



Victorian Certificate of Education

2009

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

Letter

Figures

Words

CHEMISTRY

Written examination 2

Thursday 12 November 2009

Reading time: 9.00 am to 9.15 am (15 minutes)

Writing time: 9.15 am to 10.45 am (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	Number of questions	Number of questions to be answered	Number of marks
A	20	20	20
B	7	7	56
			Total 76

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 20 pages.
- A data book.
- Answer sheet for multiple-choice questions.

Instructions

- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep the data book.

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

SECTION A – Multiple-choice questions**Instructions for Section A**

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

SECTION B – Short answer questions**Instructions for Section B**

Answer **all** questions in the spaces provided.

To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $\text{H}_2(\text{g})$; $\text{NaCl}(\text{s})$



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DATA BOOK

Directions to students

- A question and answer book is provided with this data book.

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1. Periodic table of the elements

1 H Hydrogen 1.0		2 He Helium 4.0	
3 Li Lithium 6.9		4 Be Beryllium 9.0	
11 Na Sodium 23.0		12 Mg Magnesium 24.3	
19 K Potassium 39.1		20 Ca Calcium 40.1	
37 Rb Rubidium 85.5		38 Sr Strontium 87.6	
55 Cs Caesium 132.9		56 Ba Barium 137.3	
87 Fr Francium (223)		88 Ra Radium (226)	
21 Sc Scandium 44.9		22 Ti Titanium 47.9	
39 Y Yttrium 88.9		40 Zr Zirconium 91.2	
71 Lu Lutetium 174.9		72 Hf Hafnium 178.5	
89 Ac Actinium (227)		90 Th Thorium 232.0	
103 Lr Lawrencium (260)		104 Rf Rutherfordium (261)	
101 Md Mendelevium (258)		102 No Nobelium (259)	
105 Ds Darmstadtium (271)		106 Sg Seaborgium (266)	
107 Bh Bohrium (264)		108 Hs Hassium (277)	
111 Rg Roentgenium (272)		112 Uub Ununbium (285)	
79 Au Gold 197.0		80 Hg Mercury 200.6	
81 Tl Thallium 204.4		82 Pb Lead 207.2	
83 Bi Bismuth 209.0		84 Po Polonium (209)	
85 At Astatine (210)		86 Rn Radon (222)	
53 I Iodine 126.9		54 Xe Xenon 131.3	
51 Sb Antimony 121.8		52 Te Tellurium 127.6	
49 In Indium 114.8		50 Sn Tin 118.7	
47 Cu Copper 63.6		48 Cd Cadmium 112.4	
27 Co Cobalt 58.9		28 Ni Nickel 58.7	
26 Fe Iron 55.9		29 Zn Zinc 65.4	
25 Mn Manganese 54.9		30 Ga Gallium 69.7	
24 Cr Chromium 52.0		31 Ge Germanium 72.6	
23 V Vanadium 50.9		32 As Arsenic 74.9	
21 Sc Scandium 44.9		33 Se Selenium 79.0	
39 Y Yttrium 88.9		34 Br Bromine 79.9	
71 Lu Lutetium 174.9		35 Kr Krypton 83.8	
89 Ac Actinium (227)		36 Kr Krypton 83.8	
103 Lr Lawrencium (260)		37 Rb Rubidium 85.5	
101 Md Mendelevium (258)		38 Sr Strontium 87.6	
105 Ds Darmstadtium (271)		39 Y Yttrium 88.9	
107 Bh Bohrium (264)		40 Zr Zirconium 91.2	
111 Rg Roentgenium (272)		41 Nb Niobium 92.9	
112 Uub Ununbium (285)		42 Mo Molybdenum 95.9	
79 Au Gold 197.0		43 Tc Technetium 98.1	
81 Tl Thallium 204.4		44 Ru Ruthenium 101.1	
83 Bi Bismuth 209.0		45 Rh Rhodium 102.9	
