

Student Number

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Exam Choice

2010

**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 - 20

75 marks

This section has two parts, Part A and Part B

Part A – 20 marks

- Attempt Questions 1-20
- Allow about 35 minutes for this part

Part B – 55 marks

- Attempt Questions 21-32
- Allow about 1 hour and 40 minutes for this part

Section II Pages 22 - 31

25 marks

- Attempt **ONE** Question from Questions 33-37
- Allow about 45 minutes for this section

Section I
75 marks

Part A – 20 marks

Attempt Questions 1-20

Allow about 35 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 ☐

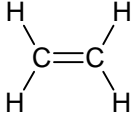
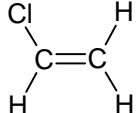
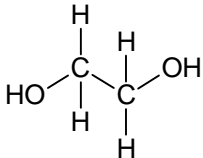
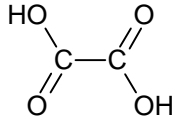
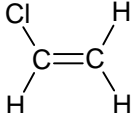
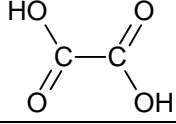
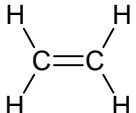
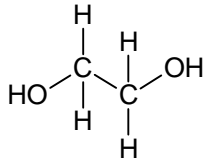
If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word **correct** and drawing an arrow as follows.

A ☒ B ☒ C ☐ D ☐
correct

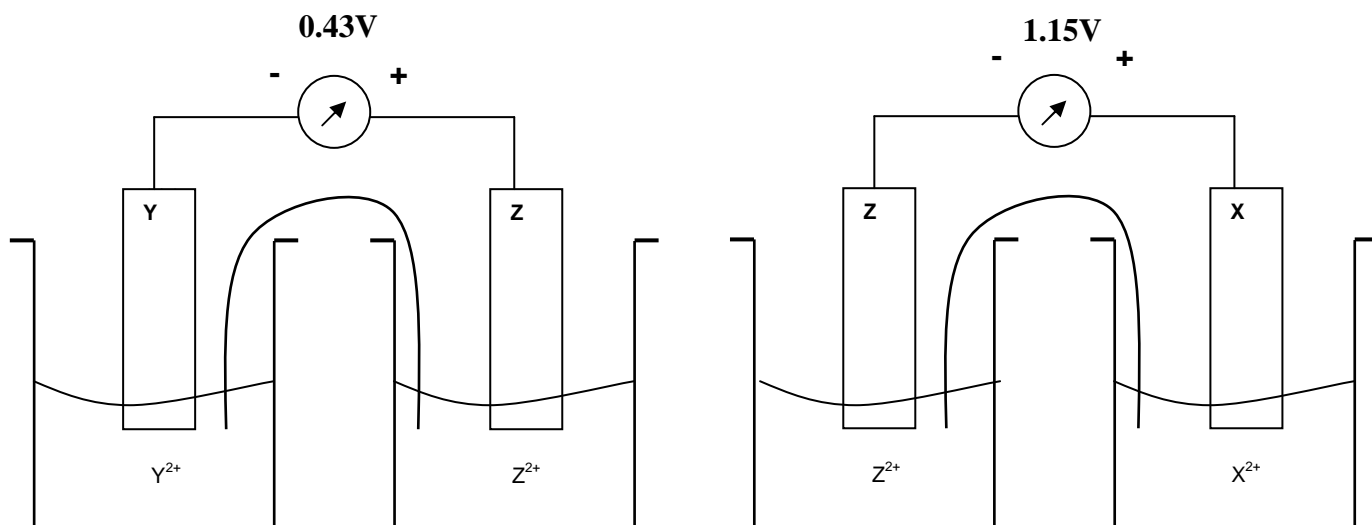
- How many products may be formed when water reacts with 3-hexene?
 - 1
 - 2
 - 3
 - 4

- Which of the following is a method for increasing our supply of ethylene?
 - thermal cracking of ethane
 - catalytic cracking of ethane
 - fermentation of ethane
 - dehydration of ethane

- Which of the following pairs of compounds could be used to produce a condensation polymer?

