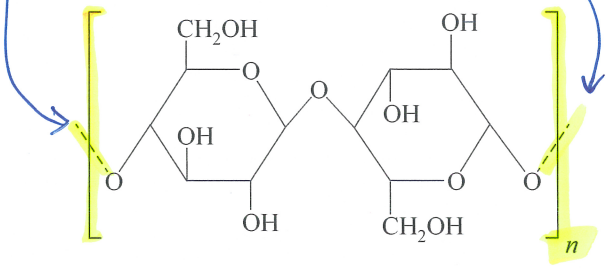
AMIDE GROUP



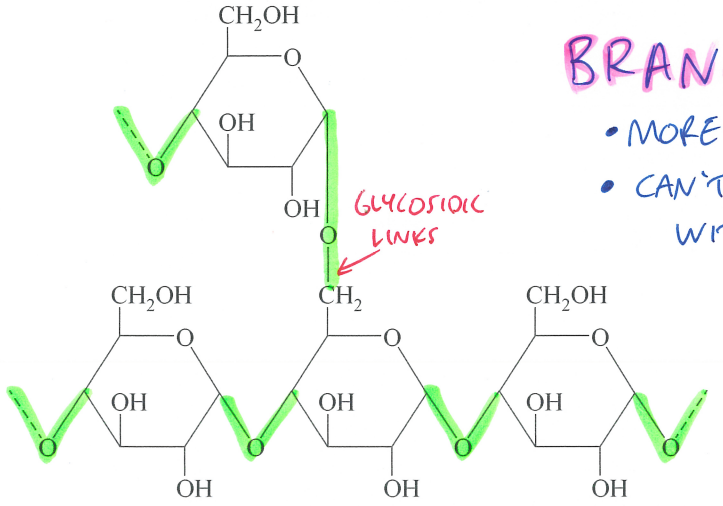
aspartame

USED TO BE AN H ATOM ON PHENYLALANINE AS PART OF A CARBOXYL.

IT'S ESSENTIAL TO DRAW BONDS THROUGH SQUARE BRACKETS LIKE THIS



cellulose

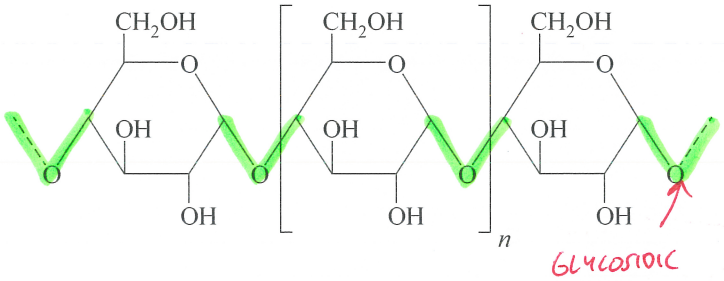


GLYCOSIDIC LINKS

amylopectin (starch)

BRANCHED

- MORE SOLUBLE IN WATER
- CAN'T BE HYDROLYSED WITH AMYLASE COMPLETELY.



GLYCOSIDIC LINKS

amylose (starch)

STRAIGHT

- LESS SOLUBLE IN WATER
- CAN BE HYDROLYSED WITH AMYLASE

*RECENTLY CHANGED

11. Heats of combustion of common fuels

The heats of combustion in the following table are calculated at SLC (25 °C and 100 kPa)* with combustion products being CO_2 and H_2O. Heat of combustion may be defined as the heat energy released when a specified amount of a substance burns completely in oxygen and is, therefore, reported as a positive value, indicating a magnitude. Enthalpy of combustion, ΔH, for the substances in this table would be reported as negative values, indicating the exothermic nature of the combustion reaction.

