Centre Number

Student Number

CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NSW

2011
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Morning Session
Friday, 5 August 2011

Total marks – 100

Section I Pages 2–20

75 marks
This section has two parts, Part A and Part B

Part A – 20 marks
- Attempt Questions 1–20
- Allow about 40 minutes for this part

Part B – 55 marks
- Attempt Questions 21–32
- Allow about 1 hour and 35 minutes for this part

Section II Pages 21–30

25 marks
- Attempt ONE question from Questions 33–37
- Allow about 45 minutes for this section

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Use the Data Sheet and Periodic Table provided
- Use the Multiple Choice Answer Sheet provided
- Write your Centre Number and Student Number at the top of this page and page 9

Section I
75 marks

Part A – 20 marks
Attempt Questions 1-20
Allow about 40 minutes for this part

Use the Multiple Choice Answer Sheet provided.

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1 Most of the world's ethylene is

(A) sourced as a fraction of crude oil.

(B) produced by dehydration of ethanol.

(C) produced by catalytic cracking of alkanes.

(D) distilled after the fermentation of glucose.

2 A student was given two beakers each containing 50mL of an unknown liquid. He was told that one of the liquids was cyclohexane and one was cyclohexene. He added 5mL of bromine water to each beaker and went to lunch. When he returned, the liquids in both beakers were colourless. The most likely explanation is that

(A) the reaction requires more time.

(B) more than 5mL of bromine water is required.

(C) this test does not work for pure alkanes or alkenes.

(D) both liquids reacted due to the presence of UV light.

3 A student has **incorrectly** named an organic substance 3-butanol. The correct name is most likely to be

(A) butan-3-ol

(B) 3-butane-ol

(C) 3-hydroxybutane

(D) 2-butanol

4 What mass of 1, 2-dibromoethane is produced when 2.00L of ethylene gas is reacted with 11.18g of bromine at 25°C and 100kPa?

(A) 13.1g

(B) 15.2g

(C) 16.5g

(D) 26.3g

5 Hydrogen gas is produced when zinc reacts with dilute hydrochloric acid. The best explanation for why this reaction occurs is

(A) the hydrogen ion is a more powerful oxidising agent than the zinc ion.

(B) the zinc ion is a more powerful reducing agent than the hydrogen ion.

(C) the zinc ion is a more powerful oxidising agent than the hydrogen ion.

(D) the hydrogen ion is a more powerful reducing agent than the zinc ion.

6 A Galvanic cell is constructed using a zinc half-cell as an anode and a nickel half-cell as the cathode. When carried out under standard conditions the cell voltage produced would be

(A) -1.01V

(B) -0.52V

(C) +0.52V

(D) +1.01V

7 A Geiger-Muller counter is a device that could be used for

(A) measuring the concentration of metal ions in solution.

(B) determining the length of a polymer chain.

(C) treating cancerous cells in a hospital.

(D) detecting cracks in sheet metal.

8 An unknown colourless solution is tested with three common indicators – methyl orange, bromothymol blue and phenolphthalein.

The results showed:

Indicator	*Colour in the presence of the solution*
Methyl Orange	Orange
Bromothymol Blue	Yellow
Phenolphthalein	Colourless

The solution can be classified as

(A) mildly basic.

(B) very basic.

(C) mildly acidic.

(D) very acidic.

9 Compare the following solutions

Solution 1	*Solution 2*
0.25 mol L^{-1} H_2SO_4	0.50 mol L^{-1} HCl

The H^+ ion concentration and pH of solution 1 would be

	Hydrogen ion concentration	*pH*
(A)	lower than solution 2	higher than solution 2
(B)	lower than solution 2	lower than solution 2
(C)	the same as solution 2	lower than solution 2
(D)	the same as solution 2	the same as solution 2

10 Calculate the pH of the resulting solution when 25.0mL of 0.750mol L^{-1} hydrochloric acid solution is added to 10.0mL of 0.500mol L^{-1} barium hydroxide solution.