(A)		
(B)		
(C)		
(D)		

4. A student measured the heat of combustion of 1-propanol, by heating 200 g of water initially at 21.0 °C. 0.60 g of 1-propanol was burnt in the reaction. The heat of combustion of 1-propanol is 2020 kJ/mol. Assuming that 50% of the heat produced was lost to the environment, what would the final temperature of the water be?
- (A) 22.6 °C
 (B) 25.1 °C
 (C) 33.1 °C
 (D) 34.7 °C
5. Which of the following pairs of chemicals could spontaneously react to form products?
- (A) I_2 and Br^-
 (B) H^+ and Cu
 (C) MnO_4^- and F_2
 (D) Ag^+ and Fe^{2+}
6. This question refers to the half-cells shown in the diagram below. X, Y and Z are symbols of fictitious metals.



The reduction potential of Y is known to be -0.24V

Assuming standard conditions, what is the reduction potential of X?

- (A) 0.48 V
 (B) 0.96 V
 (C) 1.34 V
 (D) 1.82 V

7. A student researching the use of nuclear power found that there are over 400 nuclear power stations operating on earth-more than 100 of them operating in the United States alone. They also found that there are currently no nuclear power stations operating in Australia.

Which of the following may be one factor contributing towards the Australian Government's reluctance to construct nuclear power stations?

- (A) Concern about how to deal with radioactive waste produced at such reactors.
 - (B) Australia does not have enough uranium and would have to import it.
 - (C) The technology to enrich uranium for use in reactors is not well developed.
 - (D) Nuclear reactors from overseas have had a poor safety record and many accidents have occurred at these plants.
8. The pH range of a number of acid-base indicators are shown in the table below:

Indicator	pH range	Colour
Congo red	3.0-5.0	Blue-red
Methyl orange	3.1-4.4	Red-orange
Phenol red	6.8-8.4	Yellow-red
Cresol red	7.2-8.8	Yellow-red

Which of the following indicators may be able to distinguish between distilled water and unpolluted rain water?

- (A) congo red
 - (B) methyl orange
 - (C) phenol red
 - (D) cresol red
9. A chemist uses a pH probe to determine the pH of a 0.1M solution of sodium hydroxide.

Which of the following chemical species does the pH probe detect and measure?

- (A) Na^+
- (B) OH^-
- (C) H_2O
- (D) H^+

10. Four monoprotic acids, W, X, Y and Z were tested and the following data collected:

Acid	Concentration (mol/L)	pH
W	0.01	2.0
X	0.01	3.8
Y	0.10	3.5
Z	0.05	1.35

Which one is the weakest acid?

- (A) W
(B) X
(C) Y
(D) Z
11. Three organic chemicals are:

- ethene
- ethanol
- ethyl butanoate

Which of the following correctly identifies a common use of each substance?

	ethene	ethanol	ethyl butanoate
(A)	petrochemical feedstock	solvent	artificial flavouring
(B)	fuel	solvent	fuel
(C)	petrochemical feedstock	fuel	solvent
(D)	fuel	fuel	artificial flavouring

12. An alkanol with a molar mass of 74g/mol was added to an alkanoic acid with a molar mass of 60g/mol, forming an ester.

Which of the following must be the molar mass of the ester produced?

- (A) 116 g/mol
(B) 118 g/mol
(C) 134 g/mol
(D) The molar mass cannot be determined from the data provided.