85 At Astatine (210)		46 Pd Palladium 106.4	
53 I Iodine 126.9		47 Ag Silver 107.9	
51 Sb Antimony 121.8		48 Cd Cadmium 112.4	
49 In Indium 114.8		49 In Indium 114.8	
47 Cu Copper 63.6		50 Sn Tin 118.7	
27 Co Cobalt 58.9		51 Sb Antimony 121.8	
26 Fe Iron 55.9		52 Te Tellurium 127.6	
25 Mn Manganese 54.9		53 I Iodine 126.9	
24 Cr Chromium 52.0		54 Xe Xenon 131.3	
23 V Vanadium 50.9		55 Cs Caesium 132.9	
21 Sc Scandium 44.9		56 Ba Barium 137.3	
39 Y Yttrium 88.9		57 La Lanthanum 138.9	
71 Lu Lutetium 174.9		58 Ce Cerium 140.1	
89 Ac Actinium (227)		59 Pr Praseodymium 140.9	
103 Lr Lawrencium (260)		60 Nd Neodymium 144.2	
101 Md Mendelevium (258)		61 Pm Promethium (145)	
105 Ds Darmstadtium (271)		62 Sm Samarium 150.3	
107 Bh Bohrium (264)		63 Eu Europium 152.0	
111 Rg Roentgenium (272)		64 Gd Gadolinium 157.2	
112 Uub Ununbium (285)		65 Tb Terbium 158.9	
79 Au Gold 197.0		66 Dy Dysprosium 162.5	
81 Tl Thallium 204.4		67 Ho Holmium 164.9	
83 Bi Bismuth 209.0		68 Er Erbium 167.3	
85 At Astatine (210)		69 Tm Thulium 168.9	
53 I Iodine 126.9		70 Yb Ytterbium 173.0	
51 Sb Antimony 121.8		71 Lu Lutetium 175.0	
49 In Indium 114.8		72 Hf Hafnium 178.5	
47 Cu Copper 63.6		73 Ta Tantalum 180.9	
27 Co Cobalt 58.9		74 W Tungsten 183.8	
26 Fe Iron 55.9		75 Re Rhenium 186.2	
25 Mn Manganese 54.9		76 Os Osmium 190.2	
24 Cr Chromium 52.0		77 Ir Iridium 192.2	
23 V Vanadium 50.9		78 Pt Platinum 195.1	
21 Sc Scandium 44.9		79 Au Gold 197.0	
39 Y Yttrium 88.9		80 Hg Mercury 200.6	
71 Lu Lutetium 174.9		81 Tl Thallium 204.4	
89 Ac Actinium (227)		82 Pb Lead 207.2	
103 Lr Lawrencium (260)		83 Bi Bismuth 209.0	
101 Md Mendelevium (258)		84 Po Polonium (209)	
105 Ds Darmstadtium (271)		85 At Astatine (210)	
107 Bh Bohrium (264)		86 Rn Radon (222)	
111 Rg Roentgenium (272)		87 Fr Francium (223)	
112 Uub Ununbium (285)		88 Ra Radium (226)	
79 Au Gold 197.0		89 Ac Actinium (227)	
81 Tl Thallium 204.4		90 Th Thorium 232.0	
83 Bi Bismuth 209.0		91 Pa Protactinium 231.0	
85 At Astatine (210)		92 U Uranium 238.0	
53 I Iodine 126.9		93 Np Neptunium (237.0)	
51 Sb Antimony 121.8		94 Pu Plutonium (244)	
49 In Indium 114.8		95 Am Americium (243)	
47 Cu Copper 63.6		96 Cm Curium (247)	
27 Co Cobalt 58.9		97 Bk Berkelium (247)	
26 Fe Iron 55.9		98 Cf Californium (251)	
25 Mn Manganese 54.9		99 Es Einsteinium (252)	
24 Cr Chromium 52.0		100 Fm Fermium (257)	
23 V Vanadium 50.9		101 Md Mendelevium (258)	
21 Sc Scandium 44.9		102 No Nobelium (259)	
39 Y Yttrium 88.9		103 Lr Lawrencium (260)	
71 Lu Lutetium 174.9		104 Rf Rutherfordium (261)	
89 Ac Actinium (227)		105 Ds Darmstadtium (271)	
103 Lr Lawrencium (260)		106 Sg Seaborgium (266)	
101 Md Mendelevium (258)		107 Bh Bohrium (264)	
105 Ds Darmstadtium (271)		108 Hs Hassium (277)	
107 Bh Bohrium (264)		109 Mt Meitnerium (268)	
111 Rg Roentgenium (272)		110 Ds Darmstadtium (271)	
112 Uub Ununbium (285)		111 Rg Roentgenium (272)	
79 Au Gold 197.0		112 Uub Ununbium (285)	
81 Tl Thallium 204.4		113 CNh Ununtrium (288)	
83 Bi Bismuth 209.0		114 Uuq Ununquadium (289)	
85 At Astatine (210)		115 Uup Ununpentium (290)	
53 I Iodine 126.9		116 Uuh Ununhexium (291)	