(A) 0.456

(B) 0.602

(C) 1.862

(D) 2.058

11 In the following equation

$$H_2PO_4^-(aq) + H_2O(l) \leftrightarrow H_3PO_4(aq) + OH^-(aq)$$

(A) $H_2PO_4^-$ is acting as a base and H_3PO_4 is acting as its conjugate acid

(B) $H_2PO_4^-$ is acting as an acid and H_3PO_4 is acting as its conjugate base

(C) $H_2PO_4^-$ is acting as a base and OH^- is acting as its conjugate acid

(D) $H_2PO_4^-$ is acting as an acid and OH^- is acting as its conjugate base

12 The pH of a solution of sodium acetate (CH_3COONa) was measured to be 9.05.

Which of the following statements best explains the measured pH?

(A) Sodium ions donate protons to water.

(B) Acetate ions donate protons to water.

(C) Sodium ions accept protons from water.

(D) Acetate ions accept protons from water.

13 Ethanol (boiling point (B.P.) 78.1°C) and butanoic acid (B.P. 163.5 °C) will react under reflux to produce ethyl butanoate (B.P. 121.0°C). When the reflux mixture is distilled, four pure liquids are collected in separate beakers labelled 1, 2, 3 and 4, in order of collection.

Which beaker contains the ester?

(A) 1

(B) 2

(C) 3

(D) 4

14 The equation that correctly represents the Haber process is

(A) $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$ $\Delta H = +92 \text{ kJ mol}^{-1}$

(B) $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$ $\Delta H = -92 \text{ kJ mol}^{-1}$

(C) $N_2(g) + 2H_2(g) \leftrightarrow 3NH_3(g)$ $\Delta H = +92 \text{ kJ mol}^{-1}$

(D) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ $\Delta H = -92 \text{ kJ mol}^{-1}$

15 A student performed a cation analysis of a solution and the results are shown below:

SOLUTION
↓
add $Cl^-(aq)$ – no precipitate
↓
add $SO_4^{2-}(aq)$ – no precipitate
↓
add $OH^-(aq)$ – blue precipitate

Which of the following cations was present in the starting solution?

(A) Barium

(B) Copper

(C) Iron

(D) Lead

16 Atomic Absorption Spectroscopy (AAS) was performed to determine the concentration of iron in a stream. The results are shown in the table below.

Trial	*Absorption*
1	0.282
2	0.287
3	0.216
4	0.285
5	0.279

What value should be used to determine the concentration of iron?

(A) 0.2698

(B) 0.270

(C) 0.283

(D) 0.28325

17 In order to analyse a sample of filtered water a student added excess silver nitrate solution, filtered, then dried and weighed the residue. Which of the following information about the sample would this provide?

(A) Total dissolved solids

(B) Chloride concentration

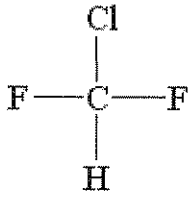
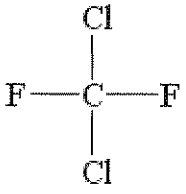
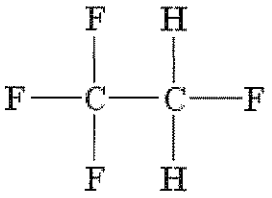
(C) Turbidity

(D) Hardness

18 Which of these samples represents water of highest quality?

	DO ($mg\ L^{-1}$)	*BOD* ($mg\ L^{-1}$)
(A)	8	4
(B)	1	4
(C)	8	20
(D)	1	20

19

Compound X	*Compound Y*	*Compound Z*
		

Which of the following ranks these compounds in decreasing (strongest to weakest) order of ozone depleting capacity?

