

INSIGHT
Trial Exam Paper

2006

CHEMISTRY

Written examination 2

STUDENT NAME:

QUESTION AND ANSWER BOOK

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

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>	<i>Suggested times (minutes)</i>
A	20	20	20	27
B	9	9	56	63
		Total	76	90

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

Materials provided

- The question and answer book of 21 pages with a separate data sheet.
- An answer sheet for the multiple-choice questions.

Instructions

- Remove the data sheet during reading time.
- Write your **name** in the box provided and on the multiple-choice answer sheet.
- You must answer the questions 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 or any other electronic devices into the 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.

1 mark will be awarded for a correct answer; no marks will be awarded for an incorrect answer.

Marks are **not** deducted for incorrect answers.

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

Question 1

Which response does **not** represent one of the energy conversions in a coal-fired power station?

- A. chemical → thermal
- B. thermal → electrical
- C. thermal → mechanical
- D. mechanical → electrical

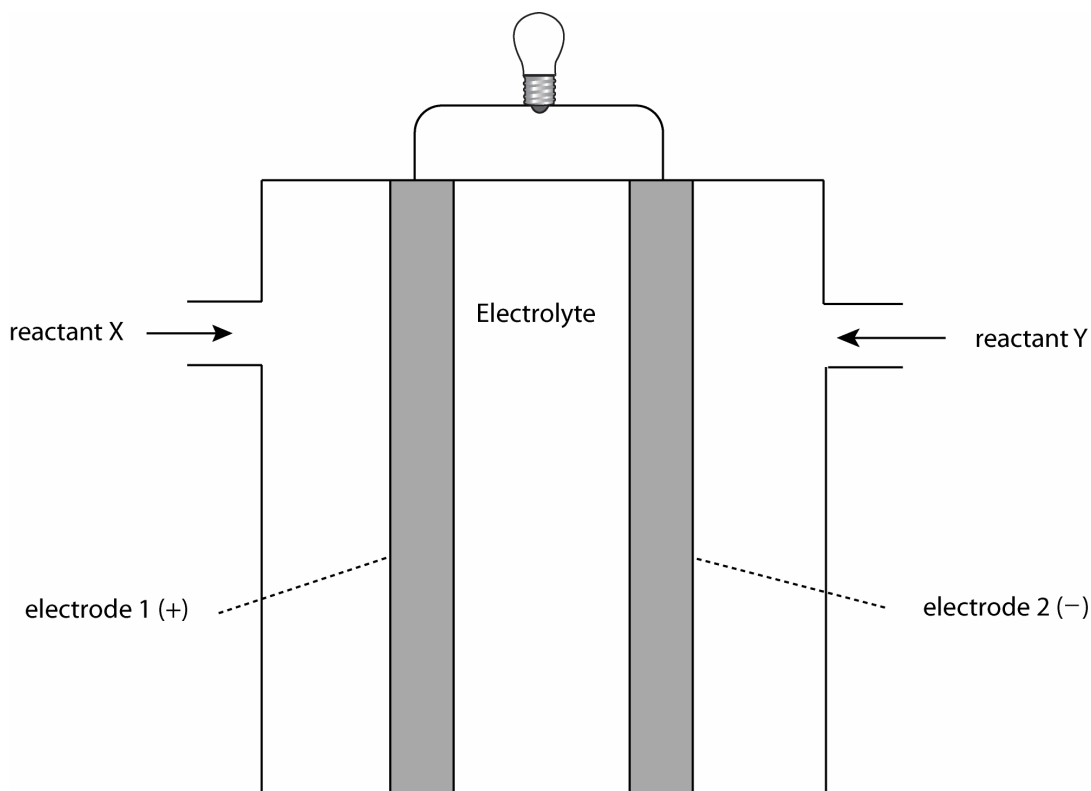
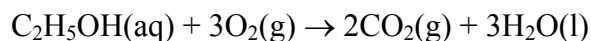
Question 2

The amount of energy required to increase the temperature of a 500 g block of iron by 50°C is 11.825 kJ. The specific heat capacity of iron, in $\text{J g}^{-1} \text{ } ^\circ\text{C}^{-1}$, is

- A. 4.73×10^{-4}
- B. 0.473
- C. 47.3
- D. 473

Questions 3 and 4 refer to the following information.

