QATs
Quality Assessment Tasks

NAME: _____

VCE®Chemistry

UNITS 3 & 4 Practice Examination

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

QUESTION AND ANSWER BOOKLET

Section	*Number of questions*	*Number of questions to be answered*		*Marks*
A	30	30		30
B	10	10		90
			Total	120

- Students are permitted to bring into the examination room: blue or black pens, pencils, highlighters, erasers, sharpeners and ruler. A scientific calculator is allowed.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 34 pages.
- A Data Book PROVIDED BY YOUR TEACHER.
- Answer sheet for multiple choice questions.

Instructions

- Write your **student name** in the space provided above on this page.
- Check that your **name** is printed on your answer sheet for multiple-choice questions.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep the data book.

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

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.

Question 1

Which statement about the electrochemical series is correct?

A. Strong oxidising agents have strong conjugate reducing agents.

B. The stronger the reductant, the more positive the E^0 value.

C. The stronger the reductant, the closer to zero the E^0 value.

D. Strong reducing agents donate electrons more readily than weak ones.

Question 2

The main constituent of ant venom is formic or methanoic acid (HCOOH). 1.150 g of formic acid is titrated against sodium hydroxide. The phenolphthalein indicator changed permanently from colourless to pink when 24.95 mL of NaOH was added from the burette.

The molar concentration of the sodium hydroxide solution is closest to

A. 1.0 M

B. 0.1 M

C. 2.0 M

D. 0.5 M

Question 3

A student is preparing a standard solution of sodium carbonate to use as a primary standard. Which of the following pieces of equipment must be used?

A. Analytical balance and pipette.

B. Volumetric flask and burette.

C. Volumetric flask and analytical balance.

D. Analytical balance and burette.

Question 4

Which of the following statements is correct?

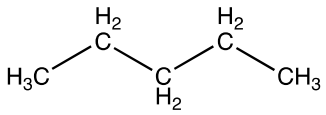
A. Triglycerides dissolve readily in water.

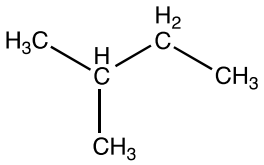
B. Cellulose is an important structural carbohydrate in plants.

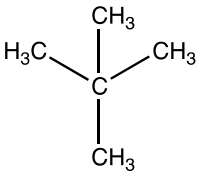
C. Glucose and fructose are stereoisomers.

D. NAD^+ (vitamin B_3) is a coenzyme which increases the activation energy of many reactions.

*Use the following information to answer the next **two** questions*







Compound: X Y Z

Question 5

Which of the following statements about compounds *X*, *Y* and *Z* is correct?

A. They are isomers of pentane and therefore have the same boiling point.

B. *X* is non-polar but *Y* and *Z* are polar.

C. They are cis-trans isomers.

D. Compound *Z* has the lowest flash point.

Question 6

Which of the above organic molecules will show 4 peaks in the ^{13}C-NMR and 4 peaks in the ^{1}H-NMR?

A. Compound *X*.

B. Compound *Y*.

C. Compound *Z*.

D. None of them.

Use the following information to answer Questions 7 – 8.

Chloroform ($CHCl_3$), is one of the most important organic solvents in industry and also an important precursor in the production of refrigerants. It can be produced via the reaction of bleach (NaOCl) and acetone (CH_3COCH_3) according to the following equation:

$$CH_3COCH_3 + 3NaOCl \rightarrow CHCl_3 + 2NaOH + CH_3COONa$$

$M(CHCl_3) = 119.4\ g\ mol^{-1}$ $M(CH_3COCH_3) = 58.1\ g\ mol^{-1}$ $M(NaOCl) = 74.4\ g\ mol^{-1}$

Question 7

The percentage yield for this reaction in which 65 g of acetone was reacted with NaOCl to produce 130 g of chloroform is closest to

A. 50%

B. 24%

C. 82%

D. 97%

Question 8

The atom economy for this reaction is 42.4%. The total mass of reactants needed, in g, required to make 130 g of chloroform is

A. 307 g

B. 25.7 g

C. 282 g

D. 104 g

Question 9

The chemical reaction between tin(IV) oxide, SnO_2 and carbon is an endothermic reaction, according to the following equation,

$$SnO_{2(s)} + C_{(s)} \rightarrow Sn_{(s)} + CO_{2(g)} \qquad \Delta H = + 360.0 \text{ kJ mol}^{-1}$$

An activation energy of 640 kJ mol^{-1} is needed. The activation energy for the reverse reaction, in kJ mol^{-1}, is

A. +280

B. - 280

C. +640

D. - 640

Question 10

A student is asked to set up a galvanic cell under standard conditions involving two half cells, Sn^{2+} / Sn^{4+} and Ag / Ag^{+} to produce a cell voltage of approximately 0.65 V.

Which of the following combination of chemicals for electrode, salt bridge and electrolyte solution should the student choose?

	Electrodes	**Salt bridge**	**Electrolyte solutions**
A.	Tin and silver rods	KNO_3(aq)	$Sn(NO_3)_2$, $Sn(NO_3)_4$, AgCl
B.	Tin and silver rods	KNO_3(aq)	$Sn(NO_3)_2$, $AgNO_3$
C.	Carbon and silver rods	KNO_3(aq)	$Sn(NO_3)_2$, $Sn(NO_3)_4$, $AgNO_3$
D.	Carbon and carbon rods	KCl(aq)	$Sn(NO_3)_2$, $AgNO_3$

Question 11

A rechargeable nickel- cadmium battery is used to operate a smoke detector. The reaction occurring in this cell during the production of electrical energy is as follows:

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

What mass of cadmium, Cd(s) would be needed to keep the smoke detector operating for the required one year (365 days) if it produces a steady current of 0.0500 mA?

A. 918 g

B. 0.918 g

C. 1.836 g

D. 459 g

Question 12

Which of the following reactions will **not** occur spontaneously?

A. $Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

B. $Zn(s) + 2AgNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + 2Ag(s)$

C. $Cu(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2(g)$

D. $Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

Question 13

A student uses a calibrated electronic balance to determine the mass of pure water delivered by a pipette at 25^{o}C. The student takes five mass readings. The results, in gram, are:

25.33, 25.32, 25.32, 25.34, 25.33

If the pipette actually delivers 25.00 g water, it can be concluded that the results are

A. precise and accurate.

B. accurate but not precise.

C. precise but not accurate.

D. neither precise nor accurate.

Question 14

A drug company is investigating the extraction of the active chemical from an ancient herb found to be an effective treatment for Malaria. Which of the following techniques would be **most** suitable for the large-scale purification and isolation of the chemical?

A. Paper chromatography.

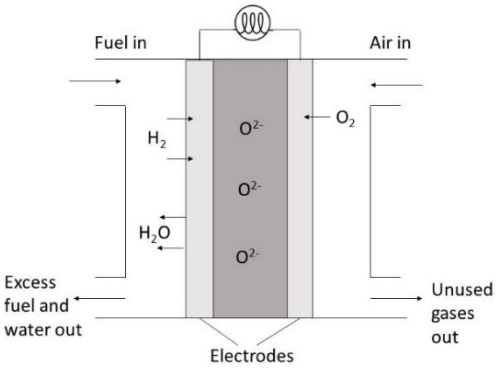
B. Thin layer chromatography.

C. NMR spectroscopy.

D. Column chromatography.

Question 15

Solid oxide fuel cells (SOFC) are being considered for power generation and for use in space because of their high efficiency, high power density and extremely low pollution. A simplified diagram showing the key parts of a SOFC is shown below.



The electrode reactions are:

Reaction 1: $O_2(g) + 4e^- \rightarrow 2O^{2-}(s)$

Reaction 2: $H_2(g) + O^{2-}(s) \rightarrow H_2O(l) + 2e^-$

When the SOFC is generating electricity, which of the following statements is most likely to be correct?

