INSIGHT

Year 12 *Trial Exam Paper*

2013

CHEMISTRY

Written examination

STUDENT NAME:

QUESTION AND ANSWER BOOK

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	30	30	30
B	13	13	98
			Total 128

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

Materials provided

- The question and answer book of 35 pages
- An answer sheet for multiple-choice questions.
- A data sheet

Instructions

- Remove the data sheet from this book during reading time.
- Write your **name** in the box provided.
- You must answer the questions in English.

At the end of the examination

- Place the multiple-choice answer sheet inside the front cover of this question and answer book.

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

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SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for the multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
1 mark will be awarded for a correct answer; no marks will be awarded for an incorrect answer.
Marks are **not** deducted for incorrect answers
No marks will be awarded if more than one answer is chosen for any question.

Question 1

A student wishes to determine the zinc content of a corroded piece of zinc. She dissolves the 1.46 g sample in sulfuric acid, and then adds excess sodium carbonate, Na_2CO_3. This neutralises the acid and precipitates the zinc as zinc carbonate. Once the precipitate has been collected, it is heated strongly to produce zinc oxide, ZnO (molar mass 81.4 g mol^{-1}). The mass of zinc oxide obtained is 1.62 g. The purity of the zinc is close to

A. 44%
B. 50%
C. 76%
D. 89%

Question 2

The concentration of chloride ions in a solution of $MgCl_2$ is determined to be 24 mg L^{-1}. The concentration of the $MgCl_2$ solution, in M, is

A. 3.4×10^{-4}
B. 6.8×10^{-4}
C. 0.34
D. 12

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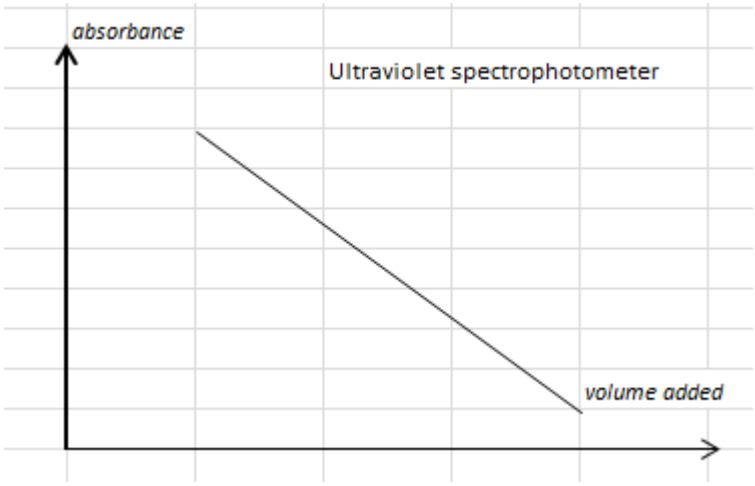
Question 3

The progress of a redox titration is monitored by measuring the absorbance of the reaction mixture after each addition from the burette. The results are shown on the graph below.



The shape of the graph suggests that

A. there is no obvious endpoint
B. one of the reactants is coloured but the product is not
C. one of the products of the reaction is coloured
D. this instrument is not applicable to titrations

Question 4

Which of the following would be the most suitable analytical technique to determine the concentration of a green nickel solution?

A. proton NMR spectroscopy
B. titration
C. infrared spectroscopy
D. atomic absorption spectroscopy

Question 5

In which alternative does the underlined element have the same oxidation number in each compound?

A. $\underline{Fe}Cl_2$, $\underline{Fe}Cl_3$, $O\underline{Cl}_2$
B. $Mg\underline{O}$, $H_2\underline{O}$, $H_2\underline{O}_2$
C. $K\underline{N}O_3$, $\underline{N}_2O_4$, $\underline{N}H_3$
D. $K_2\underline{S}_2O_7$, $K_2\underline{S}O_4$, $\underline{S}O_3$

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Question 6

The ammonium content of lawn fertiliser can be determined by boiling the fertiliser in sodium hydroxide. The equation for the reaction is

$NH_4^+(aq) + NaOH(aq) \rightarrow NH_3(g) + H_2O(l) + Na^+(aq)$

This reaction is

A. an acid–base reaction with ammonium ions acting as an acid
B. a precipitation reaction, in which NH_3 solid forms on the bottom of the container
C. an acid–base reaction and a redox reaction as the NH_4^+ ions are reduced
D. a redox reaction because electrons are transferred from the NH_4^+ ions to the NaOH

Question 7

40 mL of 0.25 M NaOH is added to 60 mL of 1.0 M HCl. The final pH is likely to be close to

