Neap:

Trial Examination 2017

VCE Chemistry Units 3&4

Written Examination

Question and Answer Booklet

Reading time: 15 minutes
Writing time: 2 hours 30 minutes

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*	*Suggested time (minutes)*
A	30	30	30	40
B	9	9	90	110
			Total 120	Total 150

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 correction fluid/tape.

Materials supplied

Question and answer booklet of 26 pages.

A Data Booklet.

Answer sheet for multiple-choice questions.

Instructions

Write your **name** and your **teacher's name** in the space provided above on this page, and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

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.

You may keep the data booklet.

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 2017 VCE Chemistry Units 3&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 marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Question 1

Which one of the following statements about the compounds benzene and cyclohexane is **incorrect**?

A. Each compound has a different empirical formula and a different molecular formula.

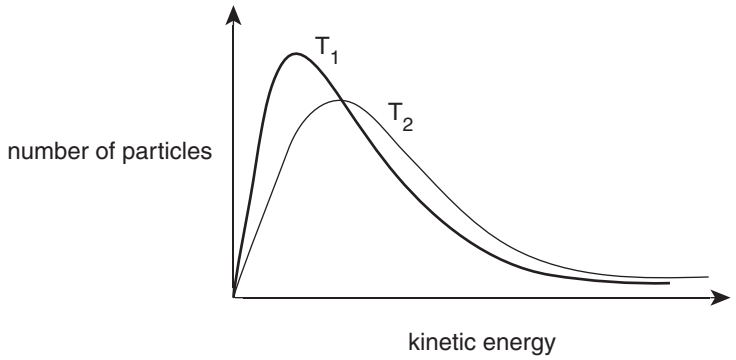
B. Both compounds consist of a ring structure with six carbon atoms and single bonds.

C. The compounds are hydrocarbons and have different structural formulas.

D. Benzene has a higher percentage composition by mass of carbon than cyclohexane.

Question 2

The diagram below shows the distribution of energies of reactant particles in a particular chemical reaction at two different temperatures (T_1 and T_2).



Consider the following statements about the information provided above.

I T_2 is a lower temperature than T_1.

II The average kinetic energy of the particles is higher at T_2 than at T_1.

III More particles have energies greater than the activation energy at T_2 than at T_1.

IV The activation energy for the reaction at T_1 is higher than at T_2.

Which of these statements are correct?

A. I and II only

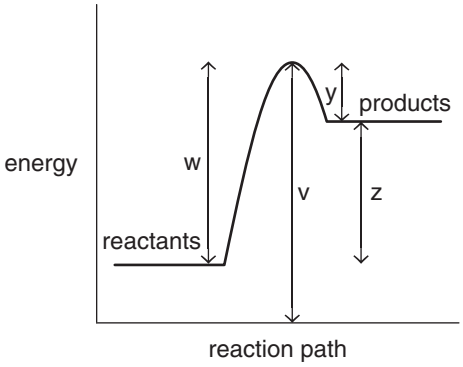
B. II and III only

C. II, III and IV only

D. I, III and IV only

Use the following information to answer Questions 3 and 4.

The energy profile for a particular catalysed reaction is shown below. Various energy values are labelled with the letters w, v, y and z.



Question 3

Which one of the following is correct for the reaction shown in the energy profile?

	Type of chemical reaction	Sign of enthalpy change
A.	endothermic	negative
B.	exothermic	negative
C.	endothermic	positive
D.	exothermic	positive

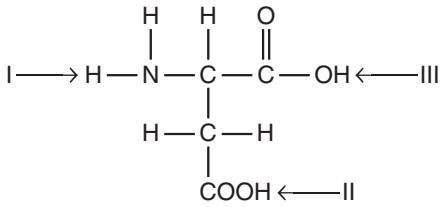
Question 4

What is the value of the activation energy for the reverse reaction?

A. v – y
B. w – z
C. y + w
D. v – z

Question 5

The structure of an amino acid is shown with three hydrogen atoms labelled with the numerals I, II and III.



Which of these hydrogen atoms could be removed as a proton when the amino acid is in a solution of high pH?

A. I and II only
B. II and III only
C. I and III only
D. I, II and III

Question 6

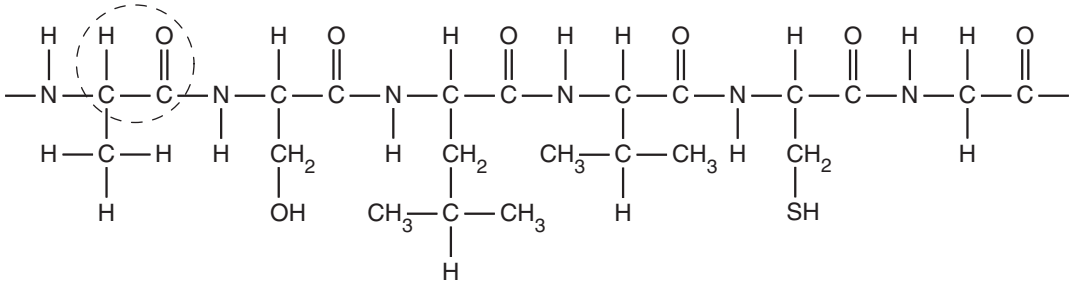
The glycaemic index ranks the ability of foods to produce a particular compound in the body.

That compound is

A. glycogen.
B. glycerol.
C. glucose.
D. glycine.

Question 7

The structure of part of a protein is shown below with a group of atoms circled.



Consider the following statements about the structure.

I A peptide bond has been circled using a dotted line.

II One of the constituent amino acids is isoleucine.

