

--	--	--	--	--

Centre Number

--	--	--	--	--	--	--	--	--	--	--	--

Student Number



51
33

CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NEW SOUTH WALES

2003
TRIAL HIGHER SCHOOL CERTIFICATE
EXAMINATION

Chemistry

Afternoon Session
Friday 8 August 2003

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Board-approved calculators may be used
- Draw diagrams using pencil
- Use Multiple Choice Answer Sheet provided
- Write your answers for Part B in the spaces provided
- A Data Sheet and Periodic Table are provided separately

Total marks – 100

Section I Pages 3–15

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 17–24

25 marks

- Attempt ONE question from Questions 28–32
- Allow about 45 minutes for this section

Disclaimer

Every effort has been made to prepare these 'Trial' Higher School Certificate Examinations in accordance with the Board of Studies documents, *Principles for Setting HSC Examinations in a Standards-Referenced Framework* (BOS Bulletin, Vol 8, No 9, Nov/Dec 1999), and *Principles for Developing Marking Guidelines Examinations in a Standards Referenced Framework* (BOS Bulletin, Vol 9, No 3, May 2000). No guarantee or warranty is made or implied that the 'Trial' Examination papers mirror in every respect the actual HSC Examination question paper in any or all courses to be examined. These papers do not constitute 'advice' nor can they be construed as authoritative interpretations of Board of Studies intentions. The CSSA accepts no liability for any reliance use or purpose related to these 'Trial' question papers. Advice on HSC examination issues is only to be obtained from the NSW Board of Studies.

Section I

Total marks – 75 marks

Part A

15 marks

Attempt Questions 1–15

Allow about 30 minutes for this part

Use the Multiple Choice Answer Sheet provided

- 1 Which of the following reagents could be used to distinguish between hexane and 1-hexene?
 - (A) Universal indicator
 - (B) Sodium bromide solution
 - (C) Sodium hydroxide solution
 - (D) Bromine water

- 2 Which of the following lists contains metals which will all displace lead from a solution of lead (II) nitrate?
 - (A) Copper, silver, zinc
 - (B) Zinc, magnesium, copper
 - (C) Silver, iron, zinc
 - (D) Iron, zinc, magnesium

- 3 A patient with a suspected liver disorder is to be injected with a radioisotope. The radioisotope will enter the bloodstream and accumulate in the liver. The radiation it emits will be measured by an instrument outside the patient's body, and be used to assess the health of the liver.

Which of the following properties of a radioisotope would make it suitable for such an application?

	Half-life	Type of emission
(A)	7.5 hours	alpha and gamma
(B)	3.2 minutes	gamma only
(C)	6 hours	gamma only
(D)	5,400 years	beta and gamma

- 4 A half cell made by immersing a metal, X, in a 1 mol.L^{-1} solution of X sulfate is connected to a silver half cell under standard conditions. The maximum cell potential produced when the half-cells are connected is 1.24V, the silver electrode being positive with respect to X.

From this information, metal X could be:

- (A) zinc
- (B) iron
- (C) copper
- (D) barium

- 5 The heat of combustion of ethanol is 1360 kJ/mol. Approximately how much energy would be produced theoretically by the complete combustion of 11.5 g of ethanol?

- (A) 118 kJ
- (B) 340 kJ
- (C) 521 kJ
- (D) 5440 kJ

- 6 Which of the following substances is acidic?

- (A) Orange juice
- (B) Ammonia
- (C) Laundry detergents
- (D) Distilled water

- 7 Identify the CORRECT statement about oxides.

- (A) Metals tend to form acidic oxides
- (B) Magnesium oxide is an acidic oxide
- (C) Basic oxides neutralise basic solutions
- (D) Non-metals tend to form acidic oxides

- 8 Select the row which matches the compounds with the correct boiling points.

	Propanoic acid ($^{\circ}\text{C}$)	Propane ($^{\circ}\text{C}$)	1-Propanol ($^{\circ}\text{C}$)
(A)	141	-42	97
(B)	99	-42	97
(C)	141	97	-42
(D)	141	139	-42

- 9 10.0g of calcium carbonate was reacted with 50 mL of 1.00 mol L^{-1} hydrochloric acid.

