Student Number [ ]

Exam Choice

2005

TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Approved calculators may be used
- Write your student number in the space provided

Total marks – 100

Section I   Pages 2 - 19

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 16-27
- Allow about 1 hour and 45 minutes for this part

Section II   Pages 20 - 28

25 marks
- Attempt **ONE** Question from Questions 28-32
- Allow about 45 minutes for this section

1

Section I
75 marks

Part A – 15 marks
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 the correct answer by writing the word **correct** and drawing an arrow as follows.

A ✖ B ✖ C ◯ D ◯

correct

1. Polyethene and ethene are two important materials used by humans. A major difference between the two is-

    (A)   The products that form after their complete combustion.

    (B)   Their empirical formulae.

    (C)   The original source of the elements that made these molecules.

    (D)   Their state at room temperature.
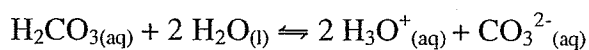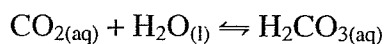

2. Which product is formed when bromine and 2-pentene react together?

    (A)   2-bromopentene

    (B)   2-bromopentane

    (C)   2,3-dibromopentane

    (D)   2,2-dibromopentane

3. One mole of which of the following acids will require three moles of sodium hydroxide to achieve complete neutralisation?

    (A)   Hydrochloric acid

    (B)   Citric acid

    (C)   Sulfuric acid

    (D)   Ethanoic acid

4. The following equilibria occur in a bottle of carbonated soft drink:

    $$CO_{2(g)} \rightleftharpoons CO_{2(aq)} + energy$$

    $$CO_{2(aq)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)}$$

    $$H_2CO_{3(aq)} + 2 H_2O_{(l)} \rightleftharpoons 2 H_3O^+_{(aq)} + CO_3^{2-}_{(aq)}$$
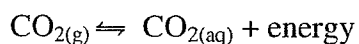
    Which one of the following will favour the release of carbon dioxide from the soft drink?

    (A)   Putting a lid on the bottle.

    (B)   Decreasing the temperature of the soft drink.

    (C)   Increasing the pH of the soft drink.

    (D)   Adding a small amount of vinegar to the soft drink.

5. 10 ml of a 0.05 mol L^{-1} solution of sulfuric acid was diluted by making up to 1000 ml with distilled water. What was the pH of the resulting solution?

(A) 3.0

(B) 2.0
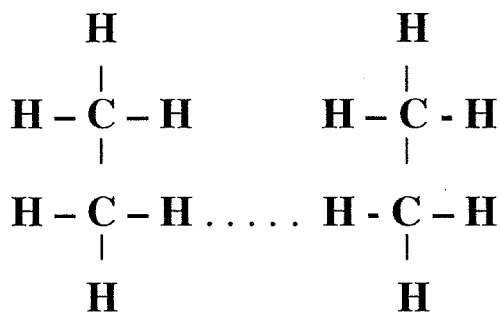
(C) 4.0

(D) 3.3

6. In which one of the following pairs of molecules does the dotted line correctly show a hydrogen bond?

(A)

$$
\begin{array}{cc}
\text{H} & \text{H} \\
| & | \\
\text{H} - \text{C} - \text{H} \quad\quad \text{H} - \text{C} \cdot \text{H} \\
| & | \\
\text{H} - \text{C} - \text{H} \ldots\ldots \text{H} \cdot \text{C} - \text{H} \\
| & | \\
\text{H} & \text{H}
\end{array}
$$

(B)

$$
\begin{array}{cc}
\text{H} & \text{H} \\
| & | \\
\text{H} - \text{C} - \text{H} \quad\quad \text{H} - \text{C} \cdot \text{H} \\
| & | \\
\text{H} \cdot \text{C} - \text{H} \quad\quad \text{H} - \text{C} \cdot \text{H} \\
| & | \\
\text{H} \ldots\ldots\ldots \text{OH}
\end{array}
$$

(C)

$$
\begin{array}{cc}
\text{H} & \text{NH}_2 \\
| & | \\
\text{H} \cdot \text{C} - \text{H} \quad\quad \text{H} \cdot \text{C} - \text{H} \\
| & | \\
\text{OH} \ldots\ldots\ldots\ldots \text{NH}_2
\end{array}
$$