A. 0
B. 0.3
C. 1
D. 7

Question 8

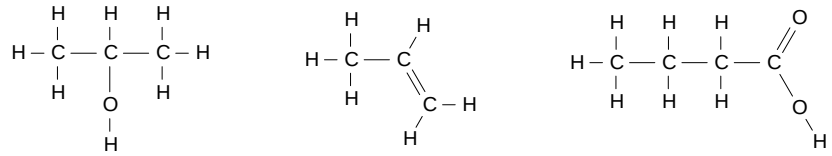
The reaction between lithium and oxygen is

$4Li(s) + O_2(g) \rightarrow 2Li_2O(s)$

If 128 g of lithium is reacted with 128 g of oxygen gas, the mass of lithium oxide that should form is, in g, closest to

A. 238
B. 256
C. 298
D. 310

Question 9



The systematic names for the molecules shown are, respectively

A. propanol, 2-propene and 1-butanoic acid
B. 2-propanol, propene and butanoic acid
C. 2-propanol, propene and 1-butanoic acid
D. 1-propanol, propene and butanoic acid

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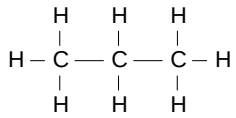
Question 10

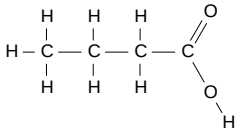
A molecule of propane is drawn below.



A proton NMR spectrum of propane will show

A. one singlet (single peak) because all protons have the same environment
B. two sets of peaks, one a quartet and the other a triplet
C. two sets of peaks, one a septet (seven) and the other a triplet
D. three sets of peaks because there are three different proton environments

Question 11



The molecule shown could be formed from

A. butane, using a substitution reaction followed by an oxidation reaction
B. butane, using an oxidation reaction followed by an addition reaction
C. butane, using an addition reaction followed by an oxidation reaction
D. butane, using substitution reactions and then an oxidation reaction

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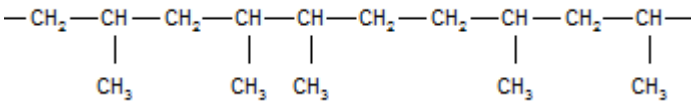
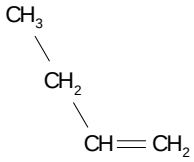
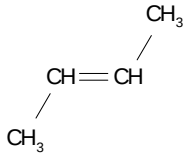
Question 12

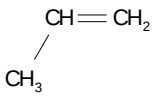
A segment of a polymer chain is drawn below.

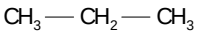


The monomer used to make this polymer was

A. 

B. 

C. 

D. 

Question 13

A dipeptide has a molar mass of 192 g mol^{-1}. The dipeptide could consist of

A. alanine and alanine
B. serine and serine
C. serine and alanine
D. serine and cysteine

Question 14

Bromine is reacted with two different fatty acids.

Sample A: 0.366 mole of bromine reacts exactly with 0.183 mole of fatty acid A.
Sample B: 0.429 mole of bromine reacts exactly with 0.143 mole of fatty acid B.

Fatty acid A and fatty acid B could be, respectively

A. myristic and oleic
B. oleic and linoleic
C. linoleic and linolenic
D. stearic and oleic

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Question 15

Bromine is a brown coloured liquid. When it reacts with methanoic acid, it is reduced to colourless bromide ions. The equation for the reaction is

$HCOOH(aq) + Br_2(l) \rightarrow 2Br^-(aq) + 2H^+(aq) + CO_2(g)$

Consider the following possible measurements.
I absorbance of ultraviolet light
II proton NMR spectrum
III pH
IV mass of container

Which of the measurements I to IV could be used to monitor the rate of the reaction between bromine and methanoic acid?
A. IV only
B. I and IV only
C. I, II and IV only
D. I, III and IV only

Question 16

The contents of two beakers are:
Beaker A: 200 mL solution of pH 3
Beaker B: 800 mL solution of pH 4

Which statement about the contents of the two beakers is correct?
A. Beaker B contains more H_3O^+ ions.
B. Beaker A contains more H_3O^+ ions.
C. Neutralisation of the solution in beaker B would require the larger volume of 0.1 M NaOH.
D. Neither beaker will contain OH^- ions because the solutions are acids.

Question 17

Scientists studying a particular reaction find that at 420°C, the equilibrium constant for the forward reaction has the same numerical value as the equilibrium constant for the reverse reaction. The conclusion that can be drawn from this is that the
A. reaction is not reaching a point of equilibrium
B. number of mole of reactants must equal the number of mole of products
C. value of the equilibrium constant for both reactions must be 1
D. yield must be exactly 50%

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Question 18

When NOCl gas is added to a reactor, it can form an equilibrium mixture with nitrogen monoxide and chlorine gas.

