



Cheltenham Girls
High School

2011

Trial Higher School Certificate
Examination

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Write your Student Number at the top of each page you write
- This paper is a Trial Paper only. It follows the structure of the BOS HSC but only examines 9.5.2 and 9.5.3 of the Industrial Chemistry Option
- Page 21 can be removed and handed in separately
- A Periodic Table and Data sheet are also provided

Student number

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Total marks – 100

Section I Pages 2 – 16

75 marks

This section has two parts, Part A and Part B

Part A – 20 marks

- Attempt Questions 1 to 20
- Allow about 35 minutes for this part

Part B – 55 marks

- Attempt Questions 21 to 30
- Allow about 1 hour and 40 minutes for this part

Section II Pages 17-20

25 marks

- Attempt Questions 31
- Allow about 45 minutes for this section

Section I
75 marks**Part A – 20 marks****Attempt Questions 1 – 20****Allow about 35 minutes for this part**

Use the multiple-choice answer sheet for Questions 1–20 (remove this sheet from the exam end)

- 1 A solution of bromine water is suitable to identify which group of compounds?
- (A). Alkanes
 - (B). Alkenes
 - (C). Alkanols
 - (D). Esters
- 2 Ethanol is now widely used as a component of petrol. The molar heat of combustion of ethanol is 1370 kJ mol^{-1} and its density is 0.80 g mL^{-1} .
- What is the heat produced when 1.00L of ethanol undergoes complete combustion?
- (A). 1370×800
 - (B). $1370 \div 46$
 - (C). $1370 \times 46 \div 800$
 - (D). $1370 \times 800 \div 46$
- 3 Which reagent oxidises copper metal to copper (II) ions?
- (A). Silver nitrate solution
 - (B). Concentrated hydrochloric acid solution
 - (C). Steam
 - (D). Zinc sulphate solution
- 4 For any working galvanic cell, which statement is correct concerning the oxidation electrode?
- (A). It is always metal
 - (B). The polarity is negative
 - (C). Oxygen is required for the reaction
 - (D). Electrons pass from the external circuit into this electrode

Refer to the following information to answer Questions 5 and 6

In April 2010, the following news item appeared reporting the discovery of a new element

“In this case, the target was made from berkelium, a radioactive element. It took Oak Ridge National Laboratory more than one year to process and purify the berkelium used as the cyclotron’s target. Researchers at the cyclotron in Dubna then fired beams of calcium ions at the target for 150 days. The haul for all that trouble: six atoms of element 117.

The atoms existed for between 21 and 45 millionths of a second”.

- 5 Which of the following is the main reason that berkelium was selected as the target for calcium ions, to create element 117?
- (A). Berkelium is easy to obtain
 (B). Berkelium is very stable
 (C). Berkelium atoms have 97 protons
 (D). Berkelium has a very large atomic radius making it easier to hit
- 6 To which of the following groups do both berkelium and element 117 belong?
- (A). Alkali metals
 (B). Halogens
 (C). Lanthanides
 (D). Transuranics
- 7 Bromothymol blue is an indicator, changing from yellow to blue with a pH range of 6.0-7.6. Bromothymol blue is added to a variety of different solutions. The solutions were made by dissolving samples of the compounds shown in the table below.

Which alternative below matches the solutions shown with the correct indicator shown;

		Solution			
		NO ₂	CaO	NaCl	Na ₂ O
(A).	Yellow	Blue	Green	Blue	Blue
(B).	Blue	Blue	Green	Yellow	Yellow
(C).	Green	Yellow	Blue	Green	Green
(D).	Blue	Green	Blue	yellow	yellow

- 8 Dilute solutions of citric acid and hydrochloric acid are both found to have a pH of 2.0.

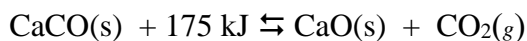
Which combination of concentrations, in mol⁻¹, could explain this observation?

		Citric Acid	Hydrochloric acid
(A).	0.020	0.020	0.020
(B).	0.10	0.010	0.010
(C).	2.0	1.0	1.0
(D).	0.20	0.020	0.020

9 Which of the following solutions has the highest pH?

- (A). 0.1M HCl
- (B). 0.1M NaF
- (C). 0.1M CH₃COONa
- (D). 0.1M NH₄Cl

10 Limestone is decomposed to make quicklime (CaO) according to the following equilibrium:



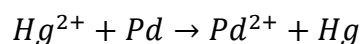
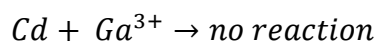
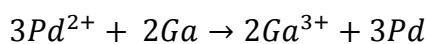
Which of the following conditions would produce the greatest yield of CaO (s)?

