2006

Higher School Certificate

Trial Examination

(INDEPENDENT)

Chemistry

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Board approved calculators may be used
- Write using black or blue pen
- Draw diagrams using pencil
- A Data Sheet and Periodic Table are provided
- Write your student number and/or name at the top of every page

Total Marks – 100

Section I Pages 2 - 15
Total marks (75)
This section has two parts, Part A and Part B

Part A
Total marks (15)
Attempt questions 1 – 15
Allow about 30 minutes for this part

Part B
Total marks (60)
Attempt questions 16 – 26
Allow about 1 hour 45 minutes for this part

Section II Pages 16 - 28
Total marks (25)
Attempt ONE question from Questions 27-31
Allow about 45 minutes for this section

This paper MUST NOT be removed from the examination room

STUDENT NUMBER/NAME: .....

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Section I

Total marks (75)

Part A

Total marks (15)
Attempt questions 1 – 15
Allow about 30 minutes for this part

Select the alternative A, B, C or D that best answers the question and indicate your choice with a cross (X) in the appropriate space on the grid below.

	A	B	C	D
1				
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1. An unlabelled reagent bottle on a laboratory shelf contains a colourless liquid. A few drops of the liquid are shaken with bromine water in a test tube. The bromine water rapidly loses its colour. Which of the following could this substance be?

   (A) Ethene
   (B) Ethanol
   (C) 1-hexene
   (D) Methyl propanoate

2. Consider the following reaction

   $$Zn_{(s)} + 2\,H^+ + 2\,MnO_{2\,(s)} \longrightarrow Zn^{2+} + Mn_2O_{3\,(s)} + H_2O_{(l)}$$

   What is the oxidant in this reaction?

   (A) $MnO_{2\,(s)}$
   (B) $Mn_2O_{3\,(s)}$
   (C) $Zn_{(s)}$
   (D) H^+

3. Which of the following is true?

   (A) Reduction is the loss of electrons
   (B) Oxidation is the loss of electrons
   (C) Oxidation is the reaction between acids and metals
   (D) Oxidation is donating a proton

4. The radioisotope strontium – 90 undergoes beta decay. Which of the following is the remaining nucleus after decay?

   (A) Krypton – 86
   (B) Rubidium – 89
   (C) Yttrium – 90
   (D) Zirconium – 94

5. A spirit burner containing ethanol (molar mass 46gmol^{-1}) was used to heat a 200g sample of water, initially at 19°C, in a calorimeter. The initial mass of the spirit burner was 253.6g. After the water temperature reached 31°C, the spirit burner was extinguished and its mass was measured to be 251.9g.
From these results, which calculation gives the heat of combustion of ethanol, in kJg^{-1}?

(A) $\frac{200 \times 4.18 \times 103 \times 31 \times 19}{253.6 \times 251.9}$

(B) $\frac{200 \times 4.18 \times 10^3 \times (31 - 19)}{(253.6 - 251.9)}$

(C) $\frac{200 \times 4.18 \times 10^3 \times (31 - 19) \times 46}{(253.6 - 251.9)}$

(D) $\frac{200 \times 4.18 \times 10^3 \times (253.6 - 251.9)}{(31 - 19) \times 466}$

6. Which substance can act both as an acid and as a base, in dilute solutions?

(A) Calcium carbonate
(B) Ammonium nitrate
(C) Ethanol
(D) Water

7. The pH values of four acids and their concentrations are shown in the table below.

Acid	Conc. (mol L^{-1})	pH
P	0.01	2.0
Q	0.05	1.0
R	0.1	1.0
S	0.1	2.0

Which acid can donate more than one proton?

(A) P
(B) Q
(C) R
(D) S

8. Which group of substances below result in a lower pH when dissolved in water?

(A) Ammonia, sodium hydroxide, potassium carbonate
(B) Hydrogen chloride, ethanol, carbon monoxide
(C) Sodium oxide, magnesium oxide, calcium hydroxide
(D) Carbon dioxide, sulfur dioxide, hydrogen bromide

9. Which molecule contains a coordinate covalent bond?

(A) Water
(B) Ammonia
(C) Ozone
(D) Methane

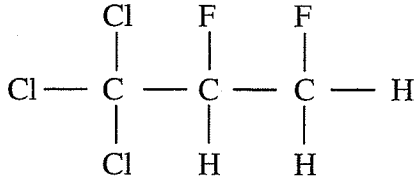
10. Two drops (0.1 mL) of 0.1 mol L^{-1} HCl is added to a small beaker of each of the following liquids.
In which case would the pH remain the same?

