Neap:

Trial Examination 2016

VCE Chemistry Units 3&4

Written Examination

Question and Answer Booklet

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

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*	*Suggested time (minutes)*
A	30	30	30	40
B	10	10	90	110
			Total 120	Total 150

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.

Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

Question and answer booklet of 27 pages.

A data booklet.

Answer sheet for multiple-choice questions.

Instructions

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

All written responses must be in English.

At the end of the examination

Place the answer sheet for multiple-choice questions inside the front cover of this booklet.

You may keep the data booklet.

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

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2016 VCE Chemistry Units 3&4 Written Examination.

SECTION A – MULTIPLE-CHOICE QUESTIONS

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

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

Question 1

The balanced equation below represents the reaction between hydrogen peroxide and concentrated nitric acid.

$$2NO_3^-(aq) + H_2O_2(aq) + 2H^+(aq) \rightarrow 2NO_2(g) + O_2(g) + 2H_2O(g)$$

During this reaction, hydrogen peroxide acts as

A. a reductant, and the oxidation number of oxygen increases by 1.

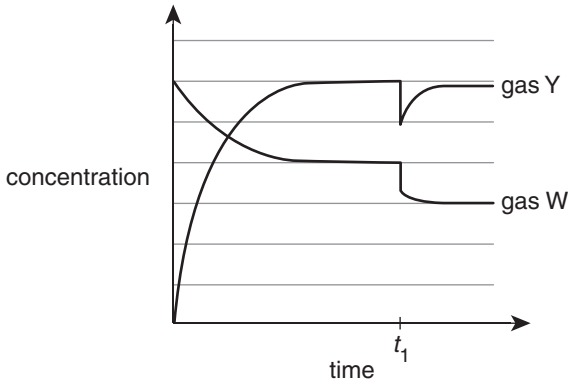
B. a reductant, and the oxidation number of oxygen increases by 2.

C. an oxidant, and the oxidation number of oxygen increases by 1.

D. an oxidant, and the oxidation number of oxygen increases by 2.

Question 2

The gases W and X were placed in a sealed container and allowed to reach equilibrium in an exothermic reaction represented by the equation $W(g) + X(g) \rightleftharpoons 3Y(g) + Z(g)$. The graph below shows the concentration of gases W and Y throughout the reaction.



Which one of the following most likely occurred at time t_1?

A. Samples of gas W and gas Y were added to the container.

B. The gases in the container were heated to a higher temperature.

C. The volume of the container was increased at constant temperature.

D. An inert gas was injected into the mixture at constant temperature.

Use the following information to answer Questions 3–5.

Ammonia is formed in the reaction of nitrogen gas and hydrogen gas:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Variables for the reaction include:

I equilibrium constant at 400°C: $0.0520\ M^{-2}$

II enthalpy change: $-92.4\ kJ\ mol^{-1}$

III activation energy: $242.6\ kJ\ mol^{-1}$

Question 3

If a catalyst for the reaction was used, which of the variables would **not** be affected?

A. I and II only

B. II and III only

C. I and III only

D. I, II and III

Question 4

The activation energy for the decomposition of two mole of ammonia to produce the gases nitrogen and hydrogen is

A. $92.4\ kJ\ mol^{-1}$

B. $150.2\ kJ\ mol^{-1}$

C. $242.6\ kJ\ mol^{-1}$

D. $335.0\ kJ\ mol^{-1}$

Question 5

Consider the reaction below.

$$4NH_3(g) \rightleftharpoons 2N_2(g) + 6H_2(g)$$

What is the magnitude of the equilibrium constant for the above reaction at 400°C?

A. 2.70×10^{-3}

B. 5.20×10^{-2}

C. 38.4

D. 370

Question 6

At 75°C, the self-ionisation constant (K_w) of pure water is 2.0×10^{-13}.

Which one of the following statements is correct?

A. At 75°C the water is basic, with the hydroxide concentration being 4.5×10^{-7} M.

B. At 90°C the value of K_w is greater than 2.0×10^{-13}.

C. Cooling the water produces a more acidic liquid.

D. The self-ionisation of water is an exothermic process.

Question 7

Equal volumes of 0.050 M $Ba(OH)_2$ and 0.050 M HCl solutions were mixed.

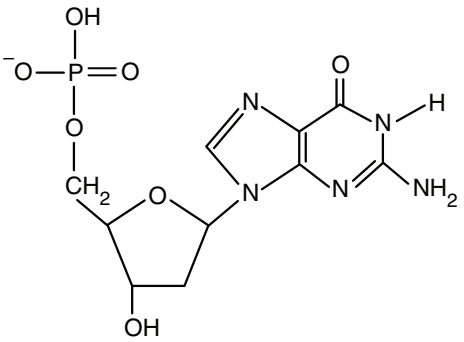
When the reaction is complete, what is the best approximation of the pH of the resulting solution at 25°C?

A. 2
B. 7
C. 9
D. 12

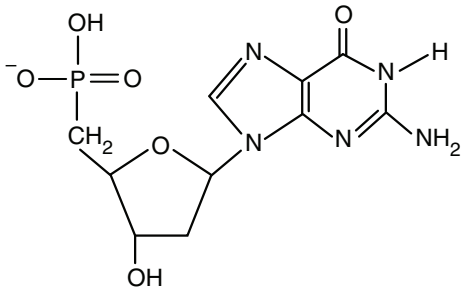
Question 8

Which of the following correctly shows the structure of the DNA monomer, a guanine-based nucleotide?