51 Sb Antimony 121.8		117 Uuq Ununseptium (292)	
49 In Indium 114.8		118 Uuo Ununoctium (293)	
47 Cu Copper 63.6		119 Uuq Ununnonium (294)	
27 Co Cobalt 58.9		120 Uuq Ununnilium (295)	
26 Fe Iron 55.9		121 Uuq Ununnilium (296)	
25 Mn Manganese 54.9		122 Uuq Ununnilium (297)	
24 Cr Chromium 52.0		123 Uuq Ununnilium (298)	
23 V Vanadium 50.9		124 Uuq Ununnilium (299)	
21 Sc Scandium 44.9		125 Uuq Ununnilium (300)	
39 Y Yttrium 88.9		126 Uuq Ununnilium (301)	
71 Lu Lutetium 174.9		127 Uuq Ununnilium (302)	
89 Ac Actinium (227)		128 Uuq Ununnilium (303)	
103 Lr Lawrencium (260)		129 Uuq Ununnilium (304)	
101 Md Mendelevium (258)		130 Uuq Ununnilium (305)	
105 Ds Darmstadtium (271)		131 Uuq Ununnilium (306)	
107 Bh Bohrium (264)		132 Uuq Ununnilium (307)	
111 Rg Roentgenium (272)		133 Uuq Ununnilium (308)	
112 Uub Ununbium (285)		134 Uuq Ununnilium (309)	
79 Au Gold 197.0		135 Uuq Ununnilium (310)	
81 Tl Thallium 204.4		136 Uuq Ununnilium (311)	
83 Bi Bismuth 209.0		137 Uuq Ununnilium (312)	
85 At Astatine (210)		138 Uuq Ununnilium (313)	
53 I Iodine 126.9		139 Uuq Ununnilium (314)	
51 Sb Antimony 121.8		140 Uuq Ununnilium (315)	
49 In Indium 114.8		141 Uuq Ununnilium (316)	
47 Cu Copper 63.6		142 Uuq Ununnilium (317)	
27 Co Cobalt 58.9		143 Uuq Ununnilium (318)	
26 Fe Iron 55.9		144 Uuq Ununnilium (319)	
25 Mn Manganese 54.9		145 Uuq Ununnilium (320)	
24 Cr Chromium 52.0		146 Uuq Ununnilium (321)	
23 V Vanadium 50.9		147 Uuq Ununnilium (322)	
21 Sc Scandium 44.9		148 Uuq Ununnilium (323)	
39 Y Yttrium 88.9		149 Uuq Ununnilium (324)	
71 Lu Lutetium 174.9		150 Uuq Ununnilium (325)	
89 Ac Actinium (227)		151 Uuq Ununnilium (326)	
103 Lr Lawrencium (260)		152 Uuq Ununnilium (327)	
101 Md Mendelevium (258)		153 Uuq Ununnilium (328)	
105 Ds Darmstadtium (271)		154 Uuq Ununnilium (329)	
107 Bh Bohrium (264)		155 Uuq Ununnilium (330)	
111 Rg Roentgenium (272)		156 Uuq Ununnilium (331)	
112 Uub Ununbium (285)		157 Uuq Ununnilium (332)	
79 Au Gold 197.0		158 Uuq Ununnilium (333)	
81 Tl Thallium 204.4		159 Uuq Ununnilium (334)	
83 Bi Bismuth 209.0		160 Uuq Ununnilium (335)	
85 At Astatine (210)		161 Uuq Ununnilium (336)	
53 I Iodine 126.9		162 Uuq Ununnilium (337)	
51 Sb Antimony 121.8		163 Uuq Ununnilium (338)	
49 In Indium 114.8		164 Uuq Ununnilium (339)	
47 Cu Copper 63.6		165 Uuq Ununnilium (340)	
27 Co Cobalt 58.9		166 Uuq Ununnilium (341)	
26 Fe Iron 55.9		167 Uuq Ununnilium (342)	
25 Mn Manganese 54.9		168 Uuq Ununnilium (343)	
24 Cr Chromium 52.0		169 Uuq Ununnilium (344)	
23 V Vanadium 50.9		170 Uuq Ununnilium (345)	
21 Sc Scandium 44.9		171 Uuq Ununnilium (346)	
39 Y Yttrium 88.9		172 Uuq Ununnilium (347)	
71 Lu Lutetium 174.9		173 Uuq Ununnilium (348)	
89 Ac Actinium (227)		174 Uuq Ununnilium (349)	
103 Lr Lawrencium (260)		175 Uuq Ununnilium (350)	
101 Md Mendelevium (258)		176 Uuq Ununnilium (351)	
105 Ds Darmstadtium (271)		177 Uuq Ununnilium (352)	
107 Bh Bohrium (264)		178 Uuq Ununnilium (353)	
111 Rg Roentgenium (272)		179 Uuq Ununnilium (354)	
112 Uub Ununbium (285)		180 Uuq Ununnilium (355)	
79 Au Gold 197.0			

