Chemistry

HSC Course

2013

Trial HSC Examination

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours

- Attempt all questions
- Write using blue or black pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your student number on each section of the examination booklet
- Liquid paper must NOT be used on this paper

Total marks – 100

Section I – Core modules
75 marks
This section has two parts, Part A and Part B

Part A – 20 marks
Attempt questions 1-20 (multiple choice)
Allow about 35 minutes for this part.

Part B – 55 marks
Attempt questions 21 to 35
Allow about 1 hour 40 minutes for this part

Section II – Option module
25 marks
Attempt question 36
Allow about 45 minutes for this section

Teachers: Dr Morante, Mr Geerling, Ms Jackson, Mrs Davis

Task Weighting: 40 %

Section I – Part A

20 marks
Attempt questions 1 – 20
Allow about 35 minutes for this part

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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 this by writing the word correct and drawing an arrow as follows:

correct ↓

(A) ⊗ (B) ⊗ (C) ⬭ (D) ⬭

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1. Identify a chemical equation that summarises the chemistry of the fermentation process.

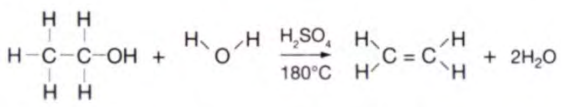
(A) $C_2H_4(g) \xrightarrow{\text{fermentation}} C_2H_5OH(l) + CO_2(g)$

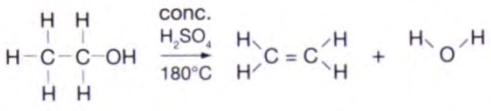
(B) $2CO_2(g) + 2C_2H_5OH(l) \xrightarrow{\text{fermentation by yeast}} C_6H_{12}O_6(aq)$

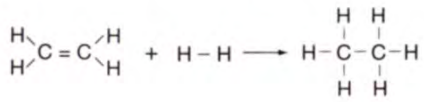
(C) $C_6H_{12}O_6(s) + 3H_2O(l) \xrightarrow{\text{fermentation}} 3C_2H_5OH(l) + 3O_2(g)$

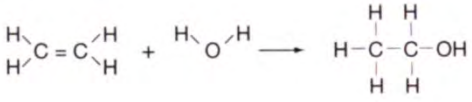
(D) $C_6H_{12}O_6(aq) \xrightarrow{\text{fermentation by yeast}} 2C_2H_5OH(l) + 2CO_2(g)$

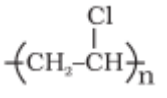
2. Which of the following represents a correct model for the dehydration of ethanol?

(A) 

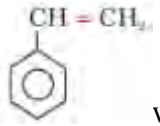
(B) 

(C) 

(D) 

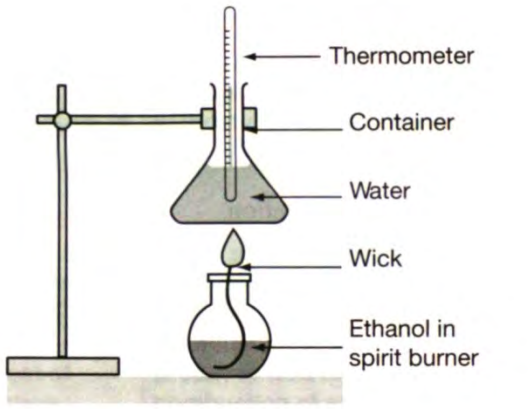
3. This substance  is:

(A) Polystyrene
(B) Polyvinyl chloride
(C) Vinyl chloride
(D) Polyethylene

4. If the following substance  were to be polymerised it would form:

   (A) Polystyrene as an addition polymer
   (B) Polyethylene as a condensation polymer
   (C) Polystyrene as a condensation polymer
   (D) Polyethylene as an addition polymer

5. A group of Year 12 students performed a first-hand investigation to find the heat of combustion of ethanol. They burned ethanol in a spirit burner, and used it to heat 100 mL of water, as shown in the diagram below. Using the results obtained calculate the molar heat of combustion for ethanol.



The results they obtained were:

The heat released by the ethanol = 5292 J

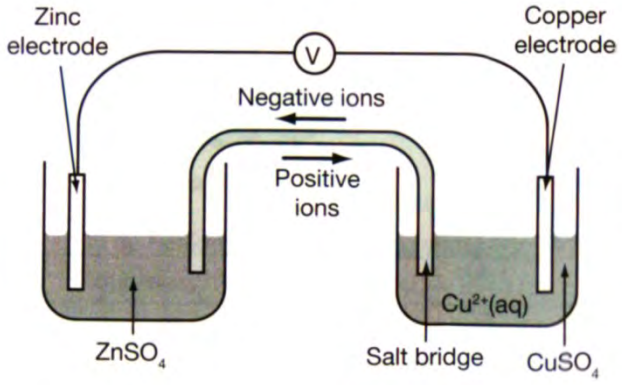
Initial mass of spirit burner + ethanol = 239.14 g

Final mass of spirit burner + ethanol = 237.81 g

Which alternative provides the experimental molar heat of combustion of ethanol?

(A) $+1.85 \times 10^2$ kJ.mol $^{-1}$
(B) -12.6 kJ.mol $^{-1}$
(C) -5292 kJ.mol $^{-1}$
(D) -1.85×10^2 kJ.mol $^{-1}$

6. The following diagram shows a galvanic cell.



In the galvanic cell illustrated above, electrons are produced at:

(A) The copper electrode because copper is more active than zinc.
(B) The copper electrode because copper is less active than zinc.
(C) The zinc electrode because zinc is more active than copper.
(D) Both electrodes because zinc and copper are equally active.

7. Which one of the following lists contains metals which will <u>all</u> displace tin from a solution of tin(II) nitrate?

(A) Copper, iron and silver.
(B) Copper, magnesium and lead.
(C) Nickel, iron and lead.
(D) Magnesium, aluminium and zinc.

