Trial Examination 2006

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	7	7	45	60
			Total 65	Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, 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 16 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 electronic communication 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 2006 VCE Chemistry Unit 4 Written Examination.

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

Which of the following sources of energy is regarded as a non-renewable source?

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

Question 2

The isotopes of an element would be expected to have the same

A. density and chemical reactivity.
B. mass number and density.
C. mass number and atomic number.
D. atomic number and chemical reactivity.

Question 3

Ammonia and oxygen react according to the following equation.

$$4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$$

For a given temperature, at a certain time, the rate of formation of nitrogen gas is 0.40 mol L^{-1} s^{-1}.

Which of the following is the rate of use of oxygen gas (in mol L^{-1} s^{-1}) at this time?

A. 0.27
B. 0.40
C. 0.60
D. 1.2

Question 4

During the fusion of ^{24}Mg and ^{4}He to form one product, the reaction will produce a

A. less stable product and release energy.
B. more stable product and release energy.
C. less stable product and absorb energy.
D. more stable product and absorb energy.

Question 5

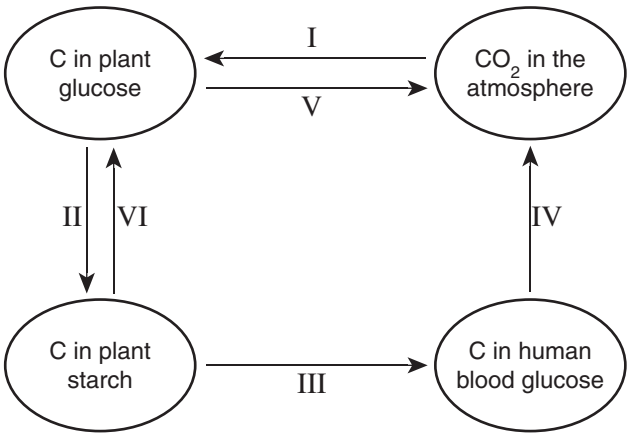
The hydrogen–oxygen fuel cell has found applications in the Apollo space missions, in the space shuttle, and in some power plants. Which of the following statements is **incorrect**?

The hydrogen–oxygen fuel cell

A. has products which are clean and non-toxic.
B. is a highly efficient primary cell.
C. converts chemical energy directly to electrical energy.
D. uses electrodes which also function as catalysts.

Questions 6 and 7 refer to the following information.

The diagram below shows part of the carbon cycle.



Question 6

The chemical reaction labelled IV could be described as an

A. exothermic reaction involving the oxidation of carbon.
B. endothermic reaction involving the oxidation of carbon.
C. exothermic reaction involving the reduction of carbon.
D. endothermic reaction involving the reduction of carbon.

Question 7

Reaction II could be described as an

A. endothermic condensation reaction.
B. exothermic condensation reaction.
C. endothermic hydrolysis reaction.
D. exothermic hydrolysis reaction.

Question 8

The first ionisation energies for five consecutive elements are shown in the table below.

Element	V	W	X	Y	Z
Ionisation energy (pm)	526	502	425	409	382

Given that the first ionisation energy of the element oxygen is 1320 pm, which of the following sets of elements from the periodic table could elements V to Z represent?

A. Period 3 elements from Group I to Group V

B. Group 1 elements from Period 2 to Period 6

C. Group 7 elements from Period 2 to Period 6

D. Transition metals from Period 4

Question 9

Which of the following shows the electron configuration of a manganese(II) ion?

A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$

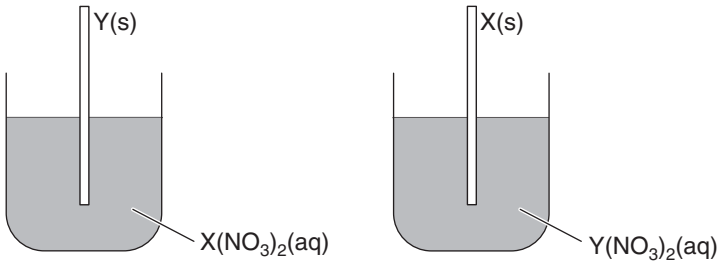
B. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

C. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$

D. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$

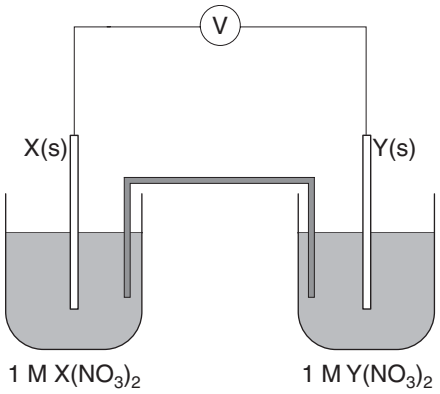
Questions 10 to 12 refer to the following information.