2. The electrochemical series

	E° in volt
$\text{F}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{F}^-(\text{aq})$	+2.87
$\text{H}_2\text{O}_2(\text{aq}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}(\text{l})$	+1.77
$\text{Au}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Au}(\text{s})$	+1.68
$\text{Cl}_2(\text{g}) + 2\text{e}^- \rightleftharpoons 2\text{Cl}^-(\text{aq})$	+1.36
$\text{O}_2(\text{g}) + 4\text{H}^+(\text{aq}) + 4\text{e}^- \rightleftharpoons 2\text{H}_2\text{O}(\text{l})$	+1.23
$\text{Br}_2(\text{l}) + 2\text{e}^- \rightleftharpoons 2\text{Br}^-(\text{aq})$	+1.09
$\text{Ag}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Ag}(\text{s})$	+0.80
$\text{Fe}^{3+}(\text{aq}) + \text{e}^- \rightleftharpoons \text{Fe}^{2+}(\text{aq})$	+0.77
$\text{O}_2(\text{g}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2\text{O}_2(\text{aq})$	+0.68
$\text{I}_2(\text{s}) + 2\text{e}^- \rightleftharpoons 2\text{I}^-(\text{aq})$	+0.54
$\text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^- \rightleftharpoons 4\text{OH}^-(\text{aq})$	+0.40
$\text{Cu}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Cu}(\text{s})$	+0.34
$\text{Sn}^{4+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Sn}^{2+}(\text{aq})$	+0.15
$\text{S}(\text{s}) + 2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2\text{S}(\text{g})$	+0.14
$2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$	0.00
$\text{Pb}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Pb}(\text{s})$	-0.13
$\text{Sn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Sn}(\text{s})$	-0.14
$\text{Ni}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ni}(\text{s})$	-0.23
$\text{Co}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Co}(\text{s})$	-0.28
$\text{Fe}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Fe}(\text{s})$	-0.44
$\text{Zn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Zn}(\text{s})$	-0.76
$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$	-0.83
$\text{Mn}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Mn}(\text{s})$	-1.03
$\text{Al}^{3+}(\text{aq}) + 3\text{e}^- \rightleftharpoons \text{Al}(\text{s})$	-1.67
$\text{Mg}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Mg}(\text{s})$	-2.34
$\text{Na}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Na}(\text{s})$	-2.71
$\text{Ca}^{2+}(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{Ca}(\text{s})$	-2.87
$\text{K}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{K}(\text{s})$	-2.93
$\text{Li}^+(\text{aq}) + \text{e}^- \rightleftharpoons \text{Li}(\text{s})$	-3.02

