Neap:

Trial Examination 2007

VCE Chemistry Unit 4

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Marks	Suggested time (minutes)
A	20	20	20	30
B	6	6	45	60
			Total 65	Total 90

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 booklet of 13 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 booklet during reading time.
Please ensure that you write **your name** and your **teacher's name** in the space provided on this booklet and in the space provided on the answer sheet for multiple-choice questions.
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 booklet and hand them in.

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

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2007 VCE Chemistry Unit 4 Written Examination.

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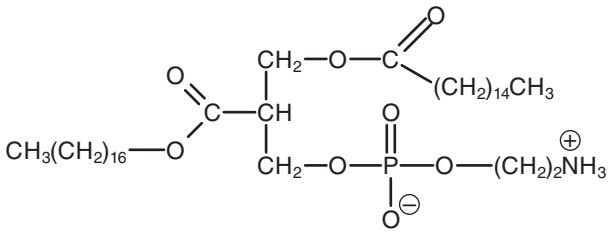
SECTION A: MULTIPLE-CHOICE QUESTIONS

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 mark will be given if more than one answer is completed for any question.

Question 1

The compound whose structure is shown below is added to some foods.



Based on its structure, the most likely role for the compound is to

A. catalyse the breakdown of cellulose in the food to glucose.
B. improve the colour and texture of the food.
C. prevent the food undergoing a combustion reaction with oxygen in the air.
D. prevent the separation of oil-based and water-based components of the food.

Question 2

Small samples of three oxides (Al_2O_3, Na_2O and P_2O_5) were placed in separate test tubes. Water was added to each, and the mixture tested with universal indicator.

For which oxide or oxides would you expect the mixture to be acidic?

A. Na_2O only
B. Na_2O and Al_2O_3 only
C. P_2O_5 only
D. P_2O_5 and Al_2O_3 only

Question 3

Which of the following reactions involving glucose is endothermic?

A. $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$
B. $nC_6H_{12}O_6(aq) \rightarrow (C_6H_{10}O_5)_n(s) + (n - 1)H_2O(l)$
C. $C_6H_{12}O_6(aq) \xrightarrow{\text{yeast}} 2CO_2(g) + 2C_2H_5OH(aq)$
D. $C_6H_{12}O_6(s) \xrightarrow{H_2SO_4} 6C(s) + 6H_2O(g)$

Question 4

Which of the following is the largest energy source for the generation of electricity in Australia?

A. hydroelectric
B. coal
C. nuclear
D. geothermal

Question 5

Which of the following would require the highest ionisation energy for the removal of the **second** electron?

A. Na
B. F
C. Ne
D. Mg

Question 6

Starch and cellulose are both condensation polymers of glucose.

Humans are able to use starch as an energy source but cannot use cellulose because

A. cellulose is not soluble in water, while starch is soluble.
B. humans lack the enzyme necessary to hydrolyse cellulose, but have the enzyme needed to hydrolyse starch.
C. digestion of cellulose requires strongly acidic conditions which are not found in the human digestive system.
D. the complete breakdown of cellulose is an endothermic process, while complete breakdown of starch is an exothermic process.

Question 7

In developing his model of the atom, Niels Bohr studied the emission spectrum of hydrogen.

Study of emission spectra provides evidence for the existence of

A. a small, positively charged nucleus.
B. neutral particles in the nucleus of the atom.
C. a maximum of eight electrons in the outer shell of any atom.
D. specific energy levels for electrons within an atom.