I Chemical energy is not completely converted into electrical energy.
II The reduction of the oxidant consumes electrons.
III The fuel undergoes oxidation and its oxidation number increases.

A. I only.

B. II and III only.

C. I and II only.

D. III only.

Question 16

In this cell

A. Reaction 2 occurs at the anode which is negative.

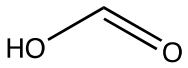
B. Reaction 2 occurs at the anode which is positive.

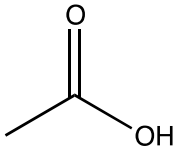
C. Reaction 2 occurs at the cathode which is negative.

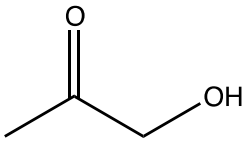
D. Reaction 2 occurs at the cathode which is positive.

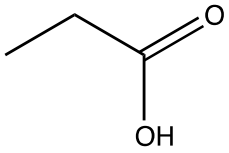
Question 17

Which of the following compounds is not a carboxylic acid?

A. 

B. 

C. 

D. 

Question 18

The correct IUPAC name for a compound with the semistructural formula $CH_3CH_2CH=C(CH_2CH_3)CH_3$ is

A. 2-ethylpent-2-ene.

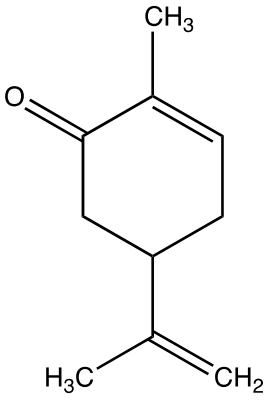
B. 3-methylhex-3-ene.

C. 3-methylhept-3-ene.

D. 4-methylhex-3-ene.

Question 19

How many chiral centres are in the molecule on the right?



A. 1

B. 2

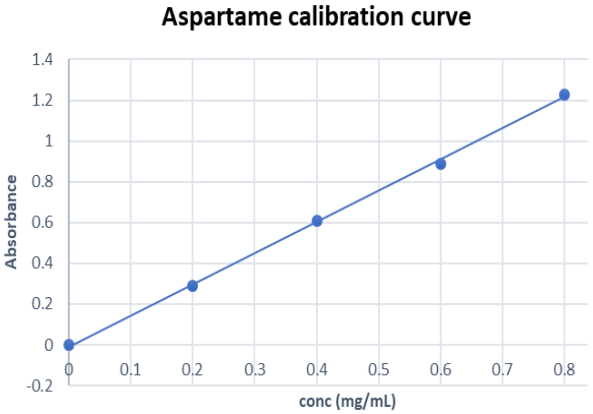
C. 3

D. 4

*The next **two** questions refer to the information below.*

Aspartame is an artificial non-saccharide sweetener used widely in food and drinks labelled 'Diet'. However, many studies have found that it may be linked to health conditions ranging from headache to cancer.

The aspartame content of various 'Diet' drinks was analysed via HPLC (High Performance Liquid Chromatography). A series of standard aspartame solutions were prepared and their absorbances measured. Samples of the various drinks were then directly injected into the HPLC column under exactly the same conditions as the standard solutions. The resulting calibration curve and results from several different samples are given below.



Description	Aspartame content
diet coke – 150 mini-can	78 mg per 150 mL
diet pepsi – 1.25 litre bottle	578 mg per 1.25 L
pepsi Max – 200 mL bottle	74 mg per 200 mL
Red Bull *zero* – 330 mL can	99 mg per 330 mL
Red Bull *sugarfree* -330 mL can	135 mg per 330 mL

Question 20

The absorbance reading for one particular sample, X was 0.45. By using the absorbances of the aspartame standards in the calibration curve (above), the aspartame content of sample X is closest to

A. 25 mg per 100 mL.

B. 30 mg per 100 mL.

C. 35 mg per 100 mL.

D. 40 mg per 100 mL.

Question 21

Sample X, which is one of the drinks listed in the Table is

A. 'Diet' coke.

B. Pepsi Max.

C. 'Diet' Pepsi.

D. Red Bull *zero.*

*Use the following information to answer the next **three** questions, Question 22 -24.*

Consider the following reaction at equilibrium at 350 K.

$$CH_4(g) + CCl_4(g) \rightleftharpoons 2CH_2Cl_2(g) \qquad \Delta H = +ve$$

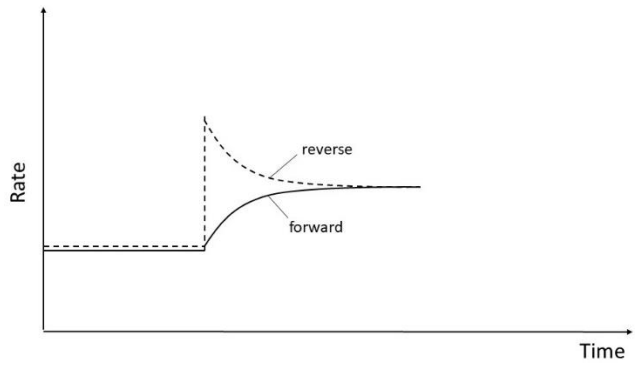
Question 22

What will happen to the position of equilibrium and the value of the equilibrium constant when the temperature is increased in the above reaction?

	Position of equilibrium	**Value of equilibrium constant**
A.	Shifts to the left	increases
B.	Shifts to the left	decreases
C.	Shifts to the right	increases
D.	Shifts to the right	decreases

Question 23

The graph below shows the rate changes after a second change occurred to the above reversible gas phase reaction. Which of the following changes could lead to the depicted rate change?



A. Adding dichloromethane (CH_2Cl_2) to the reaction mixture.

B. Adding methane to the reaction mixture.

C. Decreasing the pressure by increasing the volume of the container.

D. Adding an inert gas, argon (container volume remains constant).

Question 24

At a certain temperature, the value of the concentrations for all reactants and products is 0.2 mol L^{-1}. What happens to the value of K_c when the concentration values of the reactants are doubled to 0.4 mol L^{-1} at the same temperature?

A. It is halved.

B. It doubles.

C. It does not change.

D. It decreases by the factor of 4.

Question 25

Which of the following vitamins is a non-essential vitamin?

A. Vitamin A

B. Vitamin D

C. Vitamin E

D. Vitamin K

Question 26

Enzymes in the human body start to denature at temperatures above

A. 40^{o}C

B. 70^{o}C

C. 15^{o}C

D. 95^{o}C

Question 27

Which of the following amino acids contains a non-polar side chain?

A. Cys

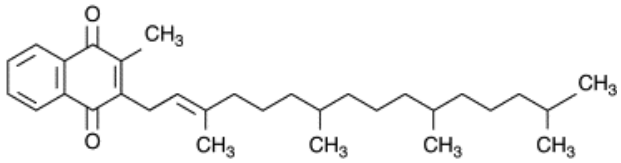
B. Trp

C. Arg

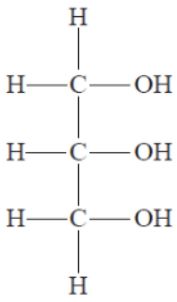
D. Val

Question 28

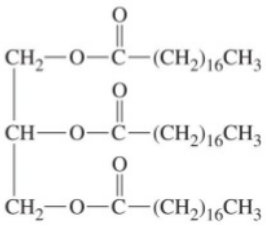
Which of the following compounds below belongs to the class of biological molecules called lipid?



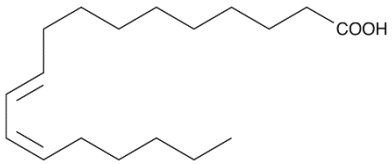
Compound **I**



Compound **II**



Compound **III**



Compound **IV**

A. Compound I

B. Compound II

C. Compound III

D. Compound IV

Question 29

Which of the following compounds, when in the liquid state is **most** likely to be miscible in water?