3. Physical constants

Avogadro's constant (N_A) = $6.02 \times 10^{23} \text{ mol}^{-1}$

Charge on one electron = $-1.60 \times 10^{-19} \text{ C}$

Faraday constant (F) = $96\,500 \text{ C mol}^{-1}$

Gas constant (R) = $8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

Ionic product for water (K_w) = $1.00 \times 10^{-14} \text{ mol}^2 \text{ L}^{-2}$ at 298 K
(Self ionisation constant)

Molar volume (V_m) of an ideal gas at 273 K, 101.3 kPa (STP) = 22.4 L mol^{-1}

Molar volume (V_m) of an ideal gas at 298 K, 101.3 kPa (SLC) = 24.5 L mol^{-1}

Specific heat capacity (c) of water = $4.18 \text{ J g}^{-1} \text{ K}^{-1}$

Density (d) of water at 25°C = 1.00 g mL^{-1}

1 atm = 101.3 kPa = 760 mm Hg

0°C = 273 K

4. SI prefixes, their symbols and values

SI prefix	Symbol	Value
giga	G	10^9
mega	M	10^6
kilo	k	10^3
deci	d	10^{-1}
centi	c	10^{-2}
milli	m	10^{-3}
micro	μ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}

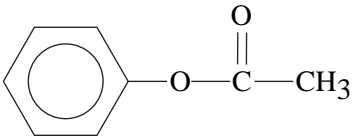
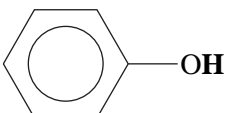
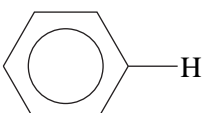
5. ^1H NMR data

Typical proton shift values relative to TMS = 0

These can differ slightly in different solvents. Where more than one proton environment is shown in the formula, the shift refers to the ones in bold letters.

Type of proton	Chemical shift (ppm)
R-CH ₃	0.9
R-CH ₂ -R	1.3
RCH = CH- CH₃	1.7
R ₃ -CH	2.0
$\text{CH}_3-\text{C} \begin{array}{l} \text{=O} \\ \text{OR} \end{array}$ or $\text{CH}_3-\text{C} \begin{array}{l} \text{=O} \\ \text{NHR} \end{array}$	2.0