Question 8

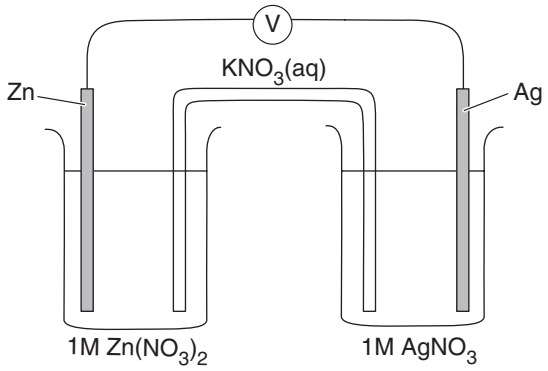
During the production of aluminium using the Hall–Heroult electrolytic cell, both the anode and cathode are made of carbon. One of these electrodes is directly involved in the reaction which occurs there.

Which of the following correctly identifies the reactive electrode, and the product produced at it during the electrolysis?

A. anode; carbon dioxide (CO_2)
B. anode; carbonate ion (CO_3^{2-})
C. cathode; carbon dioxide (CO_2)
D. cathode; carbonate ion (CO_3^{2-})

Questions 9 and 10 refer to the following information.

A student set up the electrochemical cell shown in the diagram below, using a strip of filter paper soaked in $KNO_3(aq)$ as the salt bridge.



Question 9

When the cell is generating a current,

A. potassium ions from the salt bridge move into the Ag^+/Ag half cell.
B. electron flow in the external circuit is from the silver electrode to the zinc electrode.
C. zinc ions are reduced to produce zinc metal.
D. the cathode is negatively charged.

Question 10

Using the electrochemical series, the student predicted a cell voltage of 1.56 V. However, when the cell was constructed, the recorded cell voltage was only 1.05 V.

Which of the following is the most likely explanation for the difference between the predicted and observed cell voltages?

A. The student had connected the electrodes to the wrong terminals of the voltmeter.
B. The concentration of the solutions used was not 1.0 M.
C. The experiment was conducted on a warm day with a room temperature of 25°C.
D. The student used $NaNO_3(aq)$ instead of $KNO_3(aq)$ in the salt bridge.

Question 11

In the electrolysis of a dilute solution of KNO_3, the nitrate ions are

A. attracted to the positive electrode where they are oxidised.
B. attracted to the positive electrode where they are reduced.
C. attracted to the positive electrode where they are neither reduced nor oxidised.
D. not attracted to either electrode as they are spectator ions only.

Question 12

The mass of the ^4_2He nucleus is

A. equal to the sum of the masses of two protons and four neutrons.
B. equal to the sum of the masses of two protons and two neutrons.
C. slightly less than the sum of the masses of two protons and two neutrons.
D. slightly greater than the sum of the masses of two protons and two neutrons.

Question 13

Which of the following represents a nuclear reaction occurring when ^{242}Cm fuses with an alpha particle or particles to produce ^{245}Cf?

A. $^{242}_{96}Cm + {}^{4}_{2}He \rightarrow {}^{245}_{98}Cf + {}^{1}_{0}n$ with energy released

B. $^{242}_{96}Cm + 3\,{}^{1}_{1}H \rightarrow {}^{245}_{98}Cf + {}^{0}_{+1}e$ with energy absorbed

C. $^{242}_{96}Cm + 3\,{}^{1}_{1}H \rightarrow {}^{245}_{98}Cf + {}^{0}_{+1}e$ with energy released

D. $^{242}_{96}Cm + {}^{4}_{2}He \rightarrow {}^{245}_{98}Cf + {}^{1}_{0}n$ with energy absorbed

Question 14

Benzoic acid (C_6H_5COOH) is commonly used to calibrate a calorimeter. The acid reacts completely according to the equation

$$2C_6H_5COOH(s) + 15O_2(g) \rightarrow 14CO_2(g) + 6H_2O(g) \quad \Delta H = -6454 \text{ kJ mol}^{-1}$$

When 1.793 g of benzoic acid underwent combustion, the calorimeter temperature rose from 18.2°C to 35.3°C.

The calibration factor of the calorimeter, in kJ $°C^{-1}$, was

A. 0.68

B. 1.34

C. 2.77

D. 5.55

Questions 15 and 16 refer to the following information.