13. Which of the following species is a conjugate base of a strong acid?

- (A) NO_2^-
- (B) OH^-
- (C) CH_3COO^-
- (D) HSO_3^-

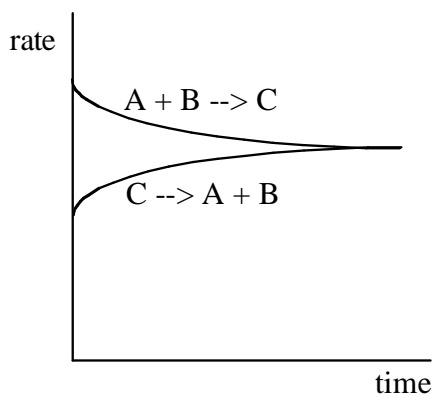
14. Which of the following species contains a coordinate covalent bond?

- (A) NaCl
- (B) NH_4^+
- (C) H_2O
- (D) O_2

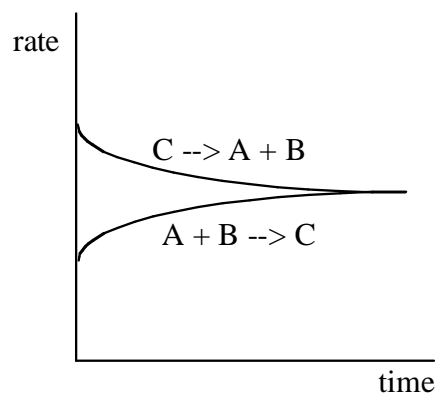
15. Consider an equilibrium system: $\text{A} + \text{B} \leftrightarrow \text{C}$.

Which of the following graphs represents a system reaching equilibrium by *shifting the equilibrium position to the right*?

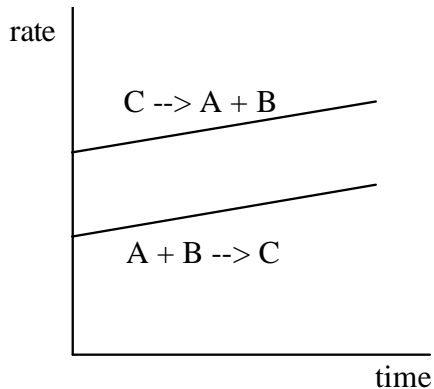
(A)



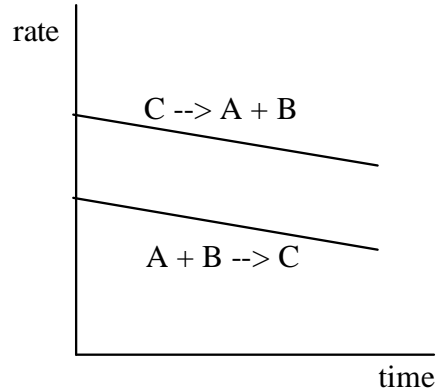
(B)



(C)



(D)



16. Which of the following is an important industrial use of ammonia?
- (A) production of addition polymers
 - (B) production of explosives
 - (C) production of sulfuric acid
 - (D) production of CFCs
17. Combustion reactions are the basis for our modern way of life, and are inherently polluting. Which of the following statements outlines a reason why these reactions need to be monitored?
- (A) When there is inadequate oxygen present, combustion reactions can also produce sulfur dioxide.
 - (B) When there is excess oxygen present, combustion reactions can also produce oxides of nitrogen.
 - (C) When there is excess oxygen present, combustion reactions can also produce sulfur dioxide.
 - (D) When there is inadequate oxygen present, combustion reactions can also produce carbon monoxide
18. Which of the following is a description of *turbidity*?
- (A) It gives an indication of the dissolved solids in a sample.
 - (B) It gives an indication of the concentration of suspended solids in a sample.
 - (C) It gives an indication of the dissolved oxygen concentration in a sample.
 - (D) It gives an indication of the concentration of dissolved and suspended solids in a sample.
19. Which of the following test results could be used to determine that the CO_3^{2-} ion is present in a sample?
- (A) addition of HCl(aq) causes a yellow precipitate to form
 - (B) addition of $\text{H}_2\text{SO}_4\text{(aq)}$ causes a white precipitate to form
 - (C) addition of $\text{HNO}_3\text{(aq)}$ causes gas bubbles to form
 - (D) addition of $\text{H}_3\text{PO}_4\text{(aq)}$ causes a blue precipitate to form