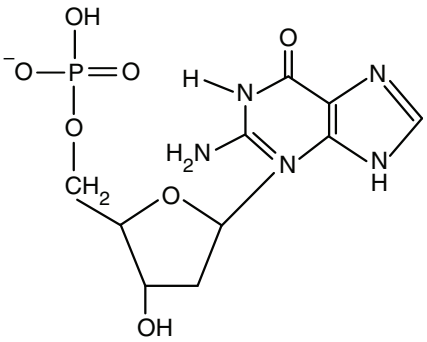
A.



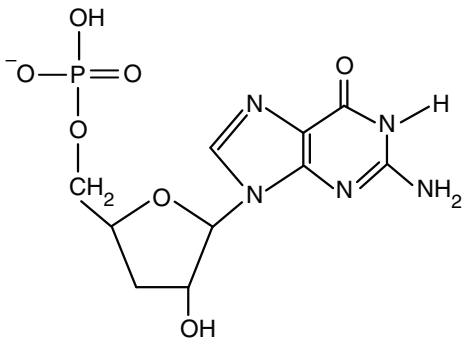
B.



C.



D.



Use the following information to answer Questions 9 and 10.

Using suitable conditions, two mole of HCl reacts completely with one mole of $H_2CCHCHCH_2$.

Question 9

Which of the types of reaction listed below occurred when HCl reacted with $H_2CCHCHCH_2$?

A. substitution
B. condensation
C. addition
D. esterification

Question 10

What is name of the product formed when a complete reaction occurs?

A. 2-chlorobut-1-ene
B. 3-chlorobut-1-ene
C. 2,3-dichlorobutane
D. 3,4-dichlorobutane

Question 11

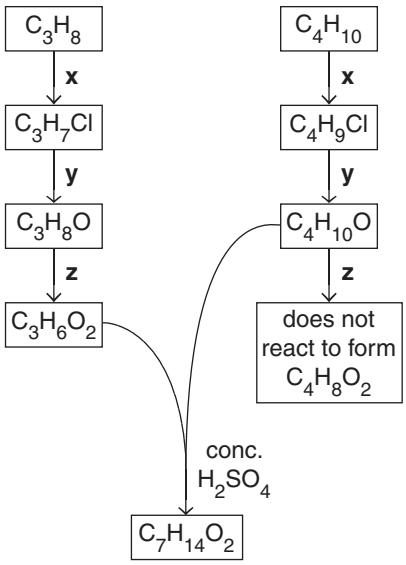
A protein in solution is heated and then the pH is lowered from 7 to 5.

Which level/s of protein structure will be affected by these processes?

A. primary and secondary only
B. secondary and tertiary only
C. tertiary only
D. primary, secondary and tertiary

Use the following information to answer Questions 12 and 13.

The flowchart below shows the reaction pathways leading to the formation of an ester of molecular formula $C_7H_{14}O_2$.



Question 12

Which of the following alternatives correctly identifies possible reagents x, y and z?

	x	y	z
A.	Cl_2/UV light	H_2O	NaOH
B.	HCl/catalyst	NaOH	MnO_4^-/H^+
C.	Cl_2/UV light	NaOH	MnO_4^-/H^+
D.	HCl/catalyst	MnO_4^-/H^+	H_2O

Question 13

Which of the following is **not** a structural isomer of the ester $C_7H_{14}O_2$?

A. heptanoic acid
B. ethylpentanoate
C. 1-propylbutanoate
D. 1-butylbutanoate

Question 14

A sample of an ore was dissolved in acid and the resultant solution was analysed by atomic absorption spectroscopy (AAS). The following statements relate to this analysis:

I Both the identity and concentration of positive and negative ions can be measured in this analysis.

II Each ion analysed will require a separate set of standards to be measured and a calibration graph plotted.

Which of these statements is/are correct?

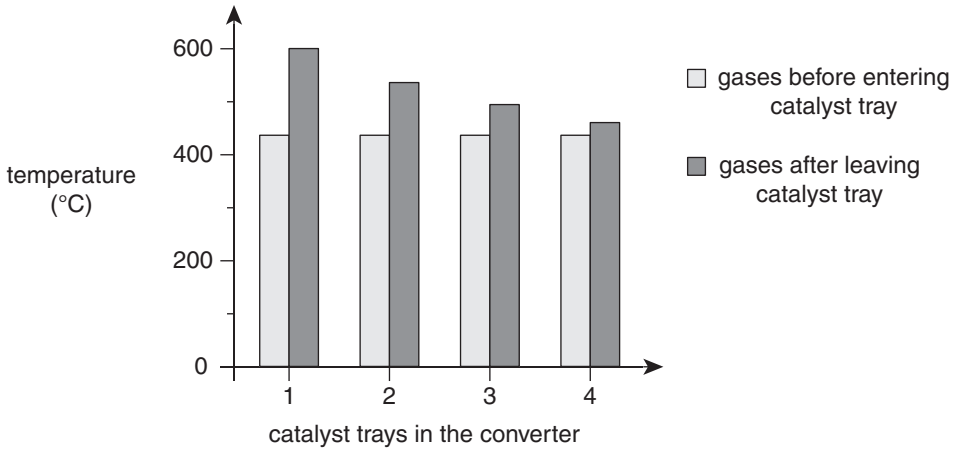
A. I only
B. II only
C. I and II
D. neither I nor II

Use the following information to answer Questions 15 and 16.

In the industrial manufacture of a compound, the following reaction occurs when the reactant gases are passed over a series of four trays of catalyst in a vessel known as the converter:

$$2X(g) + 3O_2(g) \rightleftharpoons 2Y(g)$$

The temperature of the gases in the converter was monitored and the results are shown in the graph below.