A student conducted the following experiment to compare the reactivity of two metals, X and Y. A strip of each metal was placed in a solution containing the cation of the other metal. The two solutions were allowed to stand overnight and observations were then made. The results are shown below.



Observations: A deposit of X forms; Mass of Y decreases — No change

The galvanic cell shown below was then constructed using metals X and Y, along with 1.0 M solutions of $X(NO_3)_2$ and $Y(NO_3)_2$. The salt bridge was constructed using filter paper dipped in KNO_3 solution. A cell voltage of 0.78 V was recorded.



Question 10

Which of the following statements is consistent with the observations made during the first experiment?

A. Metal Y is a stronger reductant than metal X.
B. The NO_3^- ion is a stronger reductant than metal X.
C. The Y^{2+} ion is a stronger oxidant than the X^{2+} ion.
D. Water is a stronger oxidant than the X^{2+} ion.

Question 11

Which of the following correctly identifies the electrodes in the galvanic cell?

A. Electrode X is the positively charged anode.
B. Electrode X is the negatively charged anode.
C. Electrode Y is the positively charged anode.
D. Electrode Y is the negatively charged anode.

Question 12

Which of the following correctly identifies the flow of charged particles in this cell?

	Flow of cations	**Flow of electrons**
A.	From X^{2+}/X half-cell to the Y^{2+}/Y half-cell	From X to Y
B.	From X^{2+}/X half-cell to the Y^{2+}/Y half-cell	From Y to X
C.	From Y^{2+}/Y half-cell to the X^{2+}/X half-cell	From X to Y
D.	From Y^{2+}/Y half-cell to the X^{2+}/X half-cell	From Y to X

Question 13

Period 4 of the periodic table contains 18 elements.
Which sub-shells are being filled with electrons in the elements of Period 4?

A. s only
B. s and p only
C. s, p and d only
D. s, p, d and f

Question 14

Which of the following best describes the role of bile in the digestion of lipids?

A. surfactant
B. enzyme
C. reactant
D. antioxidant

Question 15

Which of the following lists the atoms and ions in order of decreasing size?

A. Na^+, Na, Mg^{2+}, Mg
B. O, N, Be, Li
C. Na^+, F, O^{2-}, N^{3-}
D. Na, Si, C, O

Question 16

Animals primarily use lipids, rather than carbohydrates, as energy storage molecules.
A major reason for this is that lipids

A. have greater solubility than carbohydrates in the aqueous cell environment.

B. have a greater energy content per gram than carbohydrates.

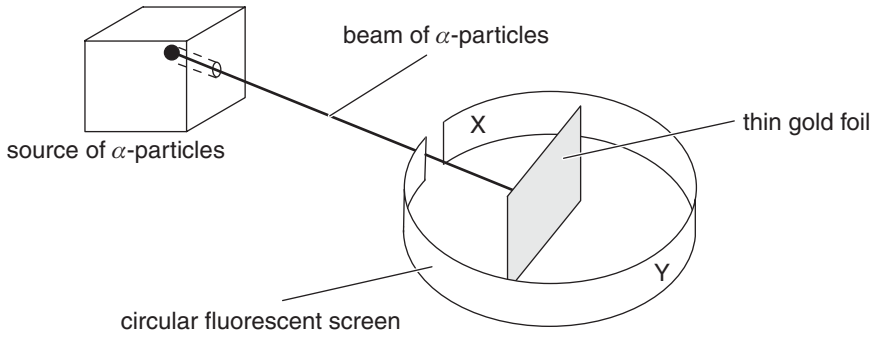
C. react more easily in cells as their oxidation is an anaerobic reaction.

D. do not require deamination before storage, whereas carbohydrates do.

Question 17

Around 1910, Ernest Rutherford, with his students Geiger and Marsden, conducted an experiment which consisted of firing α-particles at high speed at a thin sheet of gold foil and observing the scattering of these α-particles using a fluorescent screen.

The design of the experiment is illustrated below.



Rutherford concluded from the experiment that the atom has a small, positively charged nucleus.
Observation of the α-particle scattering at which points shown on the diagram above led Rutherford to this conclusion?

A. X only

B. Y only

C. both X and Y

D. neither X nor Y

Question 18

Some atoms undergo a nuclear decay process to lose an α-particle.
Which of the following shows the change in the number of neutrons and the number of protons in an atom when this decay occurs?