(D)

$$
\text{H} - \text{Cl} \ldots\ldots \text{H} \cdot \text{Cl}
$$
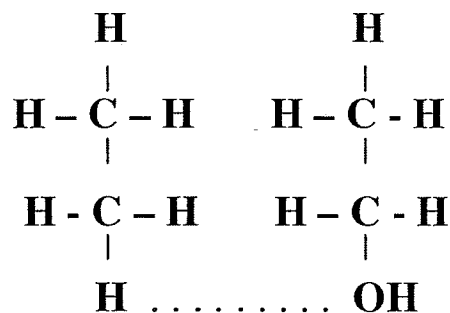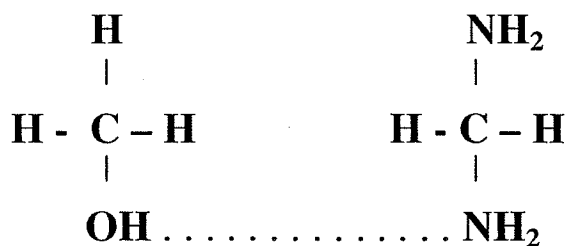
7. What volume of oxygen gas (at 25^{0}C and 100kPa) would be required for the complete combustion of 16.0 grams of methanol?

(A) 18.59 L

(B) 37.19 L

(C) 24.00 L

(D) 12.40 L

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8. A student performed a titration using computer based technology and the following graph was produced.
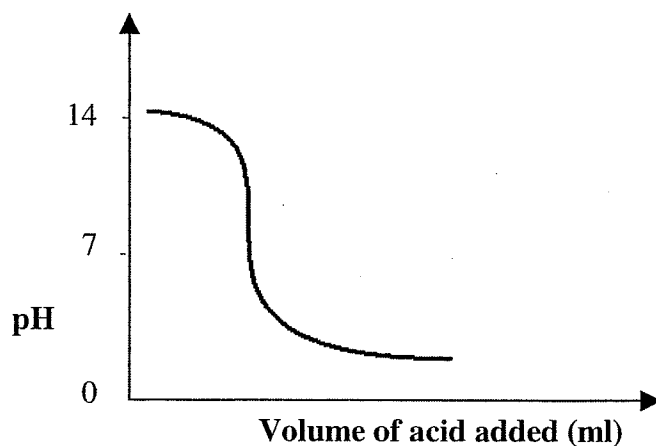
From the information in the graph it can be deduced that:

(A) the acid was a weak acid and the end point was at pH 8

(B) the acid was a strong acid and the end point was at pH 8

(C) the acid was a weak acid and the end point was at pH 2.5

(D) the acid was a strong acid and the end point was at pH 11

9. The reason why the synthesis of ammonia in the Haber process requires moderately high temperatures, is:

(A) As an equilibrium reaction it absorbs heat energy when ammonia is the product.

(B) Higher temperatures are required to overcome the activation energy needed for hydrogen and nitrogen to react.

(C) The catalyst requires these temperatures in order to do its job.

(D) Higher temperatures are required to maintain the high pressures necessary for the reaction

10. Lead could be separated from a mixture of $Pb(NO_3)_{2(aq)}$, $Ca(NO_3)_{2(aq)}$, $Cu(NO_3)_{2(aq)}$ and $Ba(NO_3)_{2(aq)}$ by precipitating with a solution of:-

(A) sulfuric acid

(B) sodium carbonate

(C) sodium phosphate

(D) sodium chloride

11. In which one of the following beakers will a displacement reaction occur?
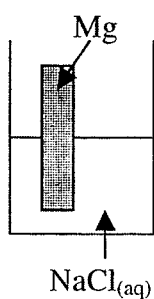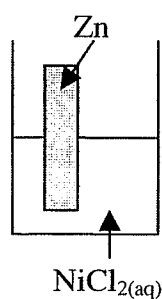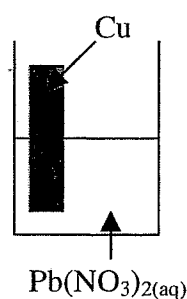
Mg	Zn	Cu	Ni
$NaCl_{(aq)}$	$NiCl_{2(aq)}$	$Pb(NO_3)_{2(aq)}$	$FeCl_{2(aq)}$
Beaker 1	Beaker 2	Beaker 3	Beaker 4
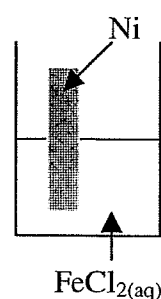
(A) Beaker 1

(B) Beaker 2

(C) Beaker 3

(D) Beaker 4

12. Which one of the following would be a suitable qualitative method of testing for chloride ions in water?

(A) a flame test

(B) gravimetric analysis

(C) precipitation with a suitable cation

(D) observing the colour of the solution

6

13. An organic compound has the molecular formula, $C_4H_8O_2$. A possible name for the compound is-

    (A) butanol

    (B) pentanoic acid

    (C) ethyl propanoate

    (D) propyl methanoate

14. Which one of the following identifies a major pollutant found in the lower atmosphere and states its correct source?

    (A) Ozone from CFC's interacting with oxygen molecules.

