2008

Trial HSC Examination

Chemistry

General Instructions
Reading time – 5 minutes
Working time – 3 hours

- Write using blue or black pen
- Draw diagrams using pencil
- Approved calculators may be used
- Do NOT use liquid paper or white out on this exam paper. If you make a mistake, cross it out then continue writing.
- If you do use liquid paper/white out, anything written over it will NOT be remarked at a later date.
- Write your student number on each section of this booklet
- A data sheet and Periodic Table are provided at the back of this paper.
- The multiple-choice answer sheet may be detached for your convenience

Total marks 100
Section I
75 marks
This section has two parts, Part A and Part B.
Part A – 15 marks
Attempt Questions 1 – 15.
Allow about 30 minutes for this part.
Part B – 60 marks
Attempt Questions 16 – 29.
Allow about 1 hour and 45 minutes for this part.
Section II
25 marks
Attempt ONE question from this section.
Attempt Question 30 – Industrial Chemistry.
Allow about 45 minutes for this section.

Teacher-in-charge: Mrs Davis

Task Weighting: 40%

Section I.

Part A - 15 marks

Attempt questions 1 - 15.
Allow about 30 minutes for this part.
Record your answers on the separate multiple-choice answer sheet.

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

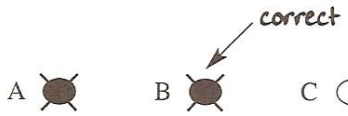
Sample: 2 + 4 = (A) 2 (B) 6 (C) 8 (D) 9

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 the correct answer by writing the word **correct** and drawing an arrow as follows.



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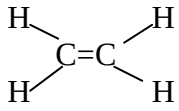
1. Which equation best represents catalytic cracking of a petroleum fraction?

(A) $C_{16}H_{34(l)} \longrightarrow C_{16}H_{34(g)}$
(B) $nC_2H_{4(g)} \longrightarrow -(CH_2—CH_2)_n-_{(s)}$
(C) $C_{16}H_{34(l)} \longrightarrow C_7H_{16(l)} + 3C_2H_{4(g)} + C_3H_{6(g)}$
(D) $C_7H_{16(l)} + 3C_2H_{4(g)} + C_3H_{6(g)} \longrightarrow C_{16}H_{34(l)}$

2. The diagram shows a commercially significant monomer.



What is the name of the polymer made from this monomer?

(A) polyethylene
(B) polyethane
(C) polyvinyl acetate
(D) polyvinyl ethene

3. Which of the following equations shows the greatest change in oxidation state for the reduction of the reactant?

(A) $Fe \rightarrow Fe^{3+} + 3e^-$
(B) $Fe + 3e^- \rightarrow Fe^{3+}$
(C) $Fe^{3+} + e^- \rightarrow Fe^{2+}$
(D) $Fe^{2+} + 2e^- \rightarrow Fe$

4. Identify the correct IUPAC name for an isomer of CH_3CHCl_2.

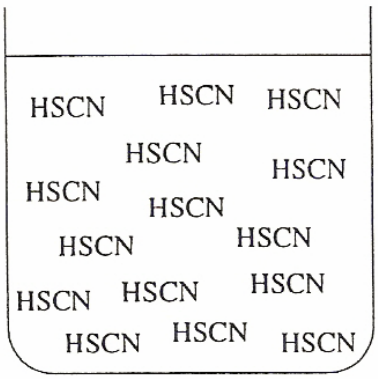
(A) 1,1-chloroethane
(B) 1,1-dichloroethane
(C) 1,3-dichloromethane
(D) 1,2-dichloroethane

5. The heat of combustion of 1-butanol is 2676 kJ mol^{-1}.
What is the value of the heat of combustion in kJ g^{-1}?

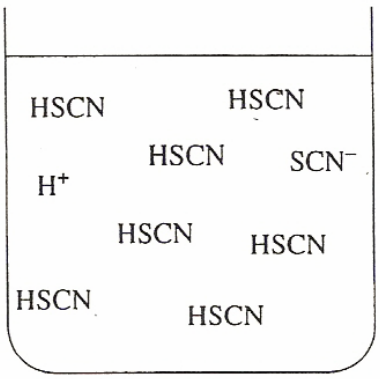
(A) 30.41
(B) 36.10
(C) 44.60
(D) 47.79

6. The acid, thiocyanic acid, HSCN, produces H^+ ions and SCN^- in water. It is a very strong acid.
Which of the following diagrams would best represent a dilute solution of this acid?