A. C_2H_5COOH

B. $C_{10}H_{21}OH$

C. C_7H_{16}

D. CCl_4

Question 30

The compound with the semistructural formula: $CH_3(CH_2)_4CH=CHCH_2CH=CH(CH_2)_7COOCH_3$ is a biodiesel molecule derived from plants.

Which of the following statements is correct about this type of biodiesel?

A. It has a higher melting point than biodiesel produced from animal fats.

B. It cannot be stored for as long as petrodiesel.

C. It is a saturated ester.

D. It is less hygroscopic than petrodiesel.

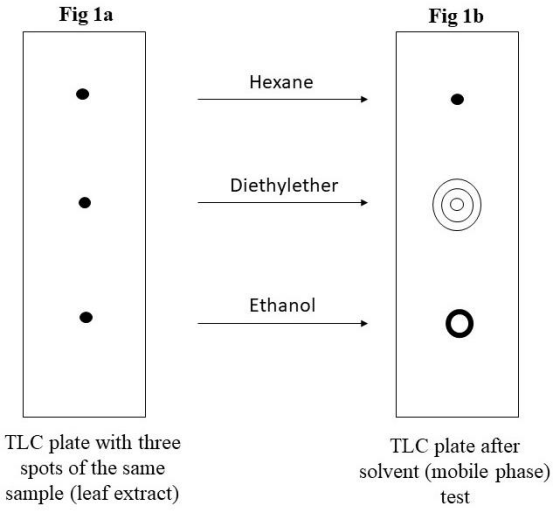
SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided. Write using a black or blue pen.
To obtain full marks for your responses you should:
- give simplified answers, with an appropriate number of significant figures, to all numerical questions; unsimplified answers will not be given full marks.
- show all working in your answer to numerical questions; no credit will be given for an incorrect answer unless it is accompanied by details of the working.
- make sure chemical equations are balanced and that formulas for individual substances include an indication of state; for example, $H_2(g)$; $NaCl(s)$.

Question 1 (7 marks)

Autumn leaf colour is a phenomenon that affects the leaves of many deciduous trees, where the normally green leaves change to various shades of yellow, red, purple and brown. The various colours are due to the presence of important pigments in plant leaves such as chlorophyll, carotenes and xanthophyll. Thin layer chromatography (TLC) is a convenient technique to investigate which of these different pigments are present in a leaf. Different solvents or solvent mixtures can be utilised as a mobile phase to obtain a separation of the pigments. The choice of a mobile phase is important as it will affect the adsorption and desorption process onto the stationary phase and therefore the separation of the pigments.
Before commencing a TLC, a so called *Spot test* is performed to determine the suitability of a solvent. In this test, the leaf extract containing a mixture of these pigments is spotted three times onto a TLC plate (see Fig 1a) and then onto each sample a different solvent (hexane, diethyl ether, and ethanol) is spotted multiple times. The solvent spreads in a circular motion and a separation of the mixture into its different pigments could be achieved for the most suitable solvent. Fig 1b shows the result of this spot test.



a. Compare the suitability of the 3 tested solvents in the separation of the pigments in the leaf extract and justify your statement. 3 marks

_____

_____

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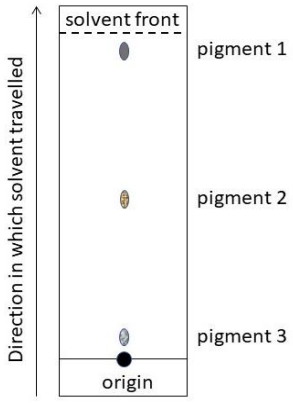
b. After completion of the *Spot test*, a second TLC plate was prepared. The leaf extract was spotted onto the TLC plate and one of the tested solvents from a) was allowed to move up the plate potentially carrying with it the various compounds in the leaf extract. The following chromatogram was obtained (Fig 2).

Fig 2



R_f values for plant pigments	
Carotene	0.98
Chlorophyll a	0.72
Chlorophyll b	0.50
Xanthrophyll 1	0.28
Xanthrophyll 2	0.10
Phenophytin	0.80
Anthocyanins	0.31

i. Explain what is meant by the term R_f value. 1 mark

_____

_____

_____

ii. Referring to the chromatogram and previously obtained R_f values for several leaf pigments using an identical TLC plate / solvent system, identify the components of the leaf extract responsible for each spot. 3 marks

Pigment 1: _____

Pigment 2: _____

Pigment 3: _____

Question 2 (11 marks)

Collagen is one of the most abundant proteins in our body. It is an insoluble fibrous protein found in skin, bones, muscles, digestive system and blood vessels. In fact, our skin is made up of 75% collagen. The schematic diagram below shows parts of the primary and secondary structure of collagen.

Primary Structure: -Gly-Pro-Met-Gly-Pro-Ser-Gly-Pro-Arg-Gly-Leu-

Secondary Structure: 

a. The most common repetitive amino acid sequence of collagen is glycine-proline-X, where X is any other amino acid except for glycine or proline.
Draw a tripeptide consisting of the three amino acids glycine, proline and methionine in that order.

3 marks

b. What type of secondary structure is represented by the diagram? 1 mark

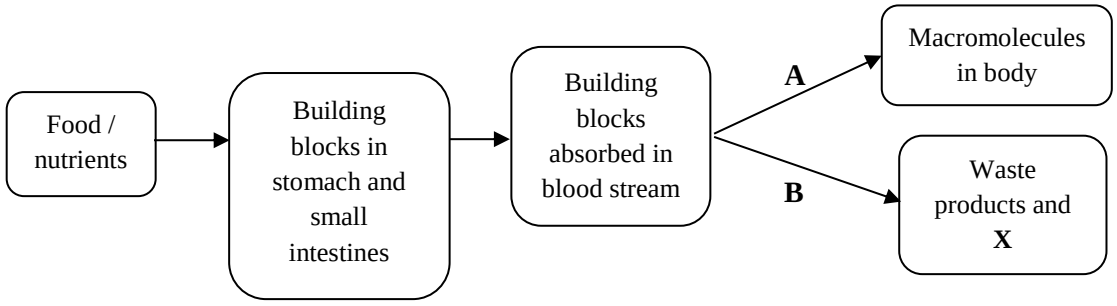
_____

c. Another amino acid occurring in the amino acid sequence in collagen is serine. Give a chemical equation for the reaction of serine with 5M hydrochloric acid solution (states not required).

2 marks

_____

d. Proteins are also classified as macronutrients and are an important part of our daily diet. Other important macronutrients include carbohydrates and fats and oils. The flow chart below shows the general digestion and absorption of nutrients in the human body.



Use the flow chart to answer the following questions

i. Give an example of a typical food source which is high in proteins. 1 mark

_____

ii. What type of chemical reaction occurs when macromolecules are formed in the body (reaction **A**)? 1 mark

_____

iii. Process B shows the process of cellular respiration. Write a balanced chemical equation for aerobic respiration of glucose. 2 marks

_____

iv. What else (labelled **X**), apart from chemical products, is usually produced in process B? 1 mark

_____

Question 3 (11 marks)

A group of students were investigating the use of bomb calorimeters in determining the amount of heat released in a number of combustion reactions of food. Students first calibrated their bomb calorimeter by passing a constant current and voltage through a heating element inside the calorimeter for 3 minutes. Different foods were then combusted by different students. Experimental results were discussed at the end of this investigation.