VERY USEFUL INFO

Fuel	Formula	State	Heat of combustion ($kJ\ g^{-1}$)	Molar heat of combustion ($kJ\ mol^{-1}$)
hydrogen	H_2	gas	141	282
methane	CH_4	gas	55.6	890
ethane	C_2H_6	gas	51.9	1560
propane	C_3H_8	gas	50.5	2220
butane	C_4H_{10}	gas	49.7	2880
octane	C_8H_{18}	liquid	47.9	5460
ethyne (acetylene)	C_2H_2	gas	49.9	1300
methanol	CH_3OH	liquid	22.7	726
ethanol	C_2H_5OH	liquid	29.6	1360

NOTHING AQUEOUS COMBUSTS (ACCORDING TO VCAA)

12. Heats of combustion of common blended fuels

Blended fuels are mixtures of compounds with different mixture ratios and, hence, determination of a generic molar enthalpy of combustion is not realistic. The values provided in the following table are typical values for heats of combustion at SLC (25 °C and 100 kPa) with combustion products being CO_2 and H_2O. Values for heats of combustion will vary depending on the source and composition of the fuel.

Fuel	State	Heat of combustion ($kJ\ g^{-1}$)
kerosene	liquid	46.2
diesel	liquid	45.0
natural gas	gas	54.0

ALL MIXTURES
ALL FOSSIL FUELS

BALANCE COMBUSTION EQUATIONS.

C, H, O.

HALVES & TOP-HEAVY FRACTIONS ARE RECOMMENDED! (eg) $2\frac{1}{2}$, $\frac{5}{2}$.

13. Energy content of food groups

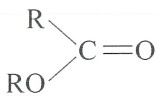
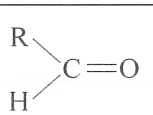
Food	Heat of combustion ($kJ\ g^{-1}$)	DIGESTED	BY (ENZYMES)
fats and oils	37	SMALL INTESTINE	PANCREATIC LIPASE
protein	17	STOMACH SMALL + LARGE INT.	PEPSIN TRYPSIN, ETC.
carbohydrate	16	SALIVA AND SMALL INTESTINE.	AMYLASE.

14. Characteristic ranges for infra-red absorption

Bond	Wave number (cm^{-1})	Bond	Wave number (cm^{-1})
C–Cl (chloroalkanes)	600–800	C=O (ketones)	1680–1850
C–O (alcohols, esters, ethers)	1050–1410	C=O (esters)	1720–1840
C=C (alkenes)	1620–1680	C–H (alkanes, alkenes, arenes)	2850–3090
C=O (amides)	1630–1680	O–H (acids)	2500–3500
C=O (aldehydes)	1660–1745	O–H (alcohols)	3200–3600
C=O (acids)	1680–1740	N–H (amines and amides)	3300–3500

15. ^{13}C NMR data

Typical ^{13}C shift values relative to TMS = 0
These can differ slightly in different solvents.

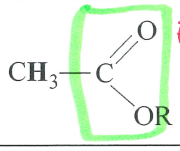
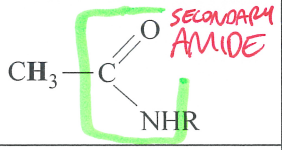
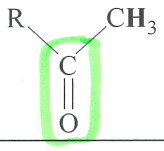
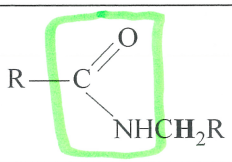
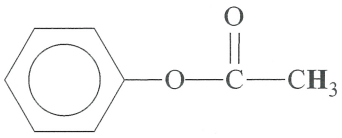
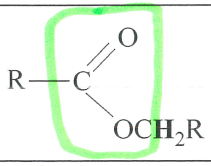
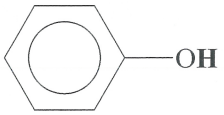
Type of carbon	Chemical shift (ppm)
$R–CH_3$	8–25
$R–CH_2–R$	20–45
$R_3–CH$	40–60
$R_4–C$	36–45
$R–CH_2–X$	15–80
$R_3C–NH_2$, $R_3C–NR_2$	35–70
$R–CH_2–OH$	50–90
$RC{\equiv}CR$	75–95
$R_2C{=}CR_2$	110–150
RCOOH	160–185
	165–175
	190–200
$R_2C{=}O$	205–220