8. In which of the following equations is the metal reduced? (These are not balanced equations.)

(A) $[Fe(CN)_6]^{4-} \rightarrow [Fe(CN)_6]^{3-}$
(B) $[MnO_4]^{-} \rightarrow MnO_2$.
(C) $[MnO_4]^{2-} \rightarrow MnO_4]^{-}$.
(D) $[Cr_2O_7]^{2-} \rightarrow [CrO_4]^{2-}$

9. The correct IUPAC name for citric acid is:

(A) 2-hydroxypropane-1,2,3-tricarboxylic acid
(B) 2-hydroxypropane-triethanoic acid.
(C) 1,1,1-tricarboxylic acid
(D) diethanoic acid

10. If equal volumes of the following aqueous solutions were mixed, which one would have the highest pH?

(A) 1 mol L^{-1} NaOH + 1 mol L^{-1} CH_3COOH
(B) 1 mol L^{-1} NH_3 + 1 mol L^{-1} H_2SO_4
(C) 1 mol L^{-1} H_2SO_4 + 1 mol L^{-1} $Ba(OH)_2$
(D) 1 mol L^{-1} KOH + 1 mol L^{-1} HCl

11. Sulfuric acid can react with pyrosulfuric acid according to the equation:

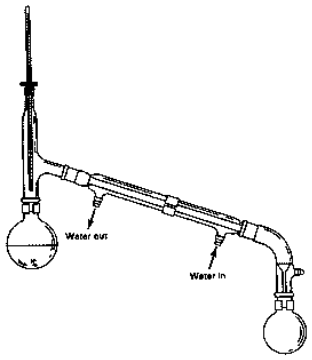
$$H_2SO_{4(l)} + H_2S_2O_{7(l)} \rightleftharpoons H_3SO_4^{+}{}_{(l)} + HS_2O_7^{-}{}_{(l)}$$

Which species are acting as acids in this reaction?

(A) H_2SO_4, $H_3SO_4^+$
(B) $H_2S_2O_7$, $HS_2O_7^-$
(C) H_2SO_4 , $HS_2O_7^-$
(D) $H_2S_2O_7$, $H_3SO_4^+$

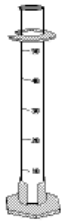
12. Which type of glassware is used in titration to deliver solution *X* to a known volume of solution *Y*?

(A)



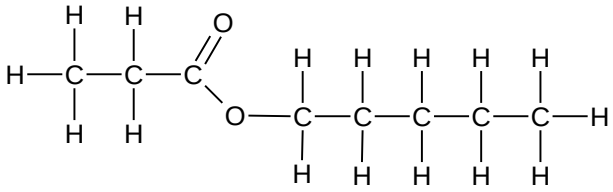
(C)

(B)



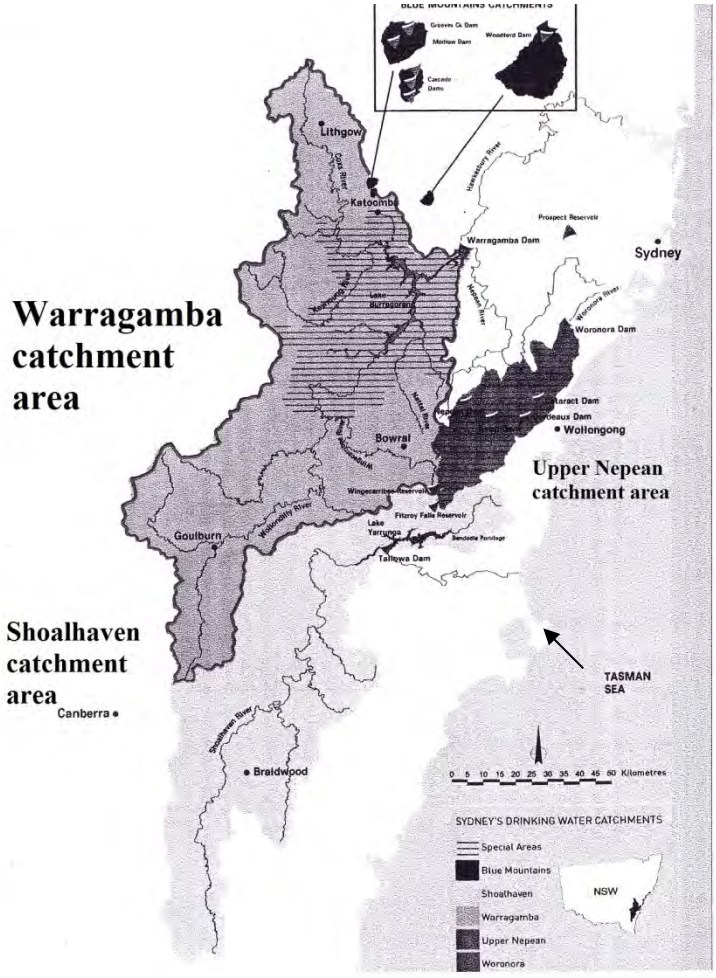
(D)

13. What is the name of this compound?



(A) butylpentanoate
(B) pentylbutanoate
(C) propylpentanoate
(D) pentylpropanoate

14. The Warragamba catchment area supplies 80% of the water used by the residents of Sydney. The map shows the location and scope of this catchment area.