Question 15

From the information provided, it can be concluded that the conditions needed for maximum yield of compound Y are

A. high temperature and high pressure.
B. high temperature and low pressure.
C. low temperature and high pressure.
D. low temperature and low pressure.

Question 16

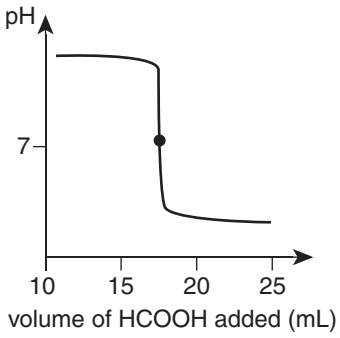
Which one of the following is most likely to be the physical state of the catalyst?

A. large blocks
B. fine powder
C. sheets of gauze
D. small pellets

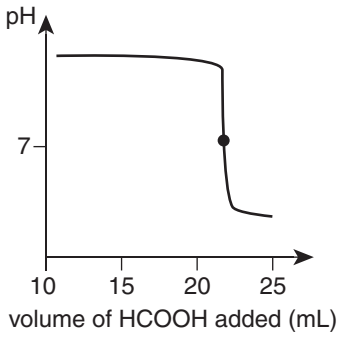
Question 17

Which of the following shows the expected graph of pH in the titration flask as 20.00 mL of 0.087 M sodium hydroxide is titrated with a standardised 0.100 M methanoic acid (HCOOH) solution?

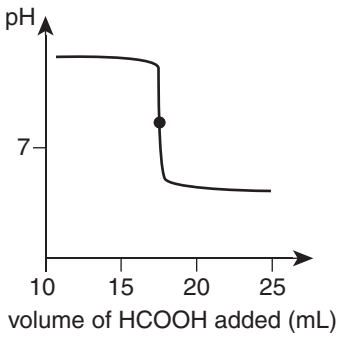
A.



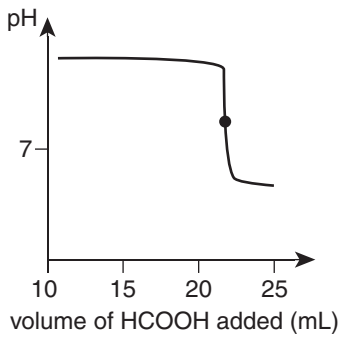
B.



C.



D.



Use the following information to answer Questions 18 and 19.

An aqueous solution of 1 M nickel sulfate ($NiSO_4$) is used as the electrolyte in an electrolytic cell with inert electrodes.

Question 18

Which of the following shows the likely products at the electrodes?

	Anode	**Cathode**
A.	oxygen gas	nickel metal
B.	nickel metal	hydrogen gas
C.	hydrogen gas	nickel metal
D.	oxygen gas	hydrogen gas

Question 19

If the inert electrodes were replaced with copper electrodes and the electrolysis was repeated under identical conditions, would the products at each electrode be the same as the original experiment or will different products form?

A. The same products as the original electrolysis will form at each electrode.

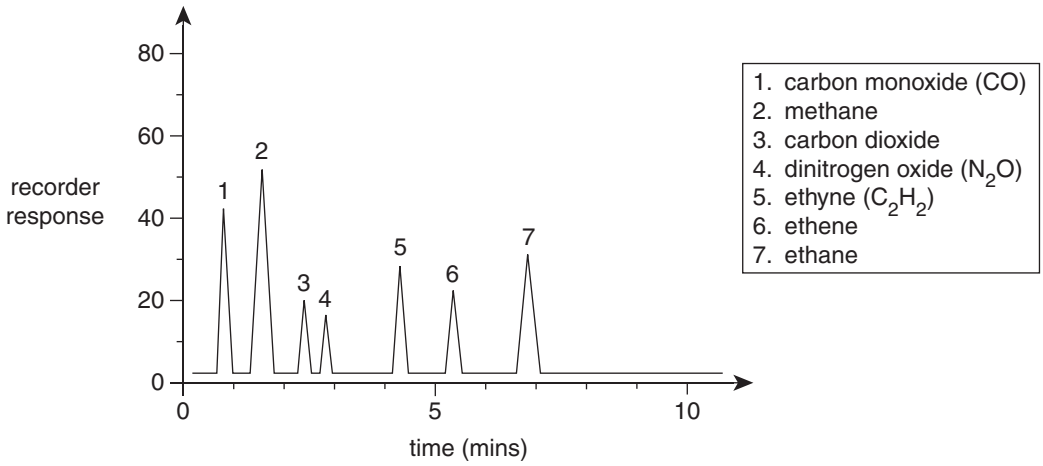
B. A different product will form only at the positive electrode.

C. A different product will form only at the negative electrode.

D. Different products to the original electrolysis will form at both electrodes.

Use the following information to answer Questions 20 and 21.

A sample of a mixture of gases was analysed by gas chromatography (GC) and produced the results below.



Question 20

Some gases which are used as carrier gases in GC include:

I helium

II hydrogen

III nitrogen

Which of these gases would be suitable as a carrier gas for the analysis shown?

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

Question 21

Which one of the following would be affected most by changing the temperature of the GC column?