Student **A** was investigating the energy content of a new brand of biscuit using a bomb calorimeter. The following results were recorded:

1. *An electrical current of 1.55 A was passed through a small electrical filament inside the bomb calorimeter for 3 minutes at a voltage of 7.00 V. The water temperature surrounding the bomb calorimeter rose from 24.60 to 25.65^{o}C.*

2. *A piece of the biscuit was placed into the bomb calorimeter, which was filled with excess oxygen and placed back into the water bath.*
   m(biscuit) = 1.605 g
   T(water bath) = 25.65^{o}C
3. *The mixture of biscuit and oxygen was ignited and a temperature increase to 40.50^{o}C was observed.*

a. Calculate the calibration factor of the calorimeter in J $^{o}C^{-1}$. 2 marks

_____

_____

_____

_____

b. Calculate the energy content of the biscuit in kJ g^{-1}. 2 marks

_____

_____

_____

_____

c. The nutrition information label on the biscuit package indicates that 100 g of the biscuit contains 62.0% carbohydrate, 7.50% proteins and 19.6% fat. The remaining 10.9% is water. Calculate the theoretical energy value of the biscuit, in kJ g^{-1}. 2 marks

_____

_____

_____

_____

_____

d. Give **two** reasons why the energy available from the biscuit theoretically determined (in **c.** above) is different from the energy released by the metabolism of the biscuit in the human body. 2 marks

_____

_____

_____

e. A fellow student claimed that the measured heat content of the biscuit may be incorrect because the biscuit originally placed in the bomb calorimeter was not completely dry.

i. Suggest a simple process the student could have undertaken with the piece of biscuit before putting it into the bomb calorimeter to ensure it was completely dry. 1 mark

_____

_____

ii. If the student making that claim was correct, what impact would this have on the measured heat content of the biscuit in **b.**? Explain your answer. 2 marks

_____

_____

_____

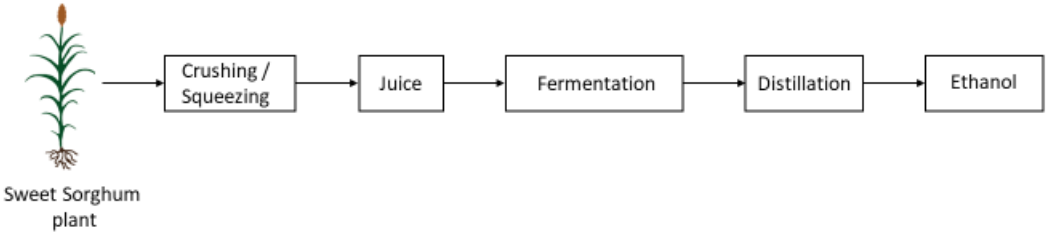
_____

_____

Question 4 (14 marks)

The Dalby Bio-Refinery is Australia's first refinery which uses sorghum as its feed stock to produce ethanol. The ethanol is produced by breaking down the starch in the sorghum grain to create sugars and then fermenting these sugars to ethanol. One tonne of sorghum grain can produce 400 litres of ethanol.

The flow chart below partly illustrates the production of bioethanol from sorghum plants.



a. Write a chemical equation for the production of bioethanol from glucose. 2 marks

_____

b. The bioethanol is commercially used in a blend of 90% petrol and 10% ethanol, also called e10 fuel. 400 litres of ethanol is enough to fill up 80 small cars (50 litre tank) with e10 fuel. The thermochemical equation for the combustion of bioethanol is

$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$ $\Delta H = -1238$ kJ mol^{-1}

i. Calculate the volume of oxygen, in ML, needed for the complete combustion of 400 L of ethanol at SLC (density of ethanol at 25^{o}C is 0.785 kg L^{-1}). 4 marks

_____

_____

_____

_____

_____

ii. Calculate the energy released, in MJ, per kilogram of ethanol. 2 marks

_____

_____

_____

iii. Calculate the total volume of greenhouse gases, $CO_2(g)$ and $H_2O(g)$, per MJ of energy in car exhaust gases produced by the complete combustion of ethanol at 500ºC and 1 atm. 2 marks

_____

_____

_____

_____

_____

iv. The accumulation of greenhouse gases in the earth's atmosphere is of great concern because they absorb and re-radiate the energy from the sun back to the earth's surface causing global warming.
Name **two** other greenhouse gases (other than carbon dioxide and water) which contribute to global warming by trapping heat in our atmosphere. 2 marks

_____

v. A recent article in a leading scientific journal ignited a fierce debate on the benefits of the role of bioethanol in helping reducing greenhouse gas emission. Comment on the following two statements which were at the centre of the heated discussions and explain why you agree or disagree. 2 marks

1. '*Increasing crop cultivation for the production of bioethanol poses risks to ecosystems and biodiversity'*

_____

_____

_____

_____

2. *'Bioethanol is **not** carbon neutral'.*

_____

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Question 5 (13 marks)

Amines are an homologous series of organic compounds that contain an amino group. Amines are also classified as organic bases and can therefore react with inorganic and organic acids.

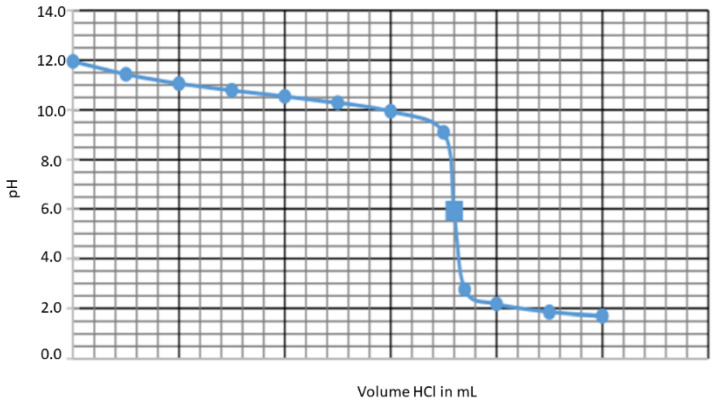
a. The titration of 20.00 mL of 0.173M of methyl amine (CH_3NH_2) with 0.115 M hydrochloric acid, HCl occurs according to the following chemical equation:

$$CH_3NH_2(aq) + HCl(aq) \rightarrow CH_3NH_3^+(aq) + Cl^-(aq)$$

i. What volume of HCl, in mL, needs to be added from the burette to reach the equivalence point? 3 marks

ii. A sketch of titration curve for this titration is shown below. Select the **most** suitable indicator for this titration and describe the colour change you would observe.

2 marks



b. The reaction pathway below illustrates the synthesis of propanamide, $CH_3CH_2CONH_2$.

1-chloropropane → compound A → compound B → $CH_3CH_2CONH_2$

i. Name compound A. 1 mark

_____

ii. Give the chemical formula for the reagent used to convert 1-chloropropane to compound A. 1 mark

_____

iii. Give the semistructural formula for compound B. 1 mark

_____

iv. Classify the type of reaction from compound A to B. 1 mark

_____

v. Write a balanced chemical equation for the reaction of compound B to produce propanamide. (No states required) 1 mark

_____

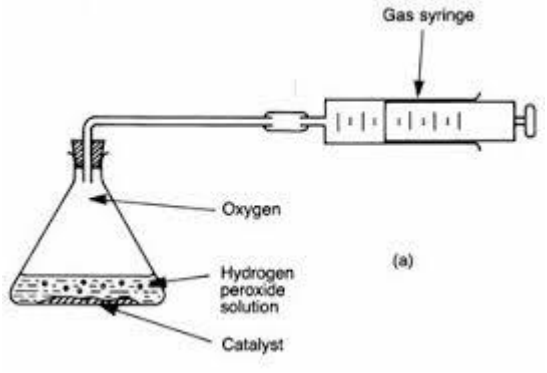
c. Use the table below to predict the ^1H NMR regarding number of peaks, chemical shift and splitting pattern for 1-chloropropane. 3 marks

Type of proton	Chemical shift / ppm	Peak area	Splitting pattern
C**H**$_3$-			
CH_3-C**H**$_2$-CH_2-			
-C**H**$_2$-Cl			

Question 6 (10 marks)