(A) Z, Y, X

(B) Z, X, Y

(C) Y, Z, X

(D) Y, X, Z

20 Which of the following shows the *most* correct distribution of ozone in the layers of the atmosphere?

	Troposphere %	*Stratosphere %*	*Mesosphere %*
(A)	90	10	0
(B)	10	90	0
(C)	0	10	90
(D)	0	90	10

Chemistry

Centre Number

Student Number

Section I (continued)

Part B – 55 marks
Attempt Questions 21-32
Allow about 1 hour and 35 minutes for this part

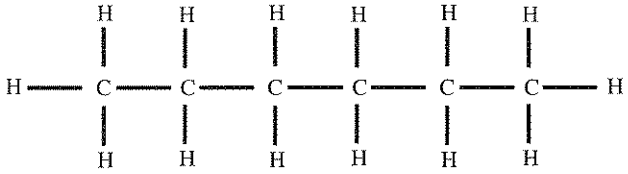
Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

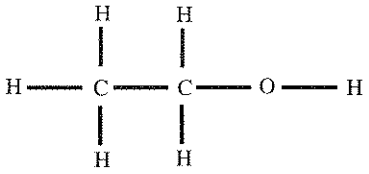
Question 21 (3 marks)

Consider these THREE compounds, all of which are liquids at room temperature: **3**

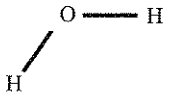
Compound A



Compound B



Compound C



Identify the compound with the ability to dissolve the greatest variety of substances, and justify your choice.

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Question 22 (5 marks)

Compare a standard dry cell or lead-acid cell to ONE of the following: **5**

- button cell
- fuel cell
- vanadium redox cell
- lithium cell
- liquid junction photovoltaic device (eg the Gratzel cell)

in terms of their chemistry and impact on society.

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Question 23 (5 marks)

Uranium is the principle element used in nuclear reactors and in certain types of atomic bombs. ONE example of a nuclear fission reaction is:

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{92}_{36}A + {}^{142}B + 2\,{}^{1}_{0}n$$

(a) Identify elements A and B. **2**

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(b) Radioisotopes have a wide range of applications in fields like agriculture, medicine and industry. However there are problems associated with their use. **3**

With reference to ONE of the above fields, analyse the problems associated with using radioisotopes and how these problems are managed.

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Question 24 (5 marks)

Octane (C_8H_{18}) is a constituent in petrol and ethanol (C_2H_5OH) is a fuel which can be used in place of petrol. When either undergoes complete combustion in a car's engine large amounts of energy are released. This energy is the source of the car's movement.

	combustion reaction	density	molar mass
octane	$C_8H_{18} + 12½O_2 \rightarrow 8CO_2 + 9H_2O + 5470$ kJ/mol	703g/L	114.224 g/mol
ethanol	$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O + 1367$ kJ/mol	789g/L	46.068 g/mol

(a) Calculate the number of moles in a litre of octane. **1**

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(b) Determine the energy produced from the complete combustion of 1 litre of octane. **2**

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(c) If a car which could travel 10km on 1 litre of octane how far could the same car travel on 1 litre of ethanol? Assume there are no issues with the conversion of the car to the different fuel. **2**

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Question 25 (6 marks)

The hydrogen ion concentration of a 375mL bottle of carbonated lemonade drink was found to be 3.02×10^{-4} mol L^{-1}.

(a) Calculate the pH.. **1**

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(b) Determine the volume of distilled water that would be needed to reduce the hydrogen ion concentration to 2.51×10^{-4} mol L^{-1}. **2**

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(c) The addition of a basic solution to the soft drink could also have been used to adjust the pH of the soft drink. **3**

Explain, in terms of Le Chatelier's Principle, the effect on the solubility of carbon dioxide if a base had been used to adjust the pH. Use equations to support your answer.

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Question 26 (4 marks)

In order to determine the concentration of a sample of vinegar a student made up a primary standard using potassium hydrogen phthalate ($KHC_8H_4O_4$ which is considered a good primary standard). The primary standard was used to standardise a solution of sodium hydroxide. The sodium hydroxide was then titrated with the vinegar.

(a) Calculate the concentration of the primary standard if 5.1025g of solid potassium hydrogen phthalate was dissolved in distilled water up to a volume of 100.00mL. **2**

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(b) Explain why the student chose to prepare a primary standard using solid potassium hydrogen phthalate and then standardise a solution of sodium hydroxide instead of using solid sodium hydroxide to prepare the primary standard. **2**

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Question 27 (3 marks)

Identify ONE element that can form an acidic oxide. Using an equation, explain how the oxide of this element may contribute, through natural processes, to the increased acidity of the environment. **3**

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Question 28 (6 marks)

A student prepared the ester, butyl ethanoate, in the school laboratory.