20. CFC molecules can be identified by a numbered code. To assign the numbered code for each molecule, the following rules are followed:

1. Count the numbers of each C, H and F atom present in the molecule.
2. Write this number as a three digit number. For example, in the molecule CCl_2F_2 , there is 1 carbon atom, 0 hydrogen atoms and 2 fluorine atoms, so the number becomes 102.
3. Subtract 90 from this number to determine the code for the molecule.

Using this rule, which of the following would be the correct code for 2,2-dichloro-1,1,1,2-tetrafluoroethane?

- (A) 112
- (B) 114
- (C) 204
- (D) 208

Part B (55 marks)

Questions: 21 – 32

Marks: 55

Time: Allow approximately 1 hour and 40 minutes for this Part.

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

	Marks
Question 21 (3 marks)	
(a) Explain the different reactivity of butane and 1-butene with aqueous bromine, illustrating your answer with a chemical equation using structural formulas. 	2
(b) Name the product of the reaction you summarised above.	1

Question 22 (4 marks)

You have studied polymers made from vinyl chloride and styrene.

- (a) Give the systematic name of one of these monomers. **1**

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- (b) Draw the structure of the polymer made from this monomer, showing three repeating units. **1**

- (c) Account for a use of this polymer. **2**

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Question 23 (4 marks)

A 1.15 g sample of copper metal is placed into a beaker containing a 100.0mL of 0.50M solution of silver nitrate. The remaining mixture was left to stand for several days.

- (a) Write a balanced equation for the reaction which occurred in the beaker. **1**

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- (b) Determine the concentration of the following ions in the beaker at the end of the reaction. **3**

(i) NO_3^-

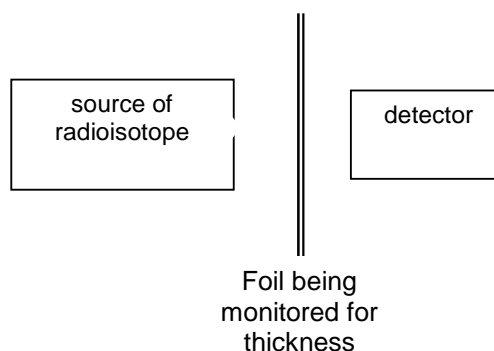
(ii) Ag^+

(You may assume the reaction had completely ceased upon standing and that there was negligible volume change in the beaker upon addition of the copper).

Question 24 (3 marks)

The following information describes the industrial use of radioisotopes to gauge the thickness of thin films, such as a thin metal foils.

The radiation emitted from a radioisotope has its intensity reduced by matter placed between the radioactive source and a detector. The detector measures this reduction and thus can be used to measure the thickness of material between the source and the detector. This is shown in the simplified diagram to the right,



- (a) Identify an instrument that may be used to detect the radiation produced by the radioisotope.

1

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- (b) The table below shows three examples of radioisotopes (A, B and C) and the type of radiation that each emits.

Radioisotope	Type of radiation it emits
A	alpha only
B	beta only
C	gamma only

On the basis of the information in the table, assess the suitability of each radioisotope for use as a thickness gauge in the production of foil.

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Question 25 (4 marks)

Evaluate the use of a recently developed biopolymer.

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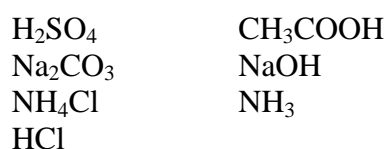
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Question 26 (3 marks)

The list below contains acids, bases and salts.



- (a) Identify the species which would react together to form a basic salt.

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- (b) Outline how a buffer solution could be prepared from two or more of the above compounds.