(A) A solution of ethanol and glucose, at equal concentrations
(B) Distilled water
(C) A solution of ethanol and ethanoic acid, at equal concentrations
(D) A solution of ammonia and ammonium chloride, at equal concentrations

11. When making the ester, ethyl propanoate, concentrated sulfuric acid is added to a mixture of ethanol and propanoic acid. One effect of the sulfuric acid is to increase the yield of the ester. Which of the following is the correct explanation for this increased yield?

(A) Sulfuric acid is a dehydrating agent and removes water as a reaction product.
(B) Sulfuric acid provides hydrogen ions which catalyse the reaction.
(C) The mixture becomes hot, which accelerates the reaction.
(D) The boiling point of the mixture increases, allowing a higher reaction temperature.

12. Identify the systematic name of the CFC molecule shown below.



(A) 1,1-dichloro-2,3-difluorobutane
(B) 1,2-difluoro-3,3,3-trichloropropane
(C) 1,1,1-trichloro-2,3-difluoropropane
(D) 1-trichloro-2,3-difluoropropane

13. Which of the following 4 carbon atom molecules has the highest boiling point?

(A) Butane
(B) Methyl propanoate
(C) Butanoic acid
(D) 2-butanol

14. Incomplete combustion of petroleum fuels is a major cause of atmospheric pollution. Which of the following are two products of incomplete combustion?

(A) Carbon and water
(B) Carbon monoxide and hydrocarbons
(C) Ozone and carbon dioxide
(D) Nitrogen oxides and sulfur dioxide

15. Atmospheric pollution by heavy metals is monitored using dust deposit plates on which solid particles from the air settle.
An environmental scientist used atomic absorption spectroscopy to analyse the dust on one such plate. He found extremely high levels of lead.
Which of the following is the most appropriate immediate response of the scientist?

(A) Alert the local media
(B) Recommend that the nearby lead smelter be shut down
(C) Change the method of analysis, using gravimetric measurements
(D) Repeat the measurement and analyse other plates from the vicinity

Section I – continued

Part B

Total marks (60)
Attempt questions 16 – 26
Allow about 1 hour 45 minutes for this part

Answer the questions in the spaces provided

Show all relevant working in questions involving calculations.

Question 16 (5 marks) **Marks**

Polyvinyl chloride (PVC) is a polymer commonly used in water pipes, electrical conduit and containers for food and other organic materials.

(a) Give the systematic name of the monomer used to produce polyvinyl chloride. **1**

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(b) Identify a property of polyvinyl chloride that makes it suitable for ONE of the above uses. **1**

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(c) The compounds used to produce polymers such as polyvinyl chloride are presently obtained from the petrochemical industry. State why alternative sources of these compounds are needed and identify TWO such sources. **3**

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STUDENT NUMBER/NAME: .....

Question 17 (6 marks) **Marks**

Ethanol is manufactured from petrochemicals by the reaction of ethene with steam, in a high pressure vessel.

(a) Construct the equation for this reaction. **1**

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(b) Identify why high pressure is used for this reaction. **1**

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(c) Outline the steps by which ethanol is produced from sugar cane. **2**

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(d) Define the term *renewable resource* with reference to these TWO methods of producing ethanol. **2**

