

HSC Trial Examination 2006

Chemistry

This paper must be kept under strict security and may only be used on or after the afternoon of Friday 4 August, 2006 as specified in the Neap Examination Timetable.

General Instructions

Reading time 5 minutes.

Working time 3 hours.

Write using blue or black pen.

Draw diagrams using pencil.

Board-approved calculators may be used.

A data sheet and Periodic Table are provided at the back of this paper.

Total Marks 100

Section I Pages 2–18

Total marks 75

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 16–28.

Allow about 1 hour and 45 minutes for this part.

Section II Pages 19–26

Total marks 25

Attempt ONE question from Questions 29–33.

Allow about 45 minutes for this section.

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2006 Chemistry HSC Trial Examination.

Section I

Total marks 75

Part A

Total marks 15

Attempt Questions 1–15.

Allow about 30 minutes for this part.

Use the 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 draw an arrow as follows:

correct
↓

A ☒ B ☒ C ☐ D ☐

1. What is the systematic name for the monomer from which polyvinyl chloride is built?
- (A) chloroethene
(B) 1,1-dichloroethene
(C) 1,2-dichloroethene
(D) vinyl chloride

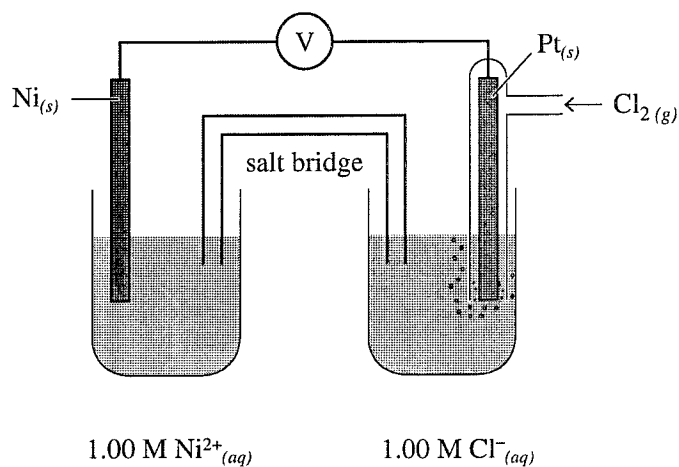
2. Consider the following standard reduction potentials:

Half-reaction	E° (V)
$\text{Ca}^{2+} + 2\text{e}^- \rightleftharpoons \text{Ca}$	-2.87
$\text{Pb}^{2+} + 2\text{e}^- \rightleftharpoons \text{Pb}$	-0.13
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+0.34
$\text{Ag}^{1+} + \text{e}^- \rightleftharpoons \text{Ag}$	+1.80

Using the above table, which of the following metals is the strongest REDUCING AGENT?

- (A) Ca
(B) Pb
(C) Cu
(D) Ag
3. In which of the following does the nitrogen have an oxidation state of +4?
- (A) HNO_3
(B) NO_2
(C) N_2O
(D) NH_4Cl

4. Consider the following diagram.



Which of the following describes what happens to the concentrations of Ni^{2+} , Cl_2 and Cl^- and the masses of the Ni and Pt electrodes as this galvanic cell spontaneously generates an electric current at 25°C and 100 kPa ?

	<i>Concentration of Ni^{2+}</i>	<i>Concentration of Cl_2</i>	<i>Concentration of Cl^-</i>	<i>Mass of Ni electrode</i>	<i>Mass of Pt electrode</i>
(A)	decreases	increases	increases	increases	decreases
(B)	increases	decreases	increases	decreases	increases
(C)	decreases	no change	no change	increases	no change
(D)	increases	decreases	increases	decreases	no change

5. Carbon-14 radioactively decays via the emission of a beta particle. Which of the following is the product nuclide of this decay?
- (A) boron-13
 (B) carbon-13
 (C) carbon-14
 (D) nitrogen-14
6. Which of the following substances would NOT be present in the reaction flask during the preparation of ethyl propanoate?
- (A) ethanoic acid
 (B) ethanol
 (C) propanoic acid
 (D) sulfuric acid

7. An unknown solution is tested with four indicators to determine its pH. The table below shows the results obtained.

<i>Indicator</i>	<i>Acidic colour</i>	<i>pH range</i>	<i>Basic colour</i>	<i>Colour in unknown solution</i>
methyl orange	red	3.1 – 4.4	yellow	yellow
bromothymol blue	yellow	6.0 – 7.6	blue	green
phenol red	yellow	6.4 – 8.0	red	orange
phenolphthalein	colourless	8.3 – 10.0	bright pink	colourless

Which of the following statements gives the best range for the pH of the solution?