    (B) Nitrogen dioxide from thunderstorms

    (C) Sulfur dioxide from the reduction of metallic ores

    (D) Carbon monoxide from the complete combustion of natural gas.

15. The conjugate base of $H_2PO_4^-$ is

    (A) H_3PO_4

    (B) HPO_4^-

    (C) PO_4^{3-}

    (D) HPO_4^{2-}

Section I (continued)

Part B – 60 marks
Attempt Questions 16 – 27
Allow about 1 hour and 45 minutes for this part.

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 16. (4 marks)

The flow chart shows a method for the production of ethanol.
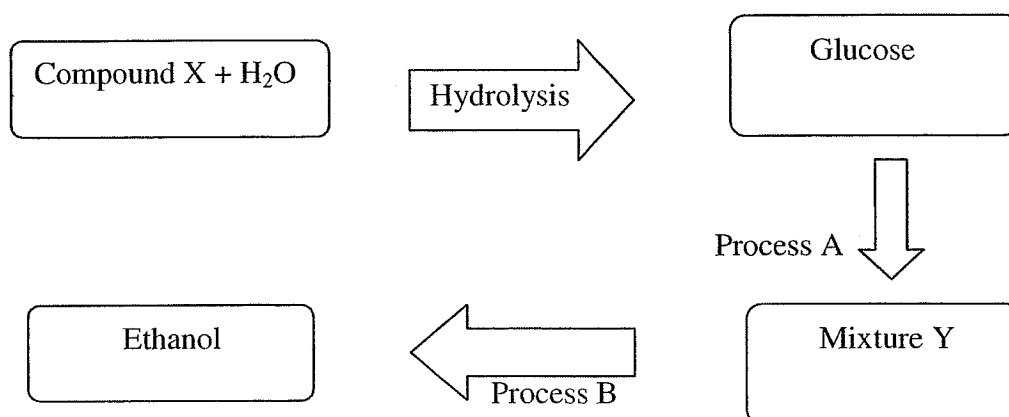
(a)   Identify compound X   1

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(b)   Write a balanced equation for Process A.   1

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(c)   Describe the conditions necessary for Process A.   2

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Question 17. (4 marks)

Propene (propylene) is an important monomer used in the production of the polymer polypropylene. The structure of propene is drawn below.

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\begin{array}{ccccc}
H & & H & & H \\
| & & | & & | \\
C & = & C & - & C & - H \\
| & & & & | \\
H & & & & H
\end{array}
$$
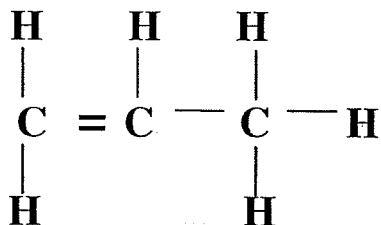
(a) Draw the structure of a small section of the polymer made from the above monomer.   **1**
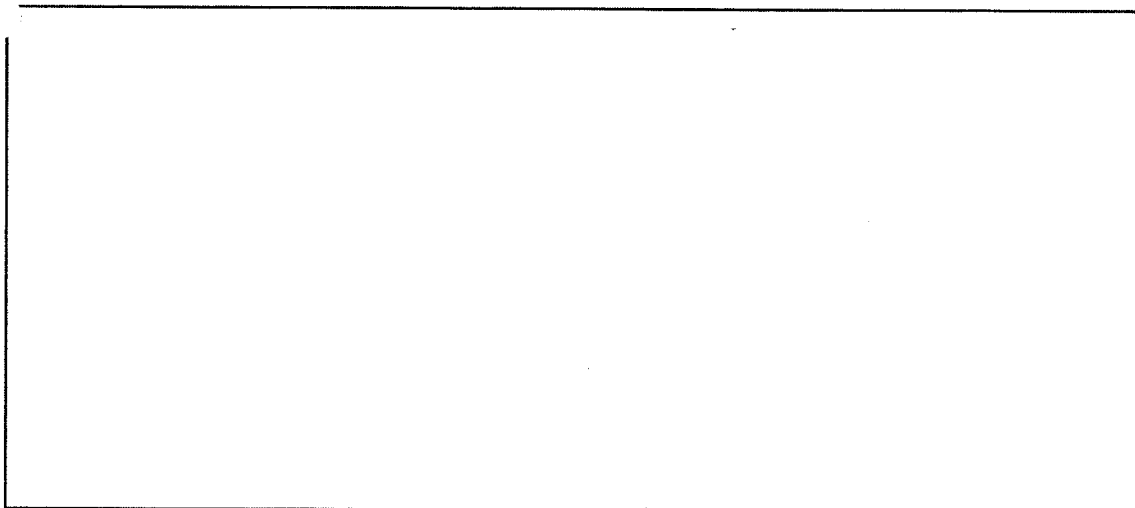
(b) Describe ONE similarity and ONE difference in properties between this polymer and polyethene (polyethylene).   **2**