$2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$

0.40 mole of NOCl is added to a 1 L reactor. When equilibrium is reached, 0.14 mole of NOCl has reacted. The equilibrium concentrations are

	[NOCl]	[NO]	$[Cl_2]$
A.	0.26	0.14	0.07
B.	0.26	0.26	0.13
C.	0.14	0.14	0.07
D.	0.14	0.26	0.13

Question 19

1 mL of phenolphthalein is added to test tube A, which is filled with distilled water at 25°C.
1 mL of thymol blue is added to test tube B, which is also filled with distilled water at 25°C.

A. The pH of test tube A will be lower than that of test tube B.
B. The pH of both test tubes will be the same.
C. The pH of both test tubes will be 7 because the substances used are indicators.
D. The pH of test tube A will be higher than that of B.

Question 20

Which of the following statements about pure water is correct?

A. K_w is always 10^{-14}.
B. If the pH is not equal to 7, then the water cannot be pure.
C. If the $[H_3O^+]$ is $10^{-6.8}$ M, then $[OH^-]$ will be $10^{-6.8}$ M.
D. If the $[H_3O^+]$ is $10^{-6.8}$ M, then $[OH^-]$ will be $10^{-7.2}$ M.

Question 21

20 mL of distilled water is added to a 0.1 M ethanoic acid solution. As a result of the dilution, the

A. pH increases and the percentage ionisation of the acid increases
B. pH drops and the percentage ionisation of the acid decreases
C. pH increases and the percentage ionisation decreases
D. pH does not change because ethanoic acid is a weak acid

Question 22

Which of the following methods of producing electrical energy is the most efficient?

A. Alkaline cell
B. Wind turbine
C. Photovoltaic cell
D. Black coal

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Question 23

One source of hydrogen is from methane.

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

The most significant impact on the yield of this reaction would be from

A. the addition of a catalyst and an increase in pressure
B. an increase in temperature and a decrease in pressure
C. an increase in temperature and an increase in pressure
D. a decrease in temperature and a decrease in pressure

Question 24

A dilute aqueous solution of NaCl is electrolysed. In this cell

A. electrons will be travelling from the cathode to the anode
B. chlorine gas will be evolved at the anode
C. energy will be produced that can be used to power portable appliances
D. the solution will be acidic around the anode and alkaline around the cathode

Question 25

When ammonium nitrate dissolves in water an endothermic reaction occurs.

$NH_4NO_3(s) \rightarrow NH_4^+(aq) + NO_3^-(aq)$

The activation energy of this reaction is +31.6 kJ mol^{-1} and ΔH is +26.2 kJ mol^{-1}.
The activation energy and the enthalpy of the **reverse** reaction will be, respectively

A. –31.6 kJ mol^{-1} and –26.2 kJ mol^{-1}
B. +31.6 kJ mol^{-1} and –26.2 kJ mol^{-1}
C. +5.4 kJ mol^{-1} and –26.2 kJ mol^{-1}
D. –5.4 kJ mol^{-1} and +26.2 kJ mol^{-1}

Question 26

Consider the following equations.

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(1) \quad \Delta H = -287 \text{ kJ mol}^{-1}$

$H_2O(g) \rightarrow H_2O(1) \quad \Delta H = -44 \text{ kJ mol}^{-1}$

From the data provided, determine the enthalpy change, ΔH (in kJ mol^{-1}) for the formation of water as a gas according to the following equation.

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$

A. –486
B. –243
C. +243
D. +331

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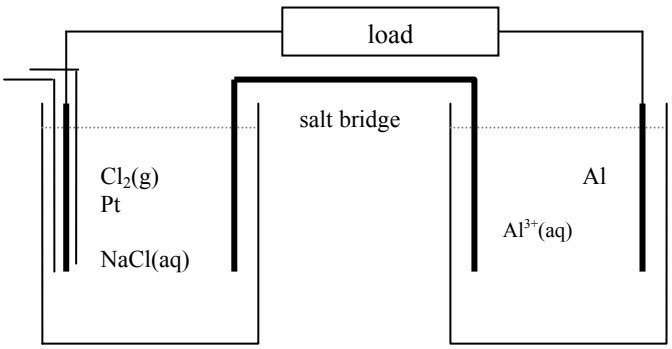
Question 27

A bomb calorimeter containing 100 mL of distilled water is calibrated. A student then conducts an experiment to determine the amount of energy released when calcium is added to water. The student inadvertently uses 120 mL of water for this reaction. The impact of this mistake would be that the

A. temperature change would be low, leading to a low value of ΔH
B. temperature change would be low, leading to a high value of ΔH
C. temperature change would be high, leading to a low value of ΔH
D. temperature change would be high, leading to a high value of ΔH

Question 28

A galvanic cell is constructed from a chlorine half cell and an aluminium half cell.