- (A) The solution has a pH less than 8.3.
 (B) The solution has a pH between 6.0 and 8.0.
 (C) The solution has a pH between 6.4 and 7.6.
 (D) The solution is neutral (pH = 7).
8. Which of the following species could best be described as amphoteric?
- (A) HNO_3
 (B) NH_2^-
 (C) H_2PO_4^-
 (D) CH_3COO^-
9. Before carrying out a titration between acetic acid, CH_3COOH , and potassium hydroxide, KOH, the equipment must be rinsed appropriately.
 If the acid is to be dispensed from the burette, which of the following indicates the best rinsing procedure?

	<i>Burette</i>	<i>Pipette</i>	<i>Conical flask</i>
(A)	rinsed with CH_3COOH	rinsed with H_2O	rinsed with KOH
(B)	rinsed with H_2O	rinsed with KOH	rinsed with H_2O
(C)	rinsed with H_2O	rinsed with H_2O	rinsed with KOH
(D)	rinsed with CH_3COOH	rinsed with KOH	rinsed with H_2O

10. During an experiment, a student measures the pH of a 0.01 mol L^{-1} solution of citric acid to be 3.6, but the pH of a 0.01 mol L^{-1} solution of hydrochloric acid is 2.0.
 What is the most likely reason for this difference in pH?
- (A) Citric acid is a stronger acid.
 (B) Hydrochloric acid is a stronger acid.
 (C) Citric acid is triprotic.
 (D) Hydrochloric acid is more concentrated.
11. Which of the following substances would be least suitable for analysis by atomic absorption spectroscopy?
- (A) iron
 (B) sodium
 (C) nitrogen
 (D) potassium

12. A student wished to analyse the sulfate content of a lawn fertiliser. Which of the following would be the best reagent to add to a solution of the fertiliser to perform a gravimetric analysis?

(A) iron sulfate
(B) sodium sulfate
(C) barium carbonate
(D) barium chloride

13. The following table compares some properties of gaseous oxygen and the oxygen free radical. Which alternative best fits the correct descriptions?

	<i>Gaseous oxygen</i>		<i>Oxygen free radical</i>	
(A)	less reactive	monatomic	more reactive	molecular
(B)	less reactive	molecular	more reactive	monatomic
(C)	more reactive	monatomic	less reactive	molecular
(D)	more reactive	molecular	less reactive	monatomic

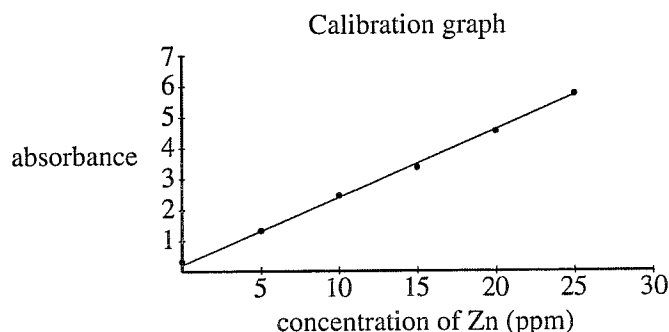
14. Microscopic membrane filters may be used as an alternative to chemical treatment of water. Which of the following is the best reason to use these filters?

(A) To remove harmful heavy metals.
(B) To remove large particulate matter.
(C) To remove fluoride and chloride.
(D) To remove harmful microorganisms.

15. A sample of water was collected downstream from a factory producing batteries. The sample was analysed for zinc content using the following method.

- Standard solutions of zinc were used to prepare a calibration curve.
- One litre of river water was collected.
- A 100 mL sample of this water was diluted to 1 L using distilled deionised water.
- A 50 mL sample of the dilute solution was used to aspirate into an atomic absorption spectrometer.

The following graph was obtained using standard solutions of zinc nitrate.



The absorbance reading of the 50 mL sample of the diluted river water was 1. Which of the following is closest to the concentration of zinc in the original river water sample?

(A) 10 ppm
(B) 40 ppm
(C) 50 ppm
(D) 100 ppm

Section I (continued)

Part B

Total marks 60

Attempt Questions 16–27.

Allow about 1 hour and 45 minutes for this part.