A diagram of a fuel cell designed to use ethanol as a fuel is shown below. The electrolyte is HCl. The cell reaction is



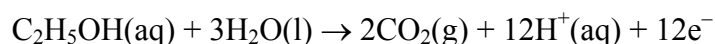
Question 3

Choose the alternative that correctly labels electrodes 1 and 2 and identifies the reactants.

	Electrode 1	Electrode 2	Reactant X	Reactant Y
A.	anode	cathode	$\text{O}_2(\text{g})$	$\text{C}_2\text{H}_5\text{OH}(\text{aq})$
B.	anode	cathode	$\text{C}_2\text{H}_5\text{OH}(\text{aq})$	$\text{O}_2(\text{g})$
C.	cathode	anode	$\text{O}_2(\text{g})$	$\text{C}_2\text{H}_5\text{OH}(\text{aq})$
D.	cathode	anode	$\text{C}_2\text{H}_5\text{OH}(\text{aq})$	$\text{O}_2(\text{g})$

Question 4

In delivering an electric current, a particular cell uses 0.750 g of ethanol in 30.0 minutes. The half equation for the reaction of ethanol is



The electric current flowing, in amps, is

- A. 0.175
- B. 0.874
- C. 10.5
- D. 629

Question 5

The electrolyte used in the electrolytic production of sodium and chlorine in the Downs cell is

- A. 1.0 M aqueous sodium chloride.
- B. an aqueous mixture of 1.0 M sodium chloride and 1.0 M calcium chloride.
- C. molten sodium chloride.
- D. a molten mixture of sodium chloride and calcium chloride.

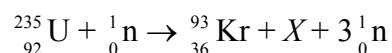
Question 6

Most plants can obtain nitrogen for the manufacture of proteins from

- A. the absorption of atmospheric nitrogen through their leaves.
- B. the absorption of ammonium ions from the soil through their roots.
- C. the absorption of amino acids from the soil through their roots.
- D. reactions in their leaves that convert atmospheric nitrogen to amino acids.

Questions 7 and 8 refer to the following information.

Consider the following nuclear reaction:

**Question 7**

In the above equation, X represents

- A. ${}_{56}^{142}\text{Ba}$
- B. ${}_{56}^{141}\text{Ba}$
- C. ${}_{56}^{140}\text{Ba}$
- D. ${}_{56}^{139}\text{Ba}$

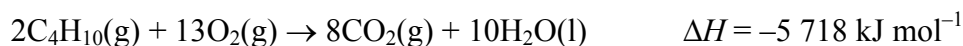
Question 8

Which of the following best describes this reaction?

- A. A nuclear fission reaction that is exothermic.
- B. A nuclear fission reaction that is endothermic.
- C. A nuclear fusion reaction that is exothermic.
- D. A nuclear fusion reaction that is endothermic.

Question 9

The combustion of butane can be represented by the equation

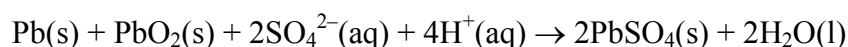


When 30.0 kg of butane undergoes complete combustion, the energy produced, in kJ, is

- A. 1.48×10^3
- B. 1.48×10^6
- C. 2.96×10^3
- D. 2.96×10^6

Question 10

The lead-acid car battery discharges according to the chemical reaction represented by the equation below.



The reaction that occurs at the anode when the battery is being recharged is

- A. $\text{PbSO}_4(\text{s}) + 2\text{e}^- \rightarrow \text{Pb}(\text{s}) + \text{SO}_4^{2-}(\text{aq})$
- B. $\text{PbO}_2(\text{s}) + \text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^- \rightarrow \text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l})$
- C. $\text{Pb}(\text{s}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{PbSO}_4(\text{s}) + 2\text{e}^-$
- D. $\text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{PbO}_2(\text{s}) + \text{SO}_4^{2-}(\text{aq}) + 4\text{H}^+(\text{aq}) + 2\text{e}^-$

Question 11

The number of neutrons in an atom of ${}^{230}_{90}\text{Th}$ is

- A. 90
- B. 140
- C. 230
- D. 320

Question 12

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

- A. nitride ion.
- B. oxide ion.
- C. sodium ion.
- D. magnesium ion.