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Question 27 (3 marks)

Describe the trend in the acid-base nature of oxides moving from left to right across the periodic table.

Include examples and relevant chemical equations in your answer.

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Question 28 (5 marks)

A Chemistry teacher performed a demonstration in which a small mass of copper metal was added to concentrated nitric acid in a gas jar.

The reaction produced 1.50L of the gas NO_2 , at 0°C and 100kPa. The other products were copper (II) nitrate and water.

(a) Write a balanced equation for this reaction.

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(b) Assuming an excess of nitric acid, calculate the mass of copper needed to produce this much NO_2 gas.

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(c) Write a risk assessment for this demonstration.

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Question 29 (8 marks)

A student set out to determine the concentration of a solution of sodium hydroxide.

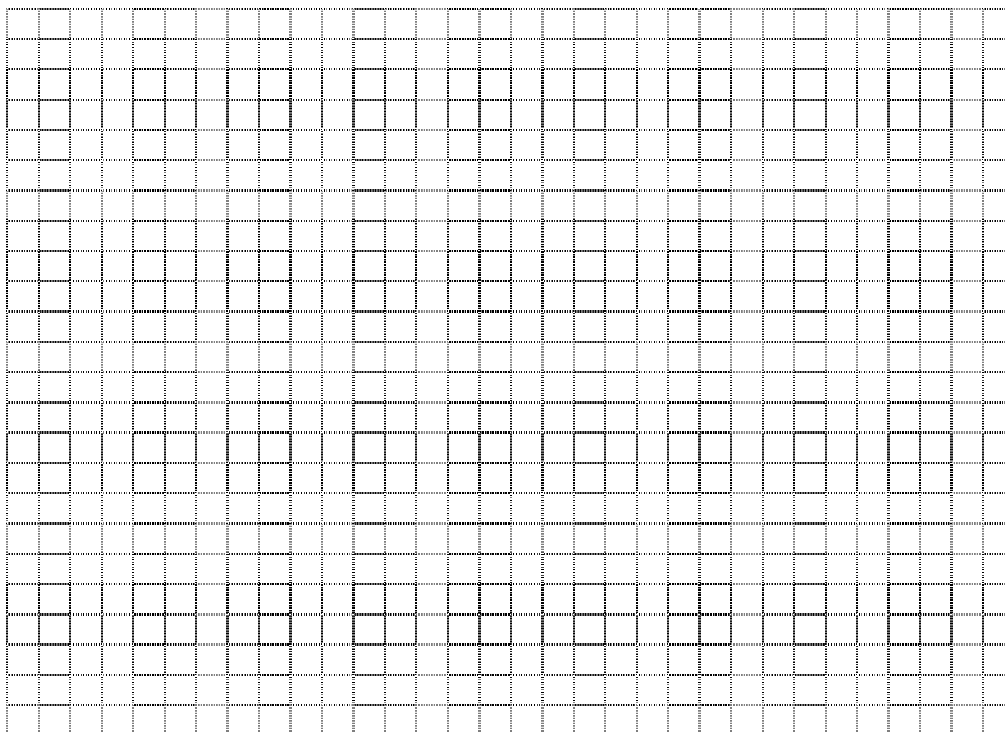
Firstly, she placed 25.0 mL of 0.100M ethanoic acid in a conical flask.

She then titrated the NaOH solution from a burette into the flask and used a pH probe to measure the pH as the NaOH solution was added.

Her results are in the table below.

Volume of NaOH added from the burette (mL)	pH of mixture in conical flask
0	2.7
5	3.1
10	3.3
15	3.5
20	4.1
25	10.3
30	10.7

- (a) Graph this data on the grid below.