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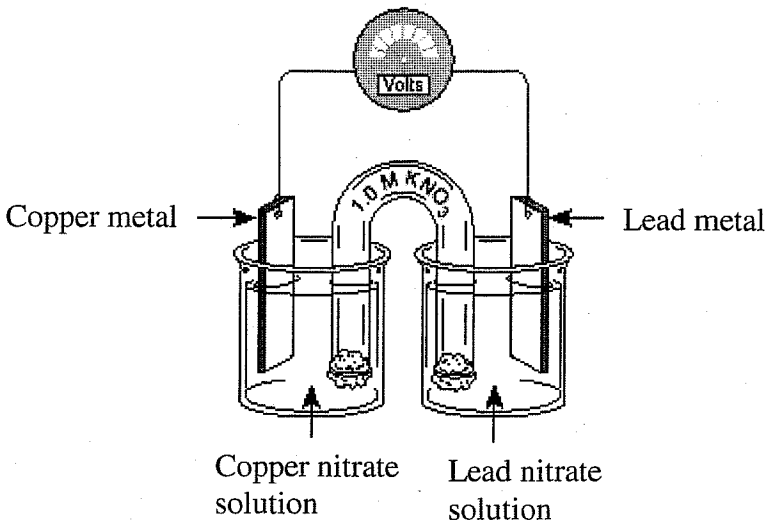
STUDENT NUMBER/NAME: .....

Question 18 (8 marks) **Marks**

The diagram below shows an electrochemical cell.



(a) Write an ionic equation to represent the overall reaction occurring in this cell. **1**

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(b) Identify the anode and state its polarity. **1**

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(c) Predict the reading on the voltmeter, assuming standard conditions. **1**

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(d) Describe THREE changes that could be observed during the operation of this cell. **3**

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(e) Outline any changes in nitrate ion concentrations as the cell operates. **2**

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Question 19 (4 marks) **Marks**

Identify a radioisotope which is used in medicine and describe problems associated with its use **4**

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Question 20 (4 marks)

Compare the terms *concentration* and *strength* as they apply to solutions of acids in water. In your answer identify ONE acid you have studied for which concentration and strength differ greatly. **4**

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Question 21 (11 marks)

A crusty white deposit around the rim of an irrigation pipe is thought to consist of a mixture of sodium chloride and sodium carbonate. To test for sodium carbonate a sample of the deposit is dissolved in water. The solution is filtered and then titrated with a standard 0.118 mol L^{-1} solution of nitric acid. The measurements are recorded below:

Mass of solid sample = 1.32 g
Volume of 0.118 mol L^{-1} HNO_3 titrated = 27.3 mL
Indicator used: methyl orange (pH range 3.5-5)

(a) Describe ONE laboratory test you could perform to show the presence of sodium ions in the sample. **1**

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(b) From the titration results calculate the mass and percentage by mass of sodium carbonate in the sample. **3**

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(c) Identify reasons why methyl orange was selected as the indicator for this titration. **1**

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Question 21 continues on the next page

Question 21 (continued) **Marks**

(d) Outline a laboratory procedure you could perform to assay the proportion of sodium chloride in the sample using the titrated solution. **3**

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(e) Identify factors in the environment and irrigation farming which result in higher salt concentrations in soil. **3**

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Question 22 (7 marks) **Marks**

To analyse a white crystalline solid a student makes the following observations:

- A platinum wire dipped in the solid and held in a bunsen flame produces a bright red colour.
- The solid dissolves easily in water. The solution has a pH of approximately 9.
- In solution the compound has no visible reaction with dilute hydrochloric acid.

(a) Suggest what the white solid might be, and construct ionic equations for it dissolving in water to produce a basic solution. **3**

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(b) Describe TWO further tests you could perform to test your identification of the solid. Include relevant equations. **2**

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(c) Identify ONE metallic salt which produces an acidic solution in water and ONE which produces a neutral solution. **2**

Acidic:..... Neutral: .....

Question 23 (3 marks)

When 2.5L of HBr gas and 1.6L of NH_3 gas, measured at 25°C and 100kPa, are mixed, ammonium bromide is formed as a white solid.

(a) Demonstrate that this is an acid-base reaction, using Bronsted-Lowry definitions. **1**

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(b) Calculate the mass of ammonium bromide formed in this reaction. **2**

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Question 24 (4 marks)

Many fish recently died in a creek on the NSW North Coast. This was blamed by some local residents on the sewage treatment works which border the creek immediately upstream of the dead fish. Authorities stated that the sewerage plant was operating properly and that the fish deaths were a natural occurrence.