TURN OVER

Type of proton	Chemical shift (ppm)
$\begin{array}{c} \text{R} \quad \text{CH}_3 \\ \quad \diagdown \quad / \\ \quad \text{C} \\ \quad \\ \quad \text{O} \end{array}$	2.1
R-CH ₂ -X (X = F, Cl, Br or I)	3-4
R-CH ₂ -OH	3.6
$\begin{array}{c} \text{O} \\ // \\ \text{R}-\text{C} \\ \backslash \\ \text{NHCH}_2\text{R} \end{array}$	3.2
R-O-CH ₃ or R-O-CH ₂ R	3.3
	2.3
$\begin{array}{c} \text{O} \\ // \\ \text{R}-\text{C} \\ \backslash \\ \text{OCH}_2\text{R} \end{array}$	4.1
R-O-H	1-6 (varies considerably under different conditions)
R-NH ₂	1-5
RHC = CH ₂	4.6-6.0
	7.0
	7.3
$\begin{array}{c} \text{O} \\ // \\ \text{R}-\text{C} \\ \backslash \\ \text{NHCH}_2\text{R} \end{array}$	8.1
$\begin{array}{c} \text{O} \\ // \\ \text{R}-\text{C} \\ \backslash \\ \text{H} \end{array}$	9-10
$\begin{array}{c} \text{O} \\ // \\ \text{R}-\text{C} \\ \backslash \\ \text{O}-\text{H} \end{array}$	11.5

6. ^{13}C NMR data

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 ₃ C-NH ₂	35–70
R-CH ₂ -OH	50–90
RC≡CR	75–95
R ₂ C=CR ₂	110–150
RCOOH	160–185

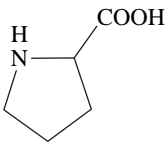
7. Infrared absorption data

Characteristic range for infrared absorption

Bond	Wave number (cm ⁻¹)
C-Cl	700–800
C-C	750–1100
C-O	1000–1300
C=C	1610–1680
C=O	1670–1750
O-H (acids)	2500–3300
C-H	2850–3300
O-H (alcohols)	3200–3550
N-H (primary amines)	3350–3500

8. 2-amino acids (α -amino acids)

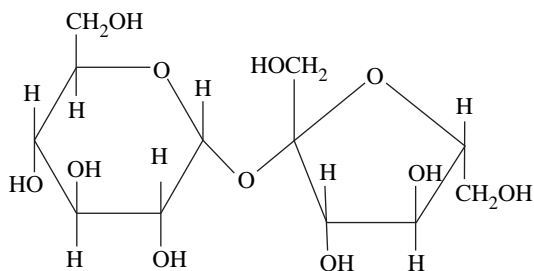
Name	Symbol	Structure
alanine	Ala	$\begin{array}{c} \text{CH}_3 \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$
arginine	Arg	$\begin{array}{c} \text{NH} \\ \\ \text{CH}_2-\text{CH}_2-\text{CH}_2-\text{NH}-\text{C}-\text{NH}_2 \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$
asparagine	Asn	$\begin{array}{c} \text{O} \\ \\ \text{CH}_2-\text{C}-\text{NH}_2 \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$
aspartic acid	Asp	$\begin{array}{c} \text{CH}_2-\text{COOH} \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$
cysteine	Cys	$\begin{array}{c} \text{CH}_2-\text{SH} \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$
glutamine	Gln	$\begin{array}{c} \text{O} \\ \\ \text{CH}_2-\text{CH}_2-\text{C}-\text{NH}_2 \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$
glutamic acid	Glu	$\begin{array}{c} \text{CH}_2-\text{CH}_2-\text{COOH} \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$
glycine	Gly	$\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$
histidine	His	$\begin{array}{c} \text{N} \\ // \quad \backslash \\ \text{CH}_2-\text{C} \quad \text{N}-\text{H} \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$
isoleucine	Ile	$\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}_2-\text{CH}_3 \\ \\ \text{H}_2\text{N}-\text{CH}-\text{COOH} \end{array}$