	Temperature	Pressure
(A).	low	low
(B).	low	high
(C).	high	low
(D).	high	high

11 Which of the following pairs of chemicals could be used to make a buffer solution?

- (A). NH₃ and H₂O
- (B). HCl and NaCl
- (C). NH₃ and NH₄Cl
- (D). CH₃COOH and HCl

12 The metals Hg, Cd, Ga and Pd react as follows:



Which of the following metals is the strongest reducing agent?

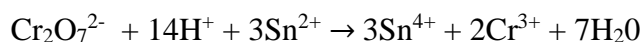
- (A). Pd
- (B). Ga
- (C). Cd
- (D). Hg

- 13** A solution is known to contain either sodium sulfate or sodium chloride. Which of the tests below would enable you to identify the substance present?
- (A). A yellow flame obtained when a platinum wire is dipped into each solution separately and heated, would indicate the presence of sulfate ions.
- (B). Add $\text{Ba}(\text{NO}_3)_2$ solution. The formation of a white precipitate would indicate the presence of sulfate ions.
- (C). Add $\text{Ba}(\text{NO}_3)_2$ solution. The formation of a white precipitate would indicate the presence of chloride ions.
- (D). Add NaOH solution. The formation of a white precipitate would indicate the presence of sulfate ions.

- 14** Identify an environmental problem associated with acid rain.

- (A). Increasing the pH of lakes
- (B). Depletion of the ozone layer
- (C). Chemical decomposition of water
- (D). Chemical erosion of limestone structures

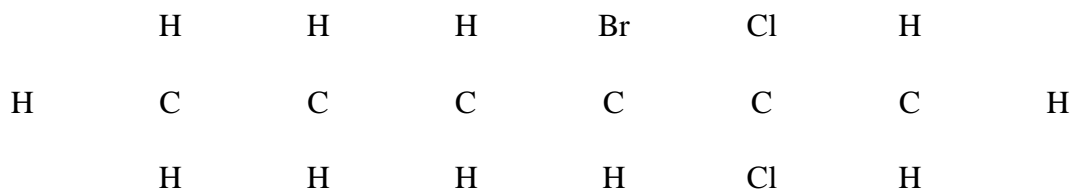
- 15** The titration of a 25.0 mL SnCl_2 sample, in acidic solution, requires 14.4 mL of 0.030M $\text{K}_2\text{Cr}_2\text{O}_7$. The balanced equation for the reaction is shown below:



What is the number of moles of SnCl_2 in the original sample?

- (A). 1.4×10^{-4} mol
- (B). 4.3×10^{-4} mol
- (C). 1.3×10^{-3} mol
- (D). 5.2×10^{-2} mol

- 16** What is the correct name for the following compound?



- (A). 3-bromo-2,2-dichlorohexane
- (B). 2-dichloro-3-bromohexane
- (C). 3-bromo-2-dichlorohexane
- (D). 4-bromo-5,5-dichlorohexane

- 17 An orange flavoured ester called octyl ethanoate can be prepared by refluxing in the presence of concentrated sulfuric acid.

Which of the following correctly represents the reaction?

- (A). $\text{CH}_3(\text{CH}_2)_6\text{CH}_2\text{OH} + \text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3(\text{CH}_2)_6\text{COOCH}_2\text{CH}_3 + \text{H}_2\text{O}$
- (B). $\text{CH}_3(\text{CH}_2)_6\text{CH}_2\text{OH} + \text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3\text{COOCH}_2(\text{CH}_2)_6\text{CH}_3 + \text{H}_2\text{O}$
- (C). $\text{CH}_3\text{CH}_2\text{OH} + \text{CH}_3(\text{CH}_2)_6\text{COOH} \rightleftharpoons \text{CH}_3\text{COOCH}_2(\text{CH}_2)_6\text{CH}_3 + \text{H}_2\text{O}$
- (D). $\text{CH}_3(\text{CH}_2)_6\text{CH}_2\text{OH} + \text{CH}_3\text{COOH} \rightleftharpoons \text{CH}_3(\text{CH}_2)_6\text{COOCH}_2\text{CH}_3$

- 18 Which of the following statements best describes chlorine free radicals?