(a) Outline a procedure for sampling the creek water to detect any contamination from the sewerage plant, including safety precautions. **2**

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(b) Identify TWO chemical tests you would perform on your water samples and the expected results if discharge from the sewerage plant had entered the waterway. **2**

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Question 25 (4 marks)

Ammonium sulfate is often used as a lawn fertiliser.
A package is labelled "more than 90%" ammonium sulfate.
Describe a first-hand investigation you have performed which could be used to verify the labelling on this package. Identify safety measures taken during your investigation. **4**

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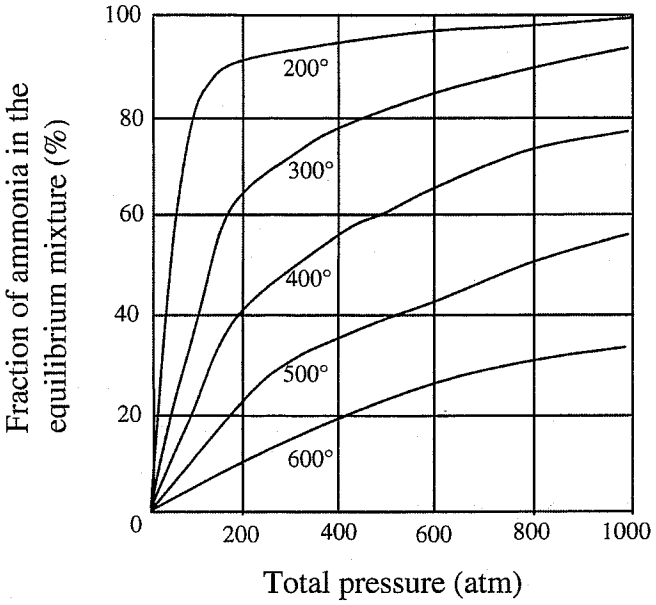
STUDENT NUMBER/NAME: .....

Question 26 (4 marks) **Marks**

The graph below shows the fractions of ammonia present at equilibrium when nitrogen and hydrogen are reacted in a pressure vessel.



(a) Construct a graph showing how the yield of ammonia varies with temperature, at a total pressure of 400 atm. **2**

(b) Referring to the energy of the reaction, explain the trend shown by the graph. **1**

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(c) Identify ONE industrial use of ammonia. **1**

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End of Section I

STUDENT NUMBER/NAME: .....

Section II

Total marks (25)

Attempt ONE question from Questions 27 – 31
Allow about 45 minutes for this part

Answer the question on your own paper or writing booklet, if provided.

STUDENT NUMBER/NAME: .....

Question 27 – Industrial Chemistry (25 marks) **Marks**

(a) Describe equilibrium reactions. **4**

(b) (i) Identify THREE uses of sulfuric acid in industry. **3**

(ii) Describe ONE use of sulfuric acid identified above. **2**

(c) Explain ONE electrolysis method used to produce sodium hydroxide. **3**

(d) Distinguish between anionic, cationic and non-ionic detergents. **5**

(e) (i) What is the solvay process used to produce. **1**

(ii) Identify the raw materials used in the solvay process. **3**

(f) Describe saponification **4**

End of Question 27

STUDENT NUMBER/NAME: .....

Question 28 – Shipwrecks, Corrosion and Conservation (25 marks) **Marks**

(a) The ocean is a strong electrolyte of aqueous ions formed from the dissociation of dissolved salts. Sea water contains approximately 35 grams of dissolved minerals per litre of water.

Outline the origins of the minerals in oceans. **4**

(b) The notation below represents an electron transfer reaction conducted in an electrochemical cell.