In this cell,

	Oxidant	Reductant	Anode	Cathode
A.	Al^{3+}	Cl^-	Pt	Al
B.	Al	Cl_2	Pt	Al
C.	Cl_2	Al	Al	Pt
D.	Cl_2	Al	Pt	Al

Question 29

One form of a popular button cell produces electrical energy from the reaction between aluminium and oxygen gas. Oxygen gas is easily sourced from air and aluminium is relatively abundant. The two half equations for this cell, as they appear on a comprehensive electrochemical series, are

$O_2(g) + 2H_2O(l) + 4e^- \rightarrow 4OH^-(aq)$ 0.40 V
$Al(OH)_3(aq) + 3e^- \rightarrow Al(s) + 3OH^-(aq)$ –1.67 V

The overall equation for this cell will be

A. $3O_2(g) + 6H_2O(l) + 4Al(OH)_3(aq) \rightarrow 4Al(s) + 12OH^-(aq)$
B. $4Al(s) + 3O_2(g) + 6H_2O(l) \rightarrow 4Al(OH)_3(aq)$
C. $Al(s) + O_2(g) + 2H_2O(l) \rightarrow Al(OH)_3(aq)$
D. $4Al(s) + 3O_2(g) \rightarrow 4Al(OH)_3(aq)$

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Question 30

A current of 8 amps is passed through an aqueous solution for 24 000 s. In this time, 1 mole of metal is deposited at the cathode and a gas is collected at the anode. When the gas is cooled to STP conditions, its volume is 11.2 L. The aqueous solution could be

A. $MgCl_2$
B. $Cu(NO_3)_2$
C. CuI_2
D. $AgNO_3$

END OF SECTION A
TURN OVER

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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 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 the formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s).

Question 1 (6 marks)

a. The concentration of iron(II) nitrate, $Fe(NO_3)_2$, solutions can be determined by titration with standardised solutions of potassium permanganate.

3 marks

i. Write a balanced half equation, including states, for the conversion of MnO_4^- ions, in acidic conditions, to Mn^{2+} ions.

_____

ii. Write a balanced half equation for the conversion of Fe^{2+} ions to Fe^{3+} ions.

_____

iii. Write a balanced overall equation for this reaction.

_____

b. 20.00 mL aliquots of iron nitrate are taken from a 500.0 mL solution of iron nitrate and titrated with 0.132 M potassium permanganate. The average titre is 14.56 mL. Calculate the concentration of the iron nitrate solution.

3 marks

_____

_____

_____

_____

_____

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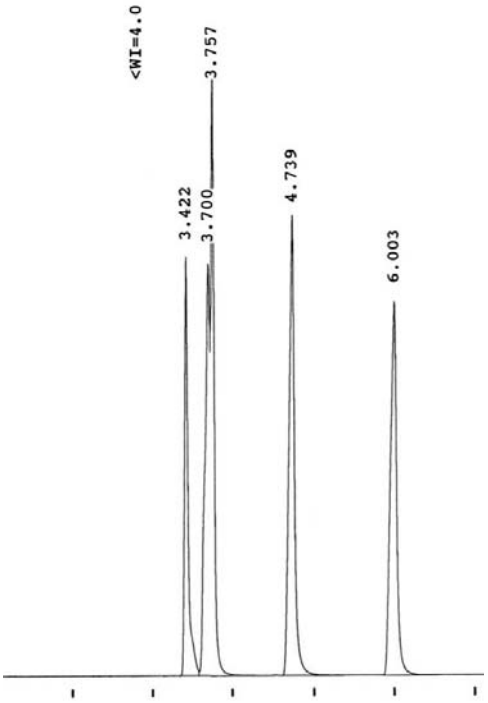
Question 2 (8 marks)

A sample containing a mixture of alkanols is injected into a gas chromatograph. The following chromatogram is obtained. Note: the chromatogram shows the exact retention times above each peak.



Further experimentation establishes the identity of each peak as shown in the following table.

Retention time (min)	Alkanol
3.422	methanol
3.700	ethanol
3.757	2-methylpropanol
4.739	1-propanol
6.003	1-butanol

a. Suggest a method that could have been used to establish the identity of each peak.

1 mark

_____

_____

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b. A brewing company wishes to use this column for the determination of the ethanol content of wine samples. Would this column be suitable for this analysis? Explain your answer.