(a) Identify the alkanol used by the student. **1**

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(b) Write a chemical equation for the reaction, using structural formulae. **2**

(c) Outline why refluxing is used during esterification. **1**

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(d) Identify TWO hazards encountered during esterification and an appropriate step to minimise each hazard. **2**

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Question 29 (5 marks)

"The development of the Haber process to synthesise ammonia an important scientific contribution during the early 1900's, not only to Germany's war efforts, but also to our understanding of equilibrium processes." **5**

Assess the accuracy of the statement above.

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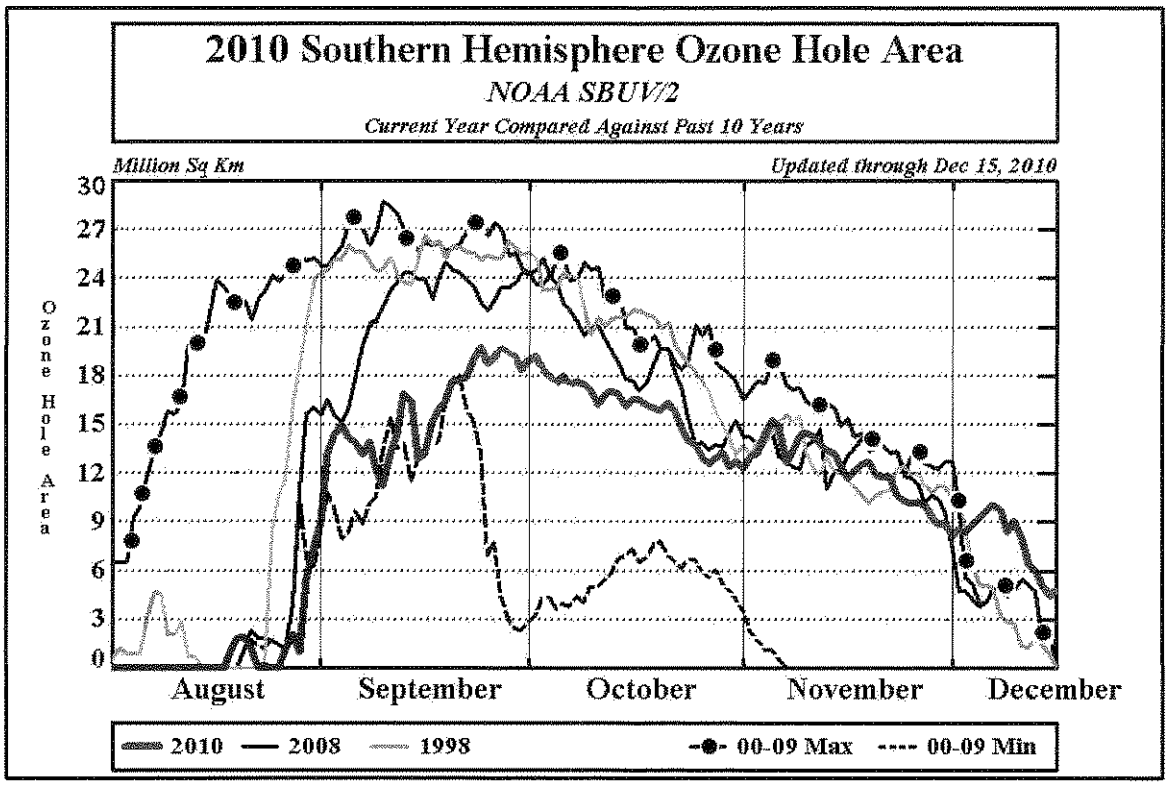
Question 30 (4 marks)

A student located this secondary source. **4**



http://www.cpc.ncep.noaa.gov/products/stratosphere/sbuv2to/ozone_hole.shtml

Outline methods for collecting the data in the graph and analyse the graph to describe changes in atmospheric ozone concentrations since 1998.

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Question 31 (2 marks)

Explain why environmental samples are often qualitatively analysed before being quantitatively analysed by Atomic Absorption Spectroscopy (AAS). **2**

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Question 32 (7 marks)

The compound CO occurs in various natural and artificial environments.