$Ag(s) / Ag^{+}(aq) // Cu^{2+}(aq) / Cu(s)$

(i) Using the list of standard potentials, predict which metal will corrode. **1**

(ii) Write the net ionic equation for the above electrochemical cell and calculate the expected voltage of the cell under standard conditions. **2**

(iii) Identify ONE observation at the Anode and ONE at the Cathode, that you would see as electrolysis occurred over a period of time. **2**

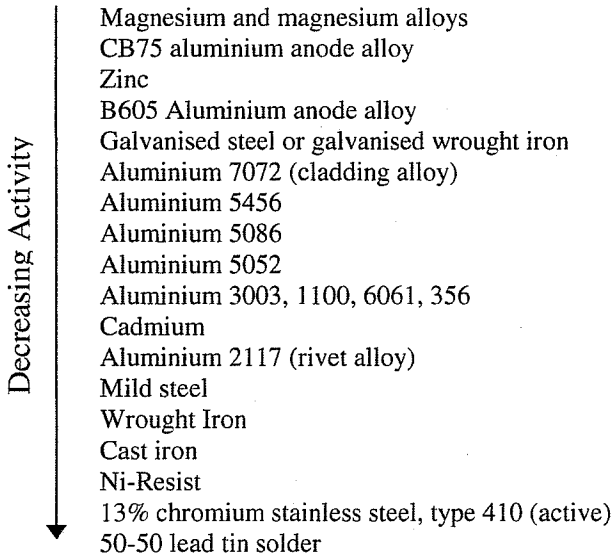
(c) Steel is an alloy of various metals and nonmetals. The properties of steel depend on the elements used and the percentage of each element in the steel.

(i) Contrast the composition and properties of THREE types of steel. **3**

(ii) The most common and economically destructive form of corrosion is the rusting of iron and steel.

Describe the conditions under which rusting occurs and explain the process of rusting. **4**

(d) The List below shows the decreasing order of activity of some metals used in ships that will sail in salt water.



Explain why solder is not used to join aluminium sheets to make boats. **3**

Question 28 continues on the next page

Question 28 (continued) **Marks**

(e) Many scientists contributed to the current understanding of electrochemistry. In 1800 Alessandro Volta showed a vertical pile of dissimilar metal discs separated from each other with cardboard soaked in salty water produced an electric current.

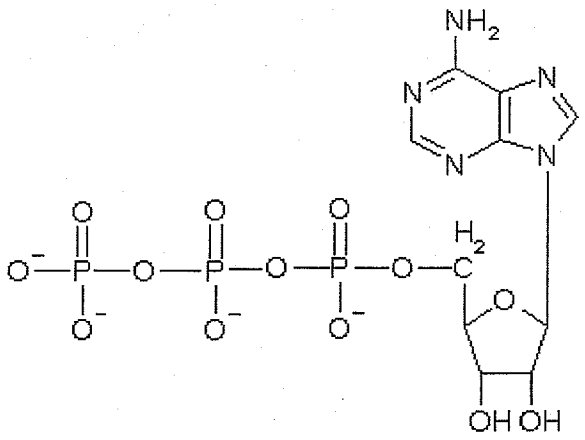
Analyse the impact of Sir Humphry Davy's (1778-1829) work on our understanding of electron transfer reactions. **6**

End of Question 28

Question 29 – Biochemistry of Movement (25 marks) **Marks**

(a) (i) Identify the general formula of an amino acid. **1**

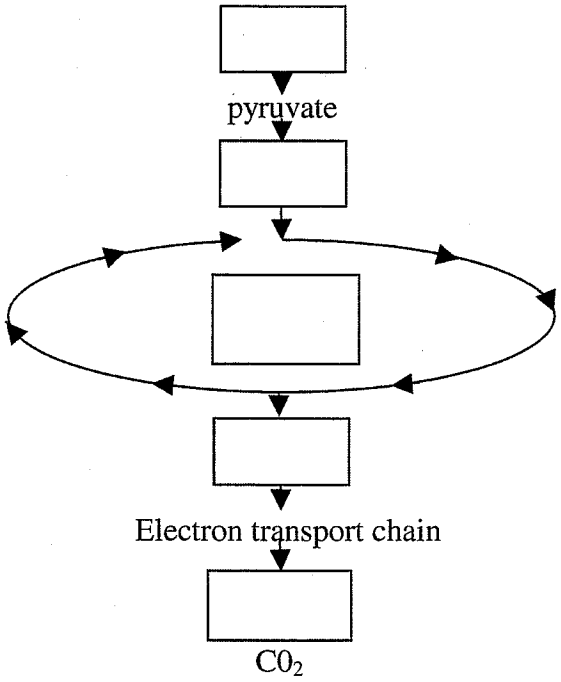
(ii) Outline the factors that may affect the shape of a protein. **4**



(b) (i) Identify the compound shown above. **1**

(ii) Identify the biologically important part of the compound. **1**

(c) Copy the following flow chart onto your writing paper before completing this question.