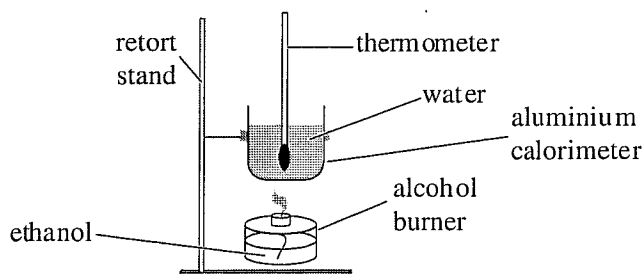
Answer Part B questions in the spaces provided.

Show all relevant working in questions that require calculations.

Marks

Question 16 (6 marks)

A student assembled the following equipment in order to determine the molar heat of combustion of ethanol.



Experimental results found that the temperature of 100 mL of water increased from 18°C to 58°C on burning 0.76 g of ethanol.

- (a) Define the term *molar heat of combustion*. 1

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- (b) Write a balanced chemical equation to show the complete combustion of ethanol. 1

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- (c) Calculate the molar heat of combustion of ethanol based on the experimental results. 2

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- (d) Explain how this calculated value would compare to the theoretical value. 2

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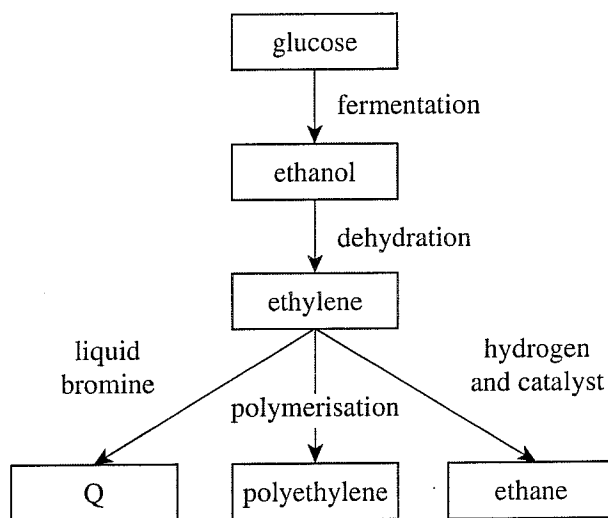
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Question 17 (4 marks)

The following flow diagram shows a series of reactions.



- (a) Draw a structural equation to illustrate the production of Q.

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- (b) Ethylene can be readily converted into ethane. Give a reason for the presence of a catalyst in this reaction.

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- (c) Polyethylene can be used as a cling film. Describe this use in terms of its properties.

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Marks

Question 18 (3 marks)

On February 1, 2004, the synthesis of the transuranic elements ununpentium ($Z = 115$) and ununtrium ($Z = 113$) was reported by Russian and American scientists.

Describe how transuranic elements such as ununpentium and ununtrium may be synthesised and identify ONE safe practice which must be adopted when working with radioactive elements such as these.

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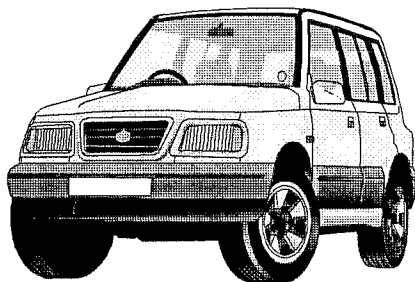
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Question 19 (5 marks)

A new vehicle is said to combine hybrid electric power with the capability of operating on a mixture of 15 per cent petrol and 85 per cent ethanol.



Evaluate the likelihood of the success of ethanol as an alternative fuel.

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Marks

Question 20 (6 marks)

Although the atmosphere naturally contains acidic oxides of carbon, nitrogen and sulfur, the levels of these oxides have been increasing since the industrial revolution.

It has been observed that the pH of rainwater is lower near significant sources of these gases.

- (a) Account for the increasing concentration of oxides of nitrogen (NO_x) in the atmosphere. 2

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- (b) Explain the formation of acidic solutions from oxides of nitrogen and evaluate reasons for concern about the effects of acid rain. 4

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Question 21 (3 marks)

During the HSC Chemistry course you performed a first-hand investigation in which you identified the pH of a variety of salt solutions. If solutions of NH_4Cl and Na_2CO_3 were used in this task, predict the acidic, basic or neutral nature that you would identify. Justify your prediction, including relevant equations in your answer. 3