A. the retention time of the gases in the mixture
B. the flow rate of carrier gas through the column
C. the area under each of the peaks in the sample
D. the order of elution of gases from the column

Question 22

Consider the following thermochemical equations:

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g) \qquad \Delta H = -484 \text{ kJ mol}^{-1}$$

$$2H_2O(l) \rightarrow 2H_2(g) + O_2(g) \qquad \Delta H = +572 \text{ kJ mol}^{-1}$$

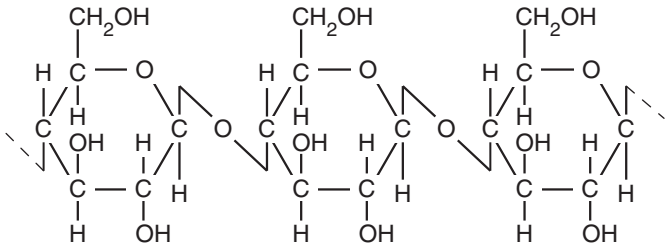
$$H_2O(g) \rightarrow H_2O(l) \qquad \Delta H_1 = ?$$

Based on the data provided, the value of ΔH_1 (in kJ mol^{-1}) is

A. –528
B. –88
C. –44
D. +88

Use the following information to answer Questions 23 and 24.

Part of the structure of the carbohydrate cellulose is shown below.



Question 23

Cellulose is a polymer made by linking carbohydrate monomer units.

Which of the following regarding the above reaction is correct?

	Linkage between monomer units	Type of reaction which forms cellulose from monomer units
A.	amide	polymerisation
B.	ether	addition
C.	ester	esterification
D.	glycosidic	condensation

Question 24

A particular enzyme will break down cellulose into its monomer units.

Which of the following statements concerning this enzyme is correct?

A. The enzyme itself will be a carbohydrate molecule.

B. The cellulose molecule will bond temporarily to the enzyme so that the cellulose linkages can be broken.

C. The active site of the enzyme is formed by the interactions of the atoms in the peptide links between the amino acid units which compose the enzyme.

D. Boiling a solution of the enzyme will destroy its catalytic ability, but cooling back to room temperature will reform the active site.

Question 25

Identical pieces of zinc were placed in the following solutions under standard conditions:

I $Pb(NO_3)_2(aq)$

II $MnCl_2(aq)$

III acidified $H_2O_2(aq)$

Which solutions are likely to react with the zinc?

A. I and III only

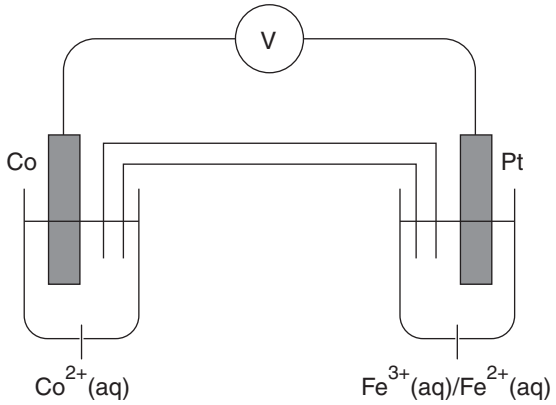
B. II only

C. I, II and III

D. none of I, II or III.

Use the following information to answer Questions 26 and 27.

A galvanic cell was constructed as shown in the diagram below.



Question 26

Which one of the following statements is accurate when the cell is producing electrical energy?

A. The platinum electrode is the cathode.

B. The mass of the cobalt electrode will increase over time.

C. Positive ions will travel in the salt bridge towards the Co^{2+}/Co half-cell.

D. Electrons move from the cathode to the anode.

Question 27

Eventually the cell will cease producing electrical energy.

At this time

A. the platinum electrode will be mostly dissolved.

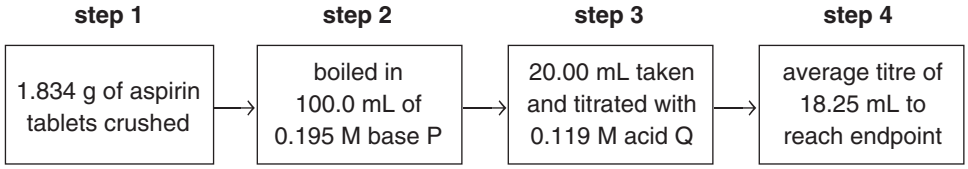
B. no ions will be present in the salt bridge.

C. the cell reaction will be at equilibrium.

D. there will be no Co^{2+} ions anywhere in the cell.

Use the following information to answer Questions 28–30.

Aspirin tablets contain not only the active ingredient acetylsalicylic acid, but also sweeteners for acceptable taste and fillers to make the tablets easier to hold. To find the aspirin content in a sample of tablets, the following procedure was used:



Question 28

What is the likely identity of base P and acid Q?

	Base P	Acid Q
A.	ammonia solution	ethanoic acid
B.	sodium hydroxide solution	hydrochloric acid
C.	sodium hydroxide solution	ethanoic acid
D.	ammonia solution	hydrochloric acid

Question 29

It can be calculated from the data that 0.00864 mol of base P reacted in step 2. Each mole of aspirin reacts completely with one mole of base P.

Given that the molar mass of aspirin is 180.2 g mol^{-1}, what is the percentage by mass of aspirin in the tablets?

A. 41.9
B. 42.5
C. 83.7
D. 84.9

Question 30

The analysis was repeated but, in step 3, the 20.00 mL aliquot was taken using a pipette which had been washed with water and left wet.

Which one of the following statements concerning the effect of this action is **incorrect**?

A. The calculated percentage by mass of aspirin is higher than the true value.
B. The volume of acid Q used in step 3 is less than expected if the titration had been correctly performed.
C. The calculated amount of base P reacting in step 2 is higher than expected if the titration had been correctly performed.
D. The amount of base P added in step 2 is lower than expected if the titration had been correctly performed.

END OF SECTION A

SECTION B – SHORT-ANSWER QUESTIONS

Instructions for Section B

Answer **all** questions in the spaces provided. Write using 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 answers to numerical questions; no marks will be given for an incorrect answer unless it is accompanied by details of the working
- make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $H_2(g)$, NaCl(s).