Name	Symbol	Structure
leucine	Leu	$\begin{array}{c} \text{CH}_3 - \text{CH} - \text{CH}_3 \\ \\ \text{CH}_2 \\ \\ \text{H}_2\text{N} - \text{CH} - \text{COOH} \end{array}$
lysine	Lys	$\begin{array}{c} \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{NH}_2 \\ \\ \text{H}_2\text{N} - \text{CH} - \text{COOH} \end{array}$
methionine	Met	$\begin{array}{c} \text{CH}_2 - \text{CH}_2 - \text{S} - \text{CH}_3 \\ \\ \text{H}_2\text{N} - \text{CH} - \text{COOH} \end{array}$
phenylalanine	Phe	$\begin{array}{c} \text{CH}_2 - \text{C}_6\text{H}_5 \\ \\ \text{H}_2\text{N} - \text{CH} - \text{COOH} \end{array}$
proline	Pro	
serine	Ser	$\begin{array}{c} \text{CH}_2 - \text{OH} \\ \\ \text{H}_2\text{N} - \text{CH} - \text{COOH} \end{array}$
threonine	Thr	$\begin{array}{c} \text{CH}_3 - \text{CH} - \text{OH} \\ \\ \text{H}_2\text{N} - \text{CH} - \text{COOH} \end{array}$
tryptophan	Trp	$\begin{array}{c} \text{CH}_2 - \text{C}_8\text{H}_6\text{N}_2 \\ \\ \text{H}_2\text{N} - \text{CH} - \text{COOH} \end{array}$
tyrosine	Tyr	$\begin{array}{c} \text{CH}_2 - \text{C}_6\text{H}_4 - \text{OH} \\ \\ \text{H}_2\text{N} - \text{CH} - \text{COOH} \end{array}$
valine	Val	$\begin{array}{c} \text{CH}_3 - \text{CH} - \text{CH}_3 \\ \\ \text{H}_2\text{N} - \text{CH} - \text{COOH} \end{array}$

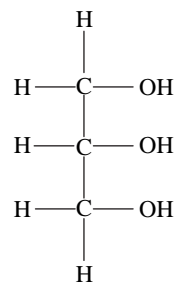
9. Formulas of some fatty acids

Name	Formula
Lauric	$C_{11}H_{23}COOH$
Myristic	$C_{13}H_{27}COOH$
Palmitic	$C_{15}H_{31}COOH$
Palmitoleic	$C_{15}H_{29}COOH$
Stearic	$C_{17}H_{35}COOH$
Oleic	$C_{17}H_{33}COOH$
Linoleic	$C_{17}H_{31}COOH$
Linolenic	$C_{17}H_{29}COOH$
Arachidic	$C_{19}H_{39}COOH$
Arachidonic	$C_{19}H_{31}COOH$

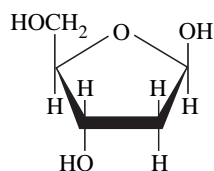
10. Structural formulas of some important biomolecules



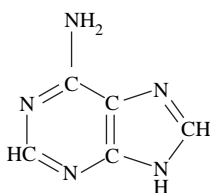
sucrose



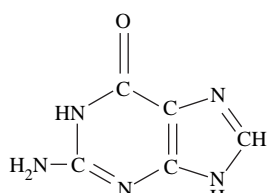
glycerol



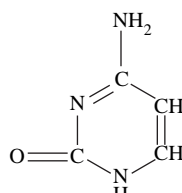
deoxyribose



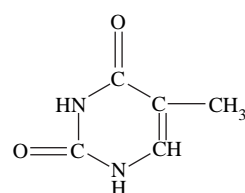
adenine



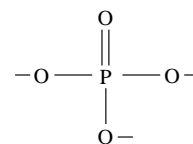
guanine



cytosine



thymine



phosphate

11. Acid-base indicators

Name	pH range	Colour change		K_a
		Acid	Base	
Thymol blue	1.2–2.8	red	yellow	2×10^{-2}
Methyl orange	3.1–4.4	red	yellow	2×10^{-4}
Bromophenol blue	3.0–4.6	yellow	blue	6×10^{-5}
Methyl red	4.2–6.3	red	yellow	8×10^{-6}
Bromothymol blue	6.0–7.6	yellow	blue	1×10^{-7}
Phenol red	6.8–8.4	yellow	red	1×10^{-8}
Phenolphthalein	8.3–10.0	colourless	red	5×10^{-10}