Question 13

The element chlorine occurs naturally as two isotopes, ^{35}Cl and ^{37}Cl . The ^{35}Cl atom has a relative isotopic mass of 34.696 and ^{37}Cl has a relative isotopic mass 36.966. The relative atomic mass of chlorine is 35.5. The percentage abundance of the lighter isotope is

- A. 33.2%
- B. 48.6%
- C. 64.6%
- D. 80.0%

Question 14

The tripeptide formed from the reaction of three alanine molecules, $\text{NH}_2\text{CH}(\text{CH}_3)\text{COOH}$, will have a relative molecular mass of

- A. 213
- B. 231
- C. 249
- D. 267

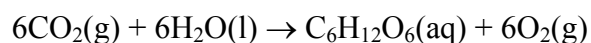
Question 15

The human body cannot obtain any energy from the polysaccharide cellulose. This is because

- A. cellulose is not present in any of the foods we eat.
- B. the molecules produced from the digestion of cellulose cannot be absorbed by the gut.
- C. the molecules produced from the digestion of cellulose are unable to be oxidised in human body cells.
- D. the human body lacks the enzyme required to digest cellulose.

Question 16

This reaction is an important reaction in the carbon cycle.



Which one of the following alternatives correctly names and describes the energy change that occurs in this reaction?

- | | Name | Energy change |
|----|----------------|----------------------|
| A. | photosynthesis | endothermic |
| B. | photosynthesis | exothermic |
| C. | respiration | endothermic |
| D. | respiration | exothermic |

Question 17

The membrane cell is used to produce chlorine gas electrolytically. Which one of the following alternatives correctly describes the electrolyte and reaction at the anode?

	Electrolyte	Anode reaction
A.	molten NaCl	$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$
B.	molten NaCl	$2\text{Cl}^-(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^-$
C.	aqueous NaCl	$2\text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{H}_2(\text{g}) + 2\text{OH}^-(\text{aq})$
D.	aqueous NaCl	$2\text{Cl}^-(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^-$

Question 18

The group 2 elements in the periodic table have an outer shell electron configuration of

- A. s^2
- B. p^2
- C. d^2
- D. s^2 or p^2

Question 19

The compound that is used as a short-term energy reserve in the human body is

- A. galactose
- B. glycine
- C. glycerol
- D. glycogen

Question 20

Which one of the following metals would you predict to react spontaneously with lead ions but not zinc ions?

- A. Cu
- B. Al
- C. Sn
- D. Mg

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

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

To obtain full marks for your answers you should

- give simplified answers with an appropriate number of significant figures to all questions; unsimplified answers will not be given full marks.
- show all working in your answers to numerical questions. No credit will be give 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, $\text{H}_2(\text{g})$; $\text{NaCl}(\text{s})$

Question 1

Give the chemical symbol for

- a. the element that forms a +2 ion with the electron configuration $1s^2 2s^2 2p^6$. _____
- b. the amino functional group. _____
- c. a nitrogen-containing compound that is the end waste product of the digestion of proteins in the human body. _____

Total 3 marks

**CONTINUED
PLEASE TURN OVER**

**SECTION B – continued
TURN OVER**

Question 2

Oleic acid, $C_{17}H_{33}COOH$, is a common fatty acid.

a. Is oleic acid a saturated or unsaturated fatty acid? _____
1 mark

b. A triglyceride is produced by a reaction between three fatty acid molecules, such as oleic acid, and one other molecule. Name the other molecule and draw its structural formula.

2 marks

c. Oleic acid forms almost one-third of the total fatty acid content in cow's milk. During the processing of cow's milk into other foods, additives are often added to prevent the foods from spoiling in air.

i. What feature of oleic acid makes it particularly susceptible to spoiling in air?

ii. What class of additives is added to prevent this type of spoiling?