The picture below shows the experimental set up for the decomposition of hydrogen peroxide into oxygen and water in the presence of a catalyst, solid manganese(IV) oxide according to the following equation,

$$2H_2O_2(aq) \rightarrow O_2(g) + 2H_2O(l)$$



6.50 mL of an aqueous solution of hydrogen peroxide was mixed in a conical flask with a small amount of the catalyst. The flask was immediately connected to a syringe. $O_2(g)$ was continuously released from the start of the reaction until the fourth minute by which time a total of 70.0 mL of gas was collected. After that time, no more oxygen gas was produced.

a. Calculate the initial molar concentration of $H_2O_2(aq)$ at standard laboratory conditions (T_1).
3 marks

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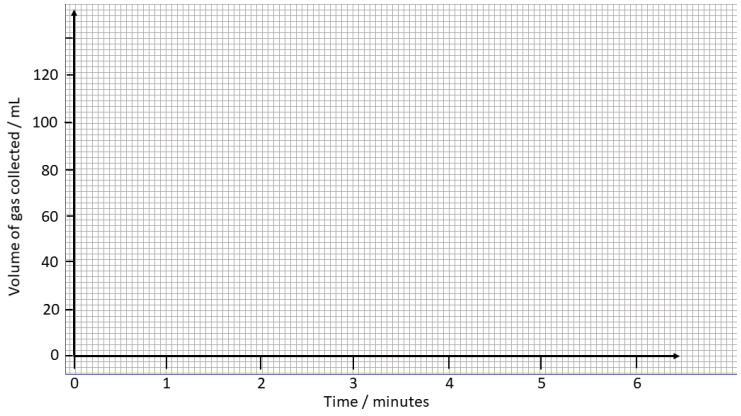
b. In the diagram below sketch a graph representing the production of oxygen collected with time for 5 minutes. 1 mark

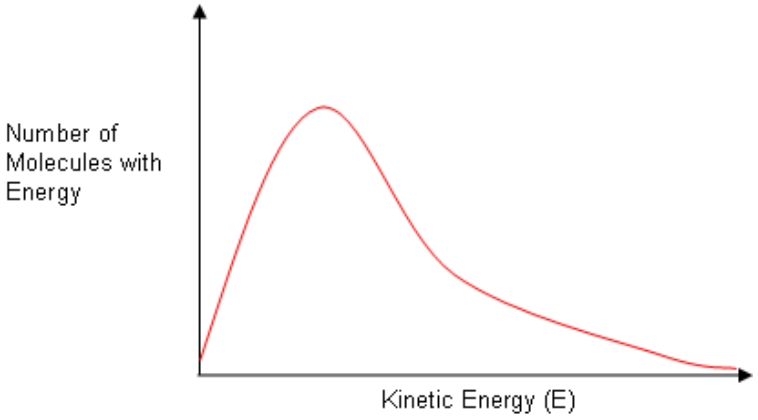


c. The experiment is repeated at a higher temperature (T_2) but all other conditions remain unchanged.

i. Use the same diagram to sketch a second graph showing the course of reaction at T_2. 1 mark

ii. Explain in terms of collision theory the effect of a higher temperature on the decomposition of hydrogen peroxide. 2 marks

d. Use the Maxwell-Bolzmann distribution curve below, to clearly explain in terms of collision theory the effect of the catalyst, MnO_2, on the rate of the decomposition of hydrogen peroxide. Your diagram should include activation energies for catalysed and uncatalyzed reaction. 3 marks



Question 7 (8 marks)

A student wishes to determine the value of the Avogadro Constant, N_A, experimentally. The student sets up an electrolytic cell using a beaker with 1M nickel(II) sulfate solution, two electrodes (copper and nickel) and a DC power supply. The voltage was adjusted so that no gas is formed at either electrode. At the end of the experiment, the electrodes are removed, carefully dried and weighed.

The following data was recorded in a logbook:

Mass of cathode start = 3.746 g
Mass of cathode end = 4.098 g
Average current used = 2.00 A
Time of electrolysis = 10 minutes

a. Write an equation for the reaction that occurs at the cathode. 1 mark

_____

b. Determine the number of moles of metal that was deposited on the cathode. 1 mark

_____

c. **i.** Determine the electrical charge, Q, produced over the ten-minute period. 1 mark

_____

ii. Determine the number of electrons that were involved in the reaction. 1 mark

_____

iii. Calculate the amount of electrons (in mol) involved in the reaction and hence calculate Avogadro constant, N_A. 2 marks

_____

_____

_____

d. Compare the experimentally determined Avogadro constant with the theoretical value. Give **one** reason why the student's result differs from the N_A value stated in the data book.

2 marks

_____

_____

_____

Question 8 (4 marks)

Carbonated soda water makers, such as SodaStream™, have become a popular appliance in many households. The basic process is forcing CO_2 to dissolve in water according to the following thermochemical equation,

$$CO_2(g) \rightleftharpoons CO_2(aq) \qquad \Delta H = -ve$$

a. Use LeChâtelier's principle to explain why it is recommended to use chilled water when adding the carbon dioxide from the gas cartridge. 2 marks

_____

_____

_____

_____

b. This carbonation process is not just about bubbles, though. The process also changes the taste of the water by creating a tangy / acidic flavour as some of the carbon dioxide reacts with the water to form carbonic acid (H_2CO_3). A state of equilibrium is established between reactants and products.

Use an appropriate equation and explain what will happen to the pH if a bottle of carbonated water is left opened. 2 marks

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Question 9 (5 marks)

Antioxidants are substances that slow down the rate of oxidation in food and therefore prolong its shelf life. They are naturally present in food or are synthetically made and added to the food.

a. Vitamin C is a naturally occurring antioxidant. Outline how vitamin C functions as an antioxidant and identify the functional group(s) involved in this process. 2 marks

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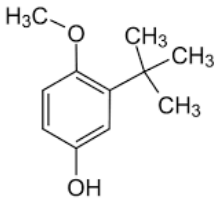
_____

b. BHA, butylated hydroxyanisole, (structure below) is a synthetic antioxidant. Discuss **one** concern of the use of synthetic antioxidants. 1 mark



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c. Another way of improving the shelf life of food is the way food is packaged. Potato chips (crisps), for example, are packaged in sealed, nitrogen-filled foil packs.

Suggest two reasons why potato chips are packaged in this way. 2 marks

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Question 10 (7 marks)

The overall reaction that takes place in the lead-acid battery as it produces electricity is shown below.

$$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$

a. Determine the oxidation number of lead in Pb, PbO_2 and $PbSO_4$. 1 mark

Pb _____ PbO_2 _____ $PbSO_4$ _____

b. Deduce the oxidation and reduction half-equations taking place at the negative lead electrode (anode) and the positive lead(IV) oxide electrode (cathode). 2 marks

_____

_____

_____

c. Describe what happen to the concentration of the sulfuric acid when the battery is recharged. 1 mark

_____

d. In order to determine the position of three metals (X, Y and Z) in a reactivity series, the metals were placed in different solutions of metal ions. The table below summarizes whether or not a reaction occurred.

	X^+	$Y^{2+}(aq)$	$X^{2+}(aq)$
X(s)		No reaction	No reaction
Y(s)	reaction		No reaction
Z(s)		reaction	

Use the information from the table above to determine the order of increasing reductant strength of the metals. Explain your choice. 3 marks

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_____

_____

_____

END OF EXAMINATION

QATs
Quality Assessment Tasks

NAME: _____

Section A: Multiple-choice Answer Sheet

For each multiple-choice question, shade letter of your choice.

Question				
1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D
21	A	B	C	D
22	A	B	C	D
23	A	B	C	D
24	A	B	C	D
25	A	B	C	D
26	A	B	C	D
27	A	B	C	D
28	A	B	C	D
29	A	B	C	D
30	A	B	C	D

END OF QUESTION AND ANSWER BOOK

Solution Pathway

Below are sample answers. Please consider the merit of alternative responses.

