VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2002

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

									Letter
Figures									
Words									

CHEMISTRY

Written examination 2

Wednesday 13 November 2002

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*	*Suggested times (minutes)*
A	20	20	20	25
B	7	7	52	65
			Total 72	90

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, an approved graphics calculator (memory cleared) and/or 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 14 pages, with a detachable data sheet in the centrefold.
- Answer sheet for multiple-choice questions.

Instructions
- Detach the data sheet from the centre of this book during reading time.
- 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.

Students are NOT permitted to bring mobile phones and/or any other electronic communication 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.

A correct answer scores 1, an incorrect answer scores 0. Marks will **not** be deducted for incorrect answers. No mark will be given if more than one answer is completed for any question.

Section A is worth approximately 28 per cent of the marks available.

Question 1

The electron configuration of an **ion** with its electrons in an excited state is

A. $1s^2 2s^2 2p^1$ (atomic number: 5)

B. $1s^2 2s^2 2p^3 3s^1$ (atomic number: 8)

C. $1s^2 2s^2 2p^5 3s^1$ (atomic number: 8)

D. $1s^2 2s^2 2p^6$ (atomic number: 9)

Question 2

The maximum number of electrons that can occupy a 4p sub-shell is

A. 2

B. 6

C. 10

D. 14

Question 3

As you move down the elements of Group 1 of the periodic table, the first ionisation energy

A. decreases and the electronegativity decreases.

B. decreases and the electronegativity increases.

C. increases and the electronegativity decreases.

D. increases and the electronegativity increases.

Question 4

In comparison with Group 1 metals, transition metals in the same period as Group 1 metals tend to

A. be harder and have a smaller atomic radius.

B. have a higher melting temperature and a larger atomic radius.

C. be more easily oxidised and display variable oxidation states.

D. have lower ionisation energy and are more likely to form complex ions.

Question 5

The mass of an atomic nucleus other than ^1H is

A. equal to the sum of the masses of its individual protons and neutrons.

B. slightly less than the sum of the masses of its individual protons and neutrons.

C. slightly greater than the sum of the masses of its individual protons and neutrons.

D. sometimes greater, sometimes smaller, than the sum of the masses of its individual protons and neutrons, depending on the binding energy of the nucleus.

Question 6

An ion with a charge of positive two, and the same electron configuration as the chloride ion, is the

A. phosphide ion.

B. sulfide ion.

C. magnesium ion.

D. calcium ion.

Question 7

In living things, glycine can react with other amino acids to form polypeptides and proteins.

This reaction between two or more amino acids to form a polypeptide is classified as

A. condensation.

B. esterification.

C. hydrolysis.

D. nitrification.

Question 8

All of the individual α-amino acids that make up human proteins

A. have an $–NH_2$ and a $–CO_2H$ group attached to the same carbon atom.

B. can be made naturally in the human body.

C. contain the peptide group.

D. have an $–NH_2$ and an –OH group attached to the same carbon atom.

Question 9

The amino acid, alanine, dissolves in water.

In an aqueous solution with a pH = 7, alanine is acting as

A. an acid only.

B. a base only.

C. neither an acid nor a base.

D. both an acid and a base.

Question 10

The excess amino acids not required for protein synthesis are broken down in the liver.

The nitrogen atoms from the excess amino acids are removed from the human body as

A. N_2

B. NH_3

C. NH_4NO_3

D. $CO(NH_2)_2$

Question 11

A substance that could be formed as a product, when a polysaccharide undergoes enzyme catalysed hydrolysis, is

A. H_2O

B. CO_2

C. $C_6H_{12}O_6$

D. $CH_2OH.CHOH.CH_2OH$

Question 12

Cellulose cannot be digested by humans because

A. it is insoluble in water.

B. it contains no glucose.

C. it is not a carbohydrate.

D. the enzymes required to catalyse its hydrolysis are not present in humans.

Question 13

The decomposition of water can be represented by the chemical equation

$$2H_2O(l) \rightarrow 2H_2(g) + O_2(g) \qquad \Delta H = +\ 571.8\ kJ\ mol^{-1}$$

From this equation, it can be concluded that the formation of two **moles** of liquid water from gaseous hydrogen and oxygen is an

A. exothermic process releasing 571.8 kJ of heat energy.

B. exothermic process releasing 1143.6 kJ of heat energy.

C. endothermic process absorbing 571.8 kJ of heat energy.

D. endothermic process absorbing 1143.6 kJ of heat energy.

Question 14

A VCE chemistry student sets up a galvanic cell using two standard half cells with half reactions.