3

	Marks
Question 29 (continued)	
(b) Use the graph to <i>estimate</i> the volume of NaOH added to reach the equivalence point.	1
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(c) Use your estimate to calculate the concentration of the sodium hydroxide solution. Show all working.	2
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(d) Explain how a modification to the student's procedure could improve the accuracy of her estimate in (b).	2
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Question 30 (3 marks)

With the aid of labelled electron-dot diagrams, compare the bonding in oxygen and ozone molecules, and explain how the differences you describe affect ONE physical property of the gases.	3
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Question 31 (6 marks)

- (a) Write a balanced chemical equation to represent the Haber process. **1**

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- (b) Explain why reaction conditions need to be carefully monitored in the Haber process. **5**

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Question 32 (9 marks)

A student collected a sample of waste water as it flowed from a factory.

Analysis of the sample in the school laboratory yielded the following results.

mass of sample (g)	147.5
mass of a dry filter paper (g)	0.152
mass of dry filter paper + residue (g)	22.52
mass of dry evaporating basin (g)	48.42
mass of evaporating basin + residue (g)	48.45
pH	6.9
DO (ppm)	5.8
BOD ₅ (ppm)	0.0

- (a) Identify the most significant type of pollution present in the sample. **1**

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- (b) Calculate the concentration of dissolved solids in the sample in ppm. **2**

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Question 32 continues on page 20.

Question 32 (continued)

Further tests were carried out on the residue in the evaporating basin. The results of these tests are summarised below.

test 1	addition of HCl	no reaction
test 2	addition of H_2SO_4	fine white precipitate
test 3	addition of $\text{AgNO}_3(\text{aq})$	white precipitate
test 4	addition of $\text{BaCl}_2(\text{aq})$	no reaction
test 5	addition of $\text{NaOH}(\text{aq})$	no reaction
test 6	flame test	orange- red

- (c) Identify the compound that is dissolved in the water. Justify your answer, including an appropriate ionic equation.

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- (d) This sample could now be quantitatively analysed using Atomic Absorption Spectroscopy (AAS).

4

Describe the chemical principles on which AAS is based, and outline how it could be used to analyse this sample.

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Section II

25 marks

Attempt ONE question from Questions 33-37

Allow about 45 minutes for this Section.

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

Show all relevant working in questions involving calculations.

	Pages
Question 33 – Industrial Chemistry	23 - 24
Question 34 – Shipwrecks, Corrosion and Conservation	25 - 26
Question 35 – The Biochemistry of Movement	27
Question 36 – The Chemistry of Art	28 - 29
Question 37 – Forensic Chemistry	30 - 31

Question 33 - Industrial Chemistry (25 marks)

- (a) The World Health Organisation considers *per capita* soap purchase an important indicator of the general level of development of a country.
- (i) Apart from soap, identify the other product of saponification reactions. 1
 - (ii) Outline the structure and properties of cationic detergents, and relate these to their uses. 2
 - (iii) Describe the cleaning action of soaps, including a labelled diagram in your answer. 3
- (b) The formation of dinitrogen pentoxide from nitrogen dioxide is an equilibrium reaction, as shown below. At 175 °C $K = 8.00$
- $$4\text{NO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{N}_2\text{O}_5 \quad \Delta H = -340\text{kJ/mol}$$
- (i) Write the equilibrium constant expression for the reaction. 1
 - (ii) A reaction vessel containing a mixture of NO_2 , O_2 and N_2O_5 was sampled at 175°C, and the following concentrations measured.
- | species | concentration (M) |
|------------------------|-------------------|
| NO_2 | 1.55 |
| O_2 | 0.75 |
| N_2O_5 | 1.25 |
- Deduce whether the system is shifting to the left or right to reach equilibrium? 3
- (iii) Explain how a change in temperature to 250°C will affect the equilibrium position. 2

Question 33 continues on page 24.