The nickel–cadmium (NiCad) cell is a secondary cell often used in video cameras, cordless drills and mobile telephones. This cell uses an alkaline electrolyte. The overall reaction occurring when the cell is in use is

$$Cd(s) + 2NiO(OH)(s) + 2H_2O(l) \rightarrow Cd(OH)_2(s) + 2Ni(OH)_2(s)$$

Question 15

The half-equation for the reaction occurring at the cathode during discharge is

A. $NiO(OH)(s) + H_2O(l) + e^- \rightarrow Ni(OH)_2(s) + OH^-(aq)$

B. $NiO(OH)(s) + H^+(aq) + e^- \rightarrow Ni(OH)_2(s)$

C. $Cd(s) + 2H_2O(l) \rightarrow Cd(OH)_2(s) + 2H^+(aq) + 2e^-$

D. $Cd(s) + 2OH^-(aq) \rightarrow Cd(OH)_2(s) + 2e^-$

Question 16

When the cell is recharging, the products formed at the positive electrode are

A. Cd and H_2O.

B. $NiO(OH)$ and H^+.

C. Cd and OH^-.

D. $NiO(OH)$ and H_2O.

Question 17

Octane, a major component of petrol, burns in air according to the following thermochemical equation.

$$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(g) \quad \Delta H = -10\,108 \text{ kJmol}^{-1}$$

Combustion of octane may also be represented by the following thermochemical equation.

$$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l) \quad \Delta H = -10\,900 \text{ kJmol}^{-1}$$

Using the information provided for octane combustion, the enthalpy change (ΔH) for the reaction $H_2O(l) \rightarrow H_2O(g)$ is equal to

A. $+44 \text{ kJmol}^{-1}$

B. -44 kJmol^{-1}

C. $+792 \text{ kJmol}^{-1}$

D. -792 kJmol^{-1}

Questions 18 and 19 refer to the following information.

Nitrogen plays an important role in allowing plants to make amino acids. It is present in both the atmosphere and the soil. Nitrogen is present in the species N_2, NO, NO_2^-, NO_3^- and NH_4^+.

Question 18

Which species do plants readily absorb to make amino acids?

A. NO_2^- and NH_4^+

B. NO_3^- and NH_4^+

C. NO_2^- and NO_3^-

D. NH_4^+ and N_2

Question 19

Of the species listed, which one can be oxidised to produce any of the other species?

A. N_2

B. NO_3^-

C. NH_4^+

D. NO

Question 20

Which of the following correctly states a difference between disaccharides and the polysaccharide starch?

A. Starch is composed of only glucose units, whereas disaccharides always contain glucose and another sugar type such as fructose.

B. Disaccharides are easily digested, whereas starch cannot be digested.

C. In the body the energy from disaccharides is used, whereas the energy from starch is stored in glycogen.

D. Disaccharides are water soluble, whereas starch is insoluble in water.

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

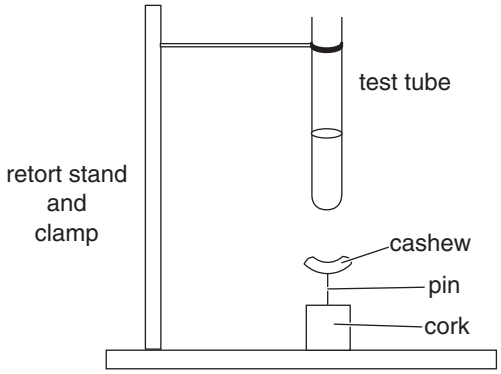
Answer **all** questions in the spaces provided.

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

Question 1

An experiment was conducted to determine the energy content of an unsalted cashew nut.



