CHEMISTRY UNITS 3&4

Edrolo

2020 Practice Exam

(including fully-worked answers for every question!)

ABOUT THIS RESOURCE

Our VCE Chemistry Practice Exam is written by our experienced textbook authors and VCE teachers.

- The exam consists of questions worth 120 marks, in exactly the same format as the VCE exam.
- The questions have been designed and written to simulate the experience of sitting a VCAA-style exam.
- Included is a full answer section with exemplar answers and checklists to guide students on how to produce a high-scoring answer.
- All questions are tailored to the study design updates for 2020.

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DATE: ________________________

STUDENT NAME: ____

TEACHER NAME: ____

CHEMISTRY

Practice written examination

Duration: 15 minutes reading time, 2 hrs 30 minutes writing time

QUESTION AND ANSWER BOOK

Structure of book

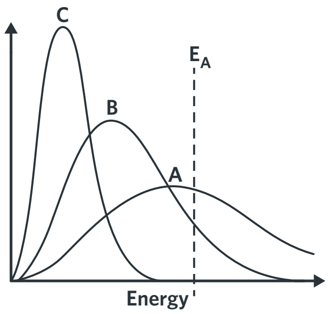
Section	Number of questions	Number of marks
A	30	30
B	10	90
		Total 120

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 question book are **not** drawn to scale.

Question 1

A reaction was subjected to three different conditions, resulting in the Maxwell-Boltzmann distribution shown.



Which of the following statements about the curve is most likely to be correct?

A The reaction resulting in curve A contains the greatest number of particles.

B The independent variable of the experiment is temperature.

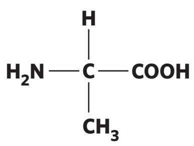
C The reaction resulting in curve B will have the highest yield.

D All particles in curve C will be converted to products.

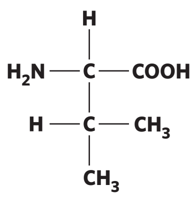
Question 2

The proteins in the human body are predominately made from α-amino acids. Based on this description, which of the following amino acids is **least likely** to be found in the human body?

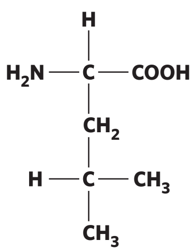
A



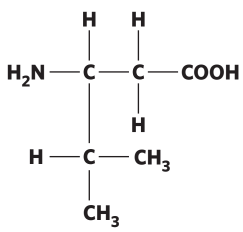
B



C



D



Question 3

A titration experiment was performed by preparing a 500 mL 0.100 M solution of sodium carbonate. An aliquot of 25.00 mL was then pipetted into a conical flask and titrated against an unknown concentration of hydrochloric acid. Which of the following would cause an overestimation of the concentration of HCl?

A Washing the conical flask with de-ionised water.

B The use of a 20.00 mL pipette instead of a 25.00 mL pipette.

C The use of a 0.200 mol L^{-1} solution of sodium carbonate.

D Pre-washing the burette with de-ionised water.

Question 4

A triglyceride consists of three stearic acid residues. Calculate the molar mass of this triglyceride.

M_r(stearic acid) = 284.0 g mol^{-1}.

A 944.0 g mol^{-1}

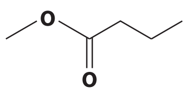
B 890.0 g mol^{-1}

C 872.0 g mol^{-1}

D 793.0 g mol^{-1}

Question 5

Determine the molecular formula for the molecule shown.



A $C_5H_{10}O_2$

B $C_3H_6O_2$

C $C_4H_6O_2$

D $C_6H_8O_2$

Question 6

Three different electrolytic cells were set up involving platinum electrodes. Each cell contained 1.50 L of either molten $Cu(NO_3)_2$, $Fe(NO_3)_3$ or KNO_3. Over 15 minutes, a charge of 48,250 C was applied to each electrolytic cell.

Which of the following shows the mass of metal that would be produced at the cathode?

	m(Cu)	*m*(Fe)	*m*(K)
A	4.8×10^2 g	2.3×10^2 g	2.9×10^2 g
B	64 g	84 g	20 g
C	16 g	9.3 g	20 g
D	21 g	53 g	14 g

Question 7

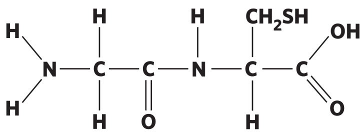
Which of the following statements regarding the molecule shown is true?

I It is a tripeptide.

II In an acidic solution, the molecule exists as a negative ion.

III It contains cysteine.

IV A water molecule was released during the formation of the molecule.



A I and II only

B II and III only

C III and IV only

D I and IV only

Question 8

Calculate the total energy released from a combustion engine operating at 85.0% efficiency when 212 g of liquid octane is added in the presence of excess oxygen?

A 1.02×10^4 kJ

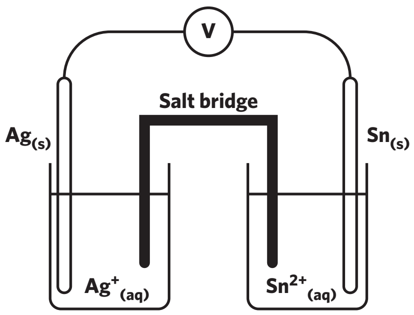
B 8.63×10^3 kJ

C 8.12×10^4 kJ

D 2.11×10^3 kJ

Question 9

An electrochemical cell was set up under standard conditions as shown.

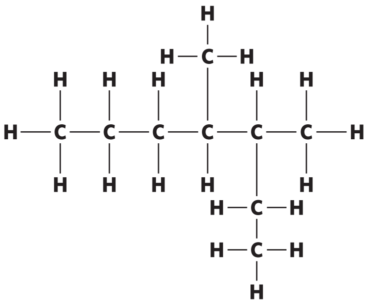


As the cell discharges, which of the following is correct?

	The positive electrode is	From the salt bridge
A	$Ag_{(s)}$	cations would flow towards the Ag^+/Ag half cell.
B	$Ag_{(s)}$	cations would flow towards the Sn^{2+}/Sn half cell.
C	$Sn_{(s)}$	anions would flow towards the Sn^{2+}/Sn half cell.
D	$Sn_{(s)}$	cations would flow towards the Ag^+/Ag half cell.

Question 10

Identify the number of peaks that would be seen in the spectrum of a low-resolution ^{1}H NMR of the molecule shown.



A 6

B 7

C 8

D 9

Question 11

A student used a sample of ethanol to increase the temperature of 100 mL of water from 25.0°C to 46.1°C. The mass, in g, of ethanol used is closest to

A 0.879 g.

B 0.297g.

C 0.594 g.

D 0.311 g.

Question 12

A calorimeter was calibrated using an external power source. A potential difference of 3.0 V was applied for three minutes using a current of 1.2 A. The thermometer showed a temperature change of 3.21°C.

The calibration factor for this calorimeter is closest to

A 7.0×10^2 J°C^{-1}.

B 2.2×10^2 J°C^{-1}.

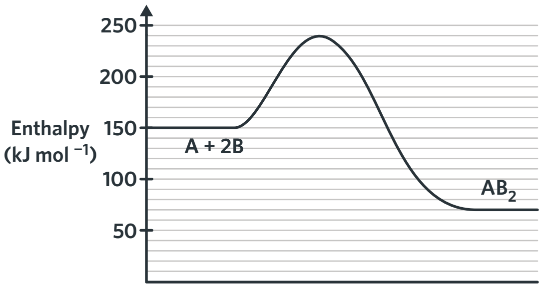
C 11 J°C^{-1}.

D 3.4 J°C^{-1}.

Question 13

The energy profile diagram for the following reaction is shown:

$A + 2B \rightarrow AB_2$



The E_a of the reaction below is

$\frac{1}{2}AB_2 \rightarrow B + \frac{1}{2}A$

A 70 kJ mol^{-1}.

B 240 kJ mol^{-1}.

C 85 kJ mol^{-1}.

D 150 kJ mol^{-1}.

Use the following information to answer Questions 14 and 15.

The Haber process produces an ammonia through a reaction between nitrogen and hydrogen as shown.