Calculate the volume of carbon dioxide produced at 25°C and 100kPa.

- (A) 2.48 L
- (B) 2.27 L
- (C) 0.62 L
- (D) 0.57 L

- 10 A student uses a pH meter to obtain the pH for solutions of sodium hydroxide and sodium carbonate. The pH reading for each solution is 10.2.

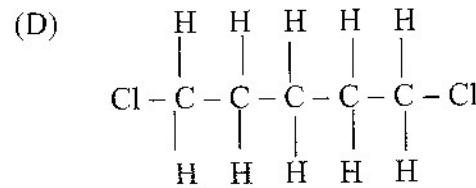
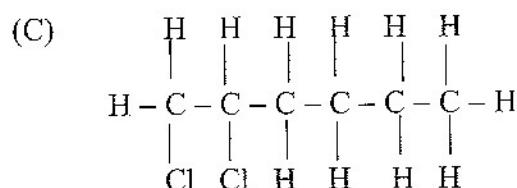
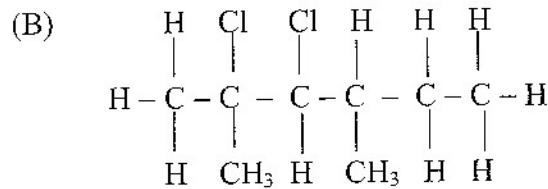
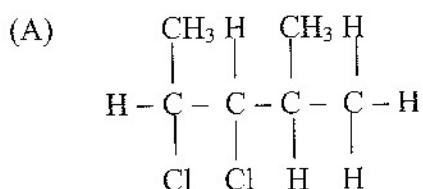
The student can correctly conclude that:

- (A) both solutions are weak bases
- (B) each solution has the same concentration
- (C) only the sodium hydroxide contains OH^- ions
- (D) both solutions have an $[\text{H}_3\text{O}^+]$ of $10^{-10.2}$

- 11 Identify the most common method for measuring the concentration of metal ions in water samples.

- (A) Measuring the amount of light scattered by the water sample
- (B) Using gravimetric analysis after filtering the water.
- (C) Analyzing a sample using an Atomic Absorption Spectrometer.
- (D) Precipitation of the metal salt by adding a solution of another salt.

12 Identify an **isomer** of 1,2-dichlorohexane.



13 The equation below represents the important industrial process for the production of ammonia.



The information in this equation allows chemists to predict that the reaction for the production of ammonia will:

- (A) occur rapidly and spontaneously
- (B) be an exothermic reaction
- (C) require a special catalyst in order to proceed
- (D) be an endothermic reaction

14 Microscopic membrane filters

- (A) only remove suspended solids
- (B) are used after chemical treatment of water
- (C) have very small pores so the filtration rate is very slow
- (D) have a large surface area so the filtration rate is high

15 Identify the species that contains a coordinate covalent bond:

- (A) CO_2
- (B) NH_4^+
- (C) NH_3
- (D) NH_2^-

Section I

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.

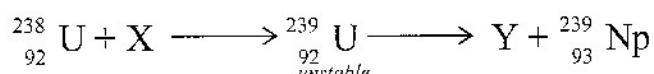
Question 16 (4 marks)

Marks

Elements with an atomic number greater than 92 do not occur naturally on earth, but small amounts of the elements have been synthesised by scientists.

Neptunium was first synthesised and isolated by American scientists in 1940.

The incomplete nuclear equation describing the reaction that produced a sample of Neptunium is shown below.



- (a) Identify particle X in the above equation.

1

.....~~a neutron~~.....

- (b) Outline the process by which a more recently discovered element has been synthesised and account for the fact that large samples of the element have generally been unable to be isolated.