The cashew nut was weighed before and after burning, and the temperature of the water measured before and after heating by the burning cashew. The results recorded are shown below.

volume of water used	20.00 mL
initial mass of cashew	2.050 g
final mass of cashew	0.860 g
initial temperature of water	18.50°C
final temperature of water	77.90°C

a. Given that the specific heat capacity of water is 4.18 Jg^{-1} $°C^{-1}$, determine the amount of energy used to heat the water.

_____

_____

1 mark

b. Hence determine the energy content of the cashew nut in J g^{-1}.

_____

_____

1 mark

c. The label on the packet of cashew nuts provided the following information for 100 g of nuts.

18 g protein, 47 g fat, 28 g carbohydrate, 2407 kJ of energy

Determine the percentage of the energy from the burning cashew transferred to the water.

_____

_____

_____

1 mark

d. Describe one modification which could be made to the experimental design to improve the accuracy of the results.

_____

_____

1 mark

Total 4 marks

Question 2

Data relating to the Period 4 elements potassium, calcium and manganese are shown in the table below.

Element	Melting point (°C)	Boiling point (°C)	Atomic radius (pm)
K	63	760	227
Ca	852	1484	197
Mn	1244	2095	137

a. Explain why

i. the radius of a calcium atom is smaller than that of a potassium atom.

_____

_____

_____

_____

_____

ii. the melting and boiling points of calcium are lower than those of manganese.

_____

_____

_____

_____

_____

2 + 2 = 4 marks

Neap:

Trial Examination 2007

VCE Chemistry Unit 4

Written Examination

Data Sheet

This data sheet is provided for your reference.

Make sure that you remove this data sheet from the centrefold during reading time.

Any writing, jottings, notes or drawings you make on this data sheet will **not** be considered in the marking.

At the end of the examination, make sure that you do **not** leave the data sheet in the centrefold of the question and answer book.

PHYSICAL CONSTANTS

Molar Volume at SLC = 24.5 L mol^{-1}

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

Ionisation constant for water at 25°C, $K_w = 1.0 \times 10^{-14}$ M^2

Specific heat capacity of water = 4.18 J $°C^{-1}$ g^{-1}

Universal gas constant, R = 8.31 J K^{-1} mol^{-1}

Faraday's constant, F = 96 500 C mol^{-1}

1 atm = 101 325 Pa = 760 mmHg

0°C = 273 K

THE ELECTROCHEMICAL SERIES	$E°$ IN VOLT
$Co^{3+}(aq) + e^- \rightleftharpoons Co^{2+}(aq)$	+1.81
$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(l)$	+1.77
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$	+1.51
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$	+1.23
$Br_2(aq) + 2e^- \rightleftharpoons 2Br^-(aq)$	+1.09
$NO_3^-(aq) + 4H^+(aq) + 3e^- \rightleftharpoons NO(g) + 2H_2O(l)$	+0.96
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	+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
$I_2(aq) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.62
$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightleftharpoons SO_2(g) + 2H_2O(l)$	+0.20
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(g)$	+0.14
$2H^+(aq) + 2e^- \rightleftharpoons H_2(g)$ (defined)	0.00
$Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$	–0.13
$Sn^{2+}(aq) + 2e^- \rightleftharpoons Sn(s)$	–0.14
$Ni^{2+}(aq) + 2e^- \rightleftharpoons Ni(s)$	–0.23
$Co^{2+}(aq) + 2e^- \rightleftharpoons Co(s)$	–0.28
$Fe^{2+}(aq) + 2e^- \rightleftharpoons Fe(s)$	–0.44
$Zn^{2+}(aq) + 2e^- \rightleftharpoons Zn(s)$	–0.76
$2H_2O(l) + 2e^- \rightleftharpoons H_2(g) + 2OH^-(aq)$	–0.83
$Al^{3+}(aq) + 3e^- \rightleftharpoons Al(s)$	–1.67
$Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$	–2.34
$Na^+(aq) + e^- \rightleftharpoons Na(s)$	–2.71
$Ca^{2+}(aq) + 2e^- \rightleftharpoons Ca(aq)$	–2.87
$K^+(aq) + e^- \rightleftharpoons K(s)$	–2.93
$Li^+(aq) + e^- \rightleftharpoons Li(s)$	–3.02

THE 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 20.2
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 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	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 195.1	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)	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (264)	108 Hs (265)	109 Mt (268)	110 Ds (271)	111 Rg (272)							

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 (251	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

END OF DATA SHEET

b. **i.** Write the electronic configuration for a manganese(II) ion, Mn^{2+}.