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ $\Delta H = -22.4$ kJ mol^{-1}

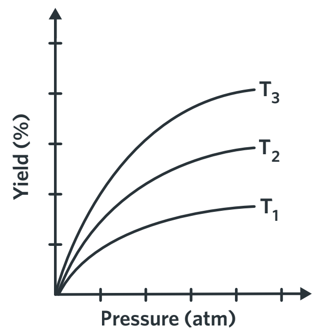
Question 14

At the start of the reaction, 2.0 mol of $N_{2(g)}$ and 1.5 mol of $H_{2(g)}$ was added to a 2.0 L vessel and allowed to reach equilibrium. At equilibrium, 1.15 mol of $H_{2(g)}$ remained. At equilibrium,

	$[N_2]$	$[H_2]$	$[NH_3]$
A	0.19	0.58	0.39
B	1.7	1.2	0.35
C	1.9	1.2	0.23
D	0.94	0.58	0.12

Question 15

The amount of ammonia produced in this process can be affected by changes in temperature and pressure through changing the volume of the vessel.



Based on the graph, the temperatures of T_1, T_2 and T_3 are

A $T_3 > T_2 > T_1$.

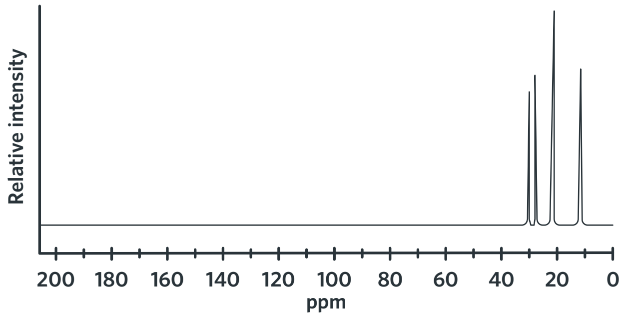
B $T_3 = T_2 = T_1$.

C $T_1 > T_2 > T_3$.

D $T_2 > T_1 > T_3$.

Question 16

The ^{13}C NMR shown is most likely to belong to



A $CH_3CH_2CH_2CH_3$.

B $CH_2CH_2CH_3$.

C $CH_3CH_2CH_2CH_2CH_3$.

D $CH_3CH(CH_3)CH_2CH_3$.

Question 17

Two containers of identical volume contained two different gases at standard laboratory conditions (SLC). It was found that 0.250 g of N_2 was present in one container and that the other container had 0.286 g of an unknown gas. The gas in the second container is

A O_2.

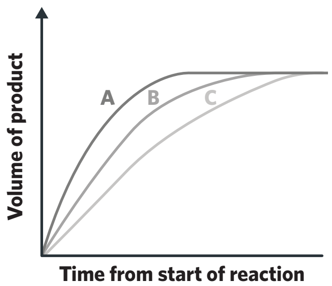
B H_2.

C SO_2.

D CH_4.

Question 18

A sample of solid zinc was left to react with hydrochloric acid in a closed vessel under different conditions. The progress of each different reaction is shown.



Compared to reaction A, reaction C

A occured at a lower temperature.

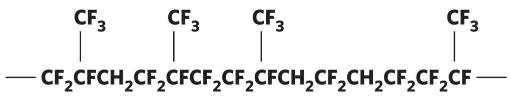
B had a higher concentration of hydrochloric acid.

C involved a catalyst whereas reaction A did not.

D involved a reaction with powdered zinc whereas reaction A used a block of solid zinc.

Question 19

The number of different monomers found in the polymer chain shown below is:



A 5

B 4

C 3

D 2

Question 20

Hydrogen gas and iodide are pumped into a closed vessel, resulting in the following reaction.

$H_{2(g)} + I_{2(g)} \rightarrow 2HI_{(g)}$ where $K_{eq} = 64$ at 440°C

At a temperature of 489°C, the equilibrium constant for this reaction is 46. This suggests that

A the production of hydrogen iodide is an exothermic process.

B the production of hydrogen iodide is an endothermic process.

C the backwards reaction is favoured with a decrease in temperature.

D the forward reaction would be favoured if the volume of the vessel is halved.

Question 21

Some machinery that use fuels operate under high temperatures. For safety reasons, engineers minimize the amount of vapor available that can undergo ignition in air.
The fuel best suited in this situation is:

	Flashpoint (°C)	**Cloud point (°C)**	**Autoignition temperature (°C)**
Petrodiesel	55	−22	280
E10	28	8	312
Biodiesel	130	−5.0	427
LPG	−104	−3.0	400

A Petrodiesel

B E10

C Biodiesel

D LPG

Question 22

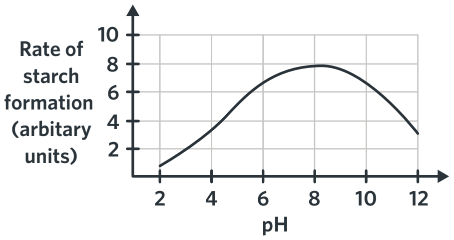
Different analytical techniques help to determine certain characteristics of the structure of organic compounds. Which of the following combinations of techniques would be most useful for determining the structure of a single compound derived from petroleum?

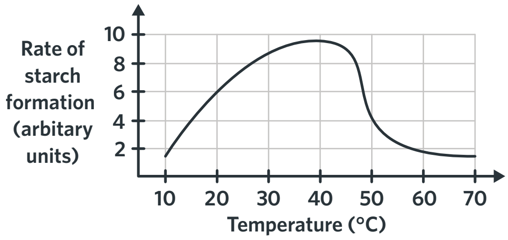
A	HPLC	IR
B	IR	^{1}H NMR
C	^{1}H NMR	HPLC
D	^{13}C NMR	^{1}H NMR

Use the following information for Questions 23 and 24

Due to their specificity, different enzymes are responsible for catalysing different reactions. Starch phosphorylase for example, is responsible for the formation of starch from glucose.

In an experiment, students wanted to see the effect of different environments on the function of starch phosphorylase. The results of the experiment are shown.





Question 23

At a temperature of 12°C

A the hydrogen bonds in the tertiary structure of starch phosphorylase have broken.

B starch phosphorylase has been denatured.

C not all of the starch phosphorylase present has formed a complex with starch.

D starch phosphorylase is inactive.

Question 24

The optimal environment for starch phosphorylase function is at

A 60°C in a highly basic environment.

B 37°C in a slightly alkaline environment.

C 30°C in a slightly acidic environment.

D 10°C in an acidic environment.

Question 25

Gas heaters are common in households and often use methane as the fuel source. One of the biggest concerns with these heaters is the fact that inefficiencies can result in incomplete combustion, which can often result in serious health effects. Which of the following statements highlights the dangers of inefficient gas heaters?

I The high production of carbon dioxide.

II The K value for the interaction between haemoglobin and oxygen is higher than the K value for the interaction between haemoglobin and carbon monoxide.

III The K value for the interaction between haemoglobin and carbon monoxide is higher than the K value for the interaction between haemoglobin and oxygen.

IV At similar concentrations, carbon monoxide is preferentially bound to haemoglobin compared to oxygen.

A I & IV only

B I & III only

C II & III only

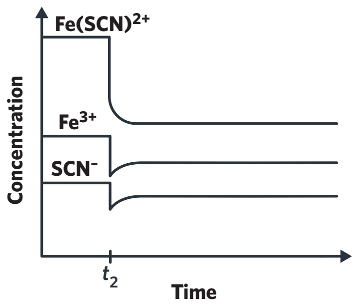
D III & IV only

Question 26

Consider the reaction

$Fe^{3+}_{(aq)} + SCN^{-}_{(aq)} \rightleftharpoons Fe(SCN)^{2+}_{(aq)}$

A change was made to the equilibrium mixture, resulting in the graph shown.



The change was most likely

A halving the volume of the reaction mixture.

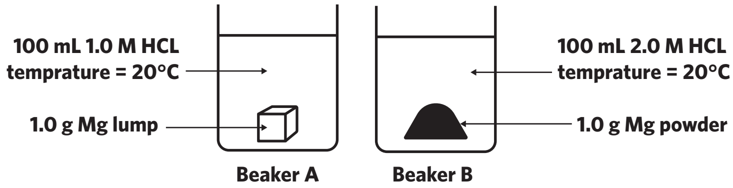
B the removal of some product.

C an increase in pressure.

D the addition of water.

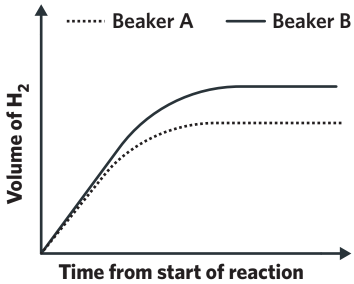
Question 27

A student wanted to test the effect of surface area on the rate of reactions. The experimental setup is shown.