Question 1 (9 marks)

Thin-layer chromatography (TLC) was used to identify the four different amino acids in a small peptide. The peptide sample was hydrolysed in acid conditions to release the individual amino acids into a mixture.

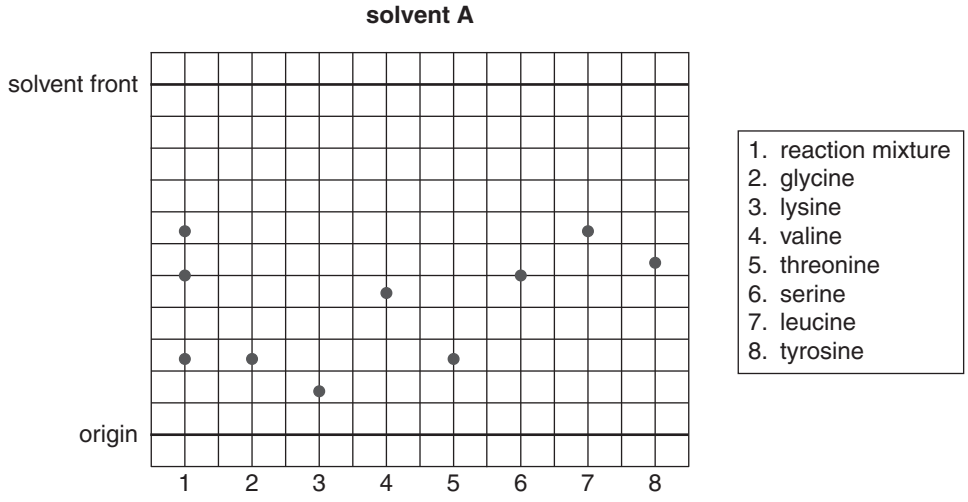
a. i. Name the type of linkage broken in the hydrolysis reaction. 1 mark

_____

ii. Name a functional group formed as a result of the hydrolysis reaction. 1 mark

_____

b. The reaction mixture was analysed by TLC using solvent A as the mobile phase. Some standard amino acid samples were also analysed. A drawing of the results is shown below.



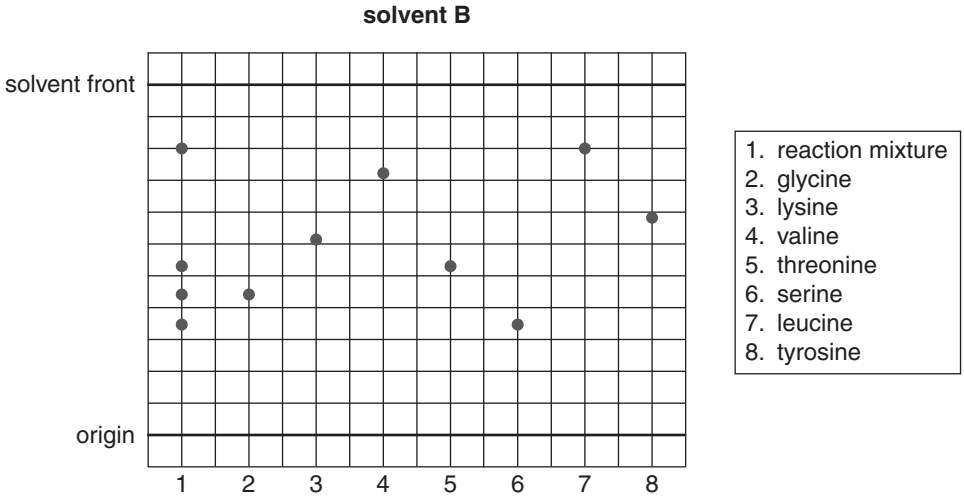
i. Calculate the R_f value of the amino acid standard with strongest attraction for the stationary phase. 1 mark

_____

ii. Name **one** amino acid which is not a component of the peptide. 1 mark

_____

c. It was noted that the TLC plate had only three spots for the reaction mixture (lane 1) whereas the peptide was composed of four amino acids. To investigate this discrepancy, the TLC analysis was repeated under identical conditions, except that a different mobile phase (solvent B) was used. A drawing of the TLC plate is shown below.



i. Explain why the first plate had three spots for the reaction mixture (lane 1) but the second plate has four spots for the same mixture. 2 marks

_____

_____

_____

_____

_____

ii. At a particular pH an amino acid has both a positive and negative charge, and is known as a zwitterion.

Draw the zwitterion structure of the amino acid which is a component of the peptide and has the lowest molar mass of the four amino acids. Show all bonds. 2 marks

iii. Which of the amino acids composing the peptide could form hydrogen bonds in the tertiary structure of a protein? 1 mark

_____

Question 2 (9 marks)

Solutions of 0.010 M ethanoic acid and sulfuric acid were prepared at 25°C.

a. The pH of the ethanoic acid is 3.4. From this information, the acidity constant of ethanoic acid can be determined.

i. Write an expression for the acidity constant (K_a) of ethanoic acid in terms of the concentration of the chemical species present. 1 mark

ii. Using the information provided, calculate the acidity constant for ethanoic acid at 25°C. 2 marks

_____

_____

_____

_____

iii. State **one** assumption made in your calculation in part **a. ii.** 1 mark

_____

_____

b. Sulfuric acid is a strong, diprotic acid.

i. Write chemical equations for the successive ionisation of sulfuric acid in water. 2 marks

_____

_____

ii. A student calculated the pH of the 0.010 M sulfuric acid solution to be 1.69. The actual value is higher than this.