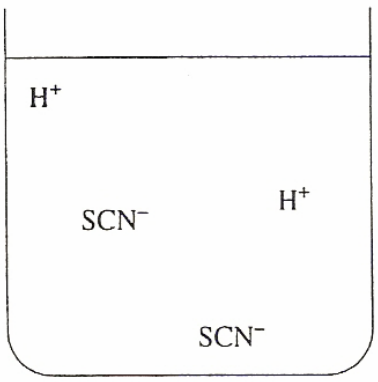
(A)



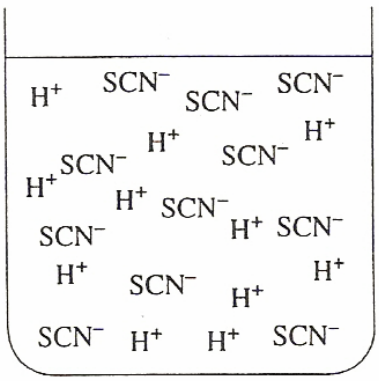
(B)



(C)



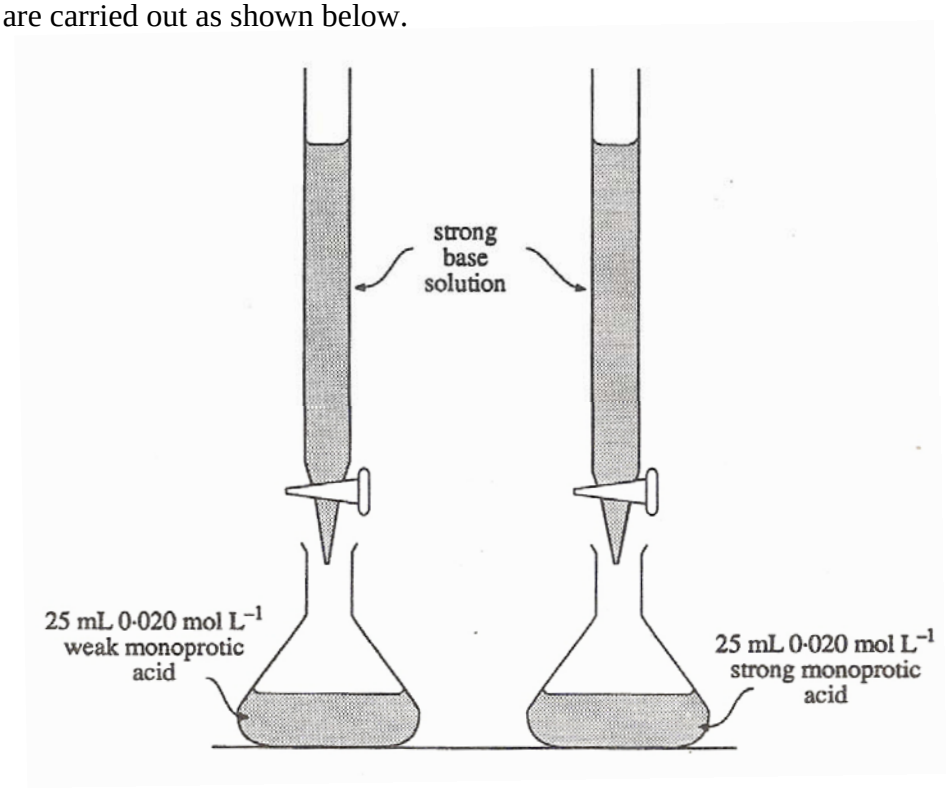
(D)



7. Which of the following species is amphiprotic in water?

(A) H_3O^+
(B) H_2CO_3
(C) CH_3COO^-
(D) $H_2PO_4^{2-}$

8. Two titrations are carried out as shown below.



Which of the following statements is true?

(A) the volume of base required to reach the equivalence point will depend upon the particular acid used
(B) the weak acid will require the same amount of base as the strong acid to reach the equivalence point
(C) the weak acid will require less base than the strong acid to reach the equivalence point
(D) the weak acid will require more base than the strong base to reach the equivalence point

9. The pH of blood is critical. If the pH falls below 7.4, the condition called acidosis results.

The following equilibrium system is involved in maintaining blood pH:

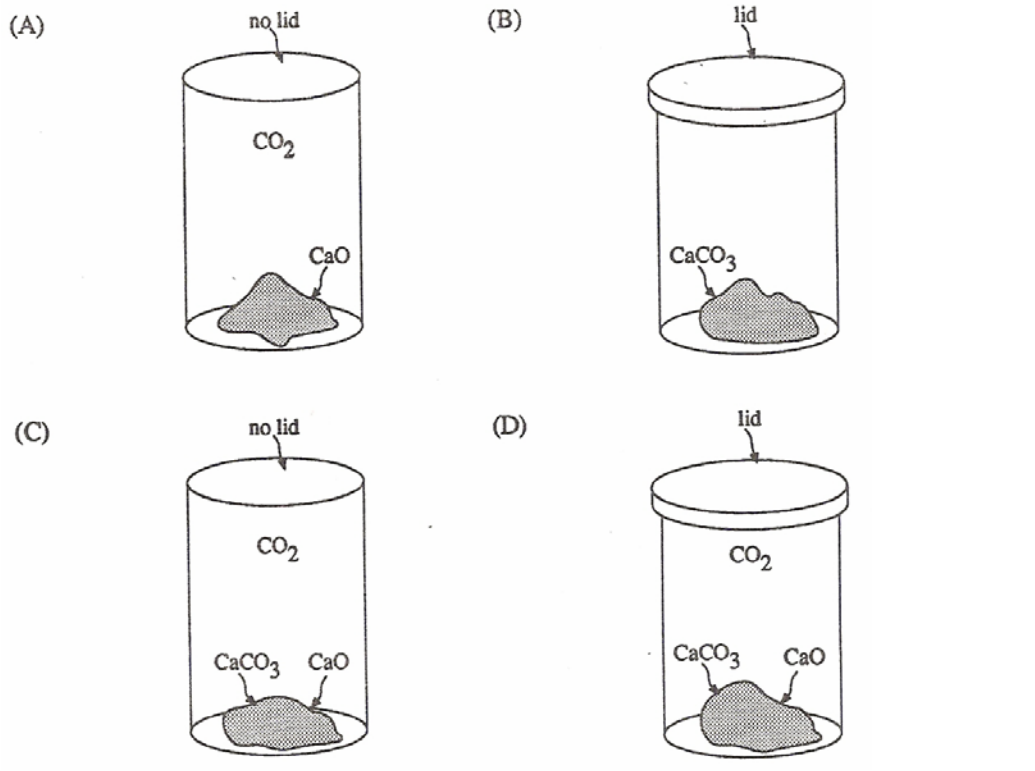
$$CO_{2(aq)} + H_2O_{(l)} \leftrightarrow H_2CO_{3(aq)} \leftrightarrow H^+_{(aq)} + HCO_3^-{}_{(aq)}$$

Acidosis may be reduced by

(A) introducing more water from cells to shift equilibrium to the right
(B) adding an enzyme to catalyse this reaction
(C) introducing NaCl into the blood to change pH levels
(D) rapid breathing to reduce CO2 in the blood

10. The conversion of calcium carbonate to calcium oxide and carbon dioxide in a reversible reaction and will reach equilibrium under certain conditions.

Which of the following diagrams shows that the system may have reach equilibrium?



11. The following equilibrium is set up in a closed container at 300°C.

$$C_{(s)} + H_2O_{(g)} \longleftrightarrow CO_{(g)} + H_{2(g)}$$

Adding more $C_{(s)}$ to this equilibrium mixture at 300°C will result in

(A) no change in the number of moles of $CO_{(g)}$
(B) an increase in the number of moles of $H_{2(g)}$
(C) an increase in the number of moles of $H_2O_{(g)}$
(D) no change in the number of moles of $C_{(s)}$

12. A coordinate covalent bond can form between

(A) Two chlorine atoms
(B) A hydrogen ion and a water molecule
(C) Two water molecules
(D) An atom of copper and an atom of zinc in brass

13. Ozone reacts with nitric oxide according to the equation

$$NO_{(g)} + O_{3(g)} \rightarrow NO_{2(g)} + O_{2(g)}$$

0.66 g $NO_{(g)}$ was mixed with 0.72 g $O_{3(g)}$.

What is the maximum volume of $NO_{2(g)}$ produced at 0°C and 100 kPa?

(A) 0.34 L
(B) 0.37 L
(C) 0.45 L
(D) 0.50 L

14. The purpose of adding chlorine to domestic water supplies is to

(A) clarify the water
(B) reduce the pH of the water
(C) remove heavy metal ions like lead from the water
(D) disinfect the water

15. The Winkler method is used to determine the amount of dissolved oxygen in a water sample. In this procedure, oxygen reacts with the manganese(II) ion under alkaline conditions to produce a precipitate of $MnO(OH)_2$.

$$2Mn^{2+}_{(aq)} + O_{2(aq)} + 4OH^-_{(aq)} \rightarrow 2MnO(OH)_{2(s)}$$

The precipitate is then dissolved in acid and reacted with iodide, forming iodine and manganese(II) ions.

$$MnO(OH)_{2(s)} + 2I^-_{(aq)} + 4H^+_{(aq)} \rightarrow I_{2(aq)} + Mn^{2+}_{(aq)} + 3H_2O_{(l)}$$

Finally, the amount of iodine produced is determined by reaction with thiosulfate.