1 mark

_____

_____

c. If a sample of 1-pentanol is injected into this column, what retention time might you expect? Explain how you arrived at your answer.

2 marks

_____

_____

d. It is often difficult to distinguish structural isomers because their properties can be very similar. Does this analysis support the use of gas chromatography in separating structural isomers? Explain your answer.

2 marks

_____

_____

e. If the concentration of 1-butanol in the above mixture is doubled, what change would you expect to see in the chromatogram?

1 mark

_____

_____

f. The chromatogram above was produced with the instrument set at 140°C. If the instrument was set at 160°C instead of 140°C, how would the chromatogram change?

1 mark

_____

_____

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Question 3 (9 marks)

a. A 2.800 g sample of an organic molecule is found to contain 1.710 g of carbon and 0.664 g of nitrogen.

3 marks

i. The compound also contains hydrogen. What is the mass of hydrogen in the sample?

_____

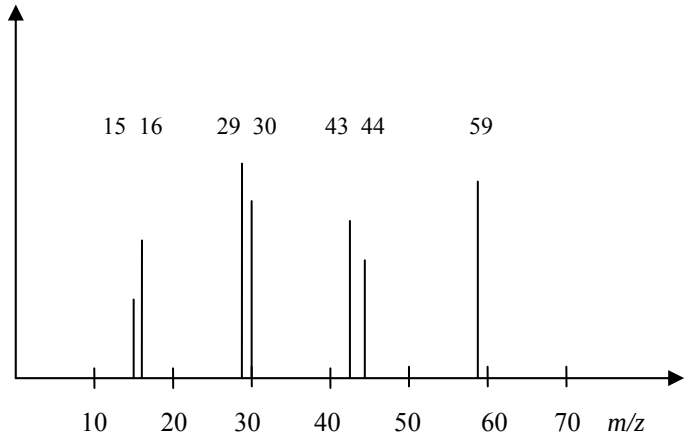
ii. Determine the empirical formula of the molecule.

_____

_____

_____

b. The mass spectrum of the molecule is shown below.



2 marks

i. What is the value of the base peak for this molecule?

_____

ii. What is the molecular formula of the molecule?

_____

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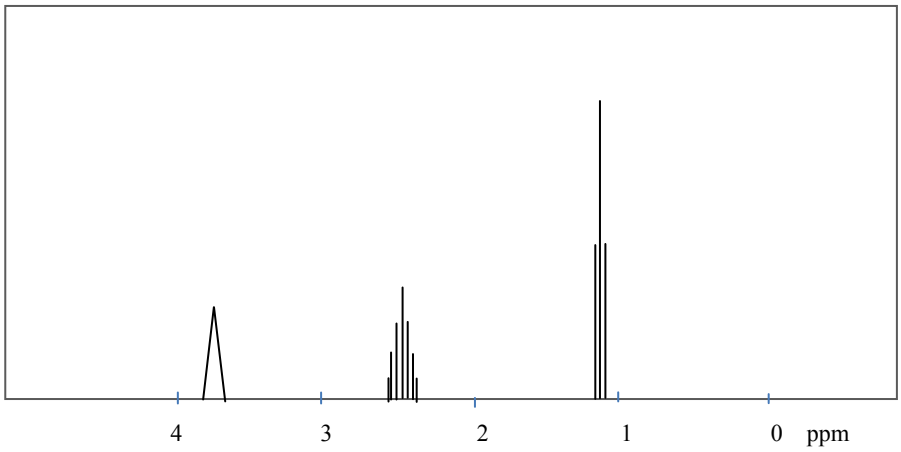
c. There are two possible structures for this molecule. Draw and name both isomers.

2 marks

Isomer 1 Isomer 2

Name: _____ Name: _____

d. The proton NMR spectrum below can be used to confirm the identity of this molecule.



What is the identity of the molecule? Explain how the NMR spectrum has helped you arrive at this conclusion.

2 marks

_____

_____

_____

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Question 4 (7 marks)

a. 1-propanol can be synthesised from an alkene.

2 marks

i. Write a balanced chemical equation for this reaction. Use the semi-structural formulas for the reactants and products.

_____

ii. Will 1-propanol be the only product in this reaction? Explain your answer.

_____

_____

b. 1-propanol can be synthesised from an alkane.

4 marks

i. Describe the steps required to prepare a sample of 1-propanol in this way. Include any other reactants required. An annotated flowchart may be used in your answer.

_____

_____

_____

_____

_____

ii. Will 1-propanol be the only product in this reaction? Explain your answer.

_____

_____

c. Will 1-propanol be soluble in water? Explain your answer.