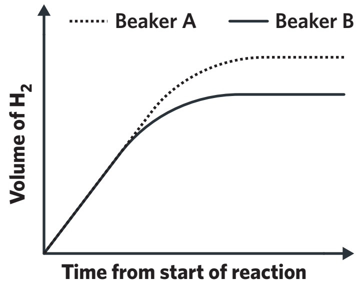


Which of the following is the most accurate representation of a comparison of the two reactions?

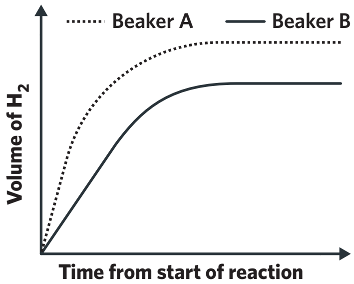
A



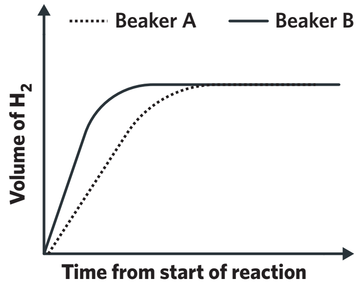
B



C



D



Question 28

The following series of unbalanced reactions were used to produce an organic compound.

Reaction 1: $CH_2CH_2 + H_2 \rightarrow CH_3CH_3$

Reaction 2: $CH_3CH_3 + W \rightarrow CH_3CH_2Br + X$

Reaction 3: $CH_3CH_2Br + NaOH \rightarrow Y + NaBr$

Reaction 4: $Y \xrightarrow{Cr_2O_7^{2-}/H^+} Z$

If in reaction 4, the $Cr_2O_7^{2-}$ was limiting, then which of the following correctly identifies the nature of X, Y and Z?

	X	Y	Z
A	HBr	CH_3CH_2OH	CH_3CHO
B	HBr	CH_3CH_2OH	CH_3COOH
C	H_2	CH_3CH_2OH	CH_3CHO
D	Br_2	CH_3CH_2OH	CH_3COOH

Use the following information for Questions 29 and 30

Iodine solutions are often used to treat wounds. A commercially available 20.00 mL iodine-containing solution was diluted to 250.0 mL. A 20.00 mL aliquot of this diluted solution was titrated against a 0.010 M solution containing thiosulfate to determine the concentration of iodine. The reaction can be represented by the following equation.

$I_{2(aq)} + 2S_2O_3{}^{2-}{}_{(aq)} \rightarrow 2I^-{}_{(aq)} + S_4O_6{}^{2-}{}_{(aq)}$

Question 29

Given that an average titre of 12.70 mL of thiosulfate was used, the concentration (%m/v) of iodine in the original solution is

A 2.1 g/100 mL

B 0.24 g/100 mL

C 1.0 g/100 mL

D 0.79 g/100 mL

Question 30

Following the same procedure, a student conducted the titration experiment until concordant titres were achieved. During the trials, the student washed the burette and conical flask containing the 20.00 mL aliquot with distilled water. Which of the following would occur as a result?

A An accurate calculation of the unknown concentration of iodine.

B A random error resulting in the calculation of a concentration of iodine that is lower concentration than the true value.

C A systematic error resulting in the calculation of a concentration of iodine that is higher than expected.

D The measurement of accurate titres.

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black 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 question book are **not** drawn to scale.

Question 1 (9 MARKS)

The label on a packet of biscuits is shown.

	Per 100g
Protein	3.2 g
Fat	
Saturated	0.79 g
Unsaturated	0.12 g
Carbohydrates	
Starches & sugars	15.0 g
Cellulose	2.9 g
Sodium	102 mg

a Calculate the amount of energy available to the body per gram of biscuit. 2 MARKS

b A student wanted to test the energy content of the biscuit to confirm the advertised nutritional value. A 5.0 g sample of the biscuit was burned in a bomb calorimeter with excess oxygen, raising the temperature in the vessel from 19.7°C to 23.8°C.

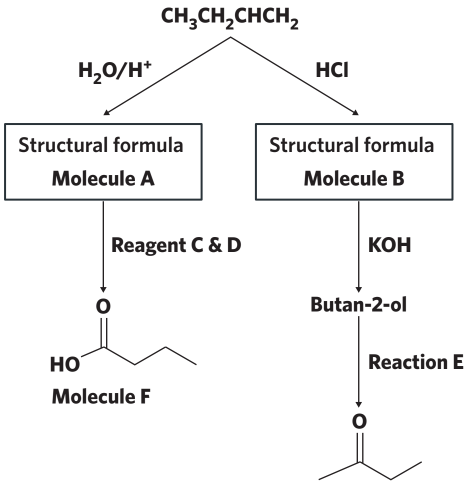
i Given that the calibration factor was determined to be 1711 J°C^{-1}, calculate the energy, in kJ, released per gram of biscuit. 2 MARKS

ii Compare the result from the experimental value and the value calculated in part a. Give a possible explanation for any differences seen. 1 MARK

c Different types of fats have different effects on the body. It was known that the only unsaturated fat present was a triglyceride with three identical unsaturated fatty acid residues and 100 g of the biscuit reacted with 0.1308 g of bromine gas. The molar mass of the triglyceride is 879.4 g mol^{-1}. Identify the name of the unsaturated fatty acid present in the triglyceride. 2 MARKS

d The breakdown of fats in the body occurs mostly in the intestines which has a relatively alkaline environment. The process also involves the use of the enzyme lipase. Explain why the breakdown of fats is unable to occur in the stomach. 2 MARKS

Question 2 (6 MARKS)



a Draw the structural formula for molecules A and B. 2 MARKS

b Give the name for reaction E. 1 MARK

___

c Reagent C & D can be used to produce two different types of organic compounds. Identify the names of reagent C & D and describe the conditions that would result in the production of molecule F. 3 MARKS

___

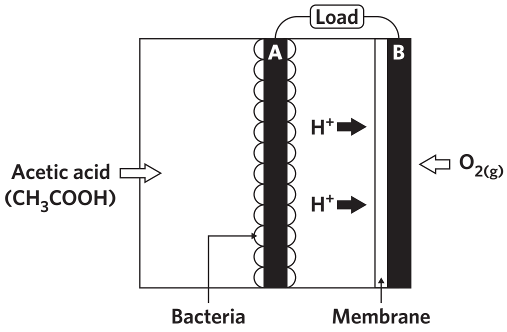
___

___

___

Question 3 (7 MARKS)

As the need for energy increases, fuel cells are continually being developed. A newly developed fuel cell known as the microbial fuel cell involves the use of bacteria to break down acetic acid (CH_3COOH) into carbon dioxide. The result of the bacterial breakdown can then be used by the cell to convert chemical energy into electrical energy.



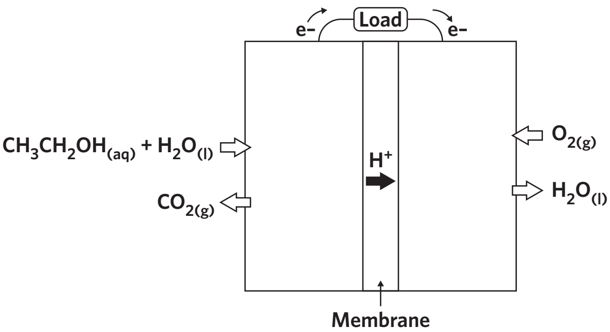
a Write the balanced half-equation for the reaction occurring during the bacterial breakdown of acetic acid (states not required). 1 MARK

____

b Identify which of the electrodes are acting as the anode and cathode. 1 MARK

____

Unlike the microbial fuel cell, direct ethanol fuel cells (DEFC) use ethanol as the fuel source. A diagram of the DEFC is shown.



c Write the half equation occurring at the anode. 1 MARK

____

d Ethanol can be produced from a variety of different methods, one of which involves the oxidation of glucose, $C_6H_{12}O_6$ in sugar cane in the presence of yeast.