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

A sample of water analysed using the Winkler method is found to have 50.60 g of oxygen dissolved in it.
How many moles of thiosulfate would have been used in the reaction?

(A) 0.791 mol
(B) 1.581 mol
(C) 3.163 mol
(D) 6.325 mol

Section I (continued)

Part B - 60 marks

Attempt questions 16 – 29.
Read the whole of each question before commencing it.
Answer the questions in the spaces provided.
Show all relevant working in questions involving calculations.
Allow about 1 hour and 45 minutes for this part.

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Question 16. (4 marks)

(a) Write a nuclear equation to represent the alpha decay of thorium-230. 1M

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(b) Nuclear reactors and linear accelerators play an important role in nuclear chemistry.
Describe their roles in the production of named transuranic elements. 3M

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Question 17. (3 marks)

Many cosmetic and pharmaceutical preparations require the use of a solvent such as ethanol.

(a) Relate the use of ethanol as a solvent to the nature of the ethanol molecule. 2M

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(b) Outline how you would convert ethylene to ethanol. 1M

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Question 18. (4 marks)

A student placed 200 mL of 0.300 mol L^{-1} silver nitrate solution into a large beaker, and stirred excess zinc powder into the solution. The mixture was left to react completely.

(a) Write the net ionic equation for this reaction. 1M

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(b) Identify the reductant. 1M

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(c) Calculate the mass of silver that would have been displaced from solution. 2M

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Question 19. (6 marks)

Analyse the impacts on society of using biomass as a source of energy and chemicals for industry. 6M

Question 20. (3 marks)

Explain what is meant by addition polymerisation using polystyrene as an example.
Include a relevant structural formula equation in your answer. 3M

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Question 21. (4 marks)

Explain the use of acids as food additives. 4M

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Question 22. (4 marks)

25.0 mL of carbonic acid was titrated in a conical flask with a 0.050 mol L^{-1} barium hydroxide solution from a burette.

(a) Sketch the graph of the titration curve for this reaction. 2M

(b) These were the results:

Indicator	1st titration (mL)	2nd titration (mL)	Average (mL)
phenolphthalein	24.7	24.9	24.8
Methyl orange	22.9	22.7	22.8

Which value should the student use in the calculations: 24.8 mL, 23.8 mL or 22.8 mL? Justify your answer. 2M

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Question 23. (7 marks)

A student placed 10 mL of 0.10 mol L^{-1} hydrocyanic acid (HCN) solution in a test tube. She measured a pH of 5.11.

(a) Write an equation which shows the ionisation of this weak acid in solution. 1M

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(b) Give the formula of the conjugate base of hydrocyanic acid. 1M

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(c) Calculate the concentration of H^+ ions present in the acid solution. 1M

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(d) Calculate the degree to which the acid ionises (ie. % ionisation). 1M

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(e) Outline a procedure suitable for measuring a pH of 5.11. 1M

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(f) Citric acid is also a weak acid. Draw its structural formula and give its IUPAC name. 2M

Question 24. (4 marks)

An environmental officer measured the pH of a lake near a zinc mine and smelter and found it to be 5.1. At the smelter, the mined zinc sulfide ore was roasted in air to produce crude zinc.

(a) Write an equation for the release of sulfur dioxide into the environment. 1M

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(b) Describe reasons for concern about the release of sulfur dioxide into the environment 3M

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Question 25. (3 marks)

Describe the design and composition of microscopic membrane filters and outline how they purify contaminated water. 3M

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Question 26. (5 marks)

Evaluate the effectiveness of steps taken to alleviate the problems associated with the use of CFCs. 5M

Question 27. (4 marks)

(a) Describe TWO methods used to collect information about atmospheric ozone concentrations. 2M

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(b) Explain why ozone in the stratosphere is beneficial to humans. 2M

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Question 28. (3 marks)

The oil refining industry employs an industrial chemist to monitor and manage the operation of the refinery. Outline a chemical principle used by the chemist and explain how it is applied to the process of refining crude oil. 3M

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Question 29. (6 marks)

The Haber process has been used for over 90 years for the industrial production of ammonia. The process must be carefully managed and monitored by industrial chemists.