III An amino acid residue in the protein could form a disulfide linkage as part of the secondary structure of the protein.

Which of these statements are incorrect?

A. I and II only
B. II and III only
C. I and III only
D. I, II and III

Question 8

Which one of the following is never a function of a coenzyme?

A. binding to the active site of an enzyme
B. altering the binding properties of an active site
C. changing the surface shape of an enzyme
D. acting as an intermediate carrier of neutrons

Question 9

In the induced-fit model of enzyme action, which of the components will change shape?

A. the active site only
B. the substrate only
C. the active site and the substrate only
D. all of the enzyme molecule and the substrate

Use the following information to answer Questions 10–12.

A synthesis experiment was conducted in which 4.50 g of $CH_3CH_2CH_2COOH$ (M = 88 g mol^{-1}) was heated with an excess of $CH_3CH_2CH_2OH$ (M = 60 g mol^{-1}) in the presence of a sulfuric acid catalyst. The mass of the ester (M = 130 g mol^{-1}) produced was 5.32 g.

Question 10

What is the name of the ester formed in the reaction?

A. 1-butyl butanoate
B. 1-propyl butanoate
C. 1-butyl propanoate
D. 1-propyl propanoate

Question 11

The per cent atom economy for the reaction is closest to

A. 70%
B. 75%
C. 80%
D. 85%

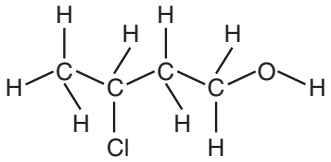
Question 12

The percentage yield of the ester in the synthesis is closest to

A. 70%
B. 75%
C. 80%
D. 85%

Question 13

How many chiral carbon atoms are present in the structure shown below?



A. 1
B. 2
C. 3
D. 4

Question 14

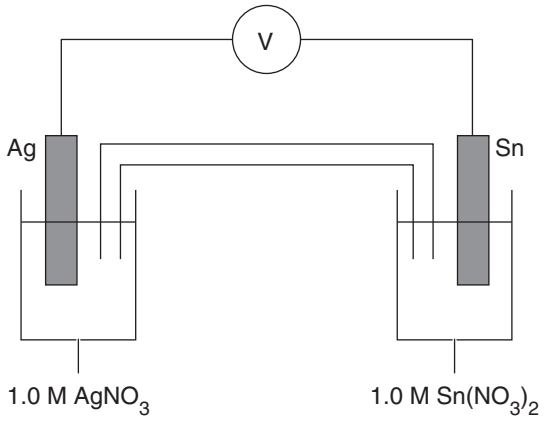
Two types of electrochemical cells are the primary cell and the secondary cell.

Which one of these features is exhibited by only one of these cells?

A. An energy transformation is from chemical energy to electrical energy.
B. The efficiency of the cell is close to 100%.
C. Products of the cell reaction remain in contact with the electrodes.
D. A spontaneous redox reaction is the overall reaction of the cell.

Use the following information to answer Questions 15–17.

The diagram below shows a galvanic cell which is set up in a laboratory under standard conditions.



Question 15

Which one of the following is correct for the cell shown above?

	Maximum cell voltage	Electrode at which oxidation occurs
A.	0.66 V	Ag
B.	0.94 V	Ag
C.	0.66 V	Sn
D.	0.94 V	Sn

Question 16

Which one of the following statements about the cell is correct when electrical energy is being produced?

A. The mass loss of one electrode equals exactly the mass gain of the other electrode.
B. Electrons travel from the positive Ag electrode to the Sn electrode.
C. Positive ions travel towards the half-cell which contains the cathode.
D. As the electrolytes are aqueous, gas bubbles will appear at each electrode surface.

Question 17

What is the role of the salt bridge?

A. to prevent any charge build-up in the half-cells by allowing ions to flow
B. to transport all of the charged particles between the half-cells
C. to maintain the initial concentration of all chemical species in the cell
D. to ensure the liquid levels in each of the half-cells are identical

Use the following information to answer Questions 18–20.

A 10.00 mL aliquot of methanoic acid was pipetted into a 150 mL conical flask and titrated with a standardised 0.150 M sodium hydroxide solution. The titration was repeated several times. An average titre of 13.4 mL was required to reach the end point.

Question 18

The concentration of methanoic acid is closest to

A. 0.100 M
B. 0.200 M
C. 0.300 M
D. 0.400 M

Question 19

The experiment was repeated but all of the glassware used had been rinsed with water and left wet. A pipette was used to take the aliquot, a burette was used to dispense the sodium hydroxide solution and a flask was used for the titration reaction.

Which of these pieces of glassware being left wet with water would affect the calculated concentration of methanoic acid?

A. pipette only
B. pipette and burette only
C. burette and flask only
D. pipette, burette and flask

Question 20

Which of the following is an example of a systematic error which could occur during this titration experiment?

A. The sodium hydroxide solution was standardised three times and values of 0.151 M, 0.150 M and 0.149 M were determined.
B. The student misread the burette during the second titration.
C. The pipette dispensed aliquots of 9.95 ± 0.03 mL.
D. A 200 mL conical flask was used in place of the 150 mL flask.

Question 21

Under standard conditions, different reagents were mixed in separate flasks as shown in the table below.

Flask 1	Flask 2	Flask 3
Solid iodine was placed in 1.0 M sodium hydroxide solution into which hydrogen gas was bubbled.	A strip of zinc metal was placed into a 1.0 M iron(III) nitrate solution.	1.0 M nickel sulfate solution was added to 1.0 M hydrogen peroxide (H_2O_2) solution.

In which of the flasks is a reaction likely to occur?