1 mark

_____

_____

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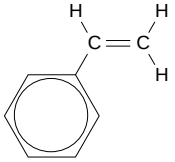
Question 5 (4 marks)

Styrene, drawn below, can be used as a building block for some interesting molecules. Its systematic name is phenylethene. The benzene ring is frequently referred to as 'phenyl' in molecules that contain benzene.



a. Styrene is the monomer for the polymer polystyrene, a versatile polymer that is often used as a co-polymer. Draw a segment of polystyrene polymer.

1 mark

b. Styrene can undergo an addition reaction with ammonia, NH_3, to form phenylethylamine (PEA), a molecule that functions as a neurotransmitter in the human brain. PEA is present in high concentrations when someone is in love!

Draw the structure of phenylethylamine.

1 mark

c. Styrene can also be converted in two stages to phenylethanoic acid. Phenylethanoic acid is used as a marker for depression, as levels are low in the urine of depressed people.

Step 1 is an addition reaction with water.

Step 2 is an oxidation reaction using $Cr_2O_7^{2-}$ solutions under acid conditions.

Draw the structures of the intermediate molecule and phenylethanoic acid in the boxes provided.

2 marks

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Question 6 (6 marks)

The molecular formulas of several molecules are shown below.

$C_{18}H_{36}O_2$ **A**	$C_{19}H_{38}O_2$ **B**	$C_5H_5N_5$ **C**
$C_{12}H_{22}O_{11}$ **D**	$C_3H_7O_2NS$ **E**	$C_3H_8O_3$ **F**
$C_{18}H_{34}O_2$ **G**	$C_3H_6O_2$ **H**	

Select from the above molecules to answer the following questions. A molecule can be used more than once.

a. A saturated biodiesel molecule

1 mark

_____

b. A disaccharide

1 mark

_____

c. A by-product of the hydrolysis of lipids (a first step in the production of biodiesel)

1 mark

_____

d. An unsaturated fatty acid

1 mark

_____

e. A molecule that can be isolated from DNA

1 mark

_____

f. A molecule that could form a peptide bond

1 mark

_____

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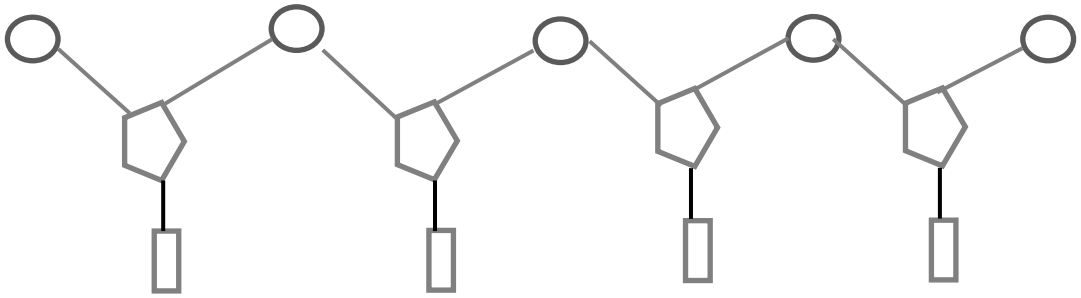
Question 7 (4 marks)

The following diagram is a simplified representation of a section of a single strand of DNA. DNA is made from monomers called nucleotides. Each nucleotide consists of a sugar, a phosphate and a base.



a. On the diagram label a sugar S, a phosphate P and a base B.

1 mark

b. Circle a complete nucleotide.

1 mark

c. How many different nucleotides are possible?

1 mark

_____

d. If there are nine hydrogen bonds between this strand and its complementary strand, what conclusion can you draw about the bases present?