RECENTLY CHANGED

16. ^{1}H NMR data

Typical proton shift values relative to TMS = 0

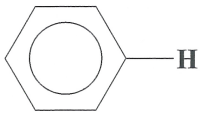
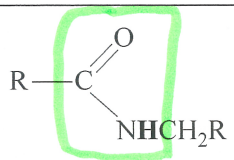
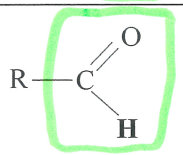
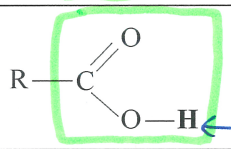
These can differ slightly in different solvents. The shift refers to the proton environment that is indicated in bold letters in the formula.

Type of proton		Chemical shift (ppm)
R–$\mathbf{CH_3}$	METHYL	0.9–1.0
R–$\mathbf{CH_2}$–R	STRAIGHT	1.3–1.4
RCH=$\mathbf{CH}$–$\mathbf{CH_3}$	-2-ENE	1.6–1.9
$\mathbf{R_3}$–$\mathbf{CH}$	BRANCHED	1.5
 or 	ESTER / SECONDARY AMIDE	2.0
	KETONE (-2-ONE)	2.1–2.7
R–$\mathbf{CH_2}$–X (X = F, Cl, Br or I)	1-HALO-	3.0–4.5
R–$\mathbf{CH_2}$–OH, R$_2$–$\mathbf{CH}$–OH	PRIMARY ALCOHOL / SECONDARY ALCOHOL	3.3–4.5
	SECONDARY AMIDE	3.2
R—O—$\mathbf{CH_3}$ or R—O—$\mathbf{CH_2}$R		3.3–3.7
	PHENYL ETHANOATE MOLECULE	2.3
	ESTER	3.7–4.8
R–O–H	ALWAYS A SINGLET / ALCOHOL	1–6 (varies considerably under different conditions)
R–$\mathbf{NH_2}$	PRIMARY AMINE	1–5
RHC=$\mathbf{CH}$R	1-ENE	4.5–7.0
	PHENOL	4.0–12.0

singlet doublet triplet quartet ... multiplet

1 2 3 4 ... n

* RECENTLY CHANGED

Type of proton	Chemical shift (ppm)
 BENZENE	6.9–9.0 *
 SECONDARY AMIDE	8.1
 ALDEHYDE	9.4–10.0 *
 CARBOXYLIC ACID ← ALWAYS A SINGLET	9.0–13.0

ALWAYS SOLUBLE IN WATER

NO_3^- CH_3COO^- K^+ Na^+ NH_4^+

X^- (EXCEPT FOR SILVER, MERCURY & LEAD SALTS)

SO_4^{2-} (EXCEPT FOR BARIUM, CALCIUM & LEAD SALTS)

NEVER SOLUBLE IN WATER

S^{2-} (EXCEPT K^+ Na^+ NH_4^+)

CO_3^{2-} (EXCEPT K^+ Na^+ NH_4^+)