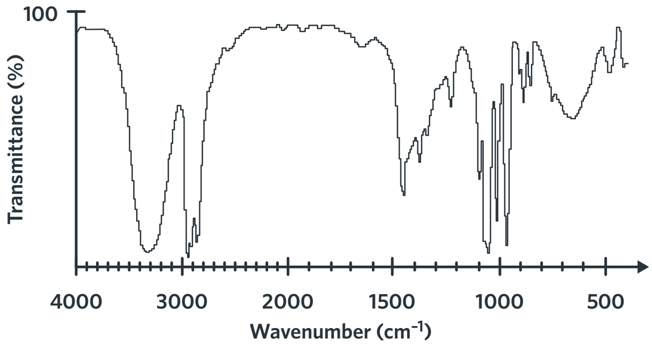
i Write a balanced equation to represent this reaction. 1 MARK

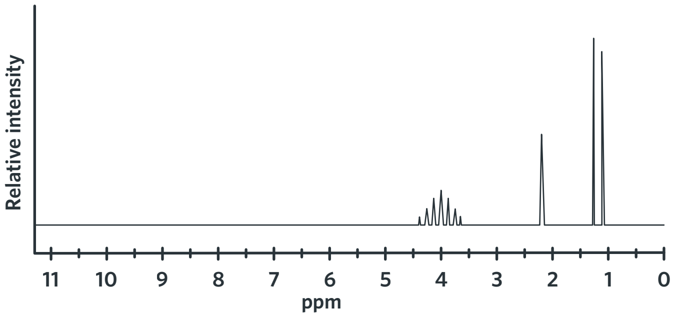
ii Compare the impact of the use of fossil fuels and biofuels on the level of CO_2 in the atmosphere. 2 MARKS

iii Identify one disadvantage of using ethanol produced in this manner for the generation of large amounts of electricity. 1 MARK

Question 4 (9 MARKS)

The empirical formula of an unknown compound is C_3H_8O. The IR and ^1H NMR spectra of the molecule are shown.





^1H NMR Data

Chemical shift (ppm)	Peak splitting
1.3	Doublet
2.2	Singlet
4.1	Septet

a Identify the number of different hydrogen environments that are present in this compound. 1 MARK

b Identify the name of the functional group(s) present in the compound. Justify your response. 2 MARKS

c The oxidation of this compound results in the production of a molecule that does not react with bases. Draw the skeletal structure of this compound and identify its name. 2 MARKS

d How many peaks would be present on a ^{13}CNMR spectrum for this compound? Explain. 2 MARKS

____

____

____

e An isomer of this compound was allowed to react with acetic acid (CH_3COOH) in the presence of sulfuric acid.

i Name the compounds produced as part of this reaction. 1 MARK

____

ii A catalyst used during the above reaction has the following MSDS (Material Safety Data Sheet) information:

Signal Words: Danger
Hazard statement(s):
H290: May be corrosive to metals.
H314: Causes severe skin burns and eye damage

Identify two safety precautions that need to be taken when handling this substance. 1 MARK

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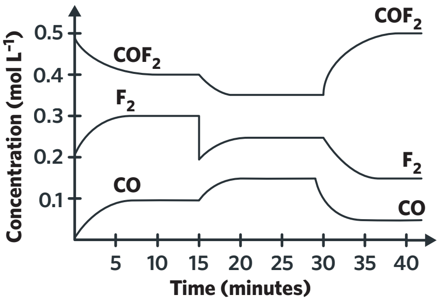
Question 5 (9 MARKS)

Carbon oxyfluoride can be formed as a result of a reaction between carbon monoxide and fluorine gas as shown in the equation:

$CO_{(g)} + F_{2(g)} \rightleftharpoons COF_{2(g)}$

An experiment was conducted to measure the changes in concentration of carbon monoxide over time. The reaction was allowed to take place in a 1.5 L sealed vessel. The results can be seen below.



a Determine the equilibrium constant when the reaction first reached equilibrium. 1 MARK

b Describe the change that occurred to the system at t = 15 minutes and the impact this had on the reaction. 2 MARKS

c After the second equilibrium was established, scientists wanted to test the effects of a change in temperature on the production of COF_2. To do so, scientists increased the temperature of the vessel. State whether the forward reaction is exothermic or endothermic. Justify your answer by referring to the results. 2 MARKS

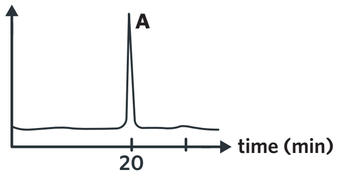
d As part of the experiment, the scientists also conducted tests to determine the effect of changing other variables on the extent of the reaction. In the table below, indicate the effect of changing volume and the addition of a catalyst on the production of COF_2. 4 MARKS

Change	**Direction of the reaction favoured**	**Explanation**
The volume was halved		
Catalyst was added		

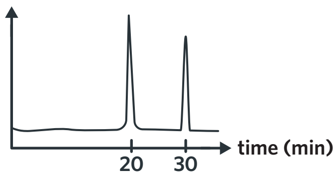
Question 6 (8 MARKS)

Energy drinks are known to contain a variety of different ingredients that are said to increase alertness. One of the main ingredients that results in an increased alertness is caffeine. The average concentration of caffeine in an energy drink is approximately 0.32 mg/L, similar to that of a cup of coffee.

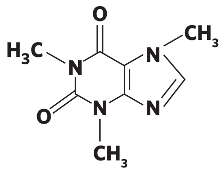
An unknown energy drink was tested to determine the concentration of caffeine using HPLC. The results of the test are shown.



Chromatogram of a pure caffine smaple



Chromatogram of a drink sample



Caffeine molecule

a Identify whether the drink sample contains caffeine and justify your answer using the data obtained. 2 MARKS

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b A non-polar compound of similar size to caffeine was also known to be found in this drink.

i Based on this information, determine the polarity of the stationary phase used. 1 MARK

____

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ii In a follow up experiment, the experimenters increased the temperature in the column. Identify the effect that this change would have on the results of the test. 1 MARK

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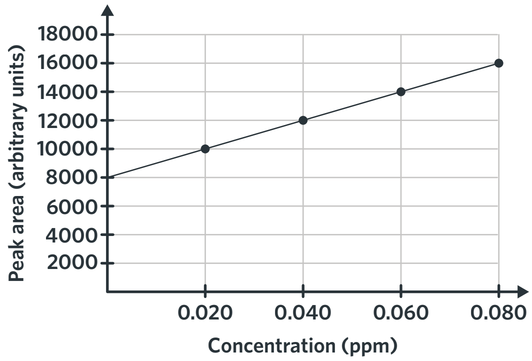
c To determine the concentration of caffeine in the drink, the experimenters developed a calibration curve as shown.



i Considering the peak area of caffeine in the sample had a peak area of 11 050, determine the molarity of caffeine in the drink. (Molar mass of caffeine = 194.2 g mol^{-1}). 3 MARKS

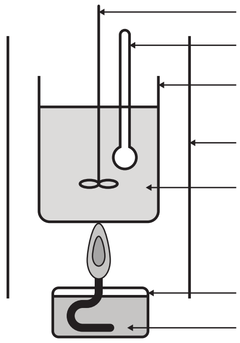
ii Compare the concentration of caffeine in this sample with the average concentration of caffeine in energy drinks. 1 MARK

Question 7 (8 MARKS)

As part of an assignment, a group of chemistry students conducted an experiment to compare the energy content of two different fuels; olive oil and methanol.

Olive oil is a triglyceride consisting of three main fatty acids: oleic acid, linoleic acid and palmitic acid and is derived from olive trees. In contrast, methanol is mainly produced through fossil fuels.

Diagram



Results

	Olive oil	Methanol
Mass of water (g)	150.00	150.00
Mass of spirit burner (g)	23.30	22.87
Mass of spirit burner & fuel (g) before heating	26.94	27.41
Mass of spirit burner & fuel (g) after heating	25.63	25.89
Initial temperature (°C)	17.5	20.1
Final temperature (°C)	66.8	53.8

a Calculate the experimental energy content of olive oil in kJ g^{-1}. 2 MARKS

b State the reason why the energy content of olive oil is expressed in kJ g^{-1}? 1 MARK

c Calculate the experimental energy content of methanol. Give your answer in kJ g^{-1}. 2 MARKS

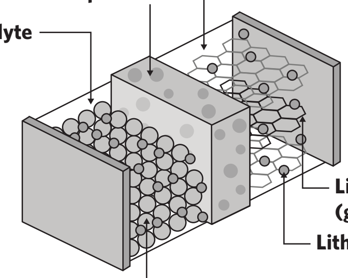
d Both of the fuels tested are quite different in both their origin and structure. Which fuel source would you expect to have a higher boiling point? Justify your answer with reference to the structure of both compounds. 2 MARKS

e Using the known heat of combustion for methanol, determine the percentage energy loss into the surrounding environment. 1 MARK

$$\text{Percentage energy loss} = \frac{(\textit{theoretical value of energy released} - \textit{experimental value of energy released})}{\textit{theoretical value of energy released}} \times \frac{100}{1}\%$$

Question 8 (9 MARKS)

Lithium-ion batteries are rechargeable batteries often used in portable consumer electronics.
The structure of a lithium battery is shown.



a Identify a key difference between a primary and secondary cell in terms of the energy conversion involved in both cells. 1 MARK

b State the chemical process that occurs at the anode during discharge. 1 MARK

The equation at the cathode during discharge for the lithium-ion battery is:

$CoO_2 + Li^+ + e^- \rightarrow LiCoO_2$

The complete recharge equation is:

$LiCoO_2 + C_6 \rightarrow CoO_2 + LiC_6$

b State the chemical process that occurs at the anode during discharge. 1 MARK

c Write the equation at the anode during discharge. 1 MARK

d Identify the condition that needs to be met in order to recharge a battery. 1 MARK

e These batteries rely on lithium ions flowing through a polymer, rather than an aqueous solution. Why are lithium batteries unable to use aqueous solutions? 2 MARKS

When the battery is overdischarged, solid lithium oxide forms in an irreversible reaction.