One of the most likely water contaminants in this catchment area is pathogens such as bacteria, and protists such as *Cryptosporidium*, *Giardia.* The process used to remove these pathogens is:

(A) Disinfection, a chemical process
(B) Filtration, a physical process
(C) Coagulation, a chemical process
(D) Flocculation, a physical process

15. Scientists studying the spectra of a distant star noticed measureable concentrations of a number of transuranic elements. They proposed a number of hypotheses that might explain these observations. The one most likely to be found to be supported is:

(A) The star is being bombarded by a stream of neutrons released from a supernova explosion
(B) Atomic fission on the star is producing larger elements.
(C) The spectra of elements on that particular distant star are not the same as those on Earth.
(D) Hydrogen- hydrogen fusion is acting at a high rate on this star producing a spectra of transuranic elements

16. Where on the Periodic Table would you most likely find elements which form basic oxides?

(A) Group 1
(B) Group 2
(C) Period 3
(D) Period 6

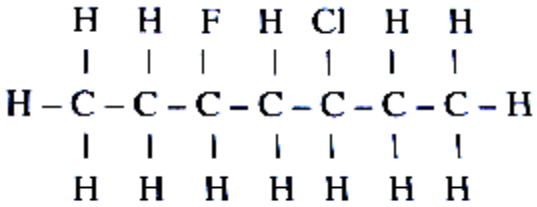
17. The reason why chlorofluorocarbons are so damaging to the ozone layer when they are such stable molecules is because:

(A) They contain a double bond that ozone readily attacks, resulting in the destruction of the ozone.
(B) They are very light molecules that rapidly diffuse into the upper atmosphere and block the radiation that causes formation of ozone.
(C) They are greenhouse gases that raise the temperature above the dissociation temperature of ozone.
(D) The radiation in the stratosphere dissociates them producing chlorine radicals that participate in a chain reaction that destroys ozone while it regenerates the chlorine radical.

18. In the early part of the 20^{th} century research was intensive to develop an industrial process that could manufacture ammonia. The Haber Bosch process came from that intense effort.
This main reason for that intense effort was:

(A) To make ammonia as quickly as possible
(B) To reduce dependence on a non-renewable resource of raw materials
(C) To maximise the cost of production of each tonne of ammonia
(D) To push the boundaries of science through basic research.

19.



The IUPAC name for this chemical is:

(A) 3-chloro-5-fluoroheptane
(B) 3-fluoro-5-chloroheptane
(C) 5-chloro-3-fluoroheptane
(D) 5-fluoro-3-chlorheptane

20 Chemical treatment of municipal water supplies commonly entails use of CaO, $Al_2(SO_4)_3$, and Cl_2. The purpose of adding CaO is to:

A) remove all HCO_3^- as solid $CaCO_3$
B) remove all SO_4^{2-} as solid $CaSO_4$
C) selectively kill anaerobic (but not aerobic) bacteria
D) make the water slightly basic so that addition of $Al_2(SO_4)_3$ will afford a gelatinous precipitate of $Al(OH)_3$

Section I – Part B

55 marks
Attempt questions
Allow about 1 hour 40 minutes for this part

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Question 21

As a part of the HSC chemistry course, you performed a first-hand investigation to identify the conditions under which a galvanic cell is produced.

(a) Outline the procedure you used in your investigation. 2M

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(b) Outline one relevant piece of observational evidence of a chemical reaction occurring during your investigation. 1M

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Question 22

The following equation shows the production of a commercial radioisotope. This is indicated with the letter X. Identify this element. 1M

$$^{239}_{94}Pu + 2\,^{1}_{0}n \rightarrow X + \,^{0}_{-1}e$$

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Radioisotopes are manufactured for the purposes of industrial use and medicine

Name a commercial radioisotope used in Australia in industry or in medicine. 0M

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(b) Outline how this isotope is used. 2M

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Question 23

Evaluate a lead acid cell or dry cell battery in comparison to one of the following:

a button cell

a fuel cell

a vanadium redox cell

a lithium cell

a liquid junction photovoltaic cell.

Make your evaluation in terms of the batteries' chemistry, cost and practicality, impact on society and environmental impact. 4M

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Question 24

During your practical work you planned and performed a first-hand investigation to compare the reactivity of appropriate alkenes with corresponding alkanes in bromine water.

Bromine water was added to an alkene and also to its corresponding alkane. Describe the planning process, and the parts of your method that provided validity for this first-hand investigation. 4M

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Question 25

The use of ethanol as a fuel which is readily available to replace or supplement fossil fuel based motor vehicle fuels has dramatically increased. Assess the potential of ethanol as an alternative fuel and discuss the advantages and disadvantages of its use. 5M

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Question 26

A student was asked to construct a galvanic cell and had the following chemicals available

copper; copper(II) nitrate solution; iron; iron(II) nitrate solution; lead; lead(II) nitrate solution; magnesium; magnesium nitrate solution; potassium nitrate solution

(a) Identify the combination of chemicals that will produce the maximum cell voltage. 1M

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(b) Calculate the maximum cell voltage that could be produced from the half cells identified in (a) at standard conditions, showing the reduction and oxidation half-equations and all relevant working. 2M

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(c) The cell voltage measured by the student was less than the calculated E° value. Suggest one possible reason for this difference. 1M

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Question 27

According to the Arrhenius theory, the ammonium ion would not be classed as an acid, while it would be classified as an acid according to the Bronsted-Lowry theory. Using the ammonium ion as the example compare the main features of the two theories. 2M

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Question 28

A 5.00 mL volume of vinegar was found to weigh 4.50 g. The vinegar was placed into a conical flask and diluted with 20.0 mL of distilled water. The concentration of acetic acid (ethanoic acid) in the vinegar was determined by titration with 0.100 mol L^{-1} sodium hydroxide. At the endpoint, the titre was 23.3 mL.

(a) What is the concentration (mol L^{-1}) of acetic acid in the undiluted vinegar? 1M

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(b) Calculate the percentage mass of acetic acid in the original undiluted vinegar? 2M

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Question 29

The *National Australian Standard* for sulfur in petrol is 500 ppm maximum. Petrol burns in vehicles and sulfur dioxide is a product of that combustion.

(a) Write a balanced chemical equation showing how sulfur dioxide produces acid rain and name the acid formed. **2M**

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Question 30

During the HSC Chemistry course a student performed a first-hand investigation to prepare an ester such as the ester **butyl ethanoate**.

(a) Write the balanced chemical equation for the reaction that produces butyl ethanoate. 1M

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(b) Identify two potential safety hazards and describe the experimental procedures that may be used to minimize these hazards in the preparation of the ester. 2M

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(c) Explain the use of concentrated sulfuric acid in the process of esterification. 2M

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Question 31

A 0.125 mol L-1 solution of a triprotic acid, H_3A, has a pH of 4.5.