Analyse the impact of changes in pressure and temperature on the yield of, and rate of production of, ammonia during the Haber process. 6M

Section II.

25 marks

Attempt Question 30.

Allow about 45 minutes for this part.

Answer the question in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions that require calculations.

Question 30. – Industrial Chemistry.

(a) In a closed container, NOCl gas decomposes at 35°C to form NO gas and Cl_2 gas according to the equation:

$$2NOCl_{(g)} \leftrightarrows 2NO_{(g)} + Cl_{2(g)}$$

The forward reaction is endothermic. At 35°C, the equilibrium constant for the reaction as represented in this equation is $K = 1.6 \times 10^{-5}$.

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

(ii) A mixture contains the following substances with concentrations as specified below.

$[NOCl] = 0.97 \text{ mol } L^{-1}$
$[NO] = 0.015 \text{ mol } L^{-1}$
$[Cl_2] = 0.016 \text{ mol } L^{-1}$

Using an appropriate calculation, show this mixture is NOT at equilibrium. 2M

(iii) If the mixture in part (ii) is allowed to come to equilibrium, predict how the concentrations of *each* species will change (increase or decrease). 1M

(iv) Predict what would happen to K if the temperature were increased. Explain your answer. 2M

(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 qualitatively analysed. 2M

(ii) Describe and account for ONE change you imposed on this equilibrium reaction. 2M

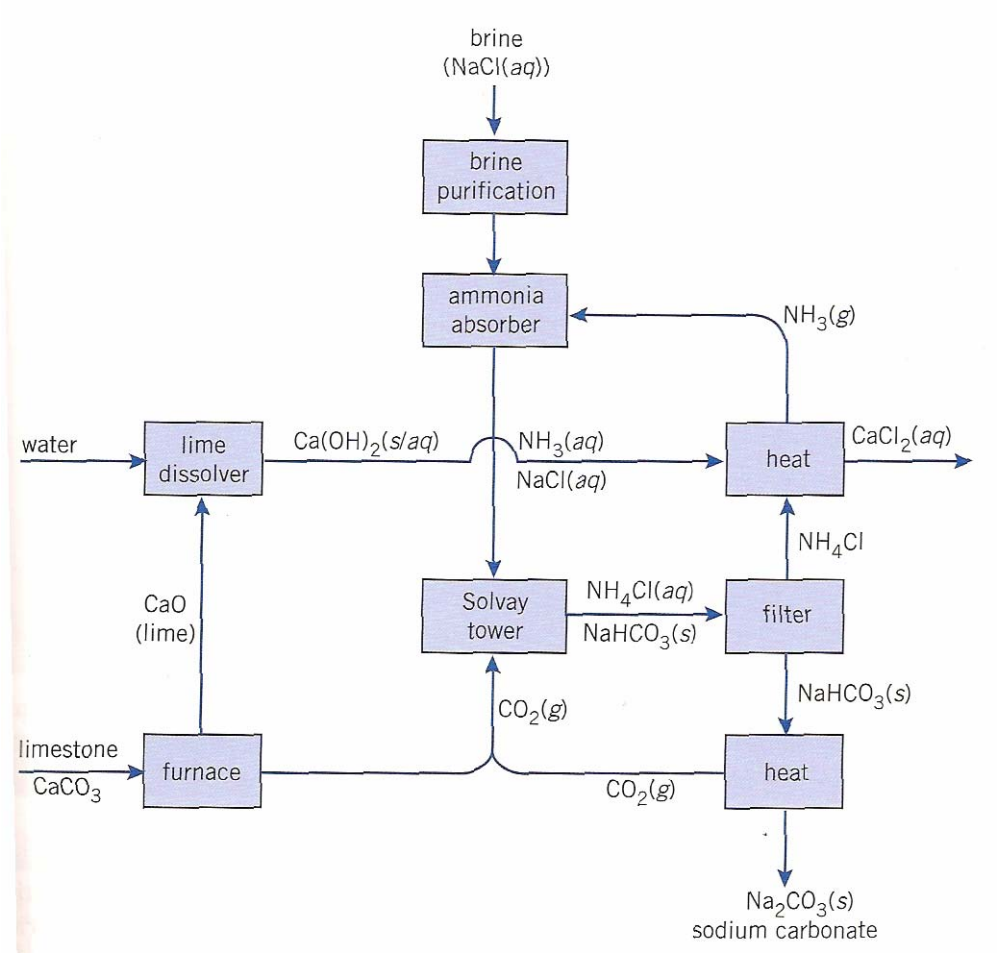
(c) The production of sulfuric acid is of great importance to industrialised nations.