$LiCoO_2 + Li^+ + e^- \rightarrow Li_2O + CoO$

f With reference to the above, identify three different factors that affect the battery performance and battery life of the lithium-ion battery. 3 MARKS

Question 9 (16 MARKS)

A student designed an experiment to investigate the kinetic properties of the enzyme lactase which is responsible for the hydrolysis of the disaccharide lactose. The student decided to measure the effect of pH on the enzyme's rate of reaction. The following is an excerpt of the student's poster.

The effect of changing pH on the enzyme lactase's ability to hydrolyse lactose

Aim: To investigate the effect of pH on the ability of lactase to increase the rate of reaction for the hydrolysis of lactose

Method:

Step 1: Rinse 5 test tubes with distilled water and place in a controlled water bath at 20°C.

Step 2: Set up the test tubes as described by the following table:

Tube	pH	Volume of 0.0001M HCl (mL)	Volume of 0.0001M NaOH (mL)	Volume of enzyme solution (mL)	Volume of lactose solution (mL)	Volume of distilled water
1	5	0.800	0	1.00	1	5.20
2	6	0.0800	0	1.00	1	5.92
3	7	0	0	1.00	1	6.00
4	8	0	0.800	1.00	1	5.20
5	9	0	0.0800	1.00	1	5.92

Step 3: For each test tube, record the concentration of glucose after 2 minutes by using a glucose test strip (frequently used for the management of diabetes).

a Identify the dependent and independent variable. 1 MARK

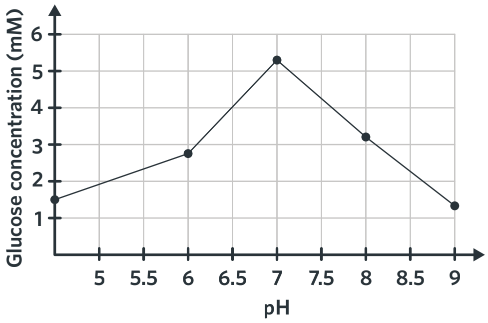
b Why are the test tubes kept at a controlled temperature? 2 MARKS

c When preparing test tube 3, a few extra drops of enzyme solution was accidentally added and lactose is in excess. What type of error is this and how would it affect the results? 2 MARKS

d Why has the student varied the volume of distilled water in this experiment? Justify the purpose of varying the volume of distilled water in this experiment with reference to the variables. 2 MARKS

The student generates the following table of data and graph based on the experimental results.

pH	Glucose concentration (mM)
5	1.5
6	2.7
7	5.4
8	3.1
9	1.2



e The table of results and graph is from one experiment only. Comment on the precision and accuracy of the results. 2 MARKS

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f The average temperature of the body is 37°C. Determine the most likely optimal temperature for the majority of enzymes. Based on enzyme structure and function, explain what happens outside of the optimum temperature. 3 MARKS

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The student is presenting the poster in front of the class and is asked to explain why measuring glucose concentration provides us with information about enzyme activity.

g With reference to the structure of lactose, explain how enzyme activity can be derived from glucose concentration over time. 4 MARKS

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Question 10 (9 MARKS)

Hydrogen has often been regarded as the 'automobile fuel of the future' which will eventually replace more conventional combustion engines. However, its adoption has not been as rapid as predicted.

"Hydrogen is the most abundant element on earth but its adoption in the automotive sector has been very slow. While many automotive manufacturers are experimenting with this technology and pouring millions of dollars into research and development, sceptics are declaring that its mass-market adoption will never happen. One proposed reason is that there is growing consumer demand for electric vehicles because consumers can easily relate to what electricity is, its safety and they can understand how the car works as opposed to a lesser known and more foreign technology. People simply don't know enough information about hydrogen and its benefits. Another reason is a lack of hydrogen infrastructure which is termed the chicken-and-egg dilemma. That is, why would I buy a hydrogen powered car if I can't fuel it anywhere and as a manufacturer, why would I build hydrogen refuelling stations if no hydrogen cars are present on the road? However, hydrogen is certainly the fuel of the future due to its environmentally friendly nature."

a With reference to the article and the chemistry you have studied this year, explain the advantages and disadvantages of hydrogen fuel cells. To what extent do you agree with the statement that 'hydrogen is certainly the fuel of the future'? 5 MARKS

One method of hydrogen production in fuel cells is the electrolysis of water.

"Hydrogen can be obtained from many different sources such as the steam reformation of fossil fuels. However, the cleanest and highest purity hydrogen gas can only be obtained by the electrolysis of water. With respect to renewability and environmental effects, the electrolysis of water is promising because it emits only oxygen as a byproduct and doesn't release any carbon emissions or require the extraction of fossil fuels from the ground. The hydrogen and oxygen produced can then be used in fuel cells and other applications. Although there are many benefits to the production of hydrogen through the electrolysis of water, only 4% of global industrial hydrogen is produced by this method due to economic and technological restraints. "

b With reference to the chemical equations and the article, describe the production of hydrogen from water electrolysis and explain whether it is truly a 'zero-emission' form of hydrogen production. 4 MARKS

END OF QUESTION BOOK

How to check your answers

SECTION A ANSWERS

For each question, the correct multiple choice response is provided and, where helpful, an additional explanation is provided to help students understand if they chose an incorrect answer.

SECTION B ANSWERS

Answers for calculation-based questions

For each calculation-based question, a full mark solution with mark allocations is provided.

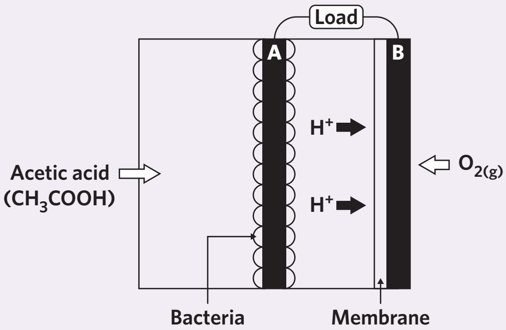
Answers for questions requiring a worded response

For each question requiring a worded response, we provide:

- An **exemplar answer** that demonstrates how a student could respond to get full MARKS. The depth of the answer is derived from the wording of the question, the number of MARKS, and an analysis of examiners' reports from previous VCAA examinations. The answers are written in full sentences to model strong literacy and aid learning, although students may distill their responses into briefer phrases or dot points and still receive full MARKS.
- A **checklist** that identifies the function of each section of the response. This should help students to understand the exemplar answer and to compare it with the unique wording of their own response. The number of checklist items **does not** always correspond to the number of MARKS. There may be more than one checklist item per mark when there are multiple distinct elements required to earn a given mark.

Question 3 (7 MARKS)

As the need for energy increases, fuel cells are continually being developed. A newly developed fuel cell known as the microbial fuel cell involves the use of bacteria to break down acetic acid (CH_3COOH) into carbon dioxide. The result of the bacterial breakdown can then be used by the cell to convert chemical energy into electrical energy.



d Ethanol can be produced from a variety of different methods, one of which involves the oxidation of glucose, $C_6H_{12}O_6$ in sugar cane in the presence of yeast.

iii Identify one disadvantage of using ethanol produced in this manner for the generation of large amounts of electricity. (1 MARK)

Exemplar responses show students what a full mark answer could look like

3 d iii [Growing sugar cane to produce enough ethanol to power large populations could take up a large area of land,[1]] [which may reduce the amount of land available for other agricultural practices.[2]]

Other answers may include:

- Growing crops such as sugar cane requires a large volume of water, which as a result would limit the amount of water available for other purposes.