12. Acidity constants, K_a , of some weak acids

Name	Formula	K_a
Ammonium ion	NH_4^+	5.6×10^{-10}
Benzoic	$\text{C}_6\text{H}_5\text{COOH}$	6.4×10^{-5}
Boric	H_3BO_3	5.8×10^{-10}
Ethanoic	CH_3COOH	1.7×10^{-5}
Hydrocyanic	HCN	6.3×10^{-10}
Hydrofluoric	HF	7.6×10^{-4}
Hypobromous	HOBr	2.4×10^{-9}
Hypochlorous	HOCl	2.9×10^{-8}
Lactic	$\text{HC}_3\text{H}_5\text{O}_3$	1.4×10^{-4}
Methanoic	HCOOH	1.8×10^{-4}
Nitrous	HNO_2	7.2×10^{-4}
Propanoic	$\text{C}_2\text{H}_5\text{COOH}$	1.3×10^{-5}

13. Values of molar enthalpy of combustion of some common fuels at 298 K and 101.3 kPa

Substance	Formula	State	ΔH_c (kJ mol^{-1})
hydrogen	H_2	g	-286
carbon (graphite)	C	s	-394
methane	CH_4	g	-889
ethane	C_2H_6	g	-1557
propane	C_3H_8	g	-2217
butane	C_4H_{10}	g	-2874
pentane	C_5H_{12}	l	-3509
hexane	C_6H_{14}	l	-4158
octane	C_8H_{18}	l	-5464
ethene	C_2H_4	g	-1409
methanol	CH_3OH	l	-725
ethanol	$\text{C}_2\text{H}_5\text{OH}$	l	-1364
1-propanol	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	l	-2016
2-propanol	$\text{CH}_3\text{CHOHCH}_3$	l	-2003
glucose	$\text{C}_6\text{H}_{12}\text{O}_6$	s	-2816



VCE CHEMISTRY

Written Examination 2

ANSWER SHEET – 2009

STUDENT NAME:

JOHN STUDENT

STUDENT NUMBER

9	9	1	2	3	4	5	6	A
0	0	0	0	0	0	0	0	
1	1		1	1	1	1	1	E
2	2	2		2	2	2	2	F
3	3	3	3		3	3	3	G
4	4	4	4	4		4	4	J
5	5	5	5	5	5		5	L
6	6	6	6	6	6	6		R
7	7	7	7	7	7	7	7	T
8	8	8	8	8	8	8	8	W
		9	9	9	9	9	9	X

INSTRUCTIONS:



SIGN HERE IF YOUR NAME AND NUMBER ARE PRINTED CORRECTLY.

SIGNATURE: *J. Student*

If your name or number on this sheet is incorrect, notify the Supervisor.
 Use a **PENCIL** for **ALL** entries. For each question, shade the box which indicates your answer.
 All answers must be completed like **THIS** example:

A		C	D
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 Marks will **NOT** be deducted for incorrect answers.
NO MARK will be given if more than **ONE** answer is completed for any question.
 If you make a mistake, **ERASE** the incorrect answer – **DO NOT** cross it out.

SUPERVISOR USE ONLY



Shade the **"ABSENT"** box if the student was absent from the examination.

ABSENT

SUPERVISOR'S INITIALS

ONE ANSWER PER LINE

ONE ANSWER PER LINE

1	A	B	C	D	11	A	B	C	D
2	A	B	C	D	12	A	B	C	D
3	A	B	C	D	13	A	B	C	D
4	A	B	C	D	14	A	B	C	D
5	A	B	C	D	15	A	B	C	D
6	A	B	C	D	16	A	B	C	D
7	A	B	C	D	17	A	B	C	D
8	A	B	C	D	18	A	B	C	D
9	A	B	C	D	19	A	B	C	D
10	A	B	C	D	20	A	B	C	D

Please **DO NOT** fold, bend or staple this form.