Note: *Teachers will need to provide the VCAA data booklet, unmarked, for student use during this Exam.*

SECTION A: Multiple-choice Answers

Question 1 Answer: D

Strong oxidising agents have *weak* conjugated reducing agents (A incorrect) and the stronger the reductant the more *negative* the E^0 value (B, C incorrect).

Question 2 Answer: A

n(HCOOH) = 1.150 / 46 = 0.025 mol

n(NaOH) = n(HCOOC) = 0.025 mol

c(NaOH) = n/v = 0.025 / 0.02495 = **1.00 mol L^{-1} (M)**

Question 3 Answer: C

A standard solution is prepared by dissolving accurately measured mass of a primary standard (using an **analytical balance**) in an accurately measured volume (**volumetric flask**).

Question 4 Answer: B

Since the long hydrocarbon chains in triglycerides are very non-polar, they do no dissolve in water (A incorrect).

The main structural component in plants is the polysaccharide *cellulose* (B correct).

Glucose and fructose are both monosaccharides with the same molecular formula but different atom connectivity. They are structural isomers but not stereoisomers (C incorrect).

NAD^+ (vitamin B_3) is a coenzyme but together with the enzyme would *decrease* the activation energy of the reaction (D incorrect).

Question 5 Answer: D

A – incorrect: compounds X, Y and Z are isomers of pentane but due to different degree of branching have different strength of dispersion forces between molecules and therefore *different* boiling points.

B – incorrect: they are all non-polar.

C – incorrect: cis-trans isomers can only occur if molecule contains a C-C double bond.

D – correct: flash point is the lowest temperature at which a liquid's vapour will ignite. Molecules with the weakest dispersion forces will have the lowest flash point. Compound Z has the highest degree of branching therefore having the weakest dispersion forces and therefore the lowest flash point.

Question 6 Answer: B

A – incorrect: Compound X is symmetrical and has three different hydrogen and C environments and therefore three peaks each in ^{13}C and ^{1}H-NMR.

B – correct: Compound Y has 2 methyl groups in the same chemical environment resulting in the same chemical shift in both spectra. All other carbons and hydrogen atoms are in a different environment and therefore each give a different signal (peak). 2-methylbutane therefore has 4 signals in ^{13}C-NMR and 4 signals in the proton NMR.

C – incorrect: the hydrogen atoms in the four methyl groups are all in the same environment resulting in one peak in proton NMR. Carbon NMR will have two signals: one due to carbons in the four $-CH_3$ groups occupying the same chemical environment and the centre carbon occupying a second different environment.

D – incorrect: see B

Question 7 Answer: D

Percentage yield = actual yield / theoretical yield x 100%

$n(CH_3COCH_3)$ = 65 / 58.1 = 1.119 mol

$n(CHCl_3) = n(CH_3COCH_3)$ = 1.119 mol

$m(CHCl_3)$ = 1.119 x 119.4 = 133.6 g

%yield ($CHCl_3$) = 130 g / 133.6 g x 100 = **97%**

Question 8 Answer: A

Since in the chemical reaction the total mass of reactants is equal to the total mass of reactants, the molar masses can be replaced with the masses of reactants and products.

Atom economy = mass of desired product / mass of all reactants x 100

42.4 / 100 = 130 g / x

x = 130 / 0.424 = 306.6 = **307 g**

Question 9 Answer: A

Activation energy for reverse reaction = 640 - ΔH = 640 – 360 = + 280

Question 10 Answer: C

A, B – incorrect: AgCl is a precipitate and cannot be used as electrolyte solution, introducing a tin rod as electrode will introduce additional cell reaction and may not produce 0.65V.

D – incorrect: using KCl as salt bridge solution may lead to a precipitation of AgCl in half cell containing $AgNO_3(aq)$, $Sn^{4+}(aq)$ also needed to complete oxidation reaction in other half cell.

Question 11 Answer: B

Q = Ixt = 0.05/1000 x 365 x 24 x 60 x 60 = 1576.8 C

$n(e^-)$ = Q/F = 1576.8 / 96500 = 0.01634 mol

n(Cd) = ½ $n(e^-)$ = 0.00817 mol

m(Cd) = 0.00817 x 112.4 = **0.918 g**

Question 12 Answer: C

For a spontaneous reaction to occur the strongest oxidising agent reacts with the strongest reducing agent.

No reaction will occur between Cu(s) and $H^+(aq)$ because the oxidising agent, $H^+(aq)$, is below the reducing agent, Cu(s), in the electrochemical series.

Question 13 Answer: C

Measurements are precise because they are in close agreement (concordant), but not accurate as they are not very close to the true value of 25.00 g.

Question 14 Answer: D

A, B, – incorrect: paper and thin layer chromatography are ideal for qualitative analysis but are not ideal as large – scale purification method as only small amounts are used and compounds are not eluted from the stationary phase.

C – incorrect: NMR spectroscopy is an analytical technique to identify the structure of a molecule, not for the separation of mixtures into its components.

D – column chromatography is the **most** suitable technique for large-scale purification as larger amounts of a mixture can be applied, separated into its components and fractions can be eluted easily from the stationary phase.

Question 15 Answer: B

Fuel cells have a high efficiency as they convert chemical energy directly into electrical energy. (statement I incorrect)

The reaction occurring at the cathode is the reduction reaction and the oxidant consumes electrons. (statement II correct)

Hydrogen gas is the fuel and undergoes oxidation reaction at the anode, producing electrons. Its oxidation number increases from 0 to +1. (statement III correct)

Question 16 Answer: A

In this cell, hydrogen gas is the fuel and undergoes oxidation reaction at the anode, which is negative.

Question 17 Answer: C

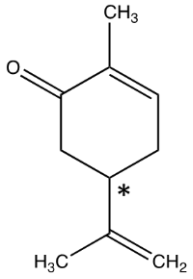
The semistructural formula for compound C is CH_3COCH_2OH. It does not contain the -COOH functional group and therefore is not a carboxylic acid. Compound A is formic acid (methanoic acid), HCOOH, Compound B is ethanoic acid, CH_3COOH, and compound D is propanoic acid, CH_3CH_2COOH.

Question 18 Answer: B

The correct IUPAC name is **3-methylhex-3-ene**. Longest carbon chain: 6 carbons, double bond at third carbon, methyl side chain coming off third carbon.

Question 19 Answer: A

1 chiral centre (*)



Question 20 Answer: B

Using the calibration curve, the absorbance reading for 'X' was 0.45 which gives a concentration of 0.3 mg/mL = 30 mg / 100 mL.

Question 21 Answer: D

'Diet' coke – incorrect – 78 mg per 150 mL = 52 mg per 100 mL
Pepsi Max - – incorrect – 74 mg per 200 mL = 35 mg per 100 mL
'Diet' pepsi - – incorrect - 578 mg per 1.25 L = 46 mg per 100 mL
Red Bull *zero* – correct - 99 mg per 330 mL = **30 mg per 100 mL**

Question 22 Answer: C

Reaction is an endothermic reaction. As temperature increases, the forward reaction is favoured to partially counteract the increase in temperature.

The equilibrium constant, K_c, increases with increasing temperature for an endothermic reaction.

Question 23 Answer: A

The addition of CH_2Cl_2, a product, will increase the number of CH_2Cl_2 molecules and therefore lead to an increase of successful collisions, which will lead to an instant increase the reverse reaction. Consequently, more reactants are produced (CH_4 and CCl_4) from the CH_2Cl_2 molecules. As the concentration of reactants increases and more frequent collisions occur between these molecules, the rate of the forward reaction (formation of CH_2Cl_2) also increases. Ultimately, the rates of forward and reverse reactions become equal again and a new equilibrium is established.

Decrease in pressure would lead to an instant decrease of both forward and reverse reactions. The volume increase would mean decrease in concentration of reactants and products and therefore decrease in rate of forward and reverse reaction.

Adding an inert gas will have no effect on the rate of the reaction as it will not change any of the concentrations of reactants and products.