(a) Is H_3A a weak or a strong acid? Justify your answer. 2M

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(b) Calculate the volume of a 0.432 mol L^{-1} NaOH which will react completely with 20.0 mL of the acid. Show your working. 3M

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Question 32

A buffer is known to contain these substances:
sodium dihydrogen phosphate, sodium hydrogen phosphate, ethanoic acid and sodium ethanoate

(a) Define a buffer. 1M

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(b) Use equations to aid explanation of how two of the substances can act as a buffer. 3M

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Question 33

Ozone is found in the Earth's atmosphere. Near the Earth's surface, ozone is a major component of photochemical smog.

(a) Describe the effects of photochemical smog on people and the environment. 2M

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Question 34

A common method of monitoring possible eutrophication of waterways is to perform the following chemical test sequence known as the Winkler method to determine dissolved oxygen (DO).

The Winkler method involves Mn^{2+} ions reacting with the dissolved oxygen in the water to form MnO_2 as a brown precipitate.

$$O_{2\,(aq)} + 2Mn^{2+}_{(aq)} + 4OH^-_{(aq)} \rightarrow 2MnO_2 + 2H_2O_{(l)}$$

This brown precipitate is dissolved by acid and then reacts with I^- to form iodine.

$$MnO_2 + 4H^+_{(aq)} \rightarrow Mn^{4+}_{(aq)} + 2H_2O_{(l)} \quad (1)$$

$$Mn^{4+}_{(aq)} + 2I^-_{(aq)} \rightarrow Mn^{2+}_{(aq)} + I_{2(aq)} \quad (2)$$

Iodine is titrated with thiosulfate ions ($S_2O_3^{2-}$) because the concentration of iodine is directly proportional to the DO concentration.

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

The net equation for this chemical test is:

$$O_{2(aq)} + 4S_2O_3^{2-}{}_{(aq)} + 4H^+_{(aq)} \rightarrow 2S_4O_6^{2-}{}_{(aq)} + 2H_2O_{(l)}$$

Starch reacts with iodine to produce a blue colour. Once the end point is reached, all of the iodine is reduced by the thiosulfate ions to iodide and the blue colour disappears.

For a set of 1 L river samples taken at four locatios a laboratory determined the number of moles of thiosulfate ($S_2O_3^{2-}$) used in the Winkler method titration to reach endpoint. The result of these chemical tests is presented in the table.

Sample	Moles $S_2O_3^{2-}$ consumed at titrant endpoint.	Concentration of dissolved moles O_2 /L
1	0.0125	0.00313
2	0.025	
3	0.0375	0.00938
4	0.075	

(a) Using the data supplied, calculate the concentration of dissolved oxygen per litre in samples 2 and 4 and use them to complete the table. 2M

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(b) Identify and justify from the data, which sample is most likely to indicate a high probability of eutrophication. 2M

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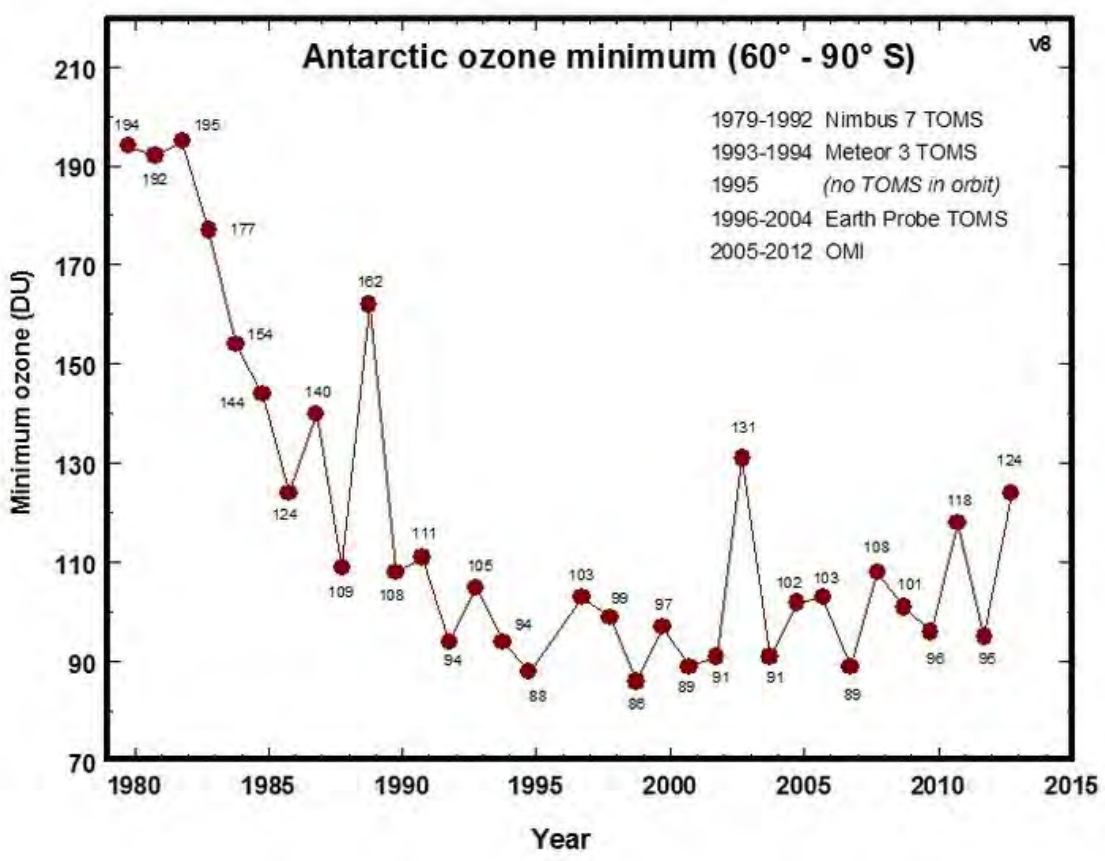
Question 35

The Total Ozone Mapping Spectrometer (TOMS) satellites have recorded ozone levels in units called Dobson units (DU) over Antarctica since 1979. The graph shows some of this collected data.