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(c) Account for that different property in terms of the molecular structure of the two polymers.   **1**

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Question 18. (6 marks)

The diagram below shows a galvanic cell similar to one you may have constructed in the laboratory.
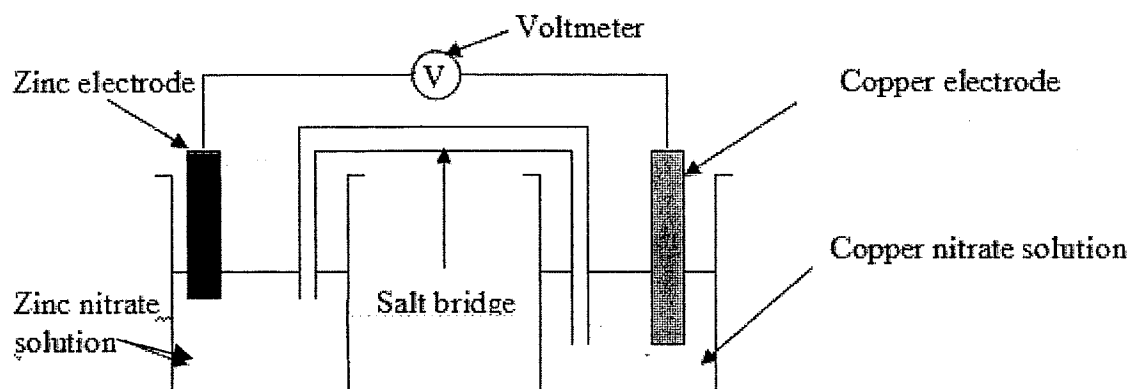
Evaluate this cell in comparison to either a dry cell or a lead-acid cell.   **6**
This must be done in terms of chemistry, practicality and environmental impact.

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Question 19. (5 marks)

A range of radioisotopes are used today in medicine.

(a) Identify one use of a named radioisotope in medicine.   **1**

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(b) Explain how the properties of the radioisotope you named above are suited   **4**
to the use you have identified.

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Question 20. (5 marks)

Rain has been recorded in Sydney with a pH as low as 4.5, however 80 kilometres to the west, in the Blue Mountains, the pH of the rain is always between 5.5 and 6.5.

(a)   How do you account for the fact that rain in the Blue Mountains is always   1
slightly acidic?

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(b)   Explain with the help of a chemical equation, why Sydney rain is usually   3
more acidic than rain in the Blue Mountains.

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(c)   A student tested some rain water with four different indicators. The
indicators used are shown in the table below as well as the colours he
obtained while testing the rainwater.

Indicator	Colour change	pH range	RESULTING COLOURS
Cresol Red	Red to yellow	3.2-4.4	YELLOW
Methyl orange	Red to yellow	3.1-4.4	YELLOW
Bromocresol green	Yellow to blue	3.8-5.4	BLUE
Bromothymol blue	Yellow to blue	6.0-7.6	YELLOW

Estimate the pH of the rain water.   1

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Question 21. (7 marks)

A student determined the concentration of an unknown solution of sulfuric acid using the following method:

Step 1: She weighed out 4.00 grams of sodium hydroxide.

Step 2: She dissolved the sodium hydroxide in a little distilled water and made it up to 1000ml in a volumetric flask. This became her 0.10 mol L^{-1} standard solution.

Step 3: She then carried out a titration using 25.0 ml of the 0.10 mol L^{-1} sodium hydroxide with the unknown sulfuric acid.

Bromothymol blue was the indicator.

Her results were recorded in the table below.