_____

ii. What is the highest oxidation state of manganese in the following list of compounds?

$$Mn_2O_3,\ MnO_2,\ KMnO_4,\ Mn(H_2O)_6^{2+}$$

_____

1 + 1 = 2 marks

c. Manganese compounds form a number of coloured solutions including the light pink Mn^{2+} solution and the intense purple MnO_4^- solution.

i. Explain why manganese compounds produce coloured solutions.

_____

_____

_____

_____

ii. MnO_4^- is a strong oxidant frequently used as an analytical reagent in acidic solution.

With the aid of the electrochemical series explain why the MnO_4^- solution cannot be acidified using hydrochloric acid when the solution is to be used in a redox titration.

_____

_____

_____

2 + 2 = 4 marks
Total 10 marks

Question 3

a. Write chemical symbols for each of the following.

i. The Period 4 element with the highest electronegativity

_____

ii. The Group 2 element with the lowest first ionisation energy

_____

iii. The second row transition metal that forms a +2 ion with a half-filled d sub-shell

_____

iv. The Period 3 element with the smallest radius.

_____

1 + 1 + 1 + 1 = 4 marks

b. Write molecular formulas for each of the following.

i. The product or products of the complete metabolic breakdown of starch in the human diet.

_____

ii. The dipeptide formed when two glycine molecules undergo a condensation reaction.

_____

iii. The molecular product produced at the anode of an electrolytic cell containing inert electrodes and a 5 M NaCl solution.

_____

1 + 1 + 1 = 3 marks

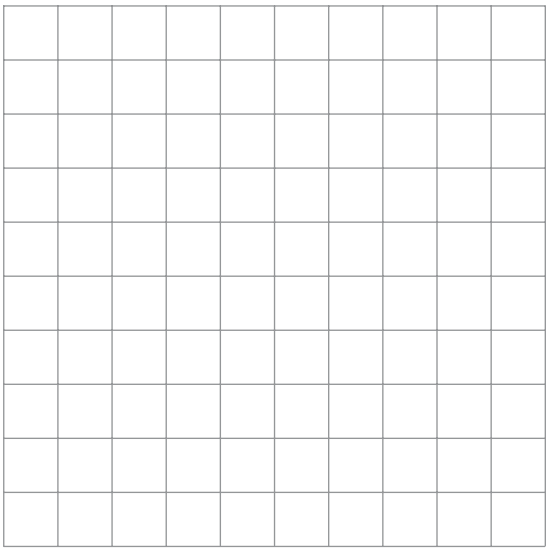
c. Gallium exists in two isotopes: ^{69}Ga and ^{71}Ga. Gallium has a relative atomic mass of 69.7.
Using the grid below, sketch the mass spectrum of gallium.

_____

_____

_____

_____



2 marks

d. Methanol is sometimes used as a fuel additive in racing cars. Methanol undergoes combustion according to the equation

$$2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g) \quad \Delta H = -1450 \text{ kJ mol}^{-1}$$

The energy in methanol can also be harnessed using a fuel cell with an acidic electrolyte.

i. Determine the heat of combustion of methanol in kJ g^{-1}.

_____

_____

ii. Write the half-equation for the reaction occurring at the anode of the methanol-based fuel cell.

_____

1 + 1 = 2 marks
Total 11 marks

Question 4

a. The enzyme polyphenoxidase is involved in the oxidation reaction responsible for the browning of apple slices in air.