Explain the student's error in performing the calculation. 1 mark

_____

_____

_____

iii. Using the same method as in part **b. ii.**, the student calculated the pH of a 0.000010 M sulfuric acid solution to be 5.0. This is very close to the actual value.

Explain why the student obtained the nearly correct answer in this calculation. 2 marks

_____

_____

_____

_____

Question 3 (8 marks)

To find the sulfate content of a garden fertiliser, a student used the following steps in a laboratory experiment:

- Step 1: A 2.0 g sample of the fertiliser was stirred in 100 mL of water to dissolve it.
- Step 2: 60 mL of 0.20 M barium chloride solution was added and a white precipitate of barium sulfate formed.
- Step 3: The precipitate was removed by filtration and was allowed to dry in air on the filter paper for 24 hours. The mass of the solid obtained was 3.2 g.

a. Write the ionic equation for the precipitation reaction. 1 mark

_____

b. Calculate the percentage by mass of sulfate in the fertiliser. 3 marks

_____

_____

_____

_____

c. The experimental method used by the student shows a number of deficiencies (errors and/or omissions).

In the table below, identify **two** deficiencies in the procedure used that could affect the reliability of the calculated result. 2 marks

	Deficiency which could affect the reliability of the calculated result
1	
2	

d. Choose **one** deficiency identified in the table in part **c.** and explain how this would affect the calculated value of the percentage of sulfate in the fertiliser. 1 mark

_____

_____

_____

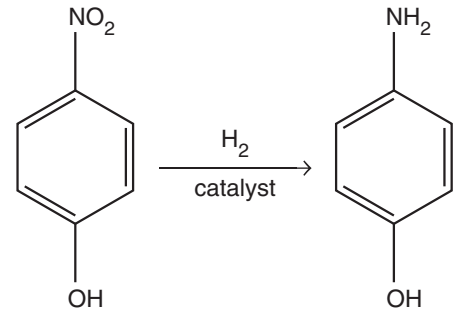
e. Assuming that all the deficiencies in the experimental steps were corrected, what further action could be taken to improve the reliability of the experimental determination of the percentage of sulfate in the fertiliser? 1 mark

_____

_____

Question 4 (10 marks)

A new catalyst has been developed which allows the following reaction to be completed in less than one minute, rather than the usual time of more than one hour:



4-nitrophenol 4-aminophenol

a. **i.** Explain how a catalyst can increase the rate of a reaction. 2 marks

_____

_____

_____

_____

ii. Increasing the temperature can also increase the rate of a reaction.

Give **one** advantage of using a catalyst to increase the reaction rate rather than using a temperature increase. 1 mark

_____

_____

b. Circle **one** of the terms below to describe the type of reaction occurring when 4-nitrophenol is converted to 4-aminophenol. 1 mark

substitution *addition* *oxidation* *reduction* *condensation* *hydrolysis*

c. It is known that 4-nitrophenol absorbs strongly at 400 nm only, while 4-aminophenol absorbs strongly at 295 nm only.

i. Why do different compounds absorb radiation of different wavelengths? 2 marks

_____

_____

_____

_____

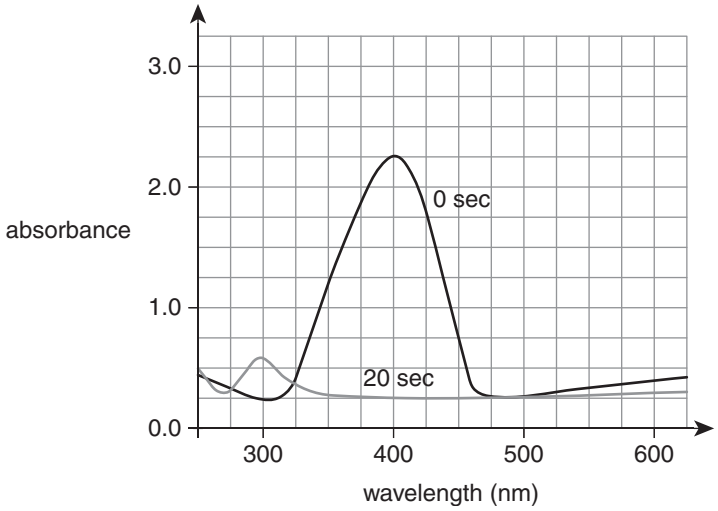
ii. How is the wavelength of the maximum absorbance of 4-aminophenol determined? 1 mark

_____

_____

_____

d. An experiment was conducted to investigate the effectiveness of the new catalyst by measuring the absorbance of a reaction mixture before the reaction commences (0 seconds), and 20 seconds after the reaction was initiated. The results are shown below.



i. Over a range of wavelengths, the absorbance of the mixture is not zero.

Suggest a reason for the non-zero absorbance at wavelengths other than near 295 nm and near 400 nm. 1 mark

_____

_____

_____

ii. What evidence is presented in the spectral data that the new catalyst is highly effective? 2 marks

_____

_____

_____

_____

_____

Question 5 (11 marks)

The fatty acids present in a lipid sample are shown in the table below. Additional information about fatty acids is found in the Data Booklet.