1 + 1 = 2 marks

Total 5 marks

Question 3

The energy content of a new brand of biscuits was determined by a series of experiments using a bomb calorimeter. The calorimeter is first calibrated by passing an electric current through the calorimeter for a period of time and measuring the resultant temperature rise. The following data was collected.

Current	1.35 A
Potential difference	6.50 V
Time	5.00 min
Temperature rise	1.05°C

- a. Use the data above to calculate the calibration factor, in $\text{kJ } ^\circ\text{C}^{-1}$ for this calorimeter.

2 marks

- b. A mass of 2.34 g of the dried biscuit was then burnt in the calorimeter and a temperature change of 0.570°C was recorded. Calculate the energy content of the biscuits in kJ g^{-1} .

2 marks

- c. Why is the energy content of the biscuit given in kJ g^{-1} rather than in kJ mol^{-1} ?

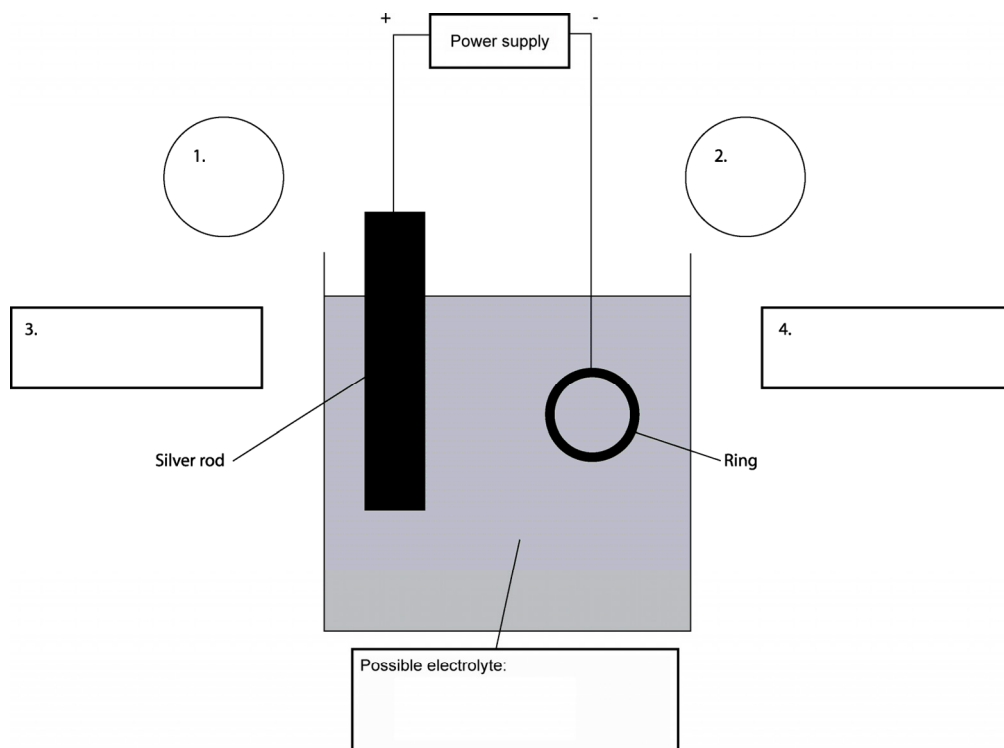
1 mark

Total 5 marks

SECTION B – continued
TURN OVER

Question 4

Electrolysis is used to coat an iron ring with silver metal. A sketch of the experimental set-up is given below.



- a.** On the diagram above
- label the polarity of the electrodes at points 1 and 2.
 - label the anode and cathode at points 3 and 4.
 - write the formula of a possible electrolyte in the space provided.

1 + 1 + 1 = 3 marks

- b.** Write an equation for the half reaction that occurs on the surface of the ring.

1 mark

- c.** A current of 3.00 A is passed through the cell for 15.0 minutes. Calculate the mass of silver that would be deposited on the ring in that time.

3 marks

Total 7 marks

SECTION B – continued

Question 5

Give a concise explanation for each of the following.