Titration	Volume of sulfuric acid used (ml)
1	5.6
2	5.2
3	4.8

(a)   Calculate the concentration of the sulfuric acid.   **3**

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Question 21 (continued)

(b)   Assess the validity and reliability of these results.   **4**

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Question 22. (4 marks)

(a)   Name a naturally occurring base.   **1**

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(b)   Write an ionic equation to show the interaction of that base with water.   **1**

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(c)   With reference to a specific natural system, explain why the addition of   **2**
        small amounts of acid or base will not change the pH of that system.

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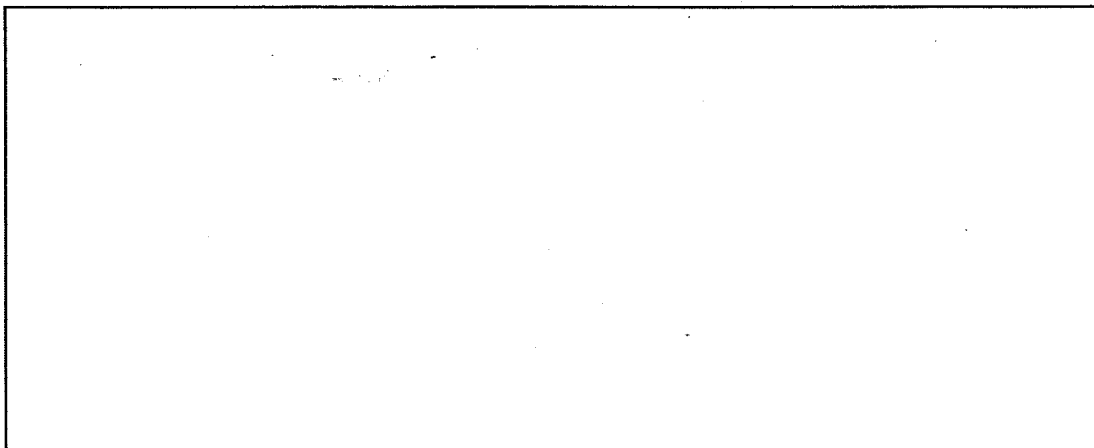..

Question 23. (4 marks)

The ester ethyl butanoate is used a flavouring agent in the confectionary industry.

(a)   Draw the structural formula of ethyl butanoate.   **1**

(c)   During your course you performed a first hand investigation to prepare an   **3**
        ester using reflux. Assess the risks involved in the preparation of an ester
        such as ethyl butanoate.

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Question24. (6 marks)

(a) Explain why pressure needs to be monitored in the Haber process. **4**

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(b) Calculate the maximum yield of ammonia that would form if 300 litres of **2**
nitrogen gas and 150 litres of hydrogen gas were reacted at a suitable
temperature and pressure. Assume the reaction went to completion.

Question 25. (5 marks)

(a)   Draw an ammonium ion using Lewis electron dot structures and on it label   2
a coordinate covalent bond.

(b)   The following table compares some of the properties of oxygen gas (O_2)
and ozone (O_3).

Property	Oxygen	Ozone
Boiling point	-183°C	-111°C
Solubility(at 20°C)	8 mg/L	12 mg/L
Reactivity	reactive	Very reactive

Account for the variations in properties of the two allotropes on the basis of   3
molecular structure and bonding.

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Question 26. (5 marks)

Cobalt is a trace element essential in the metabolism of many animals including sheep.

Soils must contain cobalt at concentrations of more than 0.05 ppm if the sheep grazing on that land are to remain healthy.

A chemist was assigned the task of analysing a farmer's soil to see if it was suitable for raising sheep. The chemist used Atomic Absorption Spectroscopy (AAS) as a means of measuring the concentration of cobalt in the soil.

Justify the procedure he should follow in order to prepare the soil and the equipment for analysis using AAS.

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Question 27. (5 marks)

Assess the effectiveness of methods used to purify and sanitise mass water supplies.

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Section II

25 marks
Attempt ONE question from Questions
Allow about 45 minutes for this section.

Answer in a writing booklet. Extra booklets are available.

Show all relevant working in questions involving calculations.

Pages

Question 28 --- Industrial Chemistry (25 marks)

(a)   (i)   Identify a shrinking natural resource product which we have needed   **1**
to replace in the last 100 years. This product should not be a fossil
fuel.

       (ii)   Evaluate the progress currently being made to develop a replacement   **3**
material for that shrinking natural resource product.

(b)   For the reaction:

$$CO_{(g)} + Cl_{2(g)} \rightleftharpoons COCl_{2(g)} \text{, the equilibrium constant, } K = 4 \times 10^5 \text{ at 400 K}$$

       (i)   Use the information given to predict whether the reaction, at   **1**
equilibrium, will strongly favour the production of products, reactants
or whether the reaction will result in similar concentrations of
reactants and products.