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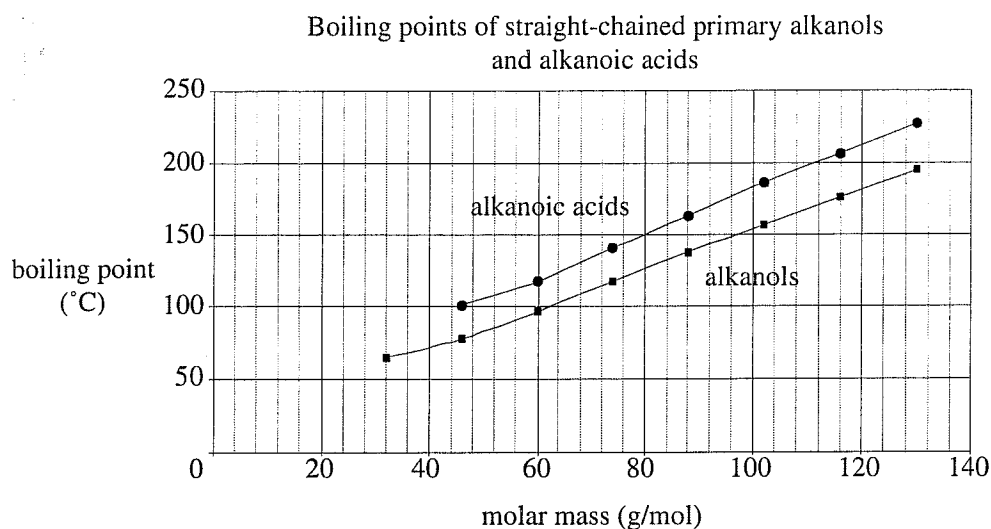
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Question 22 (5 marks)



- (a) Using the graph above, explain the trend observed in the boiling points for molecules of the same molar mass. 3

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- (b) Many products found in the supermarket contain acids or esters. Some of these are extracted from natural resources but an increasing number are being synthetically prepared. 2

Providing specific examples, outline the use of acids and esters in food products.

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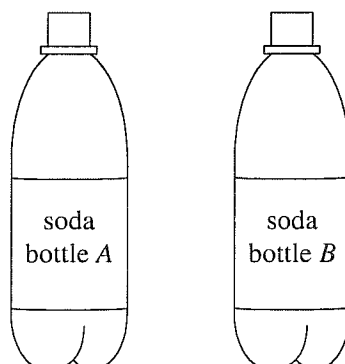
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Marks

Question 23 (4 marks)

The following results were obtained during an investigation involving the decarbonation of two bottles of soda water. Each bottle was opened for a 24-hour period before re-sealing.



	bottle A	bottle B
Initial mass of sealed bottle (g)	125.5	125.5
Final mass of sealed bottle (g)	125.1	124.8
Change in mass (g)	0.4	0.7
Room conditions	cold	warm
Volume of CO ₂ released at 25°C and 100 kPa (mL)	225.3	

- (a) Calculate the volume of carbon dioxide (CO₂) gas lost from bottle B at 25°C and 100 kPa. **1**

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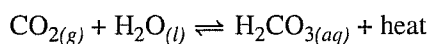
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Question 23 continues on page 14

Question 23 (continued)

- (b) In each bottle the following equilibrium process exists:



Explain the difference in the volume of carbon dioxide lost from the two bottles in terms of Le Chatelier's Principle. 3

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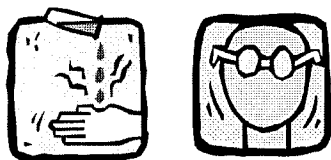
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Question 24 (4 marks)



It is well known that safety glasses should always be worn during practicals involving acids since spills and splashes can occur. The corrosive nature of acids can damage workbenches or pose a risk to people working in the lab.

A handbook for risk assessment states:

'To minimise risk, large acid spills should be neutralised with lime (CaCO_3) before mopping up.'

Assess this recommended method. 4

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Marks

Question 25 (5 marks)

'Good up high, bad down low' is a statement which has often been made in reference to atmospheric ozone.

(a) Explain this statement.

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(b) Use Lewis electron dot structures to demonstrate the formation of the bonds in an ozone molecule.

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Question 26 (4 marks)

A student was given a sample of an unknown soluble salt. She suspected the sample contained barium ions. Describe the procedures she may have used to confirm her suspicion. Include at least one precaution taken to minimise risk.

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Marks

Question 27 (5 marks)

Lake Upyajumpa is located in a highly-developed farming region and has a factory that utilises the lake's water in the production of steel.

A sample was taken from Lake Upyajumpa and tested for water quality. Two of the results obtained were:

Dissolved oxygen (DO): 3 mg L⁻¹

Biological oxygen demand (BOD): 4.1 mg L⁻¹

The reading obtained for DO was very low and vertebrate life within the lake would be in danger. The BOD value was borderline to indicating the lake was polluted.