(a) What is the IUPAC name for this compound? **1**

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(b) CO contains a coordinate covalent bond. With the aid of a Lewis electron dot structure describe the formation of this bond. **2**

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(c) Concentrations of CO as low as 650ppm (0.065% v/v) may result in seizure, coma, and death. Assess the risk of burning 1kg of coal in a barbeque in an enclosed garage measuring $50m^3$ (at 25°C and 100kPa). Assume that 2% of the coal is converted to CO. $1m^3 = 1000L$ **4**

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Chemistry

Section II

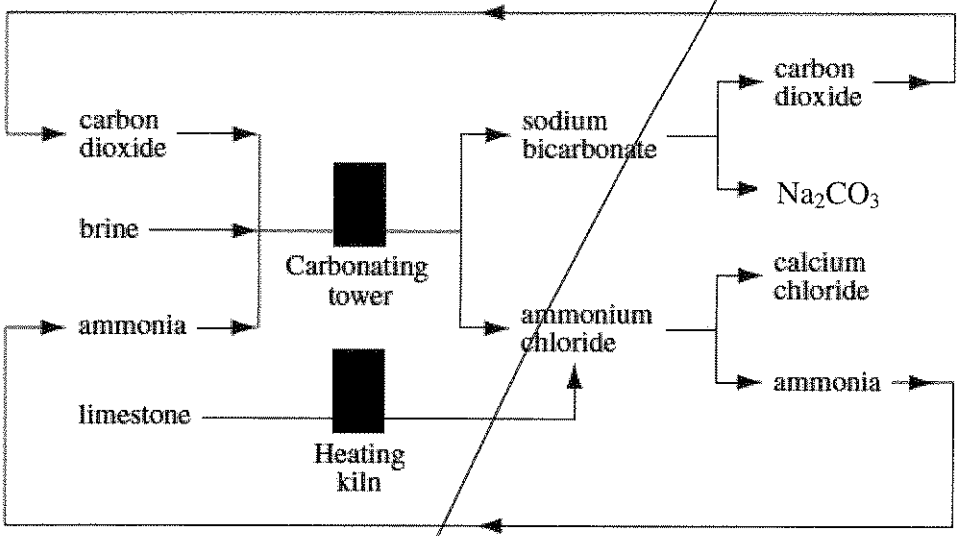
25 marks
Attempt ONE question from Questions 33–37
Allow about 45 minutes for this section

Answer the question in a SEPARATE writing booklet.

Show all relevant working in questions involving calculations.

Question 33 – Industrial Chemistry (25 marks)

(a) (i) Name the industrial process shown in the flow chart below. **1**



(2005 HSC)

(ii) Describe the chemistry involved in the production of sodium carbonate using the process identified above. **3**

(b) Name a natural product, other than a fossil fuel, that you have researched. Discuss the issues caused by its decreasing availability, identifying replacement materials and/or current research taking place to produce alternatives using industrial processes. **4**

(c) A student performed a first hand investigation to quantitatively analyse an equilibrium reaction.

(i) Outline the steps required to analyse the reaction. **2**

(ii) Write an equation for the reaction. **1**

(iii) Explain the effects of changing the conditions upon the reaction. **2**

Question 33 continues on page 23

Question 33 (continued)

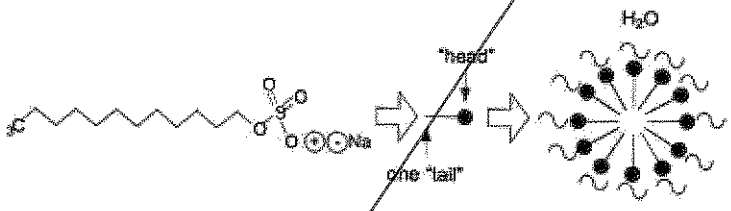
(d) Given the equilibrium equation:

$$CO_2(g) + H_2(g) \leftrightarrow CO(g) + H_2O(g)$$

(i) Write the equilibrium constant expression. **1**

(ii) Calculate the value of the equilibrium constant, K, for the system shown, if initially there are 0.2000mol of CO_2 and 0.1000mol of H_2 only present, and at equilibrium there are 0.1908mol of CO_2 present, in a 2.00L reaction vessel (at 25°C). **3**

(e) The diagram below represents the soap, sodium dodecylsulfate, forming a micelle. **2**



(http://www.globalspec.com/reference/14180/160210/Chapter-1-3-2-Polymeric-Liquid-Crystals)

Account for the cleaning action of soap by referring to the structures shown in the diagram.