(a) Describe the trend in ozone concentration shown on the graph from 1980 to 1995. 1M

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(b) Analyse the data shown of the graph to identify two years that could represent outliers in the data. 2M

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Timothy, a student at HAHS, looked at the data and concluded that the data shows a rapid recovery in ozone in the stratosphere since 1993.

(c) Discuss whether the data provided supports Timothy's conclusion. 2M

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Question 36 Section II

Option – Industrial Chemistry

25 marks
Attempt ONLY ONE question in this section
Allow about 45 minutes for this section

Answer the question in the spaces provided.

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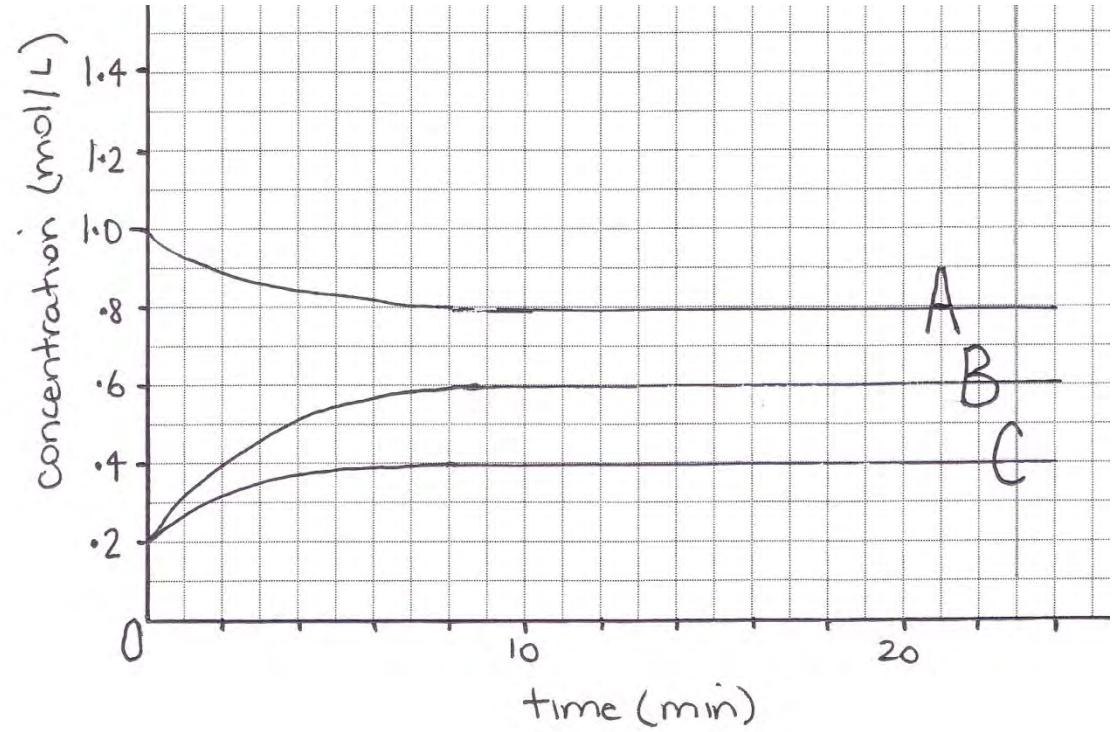
Question 36 – Industrial Chemistry

Answer all questions in this section

(a) Consider the equilibrium system involving three gases shown on the graph below. The three gases have been placed into a closed container and allowed to react until equilibrium is established.



(i) Complete the table for each substance at equilibrium:

Substance	Concentration (mol/L)
A	
B	
C	

1M

(ii) Write the equation for the reaction as described with the graph. 1M

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(iii) Calculate the equilibrium constant for this reaction. 2M

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(b) As a part of your course, you carried out a first-hand investigation to qualitatively analyse an equilibrium reaction.

(i) Describe the equilibrium reaction you analysed. 2M

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(ii) Outline the steps required to analyse the reaction. 2M

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(c) In your course you researched a natural product that is a limited resource.

(i) Name a natural product, other than a fossil fuel, that you have researched. 0M

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(ii) Discuss one issue associated with shrinking world resources of this product. 2M

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(iii) Evaluate progress currently being made to solve the problem of the dwindling supply of this product. 2M

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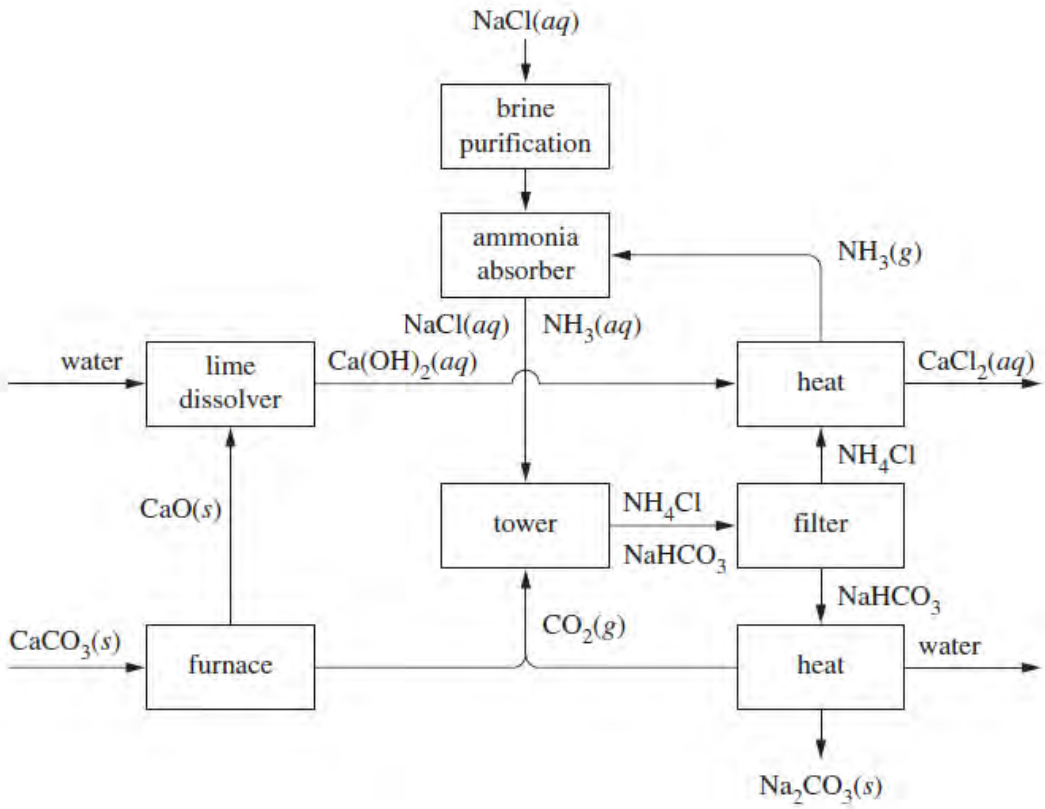
(d) The flow diagram summarises the Solvay process