half cell 1: $Cr^{3+}(aq) + e^- \rightarrow Cr^{2+}(aq)$

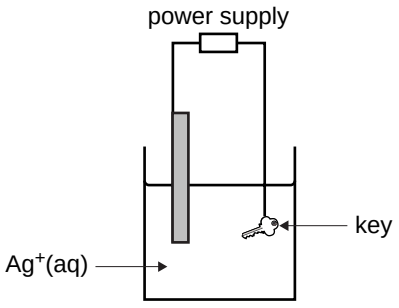
half cell 2: $Cr(s) \rightarrow Cr^{2+}(aq) + 2e^-$

Suitable materials for the electrodes of the two half cells are

	Half cell 1	**Half cell 2**
A.	Platinum	Platinum
B.	Platinum	Chromium
C.	Chromium	Chromium
D.	Chromium	Platinum

Question 15

A student decided to silver-plate a locker key using the apparatus shown.



In this cell, the key is the

A. anode and is connected to the positive terminal of the power supply.

B. anode and is connected to the negative terminal of the power supply.

C. cathode and is connected to the positive terminal of the power supply.

D. cathode and is connected to the negative terminal of the power supply.

The following information is referred to in questions 16, 17 and 18.

The Down's cell is used for the industrial preparation of sodium and chlorine. The reaction occurring in the Down's cell is

$$2NaCl(l) \rightarrow 2Na(l) + Cl_2(g)$$

Question 16

An *iron mesh screen* is a necessary part of the Down's cell.

The primary role of the screen is to

A. allow electric current to flow from the anode compartment to the cathode compartment.

B. provide a way for the liquid sodium to be run into a collection vessel.

C. prevent the chlorine and sodium from coming into contact and thereby exploding.

D. prevent chloride ions from moving from the anode into the cathode compartment.

Question 17

Pure NaCl is not used in a Down's cell. The liquid that is in a Down's cell is a mixture of $CaCl_2$ and NaCl.

The $CaCl_2$/NaCl mixture is used instead of pure NaCl because it

A. has a higher melting temperature.

B. improves the yield of chlorine produced.

C. improves the purity of the sodium produced.

D. enables the process to be carried out at a lower temperature.

Question 18

A particular Down's cell operates for 1.00×10^4 s at a current of 96.5 A.

The amount of chlorine produced, in mole, is

A. 0.050

B. 5.00

C. 10.0

D. 20.0

Question 19

Hydrogen peroxide can act as a reductant according to the half equation

$$O_2(g) + 2H^+(aq) + 2e^- \rightarrow H_2O_2(aq); \quad E^o = +0.68 \text{ V}$$

Which of the following could all be reduced by hydrogen peroxide?

A. $Fe^{2+}(aq)$, Cu(s), $I^-(aq)$

B. $Ag^+(aq)$, $Br_2(aq)$, $H_2O_2(aq)$

C. Ag(s), $Br^-(aq)$, $Fe^{2+}(aq)$

D. $I_2(s)$, $Cu^{2+}(aq)$, $Fe^{3+}(aq)$

Question 20

5 L volumes of 1.0 M $KNO_3(aq)$, 1.0 M $AgNO_3(aq)$ and 1.0 M $Cu(NO_3)_2(aq)$ are placed in three separate electrolytic cells using platinum electrodes. Over a period of 30 minutes, 96 500 coulombs of electric charge are passed through each solution.

Which of the following alternatives correctly indicates the amount, in mole, of metal deposited at the cathode in each cell?

	n(K)	n(Ag)	n(Cu)
A.	0	1	2
B.	0	1	0.5
C.	1	1	0.5
D.	0.5	0.5	1

END OF SECTION A

SECTION B – Short-answer questions

Instructions for Section B

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

Section B is worth approximately 72 per cent of the marks available.

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, $H_2(g)$; NaCl(s)

Question 1

Use the periodic table to write the chemical symbols for the following elements.

a. The element that forms a –2 ion with the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6$ _____

b. An element from period three that forms a basic oxide _____

c. The element from period three with the largest atomic radius _____

d. An element from period four that can form complex ions _____

e. The most electronegative element in group VII _____

f. The first transition series element that forms a +3 ion with a half-filled d sub-shell _____

6 marks

Question 2

a. In the periodic table the atomic mass of elements usually increases as the atomic number increases. However, there are exceptions to this general rule.

For example, tellurium, with atomic number of 52, has a relative atomic mass of 127.6 whereas iodine, with atomic number 53, has a relative atomic mass of 126.6.

How is it possible for the element with a smaller atomic number to have the greater relative atomic mass?

2 marks

b. One section of the modern periodic table contains elements known as transition metals.

i. Why does a series of transition metals have 10 elements?

ii. Some transition elements exhibit different oxidation states in different compounds.