(f) 'Sulfuric acid is one of the most important industrial chemicals in use today, despite the hazards associated with its production and transport.' **6**

Assess this statement.

End of Question 33

Question 34 – Shipwrecks, Corrosion and Conservation (25 marks)

(a) (i) What is an electrolyte? **1**

(ii) Explain why the ocean is a better electrolyte than non-marine bodies of water. **2**

(b) "An understanding of the factors that affect the ***rate*** of an electrolysis reaction is important to ensure that the electrolytic treatment of iron artefacts recovered from marine environments is carried out efficiently and without harming the artefact." **7**

Evaluate the accuracy of this statement.

(c) (i) Identify a modern alloy suitable for use in marine vessels and identify TWO major elements present in this alloy. **2**

(ii) Outline ONE feature of the marine environment that must be considered when selecting a suitable alloy. **1**

(iii) Describe how you could perform an investigation in a school laboratory to identify modern alloys best suited for use in marine vessels. **4**

(d) With the use of appropriate half equations, explain how the corrosion of iron is accelerated by mildly acidic conditions. **3**

(e) In the 19^{th} century copper metal was used to cover the wooden hulls of ships as it prevented the growth of marine organisms on the hull and therefore allowed the ships to travel faster. As corrosion of the copper was a problem, Sir Humphrey Davy was consulted. Whilst he successfully reduced the corrosion by attaching small pieces of iron to the hull, the technique was discontinued as the hulls were rapidly colonised by marine organisms.

(i) With the aid of appropriate half equations and standard potentials, explain why iron was able to reduce the corrosion of the copper hulls. **2**

(ii) Name this process. **1**

(iii) Explain why the copper hulls were no longer able to prevent the growth of marine organisms. **2**

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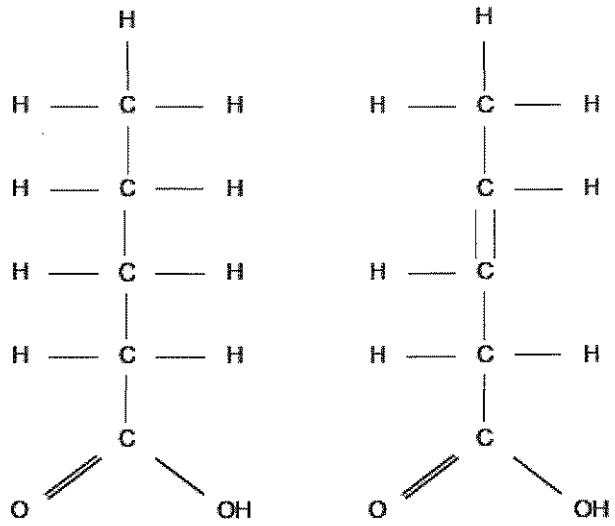
Question 35 – The Biochemistry of Movement (25 marks)

(a)



Compound A **Compound B**

(i) To what class of compounds do these molecules belong? **1**

(ii) Identify the sub class for each of the molecules **2**

(b) The 5 000 metres track event requires tactics and superior aerobic conditioning. The world record for men is held by Kenenisa Bekele of Ethiopia in a time of 12 minutes and 37 seconds at Hengelo, Netherlands on 31 May 2004. To achieve this time Bekele would be required to metabolise 0.0015mol of ATP per gram of muscle per minute. **2**

Using the balanced equation for the metabolism of glucose:

$C_6H_{12}O_6 + 6H_2O + 6O_2 + 38ADP + 38P_i \rightarrow 6CO_2 + 12H_2O + 38ATP + energy$

Calculate the mass of glucose Bekele used per kilogram of muscle.