Question 24 Answer: C

The equilibrium constant, K_c, is only affected by temperature. The increase of concentration of reactants and products will not change K_c.

Question 25 Answer: B

Vitamin D is one of the only vitamins which can be synthesised in the human body (skin).

Question 26 Answer: A

This optimal temperature for enzymes in the human body is around 37.5 C (human body temperature). Above this temperature the enzyme structure begins to break down (**denature**) since at higher temperatures intra- and intermolecular bonds are broken as the enzyme molecules gain even more kinetic energy.

Question 27 Answer: D

All amino acids are in the data book. Cysteine (cys) contains a polar -SH functional group, tryptophan contains a polar -NH group in its side chain, arginine contains a polar $-NH_2$ group. Valine contains a non-polar $-CH(CH_3)_2$ side chain.

Question 28 Answer: C

Fats and oils belong to the larger class of biomolecules called lipids. They contain triglycerides, which contain an ester functional group (-COO) and a long fatty acid tail. Therefore, compound III belongs to lipids.

Compound I is a vitamin (does not contain ester functional group).

Compound II is glycerol (see data book), which contains hydroxyl groups.

Compound IV is a fatty acid (does not contain ester functional group).

Question 29 Answer: A

Propanoic acid is soluble in water due to being able to form hydrogen bonds with water molecules. All the other compounds are insoluble / not miscible in water. (1-decanol – long non-polar hydrocarbon part, heptane and tetrachloromethane are non-polar).

Question 30 Answer: B

Biodiesel molecules derived from plants contain C-C double bonds.

A – incorrect: due to C-C double bonds, hydrocarbon chains contain 'kinks' / bends, which makes the packing of these molecules more difficult / less dense. Therefore, weaker dispersion forces between molecule, therefore *lower* melting point.

B – correct: C-C double bonds in the molecule make biodiesel more susceptible to reaction with oxygen, which leads to biodegradation.

C – incorrect: molecules with C-C double bonds are *unsaturated* molecules.

D – biodiesel molecules contain an ester functional group / polar bonds that allow these molecules to form dipole – dipole interactions with polar water molecules. Biodiesel molecules are therefore *more* hygroscopic than nonpolar petrodiesel.

SECTION B

Question 1 (7 marks)

a. 3 x 1 = **3 marks**

*Hexane – **not** suitable. Pigments have a **low** affinity to hexane and therefore **do not move**.* **1 mark**

*Ethanol - **not** suitable. All pigments have the **same high** affinity to ethanol and travel with the solvent, but **no** separation.* **1 mark**

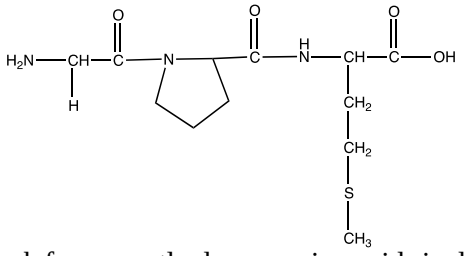
*Diethyl ether – pigments undergo **adsorption and desorption to a different degree** and therefore a **separation is achieved**.* **1 mark**

b. **i**. R_f *– retardation factor* **1 mark**

ii Pigment 1: *Carotene* 1 mark each = **3 marks**
Pigment 2: *Chlorophyll B*
Pigment 3: *Xanthrophyll 2*

Question 2 (11 marks)

a. **3 marks**



1 mark for correctly drawn amino acids including side chains, 1 mark for correct peptide bond, 1 mark for -NH_2 and -COOH at either ends (closed bonds).

b. *Alpha helix* **1 mark**

c. $H_2NCH(CH_2OH)COOH + HCl \rightarrow {}^{+}H_3NCH(CH_2OH)COOH + Cl^{-}$ **2 marks**

1 mark for correct reactants and products, 1 mark for correct amino acid **cation**

d. **i.** One of the following: *meat, fish, eggs, legumes* **1 mark**

ii. *condensation* **1 mark**

iii. $C_6H_{12}O_6(aq) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$ **2 marks**

1 mark for correct reactants and products, 1 mark for correctly balanced and states

iv. *energy* **1 mark**

Question 3 (11 marks)

a. *CF = VIt / ΔT = 1.55 x 7.00 x 180 / (25.65 – 24.60) =* ***1.86 x 10^3 J ºC^{-1}*** **2 marks**
1 mark correctly calculating the energy (VIt) and temperature change, 1 mark for correctly calculating CF in J ºC^{-1}.

b. *E = CF x ΔT = 1.86 x 10^3 x (40.50 – 25.65) = 27.6 kJ / 1.605 g * =* ***17.2 kJ g^{-1}*** *** **2 marks**
1 mark for correctly calculating the energy released.
1 mark for correctly calculating the energy per gram of biscuit (***kJ g^{-1})*** *to 3 sig fig.*

c. Energies available for each food group are in the data book (Table 13) **2 marks**

Per 100 g of biscuit: carbohydrates: 62.0 g x 16 *kJ g^{-1} = 992 kJ, protein: 7.50 g x* 17 *kJ g^{-1} = 127.5 kJ, Fat: 19.6 g x 37 kJ g^{-1} = 725.2*

Energy value = (992 + 127.5 + 725.2) / 100 = ***18 kJ g^{-1}***
1 mark for correctly calculating the energy per gram for each food group.
1 mark for correctly calculating energy value in ***kJ g^{-1}*** *(*2 sig fig).

d. Two of the following: 1 mark for each correct response **2 marks**

- *Not all nutrients from the food are absorbed by the body after digestion.*
- *Not all food may be digested, cellulose cannot be digested.*
- *Cellulose cannot be digested but contributes to heat when combusted in calorimeter.*
- *Incomplete oxidation of nutrients, such as fibre.*
- *Not all heat released by oxidation of food will be available for use in cells.*

e. **i.** *Weigh the biscuit sample, place in oven to dry for a certain amount of time, then re-weigh. If mass is unchanged then the sample is dry.* **1 mark**

ii. *Calculated heat of combustion would have been* ***lower*** (1 mark) *because the original* ***mass*** *of the biscuit* ***was too high*** (1 mark) *due to inclusion of water* **2 marks**

Question 4 (14 marks)

a. $C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$ **2 marks**

1 mark for correct reactants and products, 1 mark for correct balanced equation and states.

b. **i.** *m(ethanol) = 0.785 x 400 L = 314 kg* **1 mark**
n(ethanol) = 314 x10^3 g / 46.1 gmol^{-1} = 6.811 x 10^3 mol **1 mark**
n(O_2) = 3x n(ethanol) = 3 x 6.811 x 10^3 = 2.043 x 10^4 mol **1 mark**
V(O_2) = 24.8 x 2.043 x 10^4 = 506 759 L = ***0.507 ML*** (3 sig fig) **1 mark**

ii. *m(ethanol) = 1000g / 46.1 = 21.7 mol* **1mark**
energy released per mol = 1238 kJ,
energy released per kg = 1238 x 21.7 = ***26.9 MJ*** (3 sig fig) **1 mark**

iii. 1 mol of ethanol releases **5** moles of greenhouse gases (at 500K water will be gas)
*V = nRT / p = **5** x 8.31 x 773 / 101.3 = 317 L* **1 mark**
317L release 1.235 MJ x L release 1 MJ = 317/ 1.235 = **257 L** **1 mark**
Note: ignore sig fig here

iv. Any two of the following: 1 mark each **2 marks**
nitrogen oxides, ozone, carbon monoxide, methane

v. Both statements are correct. 1 mark each **2 marks**

1. *To keep up with large amounts of plants (e.g. sorghum), required land will be cultivated for plant growth and therefore natural habitats will be destroyed. Also, less land will be available for growing resources for food.*
2. *Bioethanol is NOT carbon neutral as energy is required in growing, transport and refining of fuel. This also contributes to emission of CO_2.*