3

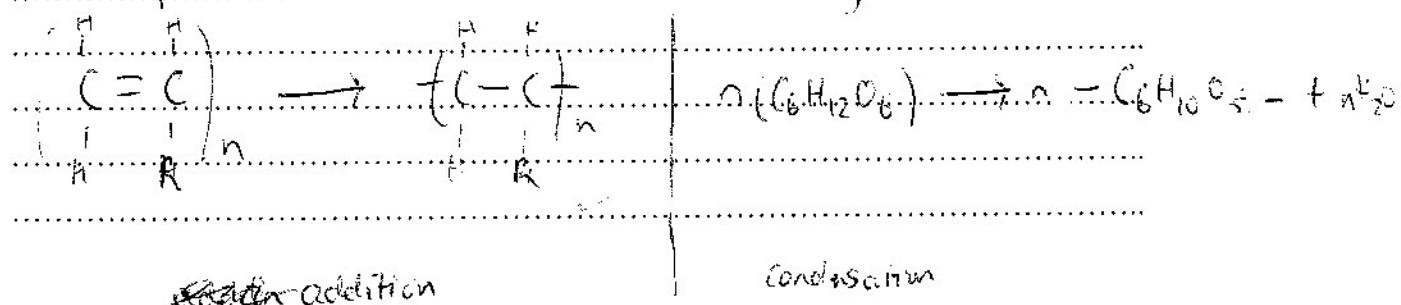
A more recently discovered element has been synthesised ~~been~~ by
in a nuclear reactor or cyclotron. These equipment ~~can~~ bombard
elements with neutrons to produce radioactive elements.....
Such example include a recently discovered element Ununnilium.
This has been synthesised by bombarding elements such as.....
lead and Nickel. Ununnilium has atomic number 110 and thus
can be bombarded with lead (atomic number 82) and Nickel (atomic number 28)
as they add up to 110.

Question 17 (5 marks)**Marks**

Compare the type of reactions that occur to produce polyethylene and cellulose. Include relevant formulae and equations to assist in your answer.

5

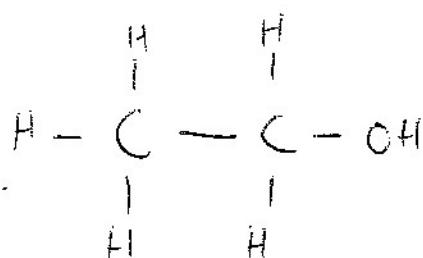
The type of reactions that occurs to produce polyethylene is addition reaction, while producing cellulose uses condensation reactions. The difference is that addition involves 2 unsaturated monomers with double bonds that split open and join to form one single polymer. No molecules have been lost. In condensation, 2 different functional group monomers join together but in the process ~~is~~ have molecules eliminated, usually water:

**Question 18 (4 marks)**

Ethanol is used as a fuel extender. Recently, there has been a call from the NRMA to have levels of ethanol added to petrol displayed at the point of sale.

- (a) Draw the structural formula for ethanol.

1



- (b) Identify and explain implications of the use of ethanol as a fuel extender.

3

Ethanol used as a fuel extender has its implications. The disadvantages include the high cost to produce, in that clearly large areas of land to grow sugar canes and the high cost of distilling. Another disadvantage is the presence of water which could cause corrosion to the engine, as well as cars requiring tuning before ethanol can be used in large amounts. The advantages include its 3 greenhouse gases and its renewable.

It's clear that the disadvantages outweigh the advantages and thus cannot be used that well. As a fuel extender its capabilities is good if the car engine can be properly tuned as ethanol provides a clean burn and doesn't produce soot.

Question 19 (7 marks)**Marks**

A student was asked to choose accessible equipment that would be suitable for carrying out an investigation involving the fermentation of glucose. The mass change in the fermentation vessel would be monitored.

The student was given a list of specifications for the investigation, as shown below:

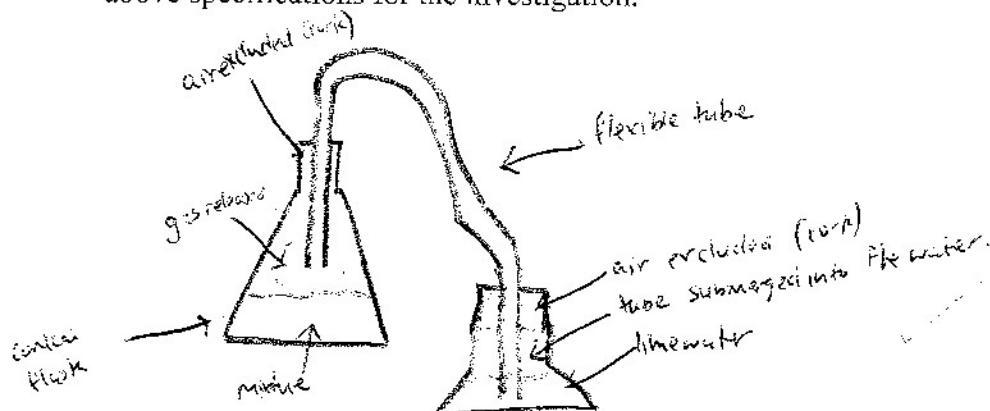
Investigation specifications

- 50 g of glucose powder is allowed to undergo fermentation in the presence of yeast.
- Air should be excluded from the vessel in which fermentation occurs.
- The gas produced in the reaction is to be trapped and passed through a suitable reagent to determine if it is carbon dioxide.

- (a) Identify the piece of equipment needed to collect data for this investigation. 1

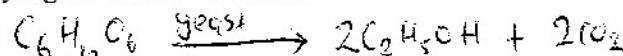
..... electronic scale

- (b) Make a neat, labelled diagram of the assembled equipment that would meet the above specifications for the investigation. 3



- (c) After 1 day the mass of the fermentation vessel had decreased by 15.0 g. 3

Calculate the theoretical volume of carbon dioxide gas produced if the reaction was carried out at 25 °C and 100 kPa, and state the assumption you made in carrying out the calculation.



$$15\text{g} = \text{CO}_2$$

$$n = \frac{15}{44}$$

$$\approx 0.34$$

$$n = \frac{m}{M}$$

$$n \times M = V \times P$$

$$0.34 \times 24.79 = V$$

$$V = 8.45 \text{ L}$$

The assumption made in carrying out the calculation is

8.45 L was ¹⁰ Carbon dioxide and 35 g is ethanol.

Question 22 (6 marks)

Marks

- (a) Outline Davy's idea about acids. 1

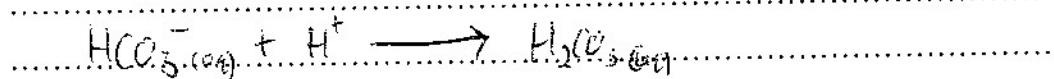
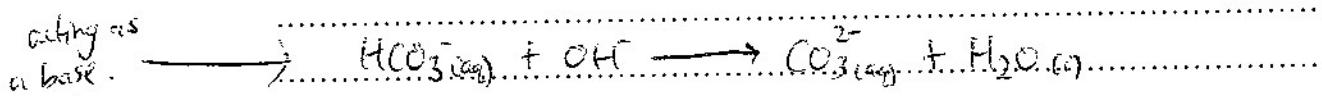
Davy's idea about acids is that all acids contained hydrogen.

- (b) Explain how the Bronsted-Lowry theory of acids and bases was an improvement on earlier ideas. 2

The Bronsted-Lowry theory of acids and bases said that acids were proton donors and bases were proton acceptors. This was an improvement on earlier ideas as it was a more general theory and was true for all acids and bases.

- (c) Define the term - amphiprotic and use equations to describe the behaviour of an amphiprotic substance in acidic and basic solutions. 3

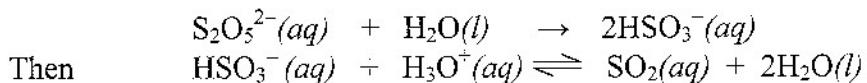
Amphiprotic means it can act as either an acid or a base such as HCO_3^- .



acting as
an acid

Question 23 (4 marks) Marks

Potassium metabisulfite, $K_2S_2O_5$, is added to wine to prevent oxidation. It works by reacting with water and the acids in wine as follows –



Use the above equations to explain how the addition of metabisulphite affects the pH of the ‘wine’.