Explain each of the following observations.

i. When an apple is first sliced, the apple is not brown.

_____

_____

ii. If the sliced apple is immediately dipped in lemon juice, browning does not occur.

_____

_____

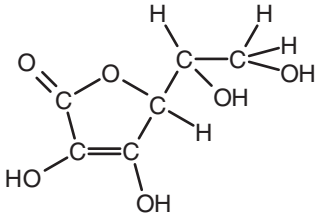
iii. If the sliced apple is crushed, browning occurs much more quickly.

_____

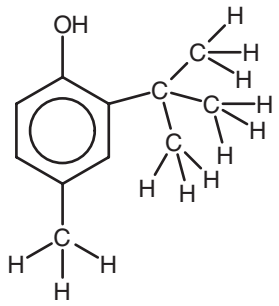
_____

1 + 1 + 1 = 3 marks

b. Unsaturated fats are susceptible to oxidation, causing the food to become rancid. Antioxidants are added to foods to prevent the oxidation of these fats. The structures of two antioxidants are shown below.



ascorbic acid
additive E300



butylated hydroxyanisole (BHA)
additive E320

Based on their structures, which would be the more suitable antioxidant for use in an oil-based nut spread: ascorbic acid or BHA? Explain your choice.

_____

_____

_____

_____

2 marks

c. The α amino acid cysteine has the molecular formula $C_3H_7O_2NS$, and has a side chain $-CH_2SH$.

i. What does the 'α' in α amino acid specify?

_____

_____

ii. Draw the structure of cysteine when it is placed in an acid solution of pH = 2.

1 + 2 = 3 marks
Total 8 marks

Question 5

Electroplating is a relatively inexpensive way of producing costume jewellery. In a particular electroplating cell, a metal cross was to be electroplated with silver. A current of 0.350 A was used to deposit 6.20 mg of silver onto the cross from a silver nitrate solution.

a. Determine the time required to electroplate the cross with silver.

_____

_____

_____

_____

_____

3 marks

b. Gold was used in another cell to plate another identical cross.

If the same current was used for the same length of time and a mass of 5.66 mg of gold was deposited, what was the charge of the gold ion present in the electrolyte solution?

_____

_____

_____

_____

_____

2 marks

c. In order to set up the electroplating cells described above, should the cross be connected to the positive or negative electrode? Explain your choice.

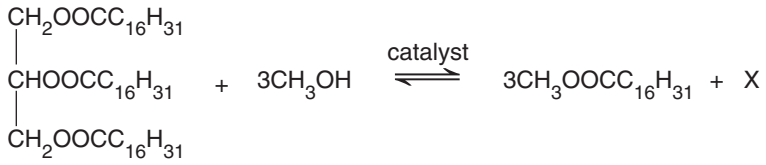
_____

_____

1 mark
Total 6 marks

Question 6

Biodiesel is an alternative energy source to the conventional diesel obtained from crude oil. Biodiesel may be produced using triglycerides obtained from fats and oils. The triglyceride is reacted with methanol in the presence of a catalyst to produce biodiesel and one other product. One such reaction is shown in the equation below.



a. Triglycerides are produced by a condensation reaction involving fatty acids.

For the triglyceride shown in the equation above, was the fatty acid used saturated or unsaturated? Explain your choice.

_____

_____

_____

_____

2 marks

b. **i.** Name the functional group present in the biodiesel molecule.

_____

ii. Name the molecule 'X' that is formed in addition to the biodiesel.

_____

1 + 1 = 2 marks

c. What is the major advantage of biodiesel over conventional diesel as an energy source?

_____

_____

1 mark

d. Energy is released when biodiesel undergoes complete combustion.

Write an equation for the complete combustion of $CH_3OOCC_{16}H_{31}$.

_____

1 mark

Total 6 marks

END OF QUESTION AND ANSWER BOOKLET