- (A). They react with CFCs causing them to release more chlorine gas
- (B). They react with ozone in the stratosphere and convert it to oxygen
- (C). They are mostly formed in the troposphere and filter through to the stratosphere
- (D). They do not directly affect ozone but cause a significant amount of greenhouse gases to form

- 19 Which of the following species is capable of forming a coordinate covalent bond with a water molecule?

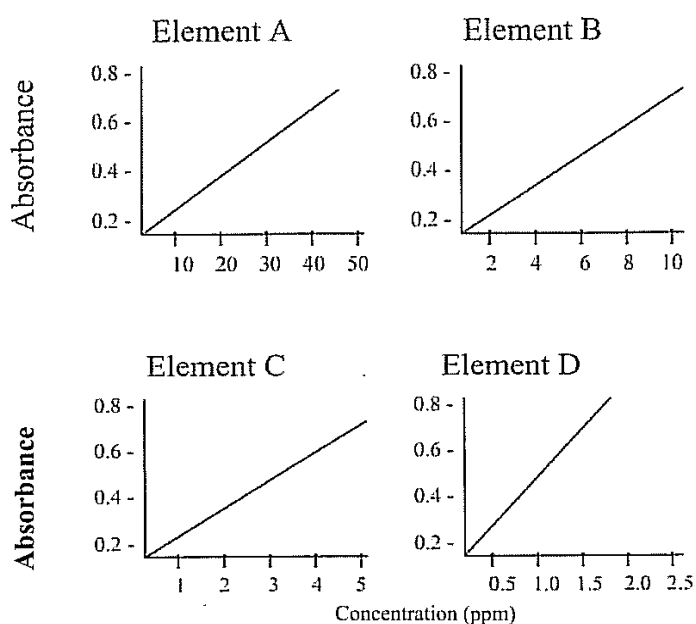
- (A). An ammonium ion
- (B). A chloride ion
- (C). A hydrogen molecule
- (D). A hydrogen ion

20

The wavelengths of light absorbed by four elements are as follows:

Element	Wavelength (nm)
A	354.8
B	551.9
C	443.7
D	587.4

Using Atomic Absorption Spectroscopy (AAS), standard solutions of these elements produced the following calibration curves.



A sample of waste water from a factory was analysed and the following results were obtained:

Wavelength emitted by sample	Absorbance
551.9	0.35
443.7	0.40
587.4	0.65
354.8	0.30

The element present with a concentration of 1.5 ppm in the waste water is:

- (A). Element A
- (B). Element B
- (C). Element C
- (D). Element D

(End of Part A)

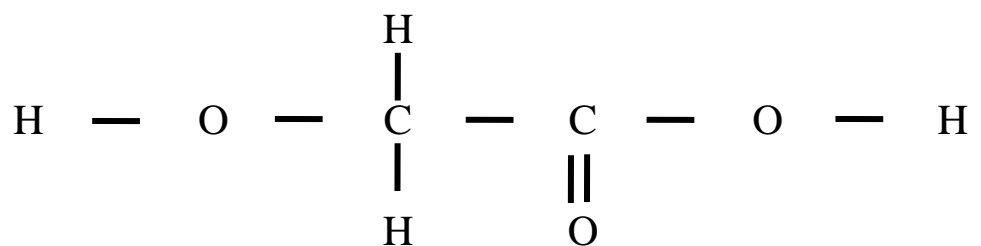
Section I (continued)

Part B – 55 marks**Attempt Questions 21 to 30.****Allow about 1 hour and 40 minutes for this part.**

Answer the questions in the spaces provided.

Marks**Question 21 (6 marks)**

Glycolic Acid (shown in the diagram) is the monomer of polyglycolic Acid (PGA) which is a polyester that is both a thermoplastic and biodegradable. It is used in surgery for self-dissolving sutures ('stitches').



Glycolic acid

- a) Polyglycolic acid is a condensation polymer, producing water as a by-product in the polymerisation process. Using at least three monomers (mers), draw the structure of a section of Polyglycolic Acid. **2**

- b) State why this polymer can be classed as a 'polyester' **1**

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Marks

- c) For surgical use, the polymer is required to have an average molecular mass of at least 60,000. Calculate the average number of repeating units (mers) per molecule for this mass.

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- d) (i) Define the term biodegradable

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- (ii) Suggest a reason, based on its chemistry, why the polymer would dissolve in living tissue.

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Question 22 (5 marks)

Ethanol can be produced industrially either by the hydration of ethylene or by the process of fermentation as a biofuel.

- a) Write a balanced equation for the industrial production of ethanol by the hydration of ethylene.