Choose one particular transition element. Give the formulas for two different compounds where this transition element shows different oxidation states.

Compound 1 _____

Compound 2 _____

2 + 2 = 4 marks

Question 3

Most of the formulas below represent elements and compounds that are important in

i. the production of food **or**

ii. the chemical processes these foods undergo in our bodies.

NH_3	NH_2CH_2COOH	$C_6H_{12}O_6$	HNO_3
CH_2OH	$C_{16}H_{33}COOH$	NO	CO_2
$\vert$			
CHOH	H_2O	N_2	O_2
$\vert$			
CH_2OH			

Select only substances from this list **as reactants** to write an equation for each of the following reactions. The products of the reactions may not all be in the list.

a. The production of an artificial fertiliser that can be used to increase the nitrogen available to crops

1 mark

b. The respiration reaction which results in the release of energy for life processes

1 mark

c. The formation of a dipeptide during protein synthesis

Circle the peptide link in the product.

2 marks

d. A condensation reaction in which a fat is produced

Circle an ester link in the product.

3 marks

Question 4

a. A balanced diet contains proteins and fats as well as carbohydrates. Although carbohydrates are the immediate energy source for living things, both proteins and fats can also be used as energy sources.

Give two functions, **other than energy sources**, for each of proteins and fats in humans.

Proteins 1 _____

2 _____

Fats 1 _____

2 _____

4 marks

b. The energy content of some vegetable oil is determined using a bomb calorimeter. A sample of oil, mass 4.75 g, was completely burnt in a calorimeter containing 1.00 L of water originally at 21.0°C. When burning was completed, the final temperature of the water was 56.8°C.

Calculate the energy content of the oil in kJ g^{-1}.

Assume that 4.18 J is required to raise the temperature of 1.0 mL of water by exactly 1°C.

_____

_____

_____

_____

3 marks

c. Salad dressing is poured onto and mixed with a salad to improve its flavour. The list of ingredients on the label of a brand of salad dressing sold in Victoria includes '*water, polyunsaturated vegetable oils, emulsifier (soya bean lecithin) and antioxidant*'.

i. What is the function of an emulsifier in salad dressing and how does it achieve this function?

_____

_____

ii. What is the function of an antioxidant in salad dressing and how does it achieve this function?

_____

_____

_____

_____

2 + 2 = 4 marks

Question 5

a. The concentration of carbon dioxide (CO_2) in the Earth's atmosphere has been increasing steadily since the mid nineteenth century. This is due mainly to the increased burning of fossil fuels (principally natural gas, petroleum and coal) since that time.

i. Name one factor, other than the heat of combustion, that should be considered when selecting a fuel for a particular purpose.

_____

_____

ii. The burning of fossil fuels is associated with other undesirable emissions besides CO_2. Give two other undesirable atmospheric pollutants directly or indirectly caused by the burning of fossil fuels.

_____

_____

1 + 2 = 3 marks

b. Other non-fossil fuel alternatives include nuclear, solar, wind, tidal and hydro energy.

Choose any **two** of the following non-fossil fuels alternatives.

nuclear, solar, wind, tidal, hydro

For each one, identify one advantage (other than the non-emission of CO_2) and one disadvantage in relation to its suitability as a substitute for the current uses of fossil fuels.

Non-fossil fuel alternative	Advantage (other than the non-emission of CO_2)	Disadvantage
1 _____	_____ _____ _____	_____ _____ _____
2 _____	_____ _____ _____	_____ _____ _____

4 marks

c. As an alternative to using fossil fuels, some countries are now relying significantly on nuclear fission for electricity production, the major fuel used being ^{235}U.

i. What is meant by the term ‘nuclear fission’?

_____

_____

ii. What is the source of the energy released when ^{235}U undergoes fission?

_____

_____

2 marks

Question 6

An isolated research station is to be staffed by a small group of scientists for 13 weeks. Part of the exercise is to test the effectiveness of liquid ethanol (CH_3CH_2OH) as a source of fuel under these conditions. It is planned to use two different methods of generating energy from the ethanol.

a. Some of the ethanol is to be directly burnt for heating and cooking, using the reaction

$$CH_3CH_2OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l); \quad \Delta H = -1370 \text{ kJ mol}^{-1}$$

The average need for heating and cooking over the 13-week period is 800 MJ per week. Calculate the total mass of ethanol needed to satisfy the heating and cooking requirements of the research station.