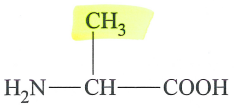
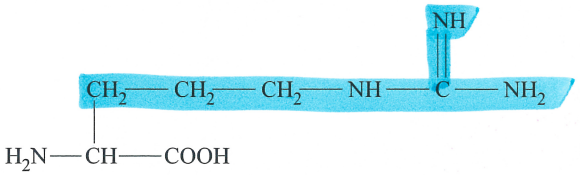
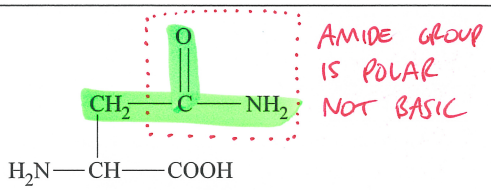
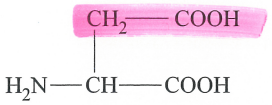
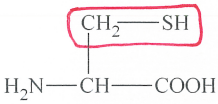
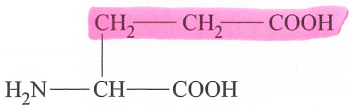
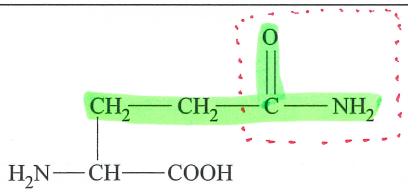
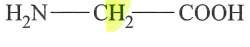
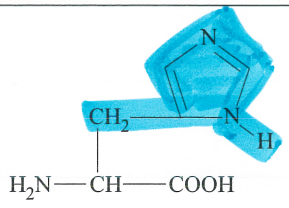
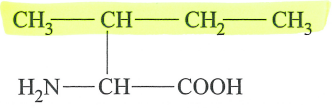
PO_4^{3-} (EXCEPT K^+ Na^+ NH_4^+)

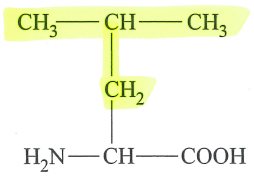
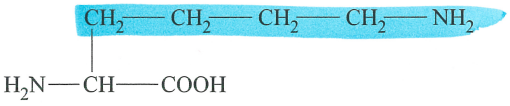
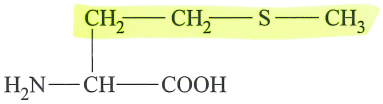
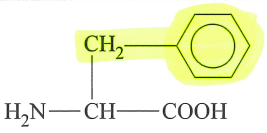
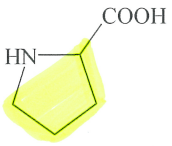
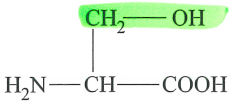
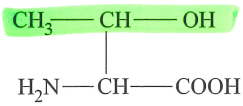
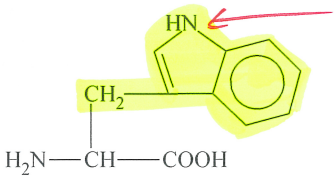
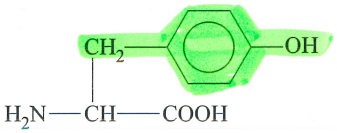
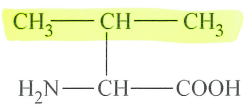
OH^- (EXCEPT K^+ Na^+ NH_4^+)

NON-POLAR
POLAR
ACIDIC
BASIC

17. 2-amino acids (α-amino acids)

The table below provides simplified structures to enable the drawing of zwitterions, the identification of products of protein hydrolysis and the drawing of structures involving condensation polymerisation of amino acid monomers.

Name	Symbol	Structure
alanine	Ala	
arginine	Arg	
asparagine	Asn	 AMIDE GROUP IS POLAR NOT BASIC
aspartic acid	Asp	
cysteine	Cys	 SULFUR-CONTAINING
glutamic acid	Glu	
glutamine	Gln	 AMIDE GROUP IS POLAR NOT BASIC
glycine	Gly	
histidine	His	
isoleucine	Ile	

Name	Symbol	Structure
leucine	Leu	
lysine	Lys	
methionine	Met	
phenylalanine	Phe	
proline	Pro	
serine	Ser	
threonine	Thr	
tryptophan	Trp	 CONSIDERED NON-POLAR DESPITE THE "NH".
tyrosine	Tyr	
valine	Val	

END OF DATA BOOK