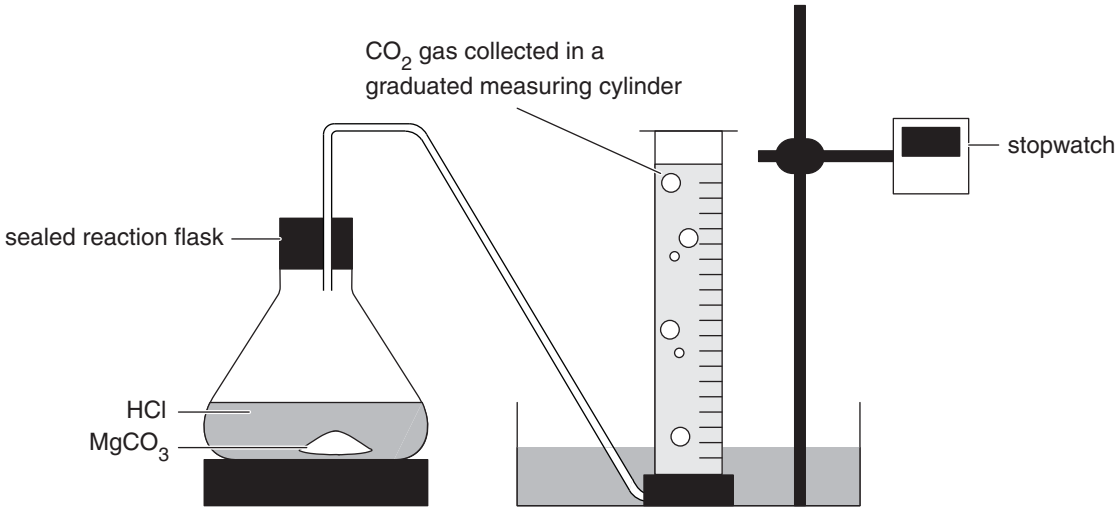
A. 1 and 2 only
B. 2 and 3 only
C. 1 and 3 only
D. 1, 2 and 3

Use the following information to answer Questions 22–25.

Magnesium carbonate reacts with hydrochloric acid according to the equation below.

$$MgCO_3(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2O(l) + CO_2(g)$$

Students were asked to design an experiment to investigate the effect of the surface area of the magnesium carbonate on the rate of this reaction. Several methods were considered. One student designed and conducted an experiment using the apparatus shown in the diagram below.



0.35 g of magnesium carbonate was added to the reaction vessel containing 50.0 mL of 0.2 M hydrochloric acid solution. The rate of reaction was measured by recording the time taken for the complete reaction of the magnesium carbonate, taken to be the time at which bubbling ceased. The experiment was repeated several times with identical conditions except that the magnesium carbonate pieces were of increasingly smaller size in each experiment. The acid was in excess in all tests, and the gas collection apparatus was maintained at 25°C. The volume of carbon dioxide produced in each test was recorded.

Question 22

Which of the following experimental design methods would be least practical in measuring the rate of the reaction?

A. measuring the rate of mass loss of magnesium carbonate during the reaction
B. weighing the open reaction vessel and contents throughout the reaction
C. measuring the change in pH of the contents of the reaction vessel as the reaction proceeds
D. using a gas syringe, collect and measure the volume of gas produced during the reaction

Question 23

Considering the student's experiment shown in the diagram above, which of the following correctly identifies the independent variable in the experiment?

A. surface area of the magnesium carbonate
B. time taken for complete reaction
C. amount of hydrochloric acid present in the flask
D. volume of carbon dioxide collected

Question 24

In designing the experiment, the student first calculated the maximum volume of carbon dioxide which could be collected during the reaction using 0.35 g of magnesium carbonate. The student recorded the room temperature as 25°C and the atmospheric pressure as 1.0 atm.

Using these conditions the calculated maximum volume of carbon dioxide is closest to

A. 10 mL
B. 70 mL
C. 100 mL
D. 170 mL

Question 25

The volume of carbon dioxide collected in each experiment was significantly less than the value calculated in **Question 24**.

Which of the following is least likely to contribute to the lower than expected volume?

A. Some carbon dioxide dissolves in the water in the gas collection apparatus.
B. The pressure of the collected carbon dioxide gas was less than atmospheric pressure.
C. The gas collection tubing was not sealed completely at the join to the reaction vessel.
D. The temperature of the water used in the gas collection apparatus was 20°C.

Question 26

The electrode reactions which occur when the nickel-cadmium battery is producing electrical energy are shown below.

$$NiO_2(s) + 2H_2O(l) + 2e^- \rightarrow Ni(OH)_2(s) + 2OH^-(aq)$$

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

Which one of the following correctly shows the type of electrode reaction and the half-cell equation at the negative electrode when the battery is being recharged?

A. oxidation: $Ni(OH)_2(s) + 2OH^-(aq) \rightarrow NiO_2(s) + 2H_2O(l) + 2e^-$
B. reduction: $Ni(OH)_2(s) + 2OH^-(aq) \rightarrow NiO_2(s) + 2H_2O(l) + 2e^-$
C. oxidation: $Cd(OH)_2(s) + 2e^- \rightarrow Cd(s) + 2OH^-(aq)$
D. reduction: $Cd(OH)_2(s) + 2e^- \rightarrow Cd(s) + 2OH^-(aq)$

Question 27

Two equations for the reaction of haemoglobin (given the symbol Hb_4) in the blood with different gases are shown below.

reaction 1 $\quad Hb_4 + 4O_2 \rightarrow Hb_4O_8$

reaction 2 $\quad Hb_4 + 4CO \rightarrow Hb_4(CO)_4$

Normally, oxygen gas is transported to cells in the body by the process in reaction 1. If any carbon monoxide is breathed in, reaction 2 will occur.