- a.** When aluminium oxide is electrolysed industrially, the carbon anodes need to be replaced regularly.

2 marks

- b.** Secondary cells can be recharged whereas primary cells can be used only once.

2 marks

- c.** An enzyme that is boiled at 100°C for a few minutes becomes inactive, yet its primary structure remains intact.

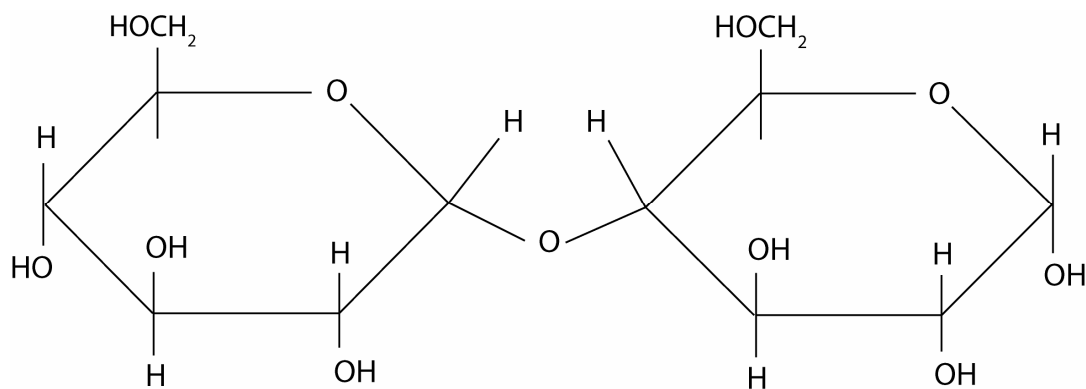
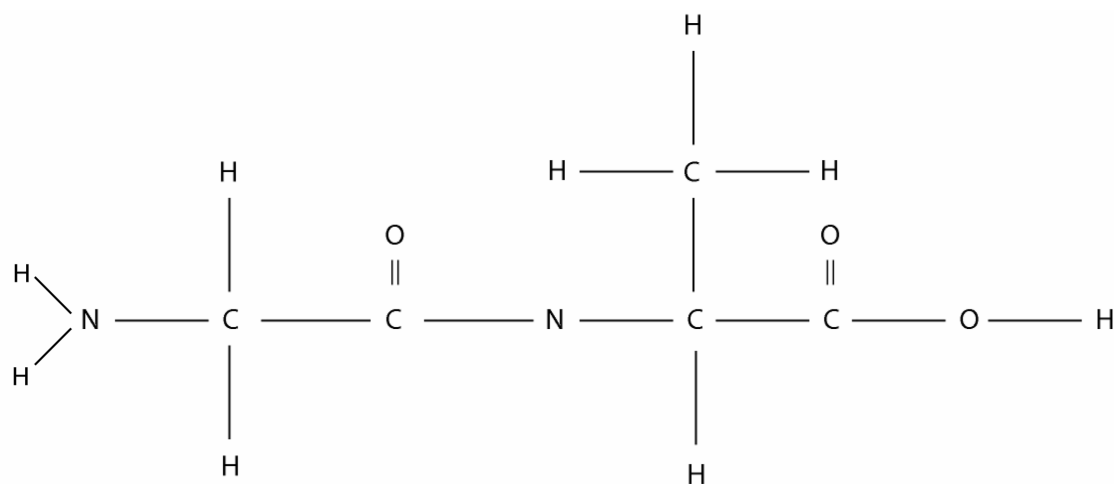
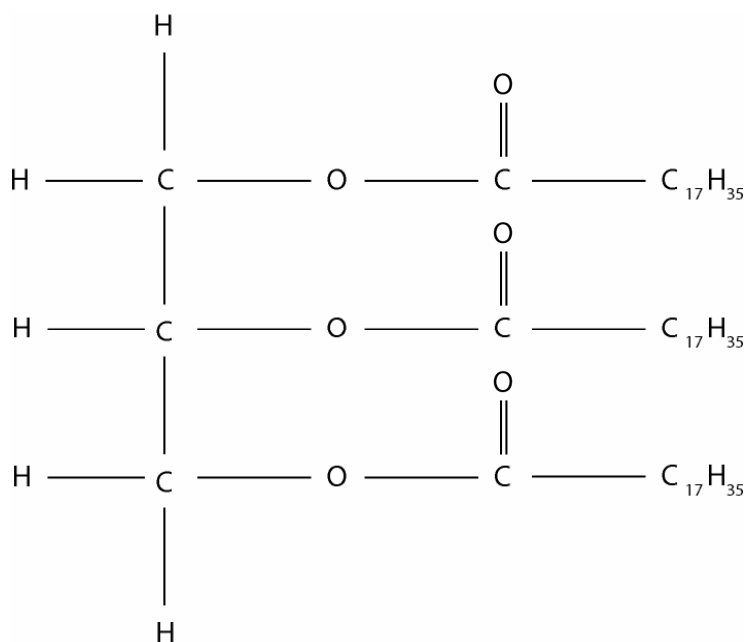
2 marks