(c) A student performed a first-hand investigation to demonstrate the effect of various factors on the reaction of a named enzyme.

(i) Describe an appropriate procedure. **3**

(ii) Identify TWO safety precautions. **2**

(iii) Outline any conclusions reached. **1**

Question 35 continues on page 27

(d) "Muscle contraction requires large amounts of ATP energy." **6**

Analyse this statement relating the structure and function of the ATP molecule to its role in muscle contraction.

(e) (i) Compare the structures of glucose and glycogen. **2**

(ii) Account for the solubility of glucose and glycogen. **2**

(iii) Muscle cramp after strenuous exercise is caused by a build up of lactic acid in the muscles. **4**

Outline the formation of lactic acid and describe how it is removed from the body.

End of Question 35

Question 36 – The Chemistry of Art (25 marks)

(a) Aboriginal people were one of the first cultures to use colour in the production of traditional art and decorations.

(i) Identify ONE pigment used in traditional art by the Aboriginal people and describe its chemical composition. **2**

(ii) Explain why the pigments used by Aboriginal people in traditional cave paintings needed to be insoluble. **2**

(b) A student performed a first-hand investigation to observe the flame colour of a number of different cations.

(i) Outline the procedure used to identify the K^+ and identify the flame colour. **2**

(ii) Explain how the result of the K^+ flame test relates to electron excitation and emission spectra. **3**

(iii) State a safety precaution that was taken during the experiment and explain how it lowered the risk. **1**

(c) The tables below show the successive ionisation energies and electronegativity of aluminium

Ionisation Energy (kJ mol^{-1})				
First	Second	Third	Fourth	Fifth
584	1823	2751	11584	14837

Electronegativity
1.5

(i) Write the full electron configuration for aluminium. **1**

(ii) Distinguish between the terms ionisation energy and electronegativity. **2**

(iii) Use the data from the table above to describe how the trend in successive ionisation energies can be used to predict the number of electrons in the outermost shell and the sub-shells occupied by these electrons. **2**

Question 36 continues on page 29

Question 36 (continued)

(d) The formation of complex ions by transition metals can lead to different coloured substances.

Cobalt chloride can be used to detect the presence of water as its colour changes with the addition of water. If sufficient water is present, the following reaction occurs:

$$\underset{\text{blue}}{[Co(Cl)_4]^{2-}(aq)} \leftrightarrow \underset{\text{blue}}{[Co(H_2O)_4]^{2+}(aq)} \leftrightarrow \underset{\text{pink}}{[Co(H_2O)_6]^{2+}(aq)}$$

(i) Describe how chloride ions and water molecules are able to form ligands and bond with cobalt. **2**

(ii) Referring to oxidation states and ligands, describe how this complex ion may be used in this example to detect the presence of water. **2**

(e) "Bohr and Pauli made major contributions to our understanding of the arrangements of electron around the nuclei of an atom. Their contributions used models or ideas to explain observations and provided both benefits and limitations when explaining how electrons behave." **6**

Evaluate this statement by considering the effectiveness of each idea in explaining experimental observations.

End of Question 36

Question 37 – Forensic Chemistry (25 marks)

(a) There are many different classes of carbon compounds. Use diagrams to distinguish between hydrocarbons, alkanols and alkanoic acids, and explain how the different groups can be identified using distinguishing tests. **3**

(b) Carbohydrates form a major group of compounds often characterised during forensic investigations.

(i) Describe the chemical difference between reducing and non-reducing sugars. **1**

(ii) Outline how reducing sugars can be distinguished from starch. **2**

(c) (i) Use the general formula for amino acids to show how polypeptides are formed. **1**

(ii) Explain how proteins can be broken into different lengths by the use of specific enzymes. **2**

(iii) Outline a process that could be used to separate amino acids or sections of a protein. **4**

(d) Explain why the analysis of DNA allows identification of individuals with a large degree of accuracy. **2**

(e) Discuss the ethical issues associated with using DNA analysis and the maintenance of DNA data banks. **4**

(f) Assess the value of modern techniques in the analysis of samples in forensic chemistry. **6**

End of Paper