Which one of the following statements relevant to this information is **incorrect**?

A. Oxygen is transported to the cells because it is a reactant in cellular respiration.
B. Carbon monoxide gas in the body will cause reaction 1 to move to the reactants.
C. The value of *K* for reaction 2 is very much larger than the value of *K* for reaction 1.
D. CO gas is a catalyst for the reverse reaction in reaction 1, ensuring Hb_4O_8 dissociates.

Question 28

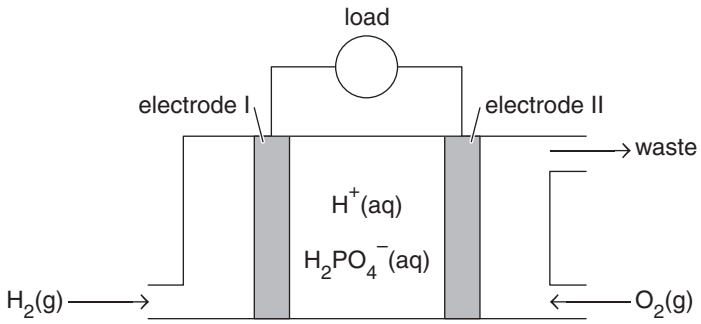
The artificial sweetener aspartame is a methyl ester of the dipeptide Asp-Phe. Sucrose is a disaccharide formed from glucose and fructose.

Which one of the following is correct?

	General type of reaction used in the formation of aspartame and sucrose molecules	Number of functional groups common to sucrose and aspartame molecules
A.	same	less than 3
B.	same	3 or more
C.	different	less than 3
D.	different	3 or more

Use the following information to answer Questions 29 and 30.

The design of the phosphoric-acid fuel cell (PAFC) is detailed in the diagram below.



Question 29

Which of the following correctly identifies the reactant, electrode polarity and type, and the product produced at the electrode during operation of the fuel cell?

A. Hydrogen reacts to produce water at the negatively charged anode.
B. Hydrogen reacts to produce water at the positively charged anode.
C. Oxygen reacts to produce water at the negatively charged cathode.
D. Oxygen reacts to produce water at the positively charged cathode.

Question 30

Consider the following statements about the PAFC.

I For a set mass of hydrogen gas, the PAFC produces the same amount of electrical energy as the combustion reaction would produce as heat energy.

II Like galvanic cells which have a gaseous reactant, the electrodes in the PAFC must be porous and catalytic.

III A significant disadvantage in the operation of the PAFC is the generation of major greenhouse gases as unwanted products.

Which of these statements are correct?

A. I and II only
B. II and III only
C. I, II and III
D. none of I, II or III

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using black or blue pen.

Give simplified answers to all numerical questions, with an appropriate number of significant figures; unsimplified answers will not be given full marks.

Show all working in your answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working.

Ensure chemical equations are balanced and that the formulas for individual substances include an indication of state, for example, $H_2(g)$, NaCl(s).

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

Question 1 (6 marks)

a. The structures of vitamin C and vitamin D are shown in the Data Booklet. You may need to refer to these diagrams when answering the following questions.

Outline why vitamin C is a water-soluble compound whereas vitamin D is fat-soluble. 2 marks

_____

_____

_____

_____

_____

_____

b. Foods containing fats and oils are prone to 'oxidative rancidity'. Vitamin C can be used as a food additive which slows the rate of this oxidative rancidity.

i. Explain what is meant by 'oxidative rancidity'? 2 marks

_____

_____

_____

_____

_____

ii. Outline how vitamin C slows the rate of oxidative rancidity. 2 marks

_____

_____

_____

_____

_____

Question 2 (10 marks)

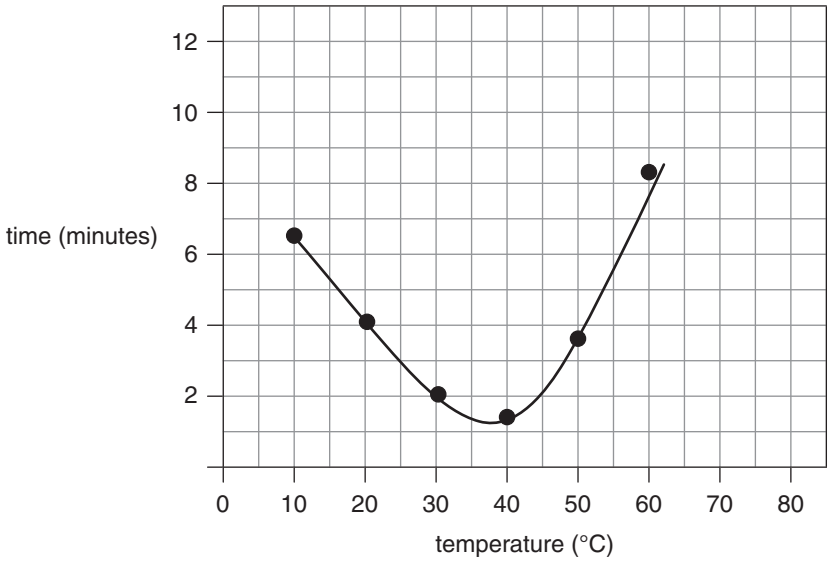
Rennin is an enzyme which causes a major protein in cow's milk to solidify. Tablets of rennin are available for use in food preparation. A student conducted an experiment to determine the effect of temperature on the activity of rennin. The following procedure was used.