       (ii)   During the early stages of the reaction, the concentration of each   **2**
substance was monitored and after a short while it was found that the
concentration of CO was 0.5 molL^{-1}, the concentration of Cl_2 was
0.08 molL^{-1} and the concentration of $COCl_2$ was 0.9 molL^{-1}.

          Was the reaction at equilibrium? Explain your answer.

       (iii)   During your Chemistry course you performed a first-hand   **4**
investigation to model an equilibrium reaction.

          Describe your model and analyse its limitations.

(c)   (i)   Using equations, show how sulfuric acid could: **2**

          1.   oxidise the metal, magnesium and

          2.   dehydrate the carbohydrate, glucose.

       (iii)   Explain how an understanding of the properties of sulfuric acid is   **3**
essential for its safe storage and transport.

Question 28 (continued)

(d)   (i)   Describe the properties of a named emulsion and relate these to its uses.   **3**

    (ii)   Account for the different effects of hard water on soaps and detergents.   **2**

(e)   During your Chemistry course you conducted a first-hand investigation in which you carried out a chemical step involved in the Solvay Process.

    (i)   Identify that chemical step and outline the procedure you used to perform that investigation.   **3**

    (ii)   Identify one difficulty associated with the laboratory modelling of that chemical step.   **1**

Question 29 --- Shipwrecks, Corrosion and Conservation (25 marks)

(a)   (i)   Identify the most abundant anion in sea water.   **1**

    (ii)   Three beakers with sodium iodide were set up as shown below.

    Platinum electrodes were set up in each beaker and the power was turned on.

Platinum electrodes

$NaI_{(aq)}$ $NaI_{(l)}$ $NaI_{(s)}$
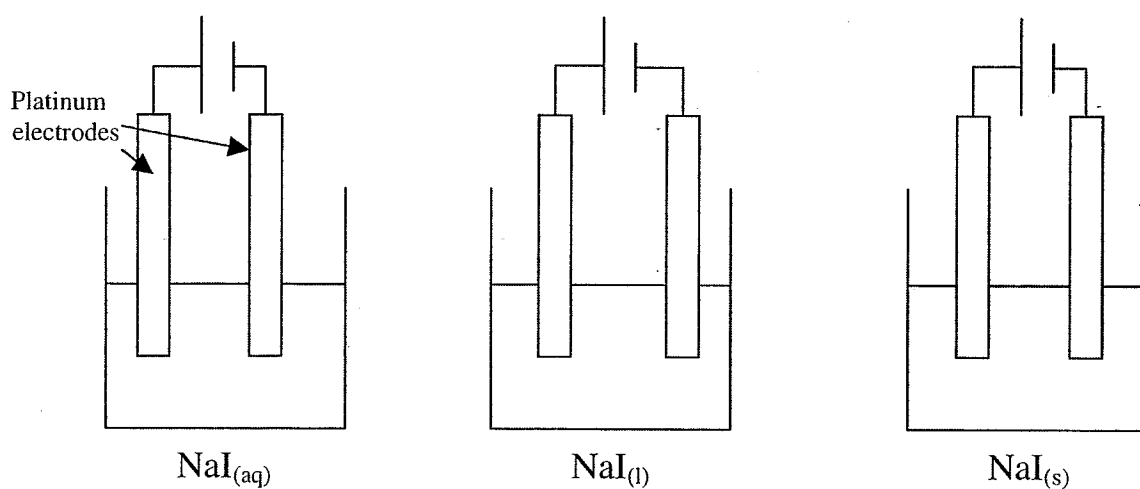
    Identify the beaker or beakers in which an oxidation-reduction reaction would occur and explain why it occurs.   **2**

    (iii)   Write the half-equation for the reaction that occurs at the cathode in one of the beakers.   **1**

(b)   During your practical work you performed a first-hand investigation to compare the rate of corrosion of iron and an identified form of steel.

    (i)   Outline the procedure used and give an account of your results.   **3**

    (ii)   Explain your results in terms of the chemical composition of the two metals.   **2**

Question 29 (continued)

(c)   Early ship builders who attached copper components to a steel hull soon
        realised that the steel corroded very quickly, especially in the area close to
        the copper. Apart from a little surface discolouration, the copper remained
        in very good condition.

    (i)   Explain why steel corrodes so quickly in the presence of copper.   **2**

    (ii)   Identify an alternative metal to copper that would protect   **4**
          steel hulls and explain how it does so.