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- b) Write a balanced equation for the industrial production of ethanol by fermentation

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This question continues over the page.

c) Justify the increased production of ethanol by fermentation in Australia.

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Question 23 (5 marks)

(a) Calculate the volume of 6.0 M hydrochloric acid which would be needed to neutralise a spill of 1.0 kg of solid sodium hydroxide pellets.

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(b) Assess the use of 6.0 M HCl to neutralise the sodium hydroxide spill.

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Question 24 (5 marks)

- (a) Below is part of the sequence of decay products formed as uranium-238 undergoes decay to lead-206. **1**



X is formed when Bi-214 emits a beta particle.
Identify the unique isotope X.

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- (b) Identify the instrument commonly used to detect radiation. **1**

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- (c) Radioisotopes are used in medicine for both diagnostic purposes and treatment. **3**
Using a named example of a medical radioisotope, explain its use in terms of its chemical properties for either diagnostic or treatment purposes.

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Marks**Question 25 (8 marks)**

A student is provided with a clean strip of zirconium metal and asked to measure its potential difference against samples of magnesium, nickel and zinc.

- (a) Construct a labelled diagram of the apparatus you would use to carry out an investigation for zirconium and nickel. **3**

- (b) The table below shows measurements obtained by the student for this investigation.

Metals	Pot. Diff. (V)	Polarity of Zr
Mg, Zr	0.7	Positive
Ni, Zr	1.2	Negative
Zn, Zr	0.7	Negative

- (i) Construct a half-equation for the nickel electrode in the second cell. **1**

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- (ii) Compare the chemical activity of zirconium with the other three metals, stating your reasoning. **2**

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- (c) Predict the polarity of the zirconium in a similar cell, using silver and zirconium electrodes, and estimate the voltage of this cell. **2**

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Question 26 (4 marks)

During your study of chemistry you performed analysis of a selected acid by titration.

4

Justify at least four named steps you took in performing your analysis to reduce experimental error and thus ensure your titration results were valid and reliable.

Step	Justification

Question 27 (3 marks)

The trace element *molybdenum* as the molybdenum (III) ion is vital to the survival of certain deep sea creatures at a required level of around 0.3 mg L^{-1} in blood serum. A solution of molybdenum (III) ions can be prepared by dissolving molybdenum (III) nitrate in water.

3

Describe a procedure to prepare a standard solution of molybdenum (III) ions, at 1.0 mg L^{-1} ($1 \times 10^{-3} \text{ g L}^{-1}$) concentration or 1 part per million, for atomic absorption spectroscopy.

[Hint: 1 gram of Mo^{3+} is present in 0.0104 moles of $\text{Mo}(\text{NO}_3)_3$]

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Question 28 (5 marks)

The synthesis of ammonia from its constituent elements occurs industrially at a moderate temperature of 400°C and a high pressure of 250 atm. Evaluate the use of these conditions.

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Question 29 (9 marks)

- (a) Chlorofluorocarbons (CFCs) are a significant problem in the stratosphere. Freon-114 is a common CFC, once used as an aerosol propellant. Freon-114 has the molecular formula $C_2Cl_2F_4$.

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(i) Draw one possible isomer of Freon-114.

(ii) State the correct IUPAC name for the isomer you have drawn.

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This question continues over the page.

- (b) Using relevant chemical equations *identify* the problems associated with the use of CFCs and *assess* the effectiveness of the steps taken to alleviate these problems.

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Question 30 (5 marks)

A bottle of soft drink was placed on an electronic balance and weighed. The cap was removed and placed next to the bottle on the balance. The mass of the cap, bottle and its contents was monitored. The results are shown on the graph. The experiment was conducted under constant conditions of 25°C and 100kPa. Assume no evaporation occurred.