1. Each of two rennin tablets was dissolved separately in 5.0 mL of pure water to produce two enzyme solutions.
2. Each 20.0 mL sample of milk in a separate beaker was heated or cooled to a particular temperature.
3. Once the temperature was reached, the beaker was placed on the bench and 1.0 mL of enzyme solution was gently stirred into the milk.
4. The time taken for the milk to solidify was recorded.

The results of the experiment are shown in the table below, together with a graph of the data.

Beaker	1	2	3	4	5	6	7	8
Temperature of milk (°C)	10	20	30	40	50	60	70	80
Time taken for milk to solidify (minutes)	6.5	4.0	2.0	1.4	3.6	8.2	no solid formed*	no solid formed*

*No solid formed within fifteen minutes after adding the enzyme.



a. Suggest two changes which could be made to improve the procedure in the investigation. 2 marks

_____

_____

_____

_____

_____

b. Based on the experimental results, what is the optimum temperature for the activity of the enzyme rennin? 1 mark

_____

c. The student made the following statements in the discussion section of the report on the investigation. Assess each statement, identifying any errors which appear.

i. Statement 1: 1 mark

The milk took so long to solidify at 10°C because the active site of the enzyme was disrupted.

_____

_____

_____

_____

ii. Statement 2: 2 marks

The milk solidifies because all milk protein is denatured by alteration of its primary, secondary and tertiary structures.

_____

_____

_____

_____

_____

iii. Statement 3: 2 marks

If the contents of beaker 8 were returned to 40°C, solidification of the milk would occur quickly.

_____

_____

_____

_____

_____

d. Another student suggested that if the original experiment had used low-fat milk in beakers 1, 3, 5 and 7 and high-calcium milk in beakers 2, 4, 6 and 8 instead of normal milk, the results would generate much more information.

Critically evaluate this suggestion. 2 marks

_____

_____

_____

_____

_____

_____

Question 3 (13 marks)

a. A bomb calorimeter was calibrated by burning 1.25 g of benzoic acid in excess oxygen.

$$2C_7H_6O_2(s) + 15O_2(g) \rightarrow 14CO_2(g) + 6H_2O(l) \quad \Delta H = -6526 \text{ kJ mol}^{-1}$$

The temperature changed from 19.74°C to 24.19°C.

i. Explain why excess oxygen was used in the calibration. 1 mark

_____

_____

ii. Calculate the amount of heat energy released during the combustion. 2 marks

_____

_____

_____

_____

iii. Show that the calibration factor for the calorimeter is 7.51 kJ $°C^{-1}$. 1 mark

_____

_____

b. A high-energy snack bar has the following percentage composition by mass of the main food groups.

Carbohydrate		**Fat**		**Protein**
sugars and starches	cellulose	saturated	unsaturated	10.6
74.2	9.78	2.29	0.27	

i. 1.47 g of the snack bar was burnt in excess oxygen in the same calorimeter (as calibrated in **part a.**) producing a change in temperature of 3.36°C.

Calculate the energy content (in kJ g^{-1}) of the sample of the snack bar. 2 marks

_____

_____

_____

ii. Researchers have calculated that the energy from the snack bar which is available for the human body to use is more than 10% lower than the amount determined by calorimetry.

Explain the most likely reason for this difference. 2 marks

_____

_____

_____

_____

c. One component of the snack bar is glucose ($C_6H_{12}O_6$, M = 180.0 g mol^{-1}) which is the primary energy source in the human body. The chemical energy in glucose is released by cellular respiration, with every gram of glucose oxidised producing 15.57 kJ.

Write the thermochemical equation (using kJ mol^{-1}) for cellular respiration. 3 marks

_____

_____

_____

_____

d. One of the amino acids which compose the protein in the energy bar is valine.

i. Why is valine classified as a 2-amino acid? 1 mark

_____

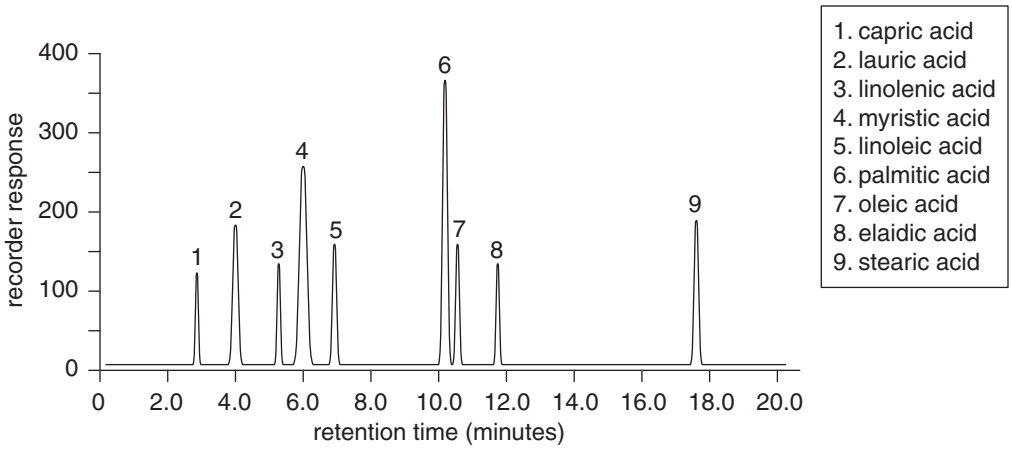
_____

ii. Give the systematic chemical name for valine. 1 mark

_____

Question 4 (11 marks)

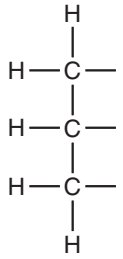
Analysis of a standard mixture of nine fatty acids by high-performance liquid chromatography (HPLC) produced the output shown below.



a. **i.** Give the formula of a fatty acid from the analysis which is saturated. 1 mark

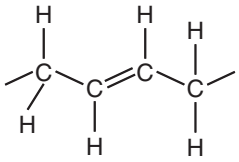
_____

ii. Using the molecular formula for the fatty acid hydrocarbon chain, complete the structure of a triglyceride which would form when linolenic acid is reacted with glycerol. Circle and name one of the functional groups formed. 2 marks



Elaidic acid is known as a trans-fatty acid, whereas its isomer, oleic acid, is known as a cis-fatty acid. Each of these compounds has one double bond at the ninth carbon in the chain.