Analyse the impact that the local community may have had which could have lead to the results of DO and BOD obtained.

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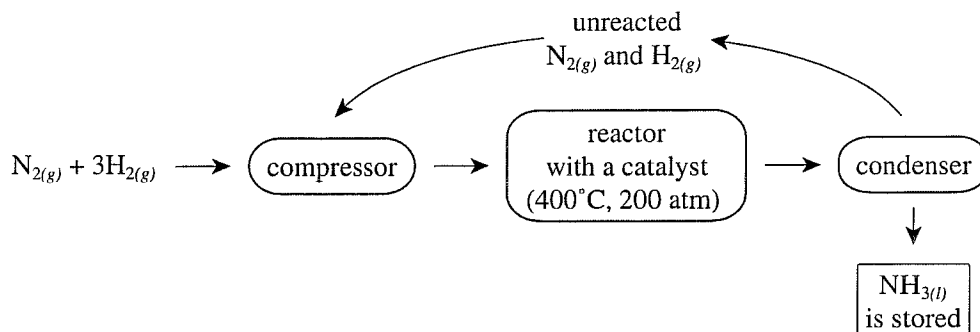
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Question 28 (6 marks)

In a modern ammonia-producing plant many factors need to be monitored carefully. The following diagram describes the main features of such a plant:



In this production plant, the pressure and temperature are closely monitored for the combination of the reactant gases (in the reactor) and for the removal of the product (in the condenser).

Explain why the temperature and pressure must be carefully monitored in these chambers. Use appropriate equations to illustrate your answer.

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Section II

Total marks 25

Attempt ONE question from Questions 29–33.

Allow about 45 minutes for this section.

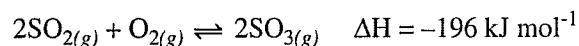
Answer the question in a writing booklet. Extra writing booklets are available.

Show all relevant working in questions that require calculations.

	Pages
Question 29 Industrial Chemistry.....	20
Question 30 Shipwrecks, Corrosion and Conservation.....	21
Question 31 The Biochemistry of Movement.....	22–23
Question 32 The Chemistry of Art	24
Question 33 Forensic Chemistry	25–26

Question 29 — Industrial Chemistry (25 marks)**Marks**

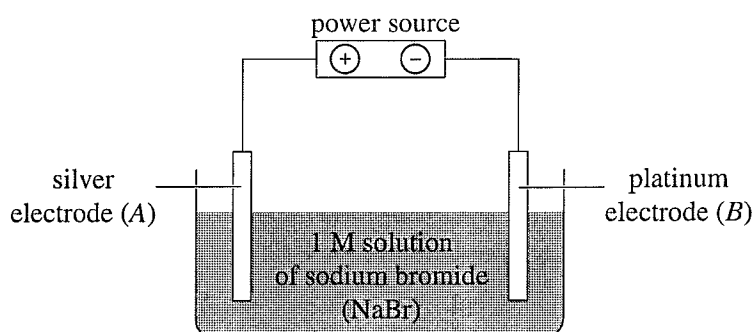
- (a) (i) Identify the products of the Solvay process. **1**
- (ii) Explain the importance of ammonia in the Solvay process using appropriate equations. **3**
- (b) The chlor-alkali industry is one of the largest in developed countries. It produces chlorine, hydrogen and sodium hydroxide on a commercial scale by an electrolytic process. Analyse the chlor-alkali industry's choice of concentrated salt water (brine) for electrolysis, rather than molten sodium chloride or dilute sodium chloride. **7**
- (c) Soaps and detergents are both cleaning agents.
- (i) Draw structural diagrams to distinguish between a soap and a cationic detergent. **2**
- (ii) List two different uses of both the soap and the cationic detergent. **2**
- (iii) Account for one of the uses of either the soap or the cationic detergent by specific reference to the soap's or detergent's structure. **3**
- (d) Sulfuric acid is produced commercially using the contact process but it may be modelled in the laboratory. One important step is the production of SO_3 according to:



- (i) In one laboratory preparation of SO_3 carried out in a 2 L reaction flask the number of mole of SO_2 , O_2 and SO_3 were 0.224, 0.136 and 0.414 respectively at equilibrium. Calculate the value of the equilibrium constant for this reaction. **2**
- (ii) Discuss the relationship between rate of reaction and equilibrium conditions with reference to the production of SO_3 . **5**

Question 30 — Shipwrecks, Corrosion and Conservation (25 marks)