From the first equation, $\text{S}_2\text{O}_5^{2-}(aq) + \text{H}_2\text{O}(l) \rightarrow 2\text{HSO}_3^-(aq)$ it shows an one way reaction that produces HSO_3^- . In the second equation, $\text{HSO}_3^-(aq) + \text{H}_3\text{O}^+(aq) \rightleftharpoons \text{SO}_2(aq) + 2\text{H}_2\text{O}(l)$ is an equilibrium reaction. From the first equation, it shows HSO_3^- being produced and thus the HSO_3^- in the second equation has been increased. From Le Chatelier's principle, the equilibrium will shift to the right and as a result the H_3O^+ will decrease. As a result the pH goes higher and thus so does the wine. This shows that the addition of metabisulphite will cause the wine's pH to go higher.

Question 24 (4 marks)

- (a) Identify a branch of chemistry.

1

Research and development

- (b) Identify and explain a chemical principle used in this branch of chemistry.

3

A chemical principle used is the law of conservation of energy. In that energy cannot be created or destroyed. The use of this is to use basic ideas and research and develop them to make better products such as drugs, medicine, paints or improve on existing products to make them more efficient or healthier.

Question 25 (5 marks)**Marks**

One method used to determine the sulfate content of lawn fertiliser is to add barium chloride and measure the mass of precipitate formed.

- (a) Identify the name of the precipitate that is formed. 1

.....Barium Sulfate.....
.....Barium Sulfate.....

- (b) Discuss some precautions that should be taken to minimise errors and improve the reliability of this method. 4

Some precautions that should be taken to minimise errors and improve the reliability of this method is to:

.....1) Use multiple layers of filter paper because sulfate is extremely small and very hard to filter all of it which could lead to measurement.

.....2) Heat the mixture for a long time so filtering is made significantly easier.

.....3) Use a ~~coaster~~ ^{more} to filter the mixture ~~more~~ properly.
~~coaster~~
Scienterfilter.

Question 26 (4 marks)

Identify TWO common indicators of water quality that would be most useful in monitoring waste water from a fruit cannery. Justify your choices. 4

Two common indicators of water quality that would be most useful in monitoring waste water from a fruit cannery is the BOD (biochemical oxygen demand) and DO (dissolved oxygen). BOD is measuring the stability for bacteria to break up waste in the water which is a useful indicator of monitoring waste water. DO is the measurement of dissolved oxygen in the water. This is important as the oxygen helps in the breakdown of waste in water and high levels of oxygen is better. These 2 methods allow identification of the quality of the water from a fruit cannery.

The DO can be measured using a DO meter or Winkler method. The BOD can be measured by exposing light in a room for 5 days and subtracting the result from the original.

Question 27 (7 marks)**Marks**

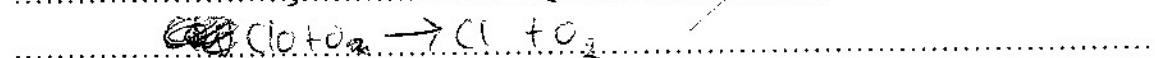
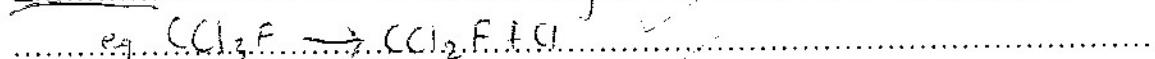
Discuss problems associated with the uses of CFC's, analyse their effects on the atmosphere using appropriate chemical equations, and evaluate the effectiveness of the steps taken to relieve this problem.

7

Problems associated with CFC's include:

- They are insoluble in water, so they don't mix with the rain.
- They cause ~~holes~~ in the ozone layer.

Effects: One Cl atom can destroy thousands of ozone.



This equation shows the indefinite repetition of the cycle when CFC's are released into the atmosphere.

- the destruction of ozone allows UV rays to pass into earth and harm living things.
- It takes many years for the layer to be healed.

Effectiveness of steps taken: Montreal protocol introduced which was to completely stop the use of CFC's

- Alternatives such as HCFC's used
- Assistance & removal of CFC's in poorer countries
- Increase awareness and development of better sunscreens

Effectiveness of these steps: the effectiveness relies on ~~the~~ global co-operation of the people and countries to reduce use of CFC's. The Montreal protocol was the first effectively step taken to ~~not~~ stop all use of CFC's.

A better sunscreen will result in better protection for ~~the~~.