A section of a fatty acid chain with the double bond on the ninth carbon is shown below.



b. **i.** Explain whether this section is from elaidic acid or oleic acid. 1 mark

_____

_____

ii. Draw the arrangement of the same atoms and bonds in the other fatty acid isomer. 1 mark

c. Elaidic acid is formed as an unwanted product when a polyunsaturated fatty acid is reacted with hydrogen gas. This hydrogenation reaction produces mostly the desired product, oleic acid.

i. Give the formula of a polyunsaturated fatty acid which could be used as a reactant in this hydrogenation reaction. 1 mark

_____

ii. Using structure and bonding, explain how and why the melting point of the polyunsaturated fatty acid will change after it has been hydrogenated to produce oleic acid. 3 marks

_____

_____

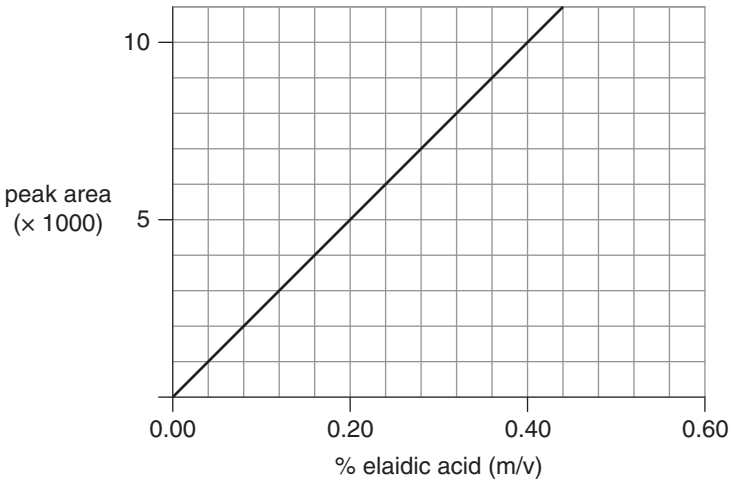
_____

_____

_____

_____

d. Elaidic acid has been shown to be a likely factor in the development of heart disease and so its presence in food is strictly controlled. Using the original column under identical conditions, HPLC was used to determine the amount of elaidic acid in samples of a margarine using the following calibration graph of standard solutions of elaidic acid.



To analyse a sample by HPLC, 0.50 g of margarine was dissolved in 10.0 mL of acetone and 10 μL was used as the injection volume (1 μL = 10^{-6} L). The area under the peak of elaidic acid when a sample of margarine was analysed by HPLC under identical conditions was 8150 units.

Determine the mass of elaidic acid in 0.50 g of the margarine. 2 marks

_____

_____

_____

_____

Question 5 (11 marks)

A chemical reactioncan be used to manufacture hydrogen cyanide gas. The equation for this reaction is

$$2CO(g) + NH_3(g) \rightleftharpoons HCN(g) + CO_2(g) + H_2(g) \quad \Delta H = +10 \text{ kJ mol}^{-1}$$

This process is sustainable because the reactants can be produced from renewable resources such as bioethanol.

a. Carbon monoxide is formed from the incomplete combustion of bioethanol.

Write a balanced chemical equation for the formation of carbon monoxide from bioethanol. 1 mark

_____

b. Using collision theory, explain the effect on the rate of production of HCN for each the following conditions.

i. using high temperatures (above 700°C) 2 marks

_____

_____

_____

_____

ii. using pressures above atmospheric pressure 2 marks

_____

_____

_____

_____

c. Explain the effect on the yield of HCN of including palladium metal (known to absorb hydrogen gas) in the reaction vessel. 2 marks

_____

_____

_____

_____

d. Suggest and explain a reason why the manufacturer is likely to use atmospheric pressure in the production of HCN. 2 marks

_____

_____

_____

_____

_____

e. The most commonly used method for the production of HCN uses methane as a reactant, rather than CO and NH_3.

i. Over many decades, methane has been classified as a non-renewable resource.
Explain why. 1 mark

_____

_____

_____

ii. How can methane now be classified as a renewable resource? 1 mark

_____

_____

_____

Question 6 (10 marks)

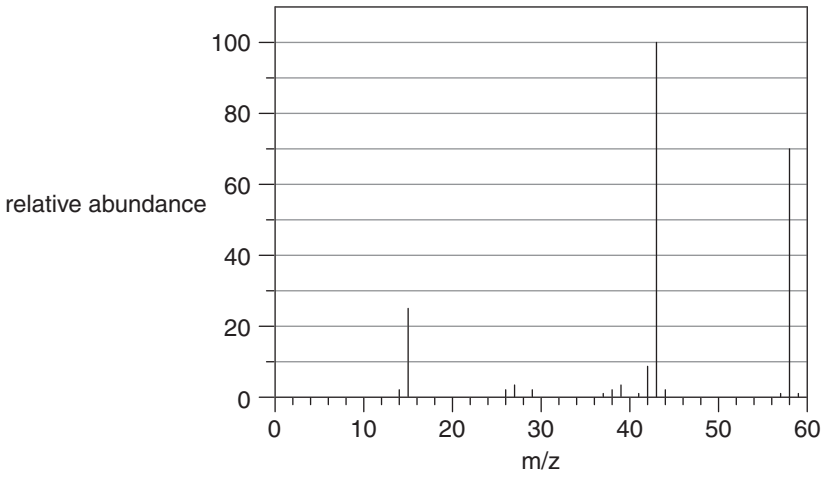
Two organic compounds (I and II) under investigation are known to share the following characteristics.