- (a) The ocean represents a massive electrolyte solution. It contains a large quantity of dissolved minerals and notable levels of dissolved gases such as oxygen and carbon dioxide.
- Identify the effect of increasing ocean depth on the solubility of oxygen and carbon dioxide. 1
 - Account for the fact that the relative solubility does not necessarily correspond to the actual concentrations of these gases at increasing depths. Include relevant equations in your answer. 4
- (b) During your study of this option you performed a first-hand investigation to compare the corrosion of iron in different temperatures and salt concentrations.
- Outline the procedure you used in this investigation. 3
 - Justify the appropriateness of the experimental procedure in part (i) to generate valid and reliable results and conclusions. 3
- (c) Describe the process of rusting and analyse and explain the conditions under which the rusting of iron occurs. 7
- (d) A student set up the following equipment to gather first-hand data about the factors affecting an electrolysis reaction:



- Identify the cathode in this electrolytic cell. 1
- Calculate the voltage required for this cell and write the half-equations for the reactions occurring at the anode and cathode. 2

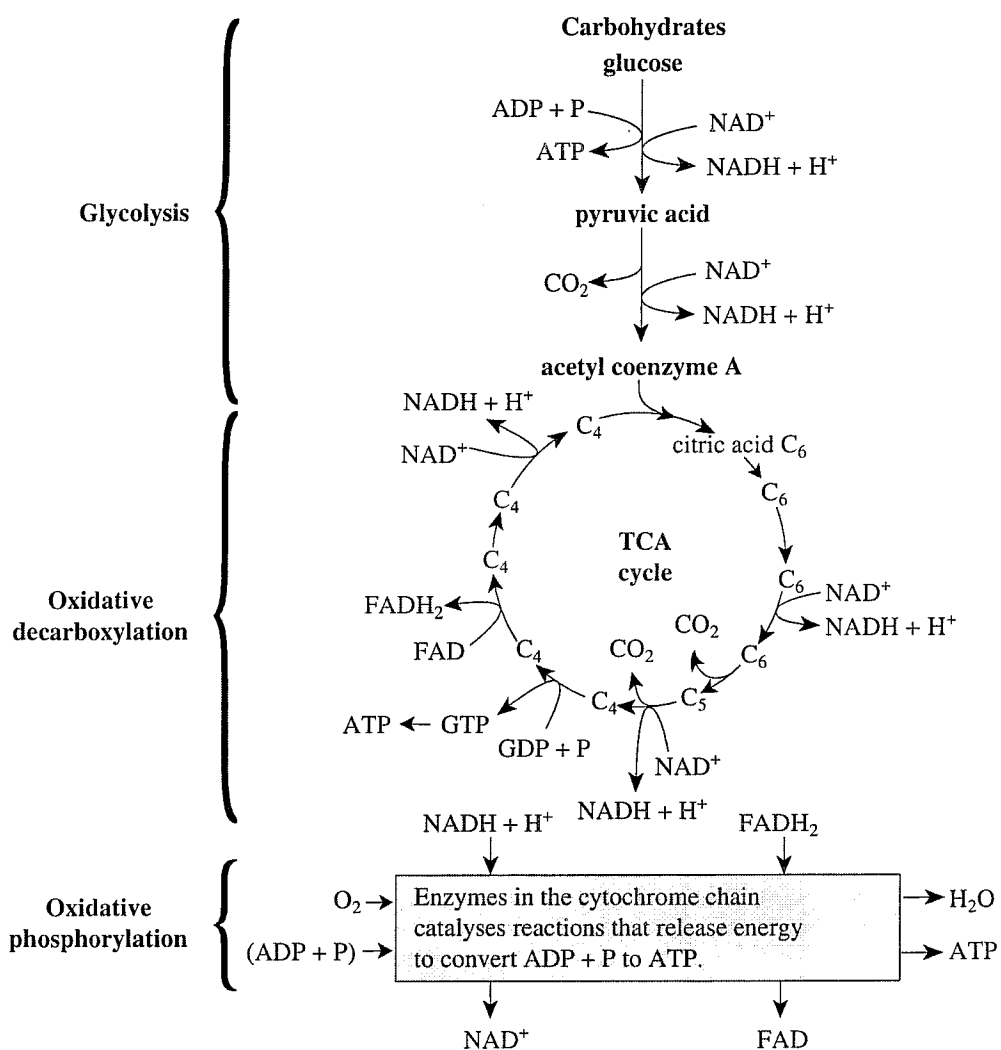
It is possible to vary the oxidation and reduction processes that take place in an electrolytic cell by altering components of the set up. This includes changing the electrodes used, the concentration or nature of the electrolyte or changing the electrolyte species altogether.