Fatty acid	**Lauric**	**Palmitic**	**Stearic**	**Oleic**	**Linoleic**
% by mass	1	28	17	47	7
Molar mass ($g\ mol^{-1}$)	200	256	284	282	280

a. What is the total percentage of saturated fatty acids in the lipid sample? 1 mark

_____

b. The lipid sample was composed only of triglycerides. The fatty acids in the triglycerides were released in a chemical reaction using a sodium hydroxide solution. After some time the reaction mixture separated into a non-aqueous layer floating on an aqueous layer.

i. Apart from water molecules, give the formula of a compound which is likely to be found in the aqueous layer. 1 mark

_____

ii. Explain why the compound in part **b. i.** is water-soluble. 2 marks

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c. 50.0 g of fatty acids obtained from the lipid sample was reacted with excess hydrogen gas using suitable conditions.

Calculate the mass of hydrogen gas needed for a complete reaction. 3 marks

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d. Research is continuing in the development of the biochemical fuel methyl palmitate, which is produced in the reaction of methanol and palmitic acid.

i. Write a balanced chemical equation for the reaction of methanol with liquid palmitic acid. 2 marks

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ii. An advantage of biochemical fuels is that they do not add a significant overall amount of carbon dioxide gas to the atmosphere when burnt.

Explain why biochemical fuels are considered to be 'carbon neutral'. 2 marks

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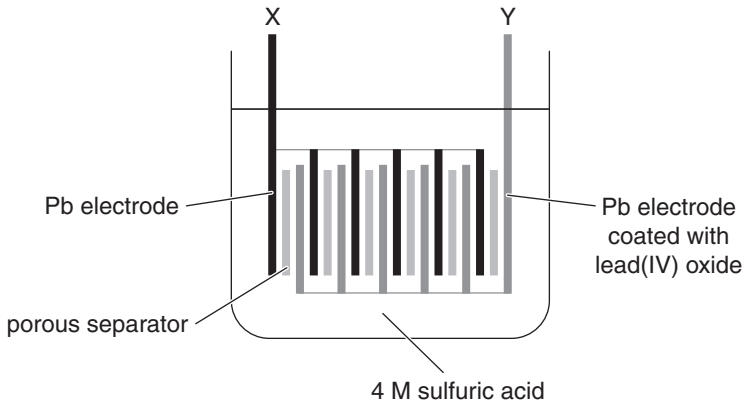
Question 6 (7 marks)

The lead–acid battery used in cars consists of six cells. The basic design of the battery is shown below.



The following half-equations are relevant to the operation of the lead–acid cell:

$$PbSO_4(s) + 2e^- \rightleftharpoons Pb(s) + SO_4^{2-}(aq) \qquad E° = -0.36 \text{ V}$$

$$PbO_2(s) + 4H^+(aq) + SO_4^{2-}(aq) + 2e^- \rightleftharpoons PbSO_4(s) + 2H_2O(l) \qquad E° = +1.69 \text{ V}$$

a. State **one** function of the porous separator. 1 mark

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_____

b. **i.** Write an equation for the overall cell reaction when electrical energy is being produced. 1 mark

_____

ii. Calculate the voltage of the cell using the $E°$ values provided. 1 mark

_____

iii. Suggest a reason why the actual voltage of the cell could be different to the voltage calculated from the $E°$ values. 1 mark

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c. Tick **one** box in the table below to show the chemical reaction occurring at electrode Y, and its polarity, when the cell is discharging. 1 mark

	Positive	**Negative**
Oxidation		
Reduction		

d. To recharge the lead–acid battery, an external power supply must be attached to the electrodes.

i. On the diagram below, draw lines to represent wires showing the correct connections to recharge the lead–acid battery. 1 mark

lead–acid battery power source

ii. Write the equation for the reaction occurring at the positive electrode when the battery is being recharged. 1 mark

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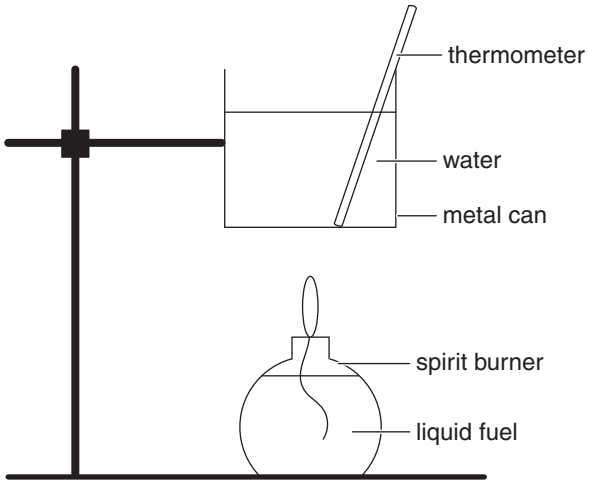
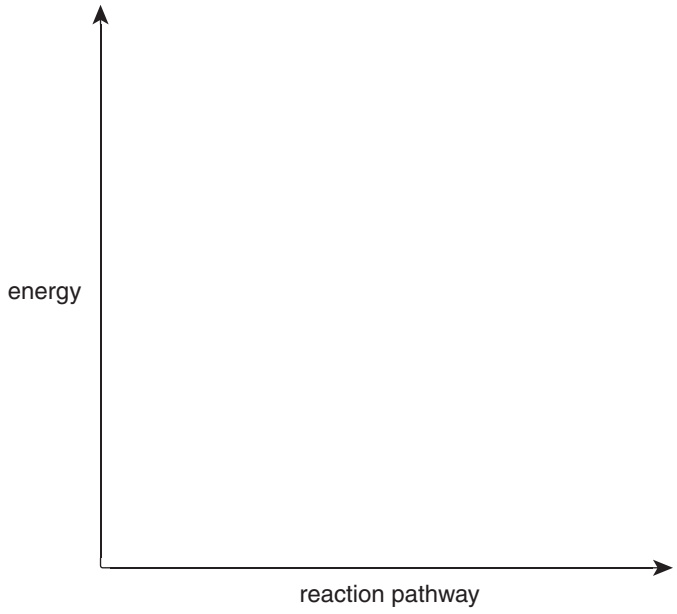
Question 7 (10 marks)