- each compound is composed of carbon, hydrogen and oxygen atoms
- there are half as many carbon atoms as hydrogen atoms in each molecule
- each compound is a liquid at room temperature

The two organic compounds (I and II) under investigation are also known to have the following characteristics.

- Compound I produces a neutral solution, while a solution of compound II is mildly acidic.

The mass spectrum of compound I is shown below.



a. **i.** The m/z of the molecular ion is 58.
What information does this reveal about compound I? 1 mark

_____

ii. Explain the occurrence of the very small peak at m/z = 59. 1 mark

_____

_____

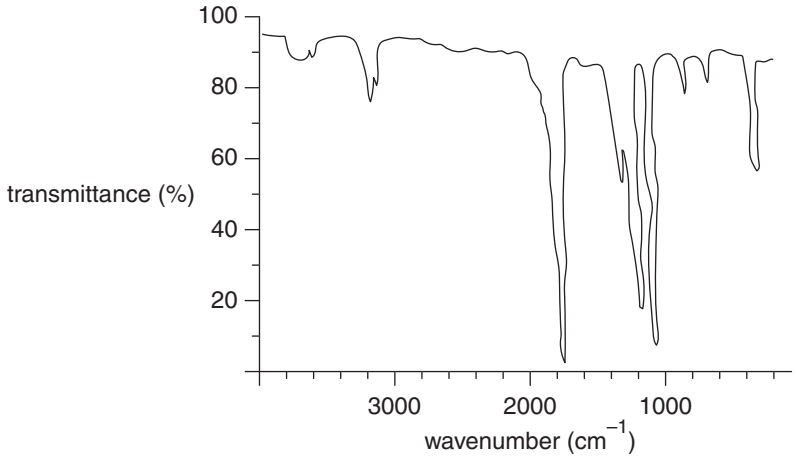
iii. Write the molecular formula of compound I. 1 mark

_____

iv. Write the formula of the chemical entity that produced the peak at m/z = 43. 1 mark

_____

b. The infrared spectrum of compound I is shown below.



i. It is known that compound I is not acidic.
Outline how this fact is confirmed by the infrared spectrum. 1 mark

_____

_____

ii. When subjected to mild oxidising conditions, compound I shows no reaction.
Draw the structure of compound I. 1 mark

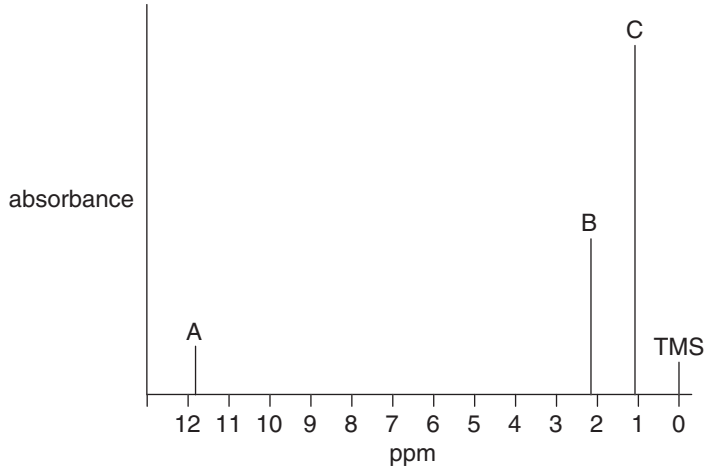
c. An isomer of compound I can be oxidised using an acidified solution of potassium permanganate ($KMnO_4$) to form compound II. The manganese ion (Mn^{2+}) is also a product.

i. Draw a structural formula for compound II. 1 mark

ii. Write a balanced ionic reduction half-equation for the reaction to form compound II. 1 mark

_____

d. The low-resolution proton NMR spectrum of compound II is shown below.



i. Complete the following to show the numerical ratio of the areas under the peaks. 1 mark

peak A : peak B : peak C = _____ : _____ : _____

ii. In the high resolution proton NMR, each peak could be split into a number of finer peaks.

Give the number of fine peaks for Peak B which would be evident in the high resolution proton NMR spectrum. 1 mark

_____

Question 7 (8 marks)

Both biodiesel and petrodiesel are used as fuels in transport.

a. Canola oil is composed of different triglycerides and can be used to produce biodiesel as shown in the flowchart below.

i. In step 1, the canola oil is heated to produce a chemical reaction.

What type of chemical reaction occurs in step 1? 1 mark

_____

ii. Other than water molecules, name a substance which is present in the aqueous layer after step 3. 1 mark

_____

b. Petrodiesel is derived from crude oil.

i. Outline the process used to extract petrodiesel from crude oil. 2 marks

_____

_____

_____

_____

ii. Name the strongest type of bonding which is disrupted when petrodiesel is extracted from crude oil. 1 mark

_____

c. 0.371 g samples of both biodiesel and petrodiesel were burned separately in excess air.

i. The heat of combustion of petrodiesel was calculated to be 44.0 kJ g^{-1}.

Explain why it is not possible to use the units kJ mol^{-1} for this value. 1 mark

_____

_____

ii. The heat generated by burning the biodiesel sample raised the temperature of 140.0 g of water from 25.0°C to 49.2°C.