The already damaged ozone layer and the increased UV light that passes through the layer and ~~onto~~ earth

Evaluation: CFC's are very destructive to the atmosphere. They were used in propellants and fridges which are a necessity for the modern society. The problem that result in substantial and alternatives needed to be taken. It's known that one single Cl atom is very reactive and is capable of destroying thousands of O₃. Ozone is a need to the earth as it shields harmful rays such as UV from the lower altitudes which is why these problems had to be solved by the co-operation of the world in stopping CFC's. These steps taken are effective but the already damaged ozone layer requires research into better sunscreens until it starts healing itself.

Question 28 – Industrial Chemistry (25 marks)**Marks**

- (a) (i) Identify ONE property of sulfur that allows it to be extracted from underground mineral deposits. 1
- (ii) Describe the processes involved in the extraction of sulfur from underground mineral deposits. 2
- (b) (i) Write a balanced full formulae equation, including states, for the production of sodium hydroxide from sodium chloride. 2
- (ii) The diaphragm process is one electrolysis method used to extract sodium hydroxide. 4
- Describe the diaphragm process and explain why this process is being phased out of use in industry.
- (c) During your practical work you performed a first-hand investigation to gather information about the properties of a named emulsion. 2
- (i) Identify the emulsion and outline the procedure used. 2
- (ii) Describe the properties of the emulsion and relate these to its use. 3
- (d) The Haber process involves the reaction of nitrogen and hydrogen under equilibrium conditions to form ammonia. 6

	[N ₂] (mol L ⁻¹)	[H ₂] (mol L ⁻¹)	[NH ₃] (mol L ⁻¹)
Before equilibrium	0.20	0.60	0
At equilibrium			0.10

- (i) Write an expression for the equilibrium constant, K, for this reaction. 2
- (ii) Calculate the equilibrium constant, K, for this reaction. Show relevant working. 3
- (e) Discuss environmental issues associated with the Solvay process and explain how these issues are addressed. 6

End of Question 28

Question 29 – Shipwrecks, Corrosion and Conservation (25 marks)		Marks
(a) (i)	Identify the scientist who developed the Laws of Electrolysis.	1
	Describe Davy's contribution to our understanding of electron transfer reactions.	2
(b) (i)	Identify the main metal present in steel.	1
(ii)	Distinguish between active and passivating metals.	2
(iii)	Identify ONE type of steel and explain how its composition determines its properties and uses.	3
(c) (i)	Outline the method you used to determine how ONE named factor affected an electrolysis reaction.	2
(ii)	Justify the method you used in (c) (i).	3
(d) (i)	Identify AT LEAST THREE factors that affect the corrosion rate of a metal wreck as the ocean depth increases.	2
(ii)	Choose ONE factor identified in (d) (i) and explain how this affects the corrosion rate of a metal wreck as the ocean depth increases.	3
(e)	Identify and evaluate ways in which ocean-going vessels may be protected from corrosion.	6

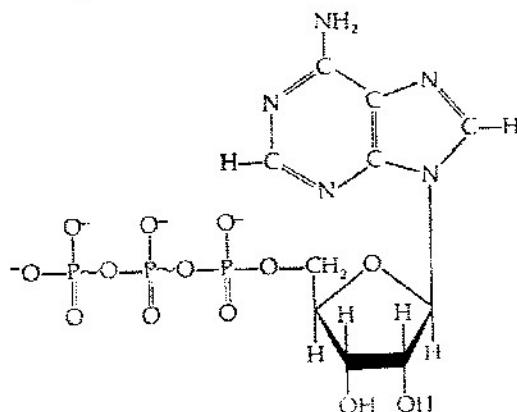
End of Question 29

Question 30 – The Biochemistry of Movement (25 marks)

Marks

- (a) (i) Identify the substance whose structure is shown below.

1



- (ii) Account for the biological importance of this substance, clearly indicating the relevant bonds.

2

- (b) Athletes who “hit the wall” have used up most of their store of glycogen, but may still carry stores of fat in their body. To overcome this problem some athletes “carbohydrate load” the day before an event, eating large amounts of pasta, potatoes or rice.

- (i) Describe how glycogen is stored in the body.

1

- (ii) Fats are compounds formed from the bonding of glycerol and fatty acids. Draw the graphic formula for glycerol and give its systematic name.