A student wants to set up an electrolytic cell similar to the one shown in order to demonstrate the effect that some of these changes will have on the overall redox reaction.

- Describe two specific modifications that could be made to the experimental set up that would alter the reactions occurring. Predict the changes that would occur. Include relevant half equations and electrode potentials in your answer. 3
- Identify one use of electrolysis in the conservation and restoration of artefacts salvaged from ocean wrecks. 1

Question 31 — The Biochemistry of Movement (25 marks)

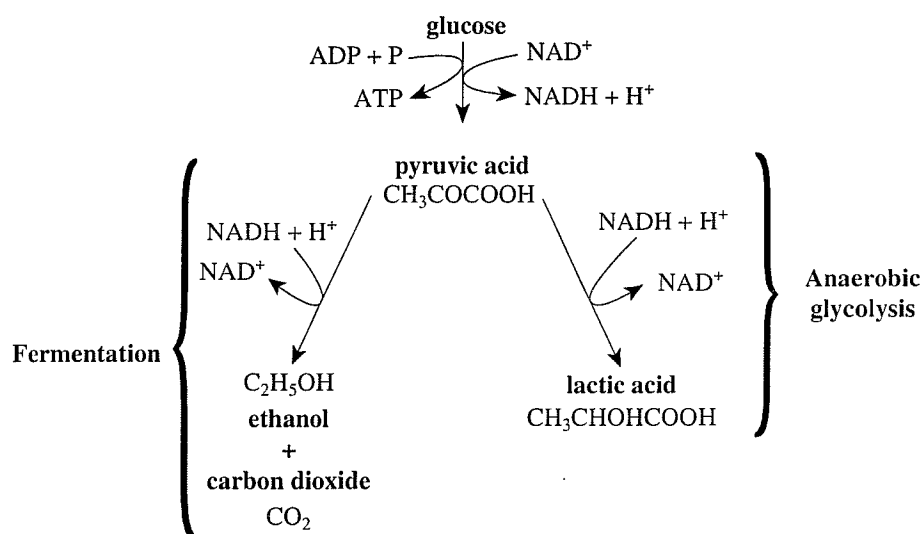
- (a) (i) ATP is an energy source for metabolic processes. Identify the original energy source of the energy secured in the bonds of ATP. **1**
- (ii) Identify the site of the glycolysis in the cell. **1**
- (b) Describe the formation of temporary bonds between actin and myosin fibres during muscle contraction and explain why ATP is consumed in the process. **4**
- (c) Use the chart of biochemical pathways shown below to:
- (i) compare the total energy output from glycolysis and the TCA cycle; **4**
- (ii) compare the formation of lactic acid with the process of fermentation. **2**



Question 31 and biochemical pathways chart continue on page 23

Question 31 (Continued)

The anaerobic release of energy



- (d) Assess the importance of the compounds NADH and FADH_2 in providing energy for muscle contraction. 7
- (e) (i) Draw a glycerol molecule. 1
- (ii) Compare the structure of glycerol with the structure of fatty acids. 2
- (iii) Predict the viscosity and solubility of glycerol compared to fatty acids and explain the reasons for your predictions. 3

End of Question 31

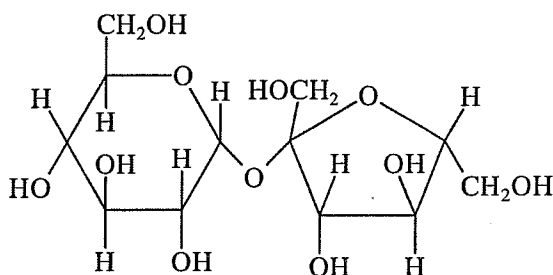
Question 32 — The Chemistry of Art (25 marks)

Marks

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|-----|-------|---|---|
| (a) | (i) | Identify the element which gives a violet (pale purple) flame colour. | 1 |
| | (ii) | In your practical work you observed the characteristic flame colours of a range of metals. Explain why characteristic flame colours are produced. | 3 |
| (b) | (i) | Identify TWO properties of minerals which made them important as pigments to ancient cultures. | 2 |
| | (ii) | Discuss the potential health risks associated with the use of pigments as cosmetics by ancient cultures. | 4 |
| (c) | | When green $\text{CuCl}_{2(s)}$ and white $\text{CuSO}_{4(s)}$ are dissolved in water, both produce a pale blue solution. Explain why this is the case and describe the bonding in the resulting complex ion. Include the structural formula of the complex in your answer. | 7 |
| (d) | (i) | State the electron configuration of the Zn^{2+} ion using <i>s</i> , <i>p</i> , <i>d</i> notation. | 1 |
| | (ii) | In your practical work you investigated the colours of a transition metal as it changed oxidation state. Name the metal you studied. Identify two oxidation states you investigated and their associated colours. | 2 |
| | (iii) | Give a detailed account of the method that you used to carry out the investigation referred to in d(ii) above. Include a risk assessment in your answer. | 5 |