Complete the flow chart representing the process of respiration. **5**

(d) Define the term *enzyme.* **1**

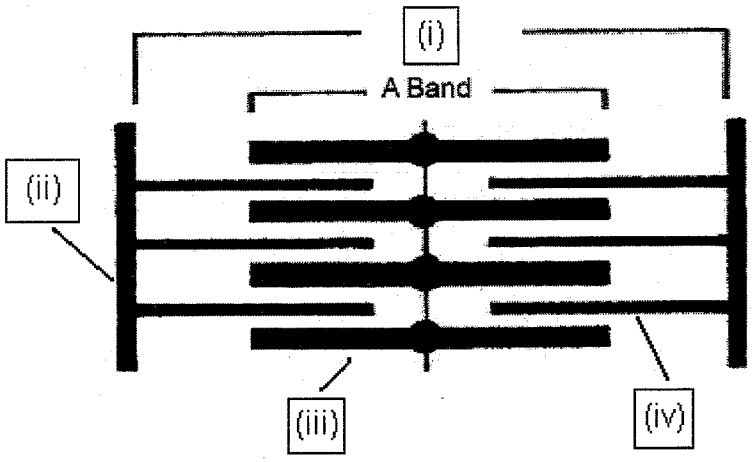
(e) Discuss the effects of heat and pH on the activity of enzymes. Use a diagram to support your answer. **4**

Question 29 continues on the next page

Question 29 (continued) **Marks**

(f) Explain the mechanisms that make enzymes substrate specific **2**

(g) (i) For the diagram below representing the mechanism of muscle contraction, identify items (i) to (iv) on your writing paper. **4**



(ii) Outline the process which stimulates muscle cells to contract **2**

End of Question 29

STUDENT NUMBER/NAME: .....

Question 30 – Chemistry of Art (25 marks) **Marks**

(a) (i) Identify THREE early uses of pigment. **3**

(ii) For ONE of the uses identified above, outline the sources of pigment that may have been used. **4**

(b) Assess the health risks associated with the use of early pigments. **5**

(c) (i) Copy and complete the table below. **6**

Ion	Flame Colour
Na^+	
	Lilac/purple
Ca^{2+}	
	Pale green
Sr^{2+}	
Cu^{2+}	

(ii) Explain why the ions emit light when heated. **2**

(d) (i) Define the term *transitional metal.* **1**

(ii) Explain why transitional metal ions change colour when there is a change in the oxidation state **2**