(i) Identify the TWO compounds used in the Solvay process which are recycled. 1M

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(ii) What volume of gas (at 25 ^{o}C and 100 kPa) will be produced when 250 000 tonne of sodium hydrogen carbonate are decomposed? 2M

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(iii) Discuss ONE environmental issue associated with the process and explain how this issue is addressed. 2M

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(e) An impurity in natural gas is hydrogen sulfide (rotten egg gas). This impurity can be removed from natural gas by reaction with sulfur dioxide.

$2H_2S_{(g)} + SO_{2(g)} \leftrightarrow 3S_{(s)} + 2H_2O_{(g)}$ $K = 5.75 \times 10^{-2}$ at 100 ^oC

(i) Determine the equilibrium expression for this reaction. 1M

(ii) The reaction was allowed to occur until equilibrium was established. At 100^{o}C the number of moles of some of the chemicals in a 2.0 L vessel were found to be:

Chemical species	H_2S	SO_2	S
amount(mol)	0.550	0.450	0.225

Calculate the number of moles of H_2O in the vessel at equilibrium. Show relevant working. 2M

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(iii) At 450 ^{o}C, the value of K for this reaction at equilibrium is found to be 8.35×10^{-4}. Is the reaction exothermic or endothermic? Justify your answer. 2M

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(iv) Using Le Chatelier's principle, explain the general conditions of temperature and pressure that would favour this reaction. 3M

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☺☺☺☺ END OF EXAM ☺☺☺☺

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number
Atomic Weight
79 Au 197.0 — Symbol of element / Name of element (Gold)

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.41 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.62 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.94 Molybdenum	43 Tc [97.91] Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.8 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po [209.0] Polonium	85 At [210.0] Astatine	86 Rn [222.0] Radon
87 Fr [223] Francium	88 Ra [226] Radium	89–103 Actinoids	104 Rf [261] Rutherfordium	105 Db [262] Dubnium	106 Sg [266] Seaborgium	107 Bh [264] Bohrium	108 Hs [277] Hassium	109 Mt [268] Meitnerium	110 Ds [271] Darmstadtium	111 Rg [272] Roentgenium							

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm [145] Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.0 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac [227] Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np [237] Neptunium	94 Pu [244] Plutonium	95 Am [243] Americium	96 Cm [247] Curium	97 Bk [247] Berkelium	98 Cf [251] Californium	99 Es [252] Einsteinium	100 Fm [257] Fermium	101 Md [258] Mendelevium	102 No [259] Nobelium	103 Lr [262] Lawrencium

For elements that have no stable or long-lived nuclides, the mass number of the nuclide with the longest confirmed half-life is listed between square brackets.

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (October 2005 version) is the principal source of data. Some data may have been modified.

HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

DATA SHEET

Avogadro constant, N_A ..... 6.022×10^{23} mol^{-1}

Volume of 1 mole ideal gas: at 100 kPa and

at 0°C (273.15 K) ..... 22.71 L

at 25°C (298.15 K) ..... 24.79 L

Ionisation constant for water at 25°C (298.15 K), K_w ..... 1.0×10^{-14}

Specific heat capacity of water ..... 4.18×10^3 J kg^{-1} K^{-1}

Some useful formulae

$$pH = -\log_{10}[H^+] \qquad \Delta H = -mC\Delta T$$

Some standard potentials

$K^+ + e^-$	$\rightleftharpoons$	$K(s)$	–2.94 V
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	$Ba(s)$	–2.91 V
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	$Ca(s)$	–2.87 V
$Na^+ + e^-$	$\rightleftharpoons$	$Na(s)$	–2.71 V
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	$Mg(s)$	–2.36 V
$Al^{3+} + 3e^-$	$\rightleftharpoons$	$Al(s)$	–1.68 V
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	$Mn(s)$	–1.18 V
$H_2O + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g) + OH^-$	–0.83 V
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	$Zn(s)$	–0.76 V
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	$Fe(s)$	–0.44 V
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	$Ni(s)$	–0.24 V
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	$Sn(s)$	–0.14 V
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	$Pb(s)$	–0.13 V
$H^+ + e^-$	$\rightleftharpoons$	$\frac{1}{2}H_2(g)$	0.00 V
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(aq) + 2H_2O$	0.16 V
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	$Cu(s)$	0.34 V
$\frac{1}{2}O_2(g) + H_2O + 2e^-$	$\rightleftharpoons$	$2OH^-$	0.40 V
$Cu^+ + e^-$	$\rightleftharpoons$	$Cu(s)$	0.52 V
$\frac{1}{2}I_2(s) + e^-$	$\rightleftharpoons$	I^-	0.54 V
$\frac{1}{2}I_2(aq) + e^-$	$\rightleftharpoons$	I^-	0.62 V
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	0.77 V
$Ag^+ + e^-$	$\rightleftharpoons$	$Ag(s)$	0.80 V
$\frac{1}{2}Br_2(l) + e^-$	$\rightleftharpoons$	Br^-	1.08 V
$\frac{1}{2}Br_2(aq) + e^-$	$\rightleftharpoons$	Br^-	1.10 V
$\frac{1}{2}O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O	1.23 V
$\frac{1}{2}Cl_2(g) + e^-$	$\rightleftharpoons$	Cl^-	1.36 V
$\frac{1}{2}Cr_2O_7^{2-} + 7H^+ + 3e^-$	$\rightleftharpoons$	$Cr^{3+} + \frac{7}{2}H_2O$	1.36 V
$\frac{1}{2}Cl_2(aq) + e^-$	$\rightleftharpoons$	Cl^-	1.40 V
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	1.51 V
$\frac{1}{2}F_2(g) + e^-$	$\rightleftharpoons$	F^-	2.89 V