A. neutron number decreases by 2, proton number decreases by 2

B. neutron number decreases by 4, proton number decreases by 2

C. neutron number decreases by 2, proton number decreases by 1

D. neutron number decreases by 4, proton number decreases by 1

Question 19

Iron can be galvanised (coated with zinc) using an electrolytic process.
The maximum mass of zinc which could be deposited on a corrugated iron cathode during a 7.5-hour working day using a current of 525 amperes would be

A. 40 g
B. 80 g
C. 2.4 kg
D. 4.8 kg

Question 20

During the electrolytic production of aluminium using the Hall–Heroult cell, aluminium is extracted from molten Al_2O_3 rather than an acidified aqueous solution of Al_2O_3. The reason for the use of a molten electrolyte is that

A. water is a stronger reductant than aluminium.
B. Al_2O_3 cannot be dissolved in an acidified aqueous solution.
C. water is a stronger oxidant than the aluminium ion.
D. using an aqueous electrolyte would produce a solid, rather than the required molten product.

SECTION B: SHORT-ANSWER QUESTIONS

Instructions for Section B

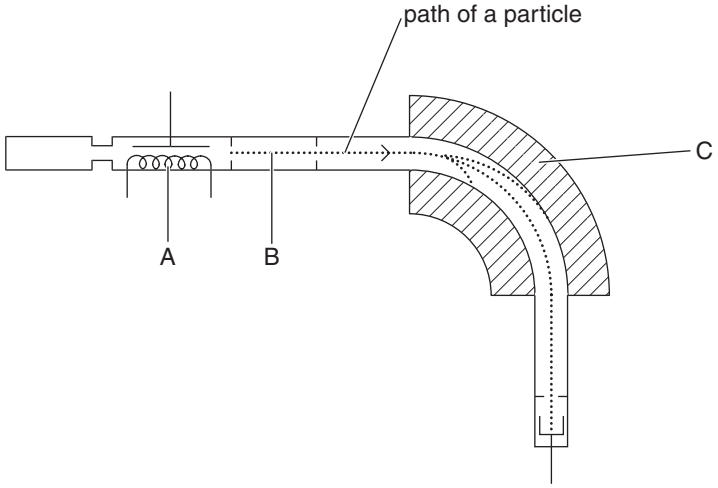
Answer **all** questions in the spaces provided.

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

The diagram below shows a schematic representation of a mass spectrometer.



a. Explain the function of, or the process occurring in, the part of the spectrometer labelled

i. A

_____

_____

ii. B

_____

_____

iii. C

_____

_____

1 + 1 + 1 = 3 marks

Trial Examination 2006

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
$Ca^{2+}(aq) + 2e^- \rightleftharpoons Ca(s)$	–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)									

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. The following data were obtained from a mass spectrometer for a nitrogen sample.

Relative isotopic mass	Percent abundance
14.003	99.633
15.001	0.3670

Calculate the relative atomic mass of nitrogen based on these data.

_____

_____

_____

_____

2 marks
Total 5 marks

Question 2

The label on a 75 g 'Stay-Slim Apple-n-Cinnamon Slice' health bar carried the following information.

> *Ingredients: wholemeal flour, dried apple (23%), sultanas (10%), semolina, rolled oats, egg white, wheat germ, soy protein, golden syrup, milk, xanthan gum, natural grain, flavours (natural vanilla), emulsifiers (471, 475), baking powder, preservative (202, 282), bicarbonate of soda, dutch cinnamon, humectant (glycerol).*

The energy content of the health bar was investigated using a bomb calorimeter. The calorimeter was first calibrated using an electrical method. A sample of the health bar was then weighed, crushed, placed in the calorimeter and ignited. The following data were recorded.

Electrical energy supplied to the bomb calorimeter	1440 J
Temperature of the water jacket (in calorimeter)	
• before the electrical energy was supplied	17.97°C
• after the electrical energy was supplied	19.55°C
Temperature change when the health bar sample was reacted	5.17°C
Mass of health bar sample	0.142 g

a. i. Calculate the calibration factor for this bomb calorimeter.

_____

_____

_____

ii. Calculate the energy content of the health bar, in kJ g^{-1}.

_____

_____

_____

_____

iii. The heat of combustion of dried apple is 1.9 kJ g^{-1}. What percentage of the energy content of the health bar is obtained from the apple?

_____

_____

_____

iv. Suggest why the health bar was crushed prior to placing it in the calorimeter.

_____

_____

1 + 2 + 2 + 1 = 6 marks

b. The health bar contains emulsifiers 471 and 475.

i. What is the role of the emulsifiers in the health bar?