(e) (i) Define the term *chelated ligand.* **1**

(ii) Give ONE example of a chelated ligand. **1**

End of Question 30

Question 31 – Forensic Chemistry (25 marks) **Marks**

(a) Consider the structures of the compounds shown below

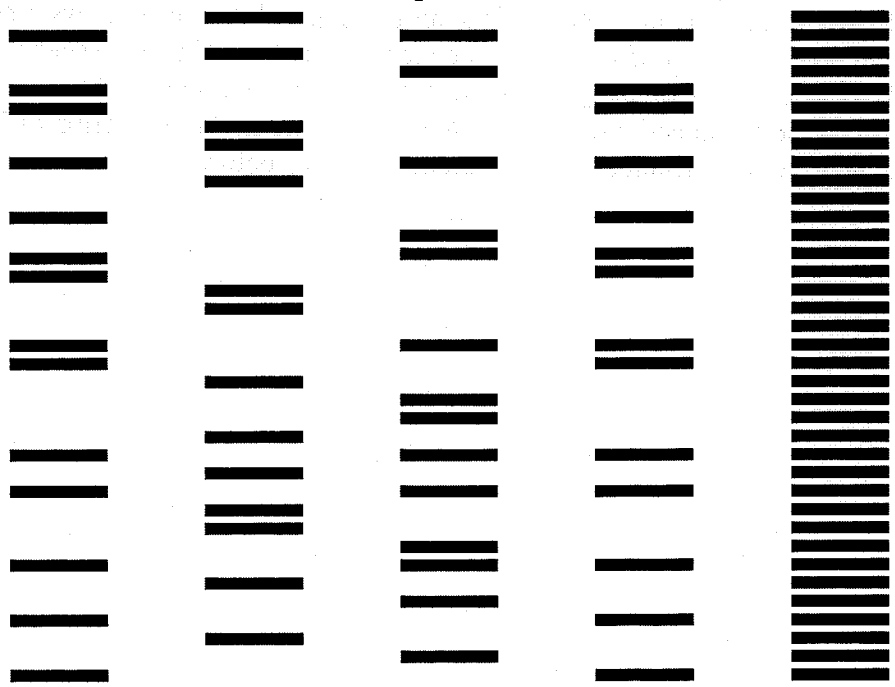
Compound 1 $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - OH$

Compound 2 $CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - \overset{\overset{O}{\|}}{C} - OH$

Compound 3 $CH_3 - CH_2 - CH_2 - CH = CH - CH_3$

Describe how you could distinguish between these compounds using chemical tests in the school laboratory. **3**

(b) An Australian court of law was presented with some DNA evidence. This evidence compared the DNA fingerprint of the defendant to those of a number of blood samples found at the scene of the crime. A small part of this evidence is given below.



The prosecution claimed that this DNA evidence showed

- blood sample 1 came from a person unrelated to the defendant
- blood sample 2 came from a close family relative of the defendant
- blood sample 3 came from the defendant

Assess the validity & reliability of the claims made by the prosecution. **5**

Question 31 continues on the next page

Question 31 (continued) **Marks**

(c) A person is under investigation for committing a certain crime.
A small sample of soil was found on a pair of boots in the suspect's car.
This soil was analysed using emission spectroscopy and found to match the soil at the scene of the crime.

(i) Outline how emission spectra is formed. **2**

(ii) Explain how analysis of this soil using emission spectroscopy could help in the solving of this crime. **4**

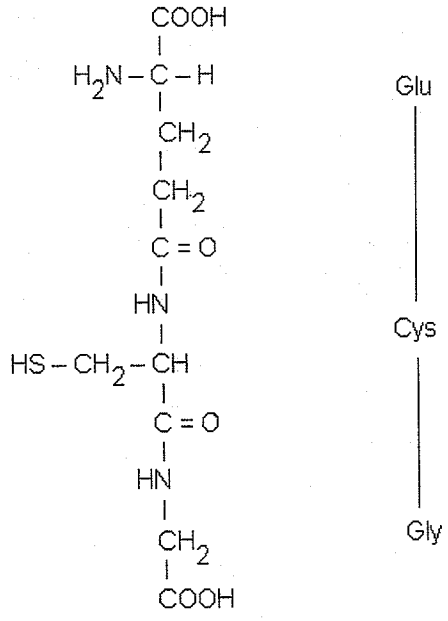
(d) Starch is an example of a *polysaccharide*.

(i) Explain why starch is considered to be a polysaccharide. **1**

(ii) Describe a chemical test that can be used to identify the presence of starch. **2**

(iii) Glycogen and cellulose are two other examples of polysaccharides. Explain how analysis can identify whether a carbohydrate sample has plant or animal origins. **3**

(e) Glutathione is a tripeptide made of the amino acids glutamic acid, cysteine and glycine (Glu – Cys – Gly) joined together in sequence. It is found in the tissues of higher animals where it plays many important roles i.e. in the amino acid transport system within the body, an activator of certain enzymes and in the protection of lipids against autoxidation. The structure of glutathione is shown below.



(i) On the structure of glutathione shown, circle a peptide bond **1**

(ii) Use the information in the structure above to draw the structure of cysteine. **1**

(iii) At pH 11 cysteine and glycine exist as singly charged (negative) ions. Outline how electrophoresis could be used to separate a mixture of these two amino acids. **3**

End of Question 31