1 MJ = 10^3 kJ

3 marks

b. Some ethanol may also be used for electric power for lighting, refrigeration, computing and other electronic equipment. This can be provided by a fuel cell with an acidic electrolyte, whose cell reaction is identical to the equation given above. In the fuel cell the cathode reaction is

$$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$$

The voltage across the fuel cell is 1.15 V.

i. Give the half reaction occurring at the anode where the ethanol is oxidised in the fuel cell.

ii. Calculate the electrical energy provided per mole of ethanol consumed in the fuel cell.

1 + 2 = 3 marks

c. An alternative way of generating electricity from ethanol is to use it as the fuel for an internal combustion engine driving a generator.

Suggest one important reason why the fuel cell would be better than the generator for this purpose.

1 mark

Question 7

High energy sparks discharged through hydrogen produce hydrogen atoms in an excited state. Light is then emitted. If the light is viewed through a spectroscope, lines of an emission spectrum are visible.

a. Explain why the spectrum is made up of discrete lines.

2 marks

b. When white light from the sun passes through hydrogen in the outer layers of the sun's atmosphere, and is viewed through a spectroscope, a set of dark lines appears superimposed on a continuous spectrum. The wavelengths corresponding to the dark lines match the lines in the emission spectrum of hydrogen.

Explain why the wavelengths of these dark lines correspond to those of the emission spectrum. In your answer you should also

- give the name of the type of spectrum that produces the dark lines
- explain how the dark lines are produced.

3 marks

c. Write an equation for the nuclear fusion of hydrogen to form helium in the sun.

1 mark

END OF QUESTION AND ANSWER BOOK

CHEMISTRY

Written examination 2

DATA SHEET

Directions to students

Detach this data sheet during reading time.

This data sheet is provided for your reference.

Physical constants

$F = 96\,500$ C mol^{-1}

$R = 8.31$ J K^{-1} mol^{-1}

1 atm = 101 325 Pa = 760 mmHg

0°C = 273 K

Molar volume at STP = 22.4 L mol^{-1}

Avogadro constant = 6.02×10^{23} mol^{-1}

Ideal gas equation

$pV = nRT$

The electrochemical series

	$E°$ in volt
$F_2(g) + 2e^- \rightarrow 2F^-(aq)$	+2.87
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$	+1.77
$Au^+(aq) + e^- \rightarrow Au(s)$	+1.68
$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$	+1.36
$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(1)$	+1.23
$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$	+1.09
$Ag^+(aq) + e^- \rightarrow Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \rightarrow Fe^{2+}(aq)$	+0.77
$I_2(s) + 2e^- \rightarrow 2I^-(aq)$	+0.54
$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$	+0.34
$S(s) + 2H^+(aq) + 2e^- \rightarrow H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \rightarrow H_2(g)$	0.00
$Pb^{2+}(aq) + 2e^- \rightarrow Pb(s)$	–0.13
$Sn^{2+}(aq) + 2e^- \rightarrow Sn(s)$	–0.14
$Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$	–0.23
$Co^{2+}(aq) + 2e^- \rightarrow Co(s)$	–0.28
$Fe^{2+}(aq) + 2e^- \rightarrow Fe(s)$	–0.44
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$	–0.76
$2H_2O(l) + 2e^- \rightarrow H_2(g) + 2OH^-(aq)$	–0.83
$Mn^{2+}(aq) + 2e^- \rightarrow Mn(s)$	–1.03
$Al^{3+}(aq) + 3e^- \rightarrow Al(s)$	–1.67
$Mg^{2+}(aq) + 2e^- \rightarrow Mg(s)$	–2.34
$Na^+(aq) + e^- \rightarrow Na(s)$	–2.71
$Ca^{2+}(aq) + 2e^- \rightarrow Ca(s)$	–2.87
$K^+(aq) + e^- \rightarrow K(s)$	–2.93
$Li^+(aq) + e^- \rightarrow Li(s)$	–3.02

Periodic table of the elements

1 **H** 1.0																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 19.0	10 **Ne** 20.1
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 39.9
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 44.9	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.9	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.6	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** 98.1	44 **Ru** 101.1	45 **Rh** 102.9	46 **Pd** 106.4	47 **Ag** 107.9	48 **Cd** 112.4	49 **In** 114.8	50 **Sn** 118.7	51 **Sb** 121.8	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba** 137.3	57 **La** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.8	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 197.0	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209.0	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac** (227)															

Lanthanides

58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.3	63 **Eu** 152.0	64 **Gd** 157.2	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0

Actinides

90 **Th** 232.0	91 **Pa** 231.0	92 **U** 238.0	93 **Np** 237.1	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (254)	100 **Fm** (257)	101 **Md** (258)	102 **No** (255)	103 **Lr** (256)