The enthalpy of combustion of 2-propanol was investigated using the equipment shown in the diagram below.



a. Draw the energy profile for reaction of 2-propanol as a fuel. Include the following labels on your profile: reactants, products, ΔH. 2 marks



b. When 1.29 g of 2-propanol was burnt in the spirit burner to heat 200 g of water in the metal can, the temperature of the water increased by 37.6°C.

i. Based on this data, calculate the amount of energy released by 1.00 mol of 2-propanol. 3 marks

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ii. Calculate the percentage of the energy from the 2-propanol which was actually transferred to the water. 1 mark

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c. In a separate experiment, 2.80 g of 2-propanol was completely oxidised in a calorimeter with a calorimeter constant of 1.473 $kJ°C^{-1}$.

Calculate the expected temperature rise in the calorimeter. 2 marks

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d. 2-propanol can be produced in a chemical reaction using an alkene as a reactant.

Write the chemical equation, using semi-structural formulas, for this reaction. Symbols of state are **not** required, but any catalyst needed should be included in your answer. 2 marks

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Question 8 (7 marks)

Hydrogen gas is produced industrially using the chemical reaction shown in the equation below.

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g) \qquad \Delta H = +206 \text{ kJ mol}^{-1}$$

a. Methane gas is extracted from natural gas.

Why is this method for the industrial production of hydrogen gas **not** sustainable? 1 mark

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b. Using high temperature would maximise both the rate of reaction and the yield.

Explain why. 2 marks

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c. The numerical value of the equilibrium constant for the reaction at a particular temperature is 0.26. A mixture of the following gases is held in a sealed 3.0 L container at this temperature.

CH_4	H_2O	CO	H_2
1.5 mol	0.75 mol	0.90 mol	0.60 mol

i. Show that this mixture of gases is not at equilibrium. 3 marks

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ii. Which way would the reaction shift (to the product side or to the reactant side) in order to reach equilibrium? 1 mark

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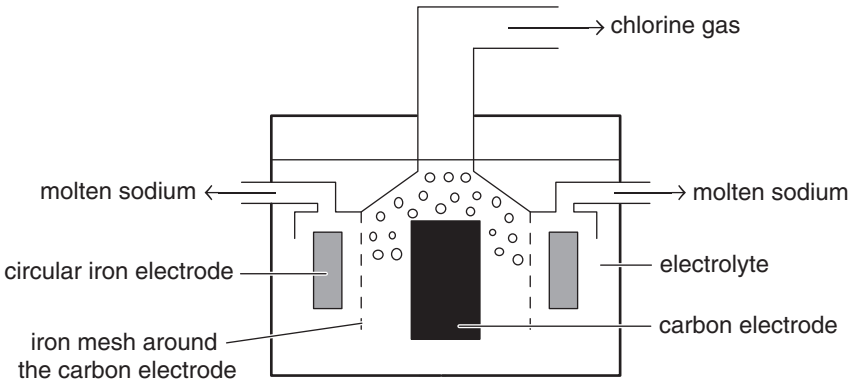
Question 9 (8 marks)

The electrolytic cell used for the industrial production of sodium is shown in the diagram below.



a. A molten electrolyte of sodium chloride is used.

Explain why an aqueous solution of sodium chloride could not be used as the electrolyte. 2 marks

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b. Chlorine gas is produced at the carbon electrode.

i. Write the equation for the reaction at this electrode. 1 mark

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ii. An iron electrode is used to generate the molten sodium. A carbon electrode is used to generate the chlorine gas.

Explain why iron is not used as the electrode for chlorine production. 1 mark

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c. The iron mesh around the carbon electrode is used to ensure that the products of the electrolysis reaction do not come into contact.

Why is this precaution necessary? 1 mark

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d. The cell is run at 7.0 volts with a current of 30 000 amperes.

Calculate the mass of sodium produced in 12.0 hours, assuming that the process is 100 per cent efficient. 3 marks

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Question 10 (11 marks)

An organic compound has the empirical formula C_2H_4O. Results of spectroscopic analyses of the compound are shown in the table below.

Mass spectroscopy	molecular ion peak at m/z = 88			
Infrared spectroscopy	major absorption band at 1715 cm^{-1}			
Low-resolution ^{1}H NMR	**Chemical shift (ppm)**	1.11	2.32	3.65
	Relative peak area	3	2	3
High-resolution ^{1}H NMR	**Number of fine peaks**	3	4	1
^{13}C NMR	chemical shift (ppm): 9.3; 27.6; 51.4; 174.6			

a. **i.** Write the formula of the species that produces the peak at m/z = 88 in the mass spectrum of the compound. 1 mark

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ii. Calculate the volume (in litres) occupied by 5.81 g of the compound at 100°C and 1.0 atm pressure. 2 marks

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_____

b. Give **one** conclusion about the structure of the compound from the results of the spectroscopic analysis for each of the following:

i. infrared spectroscopy 1 mark

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_____

ii. low-resolution ^{1}H NMR 1 mark

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_____

iii. high-resolution ^{1}H NMR 1 mark

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iv. ^{13}C NMR 1 mark

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c. Further tests on the compound showed that it was not a carboxylic acid.

i. Describe a chemical test, and the result of the test, which would show that the compound was not a carboxylic acid. 2 marks

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ii. Draw the structure of the compound, showing all bonds. 2 marks

END OF QUESTION AND ANSWER BOOKLET