1 mark

_____

_____

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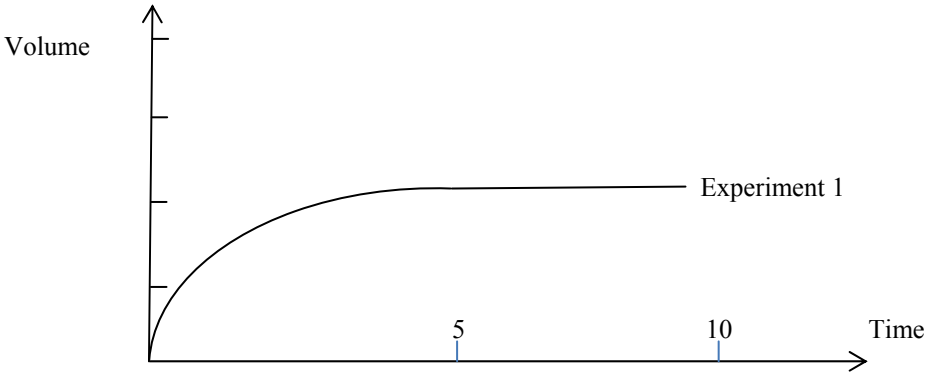
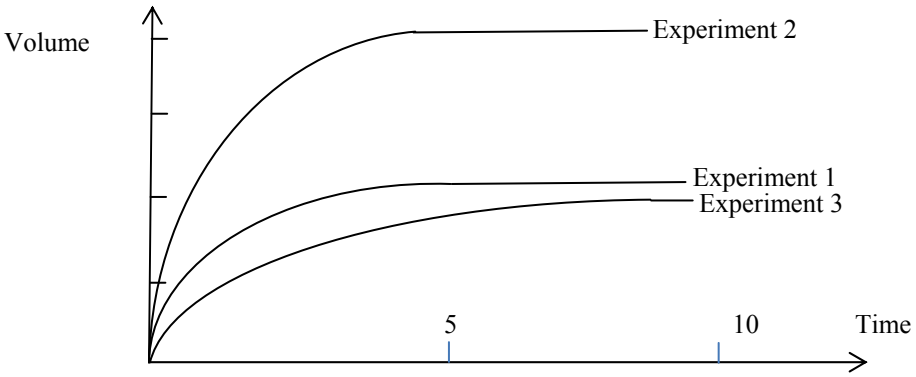
Question 8 (6 marks)

The equation for the reaction between magnesium and hydrochloric acid is
$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

An experiment is conducted where 1.0 g of magnesium is added to excess hydrochloric acid at 25°C and the volume of hydrogen gas evolved is monitored. The volume of gas produced is shown on the graph below.



Two further experiments are conducted and the hydrogen gas evolved is shown on the graph below.



a. Suggest a change that was made to the original experiment that would have led to the hydrogen production being as shown in experiment 2.

1 mark

_____

_____

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b. Suggest three possible changes to experiment 1 that might have led to the hydrogen production being as shown in experiment 3.

3 marks

_____

_____

_____

c. List two other methods that could be used to monitor the rate of this reaction.

2 marks

_____

_____

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Question 9 (8 marks)

a. Litmus is a common acid–base indicator. It is red in acidic conditions and blue in alkaline conditions. Like most acid–base indicators, litmus is a weak acid. Its K_a value is 3.0×10^{-7} at 25°C.

Litmus has a complex structure. Use HLt to represent litmus when answering this question.

2 marks

i. Write a balanced equation for the reaction of litmus in water.

_____

ii. What colour is the conjugate base of litmus?

_____

b. A few drops of concentrated sodium hydroxide, NaOH, are added to a litmus solution. Describe the impact of this addition on the pH and colour of the solution.

2 marks

_____

_____

c. At the endpoint in a titration, the concentration of the acid and its conjugate base are considered equal.

4 marks

i. Write an expression for the acidity constant, K_a, of litmus.

_____

ii. Use your knowledge of transition to simplify this expression and to calculate the pH at which litmus changes colour.

_____

_____

_____

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Question 10 (11 marks)

Ethyne gas, C_2H_2, is used in industry to generate a high-temperature flame. The flame is often used to cut through metal. Ethyne is produced from ethane in a reversible reaction.

$$C_2H_6(g) \rightleftharpoons C_2H_2(g) + 2H_2(g) \qquad \Delta H = +355 \text{ kJ mol}^{-1}$$

a. 2.00 mole of ethane is introduced into a 2.00 L reactor at 600°C. At equilibrium, the ethane concentration is 0.640 M. Calculate the value of the equilibrium constant at 600°C.

4 marks

_____

_____

_____

_____

b. The yield of ethyne at 600°C is not high enough for the process to be economical.

2 marks

i. Explain how the temperature can be adjusted to improve the yield.

_____

_____

ii. Explain how the pressure can be adjusted to improve the yield.

_____

_____

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c. A sample of ethyne is burnt under a beaker of water.

The following data was recorded:

Volume of water: 440 mL

Initial mass of ethyne: 2.88 g

Final mass of ethyne: 2.17 g

Initial temperature of water: 23.5°C

Final temperature of water: 42.6°C

5 marks

i. Write a balanced equation for the combustion of ethyne.

_____

ii. Use the change in temperature of the water to determine the amount of energy, in kJ, added during the heating.

_____

_____

_____

iii. Determine an experimental value, in kJ mol^{-1}, for the heat of combustion of ethyne.

_____

_____

_____

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Question 11 (7 marks)

Photovoltaic cells can be used to capture energy from the sun. This is not such a new idea, because plants do this every day. There are many different ways in which the energy captured by plants can be harnessed.

a. Ethanol can be produced from the starches and sugars in plants.