_____

_____

ii. Describe the general structure of a molecule that is able to act as an emulsifier.

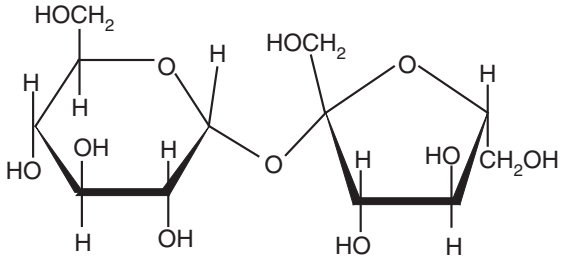
_____

_____

_____

1 + 1 = 2 marks

c. The golden syrup in the health bar contains the disaccharide, sucrose. The structure of sucrose is shown below.



Which of the compounds listed below are products of the enzyme-catalysed hydrolysis of sucrose? Indicate your responses by placing ticks in the appropriate boxes.

glucose	☐	fructose	☐
water	☐	carbon dioxide	☐

1 mark

Total 9 marks

Question 3

a. Distinguish between each of the following pairs of terms.

i. nuclear fission and nuclear fusion

_____

_____

_____

_____

ii. nitrogen fixation and denitrification

_____

_____

_____

_____

2 + 2 = 4 marks

b. Give a concise explanation of the following.

i. The oxidant strength of elements decreases down a group in the periodic table.

_____

_____

_____

_____

ii. Many transition metals are able to form at least two types of cations.

_____

_____

_____

_____

iii. No attempt could be made to generate a periodic table of elements until the 1800s.

_____

_____

2 + 2 + 1 = 5 marks

Total 9 marks

Question 4

Hydrogen iodide decomposes according to the following equation.

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g) \quad \Delta H = +25.9 \text{ kJ mol}^{-1}$$

The activation energy for this reaction is 186 kJ mol^{-1}.

a. Calculate the amount of energy absorbed when 85.0 g of hydrogen iodide is decomposed.

_____

_____

_____

_____

2 marks

b. Determine the enthalpy change (ΔH) for the reaction shown in the following equation.

$$2H_2(g) + 2I_2g) \rightleftharpoons 4HI(g)$$

_____

1 mark

c. Determine the activation energy for the reaction shown in the following equation.

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$$

_____

1 mark
Total 4 marks

Question 5

Many fats and oils are composed of triglycerides formed by the reaction of glycerol ($C_3H_8O_3$) with fatty acids. The names, molecular formulas and melting points of three fatty acids are shown below.

Fatty Acid	Molecular formula	Melting Point
Stearic	$C_{18}H_{36}O_2$	70°C
Oleic	$C_{18}H_{34}O_2$	4°C
Linoleic	$C_{18}H_{32}O_2$	–5°C

a. Explain why the melting points of stearic, oleic and linoleic acids show a decreasing trend.

_____

_____

_____

_____

2 marks

b. Linoleic acid is an *essential* fatty acid. What is meant by the term *essential*?

_____

_____

1 mark

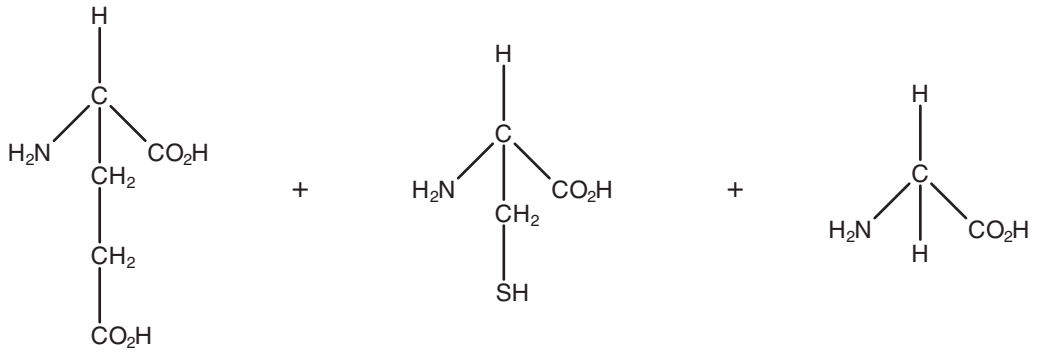
c. Write a balanced chemical equation to show how oleic acid is used as an energy source in the body.