Question 33 — Forensic Chemistry (25 marks)

- (a) An HSC Chemistry student had pure samples of cyclohexene, ethanoic acid and ethanol but did not know which was which. Describe tests that would allow him to distinguish between the chemicals. 3
- (b) During your study of this option you performed a first-hand investigation in which you carried out a chemical test to distinguish between reducing and non-reducing sugars.
- (i) Describe the chemical difference between a reducing and non-reducing sugar. 2
- (ii) The following structure is that of the carbohydrate sucrose:



- Classify sucrose as a reducing or a non-reducing sugar. 1
- (iii) Outline the procedure you used in this investigation and describe the results that were observed. 2
- (c) The table below gives the abbreviations, formulae and isoelectric points of three amino acids.

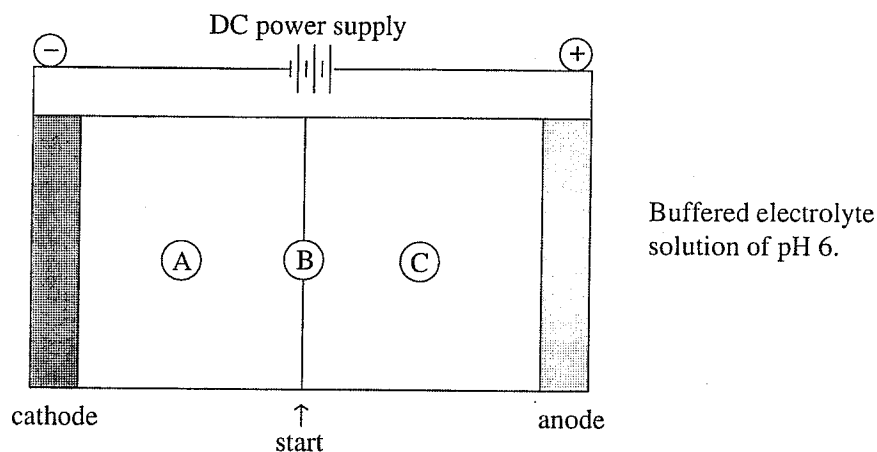
Name	Abbreviation	Structural formula	Isoelectric point (pI)
aspartic acid	asp	$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{HOOC}-\text{C}-\text{C}-\text{COOH} \\ \quad \\ \text{H} \quad \text{NH}_2 \end{array}$	2.95
lysine	lys	$\begin{array}{c} \text{H} \\ \\ \text{CH}_2-(\text{CH}_2)_3-\text{C}-\text{COOH} \\ \quad \\ \text{NH}_2 \quad \text{NH}_2 \end{array}$	9.90
valine	val	$\begin{array}{c} \text{H} \quad \text{CH}_3 \\ \quad \\ \text{H}_2\text{N}-\text{C}-\text{C}-\text{CH}_3 \\ \quad \\ \text{COOH} \quad \text{H} \end{array}$	6.00

- (i) Identify the major functional groups in an amino acid. 1
- (ii) Draw the structural formula of a dipeptide that can be made from the amino acids aspartic acid and valine. 1

Question 33 continues on page 26

Question 33 (Continued)

Gel electrophoresis was carried out on a mixture of the three amino acids shown in the table on page 25. The electrophoresis was run for 5 hours and the developed gel is illustrated below.



- (c) (iii) Explain the characteristics that allow for the mixture of the three amino acids to be separated. 3
- (iv) Identify the amino acid from the table that corresponds to each of the three letters on the above diagram. 1
- (d) Progress in analytical chemistry and changes in technology have altered forensic investigations over time. In particular, advances in DNA analysis have enabled crime scene investigators to draw more accurate conclusions about the identity of individuals implicated in crimes.
- (i) Describe the structure and composition of DNA. 2
- (ii) Discuss the issues associated with the uses of DNA analysis in terms of the maintenance of DNA data banks. 4
- (e) Explain how the emission spectra of elements may assist with the identification of the origin of a mixture. 5

End of paper