2

- (iii) Identify and explain whether carbohydrate loading is more likely to improve the performance of an athlete than eating a lot of fatty foods the day before an event.

3

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

- (i) Identifying by name the enzyme you used, describe the experimental procedure you used for this investigation.

2

- (ii) Describe the results you obtained and use these results to identify what may have happened to the enzyme being investigated.

3

Question 30 continued on page 21

Question 30 continued	Marks
1. Name the special protein fibres that form the contractile elements in skeletal muscle.	1
2. Describe briefly how a muscle cell contracts when a nerve impulse activates the muscle cell membrane, identifying the necessary substances involved.	4
3. Discuss the problems encountered by a fast moving sprinter, relating these problems to the relevant parts of the respiratory cycle. Include relevant equations in your answer.	6

End of Question 30

Question 31 – The Chemistry of Art (25 marks)**Marks**

- (a) (i) Identify the ligand present in all hydrated complex ions. 1
- (ii) Both boron and nitrogen form molecular compounds with hydrogen. The formulae of the molecules formed are BH_3 and NH_3 respectively. 2
- Explain why a molecule of ammonia (NH_3) can act as a ligand yet a molecule of boron trihydride (BH_3) cannot.
- (b) (i) Identify the scientist who proposed an atomic model which included the presence of electrons in principal energy levels. 1
- (ii) Distinguish between the terms emission spectra and absorption spectra. 2
- (iii) Explain how careful observation of the spectra of elements both supported and hindered the complete acceptance of the atomic model described in (i) above. 3
- (c) (i) Outline the method you used to gather information about the colour changes that occur as a result of changes in the oxidation state of a named transition metal. 2
- (ii) Describe the results of the investigation and account for the colour changes observed by including relevant chemical equations. 3
- (d) The first ionisation energies of six consecutive elements in the Periodic Table are shown in the table below. The actual names of the elements have been replaced by letters A-F.

Element Letter	A	B	C	D	E	F
First Ionisation Energy (kJmol^{-1})	1310	1680	2080	494	736	577

- (i) State the electron configuration, in terms of shells and subshells, for the element magnesium. 1
- (ii) One of the elements (A-F) above is magnesium. Identify the letter of this element and justify your selection. 2
- (iii) Identify the element (A-F) which you would expect to have the highest electronegativity. Explain why the element has the highest electronegativity of this group of elements. 2

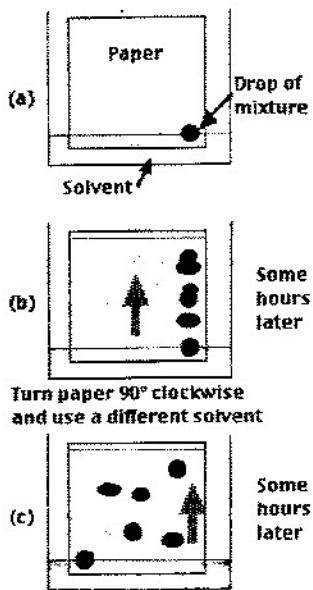
Question 31 continued on page 23

Question 31 (continued)	Marks
(e) Discuss the impact of minerals containing transition metals in the decoration of the environment and the people of TWO named early cultures (Aborigines and ancient Egyptians OR Romans).	6

End of Question 31

Question 32 – Forensic Chemistry (25 marks)**Marks**

- (a) (i) Identify BOTH functional groups of an amino acid. 1
- (ii) Describe the arrangement of amino acids in proteins. 2
- (b) (i) Account for the use of DNA analysis to identify relationships between people. 2
- (ii) Describe the processes used to analyse DNA. 4
- (c) During your practical work you performed a first-hand investigation to distinguish between different types of carbohydrates.
- (i) Outline the procedure used to identify a reducing sugar. 2
- (ii) Explain the chemical basis of the reaction outlined in part (i). 3
- (d) A student separated components of a mixture as follows:



- (i) Explain the basis of the separation shown in step (b). 2
- (ii) Explain why step (c) was performed. 3
- (e) Discuss how the development of a sensitive analytical technique has impacted on forensic investigations. Describe the chemical basis of the technique. 6

End of Question 32**End of paper**