☐ I have identified a disadvantage of the production of ethanol from sugar cane.[1]

☐ I have identified the impact of this method of ethanol production.[2]

If their answer is different to the exemplar, **other acceptable responses** help students know if they are on the right track

Numbers help students identify which part of the exemplar relates to which checklist item

Checklist items can help students identify 'hidden' marks or develop skills that make their responses more coherent

Bonus questions

Underneath some exemplar answers, there is a box that contains an exam–style question and its corresponding answer. These extra questions are from Edrolo's Year 12 Chemistry textbook, which contains hundreds of exam–style questions, answers, and checklists. The bonus question aims to provide students with an example of a different type of question they may be asked on the same topic.

WANT MORE?

Here's another question to show the theory from a different perspective:

Study design dot point:

- the use of the electrochemical series to explain or predict the products of an electrolysis, including identification of species that are preferentially discharged, balanced half-equations, a balanced ionic equation for the overall cell reaction, and states

Related Edrolo Textbook Lesson 6A pages 192–198

Question 2 (3 MARKS)

Bilbo was in a chemistry class studying redox reactions. He initially had a beaker with a 1.0 M blue solution of $Cu^{2+}_{(aq)}$ ions and accidentally put a strip of $Pb_{(s)}$ in the beaker. His teacher was angry because the class only had a short supply of lead and the following redox reaction occurred:

$Cu^{2+}_{(aq)} + Pb_{(s)} \rightarrow Cu_{(s)} + Pb^{2+}_{(aq)}$

Over time, during the electrolytic reaction, what would be observed with respect to the solution and electrodes?

Answer

2 [Since $Cu^{2+}_{(aq)}$ ions are entering the solution, it will turn a darker blue colour.[1]][Because $Pb^{2+}_{(aq)}$ is being reduced to form $Pb_{(s)}$ at the cathode, a plating of lead metal will appear on the copper electrode.[2]][The anode will appear corroded as $Cu_{(s)}$ is oxidised to form $Cu^{2+}_{(aq)}$ ions.[3]]

- I have described what will be observed in the solution.[1]
- I have described what will be observed at the cathode.[2]
- I have described what will be observed at the anode.[3]

SECTION A – ANSWERS

1 B

2 D. α-amino acids have both the amino and carboxyl group bonded to a central carbon atom.

3 B. Using a 25.00 mL pipette (and thereby a 25.00 mL aliquot) will result in more HCl being required for neutralisation.

4 B

M(triglyceride) $= (284.0 \times 3) + 92 - (18.0 \times 3)$

$= 890.0 \text{ g mol}^{-1}$

5 A

6 C

$n(e^-) = \frac{48250}{96500}$

$= 0.50 \text{ mol}$

$K^+_{(l)} + e^- \rightarrow K_{(l)}$

$m(K) = 0.50 \times 39.1$

$= 20 \text{ g}$

$Cu^{2+}_{(l)} + 2e^- \rightarrow Cu_{(l)}$

$m(Cu) = \frac{0.50}{2} \times 63.5$

$= 16 \text{ g}$

$Fe^{3+}_{(l)} + 3e^- \rightarrow Fe_{(l)}$

$m(Fe) = \frac{0.50}{3} \times 55.8$

$= 9.3 \text{ g}$

7 C

8 B

Theoretical energy released $= 212 \times 47.9$

$= 1.015 \times 10^4 \text{ kJ}$

Actual energy released $= 1.015 \times 10^4 \times \frac{85.0}{100}$

$= 8.63 \times 10^3 \text{ kJ}$

9 A

10 D

11 B

Energy $= 100 \times 0.997 \times 4.18 \times (46.1 - 25.0)$

$= 8.793 \times 10^3 \text{ J}$

$= 8.793 \text{ kJ}$

m(ethanol) $= \frac{8.793}{29.6}$

$= 0.297 \text{ g}$

12 B

$CF = \frac{3.0 \times 1.2 \times (3 \times 60)}{3.21}$

$= 201.9 \text{ J°C}^{-1}$

13 C

$E_{A(\text{reverse})} = \frac{(240 - 70)}{2}$

$= 85 \text{ kJ mol}^{-1}$

14 D

	N_2	$3H_2$	$2NH_3$
I	2.0 mol	1.5 mol	0
C	$-x$	$-3x$	$+2x$
E	2.0 − 0.117 = 1.88 mol $c = \frac{1.88}{2}$ = 0.94 M	1.15 mol $c = \frac{1.15}{2}$ = 0.58 M	2 × 0.117 = 0.234 mol $c = \frac{0.234}{2}$ = 0.12 M

Change in $H_2 = 1.5 - 1.15$

$= 0.35 \text{ mol}$

Therefore $x = \frac{0.35}{3}$

$= 0.117 \text{ mol}$

15 C

16 D

17 A

$n(N_2) = \frac{0.250}{28}$

$= 0.00893 \text{ mol}$

M(unknown) $= \frac{0.286}{0.00893}$

$= 32.0 \text{ g mol}^{-1}$

18 A

19 D

20 A. An increase in temperature favours the backwards reaction. Therefore, the forward reaction is exothermic.

21 C. The best fuel would need to have the highest autoignition temperature and flashpoint.

22 D. Petroleum contains mainly long hydrocarbons that do not contain functional groups.

23 C

24 B

25 D

26 D

27 D. In both beakers, Mg is the limiting reagent and therefore increasing the concentration of HCl and increasing the surface area will only affect the rate of reaction.

28 A. A limiting oxidising agent results in the formation of an aldehyde instead of a carboxylic acid.

29 C

$n(S_2O_3^{2-}) = 0.010 \times \frac{12.70}{1000}$

$= 1.27 \times 10^{-3}$ mol

$n(I_{2(diluted)}) = \frac{1.27 \times 10^{-3}}{2}$

$= 6.35 \times 10^{-5}$ mol

$n(I_{2(stock)}) = 6.35 \times 10^{-5} \times \frac{250.00}{20.00}$

$= 7.94 \times 10^{-4}$ mol

$m(I_2) = 7.94 \times 10^{-4} \times 126.9$

= 1.01 g per 20 mL because original iodine solution is 20 mL

= 5.0g/100 mL

%m/v = 5.0 g/100mL

30 C

SECTION B – ANSWERS

1 a Energy $= (3.2 \times 17) + ((0.79 + 0.12) \times 37) + (15.0 \times 16)$

$= 328.1$ kJ

Energy $= \frac{328.1}{100}$

$= 3.3$ kJ g^{-1}

b i Energy $= 1711 \times (23.8 - 19.7)$

$= 7015.1$ J

$= 7.015$ kJ

Energy per gram $= \frac{7.015}{5}$

$= 1.4$ kJ g^{-1}

b ii [The theoretical energy content is much higher than the energy calculated as a result of the experiment.[1]] [This may be due to the loss of energy during the combustion process in the bomb calorimeter as a result of a poorly insulated calorimeter, resulting in energy loss into the environment that was not used to increase the temperature of water.[2]]

- I have compared the theoretical and experimental energy content.[1]
- I have described the impact of an efficient system on the experimental value.[2]

c $n(Br_2) = \frac{0.1308}{159.8}$

$= 8.185 \times 10^{-4}$ mol

$n(\text{fatty acid}) = \frac{0.12}{879.4}$

$= 0.00014$

$n(\text{fatty acid}) : n(Br_2)$

$\frac{0.00014}{0.00014} : \frac{0.0008185}{0.00014}$

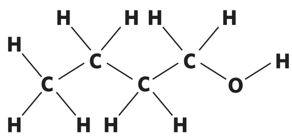
1 : 6

The fat contains 6 carbon-carbon double bonds which means there are 2 carbon-carbon double bonds in each fatty acid. Therefore, the fatty acid is linoleic acid.