(d)   The concentrations of two gases in the atmosphere and oceans are shown in
        the table below:

Gas	Percentage in the atmosphere (V/V)	Percentage in shallow ocean water (V/V)
Oxygen	21	1.0
Carbon dioxide	0.03	4.2

    (i)   Explain the higher concentration of carbon dioxide in the ocean   **2**
          compared with the atmosphere.

    (ii)   As you go deeper in the ocean the concentrations of those gases will
          change.

          Describe the changes you would expect at a depth of 500 metres and   **3**
          Account for those changes.

(e)   Assess the usefulness of electrolysis as a means of cleaning and stabilising   **5**
        marine artefacts.

Question 30 --- The Biochemistry of Movement (25 marks)

(a)   (i)   Identify the molecule whose structure is drawn below.   **1**

$$\begin{array}{ccc} H & H & H \\ | & | & | \\ H-C-C-C-H \\ | & | & | \\ OH & OH & OH \end{array}$$
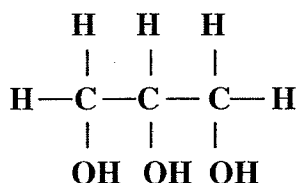
         (ii)   Predict its solubility in water giving a reason for your prediction   **2**

(b)   During your practical work you performed a first-hand investigation that demonstrated the effect of temperature on the reaction of a named enzyme.

         (i)   Name the enzyme and outline the procedure used for the investigation.   **3**

         (ii)   Sketch a simple graph to show how the enzyme's activity changed over a range of different temperatures.   **1**

         (iii)   Account for the enzyme's activity at very low temperatures and very high temperatures.   **3**

(c)   (i)   Explain the significance of the three phosphate groups in an ATP molecule.   **1**

         (ii)   Describe the role of ATP in the contraction of a muscle cell.   **3**

(d)   Assess the importance of anaerobic respiration during sprinting.   **6**

Question 30 (continued)

(e) The following flow chart summarises the production of ATP from glucose and fatty acids.

One glucose molecule　　　　　　**One fatty acid molecule**

Glycolysis　　　　　　　　　　　Pathway D

Pyruvic acid

Acetyl Coenzyme A

TCA Cycle

Oxidative phosphorylation

36 ATP molecules　　　　　　　　146 ATP molecules
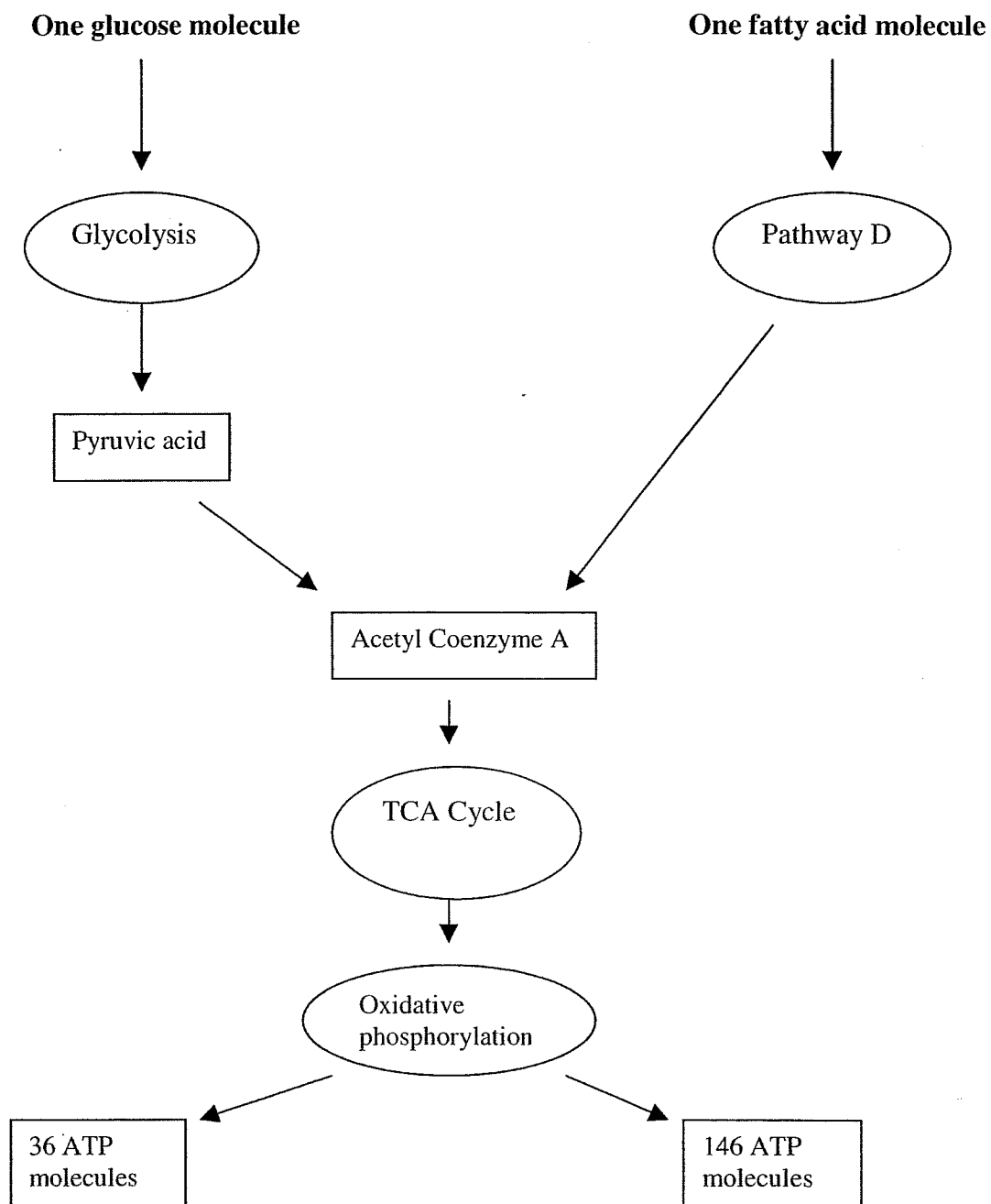
(i) Identify pathway D. 　　　　　　　　　　　　　　　　　　**1**