Total 6 marks

SECTION B – continued
TURN OVER

Question 6

a. The compounds shown below are all important molecules found in the foods we eat.



- i. Which of the molecules shown on page 14, A, B or C, can be digested by the body to produce two amino acids? _____
- ii. Name the type of reaction involved in the digestion of this molecule.

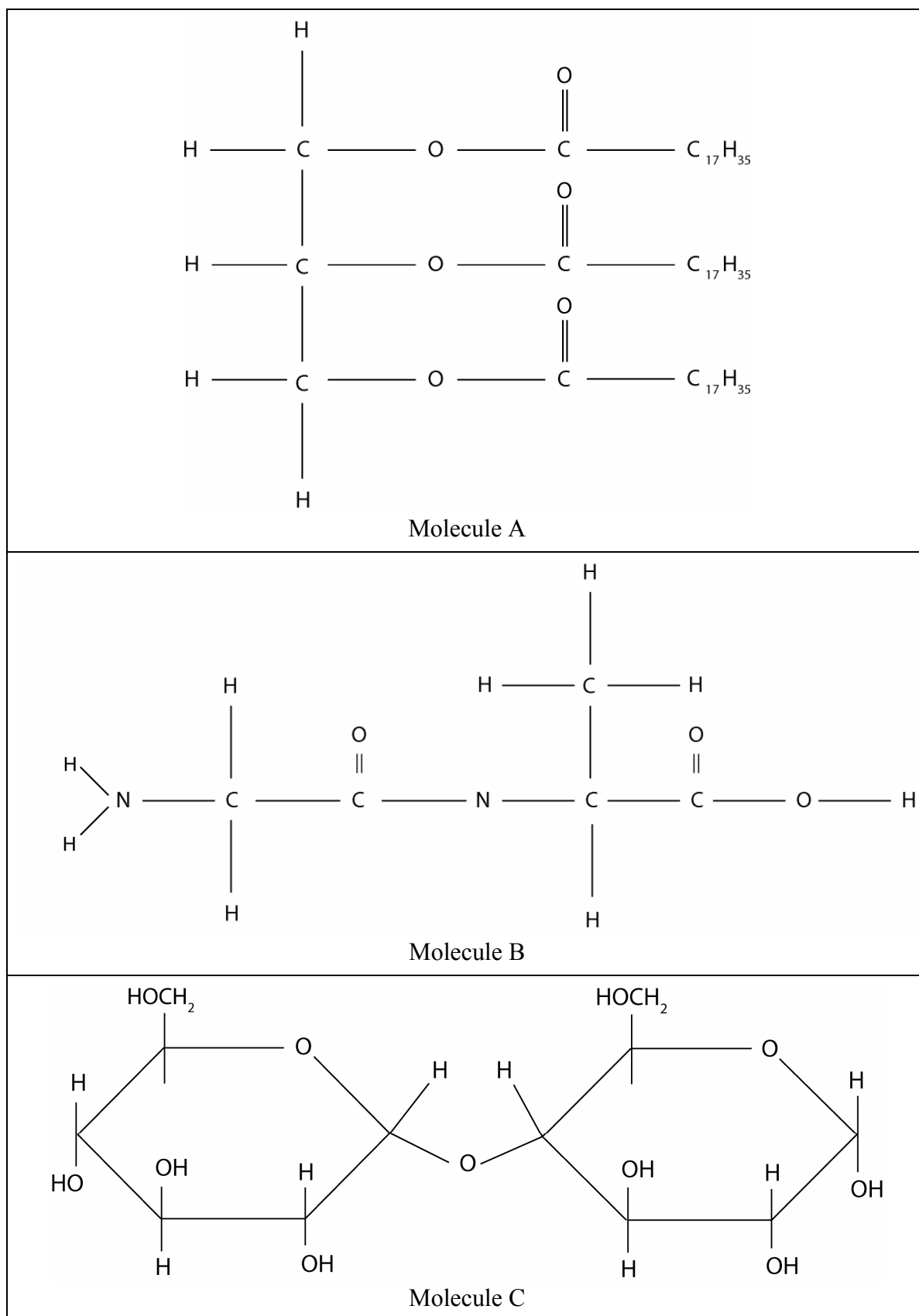
iii. Draw the structural formulas for the two amino acids formed.