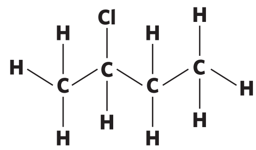
d [Enzymes such as lipase are proteins.[1]] [Compared to the alkaline conditions in the intestines, the stomach is highly acidic.[2]] [The low pH can cause the ionisation of side groups on the amino acids, disrupting the ionic interactions that are responsible for maintaining the tertiary (and/or quaternary) structure of the protein.[3]] [As a result, the lipase enzyme may be denatured and therefore unable to function.[4]]

- I have identified the type of macromolecule to which enzymes belong.[1]
- I have compared the environmental conditions of the stomach and intestines.[2]
- I have described the impact of acidic conditions on the structure of proteins.[3]
- I have identified the effect of acidic conditions on enzyme function.[4]

2 a



Molecule A



Molecule B

b Oxidation

c [The reagents required for this reaction are $Cr_2O_7{}^{2-}{}_{(aq)}$ and H^+.[1]] [In this reaction pathway, the oxidation of the alcohol results in the production of a carboxylic acid.[2]] [In order to ensure that a carboxylic acid is produced, there has to be an excess of the oxidising agent present.[3]]

- I have identified the reagents required.[1]
- I have identified the type of organic molecule produced.[2]
- I have identified the environmental condition required to produce carboxylic acids.[3]

3 a $CH_3COOH + 2H_2O \rightarrow 2CO_2 + 8H^+ + 8e^-$

b Anode : Electrode A

Cathode : Electrode B

c $CH_3CH_2OH_{(aq)} + 3H_2O_{(l)} \rightarrow 2CO_{2(g)} + 12H^+{}_{(aq)} + 12e^-$

$C_2H_5OH_{(aq)} + 3H_2O_{(l)} \rightarrow 2CO_{2(g)} + 12H^+{}_{(aq)} + 12e^-$ is also accepted

d i $C_6H_{12}O_{6(aq)} \rightarrow 2C_2H_5OH_{(aq)} + 2CO_{2(g)}$

ii [The burning of fossil fuels results in the production of carbon dioxide that contributes to greenhouse gas emissions.[1]] [In contrast, the carbon dioxide generated from the combustion of biofuels is recycled by the plants to grow and therefore, biofuels are generally considered as being carbon neutral.[2]]

- I have identified the impact of carbon dioxide produced from the combustion of fossil fuels.[1]
- I have described the impact of carbon dioxide produced from the combustion of biofuels.[2]

iii [Growing sugar cane to produce enough ethanol to power large populations could take up a large area of land,[1]] [which may reduce the amount of land available for other agricultural practices.[2]]

Other answers may include:

- Growing crops such as sugar cane requires a large volume of water, which as a result would limit the amount of water available for other purposes.

- I have identified a disadvantage of the production of ethanol from sugar cane.[1]
- I have identified the impact of this method of ethanol production.[2]

4 **a** 3 hydrogen environments

b [Hydroxyl functional group.[1]] [This is due to the peak occurring at wavenumber of approximately at 3200 cm^{-1} on the IR spectrum, which signifies the presence of an O-H alcohol group.[2]]

- I have identified the name of the functional group.[1]
- I have used evidence from the IR spectrum to support my response.[2]

c

Propan-2-ol

d [Although propan-2-ol has three carbons, it has two distinct carbon environments due to its symmetry. As a result, there would be a single peak to represent both R-CH_3 groups.[1]] [The second environment would be due to the OH functional group bonded to the second carbon.[2]] [Therefore, this molecule would have two peaks on its ^{13}C NMR spectrum.[3]]

- I have described the environment occuring due to symmetry.[1]
- I have identified the nature of the second carbon environment.[2]
- I have linked the structure to the number of peaks on a ^{13}C NMR spectrum.[3]

WANT MORE?

Here's another question to show the theory from a different perspective:

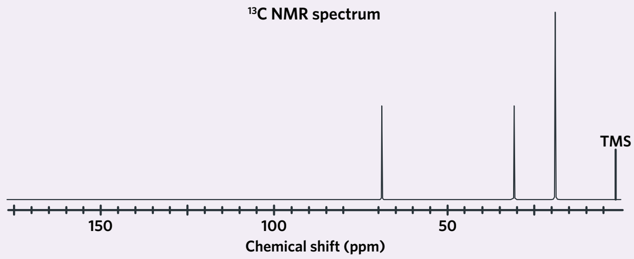
Study design dot point:

- the principles (including spin energy levels) and applications of proton and carbon-13 nuclear magnetic resonance spectroscopy (NMR) (excluding features of instrumentation and operation); analysis of carbon-13 NMR spectra and use of chemical shifts to determine number and nature of different carbon environments in a simple organic compound; and analysis of high resolution proton NMR spectra to determine the structure of a simple organic compound using chemical shifts, areas under peak and peak splitting patterns (excluding coupling constants) and application of the n+1 rule.

Related Edrolo Textbook Lesson 8C pages 306–315

Question 12b

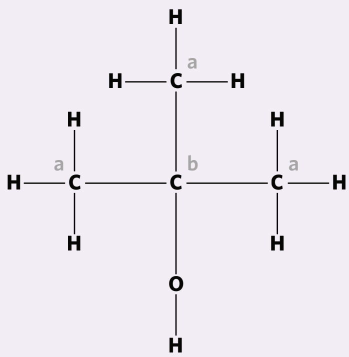
The ^{13}C NMR spectrum for an unidentified molecule is given.



A student, James, proposes that the unidentified molecule is 2-methylpropan-2-ol. Explain whether this response is consistent with the ^{13}C NMR spectrum given (include a diagram in your answer). (3 MARKS)

Answer

12 **b** [As identified in the structural formula, 2-methylpropan-2-ol has two different carbon environments, (labelled a and b).[1]] [The ^{13}C NMR spectrum given shows three peaks, indicating three carbon environments in the unidentified molecule.[2]] [Therefore the molecule James proposes is not consistent with the ^{13}C NMR data provided.[3]]



- I have identified the number of carbon environments in the molecule.[1]
- I have identified the number of peaks in the spectrum.[2]
- I have linked the answer to the question.[3]
- I have included a diagram

e **i** Propyl ethanoate and water

ii Answers may include:

- Wearing gloves to protect skin from burns
- Wearing glasses to protect eyes
- Store in a tightly sealed container to avoid fumes escaping
- Use in areas with plenty of ventilation / fume hood to avoid fumes escaping
- Avoid using around metal-based materials

5 **a** $K = \frac{0.4}{(0.3) \times (0.1)}$

$= 1.33 \times 10^1\ M^{-1}$

$= 10\ M^{-1}$

b [At t=15 minutes, there was a sharp decrease in the concentration of F_2, suggesting that F_2 was removed from the system.[1]][To partially oppose the change according to Le Chatelier's principle, the backwards reaction is favoured, resulting in a gradual increase the concentration of CO and F_2 and a decrease in COF_2 as seen in the graph.[2]]

I have described the change occurring at t = 15 minutes.[1]

I have explained the impact of this change on the reaction.[2]

c [According to the graph, an increase in temperature resulted in an increase in the concentration of COF_2 (the product) and a decrease in F_2 and CO.[1]][Since an increase in temperature would favour an endothermic reaction,[2]][the favouring of the forward reaction means that the forward reaction is an endothermic reaction.[3]]

I have identified the effect of the temperature change on the reaction with reference to the graph.[1]

I have identified the impact of an increase in temperature on a reaction.[2]

I have identified the nature of the forward reaction.[3]

d

Change	Direction of the reaction favoured	Explanation
The volume was halved	**Forward**	**Halving the volume results in an increase in the partial pressures of all species. The reaction will favor the direction that produces the least number of particles, which in this case is the forward reaction.**
Catalyst was added	**Neither**	**A catalyst can speed up the reaction of both the forward and backwards reaction, however, would have no effect on the equilibrium position.**

6 **a** [The chromatogram of the pure caffeine sample shows that caffeine has a retention time of 20 minutes.[1]][Since the sample chromatogram also contains a peak at 20 minutes, and given that the chromatography column was run under the same conditions, this shows that the sample contains caffeine.[2]]

I have identified the retention time of caffeine.[1]

I have identified the presence of caffeine with reference to the peaks in the chromatogram.[2]

b **i** [The non-polar molecule in the sample has a peak with retention time that is higher than caffeine.[1]][Since caffeine contains multiple polar functional groups, caffeine can be considered as being polar and more strongly attracted to a phase that is more polar[2]][which suggests that the stationary phase is non-polar (and mobile phase polar).[3]]

I have compared the retention time of the peak of the non-polar compound and caffeine.[1]

I have described the relationship between caffeine's structure and its attraction to a particular phase of HPLC.[2]

I have identified the polarity of the stationary phase.[3]

ii Increasing the temperature would result in both compounds having a shorter retention time.

c **i** Concentration of caffeine = 0.030 ppm

0.030 ppm → 0.030 mg/L

$c(\text{caffeine}) = \frac{(0.030 \div 1000)}{194.2}$

$= 1.5 \times 10^{-7}\ M$

ii The concentration of caffeine in this drink, 0.03 mg/L is approximately 10 times less concentrated than the average energy drink with a concentration of 0.32 mg/L.