Question 33 (continued)

- (c) Two very important basic substances in the chemical industry are sodium hydroxide and sodium carbonate.
- (i) Identify the starting material common to the production of both sodium carbonate and sodium hydroxide. **1**
- (ii) Describe the mercury method for producing sodium hydroxide, including the chemistry of the process and environmental impacts associated with it. **3**
- (iii) Outline the method you used to safely model a step in the Solvay Process. Include the reactant(s) you used. **3**
- (d) Describe the steps and chemistry involved in the production of sulfuric acid from its elements. Assess the importance of the reaction conditions used. **6**

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

- (a) Our understanding of electricity has changed over time, thanks to the work of several scientists.
- (i) In the 1790's Galvani concluded that animal tissue contained a force that he called 'animal electricity'.
- Outline the experimental work which led to this conclusion. **2**
- (ii) Identify the actual source of the electrical current that Galvani observed in his experiments. **1**
- (iii) Explain how the work of Volta ultimately led to Davy's discovery of the alkali metals. **3**
- (b) Metal objects are often made to look as if they are silver by electroplating silver onto their surface, using electrolysis of solutions containing silver ions.
- (i) Identify the scientist who formulated the Laws of Electrolysis. **1**
- (ii) 'Increasing electrolyte concentration increases the rate of silver deposition by electrolysis.'
- Write a valid and reliable method to test this hypothesis. **3**
- (iii) Electrolysis is also used in the restoration of artefacts found on shipwrecks.
- Write two half equations to show the reactions which occur when a silver coin coated with silver sulfide is treated using electrolysis. **2**

Question 34 continues on page 26.

Question 34 (continued)

- (c) A team of Navy divers discovers a shipwreck sitting on the ocean floor at a depth of 3000m. A knowledge of chemistry will play an important role in understanding the extent to which artefacts on the ship have altered, and will aid in their eventual recovery and restoration.
- (i) Identify the relationship between gas pressure and gas solubility. **1**
- (ii) Explain why the rate of corrosion of this ship would be different to that of a ship wrecked on a shallow reef. **3**
- (iv) Account for the fact that wooden objects from the wreck would not be dried out immediately upon recovery and describe the correct sequence in their restoration from the wreck. **3**
- (d) Explain the chemistry involved in the rusting of iron, and in the techniques which reduce or prevent it. **6**

Question 35 – The Biochemistry of Movement (25 marks)

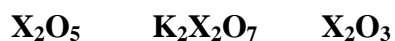
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|-------|--|----------|
| (a) | Fats can be made from the reaction between fatty acids and glycerol. | 1 |
| (i) | Identify the systematic (IUPAC) name of the molecule commonly referred to as glycerol. | |
| (ii) | Write an equation to represent the reaction of glycerol with stearic acid ($C_{17}H_{35}COOH$), and identify the type of reaction which this represents. | 2 |
| (iii) | Explain the implications of a diet low in fats. | 3 |
| (b) | As part of your practical work, you investigated factors which affect the activity of enzymes. | |
| (i) | A simple test for starch involves addition of aqueous iodine. If a sample contains starch the $I_2(aq)$ changes colour from pale yellow/brown to deep blue-black.
Amylase in human saliva catalyses the conversion of starch into disaccharides.

Using the above information as a guide, design a valid and reliable investigation to determine the effect of pH on the activity of amylase in human saliva. | 3 |
| (ii) | Explain how changes in pH affect the activity of enzymes such as amylase. | 3 |
| (c) | Movement of bones in vertebrates is brought about by contraction of muscle cells. | |
| (i) | Identify the two types of protein fibres which compose muscle cells. | 1 |
| (ii) | Explain the chemistry involved in muscle cell contraction. | 3 |
| (iii) | Compare the appearance of type 1 and type 2 skeletal muscle cells, and account for the high percentage of type 2 cells in the legs of sprinters. | 3 |
| (d) | Describe the chemistry which occurs during oxidative phosphorylation and explain the role of NADH and $FADH_2$ in this process. | 6 |

Question 36 – The Chemistry of Art (25 Marks)

- (a) Many transition metals can exist in a variety of oxidation states in their various compounds and the oxidation state can affect the colour of these compounds.