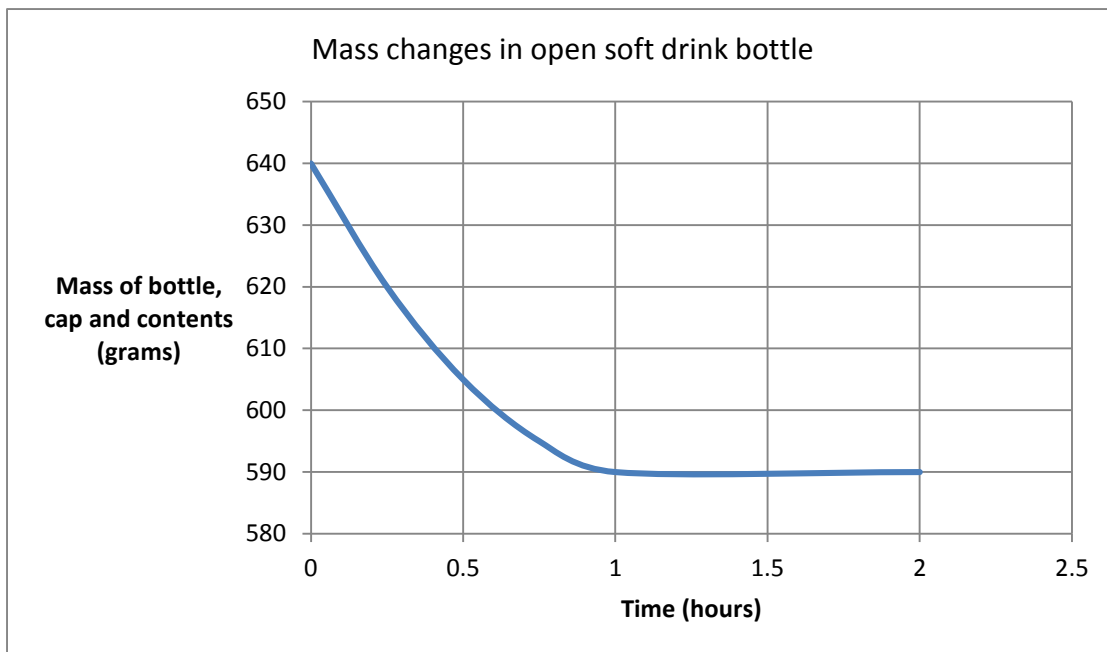


Figure 1 Mass of open soft drink bottle over time

- (a) Describe a test that would allow the gas to be identified as carbon dioxide. **2**

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- (b) Calculate the volume of gas released under the conditions given. **3**

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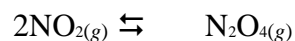
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Section II**25 marks****Attempt Question 31****Question 31 assesses the Syllabus Option – Industrial Chemistry****Allow about 45 minutes for this section.**

	Mark
Question 31 (25 marks)	
(a) One of the reactions used to form sulfuric acid is the reaction of oxygen with sulfur dioxide under equilibrium conditions to form sulfur trioxide. Before the reaction, the concentration of sulfur dioxide was 0.06 molL^{-1} and the concentration of oxygen was 0.05 molL^{-1} . After equilibrium was reached, the concentration of sulfur trioxide was 0.04 molL^{-1} . Calculate the equilibrium constant, K , for the reaction. Show relevant working.	4
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- (b) Nitrogen dioxide forms an equilibrium mixture with dinitrogen tetraoxide as shown:



At 100°C, K for this reaction is 2.08.

At 25°C, a 1.00 L vessel initially contained 0.132 mol of $\text{NO}_{2(g)}$. Once equilibrium had been established, there was 0.0400 mol of $\text{N}_2\text{O}_{4(g)}$ in the vessel.

- (i) Explain the effects of the following changes on the production, (rate and yield), of N_2O_4 in this reaction when carried out at 25°C. **4**

- a. The addition of a catalyst

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- b. An increase in pressure due to a volume change

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- (ii) Justify whether the forward reaction is endothermic or exothermic based on the information given. **3**

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Question 31 continues over the page

(c) Sulfuric acid is an important industrial chemical. One of the intermediate products in the synthesis of sulfuric acid is $\text{H}_2\text{S}_2\text{O}_7$.

(i) What is the name of $\text{H}_2\text{S}_2\text{O}_7$?

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(ii) Explain the safety precautions necessary for the transport of concentrated sulfuric acid.

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(iii) Using relevant equation(s), describe the reaction(s) when sulfuric acid is added to water in a laboratory.

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(iv) Write an equation to describe the use of sulfuric acid as an oxidising agent.

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(d) Sulfuric acid is one of the world’s most significant industrial chemicals because of the variety and importance of its uses.

(i) Identify the MAJOR use of sulphuric acid. 1

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 (ii) Identify the properties of sulfur which allows its easy extraction. 1

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(iii) Some Australian mining companies, most notably those in Western Australia, are no longer importing raw sulfur (extracted by the Frasch process) to produce sulfuric acid, but are converting their roasted sulfur based ores into sulfuric acid in what is termed “smelter acid” as a response to Government legislation regarding SO₂ emissions. They have undertaken this change for both environmental and economic arguments. 6

Assess the benefits of this new method of obtaining the raw material necessary for the production of sulfuric acid. Make reference to the environmental impacts of sulfur extraction using the Frasch Process.