(ii) Draw the general formula for a fatty acid. 　　　　　　　　**1**

(iii) Explain the role of oxidation and reduction in the TCA cycle. 　**3**

Question 31 --- The Chemistry of Art (25 marks)

(a) (i) Identify a mineral which has been used as a pigment by traditional Aboriginal artists and state the colour it is used to produce.　　2

(ii) Analyse the relationship between the chemical composition of a selected pigment and the position of the metallic component of that pigment in the Periodic Table.　　2

(b) (i) An unknown compound was heated over a Bunsen burner and produced a scarlet coloured flame. Identify the cation in the flame.　　1

(ii) Explain the effect of infra-red and ultra-violet light on pigments containing zinc oxide and pigments containing copper.　　4

(c) (i) An element has the following successive ionisation energies (in kJ/mol):

1st I.E	2nd I.E	3rd I.E	4th I.E.
600	1150	4900	6500

Predict the number of electrons in the outer most shell of this element and explain how you were able to make your prediction.　　2

(ii) Describe, using correct orbital notation, the electron configuration of the element phosphorous.　　1

(iii) Predict the most electronegative element in Period 2 of the Periodic Table and explain your choice.　　2

(d) During your practical work you performed a first-hand investigation to determine the oxidising strength of potassium permanganate.

(i) Predict the oxidation state of manganese in the compound potassium permanganate.　　1

(ii) Account for the fact that potassium permanganate is a powerful oxidising agent.
Use half-equations to support your answer.　　2

(iii) Justify the procedure you used to determine the oxidising strength of potassium permanganate.　　3

(e) Evaluate the use of models in developing an understanding of the nature of ligands and chelated ligands. Refer to specific examples.　　5

Question 32 --- Forensic Chemistry (25 marks)

(a)   (i)   Identify the polysaccharide produced in the bodies of animals.   1

        (ii)   Account for the different reducing abilities of the two sugars, sucrose   2
and glucose.

(b)   (i)   Demonstrate your understanding of the nature of a peptide bond by   2
drawing a dipeptide and labelling the relevant bond.

        (ii)   During your practical work you performed a first-hand investigation   4
to carry out chromatography to separate a mixture of organic
materials.

               Outline the procedure you used during the investigation.

        (iii)   Compare the properties of mixtures which allow some to be   2
separated by chromatography and some mixtures to be separated by
electrophoresis.

(c)   Using a recent example, discuss how changes in technology can alter the   4
outcome of a forensic investigation.

(d)   The keeping of data banks of individual's DNA by government agencies   5
and private companies could become a major concern for people in the
years to come.

        Assess the issues associated with the keeping of data banks of DNA.

(e)   (i)   Define the term destructive testing as it applies to forensic   1
investigations.

        (ii)   Explain how a mass spectrometer operates. In your answer give an   4
example of the type of sample it could be used to identify.

End of Paper