- (i) Transition metal “X” can be found in the following compounds:



Determine the oxidation state of X in the compound X_2O_3 . **1**

- (ii) Identify which of the above compounds is likely to be the strongest oxidising agent. Justify your answer and account for its oxidising strength. **2**

- (iii) Using copper as an example, explain how the electronic configuration of a transition metal allows the metal to form compounds with a variety of oxidation states. **3**

- (b) As part of his practical studies of Chemistry of Art, a student recorded the following results table.

Metal present	Flame colour
Potassium	Lilac
Sodium	Yellow
Strontium	Scarlet

- (i) Describe a procedure which would have allowed the student to safely gather the above results. **3**
- (ii) Assess the ability of the Bohr model to account for the difference in flame colours of various metal ions. **3**

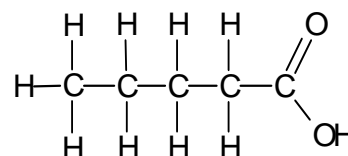
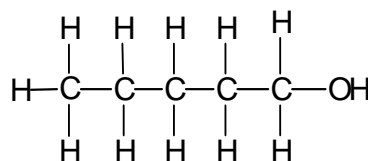
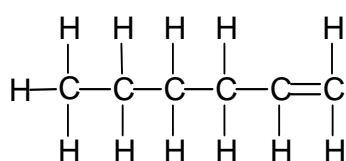
Question 36 continues on page 29.

Question 36 (continued)

- (c) From the earliest of times, humans have used colour to decorate themselves and their environments.
- (i) Identify a mineral that was used by an ancient culture and the colour the mineral imparted. **1**
- (ii) In an attempt to model paint production by early Aboriginals, a student added a small amount of copper (II) sulfate to water and applied the resulting blue liquid to a prepared wooden surface.
- Draw an electron-dot diagram of the species responsible for the blue colour of the liquid prepared by the student and describe fully the bonding within this species. **3**
- (iii) Explain why this procedure was not an appropriate method to model paint making by early Aboriginals, and describe modifications which could better model the process. **3**
- (d) Period 3 of the Periodic Table begins with sodium and ends with argon.
- Analyse the relationships between the atomic structures of the Period 3 elements and their first ionisation energies, electronegativity values and the block of the periodic table to which they are assigned. **6**

Question 37 – Forensic Chemistry (25 marks)

- (a) The work of a forensic chemist is based on the analysis and classification of materials found at crime scenes.
- (i) Identify the key difference between organic and inorganic compounds. **1**
- (ii) Emission spectra can be used to identify trace elements in inorganic compounds. Outline the chemical principle upon which emission spectroscopy is based. **2**
- (iii) Outline a sequence of tests which could be used to distinguish between the compounds below. Include relevant chemical equations. **3**



- (b) The analysis of materials from plants and animals often requires the identification of different types of carbohydrates.
- (i) State the general formula for all carbohydrates. **1**
- (ii) “The type of sugar in a sample does not affect its ability to reduce copper ions”.
- Write a valid and safe method to refute this hypothesis. **3**
- (iii) Distinguish between the composition of the polysaccharides (carbohydrates) found in plants and animals. **2**

Question 37 continued on page 31.

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Question 37 (continued)		
(c)	Forensic analysis often involves the analysis of small amounts of material such as protein samples.	
(i)	Outline the implications for forensic science of using a destructive test on a sample found at a crime scene.	1
(ii)	Describe the function, structure and composition of proteins, and illustrate your answer with an equation using structural formulas. Show the formation of a peptide bond.	3
(iii)	Explain why electrophoresis is a useful technique for identifying the origins of protein samples.	3
(d)	Describe the structure of DNA and explain why tissue samples found in modern crime scenes are more useful to investigators than those found in the early 1900's.	6

End of Paper