[Please note: the FRASCH process does not need to be described]

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End of Exam



Remove and hand this Multiple Choice Answer Sheet in separately.

Chemistry Trial Higher School Certificate

Student name:.....

Student number:.....

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
 A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A B C D
 correct

1	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
2	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
3	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
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5	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
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9	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
10	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
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14	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
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19	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
20	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>

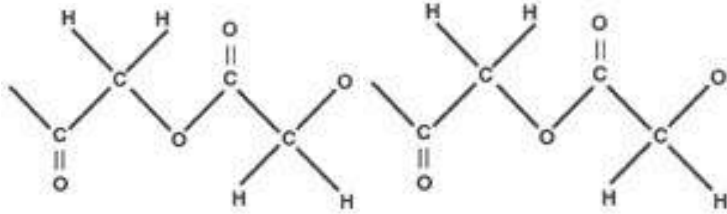


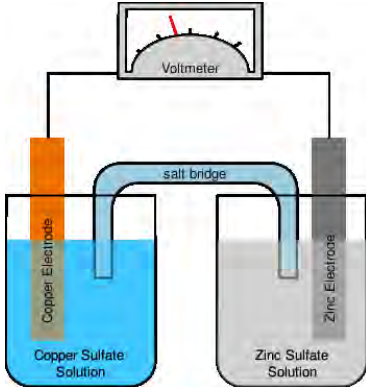
Cheltenham Girls High School

2011 Chemistry

Trial Higher School Certificate Examination
Marking Guidelines

Question	Response	Marks
1	B	
2	D $1370\text{kJmol}^{-1} * 800\text{gL}^{-1} / 46\text{ g mol}^{-1} = 23826\text{ kJ}$	
3	A	
4	B	
5	C	
6	D	
7	A	
8	B	
9	C	
10	C	
11	C	
12	B Strongest reducing agent will itself be oxidised	
13	B	
14	D	
15	D	
16	C	
17	B	
18	B	
19	D	
20	D	

Question	Response	Marks
21a	<ul style="list-style-type: none"> Clearly shows the formation of the polymer using three monomers All ester linkages (COO) shown 	1 1
	 <p style="text-align: center;">or similar</p>	
21 b	This polymer contains the ester linkage and is therefore a polyester	1
21 c	<ul style="list-style-type: none"> Calculates the mass of the glycolate unit $C_2H_2O_2 = (58)$ Calculates number of units for this molecular mass = (1035) 	1 1
21d	<ul style="list-style-type: none"> Defines the term biodegradeable Relates condition in the body to the reversibility of the esterification reaction 	1 1
	<i>A biodegradable substance is one which is chemically broken down to harmless molecules by natural processes in the environment. Esterification is a reversible process. Body fluids provide high concentration of water and suitable enzymes for the depolymerisation reaction.</i>	
22 a	Balanced equation for the hydration of ethylene (Should include acid catalyst (Phosphoric acid))	1
	$C_2H_4 + H_2O/H^+ \rightarrow C_2H_5OH$	
B	$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$	1
	Nominal conditions: yeast, 37°C, anaerobic	
C	<ul style="list-style-type: none"> Ethylene from non-renewable sources Fossil fuels running out Ethanol by fermentation based on sustainable resource <u>therefore</u> prolonging life of fossil fuel reserves <p>(“Justify= give reason for”) <i>Since most ethanol is produced by the hydration of <u>ethylene sourced from fossil fuels(oil)</u> and that <u>this resource is becoming scarce</u>, an alternative source of ethanol must be procured. Ethanol by <u>fermentation is sourced from renewable/sustainable</u> resources, such as sugar cane, and offers no limitation on its production and extends the life of viable fossil fuel reserves.</i></p>	1 1 1