(i) Outline ONE use of sulfuric acid in industry. 1M

(ii) Justify the use of the Frasch process to extract sulfur from underground deposits. 4M

(iii) Describe the chemistry involved in the conversion of sulfur trioxide to sulfuric acid. 3M

(d) Below is a flowchart of the Solvay process.



(i) Calculate the minimum volume of carbon dioxide required at 25°C to produce 1 tonne of sodium hydrogen carbonate. 2M

(ii) Discuss environmental issues associated with the Solvay process and explain how these issues are addressed. 5M

END OF PAPER

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.

– 1 –

PERIODIC TABLE OF THE ELEMENTS

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							

KEY

Atomic Number — 79 — Symbol of element

Atomic Weight — 197.0 — Name of element

Gold

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.

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) ⬭

Part A

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) ⬭

Marking Guidelines THSC Exam 2008
Year 12 CHEMISTRY

Multiple choice

Question	Answer	Question	Answer
1	C	**9**	D
2	A	**10**	D
3	D	**11**	A
4	D	**12**	B
5	B	**13**	A
6	C	**14**	D
7	D	**15**	D
8	B		

16. a.

Marking criteria	*Marks*
Equation shows an alpha particle and Ra-226 as the products using the correct conventions	1

16. b.

Marking criteria	*Marks*
(1) Describes **ONE technology thoroughly** by including the following – types of particles used; specific detail about how the particle is used in the process; names an appropriate transuranic element. (2) Describes **THE SECOND technology soundly** by including TWO of the following – types of particles used; specific detail about how the particle is used in the process; names an appropriate transuranic element	3
Describes **BOTH** technologies soundly (see above)	2
Describes one technology	1

17. a.

Marking criteria	*Marks*
(1) Outlines(or indicates on a diagram) that the ethanol molecule has a non-polar alkyl end and a polar hydroxyl end (2) Identifies that the polar end dissolves polar substances and that the non-polar end dissolves non-polar substances	2
Outlines(or indicates on a diagram) that the ethanol molecule has a non-polar alkyl end and a polar hydroxyl end **OR** Identifies that ethanol dissolves both polar substances and non-polar substances	1

17. b.

Marking criteria	*Marks*
Describes the conversion process by identifying that the ethylene is reacted with water AND that an acid catalyst is required AND that heat is a necessary condition	1

18. a.

Marking criteria	*Marks*
Writes an ionic equation (states for species must be included)	1

18. b.

Marking criteria	*Marks*
Identifies zinc as the reductant	1

18. c.

Marking criteria	*Marks*
Determines the mass of silver to be 6.47 g **AND** Shows full and appropriate working	2
Calculates the moles of silver nitrate as 0.06 mol	1

19.

Marking criteria	*Marks*
(1)Thoroughly (details about the source of biomass and describes the chemical conversion to useful products) describes the use of biomass as a source of energy AND as industrial chemicals (2) Includes ONE or TWO equations to support the information detailed above (3) Identifies two impacts on society (of using biomass) with ONE or TWO fully explored.	5 - 6
Identifies TWO impacts on society(of using biomass), fully explored. **OR** Provides an explanation of biomass used for energy and industrial chemicals; and outlines impacts on society.	4
Provides an explanation of biomass used for energy OR industrial chemicals.	3
Outlines impacts and the response refers to the use of biomass as fuel source and to replace industrial chemicals.	2
Outlines impacts on society	1

20.

Marking criteria	*Marks*
(1) Describes addition polymerisation as many repeating units bonded chemically together without the loss of atoms (2) Presents a structural equation showing the formation of polystyrene from TWO monomer units	3
(1) Describes addition polymerisation as many repeating units bonded chemically together (2) Presents a structural equation showing the formation of polystyrene from TWO monomer units HOWEVER there are errors in the construction of the equation (eg. condensed structural formula)	2
Describes polymer as monomers joining together to form polymers	1

21.

Marking criteria	*Marks*
(1) identifies TWO different uses of acids as food additives (2) identifies the specific acids for each use (3) establishes a cause and effect relationship for each use as well as providing why and/or how	4
(1) identifies TWO different uses of acids as food additives (2) identifies the specific acids for each use (3) establishes a cause and effect relationship for each use OR (a) identifies TWO different uses of acids as food additives (b) identifies the specific acid for one of the uses (c) extensively explains one use (ie. cause/ effect/ how &/or why)	3
(1) identifies TWO different uses of acids as food additives (2) identifies the acid for one use (3) establishes a cause and effect relationship for one use	2
Identifies TWO different uses of acids as food additives	1

22. a.