_____

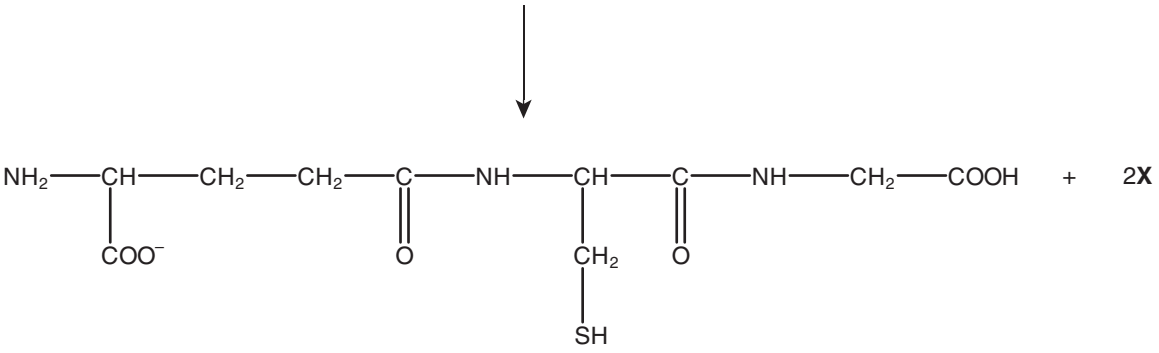
1 mark
Total 4 marks

Question 6

Glutathione is an important tripeptide found in high concentrations in all tissues. It is formed by the reaction of three amino acids: glutamic acid (Glu), cysteine (Cys) and glycine (Gly). The formation of glutathione is shown in the equation below.



(Glu) **(Cys)** **(Gly)**



a. **i.** Circle one peptide link on the glutathione molecule shown above.

ii. Give the formula of molecule X in the equation shown above.

$\frac{1}{2} + \frac{1}{2} = 1$ mark

b. What is unusual about the connection between Glu and Cys in glutathione?

_____

_____

1 mark

c. Glutamic acid (Glu) could be described as both diprotic and amphiprotic. Explain why Glu is

i. diprotic.

_____

_____

ii. amphiprotic.

_____

_____

1 + 1 = 2 marks

d. The presence of cysteine in many proteins is important in determining their tertiary structure. What is meant by the tertiary structure of a protein?

_____

_____

1 mark

e. Excess dietary amino acids may be used as an energy source. Three end products are formed when amino acids are used as a source of energy in the human body.

i. Draw a structural formula for the nitrogen-containing end product.

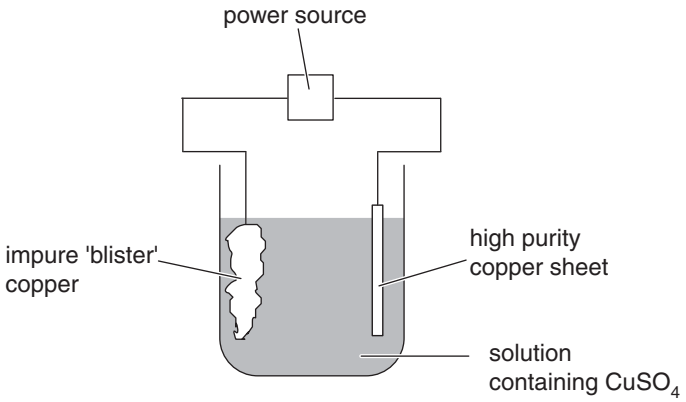
ii. Write the chemical formulas for the other two end products.

_____

1 + 1 = 2 marks
Total 7 marks

Question 7

When copper is extracted from its ores by roasting, the product is 'blister' copper – copper containing 1–2% impurities including Zn, Fe, Ni, Ag, Au and Pt. This 'blister' copper is refined electrolytically. A simplified version of the electrolytic cell is shown below. The potential difference is adjusted to allow copper to be oxidised at the 'blister' copper anode.



a. Which terminal (positive or negative) of the power source is the 'blister' copper connected to? Explain your choice.

_____

_____

_____

2 marks

b. With the aid of any relevant half-equations, explain what initially happens to each of the following during the electrolysis process.

i. Cu atoms in the 'blister' copper

_____

_____

ii. Fe atoms in the 'blister' copper

_____

_____

iii. Ag atoms in the 'blister' copper

_____

_____

1 + 1 + 1 = 3 marks

c. **i.** Write a half-equation for the reaction occurring at the surface of the high purity copper strip.

_____

ii. What change, if any, would be expected if the high purity copper strip were to be replaced by a graphite electrode? Include any relevant half-equation in your answer.

_____

_____

1 + 1 = 2 marks
Total 7 marks

END OF QUESTION AND ANSWER BOOKLET