Question 5 (13 marks)

a. i. *$n(CH_3NH_2) = 0.173 \times 0.02000 = 3.46 \times 10^{-3}$ mol* **1 mark**
at equivalence point: $n(CH_3NH_2) = n(HCl) = 3.46 \times 10^{-3}$ mol **1 mark**
*$V(HCl) = 3.46 \times 10^{-3} / 0.115 = 0.03009$ L = **30.1 mL*** (3 sig fig) **1 mark**

ii. The equivalence point is at pH = 6. For table of indicators see data book. **2 marks**

Accept: *methyl red* colour change: *yellow to red* (basic pH to acidic pH) or
Bromothymol blue *blue to yellow*
1 mark for correct indicator, 1 mark for correct colour change.

b. i. *1-propanol* or *propan-1-ol* **1 mark**

ii. *NaOH* or *OH^-* or *H_2O and catalyst* **1 mark**

iii. *CH_3CH_2COOH* **1 mark**

iv. *Oxidation* **1 mark**

v. *$CH_3CH_2COOH(l) + NH_3(g) \rightarrow CH_3CH_2CONH_2(aq) + H_2O(l)$* **1 mark**
1 mark for correct reactants and products.

c. Students should refer to data book, page 12. **3 marks**

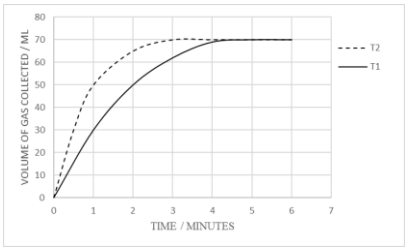
Type of proton	Chemical shift / ppm	Peak area	Splitting pattern
C**H**$_3$-	0.9	3	triplet
CH$_3$-C**H**$_2$-CH$_2$-	1.8	2	Sextet / multiplet
-C**H**$_2$-Cl	3.0– 4.5	2	triplet

1 mark per correct row 3x1 = 3 marks, minus ½ mark for each incorrect entry

Question 6 (10 marks)

a. $n(O_2) = 0.070 / 24.8 = 0.0028226$ mol **1 mark**
$n(H_2O_2) = 2x\ n(O_2) = 2 \times 0.0028226$ mol $= 0.005645$mol **1 mark**
$c\ (H_2O_2) = 0.005645 / 6.50/1000 =$ **0.868 mol L^{-1} (3 sig fig)** **1 mark**

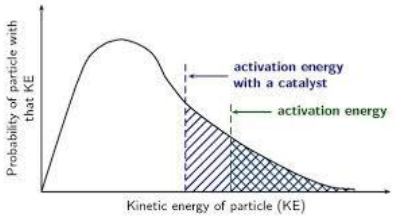
b. **1 mark** for correct graph. See T1 graph on right.
After 4 minutes the volume of collected oxygen gas should not change.



c. **i.** The rate increases with increasing temperature.
Steeper gradient for curve T2 and *70 mL should be reached faster* **1 mark**

ii. Increasing temperature leads to an increase of kinetic energy. *More particles will have energies that are greater than or equal to the activation energy* (1 mark) hence *proportion of successful / fruitful collisions also increases* (1 mark). **2 marks**

d. **1 mark** for correctly showing E_A's for uncatalyzed and catalysed reaction on graph (see below).



A *catalyst (MnO_2) lowers the activation energy of a reaction* by providing an alternative reaction pathway (1 mark). Hence *a greater proportion of particles* will *have energies greater than or equal to the lower activation energy* (1 mark).

Question 7 (8 marks)

a. $Ni^{2+}(aq) + 2e^- \rightarrow Ni(s)$ **1 mark**

b. $n(Ni) = (4.098 - 3.746) / 58.7 = 0.352 / 58.7 = 0.00599$ mol **1 mark**

c. **i.** $Q = It = 2.00 \times 10 \times 60 = 1200$ C **1 mark**

ii. $N(e^-) = Q /$ charge on one electron $= 1200 / 1.6 \times 10^{-19} = 7.50 \times 10^{21}$ **1 mark**

iii. $n(e^-) = 2 \times n(Ni) = 2 \times 0.00599 = 0.01199$ mol **2 marks**
N_A = number of electrons / number of moles of $e^- = 7.50 \times 10^{21} / 0.01199 =$ ***6.25 x 10^{23} mol^{-1}***

d. *Experimentally determined N_A by student is* ***slightly larger*** (1 mark) *than N_A (6.02×10^{23} mol^{-1})*
reason: *some Ni(s) may have fallen off during electrolysis* (1 mark)
(less weight = less n_{Ni} = less n_{e^-} = larger N_A) **2 marks**
Accept any other acceptable reasons which could lead to a decrease in mass of electrode. But electrode not totally dry would lead to lower N_A.

Question 8 (4 marks)

a. *Exothermic reaction* therefore *decreasing the temperature would shift equilibrium to the right (1mark) dissolving more CO_2 gas in water (1 mark) making the drink bubblier*. **2 marks**

b. $CO_2(g) + H_2O(l) \rightleftharpoons HCO_3^-(aq) + H^+(aq)$ or **2 marks**
$CO_2(g) + H_2O(l) \rightleftharpoons CO_3^{2-}(aq) + 2H^+(aq)$
As a bottle is opened, $CO_2(g)$ escapes from it (removing reactant) shifting equilibrium to the left to partially compensate for the loss of $CO_2(g)$ hence decreasing $[H^+(aq)]$ and increasing the pH
1 mark for correct equation forming $H^+(aq)$ ions.
1 mark for correct explanation of why pH increases.

Question 9 (5 marks)

a. *Vitamin C interrupts propagation of free radicals* (1 mark) (do not accept "stop" formation of free radicals) *by donating hydrogen atoms to radicals*

Hydroxyl functional groups (1 mark) facilitate this process (structure of vitamin C is available in data book) **2 marks**

b. One of the following: **1 mark**
- *perceived less safe by consumers*
- *can be detrimental to health if level of BHA in food is not regulated / too high.*

c. Two of the following: **2 marks**
- *nitrogen gas is an inert gas and filling the bags with nitrogen instead of air will prevent chemical reaction / oxidative rancidity from happening*
- *prevent the chips from oxidizing, which is part of what makes them go stale / rancid*
- *prevent chips to react with moisture from air and becoming soggy*
- *gas also gives the chips a cushion protecting the chips from damage during transportation.*
- *foil is a good barrier for light, which would speed up the rancidity process.*

Question 10 (7 marks)

a. *Pb: 0, PbO_2: +4, $PbSO_4$: +2;* **1 mark**
1 mark for all three oxidation numbers assigned correctly.
Need sign for mark. Do not accept notations such as 4+, 2+ or IV, II.

b. Negative/–/anode $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$ or $Pb(s) \rightarrow Pb^{2+}(aq) + 2e^-$
Positive/+/cathode $PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$
or $PbO_2(s) + 4H^+(aq) + 2e^- \rightarrow Pb^{2+}(aq) + 2H_2O(l)$
or $PbO_2(s) + H_2SO_4(aq) + 2H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$

1 mark each for correct half equation of oxidation and reduction reaction. **2 marks**

c. When the cell is recharged, the reverse reaction takes place. Sulfuric acid is produced / water is used up and therefore *concentration of sulfuric acid increases.* **1 mark**

d. *Decreasing order: Z, Y, X* or *Z > Y > Z* **1 mark**

Z is a stronger reducing agent than Y and/or X **or** *Z most reactive as it can reduce/displace both* Y^{2+} *and* X^{+}*;* **1 mark**

Y is a stronger reducing agent than X but not Z **or** *Y in the middle (of the three) as it can reduce/displace* X^{+} *but not* Z^{2+} **1 mark**

Accept converse argument. Do not accept: Z^{2+}, Y^{2+}, X^{+} *for Z, Y and X.*