Marking criteria	*Marks*
Indicates start of graph at a low pH, finishing at a high pH approx 12.5-13, equivalence point pH>7, both axes correctly labelled	2
Indicates start of graph at a low pH and finishes at a high pH of approx 12.5-13	1

22. b.

Marking criteria	*Marks*
Identifies the value of 24.8 mL as being the most appropriate to use in calculations **AND** Justifies this by identifying that carbonic acid is a weak acid and barium carbonate is a strong base and hence the salt produced will be a basic salt	2
Identifies the value of 24.8 mL as being the most appropriate to use in calculations **OR** Justifies this by identifying that carbonic acid is a weak acid and barium carbonate is a strong base and hence the salt produced will be a basic salt	1

23. a.

Marking criteria	*Marks*
Writes an appropriate equation	1

23. b.

Marking criteria	*Marks*
Identifies CN^- as the conjugate base	1

23. c.

Marking criteria	*Marks*
Calculates the hydrogen ion concentration as 7.76×10^{-6} $molL^{-1}$	1

23. d.

Marking criteria	*Marks*
Calculates the % ionisation as 7.76×10^{-3} %	1

23. e.

Marking criteria	*Marks*
Indicates the use of a data logger and pH probe or a pH meter	1

23. f.

Marking criteria	*Marks*
Draws a correct structural formula for citric acid **AND** Identifies its IUPAC name as 2-hydroypropane-1,2,3-tricarboxylic acid	2
Draws a correct structural formula for citric acid **OR** Identifies its IUPAC name as 2-hydroypropane-1,2,3-tricarboxylic acid	1

24. a.

Marking criteria	*Marks*
Writes a correct balanced equation for the formation of sulphur dioxide	1

24. b.

Marking criteria	*Marks*
Correctly describes two reasons for concern and identifies the effect on the environment linked to the reason	3
Correctly describes one reason for concern and identifies the effect on the environment linked to the reason	2
Identifies the effect on the environment linked to a reason	1

25.

Marking criteria	*Marks*
Describes the design of the filter including either the material used or the size of the pore and shows knowledge into how the water passes through the filter and the contaminants do not	3
Correctly describes the shape of the filter and shows knowledge into how the water passes through the filter and the contaminants do not	2
Identifies how the water passes through the filter and the contaminants do not	1

26.

Marking criteria	*Marks*
Correctly describes the problem associated with the use of CFC's using equations and outlines two steps taken to alleviate the problem ie Montreal Protocol and Replacements and provides a clear judgement	5
Any 4 of the above points	4
Any 3 of the above points	3
Any 2 of the above points	2
Any 1 of the above points	1

27. a.

Marking criteria	*Marks*
Describes TWO methods used to collect information about ozone concentrations (note – helium balloons do not collect information, they merely transport pieces of equipment)	2
Describes ONE method used to collect information about ozone concentrations **OR** Identifies TWO methods	1

27. b.

Marking criteria	*Marks*
Describes that ozone in the stratosphere absorbs UV light **AND** Identifies that UV light can cause skin cancer or other health problems.	2
Describes that ozone in the stratosphere absorbs UV light **OR** Identifies that UV light can cause skin cancer, etc.	1

28.

Marking criteria	*Marks*
Provides features of a chemical principle that could be used by a chemist in the oil refining industry (eg. boiling point of chemicals depends on structure and bonding) **AND** Describes the cause and effect relationship of applying the principle to the process of refining crude oil	3
States a chemical principle that could be used by a chemist in the oil refining industry **AND** Relates the chemical principle to an aspect of the oil refining process (eg. the effectiveness of fractional distillation depends on differences in b.p.)	2
States a chemical principle an industrial chemist could use	1

29.