Question	Response	Marks
23a	<ul style="list-style-type: none"> Writes balanced equation Correct volume of HCl determined $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$ $n(\text{NaOH}) = 1000\text{g} / 40\text{g mol}^{-1} = 25 \text{ moles NaOH}$ $\text{Volume } 6\text{M HCl} = 25 \text{ mol} / 6 \text{ mol L}^{-1}$ $= 4.167 \text{ L or } 4.2 \text{ L}$	<p>1 1</p> <p>No half marks</p>
23b	<ul style="list-style-type: none"> Makes an assessment consistent with arguments Makes at least TWO arguments <p><i>6M HCL is an <u>inappropriate choice of acid</u> to use to neutralise the spill of NaOH because it is <u>too concentrated</u> and poses a risk in itself (corrosive) and the reaction between NaOH and HCl is <u>strongly exothermic, which would produce dangerous vapours</u>.</i></p>	<p>1 1 each</p>
24a	<p>Correct isotope determined</p> <p><i>The isotope X is Polonium-209 ${}_{84}\text{Po}^{214}$</i></p>	1
B	The Geiger counter	1
C	<ul style="list-style-type: none"> States a radioisotope used in medicine Identifies how the radioisotope is used in diagnostic OR treatment Relates use in terms of its chemical properties <p><i>Both technecium-99 and Iodine-131 are radioisotopes used in medicine used for both diagnostic purposes. They are chosen because the emitted gamma ray has an appropriate energy for imaging. They both have short half lives. Tc can be bonded to glucose molecules whereas Iodine accumulates in the thyroid.</i></p>	<p>1 1 1</p>
25a	<ul style="list-style-type: none"> diagram, including salt bridge, voltmeter and separate beakers labels, Zr and other metal solutions labelled  <p>With appropriate labels ($\text{Zr} \text{Zr}^{2+} \text{Ni} \text{Ni}^{2+}$) etc</p>	<p>1 1 1</p>

Question	Response	Marks														
25b (i)	<ul style="list-style-type: none"> Correct equation $\text{Ni}^{2+} + 2\text{e}^{-} \rightarrow \text{Ni}_{(\text{s})}$ 	1														
B (ii)	<ul style="list-style-type: none"> Identifies the activity of Zr relative to other metals Relates the activity of Zr to the observed cell voltages <p>Zirconium is less active than magnesium, but more reactive than zinc and nickel.</p> <p>This can be shown by considering in the cell with magnesium, magnesium is the anode (oxidised, negative electrode) whereas Zr is more active than the other two metals where it is oxidised preferentially.</p>	1 1														
c	<ul style="list-style-type: none"> Uses the redox table to predict approximate voltage and polarity <p>The Ag Zn cell has a voltage of +1.56V and the Zn Zr cell has a voltage of +0.7V, thus the voltage of Ag Zr would be about 2.26V, silver being positive.</p>	1 1														
26	Identifies and Justifies ANY FOUR measures taken to ensure accuracy of the titration result	4														
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27	<ul style="list-style-type: none"> 1 mark for mass of Mo(NO₃)₃ to be dissolved (2.94g) in 1 litre 1 mark for description of preparing std solution 1g/L of Mo³⁺ using volumetric flask 1 mark for repeated dilutions (1 ml/1000ml) to achieve 1.0 mg L⁻¹ concentration <p><i>To prepare a standard solution of Mo(III) ions at 1 milligram per litre, 2.94g of molybdenum (III) nitrate are dissolved in distilled water and the volume made up to 1 litre in a 1 litre volumetric flask.</i></p>	3														

Question	Response	Marks
28	<ul style="list-style-type: none"> Writes balanced equation States that the reaction is exothermic for the production of ammonia Applies Le Chatelier's Principle to equation in discussing: <ul style="list-style-type: none"> Advantages of low temperature (greater yield) as opposed to slower rate compared with disadvantage of high temperature (low yield) but faster rate. Therefore moderate temperature used. Advantages of High pressure for the system (to increase yield) as against cost for the plant (avoid extremely high pressures) 	5
29a	<ul style="list-style-type: none"> Appropriate diagram with correct name <i>1,1-dichloro-1,2,2,2-tetrafluoroethane or 1,2-dichloro-1,1,2,2-tetrafluoroethane</i> 	2
B	<ul style="list-style-type: none"> Identifies that CFCs are produced in the troposphere where they are chemically inert and stable. This means that they are not <u>decomposed in the troposphere.</u> Identifies that over time CFCs are able to migrate to the stratosphere where high energy radiation causes the formation of chlorine radical Equation <u>Identifies that the chlorine radical is capable of reacting with ozone to produce oxygen</u> and OCl Or Equation Identifies that OCl splits to form more chlorine radical which recycles and attacks more ozone, thus reducing ozone concentration OR equation leading to damaging radiation reaching the Earth's surface. Various protocols have been mandated to alleviate this problem and Identifies at least one suitable replacement (HCFC, HFC) Makes an assessment on the effectiveness of replacement. 	7
30a	<ul style="list-style-type: none"> Identifies the limewater test as a suitable test Identifies the confirmatory test (limewater milky) 	1 1
B	<ul style="list-style-type: none"> Determines mass change = 50g $n(\text{CO}_2) = 50/44 = 1.136$ moles CO_2 Volume = $1.136 * 24.79 = 28.17$ L or 28.2L 	1 1 1