1 + 1 + 2 = 4 marks

- b. Which of the molecules A, B or C, shown on page 14, can be digested by the body to produce two monosaccharides? _____

1 mark

c. Circle all of the ester linkages present in the molecules A, B and C, shown below.



1 mark

- d.** The digestion of food is catalysed by a large number of different enzymes. Explain how enzymes are able to catalyse the breakdown of food molecules and why so many different enzymes are needed.

3 marks

Total 9 marks

**CONTINUED
PLEASE TURN OVER**

**SECTION B – continued
TURN OVER**

Question 7

The modern periodic table is an extremely useful reference tool for chemists.

- a. Give two ways in which the modern periodic table differs from the one developed by Mendeleev.

2 marks

- b. The elements Li, Be, B, C, N, O and F are all members of period 2 of the periodic table. Consider the following properties of these elements.

First ionisation energy

- i. Which of the elements listed above has the highest first ionisation energy? _____
- ii. Explain the trend in the first ionisation energies of the listed atoms.

Atomic radius

- iii. Which of the elements listed above has the largest atomic radius? _____

1 + 2 + 1 = 4 marks

- c. The elements Be, Mg, Ca, Sr, Ba and Ra are all members of group 2 of the periodic table. Consider the following properties of these elements

First ionisation energy

- i. Which of the elements listed above has the highest first ionisation energy? _____
- ii. Explain the trend in the first ionisation energies in the atoms of the listed elements.

Oxidising strength

- iii. Which of the listed elements is the strongest oxidant? _____

1 + 2 + 1 = 4 marks

Total 10 marks

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SECTION B – continued
TURN OVER

Question 8

The transition metals occupy the d block in the periodic table.

- a. Why is the d block 10 elements wide?

1 mark

- b. Solid copper sulfate exists in a hydrated form with the formula $\text{CuSO}_4 \cdot 6\text{H}_2\text{O}$. The solid contains the hydrated ion $\text{Cu}(\text{H}_2\text{O})_6^{2+}$.

- i. Sketch the structure of $\text{Cu}(\text{H}_2\text{O})_6^{2+}$, showing the arrangement and orientation of the water molecules around the copper ion.

- ii. Name the type of bonding that exists between the Cu^{2+} ion and the water molecules.

- iii. Name the type of bonding that exists within the water molecules.

2 + 1 + 1 = 4 marks

- c. Give the subshell ground state electronic configurations for the cobalt (Co) atom and the Co^{2+} ion in terms of shells and subshells.

Co _____

Co^{2+} _____

2 marks

Total 7 marks

SECTION B – continued

Question 9

Write balanced equations to demonstrate each of the following reactions.

- a. a zwitterion reacting with excess hydroxide ions

2 marks

- b. the formation of carbon by nuclear reaction in stars

1 mark

- c. aluminium oxide reacting with excess hydrogen ions

1 mark

Total 4 marks