7 **a** Energy released $= 150.00 \times 4.18 \times (66.8 - 17.5)$

$= 30911.1\ J$

$= 30.9\ kJ$

$m(\text{olive oil})_{used} = 26.94 - 25.63$

$= 1.31\ g$

Energy content of olive oil $= \frac{30.9}{1.31}$

$= 23.6\ kJ\ g^{-1}$

b [Olive oil is a mixture of different triglycerides, therefore we cannot calculate the amount, in mol, of olive oil.[1]][Therefore the energy content of olive oil is expressed as a function of mass ($kJ\ g^{-1}$) rather than per mole.[2]]

I have described the effect of the composition of olive oil on the units used.[1]

I have identified the units used to express the energy content of olive oil.[2]

c Energy released $= 150.00 \times 4.18 \times (53.8 - 20.1)$

$= 21129.9\ J$

$= 21.1\ kJ$

$m(\text{methanol})_{used} = 27.41 - 25.89$

$= 1.52\ g$

Energy content of methanol = $\frac{21.1}{1.52}$

= 13.9 kJ g^{-1}

d [Methanol is a polar compound that contains a hydroxyl group that is able to take part in hydrogen bonding, a very strong intermolecular bond, with other methanol molecules as well as dispersion forces and permanent dipole-dipole forces.[1]] [Olive oil is a triglyceride with a polar, ester group that is able to take part in permanent dipole-dipole interactions and also contains long non-polar fatty acid chains that can take part in dispersion forces.[2]] [Although methanol can take part in a stronger type of intermolecular bonding, the size of the triglycerides in olive oil means that it is held together by stronger intermolecular forces overall due to a greater strength of dispersion forces.[3]] [Consequently, olive oil would have a higher boiling point than methanol.[4]]

- I have described the types of bonding between methanol molecules.[1]
- I have described the types of bonding between triglycerides in olive oil.[2]
- I have compared the strengths of the bonds between methanol and olive oil.[3]
- I have identified the substance with a higher boiling point.[4]

e Theoretical energy released from 1.52 g of methanol = 1.52 × 22.7

= 34.5 kJ of energy

% energy loss = $\frac{34.5 - 21.1}{34.5} \times 100$

= 38.8 %

8 a [A primary cell is only able to convert chemical energy to electrical energy (be discharged)[1]] [whereas secondary cells are able to be recharged to also convert electrical energy to chemical energy.[2]]

- I have identified the function of primary cells.[1]
- I have compared the function of primary cells to secondary cells.[2]

b Oxidation

c $LiC_6 \rightarrow C_6 + Li^+ + e^-$

d To be able to be recharged, the products formed during discharge need to be in contact with the electrodes.

e [Lithium is a strong reducing agent,[1]] [therefore would be able to react explosively in the presence of water.[2]] [Therefore, the use of an aqueous solution is highly dangerous.[3]]

- I have identified the reducing strength of lithium.[1]
- I have described the interaction between lithium and water.[2]
- I have identified a key concern with the use of an aqueous solution.[3]

f Answers may include:

- Lithium oxide formed during overdischarge reduces the amount of available $LiCoO_2$ for battery function.
- Lithium oxide formed during overdischarge reduces the amount of Li^+ available for battery function.
- An increase in temperature of the battery results in reduced battery life due to the increased potential for side reactions to occur.
- Electrodes become contaminated with other products that prevent the battery from being recharged.

9 a Independent variable – pH

Dependent variable – glucose concentration

b [The test tubes are kept at a controlled temperature so that the temperature of each reaction is the same and the enzyme doesn't denature.[1]] [This allows for more valid results.[2]]

- I have identified the purpose of controlling the temperature of the test tubes.[1]
- I have identified the effect of this treatment on the experiment's results.[2]

c [This is an example of a random error as it was accidental.[1]] [Consequently, since there is more enzyme present and lactose is in excess, there will be an increase in glucose concentration compared to no extra enzyme being added.[2]]

- I have identified the type of error.[1]
- I have identified the effect on the results.[2]

d [By adding different amounts of water, each test tube would have an overall volume of 8.00 mL.[1]] [By controlling this variable, the concentration of enzyme and substrate is the same throughout all tests,[2]] [therefore allowing the results of each test tube to be compared.[3]]

- I have identified the key consideration for the varying volumes of distilled water.[1]
- I have described the impact of this on the experiment.[2]
- I have identified the comparability (and thereby validity) of the experiment.[3]

e [Precision of results describes the closeness of measured values,[1]] [therefore one test is not enough to confirm the precision of results.[2]] [Accuracy of results refers to the closeness of the values to the true value.[3]] [This can be determined with one test if the theoretical value is known.[4]]

- I have defined precision.[1]
- I have identified the appropriateness of using one test to determine precision.[2]
- I have defined accuracy.[3]
- I have identified the appropriateness of using one test to determine accuracy.[4]

f [The most likely optimal temperature for an enzyme is 37°C because this is the average temperature of the body.[1]] [Enzyme function decreases at colder temperatures because the rate of reaction is slower as less particles have sufficient energy to overcome the activation energy barrier, even when catalysed by an enzyme.[2]] [Enzyme function decreases at warmer temperatures because enzymes being proteins become denatured and lose their secondary, tertiary and quaternary structure which is important for enzyme catalysis.[3]]

- I have determined the optimal temperature of an enzyme.[1]
- I have described the effect of colder temperatures on enzyme function.[2]
- I have described the effect of warmer temperatures on enzyme function.[3]

g [Lactose is a disaccharide composed of the monomer glucose and galactose.[1]] [The hydrolysis of lactose into its monomers requires the presence of the enzyme lactase.[2]] [As the presence of lactase allows for the hydrolysis of lactose into glucose and galactose, measuring the concentration of glucose evolved within a given period can indicate the function of lactase. A decrease in lactase activity will result in a decrease in the rate of breakdown of lactose into glucose and galactose, thereby decreasing the concentration of glucose present during that time period and vice versa.[3]]

- I have identified the composition of lactose.[1]
- I have identified the importance of lactase in the hydrolysis of lactose.[2]
- I have explained the effect of enzyme function on the production of glucose.[3]

10 a [In terms of disadvantages, the article references the lack of infrastructure available for hydrogen fuelled vehicles as well as the fact that customers are unable to understand and relate to this technology.[1]] [However, in terms of advantages, the article references the environmentally friendly nature of hydrogen as a fuel source with water being the only product.[2]] [With reference to the chemistry studied this year, hydrogen is the 'fuel of the future' because

Benefits:

- More efficient than traditional combustion engines
- Release less particulate matter than combustion engines
- Quieter
- Hydrogen fuel cells release no carbon emissions
- No moving parts results in less chance of mechanical failure[3]]

[Hydrogen is not the 'fuel of the future' because

Disadvantages:

- Expensive
- Hydrogen fuel cells require high temperatures to operate
- Hydrogen is not a readily available fuel source
- There is a lack of hydrogen refuelling stations[4]]

- I have described the disadvantages of hydrogen referenced in the article.[1]
- I have described the advantages of hydrogen referenced in the article.[2]
- I have referenced some advantages of hydrogen studied this year.[3]
- I have referenced some disadvantages of hydrogen studied this year.[4]

b [Hydrogen is produced from the electrolysis of water via the following equation: $2H_2O_{(l)} \rightarrow 2H_{2(g)} + O_{2(g)}$[1]] [The article states that this is a clean form of hydrogen production compared to other sources such as steam reformation of fossil fuels because the only products are hydrogen and oxygen, which is correct as shown by the equation.[2]] [However, it can be argued that hydrogen production from the electrolysis of water is not truly 'zero-emisison' because the energy required to drive electrolysis could be sourced from fossil fuels and other non-renewable sources of energy.[3]] [However, when this energy is sourced from renewables such as solar or wind energy, hydrogen produced via this method becomes a truly 'zero-emission' source of energy.[4]]

- I have given the equation for the electrolysis of water.[1]
- I have justified the article's position.[2]
- I have referenced by hydrogen sourced via this method may not be 'zero-emission'.[3]
- I have provided a counter argument to the above checklist item.[4]