Aylward and Findlay, *SI Chemical Data* (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

Multiple-choice Answer Sheet

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 this by writing the word correct and drawing an arrow as follows:

correct ↓

(A) ⊗ (B) ⊗ (C) ⬭ (D) ⬭

---

1. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
2. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
3. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
4. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
5. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
6. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
7. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
8. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
9. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
10. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
11. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
12. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
13. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
14. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
15. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
16. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
17. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
18. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
19. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭
20. (A) ⬭ (B) ⬭ (C) ⬭ (D) ⬭

Marking Guidelines - THSC Exam 2013
Year 12 CHEMISTRY

Multiple choice

Question	Answer	Question	Answer
1	D	11	D
2	B	12	D
3	B	13	D
4	A	14	A
5	D	15	A
6	C	16	B
7	D	17	D
8	B	18	B
9	A	19	C/A
10	A	20	D

21.a.

Marking criteria	*Marks*
Outlines the general procedure used and includes a section that demonstrates a change made in order to test a condition required for a galvanic cell.	2
Outlines the general procedure used.	1

21.b.

Marking criteria	*Marks*
Outlines evidence of a chemical reaction for a galvanic cell	2

22.

Marking criteria	*Marks*
Identifies $^{241}Am_{95}$	1

22.b.

Marking criteria	*Marks*
Outlines the use of the isotope in either industry or medicine with respect to how it is administered and detected	2
Identifies the use of the isotope	1

23.

Marking criteria	*Marks*
Evaluates either the lead acid cell or the dry cell battery in comparison to one of the supplied cells by including information describing chemistry, cost and practicality, impact on society and environmental impact.	4
Three of the above	3
Two of the above	2
One of the above	1

24.

Marking criteria	*Marks*
Planning including identification of dependent and independent variables, control, controlled variables, trialling if deemed necessary, identification of issues including assessment of risks, use of MSDS and identification of part(s) of the procedure to ensure testing was valid. **Note**: planning is not a description of the method used in the investigation.	4
4 of the above	3
3 of the above	2
2 of the above	1

25.

Marking criteria	*Marks*
Assessment wrt potential either good or bad but argued, 2 or more valid advantages, 2 or more valid disadvantages	5
4 of the above ie 2 valid advantages, an assessment and identification of one disadvantage.	4
3 of the above	3
2 of the above	2
One of the above	1
Note it is the responsibility of the candidate to identify advantages and disadvantages clearly. The examiner cannot and will not make that identification for you.	

26.a

Marking criteria	*Marks*
Identifies the chemicals as magnesium, magnesium nitrate, copper and copper(II)nitrate	1

26.b.

Marking criteria	*Marks*
Includes an oxidation half equation for magnesium and a reduction half equation for copper(II) and calculates the cell voltage as +2.70V	2
For one correct half equation OR the half equations are not correct direction OR the wrong chemicals are used BUT everything for the specified cell is otherwise correct	1

26.c.

Marking criteria	*Marks*
Suggests a possible reason for incorrect voltage (that doesn't include incorrect procedure)	1

27.

Marking criteria	*Marks*
Outlines the definition for an Arrhenius acid AND the definition for a Lowry-Bronsted acid AND then relates this to NH_4^+	2
Outlines the definition for an Arrhenius acid AND the definition for a Lowry-Bronsted acid OR one definition was included and shows reference to the ammonium ion.	1

28.a.

Marking criteria	*Marks*
Calculated concentration of undiluted vinegar as 0.466 mol/L	1

28.b.

Marking criteria	*Marks*
Calculates the % mass as 3.11%	2
Equates that 0.0023mol of undiluted vinegar is present in 4.50g	1

29.

Marking criteria	*Marks*
Writes ONE equation to show how SO_2 forms an acid $SO_{2(g)} + H_2O_{(l)} \rightarrow H_2SO_{3\ (aq)}$ and identifies the acid as sulfurous acid.	2
Includes the above equation OR names the acid	1

30 a.

Marking criteria	*Marks*
Correct and balanced equation	1

30.b.

Marking criteria	*Marks*
Two relevant potential hazards identified with appropriate hazard reduction described	2
One potential hazard identified with appropriate hazard reduction described	1

30.c.

Marking criteria	*Marks*
A clear explanation: Dehydrates reaction to favour forward reaction and production of ester (le Chatelier's principle), a catalyst	2
A sound explanation of aspects of the above.	1

31.a.

Marking criteria	*Marks*
A clear justification that supports the identification of the acid as weak using the numerical information supplied to support the justification.	2
Identification of the acid as weak with a flawed or inadequate argument as justification.	1

31.b.

Marking criteria	*Marks*
Correct calculations showing working indicating a volume required of 17.4 mL	3
An incorrect calculation following a logical procedure that involves an incorrect substitution of a value	2
Correct calculation of the number of moles of H^+	1

32. a.

Marking criteria	*Marks*
Correct definition for a buffer	1

32. b.

Marking criteria	*Marks*
Explanation involving two of the substances listed acting as a buffer using correct equations to clarify or support the explanation	3
Explanation using one of the substances listed using an equation to clarify the explanation.	2
An explanation not referring to one of the substances listed or utilising no chemical equations.	1

33.