2 marks

i. Write a balanced equation for the production of ethanol from glucose.

_____

ii. Give one reason why the large-scale production of ethanol in this way is limited.

_____

_____

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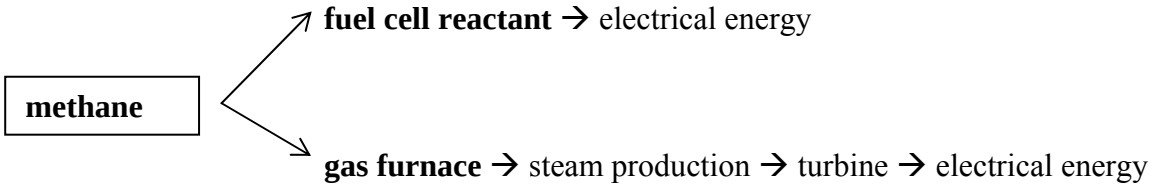
b. Methane can be produced from the action of bacteria on plant matter in an oxygen-free environment. The methane can then be used to produce electrical energy in two different ways that are outlined below.

5 marks



i. What is the name given to methane produced in this way?

_____

ii. Write balanced half equations for the reactions occurring in a methane fuel cell that operates in acidic conditions.

Anode: _____

Cathode: _____

iii. Outline the energy transformations that occur when electrical energy is produced from methane in a gas turbine.

_____

_____

iv. Which of these two electricity production processes will be the more energy efficient?

_____

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Question 12 (10 marks)

Recent research into cells has led to the development of a range of lithium-based cells. However, one British car company has branched out into research on a sodium–nickel cell. This offers the same advantages as a lithium cell but sodium is a more abundant element than lithium.

The **recharge** equation for this cell is:

$2NaCl + Ni \rightarrow 2Na + NiCl_2$

The cell produces a voltage of 2.58 volts and the electrolyte used is molten $NaAlCl_4$. The cell runs at 300°C, a temperature easily achieved because the reaction is very exothermic.

a. Write balanced half equations for the reactions occurring at the anode and at the cathode during **discharge**. Show also the polarity of each electrode.

3 marks

Anode: _____ Polarity: _____

Cathode: _____ Polarity: _____

b. Give two reasons why this cell might be of interest to researchers.

2 marks

_____

_____

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c. $NaAlCl_4$ is used as the electrolyte instead of water.

2 marks

i. Write a balanced equation for the reaction of sodium metal and water.

_____

ii. Explain why an aqueous electrolyte is not used.

_____

d. The cell operates efficiently at 300°C. Normally it is costly to increase the temperature of a cell to such levels. Explain why the high temperature is not a problem in this cell.

1 mark

_____

e. Calculate the energy produced in the cell if it operates for 72 minutes at 3.2 amps. (Assume the maximum voltage is maintained during this period.)

2 marks

_____

_____

_____

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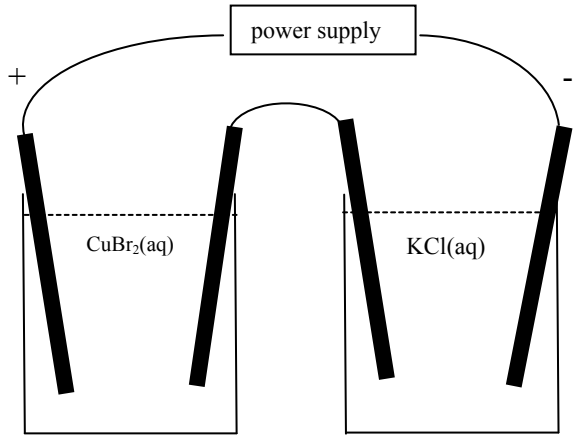
Question 13 (12 marks)

a. Two beakers are connected in series to a power supply. Beaker A contains a dilute aqueous solution of copper bromide. Beaker B contains a dilute aqueous solution of potassium chloride. Inert electrodes are used in both cells.

6 marks



Beaker A Beaker B

i. Complete this table to show the half reactions occurring in each beaker.

	Reaction at anode	**Reaction at cathode**
$CuBr_2(aq)$		
KCl(aq)		

ii. Write the overall equation for each cell.

Beaker A: _____

Beaker B: _____

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b. A current of 4.6 amps runs through this circuit for 4.5 hours.

6 marks

i. Calculate the number of mole of electrons passing through the circuit.

_____

_____

_____

ii. Calculate the number of mole of product formed at each electrode.

Beaker A anode: _____

Beaker A cathode:_____

Beaker B anode: _____

Beaker B cathode: _____

END OF QUESTION AND ANSWER BOOK

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