Calculate the heat of combustion of biodiesel in kJ g^{-1}. 2 marks

_____

_____

_____

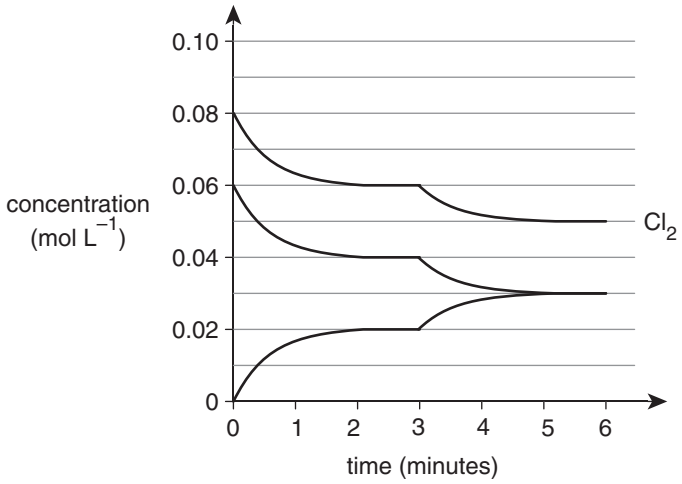
_____

Question 8 (11 marks)

When chlorine gas and carbon monoxide gas were injected into an empty and sealed container, the following reaction occurs:

$$CO(g) + Cl_2(g) \quad COCl_2(g) \quad \Delta H \text{ is negative}$$

The changes in concentration of the gases over time are shown in the graph below.



a. **i.** Write an expression for the equilibrium constant for the reaction. 1 mark

_____

ii. Calculate the value of the equilibrium constant for the reaction when equilibrium was first established. 1 mark

_____

b. There was change made to the temperature of the container at three minutes.

i. Tick **one** box in the grid below to show the change made to the temperature and the effect on the value of the equilibrium constant (K) when equilibrium was established again. 1 mark

	***K* value increased**	***K* value decreased**
Temperature increased		
Temperature decreased		

ii. Using Le Chatelier's principle, explain why the concentration of the gases changed when the temperature change was made. 2 marks

_____

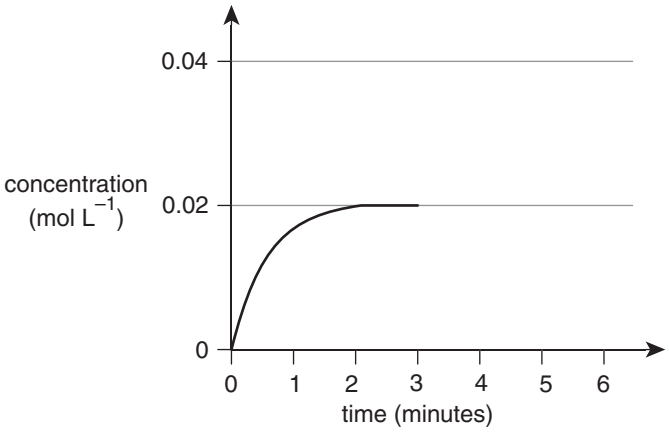
_____

_____

_____

c. The original experiment was repeated under identical conditions except that a catalyst was present in the container.

On the enlarged graph below, sketch the effect of the catalyst on the concentration of $COCl_2$ during the time from zero to three minutes. 2 marks



d. The original experiment was repeated under identical conditions except that at six minutes the volume of the container was doubled instantaneously and held at this new volume, with the temperature kept constant.

Using collision theory and, where appropriate, equilibrium principles, explain why the rate of formation of $COCl_2$

i. is constant between five and six minutes. 1 mark

_____

_____

_____

ii. decreases sharply at six minutes. 1 mark

_____

_____

_____

iii. continues to decrease for some time after six minutes. 2 marks

_____

_____

_____

_____

_____

Question 9 (10 marks)

a. Zinc can be extracted from its ores by heating to high temperatures in air or in the presence of carbon.

I $2ZnS(s) + 3O_2(g) \rightarrow 2ZnO(s) + 2SO_2(g)$

II $2ZnO(s) + C(s) \rightarrow 2Zn(s) + CO_2(g)$

i. By using oxidation numbers, show that reaction I is a redox reaction. 2 marks

_____

_____

ii. Write the balanced reduction half-equation for reaction II. 1 mark

_____

iii. Calculate the volume of carbon dioxide gas, stored at SLC, which would be produced in reaction II using 1.0 tonne (10^6 g) of zinc oxide. 2 marks

_____

_____

_____

b. To extract aluminium from its ore (Al_2O_3) by heating in the presence of carbon would require temperatures over 3700°C. Instead, aluminium is produced in an electrolytic cell using a molten electrolyte of aluminium oxide dissolved in cryolite (Na_3AlF_6). Cryolite allows Al_2O_3 to be molten at temperatures below 1000°C. The overall cell reaction is shown by the following equation:

III $2Al_2O_3(\text{in cryolite}) + 3C(s) \rightarrow 4Al(l) + 3CO_2(g)$

i. Calculate the mass of aluminium produced if the electrolytic cell operates at 150 000 A and 5.00 V for 24 hours. 3 marks

_____

_____

_____

_____

ii. State one assumption made in the calculations in **part b. i.** 1 mark

_____

_____

iii. Explain why the addition of the Na^+ ion to the molten electrolyte is predicted not to interfere with the reduction of the Al^{3+} ion to produce Al. 1 mark

_____

_____

END OF QUESTION AND ANSWER BOOKLET