Marking criteria	*Marks*
Two effects on people and two effects on the environment described.	2
One effect on people and the environment described OR two effects on the environment or people.	1

34. a.

Marking criteria	*Marks*
Two correct calculations	2
One correct calculation	1

34. b.

Marking criteria	*Marks*
Sample 1 and correct justification connecting eutrophication to low dissolved oxygen	2
Correct justification but wrong sample identified or opposite	1

35 a .

Marking criteria	*Marks*
Decreasing. Point-by-point description is not a trend.	1

35.b.

Marking criteria	*Marks*
1988/1989 and 2002/2003 and correct analysis that these points are against the trend.	2
Identification of outliers only.	1

35 c..

Marking criteria	*Marks*
Timothy is incorrect. Reason eg slight trend up, not rapid	2
Either Timothy is incorrect OR a valid description that supports Timothy.	1

OPTION – Industrial Chemistry

36 a. (i).

Marking criteria	*Marks*
Correctly identifies the concentration of each of the three substances: [A] = 0.8; [B] = 0.6; [C] = 0.4	1

a.(ii).

Marking criteria	*Marks*
Correct equilibrium equation: $A \leftrightarrow 2B + C$	1

a. (iii).

Marking criteria	*Marks*
• Answer is consistent with the equation presented in the answer to part (a) (ii) • Working is provided (eg. equilibrium constant expression & a substituted expression)	2
Answer is consistent with the equation presented in the answer to part (a) (ii) BUT working is incomplete OR Provides the correct K expression	1

b.(i).

Marking criteria	*Marks*
Describes the equilibrium reaction either in words or by using a balanced chemical equation **AND** Describes one or more features of the reaction that can be used for qualitative analysis	2
Describes the equilibrium reaction either in words or by using a balanced chemical equation	1

b.(ii).

Marking criteria	*Marks*
Outline TWO specific conditions that will be changed *(eg. put a test tube of the equilibrium mixture into an water bath at 0°C ; put another test tube of the equilbirium mixture into a water bath at 80°C)* **AND** Outlines the observations that must be made (eg. change in colour NOT just colour) **AND** Outlines how the qualitative observations will be used to make an analysis	2
One of the points outlined above	1

c.(i).

Marking criteria	*Marks*
Identifies a natural resource that is not a fossil fuel and that is a resource whose supply is decreasing eg. rubber; guano;	0

c.(ii).

Marking criteria	*Marks*
Identifies an issue that relates to "shrinking world resources" of the natural product (NOTE this is not the same as increased demand for the product) **AND** Provides some features of the issue	2
Identifies an issue that relates to "shrinking world resources" of the natural product (NOTE this is not the same as increased demand for the product)	1

c.(iii).

Marking criteria	*Marks*
Describes one development/area of research currently being used/looked into to solve the problem **AND** Clearly makes a judgement about the "progress being made" to solve the problem.	2
Describes one development/area of research currently being used/looked into to solve the problem	1

d.(i).

Marking criteria	*Marks*
Identifies the TWO compounds that are recycled as carbon dioxide and ammonia	1
Identifies ONE of the compounds that is recycled	0.5

d.(ii).

Marking criteria	*Marks*
• Calculates the moles of $NaHCO_3$ as 2.97.. X 10^9 mol • Calculates the moles of CO to be half that of $NaHCO_3$ • Determines the volume of CO_2 to be 3.68... X 10^{10}L	2 1.5 if units omitted
Calculates the number of moles of $NaHCO_3$ correctly **OR** Uses correct mole ratio (1:2) to determine moles of CO_2 produced	1

d.(iii).

Marking criteria	*Marks*
Identifies an issue **AND** Provides details to show why it is an environmental issue **AND** Explains a strategy to overcome the issue (ie a cause and effect statement needs to be provided)	2
Identifies an issue **AND** Provides details to show why it is an environmental issue **OR** Explains a strategy to overcome the issue (ie a cause and effect statement needs to be provided)	1

e.(i).

Marking criteria	*Marks*
Determines the equilibrium constant expression to be: $K = \frac{[H_2O]^2}{[H_2S]^2[SO_2]}$ nb. solids are omitted	1

e.(ii).

Marking criteria	*Marks*
• Answer is consistent with K expression presented in (e) (i). • Calculates concentration of reactants and products correctly (moles ÷ 2) • Calculates $[H_2O]$ using K expression given in (e) (i) • Converts $[H_2O]$ into moles of H_2O (0.626 mol)	
• Calculates concentration of reactants and products correctly (moles ÷ 2) OR • Converts calculated $[H_2O]$ into moles of H_2O (0.626 mol) (correct for substituted K expression)	1

e.(iii).

Marking criteria	*Marks*
• Interprets that given data and relates it to the reaction *(an increase in temperature results in a decrease in the K value THUS the reverse reaction is favoured)* • Outlines the effect an increase in temperature has on an equilibrium reaction *(an increase in temperature favours the endothermic reaction)* • Relates these TWO pieces of information to deduce that "the reaction is exothermic"	3
TWO of the points above	2
ONE of the points above	1

e.(iv).

NOTE: Answer given here must be consistent with the answer provided in e. (iii)!
NOTE also: explain means to provide a cause and effect relationship.
NOTE also: Using Le Chatelier's Principle means more than stating LCP and more that writing "according to LCP"

Marking criteria	*Marks*
• Identifies that the temperature should be LOW and **explains** why **using** Le Chatelier's principle • Identifies that the pressure should be HIGH and **explains** why **using** Le Chatelier's principle • There must be NO incorrect or inconsistent information provided in the answer.	3
Identifies that the temperature should be LOW and **explains** why **using** Le Chatelier's principle **OR** Identifies that the pressure should be HIGH and **explains** why **using** Le Chatelier's principle OR Identifies that a LOW temperature and a HIGH pressure are required and **partially** explains why these conditions are needed	2
Identifies that a LOW temperature **OR** a HIGH pressure are needed to favour the reaction	1