Question	Response	Marks
C (i)	<ul style="list-style-type: none"> H₂S₂O₇ is called oleum or pyrosulfuric acid or fuming sulfuric acid NOT oleic acid. 	1
(ii)	<ul style="list-style-type: none"> Identifies relevant transport for concentrated acid Supported explanation <p><i>Concentrated sulfuric acid is essentially in its molecular state and can be transported in stainless steel containers. However dilute sulfuric acid, because it is ionised, must be transported in glass containers as it would react with the metal and produce hydrogen gas. Sulfuric acid needs to be kept away from moisture as it readily absorbs and causes great heat which can result in dangerous splattering</i></p>	1 1
(iii)	<ul style="list-style-type: none"> When sulfuric acid is added to water, the molecular undergoes dissociation with a great amount of heat being released. $\text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{H}^+(\text{aq}) + \text{HSO}_4^-(\text{aq})$ $\text{HSO}_4^-(\text{aq}) \rightleftharpoons \text{H}^+(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$ <p>Brief description (including production of heat) and at least ONE equation.</p>	1 1
(iv)	$2\text{I}^-(\text{aq}) + 3\text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{I}_2(\text{aq}) + \text{SO}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l}) + 2\text{HSO}_4^-(\text{aq})$ <p>Identifies an oxidation reaction.</p>	1
(d)(i)	<ul style="list-style-type: none"> MAJOR use of sulfuric acid is in the production of fertilisers, in particular, superphosphate. 	1
(ii)	<ul style="list-style-type: none"> The properties of sulfur that allow for its easy extraction using the Frasch process are; <ul style="list-style-type: none"> low solubility in water Low melting point (119°C) 	1

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D(iii)												
	<table border="1"> <thead> <tr> <th>Criteria</th> <th>Mark</th> </tr> </thead> <tbody> <tr> <td>Identifies at least TWO environmental impacts of the Frasch process AND Identifies at least TWO environmental impacts of producing smelter acid AND Provides an assessment AND Coherent and logical arguments with relevant equations</td> <td>5-6</td> </tr> <tr> <td>Identifies at least TWO environmental impacts of the Frasch process AND Identifies at least TWO environmental impact of producing smelter acid AND Provides an assessment</td> <td>3-4</td> </tr> <tr> <td>Identifies at least ONE environmental impact of the Frasch process AND Identifies at least ONE environmental impact of producing smelter acid</td> <td>2</td> </tr> <tr> <td>Identifies at least ONE environmental impact of the Frasch process OR Identifies at least ONE environmental impact of producing smelter acid</td> <td>1</td> </tr> </tbody> </table> <p>The Frasch process has the following environmental impacts: Release of sulfur dioxide into the air due to the partial oxidation of sulfur. This in turn can lead to the production of acid rain within the region lowering the pH of surrounding ecosystems. $S + O_2 \rightarrow SO_2$, $SO_2 + H_2O \rightarrow H_2SO_3$ Thermal pollution in the immediate vicinity is also a problem as is the destabilization of the area where sulfur has been extracted from.</p> <p>Smelter acid: The emission of sulfur dioxide is carefully monitored by Governments. If Sulfur dioxide is obtained from the roasting of sulfide based ores, then this obviates the need for extracting raw sulfur. Further, it assists in reducing the amount of sulfur dioxide pumped into the atmosphere at smelters because it is recovered and used to manufacture sulfuric acid.</p> $2SO_2 + O_2 \rightleftharpoons 2SO_3$ <p>While this may mean increased start up costs for the recovery of SO_2, it is compensated for by making sulfuric acid on site and reducing expensive transport costs.</p> <p>Overall, the production of smelter acid represents a win-win situation for companies and the environment.</p>	Criteria	Mark	Identifies at least TWO environmental impacts of the Frasch process AND Identifies at least TWO environmental impacts of producing smelter acid AND Provides an assessment AND Coherent and logical arguments with relevant equations	5-6	Identifies at least TWO environmental impacts of the Frasch process AND Identifies at least TWO environmental impact of producing smelter acid AND Provides an assessment	3-4	Identifies at least ONE environmental impact of the Frasch process AND Identifies at least ONE environmental impact of producing smelter acid	2	Identifies at least ONE environmental impact of the Frasch process OR Identifies at least ONE environmental impact of producing smelter acid	1	6
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