Marking criteria	*Marks*
The following areas needed to be addressed – (1) describes the chemistry of the Haber process (- chemical species, equilibrium, energy, states, mole ratios all required for the maximum 4 'ticks') (2) identifies TWO specific chemical principles/laws	

that are relevant to the process of altering temperature and pressure to manipulate yield and rate (Le Chatelier's principle; Collision theory) – 2 'ticks' (3) Analyses the impact of altering temperature on yield by identifying the effect of a temperature increase/decrease and drawing out the relationship between the temperature change imposed and its effect – 2 'ticks' (4) Analyses the impact of altering temperature on rate of reaction by identifying the effect of a temperature increase/decrease and drawing out the relationship between the temperature change imposed and its effect – 2 'ticks' (5) Analyses the impact of altering pressure on yield by identifying the effect of a pressure increase/decrease and drawing out the relationship between the pressure change imposed and its effect – 2 'ticks' (6) Analyses the impact of altering pressure on rate of reaction by identifying the effect of a pressure increase/decrease and drawing out the relationship between the pressure change imposed and its effect – 2 'ticks' (7) Demonstrates coherence and logical progression - the answer in a logical, well set-out manner – 1 'tick'	
Extensive answer – 14 or 15 ticks	6
Thorough answer – 11, 12 or 13 ticks	5
Competent answer – 8, 9 or 10 ticks	4
Sound answer – 5, 6 or 7 ticks	3
Basic answer – 3 or 4 ticks	2
Limited answer – 1 or 2 ticks	1

OPTION – Industrial Chemistry

30. a. (i)

Marking criteria	***Marks***
Presents a full equilibrium constant expression (K = …….)	1

30. a. (ii)

Marking criteria	***Marks***
Calculates the value for Q, showing full working (symbol equation & substituted number equation) **AND** Compares Q with K identifying that Q does not equal to K	2
Calculates the value for Q **AND** Compares Q with K (Q not equal to K)	1

30. a. (iii)

Marking criteria	***Marks***
Identifies that [NOCl] decreases; [NO] increases; [Cl_2] increases	1

30. a. (iv)

Marking criteria	***Marks***
Identifies that the value of K will increase **AND** Outlines the cause and effect relationship (forward, endothermic reaction is favoured which results in increased [products] and decreased [reactants].	2
Identifies that the value of K will increase **OR** Outlines the cause and effect relationship (forward, endothermic reaction is favoured which results in increased [products] and decreased [reactants].	1

30. b. (i)

Marking criteria	***Marks***
Describes an equilibrium reaction (NOT model) by presenting a correct chemical equation **AND** Clearly and specifically identifies how the reaction can be qualitatively analysed	2
Describes an equilibrium reaction (NOT model) by presenting a correct chemical equation **OR** Clearly and specifically identifies how the reaction can be qualitatively analysed	1

30. b. (ii)

Marking criteria	***Marks***
Identifies the change imposed, outlining how the change was achieved **AND** Identifies the qualitative observations made	2
Identifies the change imposed, outlining how the change was achieved **AND** Identifies the qualitative observations made	1

30. c. (i)

Marking criteria	***Marks***
Outlines ONE use of sulfuric acid in industry, providing key features	1

30. c. (ii)

Marking criteria	***Marks***
(1) Outlines the Frasch process AND (2) Clearly relates THREE properties of sulfur to their role in the Frasch process (3) Quantifies the melting point and density data of sulfur	4
(1) Outlines the Frasch process AND (2) Identifies THREE properties of sulfur that are significant in the Frasch process	3
Identifies TWO properties of sulfur that are significant in the Frasch process.	2
Identifies ONE property of sulfur that are significant in the Frasch process.	1

30. c. (iii)

Marking criteria	***Marks***
(1) Describes the chemistry of the conversion of sulfur trioxide into oleum using an equation that includes states (2) Describes the chemistry of the conversion of oleum into sulfuric acid using an equation that includes states (3) identifies oleum as the intermediate product	3
TWO of these points - (1) Describes the chemistry of the conversion of sulfur trioxide into oleum using an equation (2) Describes the chemistry of the conversion of oleum into sulfuric acid using an equation (3) identifies oleum as the intermediate product	2
ONE of these points - (1) Describes the chemistry of the conversion of sulfur trioxide into oleum (2) Describes the chemistry of the conversion of oleum into sulfuric acid (3) identifies oleum as the intermediate product	1

30. d. (i)

Marking criteria	***Marks***
Calculates the volume of carbon dioxide to be 295090.943L	2

(ie. no rounding off errors)	
Correctly gives TWO of the following points (1) calculates the value for the molar mass of sodium hydrogen carbonate as 84.008 $gmol^{-1}$ (2) correctly converts 1T to 1000000g (3) uses the correct value for V_M (24.79 L)	1

30. d. (ii)

Marking criteria	***Marks***
(1) Identifies TWO significant environmental issues associated with the Solvay process (2) Outlines a reason why each issue is a problem (3) Explains one way to address each issue (cause and effect relationship)	4-5
(1) Identifies TWO environmental issues (2) Describes how ONE or BOTH issues is/are addressed	2-3
Outlines ONE environmental issues associated with the Solvay process	1